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REDUCING CONTAMINATION OF HOUSEHOLD RECYCLING

A Rapid Evidence and Practice Review for Behavioural Public Policy

An output of the
Waste and Circular Economy Collaboration

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REDUCING CONTAMINATION OF HOUSEHOLD RECYCLING: A RAPID EVIDENCE AND PRACTICE REVIEW FOR BEHAVIOURAL PUBLIC POLICY

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EXECUTIVE SUMMARY

BEHAVIOURWORKS AUSTRALIA WAS ENGAGED BY THE AUSTRALIAN GOVERNMENT DEPARTMENT OF AGRICULTURE, WATER AND ENVIRONMENT TO CONDUCT A RAPID EVIDENCE REVIEW ON HOUSEHOLD RECYCLING BEHAVIOURS.

This review supports the implementation of the 2018 National Waste Policy: Less Waste, More Resources. It summarises and evaluates published literature and practitioner reflections on the effectiveness of interventions for reducing contamination and encouraging correct recycling at a household level, from a behavioural insights perspective *[1].

Background

Co-mingled recycling has taken place in Australia since the 1980s. It is characterised by a diversity of scheme characteristics across regions of Australia, multiple actors and a strong reliance on public-private arrangements to collect, sort and process recycled materials.

Changes in global and domestic policy, markets and media coverage disrupted the regime in 2018 and highlighted the significance and expected benefits of reducing contamination.

However, interviews with waste educators and broader literature highlighted that defining exactly what 'a contaminant' is in household recycling is complicated. It is influenced by the broader policy settings and economic context, and how a given item interacts with the technological and logistical capabilities of the particular collection scheme.

Reducing contamination is thus an outcome, not a single behaviour. Numerous different items and behaviours may be problematic, or desirable, in any given recycling scheme across Australia or elsewhere. Correct sorting of items for kerbside recycling is a relevant target behaviour at a very general level, but so is a range of preferred behaviours for problematic items; for example, avoiding or reducing a wide range of possible contaminants, cleaning food packaging, separating lids (or leaving them on), or collecting and delivering soft plastics to an appropriate destination. The desired outcome 'correct recycling' or 'no contamination' may depend on literally dozens of preferred behaviours to incorrect sorting, and/or avoiding, or storing and delivering problematic items elsewhere, which varies across different localities.

Reviewing the evidence

Rapid evidence reviews focus on identifying systematic reviews; in this case, of interventions targeting relevant behaviours for correct recycling and reduced contamination outcomes.

A comprehensive search yielded 1,306 citations. The total yield was screened to 137 papers, with two systematic and six narrative reviews included as the primary sources for this document.

Noting that there is only limited translation across research, policy and practice in this field, we also interviewed 17 waste educators and communicators to understand their beliefs about what works and why, what types of programs and interventions are in use, and what they know about their effectiveness, plus how all these elements are affected by their local context.

[1]Behavioural insights (BI) is an approach to policymaking that builds on lessons derived from the behavioural and social sciences. Behaviourally-informed public policy is distinguished from traditional public policy making by (1) taking an inductive approach that is driven by experimentation and piloting, and (2) use of social science theoretical underpinnings. BI then challenges established assumptions of what is thought to be rational behaviour of citizens and businesses and uses these findings to inform policies and regulation.

Policy and management findings

The key findings of most relevance to recycling managers and policymakers are:

- Behaviourally focused communications will improve most recycling outcomes where preferred recycling behaviours are already as simple, easy and consistent as possible. Making preferred behaviours more consistent and easier across regions would help reduce contamination.
- Effective, behaviourally focused communications need to be tailored to the specific characteristics of schemes, populations, behaviours and intended outcomes. Recycling behaviours are affected by a wide range of contextual characteristics. Tailoring interventions reduces unintended outcomes.
- It is not easy for users to identify the 'right thing' to do. Australian recycling schemes typically involve a mix of local government and private collectors, sorters, and processors. Product and packaging designers and retailers have varying levels of engagement and interest in the end stages of their items and can't be assumed to be communicating with those managing recycling and waste. Any and all of these players may be communicating their preferred recycling behaviours and other information differently.
- Schemes are not necessarily designed to optimise correct recycling. Cost, logistics, commercial considerations, worker safety and other characteristics all potentially have equal or greater weight for many actors when making choices about how things work.
- There is a relative lack of, and strong need for, systematic knowledge in both research and practice of evidence-informed, robust and well evaluated interventions, that can be scaled to whole recycling schemes and, especially, across recycling schemes. Little is known about effectiveness, and even less about cost effectiveness.
- Given the above points, investing in generalisable trials, with a dual focus on finding what works, while supporting multi-stakeholder learning and adoption so it can be scaled, should be a priority. This includes improving interactions between users, waste educators and operators, but also brand owners, retailers and industry groups and co-regulatory bodies.
- Persuasive communication is more likely to promote desired behaviours if it is devolved to locality-specific messages about scheme characteristics and desired behaviours that can be kept consistent. Messages can then be tailored to the specifics of the relevant area, audience segments' behavioural drivers, and scheme characteristics.
- Conversely, cross regional and/or national mass communication and education could aim to create a supportive environment for local behaviour change efforts. For example, by raising awareness of the need for action, 'myth busting' (noting local variations), and channelling users to locally relevant information and education.
- Efforts at the cross regional scale to guide specific behaviour should be limited to those few behaviours, if any, that are universal across regions, otherwise they could lead to unintended and perverse outcomes. For example, encouraging behaviours that are impractical or inappropriate in particular areas, or do not dovetail with local efforts and scheme requirements.

"Cost, logistics, commercial considerations, worker safety and other characteristics all potentially have equal or greater weight for different actors."

Behavioural insights findings

Key findings for behavioural scientists supporting waste managers and policymakers are:

- All things being equal, favourable beliefs and preferences (environmental, social, and political) facilitate cooperation with waste goals. Contextual factors like limited space and time can constrain cooperation. Given that all things are not equal, understanding how such characteristics vary across a given population is important.
- Communication of scheme attributes, awareness raising, building perceptions of personal efficacy and norms can all stimulate cooperation, but can interact in complex ways with audiences, scheme attributes and behaviours if not tailored and coherent. Given this insight, cross-regional communications, in particular, need to be done with care.
- Interventions aiming to improve the convenience and ease of preferred recycling behaviours are the most widely effective.
- Demonstration of recycling behaviours by identifiable role models (social modelling), personalised feedback and public commitments are also amongst the most widely effective interventions promoting preferred recycling behaviours, such as correct sorting. There is some evidence that providing tailored feedback cards, and disincentives (charging) for incorrect behaviour, reduces contamination, with feedback cards being more cost effective than disincentives.
- Because of the overall lack of evidence on both efficacy and cost efficiency, the complexity of waste-related behaviours and their context, and the likelihood of unintended consequences, progressive experimentation in developing interventions and programs is critical. This entails systematically progressing through problem definition, target audience and context insights, solution development, experimentation and field trials, including monitoring for unintended impacts.

Conclusions

The Rapid Review found strong grounds for a context-sensitive and progressively experimental approach to reducing contamination and improving household recycling. This includes effective communications and education that link local and cross-regional efforts, but these would need to be part of supporting an evidence-informed, user-centred and integrated approach to recycling and waste management systems as a whole, focused on consistently supporting preferred behaviours in a given geographic area. These behavioural considerations also need to be incorporated in overall scheme design, such as measures improving the overall ease and consistency of desired behaviours across schemes, where this is appropriate. The prospects of individual behaviour change are strongly limited by the overall system of production, consumption and managing end-of-life options in which they occur.

"The Rapid Review found strong grounds for a context-sensitive and progressively experimental approach to reducing contamination and improving household recycling."

Summary of evidence on effective interventions:

Table 1: Quick reference on effectiveness of intervention types, from published literature and practitioner interviews

Intervention types *(after Michie, Atkins & West, 2014)*	**Effectiveness** *(Green= works better)*		**Cost** *(Green = low)*
	Published	**Practitioner**	**Practitioner**
CONTEXT RESTRUCTURING – Changes to physical/social context in which the behaviour is performed			
Changing defaults, Priming, Prompts / cues			
ENABLEMENT – Removing external barriers to increase opportunities to carry out the behaviour			
Infrastructure provision, Product and service development			
SOCIAL MODELLING – Social rules that indicate what are common and acceptable behaviours			
Modelling (demonstration)			
Commitment			
Feedback			
RESTRICTION – Reduce opportunities to engage in alternative competing behaviour			
Prohibit products, Permissions and approvals, Removal of misused equipment			
PERSUASION – Tailored communication around audience beliefs, emotions, biases to motivate behaviour			
Vivid imagery / communication; Loss aversion language			
INCENTIVES – Expectations of financial or social rewards			
Rebates, Lotteries, Gift vouchers			
COERCION – Expectations of punishment or cost			
Fines, Taxes, Other consequences			
EDUCATION – Increase knowledge and understanding			
Information on target behaviour and how to address problem; Resources to assist in carrying out the behaviours			
TRAINING – Develop personal strategies and skills to increase peoples' capacity to carry out the behaviour			
Skill-based workshops and training courses; Training packages and programs; Implementation intentions			

The above is a qualitative assessment aiming to synthesise available evidence. A more extensive comparison can be seen at Table 5 on page 24. See also limitations below.

Limitations

The following limitations of the available evidence should be considered. Despite a comprehensive search of three major reference databases, no reviews focusing specifically on the outcome of preventing contamination of recycling were found.

Two peer-reviewed systematic reviews on recycling and waste management were included, but these were assessed as being low quality reviews. While peer-reviewed and published to the standards of their disciplines and fields, the six narrative reviews are more prone to bias due to the lack of a transparent and consistent methodology and have less policy-focused review goals.

The complimentary practice interviews are only indicative of the range of waste education programs and contexts in Australia, and the beliefs and experiences reported may not be representative and accurate for the full range in existence. Rural and remote areas were not well represented.

In short, while it is unlikely that this Rapid Review failed to include any relevant existing literature reviews, a more comprehensive review, such as an exhaustive and high-quality systematic review examining every primary study on the topic for up to 18 months, may result in valuable insights and information that could change the review interpretations and conclusions presented here. Similarly, a wider survey of practice insights would likely lead to more representative and generalisable findings than are presented in this report.

BACKGROUND

AIMS

This report was commissioned by the Australian Government Department of Agriculture, Water and Environment, to inform the department's support of the implementation of the National Waste Policy (NWP) 2018. The relevant strategy section is:

> **Strategy 3: Knowledge sharing, education and behaviour change**
>
> *Implement coordinated knowledge-sharing and education initiatives, focused on the waste hierarchy and the circular economy, that address the needs of governments, businesses and individuals, and encourage the redesign, reuse, repair, resource recovery, recycling and reprocessing of products.*

This report aims to support effective local action across Australia by presenting information that the Department and others can use to translate insights into effective programs.

Within this broader agenda, the **primary aim of this review** is to support *improved recycling* by:

> *Identifying recycling interventions that are likely to be effective in reducing contamination of household kerbside co-mingled recycling by items from other waste streams.*

Broadened scope

Given the nature of the problem of 'contamination' in recycling discussed below, and our initial survey of the literature, we broadened the scope of the review. Literature focusing on effective interventions promoting preferred waste and recycling behaviours in general at municipal level, and broader waste policy goals, were also considered to the extent they support behaviours reducing contamination, as was literature reviewing interventions targeting preferred alternative behaviours. Broader waste avoidance and reduction goals and interventions beyond reducing contamination alone would merit their own review, and are not centrally addressed here. Practitioner interviews also provide broader insights, as described in the relevant section.

Timing and context of aims:

The report was commissioned in late 2018, and completed in early-mid 2019. It was an early contribution towards the BWA Waste and Circular Economy Collaboration, which was scoped in the same period and formally launched in July 2019.

INTRODUCTION

Kerbside co-mingled collection and recycling of paper, plastics and cardboard has been widely operating in Australia since the late 1980s and has enjoyed strong community support: 91% of Australians agree that recycling at home is the right thing to do (Planet Ark, 2018).

Nearly all Australians (98%) participate in some recycling (ABS, 2012). In 2016, of 565kg of municipal waste per capita generated nationally, 42% was recycled, 9% converted to energy, and 49% disposed to landfill (Pickin & Randell, 2016: 15).

In the most recent 2016-17 reporting period at the time of writing, across Australia, the recycling rate was 58% (Pickin, Randell, Trinh, & Grant, 2018). Contamination rates do not appear to be widely or consistently reported (e.g. by weight, volume, problem items etc). Industry representatives have said a 6-10% contamination rate is standard in recycling in Australia (Topsfield, 2018), and up to 15% has been reported (Ritchie & Cocks, 2018). Our practice review interviews indicate contamination rates from 3% to over 30% have been seen across Australian councils.

The recycling and waste industry in Australia is characterised by a diversity of scheme characteristics, multiple actors and a strong reliance on public-private arrangements (E&CRC, 2018). Australia is in the 50th percentile of performance in countries committed to the Sustainable Development Goals on SDG 12: responsible consumption and production (Sachs, Kroll, Schmidt, Lafortune, & Fuller, 2018). It is noteworthy that while economic and population growth began to decouple from growth in energy, water and greenhouse gas emissions by between 17-30% between 2006-2016, the relationship with waste reduced by 2% (ABS, 2018).

In developed countries, recycling is generally understood as a pro-social good, for example because it contributes to protecting the environment, however it has a dual nature as a commodity market (Minter, 2013). Environmental economists note that the aspirations of policy goals for recycling in many developed countries typically exceed what would be purely economically rational, based on present commodity values, although most acknowledge difficulty in costing in broader environmental, social and distributed economic benefits (Briguglio, 2016; Dahlen & Lagerkvist, 2010; Grazhdani, 2016; Lakhan, 2015).

What is contamination of household recycling, and why is it a problem?

Tensions between recycling as a commercial activity, and as a broader pro-social policy goal have been highlighted by recent events. The recycling system in Australia and globally was disrupted in 2018 by a glut in international flows of recyclable material stemming from a change in China's tolerance of the level of contaminants in recyclables they will import, and a subsequent drop in the international commodity value of recyclable materials (Downes, 2018; E&CRC, 2018).

Fluctuating commodity prices have impacted the viability of public-private arrangements for recycling in the past, but, previously, export of low quality, baled materials to China and other countries provided a backup option (Greber, 2016). With disruption of the low quality, low price export option, the events of 2018 impacted as much as 99% of Australia's household recyclable material – in practical terms, many councils that were being paid by private companies to take recyclables are now being asked to pay for the service to continue (Downes, 2018; Planet Ark, 2018; Ritchie & Cocks, 2018; Topsfield, 2018).

Other flow-on effects of recent disruption include a number of serious fires in Sydney and Melbourne due to temporary stockpiling of co-mingled materials. The fires may have been caused by problematic items damaging machinery, or self-combusting via residual organics rotting in baled material and producing flammable gasses (EPA Victoria, 2018). Air, water and land pollution, and community health and amenity impacts, as well as tax evasion, money laundering, illegal dumping and littering are some of the risks and unintended consequences associated with the domestic waste and recycling industry as it operates in 2019 (AELERT, 2018; E&CRC, 2018).

Increased public awareness, and the impact of popular television programs like 'The War On Waste' and 'Four Corners', is indicated by significant increases in queries about correct recycling and waste disposal to councils and community organisations (Planet Ark, 2018). Recent media has reported a decrease in trust in key attributes and outcomes of recycling (Planet Ark, 2018; Topsfield, 2018), with some audience research demonstrating this concern, if not necessarily its impact on preferred behaviours.

While it is outside of the scope of this review to evaluate the merits of different waste and circular economy policies[2], a number of policy interventions flagged in the National Waste Policy 2018 may also depend on reducing contamination rates to reach their goals.

For example, at Waste Expo 2018, an industry commentator stated that recycling contamination was occurring at approximately 15% in NSW in 2018, making the threshold required by China of 0.5% out of reach with current technologies and practices (Ritchie & Cocks, 2018). However, they believe their analysis shows that contamination of 10% or less could make continued collection of NSW recyclable streams economically viable under the recently implemented Container Deposit Recycling (CDR) legislation. If this is correct, calls for nation-wide CDR schemes, increased on-shore processing of recycling, and increased market development will also influence contamination tolerances in municipal and other recycling if/when they are implemented.

What kinds of contaminating items are problematic?

The above context shows that what constitutes contamination of kerbside recycling is partly defined by commodity markets, domestic and international policies. Other factors also play a role. Planet Ark (2018) states that contamination of kerbside recycling primarily occurs when non-recyclable items such as plastic bags are put in the recycling bin. Such materials are contaminants, they argue, because they can clog up recycling machines, degrade the value of recycled materials, increase waste going to landfill and increase the cost of recycling. Their 2018 national survey of 180 participating councils (of 537 in Australia) found that almost all councils listed reducing contamination and reducing resident confusion as a priority. They identified the following problematic contaminants (Table 2 p. 5).

[2] Note BWA has previously conducted a rapid review on CDR schemes' effectiveness, which found evidence they are effective in diverting recyclables from landfill.

