Bin2Bean

Collection of Organic Waste: Guidelines for Communication and Awareness Raising

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BIN2BEAN project

Collection of Organic Waste: Guidelines for Communication and Awareness Raising

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Executive Summary

The Bin2Bean project looks at the entire value chain for soil improvers from organic waste. Every step is important for the quality of the final product and its marketability in the region. The pre-separation of bio-waste at source is of utmost importance because potential mistakes can only be corrected partially in further steps of the process. Therefore, any awareness raising and communication strategy should consider the situation along the regional value chain. Objectives need to be set that depend on the local waste management situation, previous experience with source-separated collection of waste inter alia. Correct waste separation requires a certain behaviour of all citizens. Building up awareness for bio-waste and its benefits for soil needs some years in which measures are gradually implemented and are accompanied by appropriate communication. Neither garbage nor soil are a big issue in the public discussion – awareness raising is top priority when bio bins shall be introduced in a municipality.

The description of the strategy in this guideline follows the structure of the theory of planned behaviour including some useful extensions regarding waste sorting. This makes it possible to assess the significance of multiple factors influencing behaviour and select appropriate measures to influence them. Communication measures must be carefully tailored. Since waste separation requires additional effort and a thorough approach by citizens, the motivational drivers must be assessed and the best possible support for citizens established. There are no ideal communication solutions, but rather a target-group-specific approach is required. It is necessary to consider several motivation factors at the same time and to learn which communication measures are used to influence which factors. Cultural differences, habits and living conditions have a significant influence on awareness of recycling measures, so that the strategies of European cities can differ considerably.

This guideline is based on scientific literature, learnings from the Living Labs included in the Bin2Bean project (i.e. Hamburg / Germany, Amsterdam / The Netherlands, and Egaleo / Greece) from members of the Stakeholder Forum, and extensive experience with the separation of waste at source and the collection of bio-waste. Several examples from the Living Labs are described in the text.

1. Some basic information

Communication strategies for the promotion of separate collections of organic waste do not fundamentally differ from the awareness raising for other waste issues like littering or separate collection of used electronic devices. Therefore, we discuss the significance of garbage as part of our planetary crisis first. Most people are unaware of the critical role that waste plays in contributing to climate change and soil pollution. This lack of knowledge often leads to a weak sense of responsibility as waste producers and garbage managers, both at home and in workplaces. This is a particularly relevant problem with organic waste because sorting is often perceived as inconvenient and may raise hygiene concerns. Educating and informing the public about the significance of proper waste management is crucial for promoting the sustainable development of cities, which are integral parts of our planet's ecosystem.

1.1 Necessary information on bio-waste and soil

"Let's talk about garbage" is very rarely the start of a conversation. It is therefore no surprise that eleven out of eighteen cities that responded to a Bin2Bean survey identified "lack of public awareness" as the main challenge for the effective separation of bio-waste (see box). However, **waste matters** – lack of proper waste management contributes to climate change, pollution of soil, rivers and oceans. On the other hand, waste holds potential as a resource: for example, separately collected and processed bio-waste can be transformed into soil improvers. While there are many European regulatory attempts aiming at proper waste management, e.g. encouraging recycling instead of landfilling, their implementation is often delayed in many Member States. Enforcement also remains a major challenge. Millions and millions of households are expected to sort their waste, yet it is almost impossible to monitor compliance effectively: **Even the misthrows of only a few people can contaminate separated bio-waste of many of their fellow citizens**.
Clearly, waste – and especially **bio-waste – should become a matter of public debate.** This communication guideline was primarily intended for the three Living Labs (LL's) as partners of the Bin2Bean project. However, its general strategies can also support other municipalities that want to introduce or enhance bio-waste collection. Moreover, this guideline is intended for waste management companies, engaged citizens and NGOs that support the transformation of organic waste into soil improvers. It is based on scientific publications, discussions with responsible employees from cities and waste management companies, websites of associations engaged in bio-waste, and the author's long-standing experience with waste management. Additional insights also refer to other EU projects, such as BioBest, WaysTUP, HOOP, and in particular the "analysis of best practices in communications and engagement" delivered by the BioBest project [Jourdan & Favoino 2024].

Citations from the Bin2Bean Cities Survey:
"The process of awakening consciousness among people is underway, and it is certainly a lengthy process as it is also the most important aspect." (Sarajevo, Bosnia)
"Residents of large housing estates are difficult to reach with awareness campaigns." (Münster, Germany)
"Mainly, lack of public awareness of the importance of separate bio-waste sorting," (Sevilla, Spain)
"The problem is: how to make the information not boring." (Düsseldorf, Germany)
"Lack of public awareness of the importance of separate bio-waste sorting." (Mikkeli, Finland)

1.2 Garbage: an underestimated part of the ecological planetary crisis

The amount of waste is increasing on the global level widely following trends in economic growth. According to the Global Waste Management Outlook [UNEP 2024], about 2.126 billion tons of municipal solid waste were generated in 2020, whereas an increase of about 500 million tons is assessed for the year 2030. Waste plays an important role as part of the so-called planetary triple crisis [UNEP 2024]:

- Methane (CH_4) is released from the uncontrolled decomposition of organic waste in landfills and dumpsites. The open burning of waste releases black carbon (soot). Both reaction products strongly contribute to current global warming accounting for about 5% of all greenhouse gases (GHG). Carbon dioxide (CO_2) emissions from controlled incineration, waste transport or recycling facilities ranges far behind these main contaminants.
- The pollution of land and aquatic ecosystems by waste is one of the main drivers of biodiversity loss. Most biodiversity loss is caused by land-use change and related consumption of resources that become waste after use.
- Between 400,000 and 1 million people die every year as a result of diseases related to mismanaged waste that includes diarrhoea, malaria, heart disease and cancer.

Fortunately, waste generation and especially impacts from waste management have been mitigated by the environmental policies of the EU and its Member States. Despite considerable economic growth, per capita waste generation in EU remained nearly stable between 2010 and 2022[1]. This proves that decoupling between GDP and waste generation is possible to a certain extent.
However, a significant decrease in total waste generation by 2030 – as targeted by the EU – remains unlikely. **According to the EU landfill directive, Member States must reduce the amount of municipal waste sent to landfill to 10% or less of the total amount of municipal waste generated by 2035 and meet a recycling target of 65% of municipal waste**. **Bio-waste (= food and kitchen waste plus green waste from private and public gardens) amounts to 34% of all municipal waste, corresponding to approximately 86 million tons** [EEA 2020, p. 11]**. For this reason, recycling of bio-waste is of outstanding importance to meet the EU target by 2035**, despite several persistent challenges which must be solved as soon as possible:

[1] For details, see the actual statistical data published by EUROSTAT

- The disposal of organic waste – the primary source of CH_4 emissions from landfills – has been banned only in some Member States in Central and Northern Europe.
- The amount of recycled bio-waste remained low: the share of municipal waste composted and/or digested was 17 % in 2018 compared to 11 % in 2004 [EEA 2020].
- A significant proportion of bio-waste still ends up in the mixed waste that is landfilled (the worst disposal path) or is incinerated for energy production.
- Separately collected bio-waste is often contaminated preventing the production of high-quality, marketable compost.

1.3 Lack of carbon in soils – a long-term threat

Soil degradation is a world-wide threat for agriculture, nutrition and biodiversity [FAO 2022]. Contrary to common assumptions, this is not merely an issue of desertification in sub-Saharan Africa. European soils are also threatened by numerous problems: between 61% and 73% of agricultural soil in the EU are affected by erosion, loss of organic carbon, nutrient exceedances, compaction or secondary salinization [EC 2023]. **Maintaining a suitable concentration of organic carbon - depending on the type of soil and its use - is necessary for vital services like food production, but also to store and filter water**. **Carbon-rich soils are** well structured and **more resilient to erosion**. Moreover, **carbon stored in soils ("sequestration") contributes to mitigating climate change due to lower and slowed down CO_2 emissions from soil**.
Maps produced by the European Soil Observatory (EUSO) highlight extensive areas in Europe suffering of a lack of organic carbon. Alarmingly, for 6% of all European soil, the loss of organic carbon is already considered "critical" [Pravalie et al. 2024].
The production and application of compost from bio-waste to soils could remarkably enhance the carbon content of soils and mitigate this problem. According to the European Environment Agency (EEA), "**repeated applications of good-quality compost can improve the soil's ability to retain water and nutrients and to store carbon, as well as raising its fertility**." [EEA 2020] Additionally, findings from the European LIFE SoilCom project further underscore the benefits of compost application. Indeed, they demonstrated how the additional application of compost (20% plus) decreases the amount of water, pesticides, and inorganic fertilizers by 7% per farm and increases the crop productivity by 10% [Kristensen 2023]. **Given the high demand for soil improvers across Europe, the lack of sufficient good-quality compost is a serious concern**. Enhancing the collection and processing of bio-waste into compost represents a critical opportunity for improving soil resilience.

