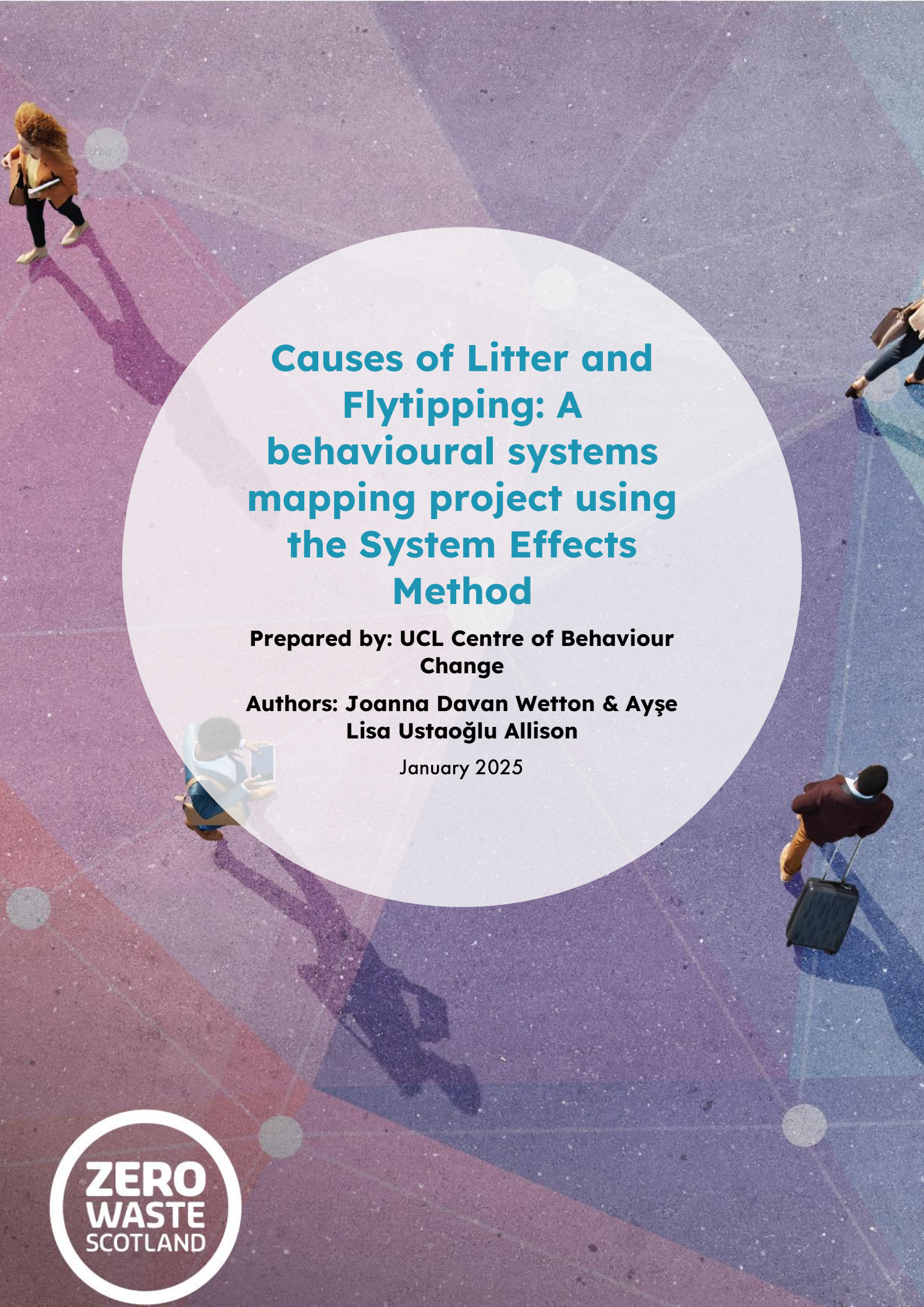




Causes of Litter and Flytipping: A behavioural systems mapping project using the System Effects Method

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1 Summary

Littering and flytipping behaviour are significant social and environmental challenges in Scotland and across many countries. This project aimed to develop and analyse two initial behavioural systems maps, one about causes of littering behaviour and one about causes of flytipping behaviour. A behavioural systems map is a diagram that aims to show how people's behaviours, and other factors that influence behaviour, affect an outcome of interest. This project sought to develop initial maps that future stakeholder engagement could build upon and help support decision making for intervention design further down the line.

The study first involved a rapid evidence review update to identify influences on littering and flytipping behaviour to inform which factors to include in the behavioural systems maps.

Next, it involved gathering views of stakeholders from public, private and charity/NGO sectors, through an online questionnaire-based method called System Effects. This method is designed to gather a wide range of views and combine them into an overall systems map. Overall, 74 stakeholders contributed to a behavioural systems map about causes of littering, and 51 stakeholders contributed to a behavioural systems map about causes of flytipping.

Findings were matched to two models of behaviour: the Capability, Opportunity, Motivation-Behaviour (COM-B) model and the Individual, Social, Material (ISM) model. Each offers benefits in terms of understanding drivers of behaviour and linking to frameworks for designing behaviour change interventions.

The rapid evidence review update identified 15 publications not included in previous Zero Waste Scotland evidence reviews and research. Overall, these reported similar factors that would not substantially affect the earlier conclusions. The literature tended to focus more on individual drivers of behaviour than social or material factors. There was also a greater focus on barriers to, rather than enablers of, desired behaviour – particularly for reducing flytipping. These represent gaps in the reviewed literature, highlighting that there is a lack of evidence around some aspects of tackling these problems.

The behavioural systems maps highlighted a large number of further drivers of littering (61 in total, 36 of these were additional to the literature) and flytipping behaviour (46 in total, 18 additional to the literature).

Prominent influences on littering behaviour, according to metrics about their connectivity in the systems map, included:

- Lack of appropriate bins nearby (or they are full)
- Not wanting to be inconvenienced
- Lack of respect for the local environment
- Dropping something by accident
- Being confused over bins

Behaviours also considered by respondents that contribute to littering included references to specific contexts and activities: littering by motorists and around schools; commercial over-use of street litter bins, smoking or vaping; consuming take-away and fast food; industry lobbying against 'polluter pays' principles; lack of engagement with nature; waste transfer companies not securing loads; and inadequate bin collection and street cleansing. This shows that a wide range of people's and organisations' actions (or inactions) play a role.

Prominent influences on flytipping, based on systems map metrics, included:

- Lack of awareness about correct waste disposal options
- Costs of using disposal sites/services
- Distance / difficulty getting to nearest disposal site
- Too few proper disposal sites
- Desire to make money or avoid costs

Behaviours also considered by respondents seen to contribute to flytipping were: inadequate residential bin collection; hiring a non-licensed waste carrier; mixing or 'contaminating' waste streams; operating an illegal business; and using alcohol or drugs. Similarly to littering, this highlights that diverse actors and actions contribute to the issue.

Only a fraction of the influences identified in each behavioural systems map (around one third for littering and two-fifths for flytipping) are addressed by existing interventions which include services, infrastructure, fines/charges, communications campaigns and educational programmes. This suggests that there are opportunities to intervene in other places in the system to help reduce littering and flytipping.

2 Introduction

2.1 Background

Littering and flytipping are major civic and environmental challenges in most countries. People disposing of waste in the wrong place (littering) and in premeditated larger volumes (flytipping) contribute to environmental damage, including pollution of waterways^{1,2}, as well as health risks^{3,4}, and damage to community pride and cohesion.

In Scotland over 67% of people believe that littering is a problem in their local area and the annual cost of cleaning up litter was estimated at around £48 million in 2019-20⁵. There are over 60,000 incidents of flytipping reported each year in Scotland, costing an estimated £12.6m million⁵. The Scottish Government's National Litter and Flytipping Strategy⁶ aims to help prevent these behaviours through various actions outlined in an annual action plan and delivered by a range of delivery partners.

Zero Waste Scotland carried out an evidence review of factors that affect littering in 2014⁷ and a similar review of flytipping in 2017⁸. These point to contributing *material factors*, such as challenges with infrastructure and collections, difficulty accessing recycling centres, or areas that are already run-down and untidy; *social factors*, such as not feeling responsible, or believing other people also litter or flytip; and *individual factors*, such as not knowing what counts as littering or flytipping, feeling that no-one is watching or there will be no consequences, dumping waste illegally to save or make money, or simply not wanting to go to the inconvenience and effort of properly disposing of items. When it comes to preventing littering and flytipping, the previous research reviewed^{7,8} highlights factors such as local pride and a sense of community belonging, seeing other people dispose of waste correctly, having adequate access to bins, recycling centres and collections, and understanding the negative impacts of waste in the wrong place.

While the previous reviews uncovered a large number of influences on littering and flytipping behaviour, this information on its own cannot necessarily tell us how these factors are interconnected and which ones may play more or less important roles in driving behaviour as part of a system. Past work contributing to the National Litter and Flytipping Strategy indicates that a wide range of actors and their activities contribute to these problems at individual, community and societal levels.⁶ Disposing of waste – whether correctly or in the wrong place – is part of complex local, national and international systems of producing, using, reusing, disposing and recycling of goods and materials, which involve consumers, retailers, distributors, manufacturers, trade bodies, financial institutions, and national and local governments. In the 7-10 years since the previous evidence reviews were carried out, patterns of people's and organisations' behaviour in these systems may have shifted with changes in local and global markets and consumption.

This project therefore aims to update and build on the previous evidence base by examining current drivers of littering and flytipping from stakeholders' experience and building a connected causal map of these factors. Efforts to prevent littering and flytipping may benefit from a joined-up approach which considers how these behaviours are connected to a wider system of drivers, and where best in the system to intervene for greatest impact.

2.2 Behavioural Systems Mapping Approach

This project aimed to develop causal systems maps of the behavioural influences on littering and flytipping. To do this we used a systems thinking method known as System Effects^{9,10}.

System effects has been used in other projects to look at the complex behavioural determinants of food waste¹¹, repair of electrical items¹⁰, and sustainable construction practices¹². This method is suitable for developing *behavioural systems maps*, which are typically qualitative diagrams showing the causal relationships between people's behaviours, factors influencing behaviour, and one or more outcomes of interest^{13,14}. They may also include the role of existing or potential behaviour change interventions.

The System Effects method involves guiding stakeholders through an open-ended online survey in which they draw upon their experience to consider things affecting an issue (in this case, causes of littering, or causes of flytipping) and create a mind-map connecting the different factors. These mind-maps are then qualitatively analysed and combined into an aggregated behavioural systems map, giving a rich and detailed picture of the reported causal influences on behaviour.

As well as offering visual insights, the behavioural systems maps can be further analysed using network metrics to indicate which factors may play a more influential role than others. Compared to other map-building methods (e.g. stakeholder workshops, and/or desk research), advantages of the System Effects method are that it can allow for a wider range of stakeholder input and may uncover factors that were not anticipated by researchers.

2.3 Definitions of key terms

There are differences between littering and flytipping behaviour in terms of what constitutes littering versus flytipping, and the drivers of each behaviour.

2.3.1 Definitions of littering and flytipping

Litter is considered to be "waste in the wrong place" where individual or a small number of items are thrown, dropped or deposited in a public place by any person and left there. In addition, materials that have escaped from collection containers and vehicles should be treated as litter.

Flytipping is the dumping of waste in the wrong place, usually pre-meditated and involving larger items or volumes as these issues have wide-ranging impacts on our health, environment and economy. It is the illegal disposal of household, industrial, commercial or other 'controlled' waste. The waste can be liquid or solid. 'Controlled' waste includes garden refuse and larger domestic items such as fridges and mattresses.

2.4 Theoretical models of behaviour

When investigating barriers and enablers to behaviour change, particularly in complex systems, it is beneficial to organise these according to theoretical frameworks that can be linked to tools for intervention design.