Table 2: Contaminant items reported by 180 Australian councils, and preferred behaviours (Planet Ark, 2018)

Rank	Item	% councils affected	Problem	Preferred behaviour
1	Soft plastics in recycling bin	46%	Gets caught up in the sorting machines	Drop off at Coles and Woolworths stores in the REDcycle bin
2	Bagged recyclables	41%	Bags get picked out manually and end up in landfill	Keep items loose when placing recyclables in the recycling bin
3	Food/organics	22%	Lowers the quality of the paper stream in mixed systems	Follow council instructions for food/garden organics collections, or put in your own compost bin or worm farm
4	Non-recyclable plastics	16%	Size, shape and colour of plastic items effect recyclability	Look for the Australasian Recycling Label or if in doubt, leave it out
5	Polystyrene	15%	Acts like paper in the sorting process	Search online at RecyclingNearYou.com.au for drop off options
6	Clothing	11%	Gets caught up in the sorting machines	Search online at RecyclingNearYou.com.au for drop off options
7	Nappies	11%	Not recyclable, and a hazard to MRF employees.	Place in general waste bin

In the US, the Recycling Partnership has found five common kerbside recycling contamination themes across municipalities:

1. tanglers (hoses, cords, clothes)
2. film plastic (plastic wrap or bags),
3. bagged things (garbage or recycling),
4. hazardous material (propane tanks, needles/sharps) and,
5. a category that can be summed up as “yuck” i.e. things that downgrade other materials and clog the system (food, liquids, diapers, etc.).

Although one or two of these categories may change because of regional differences or end markets, they typically constitute the top five categories on a US material recovery facility (MRF)’s “no” list. Although more newsworthy, immediately harmful items such as fireworks and gas bottles appear to be less common, if catastrophic when included (Marshall & Bandhauer, 2017).

For the purposes of this review, whether or not an item is a recycling contaminant is essentially a function of its compatibility with the overall recycling system in which it is found, and particularly:

1. the impact of its presence in recycling streams on the economic, technical and logistical feasibility of collection and processing,
2. the item’s relative value as a commodity plus impacts on the value of co-mingled items, and
3. the impacts of the item’s subsequent fate on people and environment.

In other words, the practical relevance of reducing contamination is on the one hand removing heterogeneous problematic items that even in relatively small amounts disrupt recycling systems; and on the other, potentially increasing the dual economic and environmental values of recycled material.

From a behavioural science perspective, this means a range of behavioural targets are relevant to waste managers wishing to reduce contamination in their particular context in Australia and elsewhere.

While correct kerbside sorting is clearly central in the above table, so is a range of preferred behaviours for problematic items; for example, avoiding or reducing a wide range of possible contaminants, cleaning food packaging, separating lids (or leaving them on), or collecting and delivering soft plastics to an appropriate destination.

Given the variable destinations for different items defined as contaminants listed above, it is noteworthy that actively attending to and learning correct actions is nevertheless emphasised for several items by organisations like Planet Ark.

Seeking to promote participating in self-education and accessing information sources are rarely the preferred end-state behaviours in behaviour change campaigns. However, in complex and changing environments, these may also be important intermediary steps before other behavioural targets become possible. In our experience, such situations also suggest that system redesign and simplification are important strategies to consider, where this is viable.

APPROACH

RAPID EVIDENCE REVIEW

A rapid literature review was undertaken to identify, evaluate and synthesise published literature investigating the effectiveness of household recycling interventions.

Rapid reviews are an emerging method of efficiently synthesising research evidence in policy and other settings where a broad overview of research evidence is required in a short timeframe. Unlike traditional systematic literature reviews (which take 12-18 months), rapid reviews focus on synthesised research evidence that can be collected within a shorter time frame, in this case approximately two months.

Caution needs to be applied when interpreting rapid review findings, as more comprehensive review approaches may elucidate further information and insights, which would influence review interpretation and conclusions (Khangura, Polisena, Clifford, Farrah, & Kamel, 2014). Therefore, systematic reviews remain the definitive method of literature review, and we recommend that systematic reviews are undertaken whenever possible. Further details of the review and other methods employed in producing this briefing document can be found in Appendix 1.

Figure 1 on p. 8 outlines the process for papers included in this review. The literature search across three reference databases yielded a total of 1306 citations, after the removal of duplicates. This total yield was screened based on title and abstract, resulting in 137 papers shortlisted for full text review. Following the full text screening, two systematic reviews (Schanes, Burcu, & Dobernig, 2018; Zacho & Mosgaard, 2016) and six narrative reviews (Schanes et al., 2018; Sharp, Giorgi, & Wilson, 2010; Xevgenos, Papadaskalopoulou, Panaretou, Moustakas, & Malamis, Briguglio, 2016; Hebrok & Boks, 2017; Lane & Wagner, 2013) were eligible for inclusion in the rapid review.

A further 44 papers have been considered, including 23 multiple and/or longitudinal studies and 21 single studies. These are cited only where they add insights over and above the review papers. Of the 82 excluded studies, the most common reasons were lack of comparability (e.g. developing country examples) and irrelevant outcomes (e.g. analysis of the impact of scheme design on Waste to Energy (WTE) values of waste streams).

Quality appraisal of systematic reviews was conducted using the recognised AMSTAR 2 tool (Shea et al., 2017). The two systematic reviews were assessed as low quality, which means the findings of these reviews should be treated with caution.

The systematic reviews scored poorly in two or more of the following domains: protocol registration before commencement of the review, inclusion of keywords or example search strategy, justification for excluding studies, adequate risk of bias assessment and consideration of risk of bias. Similarly, the included narrative reviews, while peer reviewed and published to the standards of their disciplines and fields, may be more prone to bias than systematic reviews due to the lack of a transparent and consistent methodology, and prioritising different goals to a systematic review – for example surveying a discipline, or progressing academic discourse. While the results of both types of reviews are still useful to inform practice, they should be interpreted with caution.

Appendix 2 presents full details of the AMSTAR 2 review and full summaries of included reviews are presented in Appendix 3.

Collectively, the **systematic and narrative** reviews cover the following areas:

1. Effective interventions and initial determinants of cooperation with policy goals to divert waste from landfill at a household level (Briguglio, 2016)
2. Effective interventions and initial determinants for increasing recycling rates at a household level (Varotto & Spagnolli, 2017)
3. Effective interventions to increase recycling rates at a municipal level (Xevgenos et al., 2015)
4. Examining the impact of recycling collection container attributes on recycling practices (Lane & Wagner, 2013)
5. Waste prevention (Sharp et al., 2010; Zacho & Mosgaard, 2016)
6. Household food waste drivers and potential intervention points for design professionals (Hebrok & Boks, 2017) at household and retail levels (Schanes, Dobernig, & Gözet, 2018).

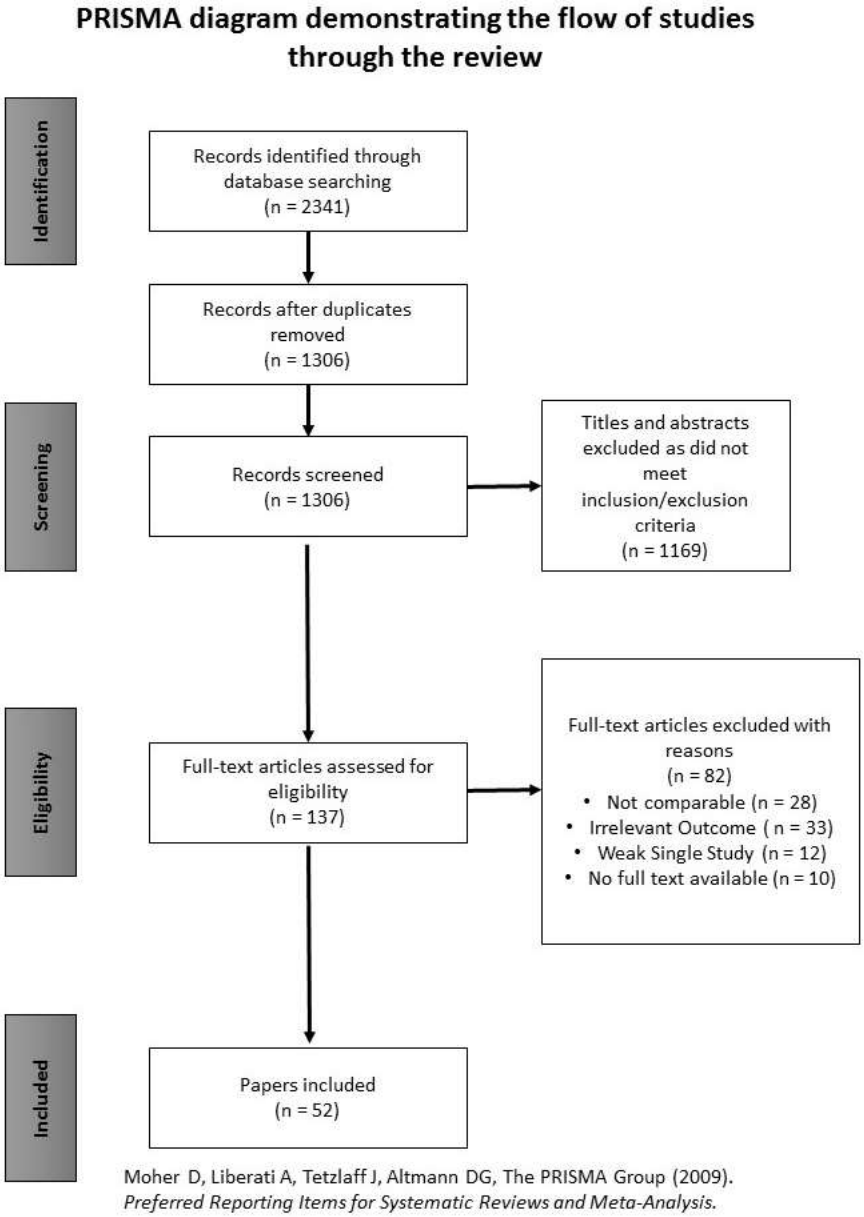

Figure 1: Flowchart of the inclusion process for studies in this review

PRACTICE REVIEW

We conducted 17 practice interviews across 6 states and territories of Australia. The interviewees were mainly waste educators and communication managers employed or contracted by either council or regional council, with one network coordinator the exception. Additionally, two academics and two communications managers of industry funded organisations provided examples of 4 overseas program contexts (United States, New Zealand, Taiwan and Malta). Semi-structured interviews aimed to understand their beliefs about what works and why, what types of programs and interventions are in use, and what they know about their effectiveness, plus how all these elements are affected by their local context.

RESULTS

INSIGHTS FROM PUBLISHED EVIDENCE

FINDINGS FOR POLICY AND PRACTICE

This section summarises key findings from the review that policymakers and waste managers and educators may wish to consider in designing interventions, programs and overall schemes.

Individual and household recycling and waste behaviours are affected by a wide range of contextual characteristics (see Briguglio, 2016; Varotto & Spagnolli, 2017)**.** Many of these characteristics are only indirectly and slowly affected by waste specific policy and management. To be successful, schemes and interventions must be based on a deep understanding of the target audience, the target behaviours and the context (Briguglio, 2016; Sharp, Giorgi, & Wilson, 2010; Varotto & Spagnolli, 2017; Xevgenos, Papadaskalopoulou, Panaretou, Moustakas, & Malamis, 2015; Zacho & Mosgaard, 2016).

Effective recycling and waste management, including communications and engagement, is targeted and tailored. As there is no ‘‘one size fits all’’, the specific characteristics of each region in scope should be identified in order for the scheme to be properly adjusted to local conditions. (Briguglio, 2016; Lane & Wagner, 2013; Xevgenos et al., 2015). Administrators can pre-empt unintended side effects (like contamination, illegal disposal, regressive impacts) of intervention. They should consider not only the attributes of the schemes but also how these are perceived, and how they interact with household members’ motives and constraints, by ensuring a deep understanding of the audience, then designing and communicating scheme characteristics sensitively (Briguglio, 2016).

Scheme characteristics are not consistent. Australia has a relatively varied and public-private partnership driven approach to recycling compared to other jurisdictions in this review. Recycling management, reporting and policy varies within and between Australian states (E&CRC, 2018). For example, different local councils maintain different relationships with waste and recycling companies, which can change what is accepted where, and over time as commodity prices, technology, consumption and many other variables change (Minter, 2013; Planet Ark, 2018).

Before initiating communication and education strategies, make correct recycling easy and consistent. Improving fundamentals might be considered as necessary before a behaviourally focused communication campaign can further improve recycling rates or better target and prevent contamination within a given recycling regime. All scheme elements should be taken into account when designing or improving a waste management scheme, especially those that alter the convenience, cost and complexity of correct behaviours (Briguglio, 2016; Varotto & Spagnolli, 2017; Xevgenos et al., 2015)

Schemes are not necessarily designed to optimise correct recycling. It can’t be assumed that basic arrangements are the same nor driven purely by householders’ needs across different council jurisdictions, let alone states, particularly problematic items that are regarded as contaminants at a given point of time. In multiple jurisdictions, cost, commercial considerations, conflicting policy goals and settings all may have determined key elements of existing recycling programs as a priority over design focused on facilitating correct recycling (Hebrok & Boks, 2017; Lane & Wagner, 2013; Minter, 2013; Xevgenos et al., 2015).

There is a relative lack of, and strong need for, evidence-informed, robust and well evaluated interventions in research and practice, that can be scaled to whole schemes. Reviews cite a lack of accessible and integrated evidence whether exploring broad scheme characteristics (Xevgenos et al., 2015), drivers of household cooperation with policy goals (Briguglio, 2016); waste prevention (Sharp et al., 2010; Zacho & Mosgaard, 2016) and food waste (Hebrok & Boks, 2017), or the effectiveness of interventions in cost, convenience and communication (Briguglio, 2016), interactions between behaviours, determinants[3] and interventions, (Briguglio, 2016; Varotto & Spagnolli, 2017), and specifics like ideal characteristics of collection containers (Lane & Wagner, 2013), and in food waste, design interventions (Hebrok & Boks, 2017), or retailing (Schanes et al., 2018). Improved integration of research and practice is recommended in multiple reviews.

KEY BEHAVIOURAL INSIGHTS AND FINDINGS

This section focuses on findings particularly relevant from a behavioural insights perspective.

Higher cooperation can be expected from households with favourable preferences. Identify and target households with favourable moral preferences and beliefs (environmental, social, political) about target behaviours (Briguglio 2016). Such groups may also be more receptive to waste prevention messages (Zacho & Mosgaard, 2016). Conversely, individuals, households and communities with unfavourable beliefs and values will need different interventions. Note that well-intentioned householders may still contaminate accidentally when schemes are complex and uncertain – e.g. if at one point in time their council accepted soft plastics in recycling, and the policy changes, or they move to a new jurisdiction.

High constraints on space and time exist, and matter, for some households. Briguglio (2016) recommends that policymakers and managers need to understand when they are engaging with neighbourhoods, localities or regions characterised by high constraints. These, in turn, may be proxied by demographic data on poverty, dwelling size, and household size. Higher cooperation can be supported by relieving constraints. Schemes may offer more frequent collection and smaller waste-collection containers to relieve limited space. Simple and clearly communicated waste separation processes can also relieve time constraints. See also (Lane & Wagner, 2013; Varotto & Spagnolli, 2017). Table 8 on page 46 in this report summarises determinants found in the psychological literature by Varotto and Spagnolli.

First, make it convenient and easy to recycle correctly. Briguglio (2016) notes interventions may aim to enhance the (perceived) benefits from cooperation, to reduce the (perceived) costs of cooperation and to increase the (perceived) costs of waste disposal. Consistently, Vorotto and Spagnolli (2017) note that environmental alterations was the second most widely effective intervention found in their review, this: “consists of making recycling more convenient and easy to perform by modifying the physical environment for instance by increasing bins’ proximity or number, changing their appearance, or providing home equipment for sorting waste” (Varotto and Spagnolli 2017: 172). Lakhan provides some evidence of the important of convenience in multi-unit dwellings (Lakhan, 2016). See Table 5 on page 24 for an indicative summary of interventions that should be considered as priorities.

[3] Determinants refers to socio-demographic and contextual factors found to be influential on behaviour, for example as listed in the appendices Table 8, on page 70.

Then, engage with personal, compelling education and feedback. Social modelling was found to be effective across multiple examples, which consists of passing on information via demonstration or discussion in which the initiators indicate that they personally engage in the behaviour (Varotto and Spagnolli 2017: 173). It may also reduce food waste, but possibly not recycling contamination (Bernstad, La Cour Jansen, & Aspegren, 2013). Timlet and Williams (2008) found that incentives and feedback cards reduced contamination rates by nearly 50%, and feedback cards were more cost effective, noting that both interventions required adequately rigorous inspection/verification of bin contents, which is itself expensive. Sharp et al (2010) recommend that waste prevention needs to become more 'visible' and campaign deliverers need to help people to identify what they can specifically do, and how to do it well. (Sharp, Giorgi, and Wilson 2010).

Support with a user-focused and 'whole scheme' approach to communications. Brigulgio (2016) finds that communication interventions, i.e. promotion of scheme attributes (including incentives themselves), awareness-raising on environmental impacts, efficacy, or norms, can also stimulate cooperation. Further testing and evaluation are suggested before investing too heavily in such campaigns however. Briguglio recommends caution as (costly) mass media appeals and promotion can simply be ignored, communication can interact with motives to create divergent outcomes, and subtle cues (including scheme attributes) communicate contrary messages to households. These all point to a strong need for localised, scheme-specific behavioural messaging, whereas mass communication efforts may better aim to build supportive beliefs about the importance of the issue, reinforcing norms supporting preferred behaviour (i.e. care/attention in recycling, participation, cooperation), and channelling engaged recipients to locally relevant support and information.

Monitor for unintended consequences, and build an evidence base. This is vital due to the risks (e.g. inadvertently encouraging contamination by providing inappropriate or conflicting information for the local scheme), and because available evidence about what works is tentative (i.e**.** Table 5, p.24) The relationship between determinants, intervention and outcomes of recycling behaviours is complex and not well understood (Briguglio 2016; Varotto and Spagnolli 2017). What works, for whom, where, and why will vary at a fine-grained level in terms of interventions, population segments, urban forms, and scheme details (Xevgenos et al. 2015; Lane and Wagner 2013; Sharp, Giorgi, and Wilson 2010; Schanes, Dobernig, and Gözet 2018; Zacho and Mosgaard 2016). As above, increased collaboration between research, policy and practice will benefit all.