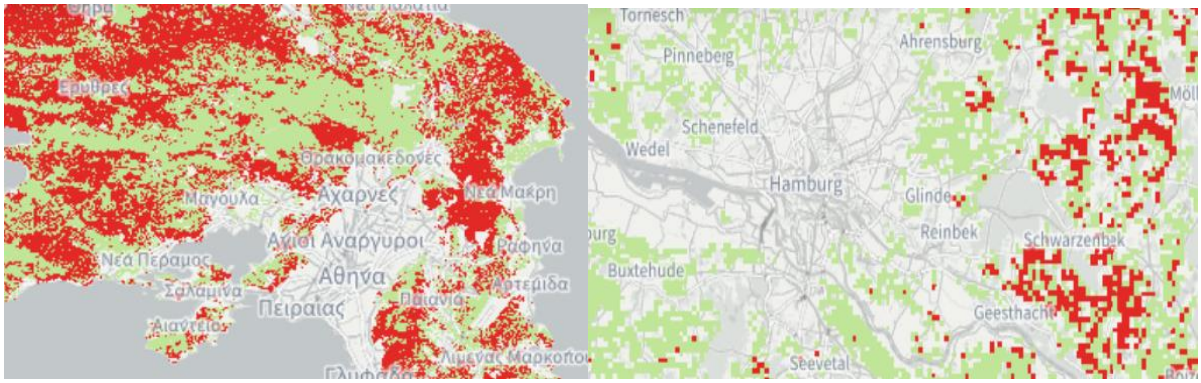


Figure 1: Examples taken from the EUSO maps: Areas endangered by water erosion in the Attica region (Greece, left) and soils compartments with low content of organic carbon in the region of Hamburg (Germany, right)

1.4 How to raise awareness in the public?

Neither garbage nor soil is a big issue in the public discussion. However, two types of events can act as effective catalysts for raising public awareness.
First, waste becomes a public issue in the event of accidents, fraud, environmental damage, increasing waste fees. Depending on the specific topic, the responsible handling of waste aiming at resource recovery can be introduced into the discussion. To capitalize this opportunity, communication must be swift and tailored with relevant information that matches with the circumstances of the event. (For example, it makes no sense to raise the issue of bio-waste during a scandal involving the illegal disposal of hazardous waste.)
Similarly, soil draws public attention in case of massive erosion, contamination, over-fertilization and other problems that threaten agricultural production. Farmers might express their concerns and, ultimately, consumers may face higher food prices. These events, and in particular erosion after heavy rain falls, provide an opportunity to raise awareness about soil health and the benefits of using soil improvers like compost. In Figure 2, the impact of heavy rain (40 mm in 30 minutes) on two agricultural soils is presented, of which one was improved with compost. It is clearly seen that this soil was far less damaged by the rainfall due to its carbon-rich, structured soil particles.

Figure 2: View of two directly adjacent agricultural areas[2] with different humus content after heavy rainfall in 2018 (source: Gerit Scheuerman)

Secondly, events supported and organised by international associations provide valuable opportunities to raise awareness: take advantage of European or national theme days to amplify the message! Drafts of press releases, recommendations for actions or video presentations are available on the websites for these events:

- European week for waste reduction (next week: 22-30 November 2025)
- International compost awareness week (each year in the first week of May)
- World Soil Day (each year on December 5)

In addition, national or European waste management and soil protection associations can offer valuable support (list in Table 1).

Table 1: List of associations dealing with (bio-)waste management or soil protection

Abbreviation	Full name	Website	Languages
BGK	Bundes--Gütegemeinschaft Kompost	www.kompost.de	German, partially also in English
ECESF	European Circular Economy Stakeholder Platform	https://circulareconomy.europa.eu/platform/en	English
ECN	European Compost Network	https://www.compostnetwork.info/	English
EUSO	European Soil Observatory	https://esdac.jrc.ec.europa.eu/euso	English
ISWA	International Solid Waste Association	www.iswa.org	English
RCC	Réseau Compost Citoyen	www.reseaucompost.org	French
CIC	Consorzio Italiano Compostatori	https://www.compost.it/	Italian, partially also in English

[2] The two fields were cultivated completely differently over the years: intensive maize cultivation (right), organic farming with compost application (left)

Key messages:

- To raise people's awareness on the importance of separate collection and use of bio-waste, it is necessary to highlight the links between waste management and other global and regional challenges.
- Waste and especially bio-waste should become a part of the public discussion and can be linked to other environmental issues of concern that are regionally or locally important.
- Find out about the status of the soil in the region and consider how compost made from organic waste can best be utilized to address local soil health challenges.

2. Strategical approach to communicating about waste sorting

In waste management, we need the cooperation of waste producers to pre-sort waste. Thus, we are asking citizens, who pay for waste disposal, to perform extra work. Obviously, it is necessary to motivate them. In order to achieve this desired behaviour, it must be clear which factors more strongly influence an individual's actions. The strategy should be based on the drivers that influence people's behaviour when it comes to sorting their waste. (See also the handbook "From bio-waste to soil" (Bin2Bean D2.1, page 26 [Soudon et al. 2024]))

For waste management purposes, most researchers use variations of the theory of planned behaviour to describe and to analyse the forces and mechanisms that influence individual behaviour for waste separation.[3] The theory of planned behaviour [Ajzen 1991] defines motivation and ability as key predictors of behaviour in a specific situation. According to this theory, several motivational factors, i.e. subjective norms and the person's attitude towards the behaviour lead to a certain intention. "The attitude towards the behaviour refers to the evaluation of the particular behaviour's likely outcomes; the subjective norms relate to whether the social milieu approves or not the particular behaviour as well as to which extent the individual is influenced by his/hers societal surroundings." [Botetzagias et al. 2015] These authors also assess personal moral norms as another important driver for an individual's intention that should be taken into account.

Moreover, perceived behavioural control is a driver of intention, for example the opinion of neighbours about one's waste sorting behaviour. An evaluation of one's behaviour by an independent third party comparing it to the behaviour of a surrounding community, can

[3] Readers who are interested in more details and other theories D4.2 "Toolkit: Intervention for change" of the WaysTUP! Project is recommended [Temmerman & Veeckman 2019]

create feelings of pleasure or shame and reinforce desired behaviour, as shown in a study conducted in two Swedish communities on the waste production of households [Ek & Söderberg 2024]. According to [Ajzen 1991], "the predictive power of perceived behavioural control on behaviour increases with the degree to which a person has a realistic perception of the control she / he has over the situation." [Stoeva & Alriksson 2017]. In other words: If we want to engage citizens effectively as pre-sorters, they should know what they are doing and why it matters. "In situations where the person has control, behaviour is predicted by the person's intention to perform it. In most everyday life situations though, there are factors which lay beyond the individual's control and could prevent the execution of intended behaviour. In these instances, a person's ability becomes an important factor for the behaviour." [Stoeva & Alriksson 2017].

In order to increase the predictive power for real behaviour, more factors can be added to the model. In case of waste management, satisfaction with the local facilities, e.g. waste collection rhythm or easily accessible garbage bins, has proven to be an important variable. "This factor is related to the efficiency of waste management on the local level… and, together with perceived behavioural control, reflects a person's ability to perform waste separation or recycling behaviour" [Stoeva & Alriksson 2017]

Besides aspects of social capital, desires for a better self-image based on personal moral norms, and the satisfaction with the local facilities, participation in household recycling schemes also depend on the costs of not recycling. Financial motivation can inversely relate to the perceived effort required for pre-sorting and storing waste until collection. "In particular it is necessary to include the great variety of values, wishes, internalized norms, as well as aspects of perception that are transmitted by social processes into the economic approach." [Berglund 2005]

Some important mechanisms are summarized graphically in Figure 3. It remains to be seen which factors dominate, as this likely depends on the individual. For example, a person with a high level of environmental awareness will sort waste even if his / her behaviour is not appreciated by his fellow-citizens. In a study on the recycling behaviour of Greek citizens using the "blue bins" for plastics, paper separation, perceived behaviour control was found to be the most important predictor of recycling intention, even more important than moral norms [Botetzagias et al. 2015]. The importance of the "satisfaction factor" was demonstrated in a study with homogenous groups in different local environments: recycling activities were considerably higher when people were satisfied with the management system in place. Therefore, the authors of this study underlined the necessity of incorporating an additional independent variable, as shown in Figure 3 (graphics taken from [Stoeva & Alriksson 2017]).

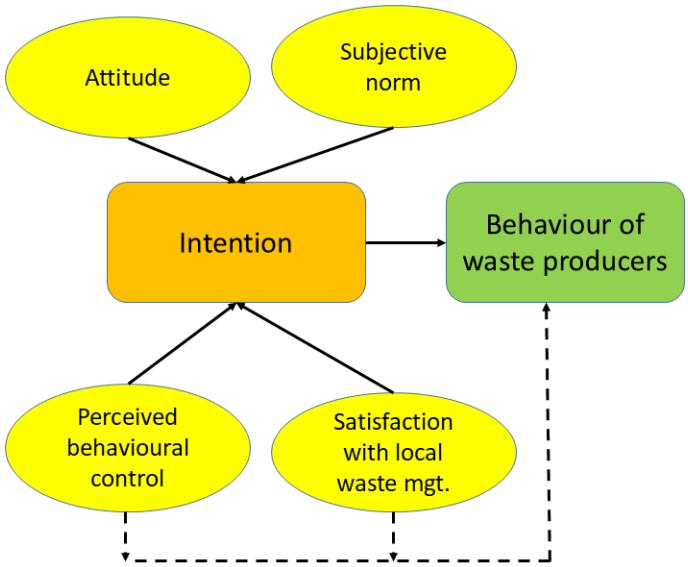


Figure 3: Extended model of the Theory of Planned Behavior for waste sorting.

On the one hand, it is essential to understand the individual factors that influence behavior. These factors are described below along with an assessment of their significance and interactions. On the other hand, it is necessary to understand how the target groups can be motivated and influenced in the respective local context and which obstacles need to be overcome. This understanding can be determined primarily by conducting surveys among representative waste producers (households, restaurants...) and by interviewing local experts.

2.1 Enabling households for waste sorting

According to the factors described above, it is necessary to create a convenient environment for source separation of waste. The BIOBEST project underpins the importance of the convenience factor [Jourdan & Favoino 2024]: "**People are more likely to adopt behaviour changes that are 'Easy, Attractive, Social and Timely'"** [BIT 2014] relying therefore on habitual or fast thinking to take decisions. When applied to bio-waste management, this insight demonstrates the **importance of user-friendliness and convenience in sorting schemes**, making "waste sorting habits more appealing in terms of individual gains (...) than the option of not sorting waste" [Thaler & Sunstein 2008]. This is confirmed by several field studies that analyse the attitude of citizens towards the introduction of separate collection of bio-waste. In a Spanish municipality with an already existing system for separate collection of paper, glass, and light-weight packaging, 81% of the respondents declared that they were willing to participate in the separation of food waste [Bernad-Beltrán et al. 2014]. Those who did not agree gave the reasons stated in Figure 4 (simplified according to [Bernad-Beltrán et al. 2014]). It can be taken from these results that the main barrier for participation "is the need to use specific waste bin and bags for the separation of bio-waste."