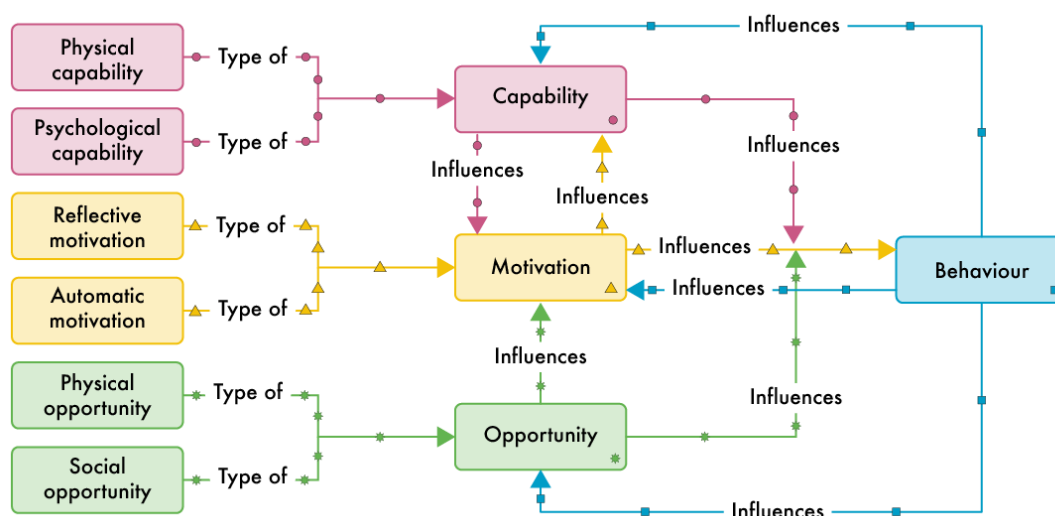
One such theoretical framework which is widely used internationally in academic and applied research is the Capability, Opportunity, Motivation-Behaviour (COM-B) model¹⁵, described in

Figure 1. COM-B is part of the Behaviour Change Wheel, which is a wider framework for considering and selecting intervention options^{14,15}.

The COM-B model was primarily chosen to guide the development and presentation of behavioural systems maps in this project. As an alternative way of looking at influences on behaviour, we also introduced the Individual, Social, Material (ISM) model¹⁶. The ISM model is described in Figure 2.

ISM is similar to the COM-B model and the two are compatible in that their constructs can be mapped to each other. Whereas COM-B is associated with a larger set of scientific tools and publications, ISM can be more accessible in terms of language. ISM is also well-suited for use in systems mapping because it places particular focus on factors outside of the individual, and this was a gap in past evidence reviews of littering and flytipping^{7,8}.

Figure 1. The COM-B Model of Behaviour¹⁷



Description of Figure 1: The diagram starts on the left with six influences on behaviour: physical capability, psychological capability, reflective motivation, automatic motivation, physical opportunity, and social opportunity. It then uses arrows and connections to show that:

Physical and psychological capability are two sub types of capability which can influence whether someone can perform a behaviour. Reflective and automatic motivation are two sub types of motivation that influence whether someone will perform a behaviour and can influence capability. Physical and social opportunity impact a person's motivation and behaviour. Finally, a person's behaviour can, in turn, influence their capability, motivation, and opportunity.

2.4.2 Definitions of parts of the COM-B model¹⁸

Physical capability: A person's sensory and physical abilities that are needed for a behaviour or that facilitate it.

Psychological capability: A person's social, emotional and intellectual understanding, and reasoning and self-regulation abilities that are needed for a behaviour or that facilitate it.

Physical opportunity: Characteristics of a person's physical (rather than social) environment that are needed for a behaviour or that facilitate it.

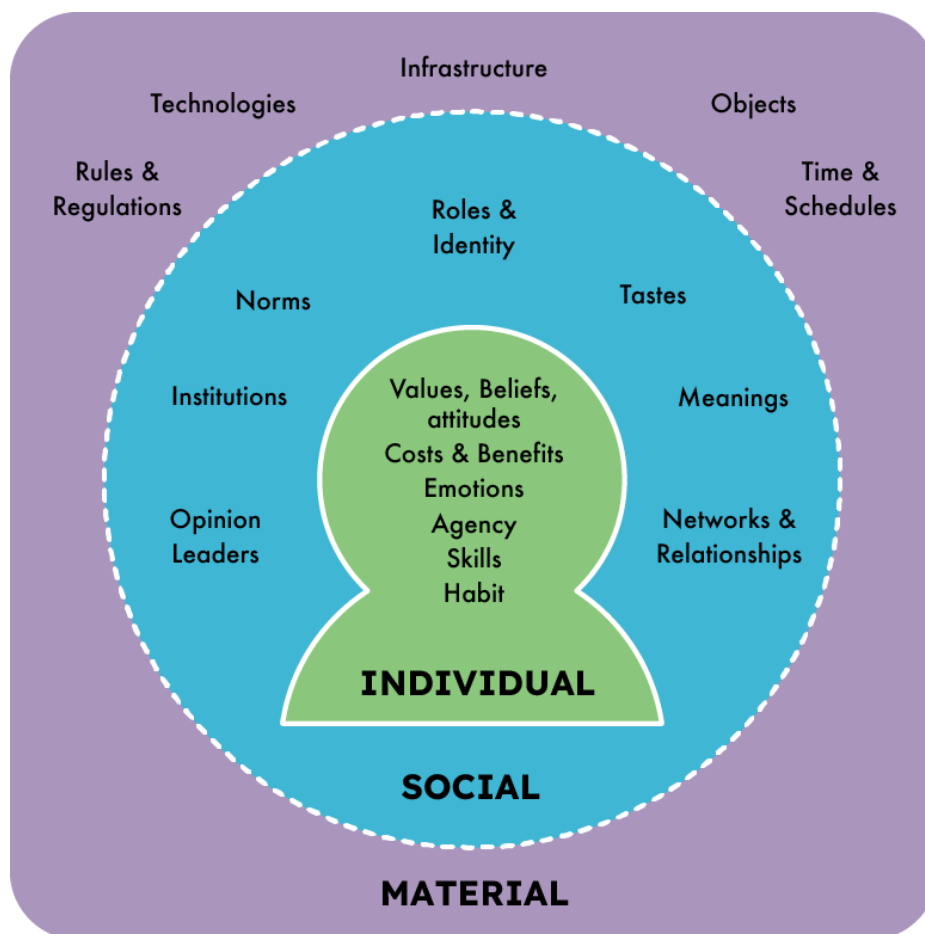
Social opportunity: Characteristics of a person's social environment that are needed for a behaviour or that facilitate it.

Reflective motivation: Motivation to enact a behaviour that involves judgements, intentions or plans.

Automatic motivation: Motivation that involves wants and needs, impulses and opposing impulses.

Behaviour: Physical actions that are controlled by the brain.

Figure 2. The ISM Model of Behaviour¹⁶



Description of Figure 2: The diagram features a person icon in the centre, representing the "individual," surrounded by two concentric circles. The inner circle represents "social," and the outer circle represents "material." Each category, individual, social, and material, includes the following subcategories of influences:

- **Individual:** Values, beliefs, attitudes; costs and benefits; emotions; agency; skills; and habits.
- **Social:** Opinion leaders; institutions; norms; roles and identity; tastes; meanings; networks and relationships.
- **Material:** Rules and regulations; technologies; infrastructure; objects; and time and schedules.

2.4.3 Definitions of parts of the ISM model¹⁶

The individual context: This includes the factors held by the individual that affect the choices and the behaviours he or she undertakes. These include an individual's values, attitudes and skills, as well as the calculations made before acting, including personal evaluations of costs and benefits.

The social context: This includes the factors that exist beyond the individual in the social realm, yet shape his or her behaviours. These influences include understandings that are shared amongst groups, such as social norms and the meanings attached to particular activities, as well as people's networks and relationships, and the institutions that influence how groups of individuals behave.

The material context: This includes the factors that are 'out there' in the environment and wider world, which both constrain and shape behaviour. These influences include existing 'hard' infrastructures, technologies and regulations, as well as other 'softer' influences such as time and the schedules of everyday life.

2.5 Research aims

To help build a greater shared understanding of the causes of littering and flytipping among industry and policy stakeholders, this project aimed to:

1. Identify reported causal influences (from literature or stakeholder expertise) on two target behavioural areas: littering and flytipping.
2. Understand how the causal influences are thought to be connected within a system and develop an initial behavioural systems map for each behaviour.
3. Understand the relative importance of the causal influences in each behavioural systems map (according to their connectivity).

To address these aims we first conducted a rapid evidence review update to identify influences on littering and flytipping behaviour (both from past reviews and new sources), which might be suitable for inclusion in the behavioural systems maps. We used the findings in conjunction with gathering stakeholders' views through the System Effects method, to develop overall behavioural systems maps for littering and flytipping.

3 Methods

3.1 Literature search method

First, relevant existing Zero Waste Scotland publications were identified. This was followed by a rapid literature search for additional research reports or reviews using Google Scholar, Google and UCL Explore. UCL Explore has access to hundreds of academic databases including SCOPUS, Web of Science, PubMed and PsycINFO. Combinations of the following search terms were used: 'flytipping', 'influences', 'behaviour', 'illegal dumping', 'littering', and 'polluting'. Publications were also identified from the reference lists of included sources.

3.1.4 Inclusion criteria

Publications were considered relevant for inclusion if they were:

- Original research reports or reviews describing influences on littering or flytipping behaviour
- Peer-reviewed journal articles or 'grey' literature (e.g., theses, other reports)
- Focussed on or relevant to a UK context (e.g., systematic reviews with a global focus)

3.1.5 Identifying influences on behaviour

From each of the existing Zero Waste Scotland publications, and the additional sources found from the literature search, we extracted all reported factors investigated as potentially influencing littering and fly-tipping behaviour. These were organized in a spreadsheet, noting which target behaviour (littering or flytipping) they relate to (including any specific sub-behaviours, e.g., littering of a particular waste type). We also noted whether each influence would act as a barrier to, or are an enabler of, the desired behaviour (i.e., reduced littering or reduced flytipping).

3.1.6 Matching influences to the COM-B and ISM models

The reported influences on behaviour were then grouped into themes expressing the same or similar causal factors. We then judged each theme against which part of the COM-B model it would reflect, and did the same in relation to the ISM model. The thematic findings organised according to COM-B and ISM were summarised in tables and illustrated visually in two 'mind maps', one for littering and one for flytipping.

3.2 Behavioural Systems Mapping using the System Effects method

System Effects⁹ is a mixed-methods (i.e. qualitative and quantitative) approach based in systems thinking¹⁹. It is designed to draw upon people's lived experience or expertise in a certain area, to investigate the causes or consequences of complex social phenomena.^{9,10} The method is facilitated by an online software platform (systemeffects.com) which enables the building of systems maps.

In this project we carried out the following steps which are part of a typical System Effects pipeline.¹⁰⁻¹²

3.2.7 Step 1: Develop an online questionnaire

We developed two short online questionnaires, one for littering and one for flytipping. Questionnaire items were designed or adapted for this study by CBC and Zero Waste Scotland, informed by past waste research and System Effects studies¹⁰⁻¹². The full questionnaires are provided in [Appendix A](#). To summarise, the questionnaires consisted of:

1. A background question: Which sector best describes the organisation you work for?
2. A prompt: From your viewpoint and experiences, what things can contribute to [littering/flytipping] or result in someone [littering/flytipping]? (Think about how people acquire, use and dispose of items)
3. A follow-up prompt: And why do you think each of these things might happen? (Think about the possible reasons) (it's ok to repeat responses)
4. And an opportunity to review and edit a mind-map of responses: Please review the connections you identified in the previous steps. Any missing connections you would like to add? (click and drag to draw additional connections)

3.2.8 Step 2: Distributing the questionnaire and collecting a sample of responses.

3.2.8.1 Participants

Participants were recruited via an email invitation from Zero Waste Scotland using a purposive approach to ensure representativeness from sectors such as waste and cleansing, transport, other parts of local government and other bodies such as retailers and manufacturers, NGOs and those with additional responsibilities around litter and flytipping, for example land owners. Participants could choose to take part in one or both questionnaires, depending on their interest and expertise. Participants provided informed consent before taking part and responses were fully anonymous (no personal data was collected in this project). Participants did not receive any financial incentives or rewards.

The target sample size was between 50 and 100 respondents per questionnaire (littering or flytipping), in line with previous System Effects research⁹⁻¹². Compared to quantitative surveys, a smaller target sample size is appropriate because the data gathered is qualitative (i.e. free-text responses). Stakeholders who were contacted by Zero Waste Scotland could opt to take part in one or both questionnaires depending on their areas of expertise and interest.

Responses were collected between 31st January and 16th February 2024. In total 74 participants completed the littering questionnaire and 51 completed the flytipping questionnaire, in line with our target sample sizes.

3.2.8.2 Procedure

Participants accessed the questionnaires via a weblink that presented each questionnaire in a randomised order. They read an information page about the task and then completed the questions. Each questionnaire was designed to take around 10 minutes.