PRACTICE INSIGHTS

WHAT ARE THE ISSUES?

The following section reports issues experienced by interviewees. They are presented in order of the most frequently emphasised and mentioned issues.

Waste, including recycling, is complex. Practitioners are well aware of the context sensitivity of contamination problems, and effective interventions, and do try to reflect this in their work.

Quality is more of a problem than quantity. Where it is offered and people know about it, most people are very happy to participate in recycling. But, they still get it wrong and all participants reported contamination to be their biggest issue in regards to recycling. The issue manifests itself in a contaminated waste stream, and usually was measured at the sorting or processing facility.

Contaminants are "anything that isn't supposed to go in the relevant bin'. The main problem with contamination was described in economic terms: *"lowers the quality of the end product"* or *"affects the price"*. In addition, it can also directly incur costs, e.g. when contaminated recyclables have to be diverted back to landfill, where it usually attracts a landfill levy based on weight. Besides financial impacts, some contaminants can also get tangled up in machinery and can cause technical issues at the sorting and processing facility.

> *There's heaps of stuff. We still get a large portion of food waste, garden waste. We get a lot of dirty containers. We get a lot of dirty nappies through the facility. Recently we did changes, like soft plastic cartons, we don't accept those anymore, we once did. They're still a reasonable contaminant. Things such as meat trays, polystyrene, there's a reasonable list of items we get as contamination. We still get a reasonable portion of recycling that is tied up in plastic bags, obviously you have no idea what's in the bag, so that's a contaminant again. It could be full of recyclables, but you can't just open the bags one by one. I would imagine it would be all the usual suspects. (PH4)*

What are problematic items? Table 3 lists the most common in bold. Bagged recyclables and soft plastics are the most common issue across all locations.

Table 3: Most common and problematic contamination items reported by practitioners.

Contaminant	Description
Plastic bags	- **Bagged recyclables** - Bin liners
Non-recyclable plastics	- **Meat trays** - Polystyrene - Soft plastics
Food waste	- Excessive 'Brown waste' (biodegradable, mainly carbon waste e.g. grass cuttings, dry leaves, twigs, hay, paper, sawdust, corn cobs, cardboard, pine needles or cones) - Dirty food packaging recyclables, e.g. tins or jars, meat trays with blood
Other	- **Nappies** - **E-waste** - **Clothes** - Hard-rubbish items - Metal items, e.g. saucepan - Glass items, e.g. mirror glass - Multi-material products, e.g. tetra pack (cardboard & plastic) or filer (cardboard & metal)

Why is there misinformation and confusion? Waste educators are able to describe a wide range of relevant factors, summarised in Figure 2. This can lead to well-intentioned but mistaken behaviours like “wish cycling” and enthusiastic but incorrect peer to peer ‘education’ about what can and can’t be recycled.

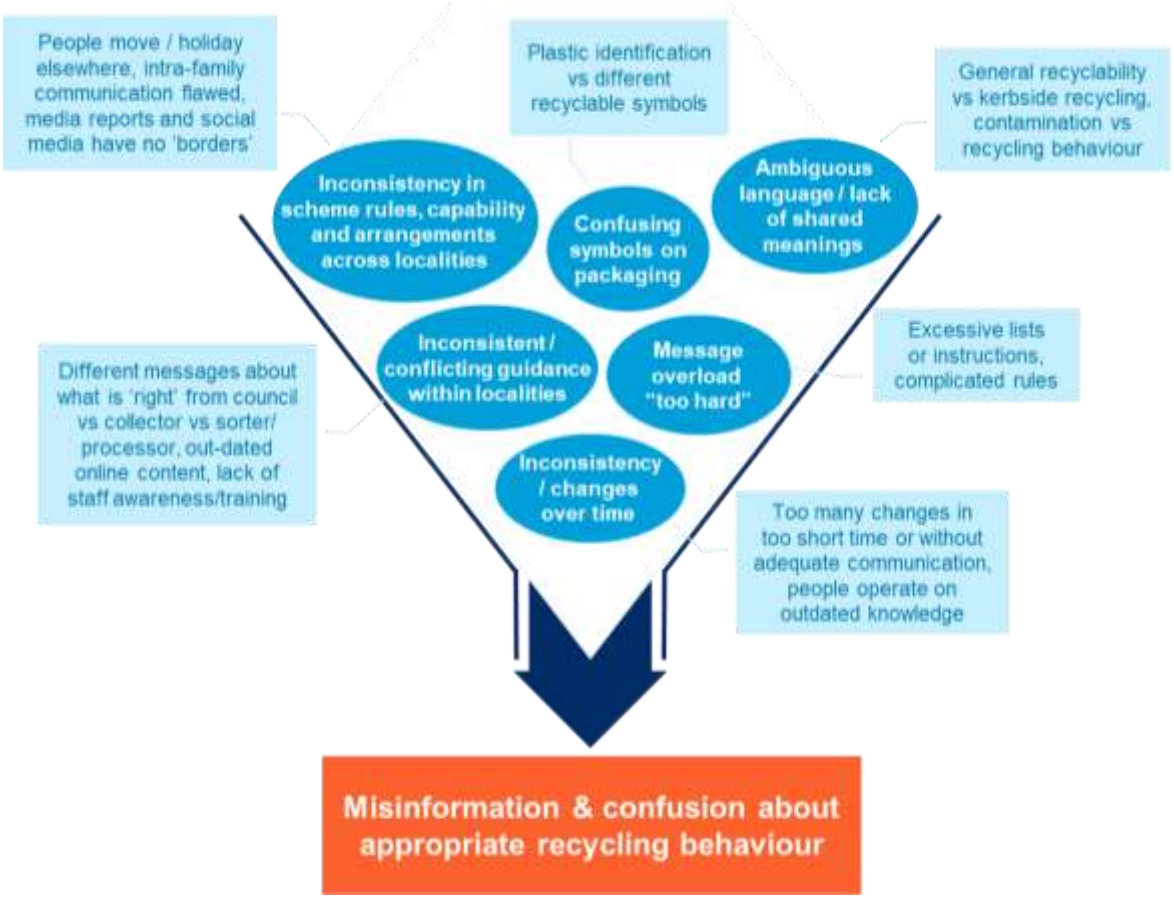

Figure 2: What makes it hard for people to recycle correctly according to waste educators?

Implicit ‘nudges’ from system design. Several interviewees highlighted that the design of the system could be blamed for contamination. Especially the overseas interviewees had experience with different systems and highlighted that, e.g., a wheelie bin can reduce the social norm as the contents are not visible, that co-mingling can cause additional confusion and that indifferent pricing might send the wrong message.

> *It's like if you step right back to the beginning and don't assume that this method [kerbside] of collection is the best, there may be other methods of collection that are actually going do a much better job of minimising contamination. So your actual method of collection could actually be a barrier in some ways. You know, so a container deposit scheme which gives somebody 10 cents when they bring you a bottle back, that may be the most effective way to reduce contamination. (GD13)*

Packaging and labelling. Practitioners note this is a large source of waste, and thus affects landfill volume and cost, but it also causes confusion and is thus inherent to the contamination issue. In terms of packaging material, they believe that more could be requested of manufacturers or retail intermediaries who are currently out of the “responsibility-loop”, e.g. to reduce importing non-recyclable packaging. There was some frustration that the freedom of choice regarding packaging created a need to deal with all kinds of waste, where a standardisation could ease this pain. Several pointed out that labelling needs to be addressed as the message on packaging is not always in line with recycling methods in Australia, e.g. the recycle triangle.

> *... without standardisation of packaging,* [in terms of labels, messaging, and actual recyclability], *there is always going to be a lot of complexity in the system. (NG9)*

Several interviewees found consumers to be ignorant of the meaning of the plastic categories present on most packaging and mistake it for a recycle symbol. They saw a strong need for either a broadscale education campaign about understanding plastics, e.g. through curriculum, or about the meaning of the label, and/or introducing a clear, visible recycle label to allow consumers to distinguish items correctly. In New Zealand and Taiwan, this kind of education is being introduced.

> *We don't know much about materials. I mean, we can say plastic; I would blend plastic, but we don't even know what is plastic, and how many sorts of things, and how we use it, how much we rely on this material. And how awesome it is, actually because* [of] *the mistreat*[ment] *and ignorance that we have towards this material… we blame the material instead of ourselves. (OD14)*

Constraints. Storage / sorting space and volume limitations in smaller homes, as well as personal time constraints, were named across almost all interviews as important barriers associated with contamination, especially in relation to multi-unit dwellings (MUDs).

Mismatches between resident's capability, needs, and collection formats and frequency. Two interviewees pointed out that mismatches can have unintended effects. E.g. MUDs, social housing, young or large families, may only have default access to a certain sized bin and collection frequency, regardless of household size, and/or inability to afford paying for additional bins, which led to heavy contamination and waste overflow. The residents one participant spoke with felt helpless, as they could not see another way to dispose of their household waste e.g. nappies. On the other hand, another two interviewees explained that especially older people struggle with their large waste bins, to fill them up as well as actually bring them to the kerb. Waste collection frequency was mentioned in this regard as both an inhibitor or enabler, depending how the collection system was designed.

> *What I see right now is obviously with our three-bin system, the red bin only goes out fortnightly, and the green bin goes out weekly. So you have yellow and green one week, and then red and green the next week. So what people do on the yellow and green is they just put all their garbage in the yellow. So it's not so much that they don't... They do have the knowledge, and maybe not 100% of the knowledge, but they have the majority of the knowledge, and they're just putting their waste in there. So that's been kind of a different barrier, it becomes a different problem. So then I looked at what's going on in their bins. Do they have a smaller red bin? Then I suggest upgrade your red bin. What's in their red bin? I'll have a quick look, it might be recyclables or whatever it might be. So they might have a cardboard in there which then could go in the yellow bin, whatever it might be. (TM8)*

Unreasonable time and effort. Consistently doing the right thing was seen as excessively hard by most interviewees. Almost all pointed out that many residents find proper recycling behaviour was "too hard" and requires too much time and effort, e.g. the appropriate cleaning of cans is not only time and water consuming, it can also be hazardous (i.e. risk of cuts). And this may or may not actually be required – most automated MRFs can accommodate somewhat dirty food packaging, with hand sorted facilities being more impacted by unwashed items. Confusion about what is needed adds to perceived effort:

> *[…] I was in a meeting recently with a woman when the topic of recycling contamination came up and she said, "Oh my god, my husband and I have these huge arguments about lids and he's saying the lids do go in and I say they don't, he says they do, the last place we lived they did, here they don't." You know? […] I just think of the conversations they're having and the amount of energy they're wasting over trying to figure out what goes in their recycling bin because it's so complicated. Because if you actually just make it consistent and then say, okay, everybody knows that lids go in or out or whatever the decision is, then people can put their energy into other things like choosing packaging that can be recycled or thinking about how can I maximise the amount of recycling and reduce my waste. It kind of diverts everybody's energy into the wrong place, I guess. (GD13)*

Non-resident recyclers and visitors. About half the participants observed that there was an increasing issue with people visiting or holidaying in their area, via e.g. AirBnB or holiday houses, with the assumption that they either didn't care or didn't know appropriate actions. Targeting them proves difficult. Similarly, recent migrants may have quite different lifestyles and understandings than long term residents.

> *We just have this really difficult problem where people are coming from other countries and sort of into this society where people are throwing away things all the time. It's kind of a throw away culture, but then if you're gonna throw it away, you have to throw it away right, and that can be kind of confusing sometimes. And then, of course, just people coming just for a short time. (DK3)*

Loss of Trust. All agreed that there were very few, if at all any, residents that simply didn't care. However, trust plays a central role in that the residents engage in recycling behaviour and trust that the council, or the rest of the supply chain, will do their bit to get it recycled. Media reports that followed the China sword coverage was troubling for many and four reported that they had exchanges with residents whose recycling behaviour was negatively affected by reports that it "did not matter what they do".

> *We still receive a lot of complaints from our residents. They are still thinking that, why should I recycle? Instead, the council send everything to landfill. And obviously I need to spend some time thinking of what else can be done to just reassure them that we do recycle. (VM9)*

Lack of authority. Views on compliance and enforcement of contamination did not come up a great deal, and were mixed. Two interviewees stated that the lack of enforcement authority fostered the behaviour, but others counted this as a positive – preferring to take a supportive and educative posture in communicating with residents.

WHAT DO WE KNOW ABOUT WHAT IS WORKING IN PRACTICE?

Contamination is being addressed widely, but perhaps not deeply. With contamination being the central issue in recycling, all interviewees confirmed they either had or have a campaign running to target this issue. However, in only one instance was it the sole focus of a campaign, except the US Recycling Partnership Organisation, relating back to the point that waste is a complex issue.

> *No one answer. You try a few things and what works, you keep trying it. And if it stops working, you try something else. Waste is a complex system. You're not talking straight cause and effect stuff, and it changes […] it's complex in the true sense. (LB6)*

While all reported ongoing information campaigns, most of the more elaborate campaigns were often targeting multiple situations at once. The most common was the introduction and/or maintenance of the three-bin system or a combination of recycling and illegal dumping. About half of the interviewees had in recent times moved on to the "zero waste" message, still including recycling but with the spotlight on waste reduction. Also, the described campaigns usually featured a battery of approaches, both in channel and method and sometimes audience.

> *Even though I'm telling you we don't have a big focus on it, we're not singing it from the rooftops, the program's there. It trundles along in the background, if you run a simple social media campaign. (CB1)*

> *In terms of what works in recycling, I think that the answers for us is not one single thing that our community will adopt, and engage with, and find out information in variety of ways and you have to be prepared to provide that information in a variety of ways. (NG9)*

There is not good evidence about what works. This tendency for multiple goals and interventions makes effectiveness measures difficult and all interviewees have pointed out the shortcomings of some of the measures they apply. While most reported behaviour change through one or several of their campaigns, they also agreed that tying this outcome to a particular campaign element remains questionable. Instead the focus was on what could be measured, e.g. reach, exposure, and

engagement were successfully measured in almost all campaigns. Some campaigns went further, measuring recall. This kind of measurement was strongly tied to the channel they were using; e.g. online and social media has built in analytics functions that delivered in depth data on some campaigns, face-to-face engagement could be captured in electronic data collection systems and overlaid with other data.

Behaviour changes themselves do not appear to be widely considered as a direct or intermediary measure. Rather, all agreed that the ultimate measure of success had to occur at the MRF, where the waste streams can be assessed. This underlines the significance of contamination being seen as primarily an economic issue. It would appear that many practitioners think about the issue from a problem frame of its impacts on their sorting/processing partners. This makes sense given that many contracts include contamination targets and provisions, and possibly the perception that operators have a greater capability to effectively monitor waste composition. Conversely, it is interesting that the more immediate and specific option of bin level measures were little mentioned except as an often difficult ideal (below). This may reflect the above problem framing, and the fact that monitoring waste composition at either level is potentially cost-intensive and would need to be tied to the campaign exposure data to be meaningful. Particularly given that these are both areas in which practitioners feel they lack capacity (resources overall, and evaluation).

Better practice in evidence informed approaches. The most rigorous example shared with us was reported by two regional councils who had commissioned consultants to collect in-depth knowledge about the problem via surveys, information and evaluation on all prevalent behaviour change interventions related to recycling behaviour and detailed data on their constituency. They still struggled to establish the effectiveness of their interventions, however. The reports were able to suggest a range of approaches respective of the problem and the target audience and were referred to as the “blue print” for the following campaign. One practitioner had received training in community-based social marketing (CBSM) through Dough McKenzie and based her *Take the Pledge* campaign on his studies around commitment. An Australian academic pointed out that the bin tagging is based on the same theory. Most continually scan for innovations or interventions that appear to produce good results. Many are connected in regional and/or national waste educator networks that provide information and resources to its members. Despite this, it can’t be assumed that outcome reports are shared to disseminate information – with many organisations experiencing barriers to sharing reports. Mimicry and transfer of approaches that are claimed/perceived to be effective, however, appear to be common, but not sharing of evidence establishing efficacy.

> *It's hard to change people's behaviour, so we are continuously working on education and we are introducing new programmes and be able to, you know... increase our recovery rate, and get those yellow top bins as clean of contamination as possible. (VT10)*

Interventions that also generate evidence are valued. For example, the bin tagging has spread through word-of-mouth on this basis. Bin tagging was piloted and established in South Australia. Participants reported to have read their outcome reports and reviews. Some interviewees went there for shadowing and training and then adapted it to their own council. Bankstown appeared as another hot spot where many got inspired for their campaigns. Most ran pilots in their own council area as well to see if the approach worked.

> *And we did a pilot first, where we learned a lot; a valuable thing to do for us, being able to see what it meant to us, would it work for us, and things like that. (RB2)*

When used at all, waste stream audits, bin audits and surveys are used most frequently to target campaigns. Surveys can help identify the problem, e.g. assess level of knowledge. Audits can identify most common contaminants as well as problem neighbourhoods and help to frame messages like “Unbag the Bag”.