Interestingly, similar results have been observed in countries far from Europe. In Bangkok, residents cited a lack of information, and the perceived effort required for pre-sorting as major reasons for not participating in waste separation [Vassanadumrongdee & Kittipongvises 2018].

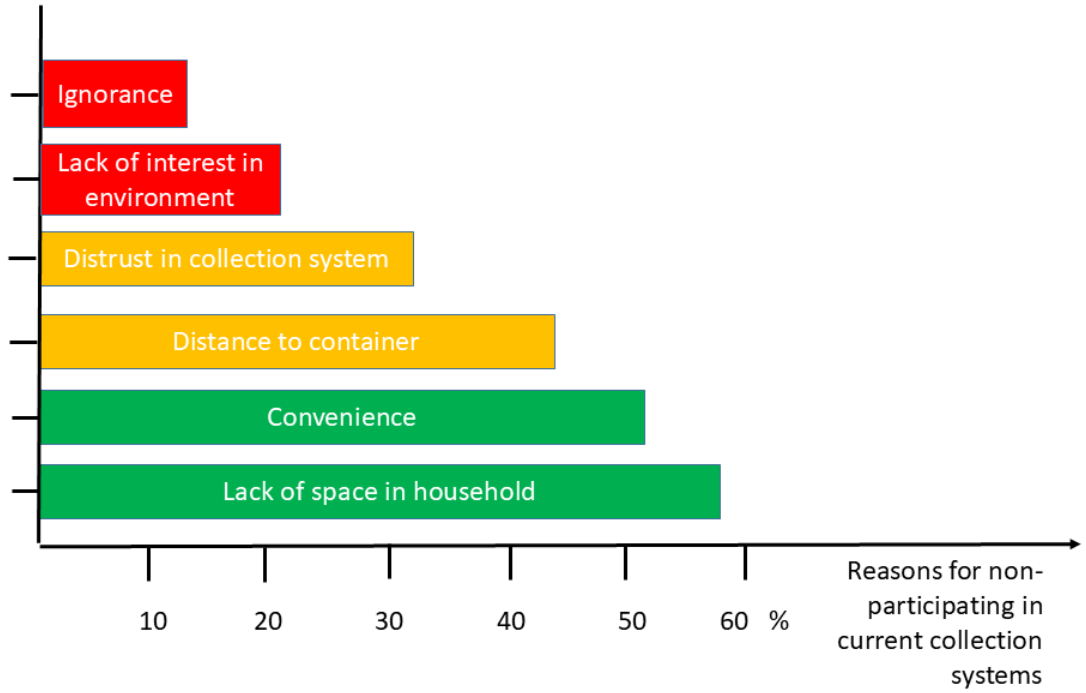


Figure 4: Reasons of residents for not willing source separation for recycling.

This means, first of all, providing clear information: What needs to be done, and how should it be done? Pre-sorting bio-waste does not appear to be difficult, but citizens may have a lot of questions that must be answered:

- What about cooked meals?
- Is it allowed to put bones into the bin?
- I use bags made from sustainable plastics – why am I not allowed to?
- The bio-bin smells – is this hazardous?
- How to protect against bacteria and fungi from bio-waste?

Unfortunately, the answers to some questions vary from country to country due to national policies and sometimes from city to city depending on the technical requirements of the regional biomass facility. This variability can lead to distrust.
As illustrated in Figure 4, distrust in the collection system is another important stumbling stone for pre-sorting. It is therefore advisable to answer these questions on two levels: i) A simple answer on often asked questions (preferably in plain speech) should be given in the information leaflets or as an imprinted guideline directly on the bins ("What belongs here?"); ii) a more detailed background document explaining the system and the technical reasons behind the guidelines should be available on the city's or the waste management company's website
Even the simple **"how to..." information should mention soil benefits** (and not just general environmental advantages). People can, and ideally should, utilize "their" bio-waste after transformation to compost. Therefore, it is meaningful to link the efforts of the

individual to the ecological needs. Additionally, **changes to the basic requirements for waste separation (what to do?) should be avoided.** This leads to confusion and, as a result, possibly to a significant deterioration in the quantity and quality of the collected waste. Distrust in the system can also be a consequence of unreliable service, e.g. unannounced cancellation of collection of residual waste, permanently dirty streets despite municipal cleaning teams. Citizens have an eye on the whole municipal service. They may find it difficult to believe that a new part of the system like bio-waste utilization works if other parts – in their observation – are unreliable.

Bins or containers must be easily accessible, well-maintained, and fairly clean. They should have consistent colours; e.g. organic waste should always be collected in brown or green bins. Do not change the colour of bins over time! Especially for public containers, clear labels with symbols and/or text must indicate the type of waste intended for disposal. Most people do not like to transport their bio-waste bags or boxes over a longer distance than to the kerbside. Thus, it is important to install the bins or containers nearby. This is underlined by findings from Catalonia: **door-to-door collection does not only result in higher amount of separately collected bio-waste but also leads to significantly lower contamination rates compared to street containers** [Zero Waste Cities]. Support for pre-sorting becomes even more important in systems where citizens must carry waste farther – for instance 50 meters to a nearby container or several kilometres to a recycling yard. People who make such effort for a small amount of organic waste are highly motivated and also responsive to the quality of the delivery. This level of commitment should be fully recognized and supported. **Be aware of the citizens' capacities!**

> "Many Greeks would like to participate, but they are not ready to sacrifice much money, time, nor their convenience. They would expect the right bins to be near their home and the procedure to be as easy, clear and simple as possible." [SYMPRAXIS 2020]

It should be clear that the city provides regular collection at an appropriate frequency. But convenience means also supporting citizens' pre-sorting efforts. According to the survey in a Spanish city (see above, [Bernad-Beltrán 2014]), nearly half of the residents who initially refused to separate their bio-waste, would change their minds if they were provided with appropriate containers for pre-sorting. It is impractical to store food and kitchen residues in open bags in the apartments for more than some hours especially in hot summers. Therefore, transport bags that are sealed against odour emissions should be available free of charge. Small brown bins that can be placed under the sink and cleaned easily after use are also a good alternative. The suitability and public acceptance of technical solutions should be tested with some households before large scale investments.
"Facilitating storage at home" was ranked as "highly effective" with respect to reported behaviour, attitude and intention of households in large field tests in two Dutch cities (Almere, Rotterdam [Langeveld 2020]). Citizens practicing bio-waste separation in Sligo (Ireland) named "kitchen caddy and compostable bags" as the most encouraging measures for their sorting activities [Jourdan & Favoino 2024].

🔍**Stadtreinigung Hamburg (SRH)** provides a free pack of 30 fully biodegradable, wet-strength paper bags to households for collecting food waste at home and transporting it to the bio bin. The use of the paper bags also reduces the sticking of organic waste in the kitchen. The paper bags can be collected free of charge ("bio-bags") from recycling centers or from drugstores with a coupon that can be downloaded from the internet. The system is based on door-to-door collection of bins (up to 240 l) for smaller houses and underground containers for high-rise buildings that are accessible directly next to the house. In a pilot area of Bin2Bean's Living Lab at Hamburg, these bags can now be taken directly from the openings of underground containers so that tenants can immediately take a new bag after disposing of their organic waste (Figure 5)

Figure 5: Underground container for kitchen waste equipped with a dispenser for special pre-collection bags (source: SRH)

The costs for the "convenience factor" are not negligible, but they should be compared against the extra efforts – and financial resources – required when citizens do not pre-sort their waste correctly. Therefore, key questions for waste collection managers include: How much time do people need for their waste management? How much additional cost arises from improperly sorted bio-waste? A Danish study used the amount of time spent on waste sorting as a proxy for measuring the effort citizens must devote on a weekly basis for a specific home waste sorting system. By combining sorting time with waste collection fees, researchers approximated the implied value that citizens place on home sorting efforts. Values ranged between 21 to 47 DKK (2.80 to 6.30 EUR) per hour, which can be compared

with the minimum wage in Denmark of approximately DKK 110 (14.80 EUR) [Nainggolan et al. 2019].

Key messages:

- The description of "What to do with bio-waste?" must be simple and understandable for everyone.
- "Soil", i.e. benefits for soil health from compost, should be mentioned from the very beginning.
- Sorting bio-waste requires more efforts with waste than previous practices. Therefore, do not underestimate the importance of the "convenience factor"!

2.2 Intrinsic motivation

People who are convinced of the need for a healthy environment will, due to their intrinsic motivation, be more willing to pre-sort waste than those who do not take environmental threats seriously. Fortunately, environmental issues have a high public priority especially among younger generations. This general motivation can be used and strengthened in order to support waste sorting activities. Links between bio-waste to soil improvers and carbon sequestration, relations between compost use, soil health and biodiversity can broaden people's view of food and green waste.

❗ *For example: did you know that one ton of clean bio-waste can fix 400 kg carbon-dioxide[4] in soil?*

Already motivated fellow-citizens are open for more and detailed information. This is particularly important when contamination of separately collected bio-waste should be decreased. People with an ecological motivation need to feel supported in their waste activities but not patronised. Therefore, friendly and informative campaigns are necessary, promoting messages such as: "We are good, we can get better." It is meaningful to show the link between bio-waste and soil health: "We want to fight plastic pollution in the environment. Therefore, we keep plastic out of the organic waste bin." In Figure 6, an example is presented that relates to the question of how to deal with plastic stickers on fruit and vegetables. The information in this graphics (taken from the homepage of Aktion Biotonne Deutschland, https://ab-kommunen.de/Aktionspaket/) is dedicated to motivated pre-sorters of bio-waste.

[4] This is a rough estimate that needs to be adopted with regard to the local climate and soils. .