3.2.9 Step 3: Qualitative analysis of responses.

Enabled by the System Effects software platform, raw free-text responses were thematically analysed using a hybrid inductive-deductive approach. This means that we both looked for *a priori* themes that were present in the findings from the rapid literature review, as well as any

'new' themes suggested by the responses. This involved one researcher reading each response and assigning each response to an existing or a new theme, iteratively revising the groupings and the wording of the theme labels, until satisfied that all the responses within a given theme expressed the same influence on behaviour. There was no minimum number of responses per theme; some themes only contained one response. Another researcher reviewed this process and changes were made until both researchers were in agreement.

Responses were excluded from analysis if they: did not contain a meaningful answer (e.g. 'don't know'); pertained to the wrong topic (e.g. mixed up flytipping with littering); described an *effect* rather than a *cause* of behaviour (e.g. 'this spreads the rubbish everywhere'); or described a type of waste (e.g. 'food waste') rather than a causal factor. Only a very small proportion of responses were excluded from analysis on a per-response basis (rather than per-respondent) so as to include the maximum number of responses received.

The resulting themes, each describing a different factor influencing littering or flytipping behaviour, were categorised according to which parts of the COM-B model they correspond to (Physical Capability, Psychological Capability, Physical Opportunity, Social Opportunity, Reflective Motivation, Automatic Motivation, Behaviour) and which parts of the ISM model they correspond to (Individual, Social, Material, Behaviour).

The thematic factors were also compared to the findings of the rapid evidence review update, noting which were the same (or very similar) as barriers and enablers found in the literature, and which were additional.

We also compared the thematic factors against a list of existing littering and flytipping interventions in Scotland, provided by Zero Waste Scotland. These included whether each factor could reasonably be expected to change as a direct result of one or more of the existing interventions, and if so which intervention(s). For example, communications campaigns could be expected to change knowledge about litter/flytipping, and introducing fines could be expected to change a lack of penalties. This information was later added to the behavioural systems map using colour-coded flags to highlight where there are existing interventions, and an interactive button to bring these elements to the fore.

3.2.10 Step 4: Generating a behavioural systems map with weighted connections.

After qualitatively analysing responses, the researchers used the System Effects platform to calculate weighted connections between factors. The weighting corresponds to the number of times a given connection was reported across respondents. The thematic factors and the weighted connections between them form the necessary components to construct a systems map.

Kumu software (kumu.io) was used to generate systems map diagrams. One map was created for littering and one map for flytipping. Each thematic factor (i.e. influence on the target behaviour) is represented as a circle. Arrows between factors were scaled according to the response weightings. Colour-coding and symbols were used to indicate how factors correspond to parts of the COM-B model and the ISM model. Coloured 'flags' were used to highlight existing interventions and which factors they could be expected to change. Several filters were created to enable users to show or hide: (a) the factors linked to existing interventions; (b) which factors were highlighted in the rapid evidence review and which were additional; (c) factors by COM-B or ISM category; and (d) connections by their response weighting.

3.2.11 Step 5: Calculating quantitative metrics about the connectivity of factors.

The System Effects platform calculates three metrics about each factor:

- **In-degree:** a metric of how much the factor is reportedly affected by others (how many connections 'in' and their weighting). Factors with a high in-degree are seen as influenced by many other factors. This could suggest they are important as 'hubs' where lots of other factors converge.
- **Out-degree:** a metric of how much the factor reportedly affects others (how many connections 'out' and their weighting). Factors with a high out-degree influence many others. This could suggest they are important as 'hubs' that lots of other factors stem from.
- **PageRank:** a recursive algorithmic metric of the importance of the factor within the system and their weightings.^{20,21} It takes into account what the factor is connected to, what those are connected to, and so on, recursively. Therefore, it can be considered as a more sophisticated measure of influence than in-degree or out-degree. Factors with a higher PageRank are more likely to explain nonlinear and emergent processes in systems.

The results section presents the barriers and enablers ranked according to these metrics.

3.3 Ethical review

Participants gave informed consent before taking part in this research. This research has been approved by the University College London Research Ethics Committee (reference CEHP/2020/579).

3.4 Strengths and limitations of the methods

Strengths of the methods used in this project include:

- **Using multiple sources of information.** Drawing from both published evidence and stakeholders' expertise on the topics may help to gain a more comprehensive and reliable understanding of key influences on littering and waste behaviour, compared to using just one of these types of information source.
- **Asking stakeholders open-ended questions.** The System Effects questionnaires involve open-ended prompts with no limit on the number of responses participants can give. Compared to more traditional, multiple-choice questionnaire items, this approach may help to uncover factors that were not previously anticipated and could help to avoid demand characteristics (people giving what they think is the 'expected' answer).
- **Integrating multiple stakeholder perspectives efficiently.** Compared to other forms of stakeholder engagement (e.g. interviews, focus groups), the System Effects approach allows a wider range of stakeholders to give input to an issue, whilst being less resource-intensive, but still highly systematic in combining people's views. This may benefit the quality of the combined insights, and may also increase buy-in to future engagement processes.

- **Matching findings to theoretical models of behaviour.** Use of the COM-B and ISM models in this project may help to aid users' interpretation and understanding of the behavioural systems maps, and also means that the maps can be more easily used as a starting-point for identifying suitable types of behaviour change intervention options, using linked tools and frameworks such as the Behaviour Change Wheel.

Limitations of the methods include:

- **Reliance on self-report.** As with most questionnaire methods, System Effects relies on self-report, which can be limited by respondents' recall, assumptions, wish to give socially desirable responses, or wish to persuade the researchers in a certain direction. Respondents may have limited insights into causes of other people's behaviours and may under-report or over-report certain causes. This may affect the weightings of the connections in the behavioural systems maps, as well as the metrics that are based on these weighted connections. Therefore, the relative 'strength' or 'importance' of different factors in the maps should be interpreted with some caution, noting that this may not reflect the 'true' effect sizes on real world behaviour.
- **Online mode of gathering stakeholder input.** While gathering responses online is efficient, when compared to in-person or telephone surveys, this mode offers fewer chances to clarify or follow-up on questions, meaning participants might sometimes interpret the questionnaire prompts differently from intended. Typing free-text responses also requires effort which could limit the number or quality. This limitation may be addressed through follow-up engagement with stakeholder to check the content of the initial behavioural systems maps.

4 Results

4.1 Rapid evidence review update

A total of 18 publications were included in the rapid evidence review update, for the purpose of identifying influences on behaviour:

- **5 ‘existing’ publications:** The National Litter and Flytipping Strategy⁶, Zero Waste Scotland previous rapid evidence reviews of littering and flytipping^{7,8}, and two further Zero Waste Scotland reports^{22,23}.
- **13 ‘new’ publications found through our literature search:** 11 original research reports, 1 global systematic review on littering behaviour²⁴, and 1 master’s thesis on Scotland’s vulnerability to waste crime²⁵.

Details of the included publications, including web links and the number of barriers/enablers extracted from each publication, can be found in [Appendix B](#). Appendix B also gives details of two further publications identified through the literature search but not included in the analysis because they did not identify relevant causal factors associated with the target behaviours.

4.1.12 Identifying influences on behaviour

A total of 191 reported influences on behaviour were identified (Table 1). Notably, the literature reported many more barriers than enablers when it comes to reducing flytipping.

Table 1. Barriers and enablers identified from the rapid evidence review update

	Littering	Flytipping
Number of reported barriers to reducing the behaviour	55	74
Number of reported enablers to reducing the behaviour	48	14

4.1.13 Matching influences to the COM-B and ISM models

After grouping the reported influences on behaviour into themes, there were 39 themes describing influences on littering behaviour (22 barriers and 17 enablers to reducing the behaviour) and 27 themes describing influences on flytipping behaviour (21 barriers and 6 enablers to reducing the behaviour).

The barriers and enablers are shown in interactive online mind-map diagrams, where they are colour-coded according to the COM-B model and ISM model, and the number of sub-barriers or sub-enablers making up each theme is shown in terms of arrow thickness:

- [Littering kumu model](#)
- [Flytipping kumu model](#)

The barriers and enablers are also given in tables in [Appendix C](#), where they are organised in relation to the COM-B model and ISM model.

4.1.14 Summary of barriers and enablers

Barriers to reducing littering at the *individual* level included eight *motivational* factors: not wanting to be inconvenienced, having a habit to litter, low tendency to comply with rules, expecting not to be caught, rationalising litter behaviour, an attitude that littering is OK, a desire to make money or avoid costs, and feeling disgust about waste items; and four *capability* factors: inattentiveness, not knowing what constitutes litter, lack of knowledge about the impacts of litter, or being drunk. Barriers at the *social* level (*social opportunity*) included seeing or believing other people litter, feeling others are responsible for the local environment, and immediate company being seen as peers, and feeling anonymous or unobserved. Barriers at the *material* level (physical opportunity) included: lack of bins, difficulty accessing bins, run-down or untidy surroundings ('broken windows' theory), and high population density/overcrowding, and vulnerabilities in regulation/enforcement (the latter is coded to *social opportunity* in COM-B as it relates to rules). Smoking was identified as a behaviour that contributes to littering.

Enablers of reducing littering often mirrored the reported barriers. They included, at the *individual* level: knowledge of the impacts of litter, knowing what constitutes litter, feeling personally responsible for the local environment, wanting to be seen in a good light, fear of being fined/punished, believing in egalitarian values, religiosity, and feeling guilty, and the perceived attractiveness of bins. *Social* level enablers were local pride and sense of community/belonging, seeing other people dispose of items properly, a societal norm not to litter, fear of reputational damage, and immediate company seen as 'respectable'. Notably, no *material* level enablers were reported for reducing littering. Behaviours reported as helping to reduce littering included running communications interventions, reducing use of plastic packaging, and holding community clean-up days.

Barriers to reducing flytipping included the *individual* level *capability* factors: not knowing what constitutes flytipping, not knowing how to report flytipping, not knowing personal legal obligations, and difficulty completing waste paperwork; and *motivational* factors: desire to make money or avoid costs, not wanting to be inconvenienced, not carrying about flytipping or its environmental impacts, an attitude that flytipping is OK, and expecting not to be caught. Many of these are common to littering as well. Material barriers to reducing flytipping included: fees/taxes to use disposal sites/services, difficulty accessing (e.g. distance, opening times), lack of space to store waste at home, too few proper disposal sites, run-down or untidy surroundings, inadequate home collection services, high population density / overcrowding, low income level of the local area, and vulnerabilities in regulation/enforcement. One *social* barrier was found: seeing or believing other people fly-tip. Not reporting flytipping was as a contributing behaviour.

Enablers of reducing flytipping were less commonly reported in the literature reviewed, compared to barriers. They included at the *individual* level, feeling guilty, fear of being fined/punished, and feeling personally responsible for the local environment; at the *social* level, local pride and a sense of community/belonging, and fear of reputational damage; and at the *material* level, adequate home collection services.

4.1.15 Summary of key messages from additional sources

Overall, the additional publications reported similar factors to those identified in previous research, with relatively more attention given towards *individual* level factors rather than

wider *social* and *material* factors. We did not find new evidence that would substantially affect the findings of the Zero Waste Scotland's previous reviews. Key messages distilled from the additional literature we found include:

- Drivers of littering can vary on waste item type e.g., cigarette butts, fruit skins/peels versus food/drinks packaging.
- Drivers of fly-tipping vary between small organisations & householders and organised offenders
- For the organisations & householders, flytipping is often a matter of pragmatics and can be thought of akin to littering.
- For the organized offenders, it is largely driven by financial profits and can be thought of as organised waste crime.
- Implications for interventions: target towards specific groups of people and litter types.

Overall, these findings show that a one-size-fits-all approach to tackling either littering or flytipping will not be effective. Multiple interventions would be needed, tailored to different types of actor/group involved in flytipping, and different types of context and items involved in littering. Whereas communications interventions (e.g. prompts, educational materials and advertisements) were most commonly referred to in the evidence we reviewed, it is clear that these alone cannot address all of the behavioural drivers and a comprehensive approach would require other types of intervention.

4.2 Behavioural Systems Maps

Table 2 gives a breakdown of the stakeholders who participated, by sector.