Success measures favoured. When used, bin audits are acknowledged as probably the most preferred in that they usually follow a protocol that defines what exactly classifies as contaminated. The assessment is mainly visual, only in two cases did they have an intervention with cameras which was described as quite cost-intensive. They captured the address, bin presentation (y/n), degree of contamination visible in which bin (if multiple bins are assessed). Sometimes they also specify the contaminants and comments, e.g. if a conversation took place. Some record the kind of information/ feedback they gave and follow up with a recommendation, e.g. send info about green waste bins. The change is assessed over the 3-4 visits in both quality and quantity and most then juxtapose this with council data on the households or neighbourhoods. Only a few have done recurring bin tagging in the same neighbourhoods and some want to do it, others are happy with the result in contamination levels for now.

Next to bin audits, the most frequently mentioned measure is feedback from the community, e.g. via social media, customer service or face-to-face. But industry awards are also mentioned to show that the interventions are deemed successful. In some cases, they even collect the commentary regarding a bin audit with a respective household.

> *How do you find and measure success of your recycling programme? As I said, we do receive a lot of accolades and positive feedback from our residents, we would see the number of awards that we upgraded our recycling centre. […] A number of awards for this great initiative was received. Then last year… our waste education programmes for schools, was in the final in the category. Just by the fact that our recovery rates are going up every year, that's a great success in itself… (VM10)*

To evaluate social media campaigns or the usefulness of tools such as a waste app, interviewees presented the typical analytics set available, including download rate, click through rates, exposure time, individual clicks and likes and shares. Some also collect commentary.

All agree that the ultimate measure is seen to occur at MRF level, whether waste streams are clear and what the level of recovery rate is. However, there was also commentary that the cost of this kind of rigorous measuring, and the difficulty in tying it back to a single campaign, limits its application.

> *MRF should have clear evidence in their waste stream. That would be the ultimate measure. (RB2)*

Coordinated campaigns. To address the widespread confusion, councils and processors have formed collaborations, but these are not common nor easy to establish in Australia, perhaps due to the underlying complexity discussed earlier. For example, in Western Australia, recycling processors, collectors, and regional council members have come together and negotiated a list of what can/can't go into the recycling kerbside bin. A similar effort in New South Wales failed to reach an agreed approach by the time of writing, although this is being revisited. Part of the challenge appears to be that varying arrangements mean uneven distribution of costs of harmonisation across localities, but all are very hopeful that this will alleviate a large amount of the confusion amongst households regarding correct recycling behaviour. As this was only finalised recently, the outcome of this can't yet be assessed. South Australia is also about to release a package of consistent campaign materials available to councils; however, participation at this stage is voluntary. Again, outcomes are not yet available. In March 2020, the *Recycling Victoria* policy announced plans to ensure consistent collection options across the state (by 2030), and coordinated communications supporting it.

OVERVIEW OF FAVOURED DELIVERY CHANNELS

A number of delivery channels were identified, including: face-to-face (individual / group), social media, online / TV advertising, online static (website, apps, newsletter) and offline static (ads, billboards, newspaper, brochures, magnets, bin stickers). Opinions vary about which channels work best.

> *We found bin tagging to be most effective. Mass and social media…people tag their friends, talk about it- it increases public awareness of it, but if it has a direct effect on their recycling behaviour or contamination, I don't know. (RB2)*
>
> *In general, we had such good take up on the social media stuff. People were positively reacting, they were engaging, they were starting conversations, they were creating humour around it, they (*were*) sharing with their friends, and then we didn't have to spend any money for Facebook advertising. So it was doing so well organically that we just needed to think about how we're gonna reallocate this money. (DK3)*
>
> *Me personally, I still believe face to face engagement is the number one way to get the message across to people. Because you're non-threatening, you're talking about a subject that is non-threatening. (GB11)*
>
> *What is most effective? So in my experience, social media is very, very powerful. And also, direct mail out. Yeah. The best results we achieved by using social media and direct mail out. Direct mail out can be expensive, if you use Australian Post. (TM10)*
>
> *Everybody is sort of using catch up TV these days and streaming TV shows at home, and it was a pretty easy choice to make. The spend is not actually that much compared to other advertising, and the return on that investment is quite good because people are on their couch, they're waiting for the show, they have to wait through a 30 second ad that they can't skip, and so the watch is like 80 to 90 %. (DK)*

The perceived strengths and weaknesses of different delivery channels are shown below in Table 4.

Table 5 on page 24 relates practitioners' perceptions of effectiveness and cost of interventions (inferred from the interviews) with promising interventions indicated by the literature[4]. Note that it is only an indication based on the best available, but overall poor-quality, evidence, and should be treated as a starting point for more comprehensive experimentation and evaluation only.

[4] Colour span / effectiveness estimate based on a qualitative assessment of both the strength of available evidence in the review, and the effect size or related impact reported in the included reviews. This is not necessarily an expert judgement due to the lack of comparable evidence across the categories and should be treated as a starting point for testing only

Table 4: Perceived strengths and weaknesses of different delivery channels for campaigns.

Channel	Benefits	Downsides	Comment
Face-to-face Individual / group	• Highly targeted information provision • Focused attention • Allows 2-way communication: Engagement and reaction qualitatively observable and immediate reaction possible • Social modelling effect • Reach and exposure, reach measurable • Highly effective source of information about problem, target audience and effectiveness	• Resource (=Cost) intensive • Relatively slow dissemination speed • Difficult to capture wide parts of the population	The unanimously best channel for engagement around the waste topic but the cost is immense especially on a one-on-one basis. Training customer service personnel in council has proved successful.
Social Media	• Low cost • Fast dissemination • Persuasive and educational information blurred • 2-way communication possible • Allows for social modelling • Reach and exposure and some engagement measurable • Reaction deducible • Source of information about problem, target audience and effectiveness	• Targeting is limited • Can cause confusion as long as system is not homogeneous • Can backfire (Malta campaign “Sort it out” was returned with “YOU sort it out, government”) • Behaviour Change not measurable • Can be preaching to the converted / fail to reach key audience segments and create ‘bubble’ effects.	Social media is a preferred channel as it allows for educating, social modelling, giving feedback and persuading. Yet, actual behaviour is not observable.
Online / TV Advertising/	• Highly targetable • Exposure measurable • One way communication • Short attention span • Can go viral • Awareness measurable via surveys	• One way • Engagement and reaction not measurable • Link to behaviour change not possible	This channel seemed favoured if there is a single message that needs to get across/ stuck in people’s mind
Online static Website, Apps, Newsletter	• Low cost • Searchable, exhaustive information provision possible • Information access and exposure measurable • Quick go-to resource	• One way • Not targeted • Engagement and reaction, sometimes reach not measurable • Easy to overwhelm	Websites and apps are the basis of information provision. It is crucial to have current, consistent information online.
Offline static One to many: Ads, Billboards Brochure, Newspaper, One to one: Magnets, Bin stickers, letter box	• Low cost • Exposure targetable, e.g. direct mail, letter drop, neighbourhoods • Allows to place prompts, reminders, go-to resource • Reaches all ages	• One way • Not easily measurable without additional primary research • May be limited space / time for messages, limiting opportunities to build on informational/instructional details with persuasive messages.	Letter dropping brochures, magnets or the like is employed by all in relation to bin tagging and can be targeted in this instance. Local paper ads are employed by many and deemed useful as long as there is no homogeneous system.

OVERVIEW OF FAVOURED BEHAVIOUR CHANGE MECHANISMS

This section provides an overview of practitioners' views on the types of interventions. Overall, practitioners associated success with delivery channels and whole programs over specific behavioural mechanisms. Consequently, views about a specific intervention's behavioural mechanisms are inferred in some cases. In Table 5 on page 24, we relate these inferred views of effectiveness to published literature findings. Conversely, Table 5 can also be read with reference to the following passages for added detail, noting the blurring of channels, and mechanisms.

Bin tagging / feedback. Overall the most favoured program, described and conducted by almost all interviewees.

> *I think probably that's been one of the most effective campaigns that I've seen in my time here, and I've done that at another organisation as well. You get some good data. It is quite resource intensive, because you have people typically paid, out on the street doing that. You can also then figure out what are some of the problem items that you don't see any change with and try and target those specifically. You see some really good change over that period across all the bins, not just the recycling. (PH4)*

It is a combination of education, audits, feedback, and social modelling. While it is deemed resource intensive and hence associated with higher cost, all practitioners who implemented it are certain that it is well-invested money. Quite often, the bin tagging is used as an implementation tool alongside structural changes, such as the introduction of a green waste bin.

Education and information were reported as fundamental, so it was always part of the mix and important. Tours of processing sites is seen as one of the most effective education tools but it is also not very common amongst the interviewees. An alternative was to provide videos of the recycling processes. This addressed two things: firstly, it provided background information as to why it was important to recycle correctly; and, secondly, it showed that it was actually being done.

At different times, in some jurisdictions, core school curriculum incorporates waste education, so a couple of participants reported making explicit links to curriculum. In Taiwan, waste education has been part of the curriculum since the 90s and the interviewee reported the strong impact this still has on people in their adult life. It is seen as a way of establishing a social norm, which is seen as the highest motivator to engage in correct recycling behaviour.

> *We have done talks and events with very specific different pictures of what can go in each bin. And this such ground level stuff, you wouldn't believe, but it's ground-breaking for here. (LB6)*

> *One council that started out with the bin tagging had really relatively low contamination rates – they spend $150,000 a year on education, and they changed their approach a number of times, they were flexible and people have smaller waste bins. So they did heaps of engagement before we started with the bin tagging, and the levels of contamination were much less as people were already doing the correct thing. (RB2)*

Incentives were usually used either as part of education packages or as a reward for good performance during the bin tagging program. Most commonly, they are products, resources and vouchers rather than direct financial incentives. It seemed to have the best effect when targeted at a specific behaviour or group, hence changing the context for that particular situation or group.

> *In the MUD programme we provide an instructor's bag. So it's actually a huge thick bag with a really nice square bottom that can either be hung on the back of the door in the kitchen that you can bring out your recycling in, its black, its washable and we hope by providing a really easy tool that the community are tuned in to take their recycling down to the bay. (NG9)*

Blacktown Council have contracted *GreenMoney,* a reward program that provides points on the basis of weighting the recycling. They married this program with the bin tagging to ensure low contamination levels and are very pleased with the progress. The reward program ties in with local business and thus is believed to build community and local commerce.

The City of Melbourne has the same approach and is also satisfied with the outcomes it produces, although it appears to be more from an engagement outcomes perspective than waste behaviour change. City of Stirling has the Recycle Champion Award, which is based on a similar idea to *GreenMoney*, yet not as systemic and more tied to the bin tagging program. It also seemed to deliver good results in connection with the green waste bin introduction. This blends social recognition with a voucher prize.

> *So we ... some residents are willing to ... we asked a time that they would like, if we could take photos of them, they were happy to do so, so we would have them holding the voucher, and they allowed us to reveal their identity, so we would say, this month's recycling champion was found in this suburb, congratulations for that person, just by sorting correctly, recycling correctly, these guys have won a voucher. And then that would go on our City of Stirling Facebook page, newsletter, and then people would just comment and just tag their friends, and just ... it was just to start the conversation. Interviewee: And it tries to make it as appealing and easy. It's easy to recycle, and if you just do the right thing you can win a prize. (TM10)*

Persuasive communication (marketing campaigns) were reported as very effective for awareness raising and starting the conversation, yet behaviour change was rarely measured. Campaigns on social media and TV platforms could provide detailed statistics about exposure and engagement. With marketing campaigns, the message frame was a central aspect. Several interviewees had sought professional support in designing their campaigns and were able to target specific groups very directly.

> *So I think, that design concept, that brief would be just a really, really simple guide for anybody else doing marketing, and don't try and sit and get people to reflect on themselves and get people to relate and/or analyse their own behaviours in any meaningful way for marketing campaigns. You have to go the other way. You go right to the punch, and education is completely different. So definitely making clear that these don't sometimes cross over, but I think we were able to do those things in marketing. This, and we had pretty good returns from it. (DK3)*

Training is popular with community members, but its reach was limited and due to the inconsistency across regions the flow-on effect was hampered. One council did a training program for 17 years and has assessed its effectiveness after cessation through awareness of the program and feedback. One regional council group has started in the last 3 years with workshops and deems it successful. They tied in other intervention types like committing to changing a particular behaviour with a social commitment (see below), which appears to be a success. In terms of training within school programs, involving students in audits in particular is seen as effective and popular by interviewees.

Social modelling is seen as effective yet strongly tied to the channel of delivery. For example:

> *Schools, for example, one of the best things that the kids like, is the school waste audits… I don't know if you watch "War on Waste", we've been doing that for years. ... kids love it, because it's visual.*

Social commitments. The *Take the Pledge* campaign is offered across member councils in South Australia. They feel the data the program delivers is unprecedented as they can compare household performance in bin audits with program participation. They recommend one stable long-term campaign for good data rather than many short ones that are not measurable.

> *Similarly, a NSW local council runs 3-4 waste education workshops per week since 3 years and concludes them with people pledging to change a particular behaviour, which is followed up by the educators. It is a resource intensive project. It requires a couple of educators to be out on the streets and have lots of materials and things, but it's been really popular. Councils love it, and our councils are contributing a little money to it, too. The idea is really well taken up, so these guys are overbooked. They're doing like three, four workshops a week, getting hundreds and hundreds of people every week, and so they have a proven mechanism of following up by sending out postcards, getting the individuals to pledge to take up one out of four. (DK3)*

Table 5: Comparison of interventions' a) expected effectiveness and b) costs, practitioners and published evidence.

Intervention types (after Michie, Atkins & West, 2014)	Examples of interventions		Further Comments	Published Effectiveness*	Practitioner Effectiveness	Practitioner Cost
	From the literature	From the interviews		Reported as MORE effective		(or affordable)
				↑		↑
				↓		↓
				Reported as LESS effective		(or affordable)
EDUCATION - Increase knowledge and understanding						
Information on - the target behaviour and how they address the problem, - resources that can assist in carrying out the behaviours - scheme information - issues and outcomes/the problem	Print, in person and broadcast or digital communications on scheme attributes and desired behaviours that primarily target awareness of options and outcomes in a general and non-personalised way.	Information about services, desired/ correct behaviour and explanations was delivered in - print (stickers, brochures, magnets) - digital (website, apps, news bulletins) - face-to-face (events, schools, seminars, door knocks) Primary target to inform and create awareness. The material was at times targeted at specific groups (e.g. MUDs, kids, non-English speakers) or generic to the location.	Necessary but not sufficient. All practitioners reported running education campaigns on an ongoing basis with a focus on the website, downloadable apps and information brochures. For campaigns with a particular message, material was created and or branded accordingly to support a particular campaign specifically. Education was seen as essential, i.e. it provides the fertile ground for any other intervention type.			
TRAINING – Develop personal strategies and skills to increase peoples' capacity to carry out the behaviour						
Skill-based workshops and training courses Training packages and programs Implementation intentions (private self-planning)	Door stepping (when focusing on skills transfer, not social modelling), training at recycling facilities.	Training was provided to - adults: specifically-designed training workshops (2) as well as more Q&A for community groups - school kids, using audits and games - households, after audits if contamination was observed	Most had school courses including games to train sorting behaviour etc. Two had specific training courses for adults. While the community love it, it is limited in reach and measurability very low especially as education across personal network is hampered due to inconsistency of approach. Personalised approach after bin audit is most effective			
PERSUASION – Tailored communication in response to target audience beliefs, emotions and biases to motivate behaviour						
Vivid imagery / communication, Loss aversion language	Tailored communications based on depth understanding of audience, behaviours and context, for example increasing sense of control and impact of own actions (self-efficacy) on environmental outcomes for those who hold such beliefs, or promoting recycling as good citizenship to those who value that.	Referred to either Marketing or Communication Campaign: - Video clips, ads and imagery tailored at specific audience - Targeted via comms channel Themes - Rather abstract theme, i.e. giving recyclables 2nd life by unbagging them (or taking it) - Recycling as 'everyday' activity, likening it to sorting and washing your laundry; appealing to social norm, i.e. being 'normal' - Trust creation to show that recycling was really occurring	Most had some kind of advertising campaign with some animated imagery. Two had a very elaborate media campaign that was targeted at contamination. One focused on unbagging recyclables and the other on sorting behaviour. Single message and simplicity were said to be at the core.			
SOCIAL MODELLING/ NORMS – Social rules or demonstration that indicate what are common and acceptable behaviours						
Group feedback/comparison Commitments / pledges Implementation intentions (public/social) Opinion leadership / authority	**Social modelling:** Any kind of passing of information via demonstration or discussion in which the initiators indicate that they personally engage in the behaviour, also, for example while doorstepping, or via television (e.g., war on waste).	- Social media via comments, tagging and sharing - Manual bin audits and related face-to-face conversation - Video clips via social media and TV platforms showing correct sorting behaviour - Public demonstrations, e.g. community events, pop-up cleaning events - School programs: public audit where students can observe/ teach correct sorting behaviour	All participants state that face-to-face conversations are the most effective tool as one can convey much more and respond with personal examples. Several state appealing to social norm is most effective. In New Zealand, a community-built waste facility has created such an observable social norm that even visitors follow the example of the locals.			
	Commitment: Individuals commit to produce a certain behaviour or reach a certain goal, most effective when made publicly.	- Take the Pledge Campaign: People commit to a recycling related behaviour and pledge to it online and share it on social media; combined with bin audits	Two interviewees reported this, one as their main and favoured campaign. It is based on Community based social marketing theory, involved training and creates good data sets. Combined with bin audit information, it allows to observe behaviour change.			