Figure 6: How to deal with stickers on fruits? Bio bin or residual waste bin? (Source: Aktion Biotonne)

For people who are interested in the ecological background, more information should be provided on the websites of the cities or links to the websites of organisations dealing with bio-waste. These people can also support the quality of the collected bio-waste by providing targeted information to their neighbours. Some cities and municipally owned companies founded advisory groups (see also section 1.2.8) that consist of volunteers who are willing to educate their fellow-citizens about home-composting, but also to answer questions on how to fill the organic bin correctly. It is also important to provide information on the quantity and quality of the collected bio-waste as well as on the utilisation of the compost. It is counterproductive to hide quality problems – on the contrary, addressing challenges openly can inspire motivated individuals.

> "… environmental sensitive people, willing to volunteer for the environment... just have to be equipped with the right knowledge, arguments and informative material, so they can disseminate this knowledge and raise awareness among their circle and the general public. Specific actions to take: Provide training and information about waste management to these people (e.g. campaign website, short course of webinars, open for everyone interested)…." [SYMPRAXIS 2020]

Key messages:

- People who are motivated to protect the environment are the most likely to adopt and support waste separation.
- Members of this group can also play a key role in encouraging and influencing others.

2.3 Social motivation

“Subjective norm is a person’s perception of the social expectations to adopt a particular behaviour. Subjective norm is influenced by a person's normative beliefs combined with the person's motivation to comply.” (source: Google). As human beings seek contact with others, they are naturally interested in knowing what others think about their behaviour and what behaviour the people around them expect. As stated in the BIOBEST report: “Human actions are indeed largely influenced by our perceptions of the popularity of certain behaviours, increasing the likelihood of individual engagement if others also participate or if societal expectations endorse the behaviour.” [Jourdan & Favoino 2024]. For the management of bio-waste this means that it is crucial to make clear that proper sorting of bio-waste is socially desirable. Even better: “Neighbours pre-sort organic waste for the brown bin, I should do as well.” However, the opposite can also occur: “Some of my neighbours put also plastic waste in the bio bin – why should I be more careful?” The sorting performance of households, in terms of quantity and quality, is best tracked in small communities, i.e. in houses where two or three families share bins for different waste fractions. This fosters a perceived control of behaviour (see also section 1.2.4). In Figure 7 a good example of social motivation is presented: “92% of all residents separate their waste. Are you participating as well?” The girl on the poster assures everyone: “This is quite simple – isn’t it?” [Milieu Centraal 2023]

Social motivation can also be enhanced by setting good examples. It is particularly important for local politicians to lead by example. If councillors or mayors show little interest in the collection of organic waste, public's awareness of the importance of waste separation is diminished. Therefore, it is important that city leaders demonstrate the ‘correct pre-sorting’ when the bio bin system is introduced. Public demonstration can also be linked to international events as mentioned in section 1.4.

Figure 7: Examples of social motivation (Source: [Milieu Centraal 2023])

Sometimes people resist social pressure, perhaps for good reasons. In those case, the 'cognitive dissonance' process can be leverages through self-persuasion: “You simply ask people to provide their own arguments…By asking about the benefits or reasons for waste separation, you let people think about their motive for doing so.” [Milieu Centraal 2023]

This method often helps to change people's attitude towards a certain activity – rather than try to enforce behaviour, self-motivation should be nurtured.

Key messages:

- Humans are social beings and usually follow what the majority believes it is right. Therefore, foster social expectation and pressure in favour of bio-waste collection.
- Figures in charge, such as local politicians, should set a good example by demonstrating proper waste separation practices.

2.4 Extrinsic motivation

Regularly, extrinsic motivation for pre-sorting starts with the introduction of appropriate regulations, typically in the form of local statutes. These statutes should not only be published in its original wording but also explained in a version that is easily comprehensible to citizens, for example as part of an information leaflet describing the "what", "why", and "how" of bio-waste collection (see also section 2.6). If necessary, especially in cities with a high number of immigrants, this information should also be made available in different languages. In European countries, the separate collection of at least one fraction, e.g. packaging waste, has been made compulsory since many years. In most countries, also glass and paper are collected using suitable systems. When an additional collection of bio-waste is introduced, it should be clear to the city that most contaminations cannot be sorted out in the process after collection unlike other waste fractions. This perception should encourage cities to intensify efforts to promote extrinsic motivation among users of the brown bin.

2.4.1 Communication activities aiming at extrinsic motivation

In addition to measures facilitating the pre-sorting (see section 2.1) and information aimed at strengthening intrinsic motivation (see section 2.2), actions to enhance extrinsic motivation at the beginning of the collection of organic waste cover among others:

- Posters in the streets, stickers on house entrances
- Sorting instructions printed on the organic waste bins
- Information leaflets with simple but urgently formulated regulations (also available in the internet)
- Incentives to start the sorting process, such as give-away articles that are linked to bio-waste, e.g. small bags with compost

Figure 8: Sticker for bio bins as a reminder to drop only pure food waste without plastic bags (source: BSR, Berlin, Germany)

Over time, citizens tend to be less careful in their sorting habits, or they may begin to dispose of plastic bags used for transporting waste directly into the organic waste bin out of convenience. Therefore, information on the correct pre-sorting behaviour should be repeated from time to time, as recommended unanimously by experts from cities that collect bio-waste of good quality (also section 2.7)0 [Friege & Eger 2022].

2.4.2 Financial incentives

Money is a major external motivator. If the city operates a "pay-as- you-throw" (PAYT) system – meaning waste charges are based on the volume or weight of waste produced rather than a flat fee - the organic waste bin should have its place in the system. It makes sense for the price for organic waste to be lower than that for a corresponding amount of residual waste. However, it is not advisable to collect organic waste free of charge to avoid misuse of the "brown bin" as an overflow container for overfilled "grey bins". The need for a suitable price for the bio bin should be clearly communicated to citizens to avoid misunderstandings. While the city can save money when citizens carefully sort their waste, the costs for collection and processing of bio-waste cannot be fully covered by revenues for compost and biogas. Waste fees that depend on the amount and type of waste can serve as key communication tool: the core message is that waste disposal is costly because it protects the environment and that careful waste sorting benefits both citizens and the city. Information campaigns on waste charges should focus on this relationship.
Scientific literature clearly shows that PAYT incentive schemes increase the amount of pre-sorted waste reflecting a change in the behaviour of households [Bucciol et al. 2011]. Other studies also observed that the specific amount of mixed waste and organic waste or only organic waste per household decreased [Andersson & Stage 2017] thanks to PAYT systems. An explanation for this effect could be that "that the tariff may lead households to plan their food consumption better, resulting in less food being discarded." [Andersson & Stage 2017]
In case of contaminated bio bins, for example with easily recognizable residual waste, plastic bags etc., interventions are necessary. In a first step, the users of the affected bins or containers should be informed. This can be performed by attaching stickers or tags to the brown bin, placed there by the refuse collectors. Yellow stickers are often used as warning signals, whereas a red-coloured sign means that this bio bin will no longer be emptied due to continuous contamination. It is important to verbally justify this measure with the

burden found so that users realize their incorrect behaviour. A good example for monitoring bio-waste bins and suitable information in case of misthrows (Borken County, Germany) can be found in [Jourdan & Favoino 2024].

How to cope with highly contaminated bio-bins? In most cases, waste collection teams are instructed not to empty such bins but instead to inform the responsible households that they must either transfer the contaminated material into the residual waste bin or remove the contamination. If these corrective actions fail, the brown bin must be emptied as residual waste; this can be billed as an extra service, reimbursed by the polluter. Such measures, though annoying for the responsible polluters, are understandable and necessary. The message sent to the neighbours is even more important: "you are separating correctly, keep up the good work!" In case of large housing areas with many households sharing the same bins, there is often only one alternative: the removal of the bio-waste container and its replacement with a residual container. In cities with differentiated charges (see above), this change results in higher costs. In Figure 9 *Information for users of bio bins about their sorting behaviour by tags that are attached to the bins [Berheide 2024]* the results of a monitoring campaign conducted in Ludwigsburg County (Germany) are visualised for users with the help of the information attached to the waste bins [Berheide 2024]. The simple traffic light system communicates the status of the bin: green tags for "great", yellow tags for "sorting can be enhanced" and red-coloured tags for "this bin cannot be collected" due to contamination. Thanks to such campaign, the City of Münster was able to reduce contamination level from 3.5% to 1.9%. The yellow cards proved to be an effective reminder, as two third of all incorrectly filled bio bins were filled correctly after receiving a yellow card [Baumann 2025].

❗ *In some cities, fines can be imposed in case of severe violations of the local waste management statutes. For example, in Milan, about 30 municipal employees monitor the quality of the bio-waste and "have the authority to issue fines to condominiums (which can range from 200 to 1,200 EUR) if the separated materials do not meet the required standards, or if recyclables/compostables are found in residual waste." [Jourdan & Favoino 2024]*[5]

[5] The subject of financial incentives will be investigated in more detail in the course of the Bin2Bean project. Please check the website for further information.

Figure 9 Information for users of bio bins about their sorting behaviour by tags that are attached to the bins [Berheide 2024]

2.4.3 Making misbehaviour visible

If the causes of inappropriate sorting are to be found in ignorance, carelessness or high level of anonymity within the neighbourhood, a special intervention by a committed citizen can help. In such cases, the group can be supervised by a volunteer waste advisor who works with residents over a few weeks to promote the correct use of waste bins, provides information leaflets or websites in the respective native languages and sets quality targets to be achieved by the group. Joint work and feedback sessions provided either by the advisor or by the waste collector after some time, help change the attitude of the people towards (bio-) waste sorting. **The visibility of the action among the neighbours and fellow-citizens is key because it temporarily breaks the "normal" anonymity associated with using communal waste containers.** Processes of this type turned out to be very effective in a Dutch field experiment: "Setting a clear goal for one's own behaviour helps residents aspire to that behaviour, especially when they actively keep the goal in mind... A neighbourhood spokesperson or waste management coach can go door to door to set personal waste management goals with residents. It is important to help residents set their goals: not too high and not too low." [Langeveld et al. 2020]. As anonymity is a main reason for poor pre-sorting in large building complexes, "peer monitoring can enhance the effect of monetary incentives: visibility of the action triggers a more virtuous behaviour compared to the situation in which the household does not share its bin." [Bucciol et al. 2019]. In this study, the authors explain this effect by factors as shame or fear of punishment which may induce less motivated households to increase their effort and attention in sorting. In

Figure 11: Prediction of unsorted waste per household per day depending on the number of households sharing a bi, the effects of more or less anonymity for correct sorting are

quantified following a field study in the Treviso province (Italy): the columns represent the daily volume of unsorted waste (with the bars indicating the 95% confidence interval) in relation to the number of households sharing a bin. Based on administrative panel data on unsorted waste bin emptying at the household level, it is obvious that two households sharing one group of bins are the best sorters – even better than households with their own individual bin.