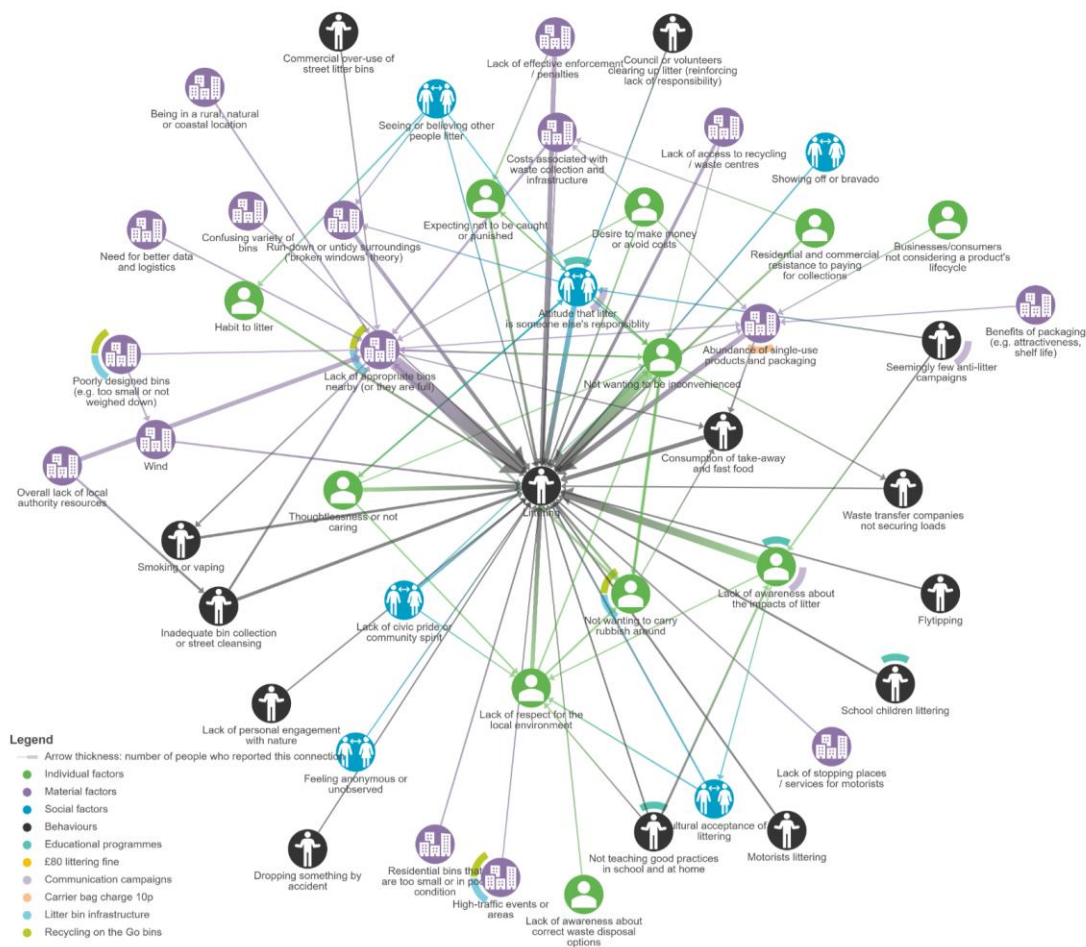
Table 2. Participants by sector.

Sector	Participants: Littering	Participants: Flytipping
Public sector – local authority	42	25
Public sector – other 'Duty body'	16	10
Other private sector organisation, e.g. Transport or land manager	10	10
Charity/NGO	5	3
Manufacturer – large/national	1	3
Total	74	51

Description of Figure 3: An interactive, accessible version of this map is available online: [Litter COM-B map](#)



Figure 4. Simplified Behavioural Systems Map of Littering (ISM view).



Description of Figure 4: An interactive, accessible version of this map is available at: [Litter ISM map](#)

4.3 Littering

Stakeholders identified 61 causal influences on littering, which were organised into an interactive online behavioural systems map which can be explored through [an online littering system map](#). Screenshots are given in [Appendix D](#), but for best viewing it is recommended to use the online link.

Circles in the map represent influences on littering behaviour, with colour-coding and symbols denoting which parts of the COM-B and ISM models each influence relates to. A control at the top of the map allows the user to filter by COM-B or ISM category. Arrows in the map represent reported causal connections, with a thickness reflecting the number of stakeholders who identified that connection.

As the behavioural systems maps are highly interconnected, it can be helpful to reduce some of the visual complexity by 'hiding' connections which were less frequently reported. Figures 3 and 4 show a simplified view of the littering map, only containing connections reported by at least 2 or more people (thus hiding the less frequently reported factors and connections). In the online versions this filter can be applied using a drop-down control at the top of the map.

Viewing the full or simplified map, some connections that stand out strongly as reported to *directly* affect littering include:

- Lack of appropriate bins nearby (or they are full)
- Not wanting to be inconvenienced (part of *motivation* in the COM-B model)
- Lack of awareness about the impacts of litter
- Attitude that litter is someone else's responsibility
- Abundance of single use products and packaging

While a prominent *indirect* factor was overall lack of local authority resources. Amongst other factors, this was reported to influence the lack of appropriate bins nearby (or they are full).

A relatively minor but notable factor appearing in the littering map was flytipping; this was included because several stakeholders referred to the act of flytipping or the presence of flytipped waste being an influence on littering behaviour (and there was not an indication that they had mixed these up).

At the top of the online map are interactive controls, allowing the user to view which factors were highlighted in or additional to the rapid evidence review findings. There were 25 factors 'in common', and 36 additional factors reported by stakeholders¹. When comparing these visually, it can be seen that stakeholders tended to report additional *material (physical opportunity)* factors, as well as additional behaviours contributing to the problem. These had been relative gaps in the literature, which focused more on individual factors.

Another control at the top left of the online map allows the user to see which factors can be linked to existing interventions known to Zero Waste Scotland. These include: educational programmes, littering fine, communications campaigns, carrier bag charge, litter bin infrastructure, and recycling on the go bins. Only about a third of the reported causes of littering (20 out of 61) seem to be directly addressed by these existing interventions. This suggests that additional interventions might be needed and there are likely to be opportunities to address other parts of the system to help reduce littering.

Bear in mind that these observations are subjective and may not be exhaustive. Visual inspection of the systems maps should be combined with a consideration of the systems metrics reported in the next section.

4.4 Ranking littering influences by quantitative metrics about connectivity

It can be difficult to tell by visual inspection alone which factors might be important within a behavioural systems map and warrant further attention. Another way to help judge the

¹ Two barriers to reducing littering from the rapid evidence review did not appear in the maps, they were: being drunk and wanting to be seen in a good light.

relative importance of factors is to look at quantitative metrics about their connectivity (although this is also subject to limitations, as explained in the methods section).

Figure 5 plots the influences on littering behaviour in rank order, according to three metrics about connectivity, which are explained in the methods section: in-degree (y-axis), out-degree (x-axis), and PageRank (colour scale and size of circles). The most sophisticated metric is PageRank, which takes into account both in-degree and out-degree of a factor and factors it is connected to. This metric is also much less easy (or even impossible) to 'see' from looking at a systems map.

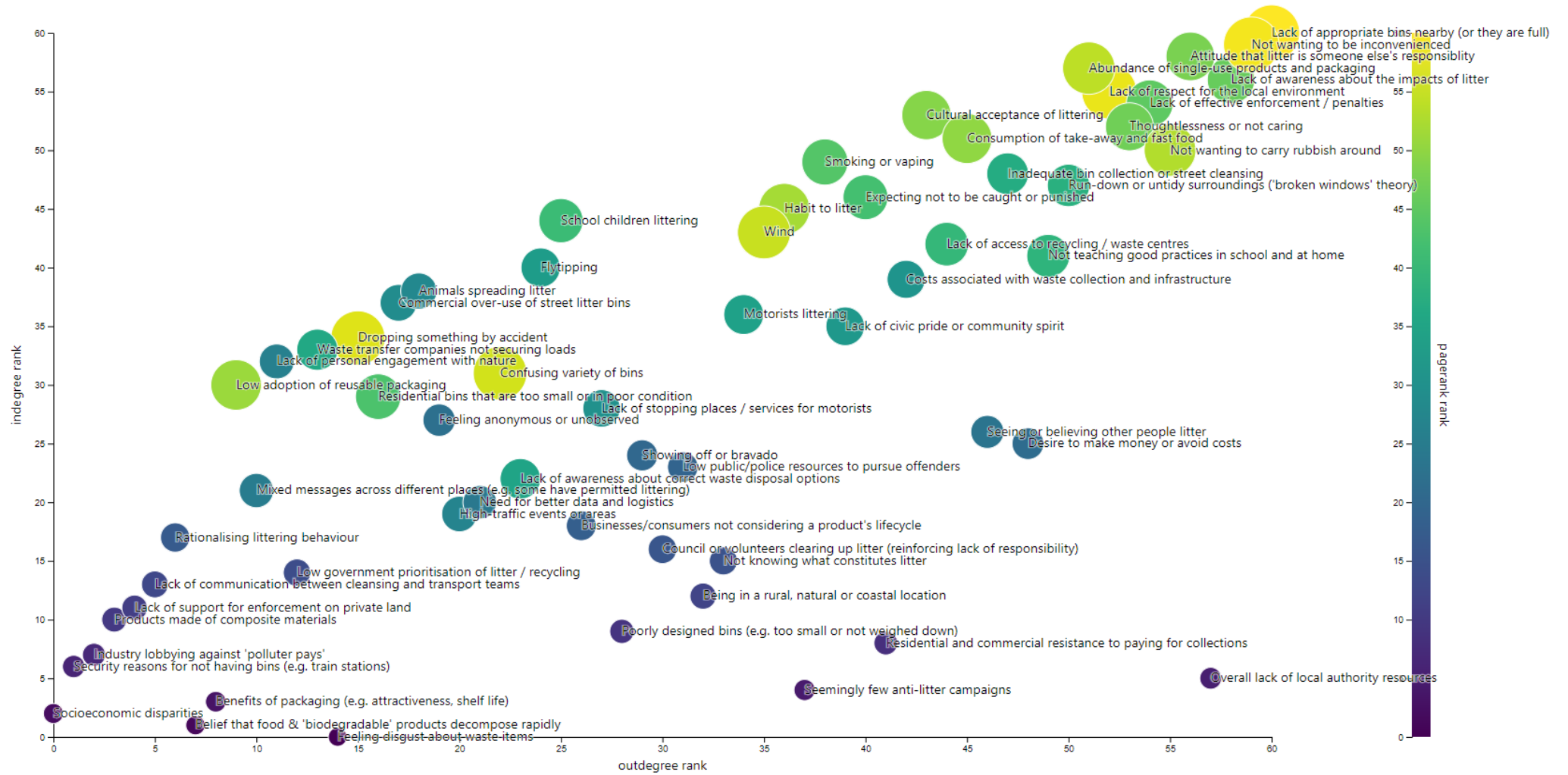
According to the PageRank metric, the 'top 10' most influential factors influencing littering were:

- Lack of appropriate bins nearby (or they are full)
- Not wanting to be inconvenienced
- Lack of respect for the local environment
- Dropping something by accident
- Being confused by variety of bins
- Wind
- Abundance of single-use products and packaging
- Not wanting to carry rubbish around
- Habit to litter
- Low adoption of reusable packaging

These overlap partly but not completely with the factors that stood out from visual inspection of the map. However, note that the 'top 10' is an arbitrary cut-off point and there is not necessarily a significant difference between, for example, the factors that rank 10th and 11th.

Generally, barriers with a higher PageRank tend to appear in the top right of the graph, which are also those factors with the highest in-degree and out-degree. However, the graph also illustrates how a given factor may rank differently across the three metrics: notably, 'dropping something by accident' and 'confusing variety of bins' have a high PageRank metric even though their in-degree and out-degree are among the mid-ranking factors.

Figure 5. Influences on littering behaviour, ranked by systems metrics about connectivity.



Description of Figure 5: A graph which shows the list of influences on littering behaviour, ranked by systems metrics about connectivity. Highlights visually the top 10 influences as described in section 4.4.

4.5 Flytipping

Stakeholders identified 46 causal influences on littering, which were organised into an interactive online behavioural systems map which can be explored at: [an online flytipping system map](#). Screenshots are available in [Appendix D](#) and simplified versions, showing only connections that were reported by at least 2 people or more, are shown in Figures 6 and 7.

When visually inspecting the simplified or full map, *direct* causes of flytipping which stand out as particularly strong influences include:

- Costs of using disposal sites/services
- Not wanting to be inconvenienced
- Desire to make money or avoid costs
- Distance/difficulty getting to nearest disposal site
- Lack of awareness about correct waste disposal options

While a notable *indirect* factor includes low household income (cost of living crisis). Not caring about flytipping or its environmental impacts was also seen as indirectly influencing a number of other factors, as well as being directly connected to flytipping.