(SOCIAL MODELLING / NORMS cont.)	**Feedback:** This intervention strategy consists of providing either individuals or groups with information regarding their recycling behaviour along with a comparison with a predefined standard, so as to show the difference with the standard and motivating them filling the gap. In recent years, new communication channels such as web sites and social networking sites have been employed alongside more traditional means (e.g., newsletters, mails, leaflets, door-hangers, etc.) to convey feedback on recycling.	- Bin Tagging: 3x visual check of kerbside bin re contamination over 6-8 week period, sticker (green, (orange), red) on bin signals performance, specific feedback via letter, postcard or f2f conversation, data collection - Visual shaming via sticker	Unanimously, this method is seen as the most effective. It combines education, feedback and social modelling and allows tying in incentives or commitment campaigns. Campaign duration varied from 6 years ongoing, once a year or a single occasion. Originally introduced in South Australia, it has spread across Australia.			
INCENTIVES – Expectations of financial or social rewards						
Rebates Lotteries Gift vouchers	Incentives refer to any kind of benefit (e.g., monetary rewards, refund and unit pricing programs, gifts, prizes, lottery tickets, discount coupons, etc.) received by consumers as a result of their participation in a recycling program, and in anticipation (e.g. targeting reciprocity). This can include gamification and non-monetary incentivisation.	Incentives campaigns: - Green Money: Reward program (redeemable points) targeted both volume of recycling and contamination behaviour; partnered with local business - Recycle Champion: Reward program (voucher) for recycling behaviour linked to audits and based on friendly competition; partnered with local business In relation to bin audits and contamination: - Visible sticker/tag indicating good performance Single incentives: Bin liners, Recycle Bags				
CONTEXTUAL RESTRUCTURING – Changes to the physical or social context in which the behaviour is performed						
Changing defaults Priming Prompts / cues	Changing bin appearance, simplifying, clarifying, making more lifestyle salient sorting options and facility layout; or other physical or social changes that make recycling correctly easy and convenient, essentially easier to adopt as a contextually queued habit.	- Harmonisation of what can be recycled across region/processors - Colour harmonisation (bins had different colour) - Stickers or tags on bin clarifying sorting/ highlighting changes - Moving from separate to co-mingled and vice versa - Special recycling bags (e.g. clear, free or at a cost)	While all international examples had only used it recently, Australia had previously minimally used this type. However, several interviewees are part of larger collaboration programs around harmonising what can/ can't be collected, with results still unfolding. Overseas examples showed side effects are not uncommon. E.g. comingling made recycling sorting easy but is associated with higher contamination levels. Wheelie bins are easier to store than crates but again are associated with higher contamination levels.			
ENABLEMENT - Removing external barriers to increase opportunities to carry out the behaviour						
Infrastructure provision Product and service development	Modifying bins proximity, size or number, frequency of collection providing home equipment for sorting waste, that reduces or removes physical and logistical barriers to correct recycling.	- Introduction of recycling/ green bin - Indoor recycle sorting bag (e.g. for MUDs) - Extra drop off or collection services (e.g. recycling stations for e-waste, battery collection, excess recyclable drop off) - Varying bin size and number and increased collection frequency (e.g. for MUDs)	After the initial introduction of recycling, the next big enabler was the introduction of a 3-bin system which appears to have greatly reduced the contamination by organic waste. All councils offer in varying degree extra collection services and drop off opportunities. Especially around MUDs infrastructure and logistics have been adapted to ease engaging in right behaviour.			
COERCION – Expectations of punishment or cost						
Fines Taxes	Pay as you throw on landfill bags or by bin weight, fines for incorrect items (if well enforced and supported by enablement and contextual restructuring).	In relation to bin audits and contamination: - Visible sticker/tag indicating poor performance - Non-collection of recycling bin - Removal of bin and priced reinstalment Many international jurisdiction charge 'pay as you throw' on landfill bags	The red stickers appear to work very well, with the final resort to remove the bin only targets people that really don't care. Many see landfill levy as potent as it will move the system to caring more. Others believe it drives illegal dumping and other perverse outcomes.			
RESTRICTION - Reduce opportunities to engage in alternative competing behaviour						
Prohibit products Permissions and approvals Removal of misused equipment	Banning the sale of contaminating items (if well enforced). Escalating non-collection and/or removal of bins if contamination continues.	In relation to bin audits and contamination: - Removal of recycling bin	This is closely tied to feedback, social shaming, and coercion in many programs – e.g. the responsive escalation of feedback, non-collection, removal and cost of re-instatement.			

DISCUSSION

Limitations of review transferability

The published evidence in this rapid review is not strong. Despite a search of three major reference databases, no systematic reviews (SR) were found focused specifically on preventing contamination of recycling, and the one SR focused on household recycling has a high likelihood of bias due to non-conformance with a number of key SR quality criteria.

Similarly, while six relevant narrative reviews were found on relevant aspects of recycling and waste management, they were not all written with the primary goal of informing policy and practice, and prioritise different goals. The lack of a fully systematic and transparent methodology in many of them means the risk of bias is high. The results must be considered in light of these limitations.

However, a full systematic literature review on this topic appears unlikely to generate much stronger conclusions, given the widespread calls for more and better research in the examined reviews. Further specifying and decomposing the problem into specific behaviours, interventions and determinants that are believed to be closely related to contamination outcomes, and related target behaviours, may help focus any such reviews and yield better results should such activity be contemplated.

Acknowledging the lack of translation occurring between research, policy and practice (in all directions), there is reason to believe that improving these links will produce better evidence. Practitioners interviewed had a lot of experience and anecdotal observations to share, but very limited access to strong evidence on what works and why on a case-by-case basis, let alone when comparing different programs, interventions or individual activities. They also represent only a narrow subgroup of local areas and programs across 534 Australian local government areas, let alone globally, and it is possible that a more thorough survey of all programs in Australia or elsewhere would reveal additional insights, and better quality practice-based evidence.

Noting the wide diversity of both determinants and interventions that may be suitable to promote behaviours associated with reducing contamination in recycling, it is not possible on this evidence to strongly recommend specific determinants and intervention to focus on, rather we have indications only.

Promising approaches to reduce contamination

The summary in Table 5 on page 24 is intended as an indicative guide for prioritising future intervention development and further testing, and should not be regarded as a strong guide, for example where there is low tolerance for uncertainty about the behavioural ‘return’ or ‘efficacy’ of a major investment.

This stated, there are some promising similarities, and important differences, between what published literature suggests might be effective behaviour change interventions, compared to practitioner reflections, especially when we consider their experience of the cost effectiveness of different interventions.

- Overall, there is high overlap between published effectiveness and perceived practitioner effectiveness.
- Persuasive communication is favoured overall in comparison with more factual educative interventions, but both should be considered as a necessary foundational component of other interventions, rather than entirely sufficient on their own.

- Contextual restructuring has the overall best result considering effectiveness and cost. We would expect, based on past experience, that this would scale with cost and specificity – i.e. relatively cheap and simple changes to bins, signage and collection areas are likely to influence a large number of people a little, while significantly improving contamination rates beyond that level will likely require more tailored and/or extensive, and therefore expensive, interventions (transitioning to Enablement).
- Enablement, such as better infrastructure and user-centred design of relevant products and services, as well as shifting negative social norms and pressures, is seen as highly effective, but also regarded as higher cost.
- Restriction, such as banning problematic items, is also potentially effective, and seen by practitioners at least as being moderate cost-wise, although many also felt unable to influence the availability of problematic items in interviews.
- Incentives are thought to be more effective by practitioners, than our judgement of the literature's support for it.

This noted, there is no strong evidence pointing to 'silver bullets' to reduce contamination in any given region and certainly not across all regions. Instead, this rapid evidence review of both published literature and practice experience suggests that both a context sensitive, and progressively experimental approach to reducing contamination and improving recycling is necessary.

A number of promising intervention focal areas – namely: making correct recycling as easy and simple as possible via removing barriers and modifying contexts; as well as simplifying choices overall (Briguglio, 2016; Varotto & Spagnolli, 2017); and providing personalised communications such as social modelling and feedback cards (Timlett & Williams, 2008), have been identified, but essentially all options outlined above should be considered in developing new interventions.

Importantly, interventions should also be progressively trialled and evaluated in a systematic and centrally reported manner so a collective picture of what works for whom, under what circumstances and why can be established.

Our practitioner insights, combined with literature, highlight that it must be remembered that in any given context, the entire scheme and how it operates communicates subtly but powerfully, and this interacts with formal communications in sometimes surprising ways. For example, citizens with pro-environmental values who moved to a new house may be surprised and shocked to find soft plastics being included in recycling in their old council was encouraged, but in their new council, is considered a contaminant. Others with different values and priorities may regard such directions or encouragement to set soft plastic aside and take it to a supermarket as unwarranted and impractical harassment while preparing a meal for a hungry toddler in a cramped apartment. Such experiences all shape behaviour and its outcomes. Conversely, the cost, commercial, logistical and environmental life cycle implications of scaling / mainstreaming behaviour effective in trials also needs to be evaluated, as any effective trial may or may not be feasible or desirable on a whole of scheme basis, under current policy settings or international markets and policies.

As a consequence, many of our interviewees proposed taking a fresh look at the system as a whole, to design it in a way that it makes household recycling easier.

> *That's happening in recycling systems around the world, contamination through the actual collection and processing system is a major issue and that's something that you can't solve through communication because it's embedded in the system. And that's where the critical choices about how you set up your system are so important because if you don't get that right, then you can spend as much as you like on the communication and it's just not going to work. (GD13)*

A systems approach means to take the entire supply chain into account and understand how certain decisions affect other parts in the chain. So, for example, practitioners suggested looking at the starting point of the chain in terms of packaging, labelling and imports; the middle part, in terms of consumer and household recycling behaviour and at the final part, understanding the entire recycling process including contractors, processing and the end product. There is an underlying critique of false efficiencies, focusing on a single element of the chain, undermining overall public outcomes, e.g. cheap contracts on council level, that affects the chain working properly together.

> *Do we need all this packaging? That's a choice from a producer and the consumer, but also, if you do have to use that packaging, what's the best packaging to use? Can it be recovered? I think it goes across the whole chain from production to consumption (PH4)*

> *I think from a government, I think from a business, I think it's a shared responsibility, but if it's a shared responsibility, we've got to be clear on who takes the lead and in which way. This is a whole of society approach (LB6)*

Implications for national leadership

Noting the diverse and multi-stakeholder nature of waste management and recycling in Australia, providing leadership and motivation to encourage scheme managers, operators, educators and stakeholders producing potentially recycled items to work together to reduce contamination is critical. Proximity and collaboration play a large role here as well as spreading the burden.

> *So consistency is very important. We need it. It should be a mix of state government, local government, industry working together jointly. And possibly the federal government would do their bit on the front, that would be nice […] That would be new though. But in order to give the states a bit more oomph, if federal could give it more oomph, that'd be great. (LE6)*

All voiced the need for collaboration and while this was somewhat possible on a local level, there was the feeling that such collaboration is easier created under an appropriate leadership and where the roles are allocated.

> *I think from a government, I think from a business, I think it's a shared responsibility, but if it's a shared responsibility, we've got to be clear on who takes the lead and in which way. This is a whole of society approach. (LE6)*

Unanimously in our practice interviews, there was a call for more leadership from a state or national level, and in some cases, from the private sector. Several reported that they felt “small and helpless” compared to the big organisations that are present in the consumer product industry as well as the waste industry itself. In this sense, there was a loud call to support local government and lead a system-wide intervention. Most practitioners pointed out that the solution was greater than just optimising recycling, it was about working more strategically towards managing issues, and ultimately reducing waste altogether and moving on to a circular economy.

> *I think if you could lead the charge with waste education from a centralised body that has reasonable funding, and that funding is available through the levy, then you could react better to things like the China Sword and issues with recycling and contamination that we're seeing, and getting the message more broadly across. It would perhaps almost then be more authoritative and have a bit more clout to it. I think that is very important, if you could centralise that education. What you don't get then is lots of people working in isolation. There's lots of people in local government doing really good stuff in the waste space, but there's so much double-up and that's inefficiency. You could be getting far more bang for your buck if you just centralise that and have it going through one source and through one body. (PH4)*

I guess I can't stress enough that the leadership that we're looking for from state and federal government on waste issues, so their agreement is to do waste management for people and for rate payers and everybody understands that, and that's fine. But there is this feeling with the government that the can is always going to kick down the road for them, […] and contamination is one of those things where councils are expected to do all the education and all the contamination management and all of the auditing and everything. And it can be a source of frustration, and if there were some outspoken adverts in the media, examples, or any that were being run at that level, maybe on TV or radio, etc. Or the governments don't have to do it themselves, but they can source it to the peak bodies like the Australian Packaging Covenant or the recycling peak bodies or the industry. It would be a stronger message, and I think it could boost what councils are often not able to do themselves, which is mass-education, mass-marketing (DK3)

Leadership was requested around helping to design a system that makes recycling easier and more efficient; create a homogeneous approach to recycling including all parts of the chain and support local government in their efforts to communicate the approach, i.e. education. While most agreed that interventions should be tailored at the local communities, which is best done by local government, many suggested that the base information and awareness campaigns around common issues in contamination, e.g. plastic bags, or education around recycling could come from a higher authority, and local efforts could be re-enforced with national communications.

So we're looking for some leadership there. A lot of things are changing, as you would know, in the industry, and there are some really meaningful momentum towards some systematic or systemic change with how the industry responds to waste management and local government is a part of that. And the state government will be part of that whether there's a change of ministers or elected officials or not, and hopefully the federal government, too. (DK3)

In the absence of the above, all practitioners have stated that while there were ways to improve contamination rates, most of the effective campaigns are resource intensive. While waste management occurred on a local level, they desired more financial support to be able to design more effective campaigns. Besides that, they voiced a desire to better evaluate their campaigns or improve the tailoring of campaigns to specific audiences. They related the inability to provide good evaluation measures, success measures, or targeted campaigns to the fact that these kinds of audits are expensive in themselves, not to mention the campaign investment that would precede them.

So evaluation for education's hard to do, and it's expensive, so I would love to do it, though. We've been keeping the EPA in the loop in terms this campaign. In fact, just today I emailed them the final report. There's some little suggestions that, "Hey, this is collateral and this approach is ready to go if there was an interest in extending it or expanding it or tweaking it to go state-wide." And that if they were really serious about it that we should do some evaluation. And that would probably be focus groups and targeted audits (DK3)

Provision of centralised capability building, systems and tools for clarifying problems, understanding audiences, developing solutions and evaluating them, including better data capture via digital and 'internet of things' enabled interventions, campaign resources, etc, may therefore be especially valuable. Similarly, developing a purpose-built waste behaviour-change trial support tool that centrally logs and reports trials and their results, along with training, mentoring and support to use it well, might support this need. As well as supporting better waste education and behaviour change campaigns, meta-analysis of such efforts would also generate policy relevant evidence highlighting the potential, and limitations, of individual behaviour change in the current recycling systems around Australia.

Key opportunities for national leadership include:

- Assist state and local government to make the recycling system easier and more convenient for householders
- Support increased consistency in both scheme characteristics and communications within and across states and territories.

- Encourage more willing cooperation and multi-stakeholder learning on how to identify and prevent contaminating items via channelling feedback from waste educators and MRF operators at the local area level to producers and retailers of problematic items.
- Similarly, the same insights and processes need to engage, and be responded to by, brand owners, retailers, industry groups and co-regulatory bodies, especially those designing and profiting from the sale of problematic and confusing items, or operating and designing recycling schemes.
- If cooperation and whole of system problem solving does not eventuate, implement regulations such as extended product stewardship responsibility that internalises the costs and aligns incentives to reduce waste and increase diversion to those best placed to act – i.e. 'polluter pays'. Waste educators and MRF operators have limited options to encourage redesign of problematic items compared to companies profiting from selling them in the first place.
- Directly invest in rigorous evaluation of promising behavioural approaches to reduce contamination, based on findings in this review, particularly scheme characteristics.
- Work with state governments to provide support and capacity building to local councils to be able to better evaluate their own efforts and disseminate results.
- Work with and support local government groups to best represent, support and champion waste educators in broader forums and policy consultation.

Implications for broader approaches to communications

The evidence indicates that a national 'education' campaign that aims to reduce contamination by primarily communicating factual information about specifics of what and how to recycle may not be effective given the many differences between what is and isn't accepted in kerbside bins across local government areas around Australia. Further findings from the reviews particularly suggest that informational communications on their own are unlikely to change behaviours.

A national 'persuasive' communications campaign, however, may provide benefit if aligned to and supporting local efforts. Persuasion rated highly amongst both the published literature and practitioners for effectiveness. There was a strong feeling amongst practitioners that national support would be extremely helpful, and that there is some base information that could be valuable coming from a higher authority. At the same time, the evidence around persuasion suggests that it is important to identify relevant positive beliefs and values, and clusters of high barriers to correct behaviour, and tailor communications to target them. Some general messages may be effective in encouraging awareness, supportive beliefs and attitudes across broad audiences, if based on a good understanding of target audience segment. This said, more behaviourally impactful messaging, leveraging the supportive environment such a campaign could facilitate, will necessarily have to be tailored to local needs and options.

This review has provided some indications of cross-regional barriers that might be valuable to address through a national campaign, as shown in the left column of Table 5. Identified barriers also align with those identified in parallel research in the broader program this report occurs within. Interviews with state government and environmental agency recycling experts, identified potential message types and associated behaviours that might mitigate the barriers, also shown in the table below.

Before utilising any such messages in a campaign however, it would be important to consult with state and local governments on the various message options to ensure they were nationally relevant and would not create conflicts with any local rules. Furthermore, promising messages should be tested before a national rollout through mechanisms such as online experiments and/or focus groups to limit any unintended perverse outcomes.

Table 6: Potentially useful cross regional messaging addressing problematic beliefs and attitudes.