❗ *People who feel they are being observed tend to behave more socially compliantly than those acting in anonymity*.

This experience is used in a German campaign poster, in which a stern-looking old lady admonishes people not to throw plastic in the organic waste bin (Figure 10).

Figure 10: Poster edited by the German #wirfuerbio campaign: Do not throw plastics into the bio bin (source: wirfuerbio e.V.)

Summing up the experiences with actions focusing on external motivation, it becomes clear that we are dealing with a complex problem. Changing behaviour of citizens who are not interested in waste issues and give low priority to environmental protection can, at best, be triggered by a combination of measures. As noted by Kirakozian [2016]: "The willingness to adopt behaviour and, therefore, to change habits may be limited by the costs involved (e.g. financial, time and convenience costs) … Awareness of individuals exposed to

environmental information depends on the behaviour of their neighbours, social norms or self-image with respect to society, as well as financial incentives."

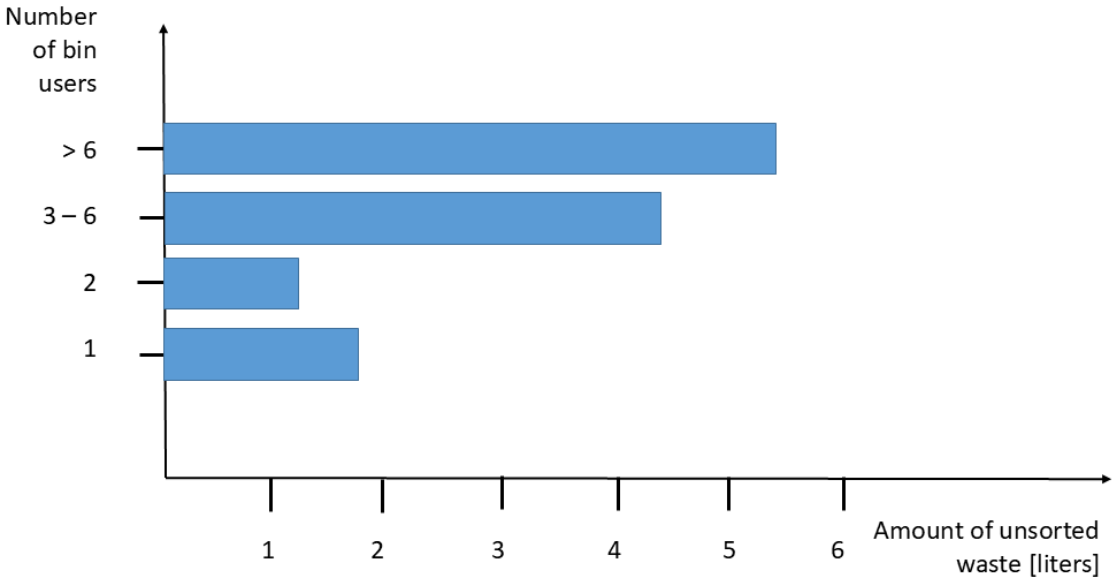


Figure 11: Prediction of unsorted waste per household per day depending on the number of households sharing a bin.

Key messages:

- There are numerous possibilities for extrinsic motivations for waste sorting.
- Waste charges based on the polluter-pays principle (PAYT) are an important driver for reducing the volume of residual waste.
- Fines for incorrect filling of organic waste containers after preliminary information (traffic light principle) are used in numerous cities to improve the quality of organic waste.
- Besides financial incentives the fear of being observed by others is a powerful driver for better pre-sorting.
- Which measures are most effective must be examined and decided on the local level.

2.5 The case of commercial waste producers

Restaurants, hotels, supermarkets, breweries are among the commercial producers of organic waste, i.e. different types of residual bio-waste: food waste, packaged out-of-date food, waste from processing of fruits and vegetables, meat etc. Therefore, it is necessary to look for separate suitable processes depending on the nature of the substrate. In case of waste with a considerable percentage of meat, separate processing is mandatory under the animal by-product regulation. The owners of restaurants, catering services, restaurants, butchers should be informed about their obligations and potential solutions, e.g. special food waste bins, bio-waste bins, dropping points for used oil and fat. It is meaningful to focus on the hygienic necessity of separately collected organic waste from packaging waste or other fractions.

❗ *The most important external motivation for commercial producers of organic waste comes with:*

- *The strict regulations on hygienic handling of food and food residues*
- *Supervision by the food and drug authorities, veterinarians or whoever is responsible for enforcement*
- *The difference between the price for an organic waste bin and the disposal via residual waste.*

Appropriate instructions for waste separation and storage of waste fractions are required for implementation (see sections 2.1 & 2.4). In many European countries, a lot of people born in Arabia, Africa or Southeast Asia work in the restaurant and food sector. As a result, cities and responsible authorities should consider whether multilingual information is necessary since, in most cases, it is not the owner but a member of the kitchen staff who brings the waste to the bin.

Campaigns aiming at reducing food waste also raise awareness about organic waste and its recycling by stimulating the public discussion on the topic (see section 1.40). An example is the RECUP project in Milan, which helped shift the perspective on food waste recognizing it not only as an economic issue (i.e. disposal costs), but also as a social and an environmental one.
This integrated view is supported by the Waste Framework Directive which combines policies for food waste reduction and collection of food residues.

Key messages:

- Incentives to separate bio-waste are easier to implement for commercial waste producers than for households.
- Municipalities should focus their information and incentives on the issue of hygiene.

2.6 Specific information for target groups

Besides information campaigns aiming at all private households and commercial waste producers in the city, it is often necessary to approach specific target groups either because they cannot be reached effectively through standard communication channels or because the standard information is not suited to their context – in other words, tailored communication is needed for diverse audience groups. This is illustrated in more detail using some examples:

- **Residents in large housing areas**: **Cooperation with the house owners is key!** In many European cities, large housing companies, often publicly owned, manage residential areas with thousands of apartments. Normally, these companies pay the waste disposal fees on behalf of their tenants and charge them in turn. Even if the management of a housing company is not interested in the waste issue, two factors may open the dialogue: the value of a clean-living environment and the reduction of utility costs – even if those are ultimately reimbursed by tenants as happy tenants mean fewer complaints. If the housing companies are willing to cooperate with the waste collection company, the waste advisory service can contact the janitors directly.

  ❗ *In a project involving more than 6,500 households, the BSR[6] started the following activities [Schulze 2024]:*
  - *Survey of tenants on their ideas for improving organic waste collection;*
  - *inspection of waste garbage container locations together with the housing companies and their optimization (accessibility, keeping clean, monitoring);*
  - *weekly documentation of the filling level of the organic waste containers and their quality;*
  - *information leaflets, stickers, posters to be installed in the stairways by the janitors;*
  - *participation of waste advisors at tenant parties with campaigns on waste separation.*

  To align the interests on both sides (housing providers and waste management services), **SRH** (Stadtreinigung Hamburg as part of the BIN2BEAN project), BSR and other waste management companies introduced regular round-table discussions with housing companies. These meetings also facilitated the development of financial tools for proper waste sorting in large residential areas. It is up to the housing companies how they allocate the waste charges among the tenants. For example, when the company distributes keys for the bio-waste containers to those tenants who are willing to sort their waste carefully, these households are effectively rewarded though lower waste charges.
- **Campaigns for bio-waste in "green" suburbs**: Families with an own garden often manage a compost heap for their green waste but dispose their food waste in the residuals waste bin. To address this, BSR started a campaign to increase orders of organic waste bins [Schulze 2024]. As part of the campaigns, bio bins with posters were placed in the streets to arouse more interest in the issue of bio-waste.

[6] BSR (Berliner Stadtreinigung, owned by the City of Berlin) is responsible for the collection of household waste

This visibility made it easier for the waste advisory service to engage residents at local markets and shopping areas. BSR also offered free soil analyses for resident's gardens, creating a personal incentive tied to soil health. The campaign received public support from the mayors of these boroughs ("Bezirksbürgermeister").

Figure 12: Advertising for more bio-bins for "green" suburbs (source: BSR)

- **Addressing immigrants**: Many immigrants from North Africa or the Middle East may not sufficiently understand the language of their new home country and may be unfamiliar with waste separation. Therefore, they require target communication. Firstly, basic information on waste separation should be provided in different languages. Additionally, for the sorting of organic waste, it is necessary to examine how these communities can be effectively motivated. For example, BSR cooperates with migrant organizations and sets up information stands at events such as Muslim festivals. They also feature immigrants in videos or on posters to promote inclusivity in the separation of organic waste.
- **More information for interested stakeholders and schools**: There are individuals and groups who can support the work of the cities and waste collectors – each with different informational needs.
    - As with many environmental topics, **children** often bring their newly acquired knowledge home, motivating and inspiring their families to improve waste separation. The more illustrative and exciting the instruction, the more effective it is. Activities like school composting, experiments with compost, and learning to know soil organisms can be facilitated by local waste management companies or national associations. (For more details, go to section 1.4.4.)
    - Another key target group includes **engaged users** of the organic waste bin who are willing to convince their neighbours to adopt the system – for example through campaigns like "Nachbarn werben Nachbarn" (neighbours recruit neighbours) by BSR. These citizens may need more detailed information and support to carry out their role effectively.
    - For **people who are interested in waste issues in general**, SRH offers a regular newsletter.

- Topics such as the GHG balance of composting and digestion of bio-waste, the impact of compost on soil, details of the technical processes are of interest for **students, teachers, and environmentalists**. Such content can be compiled by national associations or large waste management companies.