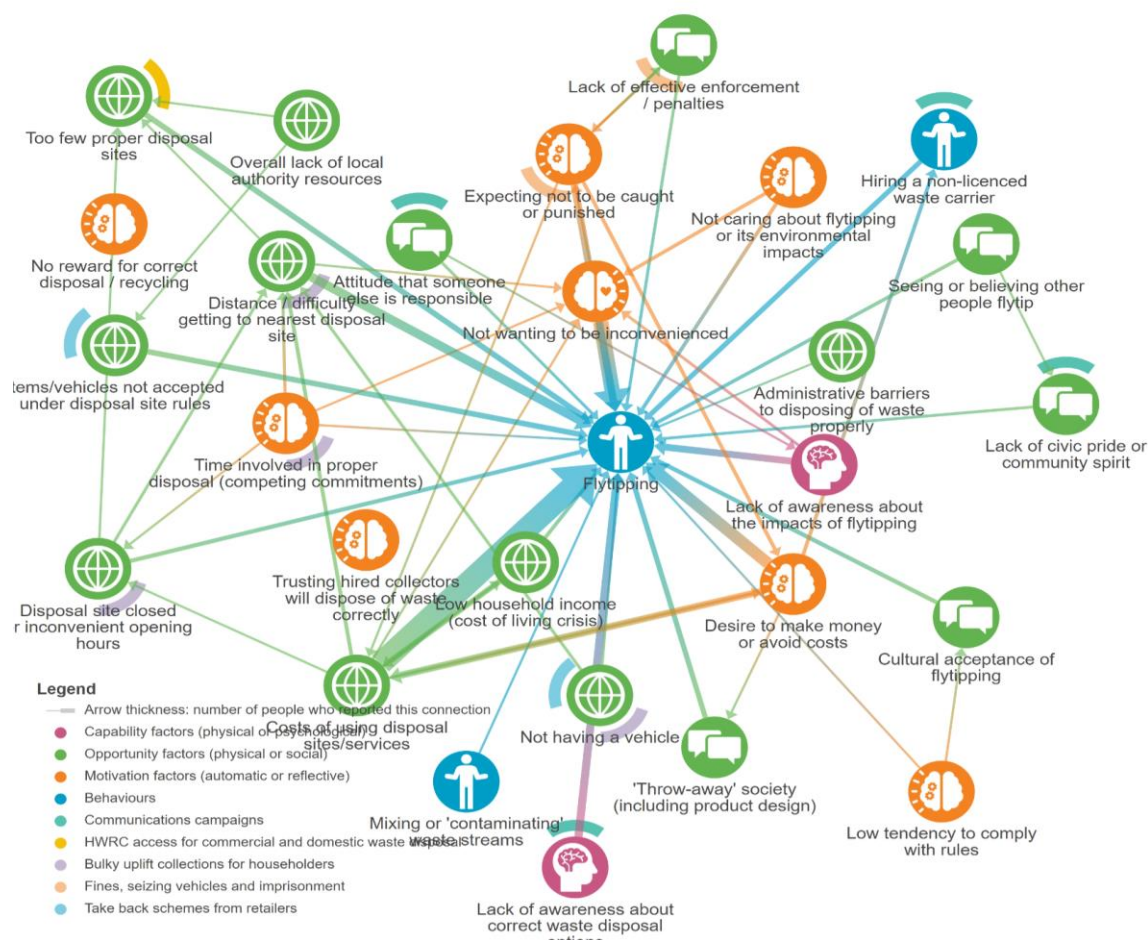
When comparing factors that were highlighted in or additional to the rapid evidence review, there were 28 factors 'in common', and 18 additional factors reported by stakeholders². As with the littering map, stakeholders tended to identify additional material and behavioural factors, although this pattern is not as strong when it comes to flytipping, partly because only half as many additional factors were identified. This could be because there were fewer respondents on the flytipping topic, or there may be less awareness about the drivers of flytipping, perhaps because it is a less common behaviour than littering.

Existing interventions to reduce flytipping include: communications campaigns, HWRC access for commercial and domestic waste disposal, bulky uplift collections for householders, fines, seizing vehicles and imprisonment, and take back schemes from retailers. When viewing which factors in the flytipping map would be directly addressed by these interventions, only about two fifths (18 out of 46) are targeted. This suggests that, like littering, additional interventions may be needed in other parts of the system to help reduce flytipping as much as possible.

As before, it is important to remember these observations are subjective and may not be exhaustive. Visual inspection of the systems maps should be combined with a consideration of the systems metrics reported in the next section.

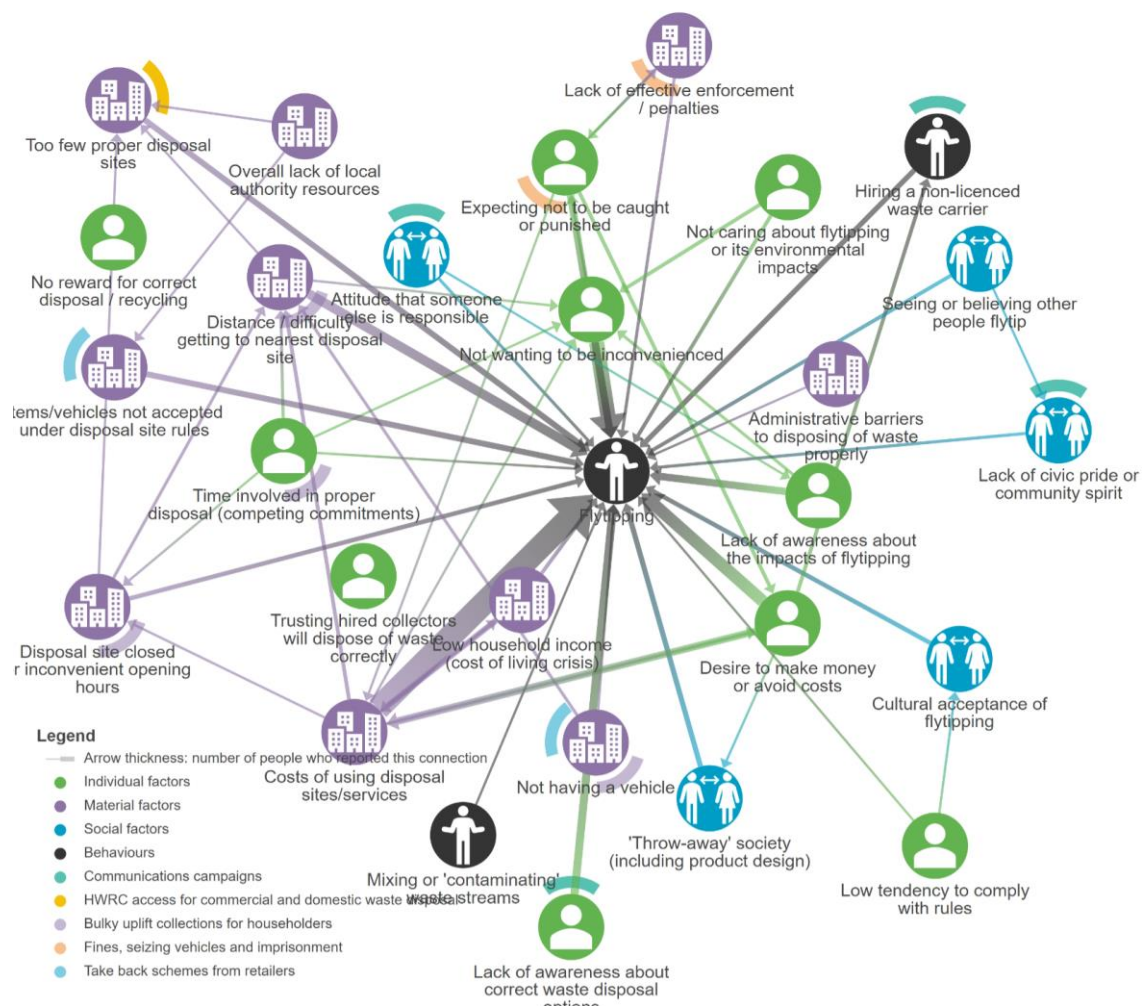
² Two barriers to reducing flytipping from the rapid evidence review did not appear in the maps, they were: not reporting flytipping and not knowing how to report flytipping.

Figure 6. Behavioural Systems Map of Causes of Flytipping (COM-B view).



Description of Figure 6: An interactive, accessible version of this map is available at: [Flytipping COM-B map](#)

Figure 7. Behavioural Systems Map of Causes of Flytipping (ISM view).



Description of Figure 7: An interactive, accessible version of this map is available at: [Flytipping ISM map](#)

4.6 Ranking flytipping influences by quantitative metrics about connectivity

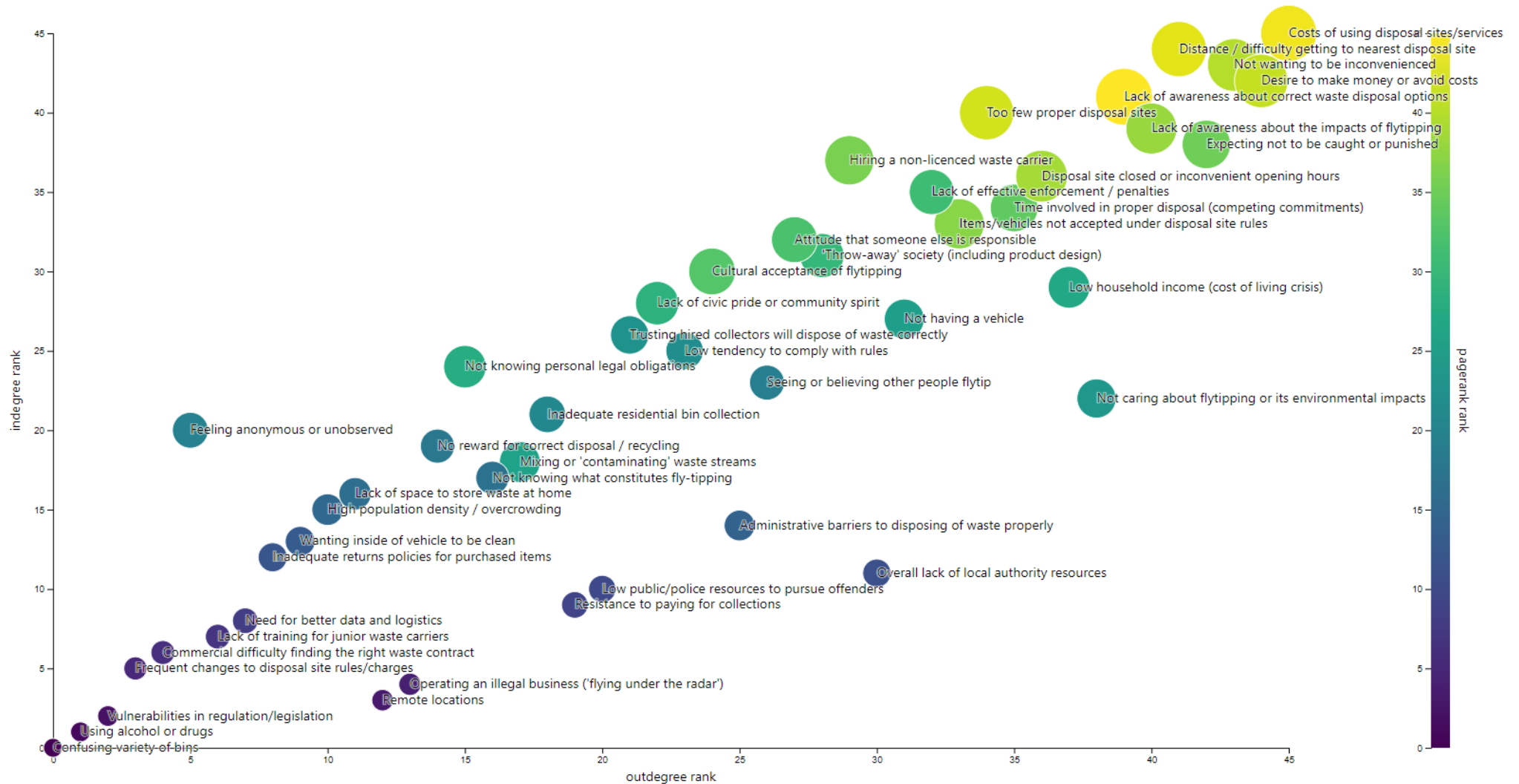
Figure 8 plots the influences on flytipping behaviour in rank order, according to in-degree (y-axis), out-degree (x-axis), and PageRank (colour scale and size of circles).