Barrier	Potential Message type	Possible target behaviour
Belief that anything recyclable can go in the kerbside bin	Not everything that is recyclable can go in the household recycling bin	Look for the ARL or check with local Council
Belief that recycling rules are universal	What is and isn't recyclable varies between Councils and collection areas Just moved? Check if your understanding of the rules on what can be recycled or not needs to move too.	Check with local council
Belief in own (outdated, incorrect) knowledge	Recycling rules have changed over the years, and may not be the same as when you first learnt them. X% of Australians think they know how to recycle but over 90% are still putting at least one wrong thing in the bin	Test your knowledge Check with local council Don't tell others what to do unless you know their local council rules
Misunderstanding of the recycling system capabilities and vulnerabilities	How the recycling system actually works (including the existence of both hand and machine sorting) Why contamination is an issue, and what happens when contaminants are included	Be careful when recycling If in doubt, leave it out Avoid 'wish-cycling'
Concern, distrust or disengagement with the recycling system	Despite recent 'shocks' most material collected from household recycled is actually being recycled, including here in Australia Your efforts are not being wasted / Recycling works, when you do You have constructive opportunities to feedback dissatisfaction with products that can't, or are difficult to recycle to makers and retailers You have constructive opportunities to feed back dissatisfaction with how your recycling scheme operates to your council and their contractors	Trust the system Be careful when recycling Don't give up, get active. If your favourite product can't be, or is hard to recycle: • Find a better alternative product or activity to meet your need, and/or • contact the retailer and/or maker, and ask them to improve it. • Encourage your council and operators to upgrade the recycling system.

Furthermore, as above, communications on their own are unlikely to result in widespread behaviour change, and so should necessarily be part of an evidence informed, user-centred and integrated approach to recycling and waste management. It is important that broad-reaching communications channel people to high quality, localised and behaviourally effective interventions relevant to their local situation. Support at the local level is also needed to ensure these exist.

CONCLUSION

BehaviourWorks Australia conducted a rapid review to identify, evaluate and synthesise published literature, and practitioner reflections, on effective interventions to reduce contamination of recycling.

The literature review was undertaken over a period of approximately two months in late 2018. Comprehensive database searching and filtering yielded 137 eligible citations, of which two were systematic reviews and six narrative reviews. Their findings were synthesised along with related primary studies, reports and other evidence cited. Our practice interviews occurred in early 2019 over approximately 6 weeks, and engaged with 17 people, predominantly waste educators in local government.

Key findings are summarised below.

Recognise the limitations of the current waste and recycling system

- Recycling schemes in Australia and elsewhere have not been designed to optimise correct recycling nor diversion of problematic items, over other scheme goals and characteristics.
- Higher cooperation with preferred behaviours can be expected among households where supportive moral preferences exist (e.g. that recycling behaviours are desirable for environmental, social, political belief reasons), all other factors remaining constant. Conversely, individuals, households and communities with unfavourable beliefs and values will need different interventions.
- High constraints on space and time exist, and matter, for some households. This suggests that policymakers need to understand when they are engaging with neighbourhoods, localities or regions characterised by high constraints. These, in turn, may be proxied by demographic data on poverty, dwelling size, and household size.

Consider the poor state of existing evidence

- Reviews cite a consistent lack of accessible and integrated evidence whether exploring broad scheme characteristics. All recommend variations of progressive experimentation, adaptive management and policy. Failure to integrate research and practice has limited understanding in both academia and practice of what works and why, under what circumstances, and for whom.
- The relationship between determinants, intervention and outcome is complex and not well understood. And as noted above, increased collaboration between research and practice will benefit all.
- To be successful, interventions must be based on a deep understanding of the target audience, the target behaviour and the context. Individual's and households' recycling and waste behaviour is affected by a wide range of personal and contextual characteristics. In all cases, as there is no ''one size fits all'', the specific needs in each region in scope should be identified in order for the set of instruments to be properly adjusted.

Redesign schemes to make desired behaviours easy and reduce contamination

- Before initiating behaviour change or communications campaigns, it is important to make correct recycling easy and desirable. The findings clearly suggest that higher cooperation can be induced by relieving constraints and making correct recycling easier. Schemes may offer more frequent collection and smaller waste-collection containers to relieve limited space. Simple and clearly communicated waste separation processes can also relieve time constraints. Products need to be designed with easy and correct recycling in mind.
- Environmental alterations are the second most widely effective intervention to promote recycling, which consists of making recycling more convenient and easy to perform by modifying the physical environment, for instance, by increasing bin proximity or number, changing their appearance, or providing home equipment for sorting waste, or simpler, well-designed and communicated products to be recycled.
- Increasing the consistency and predictability across regions of what can be recycled, and preferred alternative reduction and diversion behaviours, would reduce confusion and increase the ability to encourage, learn and communicate about what works across Australia.

Then improve via behavioural communications

- The most widely efficacious intervention to preferred behaviours was social modelling, which consists of passing on information via demonstration or discussion in which the initiators indicate that they personally engage in the behaviour (Varotto and Spagnolli 2017: 173).
- Timlet and Williams (2008) found that incentives and feedback cards were highly effective for correcting contamination, and feedback cards were cost effective. The impact of social modelling via personalised communications was reduced by its limited reach and costs of deployment in this study. That said, another found it was effective in reducing contamination of sorted food waste, but not in dry recyclables (Bernstad et al., 2013).
- Personalised engagement is likely to help in waste prevention also. Sharp et al (2010) recommend that waste prevention needs to become more ‘visible’ and campaign deliverers need to help people identify what they can specifically do, and how to do it well. (Sharp, Giorgi, and Wilson 2010).
- By ensuring a deep understanding of the audience, behaviour and context, administrators can pre-empt unintended side effects (like illegal disposal, contamination and other regressive impacts) of intervention. This entails considering not only the attributes of the schemes but also how these are perceived, and how they interact with household members’ motives and constraints (Briguglio, 2016; Varotto & Spagnolli, 2017).
- Communication interventions, be it the promotion of scheme attributes (including incentives themselves), awareness-raising on environmental impacts, efficacy, or norms, can also stimulate cooperation. But some considerations merit caution too, including the prospect that (costly) mass media appeals and promotion can simply be ignored, that communication interacts with motives to create divergent outcomes; and that subtle cues (including scheme attributes themselves) can communicate messages to households (Briguglio, 2016). This reduces how targeted and behaviourally-effective a cross-regional communications and education campaign can be.

Summary of intervention effectiveness

A summary of the understood effectiveness of different intervention types, based on findings from the published literature and practitioner interviews is provided below (see Table 5, p.24 for more detail, and the discussion of promising interventions on page 26).

Table 7: Summary of understood effectiveness of different behavioral interventions to prevent recycling contamination at the curbside.

Intervention types *(after Michie, Atkins & West, 2014)*	**Effectiveness** *(Green= works)*		**Cost** *(Green = low)*
	Published	**Practitioner**	
Contextual restructuring: Changes to the physical or social context in which the behaviour is performed			
Changing defaults, Priming, Prompts / cues			
Enablement: Removing external barriers to increase opportunities to carry out the behaviour			
Infrastructure provision, Product and service development			
Social modelling/norms: Social rules that indicate what are common and acceptable behaviours			
Social modelling			
Commitment			
Feedback			
Restriction: Reduce opportunities to engage in alternative competing behaviour			
Prohibit products, Permissions and approvals, Removal of misused equipment			
Persuasion: Tailored communication relating to audience beliefs, emotions and biases to motivate behaviour			
Vivid imagery / communication; Loss aversion language			
Incentives: Expectations of financial or social rewards			
Rebates, Lotteries, Gift vouchers			
Coercion: Expectations of punishment or cost			
Fines, Taxes, Other consequences			
Education: Increase knowledge and understanding			
Information on target behaviour and how to address problem; Resources that can assist in carrying out the behaviours			
Training: Develop personal strategies and skills to increase peoples' capacity to carry out the behaviour			
Skill-based workshops and training courses; Training packages and programs; Implementation intentions			

Opportunities for national leadership

The converging implications of the reviews examined and practitioner experiences are that a centralised and cross-regional effort to reduce contamination in recycling could usefully focus on:

1. Supporting diverse stakeholders to converge on clear identification of specific problem items and preferred alternative behaviours, including in recycling, that occur and are feasible within the geographic catchment level of collection and sorting for a given area where contamination is a problem.
2. In depth, qualitative and quantitative research of target audiences in target regions to identify key population segments in terms of both demographic, psycho-social, and contextual determinants of recycling outcomes, and the drivers and barriers of both desired and problem behaviours.
3. Evidence-informed and end-user focused development of interventions to promote desired behaviours, starting with convenience, and personalised/tailored communication, but including all promising options for consideration, including redesign of major scheme elements.
4. Well-designed progressive experimental design, leading to field implementation and mainstreaming at scale, rather than business as usual or jumping to implement solutions at scale with weak evidence.
5. Comprehensive monitoring and evaluation, with central logging and reporting of trials, efforts and outcomes, including contamination, waste diversion, cost and other relevant outcomes.
6. Synthesising, integrating and translating lessons from individual trials, to build capability. The goal should be to facilitate inter- and intra-organisational and policy learning across multiple scales, and add to the collective body of published, quality evidence in a transparent, relevant and accessible manner.
7. Using national (and/or cross-regional) communications and education to build a supportive environment for behaviour change by tackling universally incorrect beliefs and negative norms, building supportive norms and attitudes, and channelling users to local information for preferred recycling, diversion and avoidance behaviours that reduce contamination. This needs to be based on a good understanding of the target audience and sub-groups within it. Behavioural communication, in particular, needs to be tailored to local scheme, audience and preferred behaviour needs.

The following caveats must be re-iterated and remembered in interpreting these conclusions:

- Despite a comprehensive search of three major publication databases, no reviews focusing specifically on contamination were identified, and on general recycling participation, only two relevant but low-quality systematic reviews, and six narrative reviews were found. The available evidence is overall weak.
- More primary research is needed, although a focused and high-quality systematic review of primary studies may also provide further and more robust insights than has been available for this review.
- Practitioner interviews provide deep insights into a relatively small number of cases, and wider input would likely provide further insights.

APPENDICES

APPENDIX 1: REFERENCES

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APPENDIX 2: PROJECT METHODS

RAPID REVIEW METHODS

Search strategy

A comprehensive search of the following database was undertaken: Scopus, ProQuest Agricultural & Environmental Science Database, and PsycINFO. Reference lists of included studies were also checked. The Scopus search strategy is reproduced below:

Table 1. *Scopus search strategy*

	Search string
1	(TITLE-ABS (*household** OR *apartment** OR *flats* OR *resident** OR *citizen** OR *neighborhood* OR *neighbourhood* OR *council* OR *community* OR *home* OR *municipal*) W/5 TITLE-ABS (*recycl** OR *waste* OR *disposal* OR *kerbside* OR *kerbside* OR *roadside* OR *contaminat**))
2	ABS (*intervention* OR *program** OR *train** OR *educat** OR *campaign* OR *strateg** OR *coercion*) W/5 TITLE-ABS (*recycl** OR *waste* OR *disposal* OR *kerbside* OR *kerbside* OR *roadside* OR *contaminat**))
3	(LIMIT-TO (SRCTYPE , *"j "*)) AND (LIMIT-TO (DOCTYPE , *"ar "*) OR LIMIT-TO (DOCTYPE , *" re "*) OR LIMIT-TO (DOCTYPE , *" ip "*)) AND (LIMIT-TO (PUBYEAR , *2019*) OR LIMIT-TO (PUBYEAR , *2018*) OR LIMIT-TO (PUBYEAR , *2017*) OR LIMIT-TO (PUBYEAR , *2016*) OR LIMIT-TO (PUBYEAR , *2015*) OR LIMIT-TO (PUBYEAR , *2014*) OR LIMIT-TO (PUBYEAR , *2013*) OR LIMIT-TO (PUBYEAR , *2012*) OR LIMIT-TO (PUBYEAR , *2011*) OR LIMIT-TO (PUBYEAR , *2010*) OR LIMIT-TO (PUBYEAR , *2009*) OR LIMIT-TO (PUBYEAR , *2008*))
4	(LIMIT-TO (LANGUAGE , *"English "*))
5	#1 AND # 2 AND #3 AND #4
	Complete Search String: (TITLE-ABS (*household** OR *apartment** OR *flats* OR *resident** OR *citizen** OR *neighborhood* OR *neighbourhood* OR *council* OR *community* OR *home* OR *municipal*) W/5 TITLE-ABS (*recycl** OR *waste* OR *disposal* OR *kerbside* OR *kerbside* OR *roadside* OR *contaminat**)) AND (TITLE-ABS (*intervention* OR *program** OR *train** OR *educat** OR *campaign* OR *strateg** OR *coercion*) W/5 TITLE-ABS (*recycl** OR *waste* OR *disposal* OR *kerbside* OR *kerbside* OR *roadside* OR *contaminat**)) AND (LIMIT-TO (SRCTYPE , *"j "*)) AND (LIMIT-TO (DOCTYPE , *"ar "*) OR LIMIT-TO (DOCTYPE , *" re "*) OR LIMIT-TO (DOCTYPE , *" ip "*)) AND (LIMIT-TO (PUBYEAR , *2019*) OR LIMIT-TO (PUBYEAR , *2018*) OR LIMIT-TO (PUBYEAR , *2017*) OR LIMIT-TO (PUBYEAR , *2016*) OR LIMIT-TO (PUBYEAR , *2015*) OR LIMIT-TO (PUBYEAR , *2014*) OR LIMIT-TO (PUBYEAR , *2013*) OR LIMIT-TO (PUBYEAR , *2012*) OR LIMIT-TO (PUBYEAR , *2011*) OR LIMIT-TO (PUBYEAR , *2010*) OR LIMIT-TO (PUBYEAR , *2009*) OR LIMIT-TO (PUBYEAR , *2008*)) AND (LIMIT-TO (LANGUAGE , *"English "*))

Screening and selection

Two reviewer screened the citations against the inclusion and exclusion criteria listed in Table 2. Data extracted from the included articles was used to inform a commentary on the outcomes of household recycling interventions.

Table 2. *Inclusion and exclusion criteria*

Aspect	Include	Exclude
Study Type	**Systematic reviews** (SRs), defined as an overview of primary studies containing an explicit statement of objectives, materials and methods and that has been conducted according to explicit and reproducible methodology. Reviews of quantitative or qualitative studies will be included. **Narrative reviews:** overviews of primary studies lacking explicit and reproducible methodologies but which have had at least some form of quality assurance such as peer review for inclusion in a journal. If too few systematic reviews and narrative reviews, then inclusion of primary studies, favouring those including and comparing several interventions.	All other study designs including: Primary studies, theory / frameworks, modelling, technical research (for example, life cycle assessment, material flows outside of the context of an intervention), single case studies, feasibility studies.
Population	**Residential populations** of any kind, living in permanent structures such as houses, flats and apartments.	Populations in managed institutional settings such as residential education, medical, military, tourist and similar facilities.
Study Design	**Interventional** (population-level or individual)	Descriptive, exploratory and formative designs lacking intervention relevance.
Study Setting	Studies in all geographical and jurisdictional settings practically comparable to Australia	Studies in geographical and jurisdictional settings in less-developed country with contexts less comparable to Australia.
Intervention	Primary aim of effective recycling **interventions that can be used to reduce contamination of kerbside collection** by other waste streams And/or as a secondary preference, **interventions to divert recyclables from landfill and other inappropriate waste streams**	A number of reviews and studies exist on food, pharmaceutical waste and hazardous waste, which we excluded.