For many target groups, small gifts can help reinforce messages delivered during training sessions or brief meetings with a "garbage coach" in the stairwell. Typical gifts include buckets with lids for pre-sorting and transportation of food waste, small bags with compost, and illustrated booklets for children. These gifts give "residents something, which makes them (unconsciously) inclined to separate their waste better." This process is called "reciprocity" that can be described as "the human instinct to return a favour with something in return." [Milieu Centraal 2023]

Key messages:

- To ensure the success of separate collection, it is important to identify target groups that require a special approach.
- Residents of large buildings are among the "critical" target groups. Co-operation with house owners is recommended,
- Citizens with strong intrinsic motivation can support the communication of the municipal waste management department as "bio bin advisors" focusing on good quality of separately collected organic waste.
- Small gifts can activate the instinct of "reciprocity" and serve as effective

2.7 Continuous information and awareness raising

Cities that collect bio-waste of good quality recommend continuous information about correct sorting, good examples, marketing of compost etc. [Friege & Eger 2022]. "To sustain community engagement, continuous communication throughout the year is imperative." [Jourdan & Favoini 2024]

It is also meaningful to publish the monitoring results including the progress being made as well as unsolved quality problems. Stay honest! It is important to maintain the trust in the system (see also [Jourdan & Favoino 2024]).

As habits can change or new concerns (e.g. about potential health problems from bio-waste) can make the collection of organic waste more difficult, consultation programmes with citizen groups, surveys or round tables with housing companies (see section 2.6) are meaningful to keep the system on track. According to the HOOP project, a bio-waste club that includes all stakeholders along the value chain can be highly beneficial.

Continuous or recurring contact with citizens takes time – and for those qualified personnel, i.e. a waste advisory service, is required. This is often the bottleneck for the introduction of the collection of bio-waste, monitoring activities and continuous contacts with citizen groups.

> "To sustain community engagement, continuous communication throughout the year is imperative…" But there is "shortage of trained and well-informed people able to support the initiative and its communication campaign…" (City of Bratislava, Czechia [Jourdan & Favoino 2024])

As outlined in sections 0 and 06, it is therefore essential to recruit volunteers who are willing to speak with their fellow citizens about the value creation from bio-waste on their own initiative and out of personal interest. Teachers, gardeners, members of associations for nature conservation are interesting candidates. Training should be provided for these volunteers so that they are fully informed, gain expertise and can thus provide the public competently.

Key messages:

- Human beings are forgetful – and there are more problems to solve besides waste sorting. Therefore, communication about bio-waste and soil must be renewed when quantity or quality of separately collected organic waste decrease significantly.

2.8 Amplification of impacts by combination of different measures / channels

As was outlined above, the behaviour of citizens in separate collection of bio-waste depends on numerous factors. People have widely different attitudes towards the regulatory requirement to sort, being motivated by a mix of extrinsic and intrinsic stimulus. Their behaviour depends on examples in the neighbourhood and the recognisability of their actions to third parties and, to a large part, on convenience factors. Therefore, as part of the communication strategy, various measures must be implemented in a sequence and interlinked manner both at the introduction of the organic waste bin and at regular intervals thereafter to effectively support the desired behaviour. There is no perfect solution that fits for all local situations.

The experiences of many cities prove that a carefully considered combination of measures – mostly tested at first in small areas of the city - leads to satisfying results. It is relatively easy to collect a large amount of source-separated bio-waste if you provide the appropriate containers and offer users a financial incentive. However, the real challenge is to ensure that the bi-waste collected is of high quality – suitable for composting or fermentations.

❗ *Practitioners from several cities whose bio-waste contains less than 3% impurities recommend the following combination of measures [Friege & Eger 2022]:*

- *Sound and suitable economic instruments,*
- *Implementation of regular control tours,*
- *Precise possible allocation of waste containers to households*
- *Feedback on the quality of bio-waste directly attached to the container,*
- *a target group-specific communication strategy.*

> "… Regulatory solutions alone, although necessary, are failing to reverse the trend of increased waste or to change consumer behaviour. However, economic incentives, which act via a price signal, encourage changes in individual behaviour. Environmental taxation appears particularly effective in the case of household waste. Indeed, empirical studies on the OECD countries show that incentive pricing in the form of progressive taxation based on the weight of garbage, is efficient. This form of taxation encourages and rewards individuals to recycle, and minimizes the amount of residual waste. However, it is difficult to assess and control the negative effects of these policies, as individuals reluctant to comply, may resort to illegal dumping to minimize their tax burden." [Kirakozian 2016]

Interestingly, waste separation behaviours tend to reinforce one another. The learning curve for sorting bio-waste seems to be easier if other waste fractions are already being sorted out. According to a survey in Vellinge (Sweden), about half of the respondents (47%) agreed or partly agreed about improvements in their packaging sorting habits caused by the introduction of food waste sorting. On the other hand, the introduction of separate collection of food waste made 39% of the respondents more aware of the amount of their bio-waste, with the result that they proactively reduced the amount of food scraps. "An increased environmental awareness after realising the amounts of wasted food was stated as the main trigger in changed behaviour, whereas only 10% stated a better visualisation of the scale of economic loss though waste as the main reason." [Miliute-Plepiene & Plepys 2015]

Key messages:

- There is no silver bullet for achieving high-quality separated organic waste - a tailored mix of measures fitting the local situation is essential.
- Fortunately, activities focusing on different motivations reinforce each other.

2.9 Soil health: How to involve the complete value chain?

Soil matters! But people especially in cities are mostly unaware of soil functions, soil quality, and soil health. Extrinsic motivation, i.e. economic consideration, works only for the relation between cities, farmers and processing facilities. When it comes to households, only intrinsic motivation matters.

"... food waste policies... have some effects: they define an implicit relationship to the environment and work in these industries... Yet while economic costs in these value chains are generally fairly well known, the social and environmental benefits are not necessarily calculated, monetized and taken into account in policy design choices... the design of these policies lends a certain coherence to the overall recycling project and gives meaning to the different successive operations in the chain... Once bio-waste is collected by the public service, it becomes invisible in the eyes of the sorters. This invisibility deprives citizens of an essential resource, that which enables them to embody the product of the labour of care they carried out and to maintain it in time and space..." [Daniel & Martin 2021] Therefore, the issue of how composts and soils become an environmental value or fall into a public blind spot is highly important. It is necessary to combine the economic and other drivers for households with the ecological "ideal of a return to the earth". [Daniel & Martin 2021]

How to make people aware of soil and the potential benefits of their sorting activities for soil improvers? Two strategic communication approaches are essential:

> ❗ *Present the entire food cycle – including the vital role of soil rather than focusing solely on bio-waste or compost,*
>
> ❗ *Look for soil organisms that can be used as popular figures to reconnect citizens with the concept of living soil.*

Up to now, only few cities include the complete food cycle in their campaigns for awareness raising. In dense urban areas, soil often means nothing more than a paved ground.

A few examples adopting these strategies.

According to a report about Catalonia, the regional Authority for Environment "moved from the 'how' and 'what' to the 'why', with a strong emphasis on the bio-waste cycle. This narrative shift occurred because it was recognised that to boost intrinsic motivation, individuals require a clear understanding of why they should adapt their habits and participate in the separate collection service." [Jourdan & Favoino 2024] Figure 13 shows a poster from Spain (in Catalonian dialect) that illustrates the link between soil, compost, plants and the collection of bio-waste (translation: "Thanks to the natural compost obtained from the recycling of bio-waste, we avoid the use of chemical fertilisers"). Many more visuals linking bio-waste to soil can be found on the homepage of gencat (Agència de residus de Catalunya) including a nice video entitled "El ciclo de la materia orgánica".

Figure 13: Poster edited by the Region of Catalonia (source: Generalitat de Catalunya)

The French network Réseau Compost Citoyen offers an excellent example of connecting bio-waste with soil restoration. Its motto ("Ensemble pour nourrir le sol!") embraces all types of composting and fermentation, ranging from compost heaps in community gardens to centralized plants. Open to engaged citizens, composting facilities and waste management companies, the network offers a broad range of information graphics, videos and educational material. It organises "compost weeks" and visits to plants.

Talking about soil and soil organisms is necessary to **raise the interest of the public in soil health**. Unfortunately, the life that thrives in soil - including the vast amount of flying insects that spend their juvenile life-phase underground - is not perceived as "pretty" to the eyes of most people. There are some exceptions that are often used in popular publications on soil health:

- **The earthworm** (lumbricus terrestris), an animal that can easily be detected. Its activities in the soil, especially its function of loosening soil and digging is facilitated by adding compost, which can easily be demonstrated in class.
- **The mole** (talpa europaea) shows its work by raising mounds. Since it needs different soil organisms as food, its appearance is an indicator of healthy soil. Moles are used as popular figures in books for children.
- Even **an "ugly" animal like the naked mole rat (or sand puppy**, heterocephalus glaber), a burrowing rodent native to parts of East Africa, can be transformed into a cuddly toy: this animal is even featured in the Disney Channel cartoon Kim Possible.

Additional creative ideas to raise soil awareness in urban communities and engage residents of large cities - including small groups of interested citizens or school classes, include the following low-barrier, engaging activities:

❗ *Geocaching for certain types of soil, field crops, ground monuments or archaeological monuments... - nature parks or environmentalists are good partners.*

❗ *Make the soil talk! The sounds that emerge from a soil reveal something about its inner life. "Sounding soils" is an interdisciplinary research and art project of the Zurich University of the Arts to characterize ecosystems by sounds (ecoacoustics). It is possible to record the sounds with the special sensors. Differently used soils sound different, too. There are also indications that the complexity of the sounds depends on the diversity of living organisms in a soil [Maeder et al. 2019, 2022]. "Sounding soil" is a Swiss initiative; explanations are available in English, German, and French.*

❗ *"Soilart" was a EU granted project (in Austria and the Czech Republic) that focused on the artistic approach to soils and the use and meaning of earth colours.*

There are about 30 soil research projects where citizens are engaged (ECHO) [JRC 2024]. Projects of this type offer a good opportunity to expand citizens' involvement in bio-waste and soil improvers. The municipalities should look for suitable leading institutions in their city or its surroundings like universities (institutes for soil science, biology, urban planning...), NGO's (nature conservation, environmentalists...), museums (e.g. for regional history, biosphere, environment...), and appropriate government agencies.