According to the PageRank metric, the 'top 10' most influential factors influencing flytipping were:

- Lack of awareness about correct waste disposal options
- Costs of using disposal sites/services
- Distance / difficulty getting to nearest disposal site
- Too few proper disposal sites
- Desire to make money or avoid costs
- Not wanting to be inconvenienced
- Disposal site closed or inconvenient opening hours
- Lack of awareness about the impacts of flytipping
- Items/vehicles not accepted under disposal site rules
- Hiring a non-licensed waste carrier

These overlap with some of the factors that stood out from visual inspection of the map.

Figure 8. Influences on flytipping behaviour, ranked by systems metrics about connectivity.



Description of Figure 8: A graph which shows the influences on flytipping behaviour, ranked by systems metrics about connectivity. Highlights visually the top 10 influences as described in section 4.6.

5 Discussion

In this project we developed and analysed two initial behavioural systems maps of littering and flytipping, which were informed by a rapid evidence review update and a wide range of stakeholder views gathered through the System Effects approach which employs online questionnaires.

The rapid evidence review update identified 15 publications not included in previous Zero Waste Scotland evidence reviews and research. Overall, these reported similar factors that would not substantially affect the earlier conclusions. The literature tended to focus more on *individual* drivers of behaviour than *social* or *material* factors. There was also a greater focus on barriers to, rather than enablers of, desired behaviour – particularly for reducing flytipping. These represent gaps in the reviewed literature, highlighting that there is a lack of evidence around some aspects of tackling these problems.

The behavioural systems maps highlighted a large number of further drivers of littering (61 in total, 36 of these were additional to the literature) and flytipping behaviour (46 in total, 18 additional to the literature). Some of these drivers were actions (or inactions) that were seen by stakeholders as contributing to, or resulting in litter and flytipping. Behaviours thought to affect littering included: littering by motorists and around schools; commercial over-use of street litter bins, smoking or vaping; consuming take-away and fast food; industry lobbying against 'polluter pays' principles; lack of engagement with nature; waste transfer companies not securing loads; and inadequate bin collection and street cleansing. Behaviours seen to contribute to flytipping were: inadequate residential bin collection; hiring a non-licensed waste carrier; mixing or 'contaminating' waste streams; operating an illegal business; and using alcohol or drugs.

In addition to the behaviours included in the systems maps, a wide range of other *individual*, *social* and *material* influences were highlighted (when using the ISM model as a lens) – these can alternatively be broken down into *capability*, *opportunity* and *motivation* influences (when using the COM-B model). Notably, stakeholders tended to identify material or physical opportunity influences which were missing from the rapid evidence review update. This could reflect the participants' contextual experience of littering and flytipping 'on the ground' (which may be lacking in some published research); it could also suggest that the System Effects approach encouraged participants to think beyond individual-level drivers of behaviour and consider the systemic context of behaviour more widely.

When looking at which elements of the behavioural systems maps are directly targeted by existing types of interventions (e.g. infrastructure, services, communications campaigns, education programmes, fees/charges), it is clear that despite the range of interventions already in place, these only directly address a fraction of the things driving littering and flytipping behaviour (although they might have other benefits, synergies or spillover not captured in our analysis).

Of particular note, **communications campaigns**, which were among the most frequently cited types of interventions in the evidence we reviewed, cannot be the only or main solution. Communications campaigns are suited mainly to influencing knowledge and attitudes^{15,26} (although may not always be effective at this), meaning they would only be able to directly address 5 out of the 61 reported behavioural influences on littering, and 6 out of 46 reported behavioural influences on flytipping. To address social and material factors (social and physical opportunity), the Behaviour Change Wheel framework points to other types of

intervention such as environmental restructuring (e.g. changes to infrastructure), restrictions (e.g. changes to rules), an enablement (e.g. providing help to overcome personal barriers to the desired behaviour, like not having a vehicle or having difficulty completing paperwork).

Taken all together, the research findings from this project clearly indicate that littering and flytipping behaviour are affected by complex and interconnected drivers, involving many different people's actions or inactions. Sometimes these can be seen to have potentially unintended or unexpected effects; for example, in the littering map it was reported by stakeholders that when councils or volunteers clear up litter, this can reinforce the attitude that litter is someone else's responsibility. In the flytipping map, stakeholders highlighted that misplaced trust can lead to people hiring unlicensed waste carriers who they believe will dispose of waste properly but actually don't.

This complex interacting picture means that achieving change in littering and flytipping will need multiple interventions working together in combination. This message is backed and emphasised by behavioural science frameworks^{15,16,27,28} and examples of successful sustained behaviour change in other policy areas, such as smoking cessation, where reductions in smoking have been attributed to multiple interventions working in tandem over many years.

Not *all* drivers of behaviour can or should be targeted in order to achieve change; for example, while wind contributes to litter, this is outside of our control, despite some mitigations that can be put in place. Not wanting to be inconvenienced – also expressed by some stakeholders as laziness – was seen as one of the top drivers of littering and flytipping, but could be challenging to address directly through behaviour change interventions. The PRIME Theory of motivation¹⁷ can help to explain this, by clarifying that how we act in a given moment is a result of what competing or reinforcing impulses and inhibitions shaped by feelings of 'want' or 'need'. While approaches like education, persuasion, incentivisation and coercion can help increase motivation^{15,26}, it is unlikely that any of these techniques on their own will reliably get people to feel they want or need to dispose of waste so much that this overrides all other wants and needs. Other indirect approaches that make it easier to dispose of waste correctly are also likely to be needed.

The initial behavioural systems maps developed here can point to *what* drivers may be relevant to consider, and they give clues as to which ones may be more or less influential within the system, but further work will be needed to establish *which* drivers should be prioritised as targets for intervention. This will help to determine what combinations of interventions are likely to be most effective. This is not something that can be determined based on behaviour change theories and frameworks alone, but requires a tailored approach based on understanding of local systems and contexts.

5.1 Future research and engagement

The initial behavioural systems maps developed in this project can be seen as resources for further research and engagement to build upon. Some stakeholders have had a chance to contribute their 'piece of the puzzle', but it will be equally important for these and other stakeholders – for example in the community sector – to have the opportunity to see the picture as a whole, interrogate and improve this picture, reach a joint understanding of each other's roles, and deliberate about the way forward.

Specific directions for future research and engagement could include:

- **Identifying which actors (people, groups or organisations) are implicated in which parts of the behavioural systems maps.** The initial behavioural systems maps refer to

some groups of people (e.g. motorists, school children, waste carriers, businesses, local authorities) but we did not systematically explore the roles of different actors in the system, nor have the opportunity to follow up with stakeholders about which actors their responses might relate to. To develop a comprehensive behaviour change strategy for littering and flytipping it will be important to gather additional information about who is involved in or responsible for which parts of the system, and what things further influence their behaviour.

- **Developing narratives around key pathways in the behavioural systems maps.** Written narratives can be an important way of interpreting systems maps and often form part of their analysis^{19,29}. They are valuable for translating abstract ideas represented in diagrams into meaningful messages, which can be a key part of communicating systems maps, particularly in a stakeholder context. In practice this can involve writing paragraphs of text (e.g. following a writing template¹⁹) which tell the 'story' of different pathways through the systems map and overall messages taken from it, in lay language. This may be done by researchers or collaboratively with stakeholders, e.g. as part of a workshop.
- **Gather more in-depth follow-up information about some of the key drivers of behaviour.** This project identified a large number of influences on both littering and flytipping and ranked these according to which ones may warrant further attention based on systems metrics. A valuable next step would be to explore some of the 'top' influences in more detail, so as to unpack why they occur. This could involve various social and behavioural research methods, for example holding in-depth interviews or focus groups with relevant stakeholders, conducting observational research, or public surveys.
- **Apply behavioural science frameworks to prioritise amongst the drivers of behaviour and identify suitable intervention options.** There are many behavioural science frameworks and tools that can help to take a systematic approach to building on the information in the initial behavioural systems maps. In the introduction we highlighted the Behaviour Change Wheel (linked to the COM-B model) and the ISM user guide. The Behaviour Change Wheel framework is associated with a step-by-step process which involves prioritising which drivers of behaviour to target and through which types of intervention employing which behaviour change techniques. A suggested next step for stakeholder engagement around littering and flytipping would be to follow this process by engaging stakeholders in judging the *impact*, *likelihood* and potential *spillover* of changing different target behaviours – using the systems maps as a reference tool – and ranking influences on behaviour according to APEASE criteria (Acceptability, Practicability, Effectiveness, Affordability, Side-effects, and Equity) which forms part of the Behaviour Change Wheel approach.

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7 Appendix A. Questionnaires.

Start of littering questionnaire.

Welcome to the System Effects survey on Littering

In this short exercise we will ask you a series of questions to build up a mind map about littering behaviour.

For this activity, litter is considered to be "waste in the wrong place," referring to individual items (such as cans, plastic bottles, plastic packaging or cigarettes for example) or a small number of items thrown, dropped, or left in a public area by anyone. Litter also includes materials that have escaped from collection containers or vehicles.

Before you begin, please take a moment to think about: from your viewpoint and experiences, what things can contribute to litter or result in people littering? And why do you think each of these might happen? (Think about the possible reasons).

In this exercise you will go through those two steps and list your ideas. You are encouraged to suggest as many ideas as you can think of.

In a third step you will see your ideas connected up as a mind map. Please spend time to check if you agree with the arrows in the map, and draw further arrows where you think two things are connected. You will have a chance to go back and edit anything until you are happy with your mind map.

Please note this is about capturing your thoughts on the topic, from your experiences - there are no right or wrong answers.

On the next page we will ask you to select what type of sectoral organisation you work for. Your comments will be fully anonymous and it will not be possible to link them to you or your organisation.

Click 'let's begin' to confirm you have read the information about this research exercise and consent to take part.

Before we get started, please answer the following:

Which sector best describes the organisation you work for?

- Public sector – local authority
- Public sector – other 'Duty body' with responsibilities for litter/flytipping
- Charity/NGO
- Central Government
- Retailer – small
- Retailer – large

- Manufacturer – small
- Manufacturer – large
- Enforcement organisation
- Other private sector organisation, e.g. Transport or land manager

From your viewpoint and experiences, what things can contribute to litter or result in someone littering? (Think about how people acquire, use and dispose of items)

[Multiple free text responses – no limit on the number of responses]

- _____
- _____
- _____
- _____
- _____

[...]

And why do you think each of these might happen? (Think about the possible reasons) (it's ok to repeat responses)

[Multiple free text responses – no limit on the number of responses]

[previous response] because...

- _____
- _____
- _____

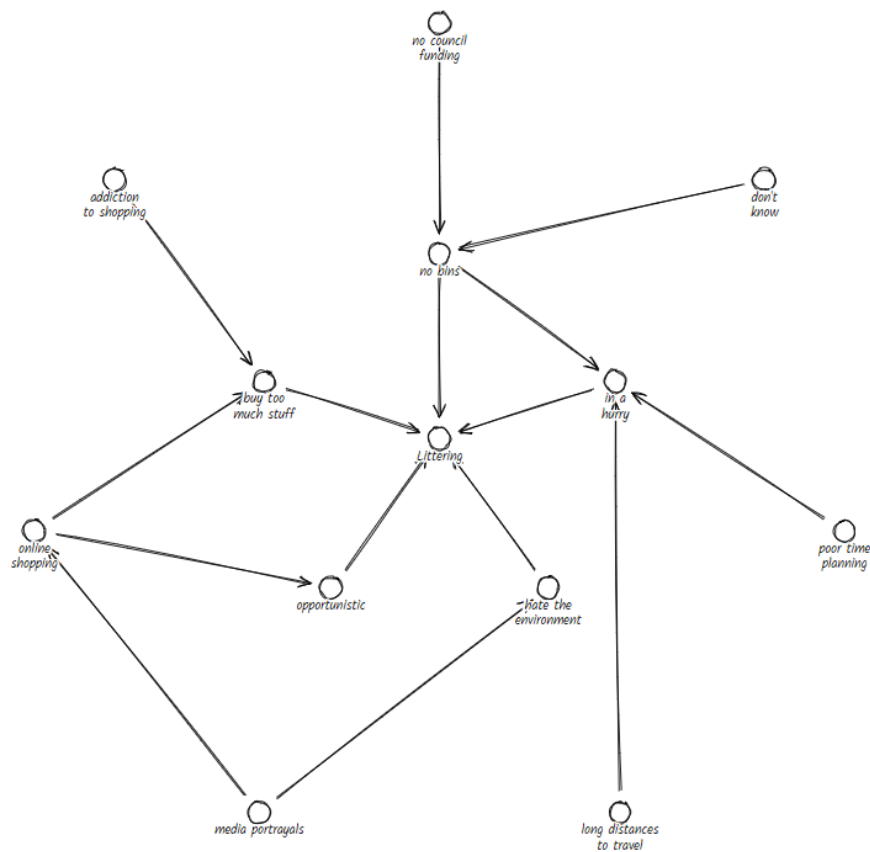
[previous response] because...