Outcome	**Primary outcome:** Identification of effective recycling interventions **Secondary outcome:** Interventions are a means to reduce contamination in recycling which can be measured by count, weight and/or volume. • Reduction of separated recyclable material being contaminated by inappropriate items by weight, volume or count. • Reduction of separated recyclable material being rejected for processing or extensive secondary treatment due to contamination. • Kg of recycling to landfill per head of population (SDG 12.5 indicator) • Kg of recycling diverted from landfill per head of population • Comparative cost of intervention to alternatives	Related outcomes: • Reducing contamination in terms of heating value • Balancing recycling versus waste to energy optimum mix.
Publication status	**English-language** **Peer-reviewed journal** **Publications or reports** Published in the **last 10 years** i.e., 2008 onwards	Books, conference proceedings, grey literature

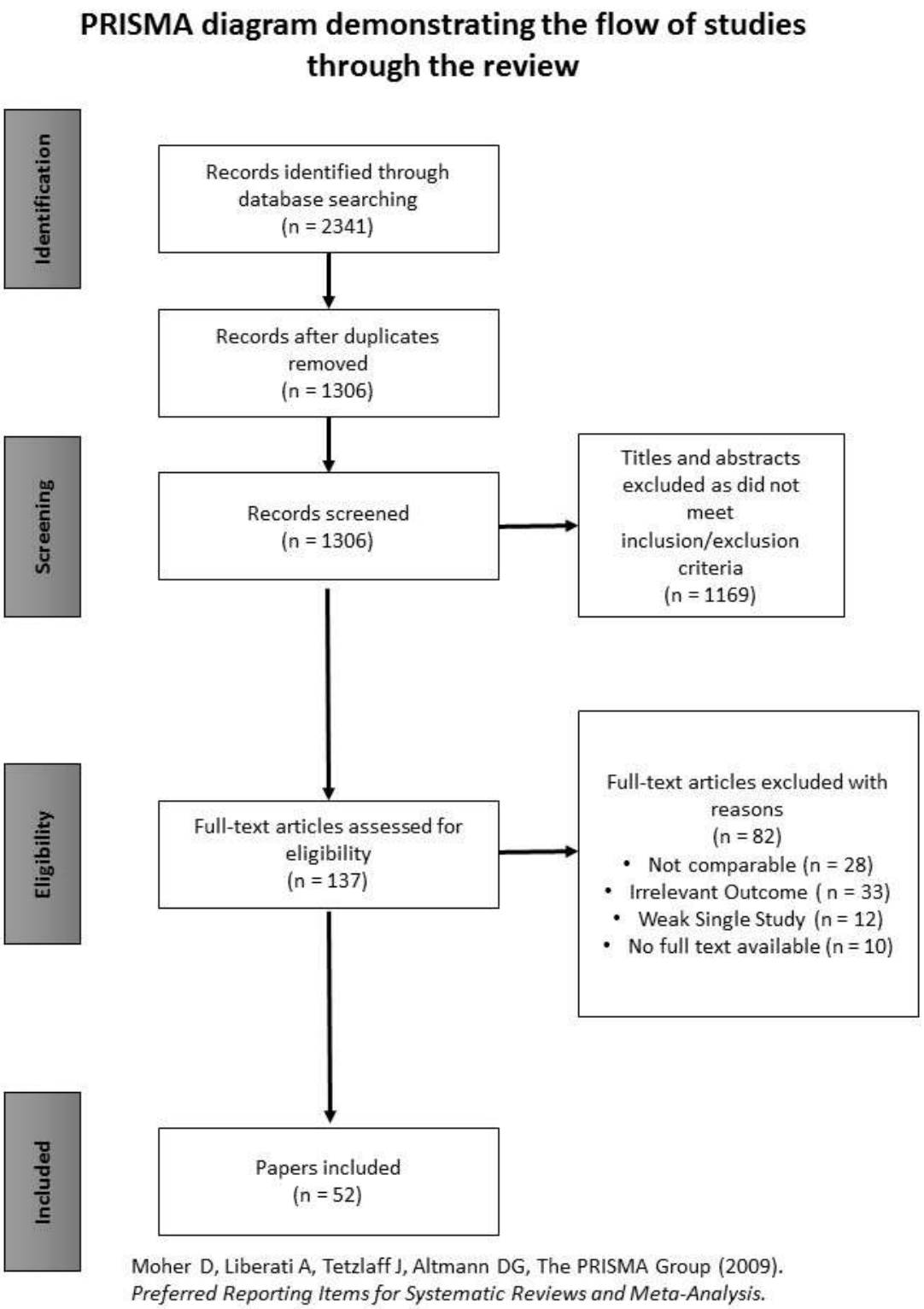

Figure 3: Flow diagram of rapid review of literature

APPENDIX 3: RAPID REVIEW QUALITY APPRAISAL

Table 3. Quality appraisal of included systematic reviews

Criterion (AMSTAR 2)	Varotto 2017	Zaccho 2016
1. Did the research questions and inclusion criteria for the review include the components of PICO?	Yes	No
2. Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol?	Partial Yes	No
3. Did the review authors explain their selection of study designs for inclusion in the review?	Yes	No
4. Did the review authors use a comprehensive literature search strategy?	Partial Yes	Partial Yes
5. Did the review authors perform the study selection in duplicate?	No	No
6. Did the review authors perform data extraction in duplicate?	No	No
7. Did the review authors provide a list of excluded studies and justify the exclusion?	No	No
8. Did the review authors describe the included studies in adequate detail?	Yes	No
9. Did the review authors use a satisfactory technique for assessing the risk of bias in individual studies that were included in the review?	No	No
10. Did the review authors report on the sources of funding for the studies included in the review?	No	No
11. If meta-analysis was performed, did the review authors use appropriate methods for statistical combination of results?	Yes	N/A
12. If meta-analysis was performed, did the review authors assess the potential impact of risk of bias in individual studies on the results of the meta-analyses or other evidence synthesis?	Yes	N/A
13. Did the authors account for risk of bias in individual studies when interpreting/discussing the results of the review?	Yes	No
14. Did the review authors provide a satisfactory explanation for and discussion of heterogeneity observed in the results of the review?	Yes	No
15. If they performed quantitative synthesis, did the review authors carry out an adequate investigation of publication bias (small study bias and discuss its likely impact on the results of the review)?	Yes	N/A
16. Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?	Yes	Yes
TOTAL yes / applicable items **Overall confidence in the results of the review**	11/16 Low	2/13 Critically low

APPENDIX 4: REVIEW SUMMARY AND DATA EXTRACTION TABLES

The below passage summarises reviews in more detail than the evidence synthesis, and is followed by extraction tables for all included reviews.

Effective interventions to increase household cooperation with waste policy goals

Briguglio (2016)

Reviewing literature from environmental and behavioural economics on household cooperation with waste policy goals, Briguglio synthesizes it around two themes. (1) initial conditions conducive to cooperation (including household motives and constraints and, by association, the demographics of cooperative households) and (2) intervention that may stimulate (or suppress) cooperation.

In reviewing literature on initial conditions, (Briguglio, 2016: 506) suggests that household cooperation in waste management is stimulated by members' desire to fulfil their moral preferences, and suppressed by the constraints of limited space and time. Habit also plays a role in determining household waste management behaviour.

The literature further suggests that demographic characteristics can act as proxies for such preferences and constraints, in turn providing useful clues as to which households are more likely to participate in recycling schemes. Higher educated persons, females as well as residents in close-knit communities are associated with stronger cooperation, while smaller dwellings and households face higher constraints and demonstrate lower cooperation. Income and age cohorts, on the other hand, are harder to associate with cooperation as they can proxy several motives and constraints. These initial conditions offer various entry points for policy-makers or service-providers aiming to stimulate cooperation in waste management.

Three distinct intervention types were studied in detail – those focused on convenience, cost and communication. Briguglio (2016: 515) summarises that effective waste management intervention can, and often does involve convenience-based attributes, sometimes complemented with monetary incentives and often with some form of public communication.

Such instruments may aim to enhance the (perceived) benefits from cooperation, to reduce the (perceived) costs of cooperation and to increase the (perceived) costs of waste disposal. A marginal tax on household waste disposal seems to incentivize cooperation but political implications, including low rates of substitution into recycling/reduction, the possibility of incentivising other (polluting) options, and the possibility that taxes suppress the moral benefits, merit consideration. Communication intervention, be it the promotion of scheme attributes (including incentives themselves), awareness-raising on environmental impacts, efficacy, or norms, can also stimulate cooperation. But some considerations merit caution here too, including the prospect that (costly) mass media appeals and promotion can simply be ignored, that communication interacts with motives to create divergent outcomes; and that subtle cues (including scheme attributes themselves) can communicate messages to households.

Effective interventions to increase recycling rates at a household level

Varotto and Spagnolli (2017)

In their systematic review, Varotto and Spagnolli (2017) focused exclusively on psychological strategies in the home environment to promote household recycling. Social modelling and environmental alterations were identified as the most effective recycling interventions among prompts and information, feedback, commitment, and incentive strategies. Numbers of studies reviewed include prompts and information (27 treatments); feedback (14 treatments); commitment (11 treatments); incentives (11 treatments); environmental alterations (4 treatments) and social modelling (6 treatments). Some studies (8) rely on a combination of strategies.

Environmental alteration interventions "consists of making recycling more convenient and easy to perform by modifying the physical environment for instance by increasing bins proximity or number, changing their appearance, or providing home equipment for sorting waste" (p. 172).

Interventions based on social modelling include passing on information via demonstration or discussion where the behaviour is personally demonstrated by the communicator. The personal engagement in recycling behaviours by the initiators is an important criteria.

Specifically tailoring the intervention to the target recipients and context was seen as important and consequently understanding the determinants and barriers of context specific household recycling are essential for an effective intervention design.

As noted by Tabanico and Schultz (2007) commenting on recycling campaigns conducted in US, it is surprising that so little attention is paid to the 'people' aspect of recycling program, and that so many campaigns seem to be based only on the perceptions of the designers or on the priorities of the service provider, instead of on any identified need of the recipients (Tucker & Speirs, 2002; Jesson, 2009).

It is pointed out that most interventions focus on the duration of the intervention itself, without considering long-lasting effects above and beyond the intervention duration, making it difficult to conclude the effectiveness over time.

The authors are encouraged by the potential of digital and 'internet-of-things' enabled interventions to improve interventions, their evaluation, and to overcome some of the limited understanding we currently have of the connections between determinants, intervention and outcomes. For example, using Radio Frequency Device (RFD) tags to track waste items, item recognition apps, smart cam and social media reporting of recycling outcomes on a personal and group basis, however none of the reported studies including such channels and strategies attempted the holistic analysis proposed by the authors.

The review also examined the relationship between identified determinants of recycling behaviours, and intervention types (see Table 4, below). Relatively few interventions take into account these determinants. Of those that do, motivation, information and knowledge, beliefs/perception of recycling consequences and social influence are widely covered. However, individual background factors (socio-demographic factors such as age, personality traits, recipients' general attitudes toward environment and specific attitudes toward recycling, recycling experience, sense of community) as well as contextual factors (the role played by the different service characteristics) are seldom considered in interventions reported in this review.

Table 8: Summary of possible determinants of recycling behaviours identified in 189 articles and categorised as per Iyer and kashyap 2007. (Varotto and Spagnolli 2017)

Factor category	Sub-categories and comments
Socio-demographic factors	Age, education level, income, gender, dwelling type, household size, homeownership, household type, employment status and ethnicity
Psychological factors	**Information & Knowledge** - information that a recycling scheme exist; knowledge about what, where, when and how to recycle (how-information)
	Convenience/Effort - perceived lack of time/space, perceived effort, perceived difficulty in carrying out recycling
	Social Influence - perceived support/pressure, beliefs about the behaviour of others, social comparisons
	Responsibility - moral obligation (perceptions about personal responsibility for recycling/internal locus of control), perception of impact (beliefs that the individual can make a difference through recycling), self-perception (considering self as a recycler)
	General Environmental Attitudes - general positive/negative attitudes toward the environment
	Beliefs/Perceptions of Recycling Consequences - information and beliefs about the consequences of (not) recycling (why-information)
	Specific Recycling Attitudes - specific positive/negative attitudes toward recycling
	Motivation - intrinsic/extrinsic motivation(s) to recycle
	Recycling Experience - habits, past recycling behaviour
	Behavioural Skills - self-organization skills, self-efficacy (beliefs about self-capability)
	Perception of Service Provider - positive/negative perception of the service provider
	Emotion - positive/negative emotions connected to recycling
	Sense of Community - a sense of attachment/concern to the community, perception of recycling as an activity that benefits own community
	Personality Characteristics - personality traits connected to recycling (e.g., conscientiousness, collectivism, etc.)
Contextual factors	**Service** - type of collection system, waste collection frequency, provision of free recycling bins/bags, whether recycling program is mandatory or not
	Monetary Incentives - unit pricing, rewards, refund programs
	Location of Bins - presence of recycling bins, their distance to the recyclers' houses, availability and accessibility
	Characteristics of Bins - bins' color, shape and capacity
	Product Characteristics - the shape of the product that has to be recycled, the material(s) composing it, its cleanliness/dirtiness

SYSTEMATIC REVIEWS

Varotto, A., & Spagnolli, A. (2017). Psychological strategies to promote household recycling. A systematic review with meta-analysis of validated field interventions. Journal of Environmental Psychology, 51, 168-188. doi:10.1016/j.jenvp.2017.03.011
Setting
Households
Inclusion/Exclusion criteria
Population: Households in developed countries Study design / intervention: - RCT - Across time design - Combination of RCT and across time design Outcome: Field interventions to promote household recycling Other study characteristics: N/A
No. of included studies / Total number of participants
- 47 studies included in qualitative synthesis - 36 studies included in quantitative synthesis (meta-analysis) - 187 studies regarding determinants of household recycling
Study designs of included studies
Diverse, includes RCTs, pre-post, and exploratory.
Date of most recent search (month, year)
Published from 1990 to 2015
Authors' conclusions
"The most effective ones, according to the meta-analysis conducted here, are social modeling and environmental alterations. An examination of the underlying factors considered in each intervention also showed that some of them are severely underrepresented, namely those that would make such interventions better tailored to the targeted recipients and context" p.176 "On the basis of such a preliminary analysis, it might also be possible to segment people, in order to tailor the intervention strategy to the needs of specific audiences (Jesson, 2009; McKenzie-Mohr, 2013; Tucker & Speirs, 2002). p. 177 "The results of the meta-analysis highlight that various types of interventions are successful in increasing recycling behaviour for the duration of the intervention itself. However, the long-lasting effects of these treatments remained largely untested, with obvious negative implications for policy-makers and community leaders" p. 177 "We tried to delineate a stronger link between intervention-based and determinant-based research. In doing so, we evidenced that some determinants of recycling are systematically underrepresented in intervention-based research, and that preliminary indepth analysis of the context under examination is needed to better address the existing barriers to recycling and to design more effective interventions." p.177
Results of quality appraisal (appendix)
Low

Zacho, K. O., & Mosgaard, M. A. (2016). Understanding the role of waste prevention in local waste management: A literature review. Waste Management and Research, 34(10), 980-994. doi:10.1177/0734242X16652958
Setting
Households
Inclusion/Exclusion criteria
Keywords: 'waste prevention', 'household', and 'reuse' Population: Household in developed countries Study design / intervention: n/a Outcome: To inform local waste managers about household waste prevention Other study characteristics: n/a
No. of included studies / Total number of participants
- 50 publications of relevance through search - 8 through reference search
Study designs of included studies
- Quantitative/surveys - Case studies - Qualitative micro-studies - Modelling (quantitative) - Review - Studies based on secondary data/discussion articles
Date of most recent search (month, year)
2015?
Authors' conclusions
"… Consensus that it is too simplistic to view waste reductions as merely a question of individuals making better choices. Rather there is a need to change the structures in which practices related to waste prevention occur." (p. 990) "In the design of future casevstudies, we suggest specific attention be paid to monitoring methods of specific types of initiatives. The reason is that in a majority of recent case studies it has not been possible to reliably determine the correlations between cause and effect. Too many measures have been initiated simultaneously to determine which one(s) had which effect." (p. 990) "Reuse is principally the second best solution in the waste hierarchy and is covered by the definition of waste prevention. However, it is unclear what the environmental effects of reuse actually are, because second-hand products do not replace new products one-to-one. Defining the system boundaries of reuse is the largest challenge of determining the effects of reuse, but if reuse is to be prioritised, there may be a need for more specific assessments of the environmental effects." (p. 990) "The potential of waste prevention measures depends on local characteristics." (p. 990)
Results of quality appraisal (appendix)
Very Low

NARRATIVE REVIEWS

Briguglio, Marie. 2016. 'Household Cooperation in Waste Management: Initial Conditions and Intervention'. Journal of Economic Surveys 30 (3): 497–525. https://doi.org/10.1111/joes.12156.

Setting

International review for the purposes of supporting household cooperation in waste management.

Inclusion/Exclusion criteria

- Unsystematic desktop research focusing primarily on environmental economic and behavioural economic research reviewing both the determinants of household level cooperation with existing policies, and a range of applied studies seeking to determine the impact of different intervention regimes in different contexts.
- No review methodology provided but it appears to be a comprehensive review, if not definitively systematic.

Population: Household focus

Study design / intervention: In assessing the role of intervention, by far the strongest emphasis in economic studies on household waste has been on the responsiveness of households to convenience-based attributes and to monetary incentives, both of which change the cost-benefit trade-off faced by households The role of communication as part of the intervention toolkit has received far less attention, not just in recycling, but in environmental economics more generally. Interventions include mass media, face to face (doorstopping), but less research considers the impacts of framing, channels and messengers. Nonetheless, the author asserts that useful insights can be drawn from economic research on public goods and social dilemmas as well as from work in the field of economic psychology on framing and priming to stimulate cooperation in environmental decisions.

A handful of studies have assessed participation in mandatory recycling schemes, where fines operate in the case of non-compliance, but this review focus on voluntary participant. The author does note research suggesting that whether recycling is mandatory or not can be a moot point - if it is neither enforced by fines, nor perceived as such by households. The relationship between a fine and participation may also be diluted by low probabilities of detection and punishment (Briguglio, 2016: 499).

Outcome: Most research reviewed is focused on waste separation rates, that is, recycling waste as a fraction of total waste generation. In some instances authors focus on rates of recycling in single streams of waste (e.g. bottles), while in others, the analysis extends to multiple streams. In some studies, recycling weight per capita was considered as the key dependent variable. Some work has sought to capture the extent of household cooperation by quantifying the effort or the time spent on recycling.

No. of included studies / Total number of participants

This is an extensive review paper looking at both determinants and interventions. Focusing on a desktop review of studies used in sections reporting on interventions (as opposed to determinants), and which were not clearly theory only, the paper cites at least 161 evidence sources.

- Three reviews
- Three meta studies
- 155 (likely) single studies

It was not possible to determine the number of participants in studies from the information provided within the review.

Study designs of included studies

Applied work in this field typically proceeds by deriving and estimating a reduced form equation, or system of equations, and employing data drawn from one or more municipalities, or across an entire country. Much work on the economics of recycling is, in fact, based on aggregated crosssectional, or panel data. This said, household-level survey-based data has become increasingly popular in economic analysis of recycling behaviour. The use of experimental or quasi experimental techniques characterises some of the more recent efforts to understand the determinants of cooperation in the field (Briguglio, 2016: 498-499).

Date of most recent search (month, year)

Not stated. Prior to 2016.