General awareness of soil should be complemented with information about the condition of local soils. Data on the soil quality - e.g. erosion risk, nutrient deficiency, over-fertilization - can be taken from the maps provided by the European Soil Observatory (EUSO, see also the example in section 1.3).

2.9.1 Self- and community composting

When it comes to self-composting, there is a visible link between food waste and soil. Some cities support composting by providing free waste advisory service and / or composting boxes to communities, schools and single households. However, especially in densely populated areas with limited public green space, it is important to avoid over-fertilization.

The **"Avfal naar Oogst"** initiative in Amsterdam is a great example of structured community composting aiming at careful management of bio-waste and soil improvers. This institution is organised by engaged citizens and collaborates with 22 community projects with about 50 to 100 participants each that perform composting on their grounds. Each location receives between 100 and 250 kg of kitchen scraps a month plus added brown material (mostly dry leafs and saw dust).

Figure 14: Composting tumblers and a garden of the Avfal naar Oogst community, Amsterdam (own picture)

Another initiative is the AWISTA company (partially shared by the City of Düsseldorf) which has offered information on self-composting for thirty years. A group of about 20 volunteers, supported by a professional waste counsellor, give advice to neighbourhoods on closed or open compost piles, small worm composters for balconies and similar topics, while also supporting the separate collection of bio-waste. The group activities also include public demonstrations at events, kindergartens, primary schools, adult education centres, and allotment garden associations. Thanks to the co-ordination with experts for plants and soil, the volunteers and target groups are trained for their valuable work.

2.9.2 Processing of organic waste in central facilities

In case of large central composting plants or anaerobic digesters, it is more difficult to demonstrate the relationship between "clean bio-waste" and "good soil improver". To bridge this gap, many processing facilities for bio-waste sell or distribute their compost products free of charge in test packs to nearby residents. This serves as a reward or, at least, as a visible sign of appreciation for citizens who separate their bio-waste properly.

Similarly, the use of biogas for public services (e.g. garbage trucks, swimming pools) or for district heating can also be communicated to reinforce the link between waste producers and the tangible benefits of their sorting effort.

Key messages:

- Soil matters! Do not forget to introduce soil health as part of the food cycle in your bio-waste communication
- Communicate the value of humus, the importance of soil for biodiversity, carbon sequestration etc. -especially to audiences interested in more than just "how to fill the bio bin" .
- Check the status of local soil to find the best arguments for compost use.
- Look for allies in the region: Are there any workings groups or institutions dealing with soil analysis?
- Choose an appropriate soil organism as a popular figure for teaching about soil in schools.

2.10 Communication pathways and media

2.10.1 Information: garbage app for waste producers

For communication about collection days, sorting etc., apps are a valuable source of digital information and ideally they should be interactive. For example, citizens can use these apps also to request the collection of bulky waste, report illegal waste disposal or notify the city about overfilled bins. Example:

- Puliamo (Milan): an interactive full-service app for all types of waste
- SRH App (Hamburg): similar also including interactive messages on snow and ice on the streets

As outlined above, the app should be available in different languages depending on the populations, e.g. in case of large groups of immigrants.

Complementing the app, it is also necessary to extend the website of the city with waste issues, an activity that further underpins that waste management and the valorisation of bio-waste are part of the environmental policy.

2.10.2 Press releases and posts in social media

Classical communication channels like letters sent to residents, press releases, radio advertisements, and posters in bus stops should not be neglected. It is essential that the message reaches everyone and cannot be easily overlooked.
Social media also plays a key role, especially when volunteers share their personal experiences with bio-waste separation. For example, BSR (Germany) offers a social media kit – "Biogut" – which includes a number of ready-made posts that are suitable for Facebook, Instagram, X and private websites.

2.10.3 Educational material (kindergartens, schools, universities)

Teaching materials must be adapted to the respective age group and be suitable for use into different subjects such as biology, geography or economics lessons. Such material should be made available by the national waste management associations. For example, in Germany, BGK (Federal Association for Compost Quality, see Table 1) provides a booklet (Figure 15) among other information material. The booklet includes illustrated stories, puzzles, and instructions for observing soil organisms targeting children aged 9 and older (Zaradiso Verlag).

Figure 15: Cover of a booklet (Zaradiso Verlag) developed with BGK

#wirfuerbio, an association of German municipal waste management companies, offers a game called "waste box" that is suitable for a 1-2 hour lesson for children of about ten years. According to the developers, "The waste box sensitizes pupils to a conscious approach to the environment and the topic of waste. The aim is to engage intensively with the topics of organic waste, compost and the circular economy." The "waste box" can be borrowed by teachers from the local waste management companies. (See also BIOBEST's fact sheets on the City of Parma and Borken County in [Jourdan & Favoino 2024]) Furthermore, children (and their parents) can download a waste sorting game for smartphones from the #wirfuerbio website. Bio-waste and potential contaminants are among the main issues of the game. This app is available in English, French, Turkish, Russian, and Albanian language.

"**Learning by doing**" is a proven education principle. Collection of organic waste in schools, self-composting activities, and accompanying lectures on biochemical processes in waste or soil biology represent an effective combination for pupils of different ages as well as

undergraduates. A successful example of this approach is the school project carried out in Sao Paulo, Brazil, managed and documented by the Climate & Clean Air Coalition (CCAC) and the International Solid Waste Association [Ricci-Jürgensen et al. 2016]. The project supported the organisation of a school network around the topic combining waste sorting, composting, and school gardens, and lecturing. The reach of such projects extends beyond students to include parents, catering providers, and kitchen staff. (see Figure 16: Involved stakeholders and their responsibilities in a project for schools (source: [Ricci-Jürgensen et al. 2016])

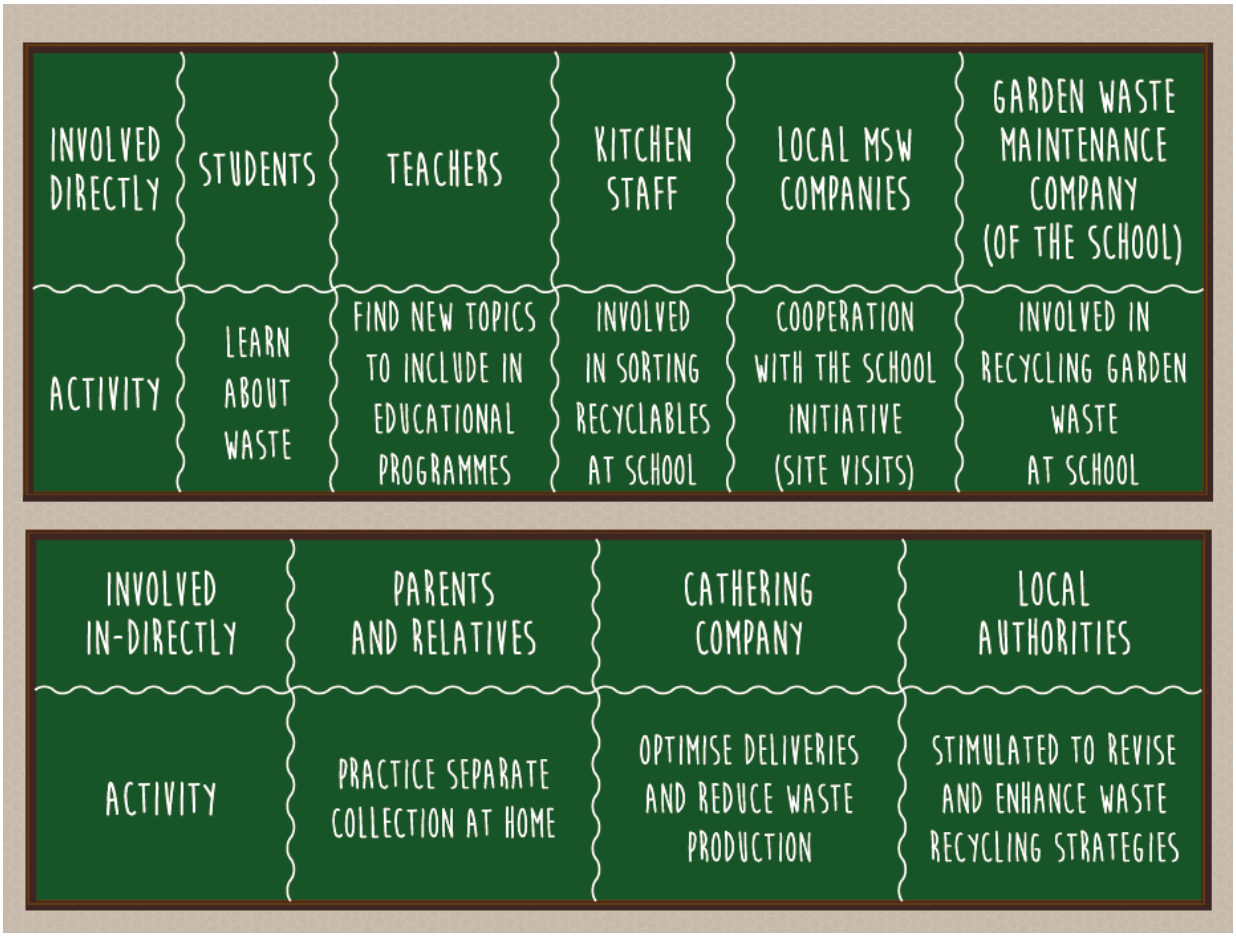


Figure 16: Involved stakeholders and their responsibilities in a project for schools (source: [Ricci-Jürgensen et al. 2016])

As already mentioned above, French municipalities, waste management companies and NGO's can become members of "Réseau Compost Citoyen" which provides a broad range of educational material for children.