- _____
- _____
- _____

[...]

Please review the connections you identified in the previous steps. Any missing connections you would like to add? (click and drag to draw additional connections)

[Interactive map]



Illustrative screenshot – not real data.

Well done!

If you would like to review or edit your response you are welcome to do so now.

When you're ready to submit your response please click the submit button below.

End of littering questionnaire.

Welcome to the System Effects survey on Flytipping

In this short exercise we will ask you a series of questions to build up a mind map about flytipping behaviour.

For this exercise, flytipping is considered to be "the dumping of waste in the wrong place", usually pre-meditated and involving large items or volumes. It is the illegal disposal of household, industrial, commercial or other 'controlled' waste. This can be liquid or solid. 'Controlled' waste includes garden refuse and larger domestic items such as fridges and mattresses.

Before you begin, please take a moment to think about: from your viewpoint and experiences, what things can contribute to flytipping? And why do you think each of these might happen? (Think about the possible reasons).

In this exercise you will go through those two steps and list your ideas. You are encouraged to suggest as many ideas as you can think of.

In a third step you will see your ideas connected up as a mind map. Please spend time to check if you agree with the arrows in the map, and draw further arrows where you think two things are connected. You will have a chance to go back and edit anything until you are happy with your mind map.

Please note this is about capturing your thoughts on the topic - there are no right or wrong answers.

On the next page we will ask you to select what type of sectoral organisation you work for. Your comments will be fully anonymous and it will not be possible to link them to you or your organisation.

Click 'let's begin' to confirm you have read the information about this research exercise and consent to take part.

Before we get started, please answer the following:

Which sector best describes the organisation you work for?

- Public sector – local authority
- Public sector – other 'Duty body' with responsibilities for litter/flytipping
- Charity/NGO
- Central Government
- Retailer – small
- Retailer – large
- Manufacturer – small
- Manufacturer – large
- Enforcement organisation

- Other private sector organisation, e.g. Transport or land manager

From your viewpoint and experiences, what things can contribute to flytipping or result in someone flytipping? (Think about how people acquire, use and dispose of items)

[Multiple free text responses – no limit on the number of responses]

- _____
- _____
- _____
- _____
- _____

[...]

And why do you think each of these things might happen? (Think about the possible reasons) (it's ok to repeat responses)

[Multiple free text responses – no limit on the number of responses]

[previous response] because...

- _____
- _____
- _____

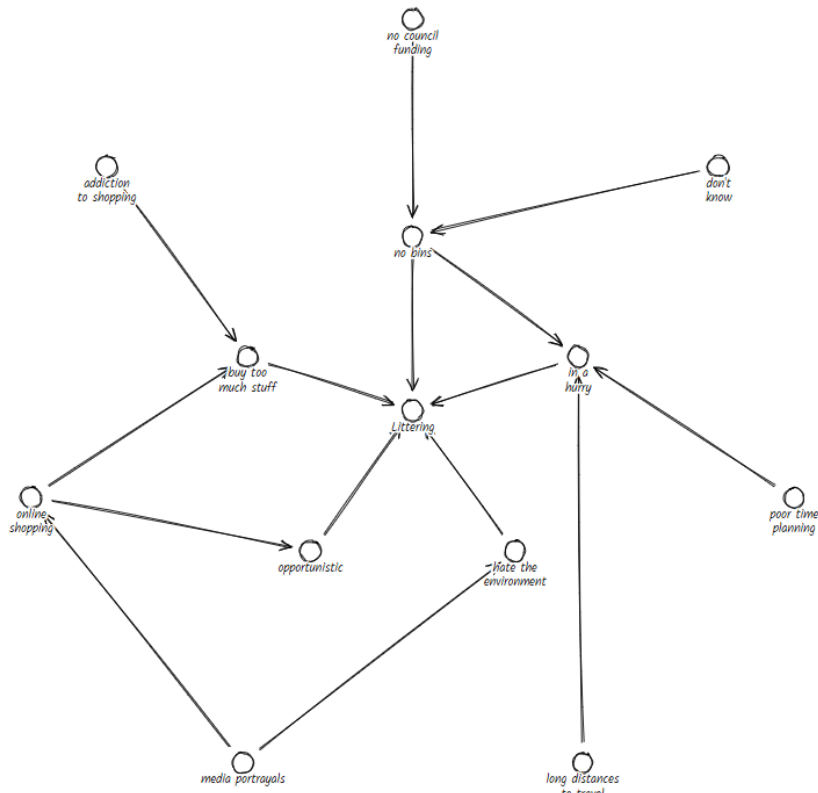
[previous response] because...

- _____
- _____
- _____

[...]

Please review the connections you identified in the previous steps. Any missing connections you would like to add? (click and drag to draw additional connections)

[Interactive map]



Illustrative screenshot – not real data.

Well done!

If you would like to review or edit your response you are welcome to do so now.

When you're ready to submit your response please click the submit button below.

End of flytipping questionnaire.

8 Appendix B. Rapid Evidence Review Sources.

Table B1. Existing Zero Waste Scotland reports and National Litter & Flytipping Strategy, included in the rapid evidence review update.

Report title and link	Number of barriers & enablers extracted
Evidence Review of Flytipping Behaviour	53
Rapid Evidence Review of Littering Behaviour and Anti-Litter Policies	30
Scotland's Litter Problem	12
Flytipping Survey	6
National Litter and Flytipping Strategy	4

Table B2. Additional publications found and included in the rapid evidence review update.

Publication reference and link	Number of barriers & enablers extracted
Chaudhary, A. H., Polonsky, M. J., & McClaren, N. (2021). Littering behaviour: A systematic review. <i>International Journal of Consumer Studies</i>, 45(4), 478-510.	27
Kolodko, J. & Read, D. (2018). Using behavioural science to reduce littering: Understanding, addressing and solving the problem of litter using a commons dilemma approach. <i>Journal of Litter and Environmental Quality</i>, 2(1), 20-35.	23
Liu, Y., Kong, F., & Gonzalez, E. D. S. (2017). Dumping, waste management and ecological security: Evidence from England. <i>Journal of Cleaner Production</i>, 167, 1425-1437.	15
Kelly, F. (2017) <i>Waste, crime and environmental harm: exploring the Scottish waste management sector and its vulnerabilities to organised crime</i>. [MSc thesis].	6
Ager, J. & Lawrence, T. (2018). Tackling current issues in fly-tipping: a view from a London borough. <i>Journal of Litter and Environmental Quality</i>, 2(1), 47-55.	3

Gellard, C., Dickins, T.E. & Coulson, M. (2019). The ecology of cooperation: Considerations for litter research. <i>Journal of Litter and Environmental Quality</i>, 3(1), 38-50.	3
Dickins, T. (2018). Pragmatic considerations and social benefits: An analysis of engagement with a fly-tipping reduction project. <i>Journal of Litter and Environmental Quality</i>, 2(1), 36-47.	2
Phillips, M. & Holt, E. (2017). Educating on litter in schools. <i>Journal of Litter and Environmental Quality</i>, 1(1), 33-36.	2
Hall, D. & Campbell, R. (2020). Testing new behaviour change methods to tackle littered gum. <i>Journal of Litter and Environmental Quality</i>, 4(1), 5-16.	1
Harris, L., Hargreaves, J., Tehan, R., Hutton, J. & Paris, L. (2019). The Big Scoop: A novel intervention to encourage human behaviour change to reduce dog fouling in public places. <i>Journal of Litter and Environmental Quality</i>, 3(1), 24-30.	1
Monck, G. (2017). Strengthening communities by reducing litter. <i>Journal of Litter and Environmental Quality</i>, 1(1), 37-39.	1
Phillips, R. (2017). A case-study on the Repurpose project: a London estate based pilot tackling fly-tipping through reuse. <i>Journal of Litter and Environmental Quality</i>, 1(1), 26-32.	1
Tehan, R., Jackson, L., Jeffers, H. & Burns, T. (2017). Beacons of litter: A social experiment to understand how the presence of certain littered items influences rates of littering. <i>Journal of Litter and Environmental Quality</i>, 1(1), 5-15.	1

Table B3. Additional publications found but not included in the rapid evidence review update (did not report relevant causal influences on behaviour).

Publication reference and link	Number of barriers & enablers extracted
Chikowore, N. (2023). "Every small action helps towards the greater cause": online communities scaling up online community-led citizen science in addressing litter challenges in Scotland. <i>Citizen Science: Theory and Practice</i>.	0
Brooks, L. & Davoudi, S. (2017). Litter and social practice. <i>Journal of Litter and Environmental Quality</i>, 1(1), 16-25.	0

9 Appendix C. Rapid Evidence Review Themes.

Table C1. Rapid evidence review findings: barriers and enablers to reducing littering.

Barriers to reducing littering	COM-B	ISM	Number of sub-barriers identified
Run-down or untidy surroundings ('broken windows' theory)	Physical Opportunity	Material	12
Difficulty accessing bins (e.g. distance, visibility)	Physical Opportunity	Material	4
Feeling anonymous or unobserved	Social Opportunity	Social	4
Lack of bins	Physical Opportunity	Material	4
Not wanting to be inconvenienced	Automatic Motivation	Individual	4
Habit to litter	Automatic Motivation	Individual	3
Seeing or believing other people litter	Social Opportunity	Social	3
Attitude that littering is OK	Reflective Motivation	Individual	2
Feeling disgust about waste items	Automatic Motivation	Individual	2
Feeling others are responsible for the local environment	Social Opportunity	Social	2
Lack of knowledge about the impacts of litter	Psychological Capability	Individual	2
Low tendency to comply with rules	Reflective Motivation	Individual	2
Rationalising littering behaviour	Reflective Motivation	Individual	2
Being drunk	Psychological Capability	Individual	1
Desire to make money or avoid costs	Reflective Motivation	Individual	1

Expecting not to be caught	Reflective Motivation	Individual	1
High population density / overcrowding	Physical Opportunity	Material	1
Immediate company seen as peers	Social Opportunity	Social	1
Not knowing what constitutes litter	Psychological Capability	Individual	1
Inattentiveness	Psychological Capability	Individual	1
Smoking	Behaviour	Behaviour	1
Vulnerabilities in regulation/enforcement	Social Opportunity	Material	1
Enablers of reducing littering	COM-B	ISM	Number of sub-enablers identified
Communication interventions (e.g. prompts, educational materials, advertisements)	Behaviour	Behaviour	12
Local pride and sense of community/belonging	Social Opportunity	Social	7
Knowledge of the impacts of litter	Psychological Capability	Individual	5
Societal norm not to litter	Social Opportunity	Social	4
Feeling personally responsible for the local environment (duty of care)	Reflective Motivation	Individual	3
Wanting to be seen in a good light	Automatic Motivation	Individual	3
Fear of being fined/punished	Reflective Motivation	Individual	2
Feeling guilty	Automatic Motivation	Individual	2
Seeing other people dispose of items properly	Social Opportunity	Social	2