Authors' conclusions
In synthesis then, waste management intervention can, and often does involve convenience-based attributes, sometimes complemented with monetary incentives and often with some form of public communication (Briguglio, 2016: 515). Communication intervention, be it the promotion of scheme attributes (including incentives themselves), awareness-raising on environmental impacts, efficacy, or norms, can also stimulate cooperation. But some considerations merit caution here too, including the prospect that (costly) mass media appeals and promotion can simply be ignored, that communication interacts with motives to create divergent outcomes; and that subtle cues (including scheme attributes themselves) can communicate messages to households (Briguglio, 2016: 515). Recommendations: Three key cues for policy makers are 1) household cooperation in waste management is stimulated by members' desire to fulfil their moral (environmental, social, political) preferences. Higher cooperation can be expected among households where such favourable preferences exist, all other factors remaining constant. 2) households have limited space and time, and that this constrains cooperation in waste management, suggests that policy makers would do best to avoid neighbourhoods, localities or regions characterised by high constraints. These, in turn, may be proxied by demographic data on poverty, dwelling size, and household size. Additionally, the findings clearly suggest that higher cooperation can be induced by relieving the constraints. Schemes may offer more frequent collection and smaller waste-collection containers to relieve limited space. Simple and clearly communicated waste separation processes can also relieve time constraints. A longer-term consideration is that developments which result in the construction of smaller dwellings could carry with them the added negative prospect of lower participation rates. 3) While there is evidence that interventions focused on cost, convenience and communication can all be effective, there is also evidence that intervention may incur unintended consequences. One implication of these findings is the need to pay due attention to the subtle cues given by the scheme attributes and sponsors themselves. Earlier commentators have suggested that, in a world where actors are less predictable than rational models would assume, governments need to adjust fiscal and regulatory measures in an iterative process (Shogren and Taylor, 2008). As it becomes increasingly feasible to conduct randomised controlled experiments (Croson and Treich Jackson, 2005, 2014), linking research to policy-development becomes one way to collect evidence and adjust policy (Dolan et al., 2012; Lunn, 2013).
Results of quality appraisal (appendix)
N/A

Hebrok, Marie, and Casper Boks. 2017. 'Household Food Waste: Drivers and Potential Intervention Points for Design - An Extensive Review'. Journal of Cleaner Production 151: 380–92. http://dx.doi.org/10.1016/j.jclepro.2017.03.069.
Setting
International review of western society relevant literature.
Inclusion/Exclusion criteria
This article reports a synthesis of consumer-relevant studies of food waste, with the aim of finding potential intervention points for design and design thinking, which, as a profession, the authors believe rarely accesses academic literature. Although, some literature on consumer food waste has been summarised within recent reviews and reports (E.g. Aschemann-Witzel et al., 2015, Canali, 2014, Parfitt et al., 2010, Thyberg and Tonjes, 2016, van Geffen et al., 2016), there is no extensive review of household food waste drivers found that is structured in a way that connects drivers with possible and existing interventions. In order to move from generating knowledge to finding solutions it is imperative that these two elements are seen in connection. The questions asked are: What are the drivers of food waste, and where can designers intervene in order to influence consumers to waste less food? Population: Consumers in the act of shopping, and residents in the process of storing, using and disposing of food. Study design / intervention: Diverse exploratory research of drivers, of consumer behaviour in context were included, from the immediate individual drivers to broader community, policy and cultural drivers. Interventions included (briefly) broad policy tools, and more targeted interventions focusing on 1) Technology that helps people plan, share, and keep an overview of stock,

2) Packaging and storing solutions that extend shelf life, and

3) Information and awareness campaigns

Outcome: Food waste – primarily characterised as post-consumer, in-household disposal of food to landfill

No. of included studies / Total number of participants

112 academic publications from a search of Oria and Google Scholar. Additionally, online available reports from three major food waste initiatives were included.

- ForMat (2010–2014) was a project where the retail industry, food industry, organisations and governments collaborated to identify and reduce food waste in Norway (Hanssen and Schakenda, 2011).
- WRAP (Waste & Resources Action Programme) is an ongoing registered charity in the UK that works with different partners within academia, businesses and communities. WRAP is the organisation that has, since 2004, published most extensively on quantification and composition of food waste, as well as issues related to attitudes and socio-demographic aspects of food waste behaviour.
- FUSIONS (Food Use for Social Innovation by Optimising Waste Prevention Strategies) was a 4-year EU project (August 2012 to July 2016). Amongst many other food waste related issues it focused on developing a common method for gathering food waste statistics, in order to be able to compare across countries

Study designs of included studies

This review focuses on understanding household food waste from a consumer perspective. Particular focus is made on studies including

- Focus groups and interviews for depth understanding, surveys for broad views
- Observational 'shop-a-long' and 'in-home' tours
- Quantitative studies mapping and describing food waste in homes in terms of volumes, food types and longevity.
- Composition and character research including waste composition analyses, surveys and food waste diaries (typically self-reported, with known drawbacks of underreporting of waste, and overreporting of environmental awareness).

Date of most recent search (month, year)

2015, month not stated. The results were limited to articles in peer-reviewed journals, written in English between 2000 and 2015. Older publications than from 2000 were not included, the authors state this was in order to compile the research most up to date with social developments, thus most relevant to possible interventions today.

Authors' conclusions

This extensive literature review identified an array of different aspects and drivers behind household food waste. The authors argue that the phenomenon of food waste can be seen as a process where food turns to waste within a web of interrelated practices, tools, concerns, skills, knowledge and anxieties. Attempts to change this process will require finding places within this web where one can intervene.

From this synthetic perspective, the authors argue that the literature illustrates that food is wasted in households because of how it is valued and because some values people try to live by are not always compatible. Our values influence our awareness and attitudes, but so does our lifestyle and the required convenience we need in order manage everyday life. Lifestyle is mainly defined by household constellation and everyday practices that influence important food waste related practices such as planning of purchases, handling of leftovers and management of food risk. Additionally, there are an array of material and structural aspects that shape and restrain our interaction with food, for instance storage, packaging, the fridge etc. In order to reduce food waste levels cultural and social norms and values residing within people as well as material and structural conditions out there in the experienced world need to be addressed simultaneously.

Fig. 1 below shows an illustration of what the authors interpret as being the major interrelated food waste drivers that can be identified in literature.

Policy to influence food waste values and practices – meso to macro scale

Mixed evidence on economic levers such as landfill tax, incineration tax, pay as you throw, unknown impact on food waste in particular, are reviewed, but but expected to be positive. The economic incentive is seen as a tool to reach those that are not reached by awareness campaigns, but the risk of waste being discarded in illegal ways, such as dumping and burning, is considerable. Changes to collection systems also considered. There appears to be little evidence to support the idea that separate collection and storage of food waste in highly visible containers would change behaviours. There is literature arguing for the need to consider multiple levels of routinsations, reflexivity and practices, but little guidance on what is likely to work and how to change these elements.

Interventions

Literature reports on several design interventions aimed at food waste reduction in households; some prototyped and tested, some merely suggestions for improvement, and others already on the market.

Three dominating categories of interventions are derived by the authors: 1) Technology that helps people plan, share, and keep an overview of stock, 2) Packaging and storing solutions that extend shelf life, and 3) Information and awareness campaigns. There is a surprising lack of diversity in food waste interventions suggested in literature, and there is also a lack of studies on effects. Especially within the two product categories most extensively explored, smart fridge functions and packaging, it remains to study the effect of the innovations in order to assess their impact on food waste quantities.

Key insights from the reviewed literature show that the practices that cause food waste are deeply entangled in the routines of everyday life, and not easily influenced by providing consumers with best-practice information and education. In light of this, further research and design endeavours should focus on ways to address food waste drivers pertaining to values and perceived value of food, awareness and attitudes, food risk, and household, lifestyles and convenience in a way that does not necessarily presuppose that there is an automated relationship between knowledge, attitudes and action. Could there be potential interventions not yet discovered, in the shape of for instance new products, systems and infrastructures that could nudge consumers to reduce their food waste? Furthermore, there is a need to address the potential of new policies and regulations aimed at households. However, addressing this issue lies outside the scope of design.

Results of quality appraisal (appendix)

N/A

Lane, G. W. S., and T. P. Wagner. 2013. 'Examining Recycling Container Attributes and Household Recycling Practices'. Resources, Conservation and Recycling 75: 32–40. https://doi.org/10.1016/j.resconrec.2013.03.005.

Setting

United States municipal recycling, although drawing on international literature.

Inclusion/Exclusion criteria

Population: Households and communities using recycling containers in kerbside collection programs

Study design / intervention: Seeks evidence regarding the impact of the size, shape, color, or inclusion of wheels

Outcome: Key outcmoes of interest are participation rates / set-out out, or recycling rates of residential curbside collection programs

Other study characteristics: Non-systematic desktop review of both academic and commissioned research, augmented with a survey of US public waste manager's.

No. of included studies / Total number of participants

92 evidence sources

- 52 commissioned consultancy reports and trade publications
- 40 academic publications

The waste professionals survey sourced 785 valid responses from a trade magazine's list of 7512 public agency waste management contacts. A response rate was not determined because it was not relevant for the survey; the focus was to obtain information for a municipality or county. The 785 responses represented 48 states and the District of Columbia. Only Delaware and North Dakota were not represented; however, 39 respondents did not identify their location or region. Of the respondents, there were 657 municipalities, 85 counties, and 42 unspecified. The total population covered by the respondents was 100,890,000, which represents 32.8% of the US population. Respondents included

representatives from 37 of the 50 most populous cities in the US. Populations of responding communities ranged from 77 to 8,392,000.
Study designs of included studies
The authors state that much of the data that exist to address questions about the significance of variations in recycling containers are buried in consulting firm studies performed for municipalities as they study and test the efficacy of recycling program designs and modifications. By the nature of their purpose, these studies do not tease out the intricacies of design factors and their individual relation/correlation to recycling rates, but determine the program that would give the biggest return on investment. In contrast, academic studies that have attempted to answer these questions have not been deployed on a large scale, or cannot be designed to accommodate more than a small handful of confounding factors due to high costs. Thus, the aim of this study is to collate these two distinct literature sources and to compare the conclusions with the actual implementation of recycling programs as reported via a national survey of US solid waste professionals.
Date of most recent search (month, year)
Not stated. Prior to 2013.
Authors' conclusions
There is no single recycling container (size, color, and type) that has been universally demonstrated to statistically, positively affect participation, set-out, and/or recycling rates. While this study identified numerous examples where container attributes had a positive effect, statistically significant data is weak or non-existent. In addition, the presence of so many confounding socio-political and infrastructure variables suggests that the identification of an optimal recycling container will depend on the unique characteristics of the community balanced with cost. While community characteristics are important to identify the impact—positive or negative—on the participation, set-out, and recycling rate, cost is equally important. Cost includes purchase cost, assembly needs, durability, maintenance, adaptability to new technology, impact on worker safety, collection limitations/needs, additional technology needs, and so forth. The overall picture from our review of the literature and the survey results are that the most effective recycling programs should include some level of population targeting, such as designing programs and thus containers differently for MFDs and SFDs. In essence, purposeful incrementalism informed by pilot studies.
Results of quality appraisal (appendix)
N/A

Schanes, K., Burcu, G., & Dobernig, K. (2018). Food waste matters - A systematic review of household food waste practices and their policy implications. Journal of Cleaner Production, 182, 978-991. doi:http://dx.doi.org/10.1016/j.jclepro.2018.02.030
Setting
Note: Systematic review not of major interest for our research. Recommendations on intervention in discussion are more relevant, which are summarised in a narrative way Review of empirical studies on food waste practices as well as distilling factors that foster and impede the generation of food waste on the household level - Global focus but mainly European setting
Inclusion/Exclusion criteria
Population: Households Study design / intervention: Outcome: Food waste
No. of included studies / Total number of participants
60 studies
Study designs of included studies
- focus on reasons and rivers for food waste on the household level

- empirical studies
- socio-demographic factors
- psycho-social factors
- food-related household behaviours

Date of most recent search (month, year)

2017

Authors' conclusions

Focus on Discussion: Key leverage points for household food waste prevention

"In order to meet the Sustainable Development Goals (SDG 12), including the target to halve per-capita food waste at the consumer level by 2030, a multifaceted approach and a combination of measures is essential. (…) Yet, a coherent and holistic policy framework that triggers appropriate action beyond the individual level and empowers actors along the supply chain is missing."

The authors elaborate various policy initiatives as well as business and retailer solutions that are particular relevant for the current rapid review.

"As highlighted by various authors, food waste generation on the household level is a highly complex and multifaceted issue driven by a variety of reasons and types of behaviour. To begin with, our analysis has shown that households are generally concerned and feel guilty about wasting food. These feelings of guilt are mainly based on personal concerns such as financial loss, rather than on concerns about the environmental and social implications of food waste. Several studies have demonstrated that guilt, perceived behavioural control, and negative attitudes towards food waste may predict the intention to reduce food waste and/or reported food waste."

"Consequently, people sense a discord between the care for oneself (and immediate others) and eliminating food waste in which they are negotiating a range of contradictory desires, aims and anxieties"

"While emphasising the strategies that can be adopted by individuals to prevent food waste in their households, one must however, acknowledge the individual as embedded in wider social, economic, and cultural structures that may prevent the adoption of less wasteful practices. Infrastructure such as storage (e.g. cellar, fridges) and shopping facilities (big supermarkets, local stores, farmers markets) play a decisive role in shaping household food (waste) practices."

"Thus, a holistic food waste prevention approach has to go beyond putting the responsibility solely on individuals"

Results of quality appraisal (appendix)

N/A

Sharp, V., Giorgi, S., & Wilson, D. C. (2010). Delivery and impact of household waste prevention intervention campaigns (at the local level). Waste Management and Research, 28(3), 256-268. doi:10.1177/0734242X10361507

Setting

Mainly UK but also international

Inclusion/Exclusion criteria

- Unsystematic desktop research using a variety of complementary methods to identify potential documents and stakeholder
- For a detailed method description see Cox et al. (2010a)

Population: Households and communities

Study design / intervention: Intervention campaigns including a broad promotional mix, e.g., door-step campaigns, events, provision of newsletter

Outcome: Other study characteristics: N/A

No. of included studies / Total number of participants

30 evidence sources

- 8 projects commissioned by WREP

- 14 other UK reports
- 8 international references including a synthesis review

Study designs of included studies

Various

Date of most recent search (month, year)

2009

Authors' conclusions

"Waste prevention has not often been evaluated robustly; survey and project design vary widely; and data are routinely presented in a way that makes it difficult to decipher what they refer to (including whether they include or exclude recycling) (see Sharp et al. 2010)." (p.266)

Recommendations:

- Engaging with households, not initially receptive to waste prevention messages
- Effective involvement and use of a project officer
- Making use of community development to foster local ownership
- Use an enthusiastic and local champion
- Promote campaign by specific topics (i.e., specific waste prevention behaviour instead of smart shopping)
- Provide a knowledgeable doorstep team of waste prevention advisors
- Connect people with the amount of waste they are producing (i.e., self-weighing)

Delivering a package of interventions is important to achieving behaviour change: 'an accumulation of campaigns is what will have the impact' (Dorset County Council et al. 2008 [WR0116], Brook Lyndhurst and Waste Watch 2006 [WR0504]).

Results of quality appraisal (appendix)

N/A

Xevgenos, D., Papadaskalopoulou, C., Panaretou, V., Moustakas, K., & Malamis, D. (2015). Success Stories for Recycling of MSW at Municipal Level: A Review. Waste and Biomass Valorization, 6(5), 657-684. doi:10.1007/s12649-015-9389-9

Setting

- Municipalities with high recycling rates or/and significant improvement through implementation of certain waste management schemes (best practice examples)
- Waste management schemes aimed at reducing the amount of waste disposed in landfiills and to increase prevention, reuse and recycling rates

Inclusion/Exclusion criteria

- High recycling rate
- Application of variety of instruments involving technical, economical or/and legislation
- Availability and quality of data

Population:

- Across the world
- Municipalities with high recycling rates or/and significant improvement through implementation of certain waste Management instruments

Study design / intervention:

- Evaluation of different technical, economic, communicative, and legal instruments

Outcome:

- High recycling rates or/and significant improvement through implementation of certain waste management instruments

No. of included studies / Total number of participants
19 out of 50 case studies included. 19 case studies come from 15 countries
Study designs of included studies
Comparison of municipalities using different solid waste management schemes
Date of most recent search (month, year)
2014
Authors' conclusions
A number of factors influence recycling performance: Collection system: access to combined systems (kerbside, bring systems, and recycling banks) and source separation of MSW streams lead to higher recycling rates; separation of organics at source (kitchen waste) can provide high quality products. "Economic instruments such as landfill taxes were found to have a rather weak effect on promoting sustainable waste management practices, as they are not based on the amount of waste generated by each household and therefore they do not provide a direct incentive to citizens for reducing their waste." Low landfill rates are observed in cases with very high landfill charges "…the implementation of PAYT schemes aspire for more responsible environmental behaviours, since they bring the users in direct and continuous contact with the waste they generate. Moreover, if they are combined with kerbside collection schemes for more than three waste streams, then optimum results can be achieved in terms of source-separated materials of high quality." "In addition, deposit-refund systems could be also considered as supporting tools for enhanced recycling performance since the user is directly rewarded for delivering source-sorted packaging containers to appropriate collection points and does not feel punished for practicing illegal disposal methods or ineffective practice of source separation of waste materials." "Product bans such as the plastic bag bans are also considered very useful for decreasing the non-recyclable content of waste." "In conclusion, all instruments should be taken into account when designing a waste management scheme, with emphasis on source separation, kerbside collection systems, regulatory measures and PAYT systems with a vision to zero waste. In all cases, as there is no ''one size fits all'', the specific characteristics of each municipality should be identified in order for the set of instruments to be properly adjusted."
Results of quality appraisal (appendix)
N/A