The introduction of the bio bin in Egaleo (part of the Bin2Bean project) is accompanied by a broad campaign in schools with the aim of motivating parents indirectly through their children. 13 schools were equipped with a composting device (after a meeting with the principal in each case). The children are educated by an employee of the Green Spaces department on composting. The LL organized an open day for schools and teachers providing detailed information to enable them to train the students in turn. This action was combined with an LL workshop on composting. Three schools that will produce the best compost based on specific testing procedures will get a reward.
SRH (partner of the Bin2Bean project) introduced special teaching resources for children up to 10 years including pictures and graphics about waste collection and management, "waste separation games" with small bins etc. Bio-waste and compost are among the main subjects. The teachers are supported (on demand) by a pedagogical specialist who is financed by SRH. The "waste training" is highlighted by the visit of a garbage truck at the school / nursery that is especially designed for children ("Das kunterbunte Müllmobil"). The children are allowed to drop their waste in the truck etc. The primary schools are also invited to visit recycling yards and a large former waste disposal site that is used as Hamburg's "energy hill". For secondary schools, more information is provided (e.g. the role of waste management for resource recovery and sustainable development) including guided tours through SRH's facilities, e.g. anaerobic digestion, composting, incineration… An additional educational platform is under development.

Similarly, the AWISTA compost advisors (see above) provide materials and simple tests for schools and kindergartens aiming at a playful adaption of biological basics about compost and soils (see Figure 17).

Figure 17: Composting experiment in a preserving jar (source: AWISTA)

2.10.4 Personal encounters

Personal experiences and authentic reports create trust in new and unfamiliar processes. Therefore, the opportunity to visit plants to get an impression of the processing is very important for building opinions. As outlined above, voluntary advisors for bio-waste sorting or home-composting are partners on equal terms for their fellow citizens.

❗ *Authentic eye-witnesses like*

- *Farmers who use compost as soil improver*
- *Garbage collectors who can talk about the necessity of good sorting practices*
- *Engineers from the bio-mass processing plant*

are also interesting discussion partner for schools, citizen groups, local associations.

2.10.5 Role of policy

The system for collecting organic waste is based on decisions made by local councils and authorities, who consider environmental, financial and social aspects. However, this alone is not enough – strong political support is essential especially during the introduction phase and in cases where bio-bins become severely contaminated. The mayor and the heads of the administration should lead by setting good examples for their neighbours and the public.

❗ *Therefore, messages and activities of local politicians should be integrated into the city communication strategy and actively disseminated through standard public channels.*

Key messages:

- The communication channels for organic waste and compost must be tailoted on the accessibility and habits of the respective target groups.
- Local waste management apps are an indispensable tool for a convenience-oriented strategy.
- The commitment of the municipality and the city council must be reflected in messages on the own website.
- National or regional associations that deal with compost, waste or citizen information can help with effective communication.

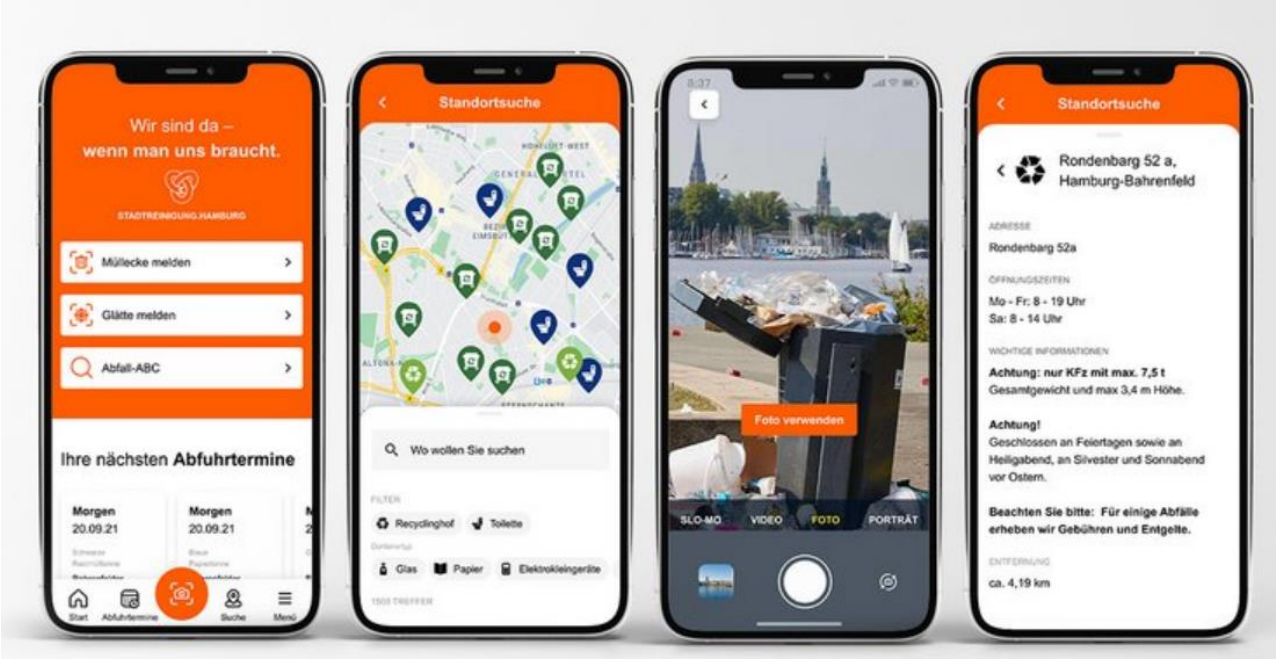
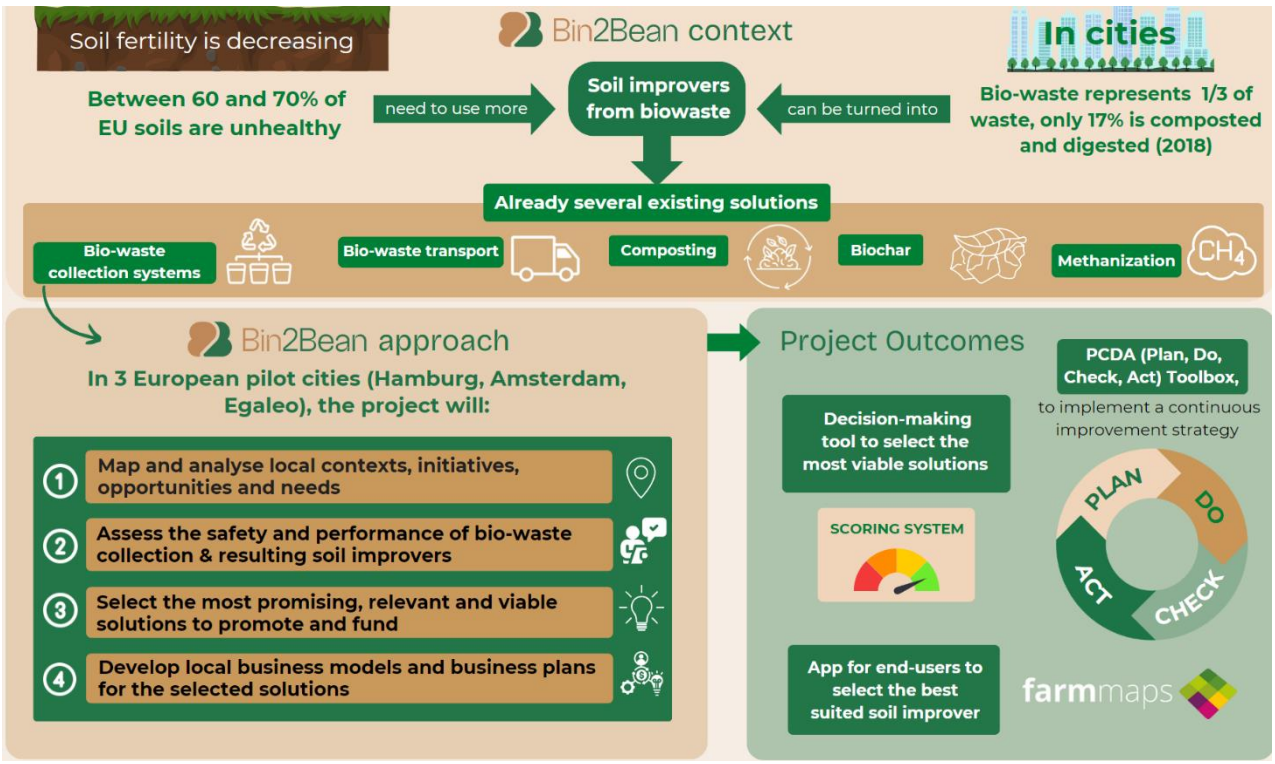


Figure 18: Interactive app for waste management for the clients of SRH

3. About Bin2Bean

Bin2Bean is a research-action project, co-funded by the European Commission under the Mission Soil, which aims to optimize the performance of bio-waste collection and transformation into soil improvers. It started in September 2023 and will last 3 years.



Bin2Bean collaborates with 3 City-Region Living Labs (*Amsterdam*, *Egaleo*, *Hamburg*), which have different states of progress and levels of experience on the topic, to implement a series of activities:

1. **Map local contexts**, in terms of state-of-progress, existing initiatives, needs, material and monetary flows.

2. **Design a tailored evaluation framework** to demonstrate the safety, environmental and socio-economic performance of bio-waste collection systems and soil improvers.

3. **Develop a scoring system**, fed by data from the evaluation framework, to help cities select the most effective and market-ready solutions adapted to their context.

4. **Develop tailored and viable business and/or community models** for the highest scored solutions, according to stakeholders' willingness-to-adopt.

5. **Draft local, national and EU policy roadmaps**, including waste charging policies and citizen awareness campaigns.

All this will feed into a **PDCA (Plan, Do, Check, Act) toolbox**, enabling any city-region to create a continuous improvement loop towards effective bio-waste recycling and regenerative soil systems.

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