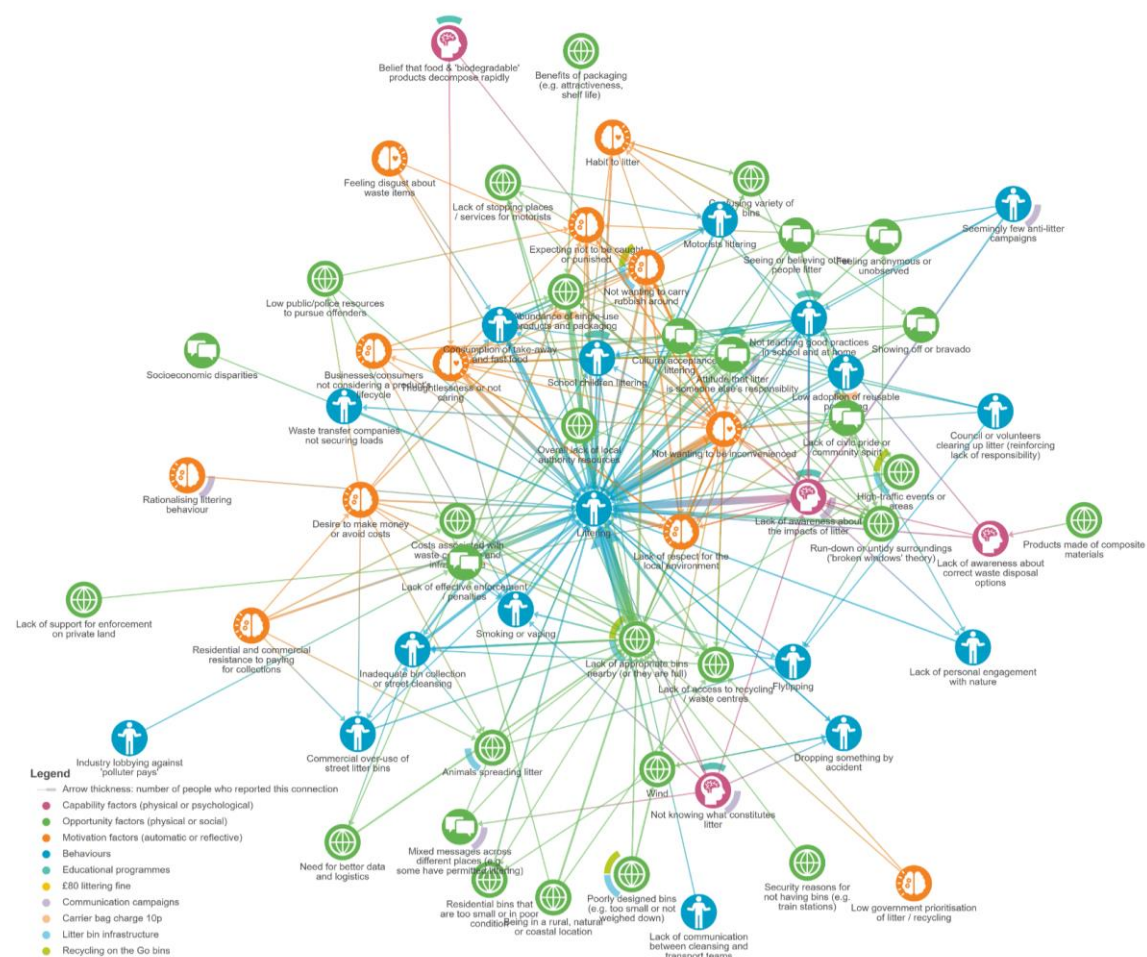
Table C2. Rapid evidence review findings: barriers and enablers to reducing flytipping.

Barriers to reducing flytipping	COM-B	ISM	Number of sub-barriers identified
Desire to make money or avoid costs	Reflective Motivation	Individual	9
Vulnerabilities in regulation/enforcement	Social Opportunity	Material	9
Difficulty accessing disposal site (e.g. distance, opening times)	Physical Opportunity	Material	6
Expecting not to be caught	Reflective Motivation	Individual	6
Fees/taxes to use disposal sites/services	Physical Opportunity	Material	5
Run-down or untidy surroundings ('broken windows' theory)	Physical Opportunity	Material	5
Not wanting to be inconvenienced	Automatic Motivation	Individual	4
Too few proper disposal sites	Physical Opportunity	Material	4
Not knowing what constitutes fly-tipping	Psychological Capability	Individual	4
Inadequate home collection services	Physical Opportunity	Material	3
Lack of space to store waste at home	Physical Opportunity	Material	3
Not reporting fly-tipping	Behaviour	Behaviour	2
High population density / overcrowding	Physical Opportunity	Material	2
Not knowing how to report fly-tipping	Psychological Capability	Individual	2
Not knowing personal legal obligations	Psychological Capability	Individual	2
Attitude that fly-tipping is OK	Reflective Motivation	Individual	2
Not caring about fly-tipping or its environmental impacts	Reflective Motivation	Individual	2
Income level of local area	Physical Opportunity	Material	1
Difficulty completing waste paperwork	Psychological Capability	Individual	1
Low tendency to comply with rules	Reflective Motivation	Individual	1
Seeing or believing other people flytip	Social Opportunity	Social	1
Enablers of reducing flytipping	COM-B	ISM	Number of sub-enablers identified
Fear of being fined/punished	Reflective Motivation	Individual	5

Local pride and sense of community/belonging	Social Opportunity	Social	3
Feeling guilty	Automatic Motivation	Individual	2
Adequate home collection services	Physical Opportunity	Material	2
Feeling personally responsible for the local environment (duty of care)	Reflective Motivation	Individual	1
Fear of reputational damage	Social Opportunity	Social	1

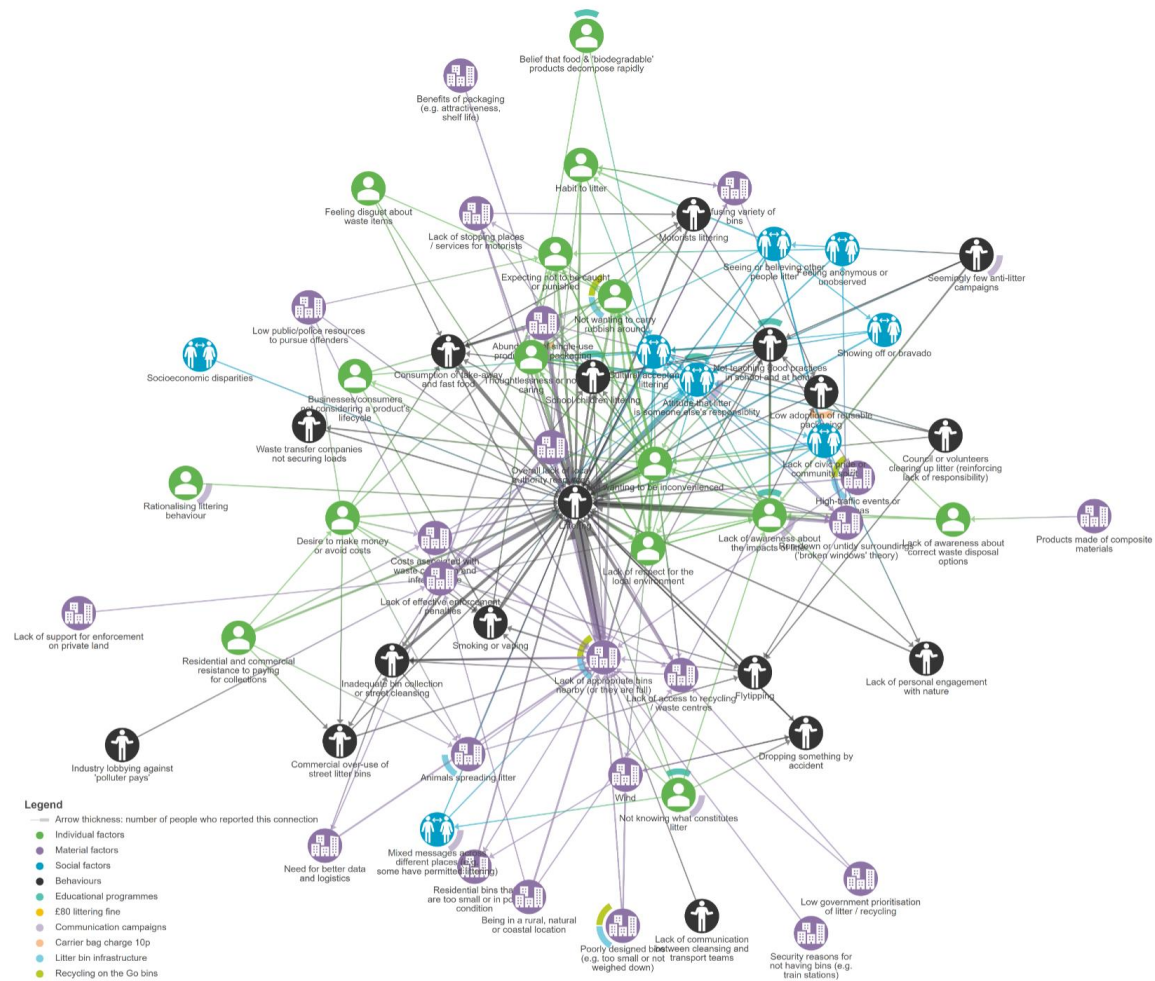
10 Appendix D. Behavioural Systems Maps.

Figure D1. Behavioural Systems Map of Causes of Littering (COM-B view).



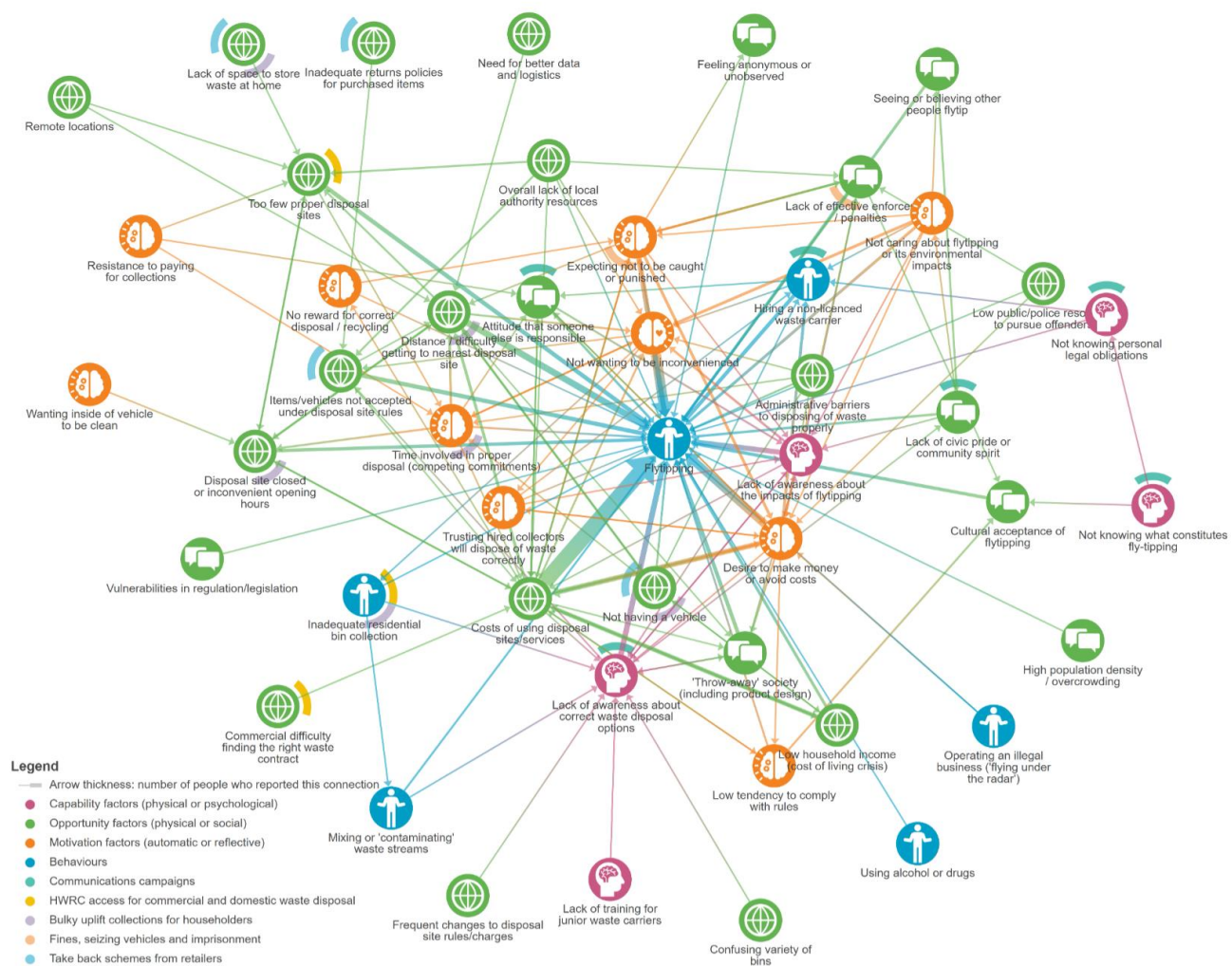
Description of Figure D1: An interactive, accessible version of this map is available at: [Litter COM-B map](#)

Figure D2. Behavioural Systems Map of Causes of Littering (ISM view).



Description of Figure D2: An interactive, accessible version of this map is available at: [Litter ISM map](#)

Figure D3. Behavioural Systems Map of Causes of Flytipping (COM-B view).



Description of Figure D3: An interactive, accessible version of this map is available at: [Flytipping COM-B map](#)

Figure D4. Behavioural Systems Map of Causes of Flytipping (ISM view).



