Green Nudging – a key against littering?

Behavioral economic measures for cleaner cities

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Content

1 Waste, littering and its consequences 5

2 Classical environmental policy instruments and their limits 7

3 Behavioral economic explanations for littering 8

4 (How) can green nudges reduce littering? 11

5 Recommendations for action for more cleanliness in cities 15

5.1 Use green nudges to prevent littering 15

5.2 Improve general waste management by using AI-tools to remove litter 16

5.3 Implement a mix of instruments to combat littering 17

Abstract 19

JEL-Klassifikation

D91 – Role and Effects of Psychological, Emotional, Social, and Cognitive Factors on Decision Making
H04 – Microeconomic Policy: Formulation, Implementation, and Evaluation
H23 – Externalities • Redistributive Effects • Environmental Taxes and Subsidies

Zusammenfassung

Die Nachfrage nach Sauberkeit in den deutschen Städten steigt: "Littering" - die illegale Vermüllung des öffentlichen Raums - verursacht nicht nur Kosten für die Umwelt und Gesellschaft, sondern hat auch erhebliche finanzielle Konsequenzen durch steigende Reinigungskosten. Ein Großteil des Litterings besteht aus „To-Go“-Verpackungen, Plastikflaschen und Zigarettenstümmeln. Derzeit wird das Problem vor allem mit Gesetzen, Bußgeldern und Aufklärungskampagnen angegangen. Politiker und Medien setzen das Erscheinungsbild der Städte auf die Tagesordnung, klassische Instrumente wie Kontrollen durch kommunale Ordnungshüter und harte Sanktionen gegen „Litterer“ stoßen bei der Lösung des Problems jedoch an ihre Grenzen. Neben den klassischen umweltpolitischen Instrumenten können die Tools der Verhaltensökonomie einen ergänzenden Beitrag bei der Problemlösung leisten: Durch die gezielte Beeinflussung der täglichen Gewohnheiten können auf den Umweltschutz ausgerichtete „Green Nudges“ die Menschen dazu bewegen, Littering zu reduzieren, wodurch die Sauberkeit in den Städten verbessert werden kann.

1 Waste, littering and its consequences

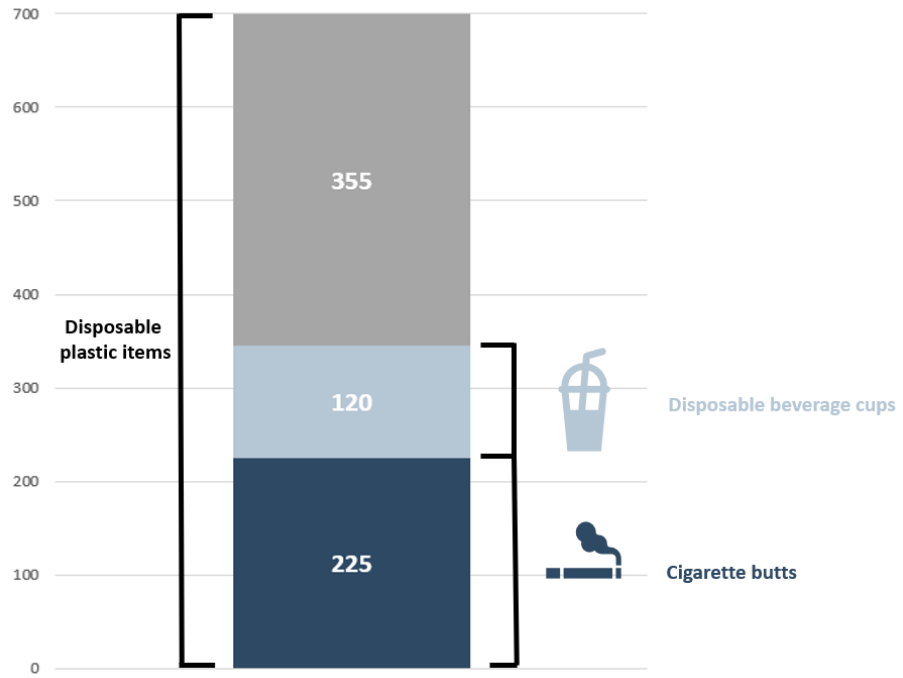
The demand for cleaner cities is rising: Especially during the pandemic there was an enormous increase of Germany's waste consumption. The amount of household waste generated per German inhabitant increased from 455 kilograms in 2018 to 483 kilograms in 2021 which is Germany's highest recorded value since 2004 (Statistisches Bundesamt, 2023). If one takes an additional look at the municipal waste volume, which includes not only household waste but also the waste generated by smaller companies and public institutions and collected by municipalities, one can see that Germany (646 kg) is the country with the fifth highest municipal waste volume per person in the European Union. In 2021, the highest waste generation per person (834 kg) was measured in Austria while Romania was the country with the lowest waste generation (302 kg) (Eurostat, 2023). Disposable products account for a large proportion of the waste generated: The volume of waste from disposable plastic packaging in the to-go and takeaway sector in Germany currently amounts to 770 tons per day. Extrapolated to an entire year, this results into more than 280,000 tons of waste (Verbraucherzentrale, 2023).

Waste becomes particularly problematic when citizens do not dispose it properly but drop plastics, bulky waste, disposable cups, chewing gums, cigarette stubs and other items on the ground. This illegal form of polluting public spaces through waste is known as „littering" which particularly affects large cities. Due to the increasing prevalence of disposable packaging and disposable items, growing mobility, use of public space and changes in consumer behavior, littering has increased in Germany in recent years (UBA, 2020a). Many of the above-mentioned items end up in parks, roadsides, and paths. In Germany, an average of 689.55 tons or 841.39 cubic meters of litter is produced per year (UBA, 2020b, 78). The TOP 3 most frequently littered waste types in Germany include plastic / composite materials (57 percent), plastic waste (49 percent), and bulky waste (43 percent) (UBA, 2020a).

Littering is harmful for several reasons: First of all, littered waste goes directly into the environment, thus endangers animals and plants. Even small amounts of litter can cover plants and transfer pollutants. Plastic waste does not decompose completely and can ultimately end up as microplastics in the waters. Moreover, littered residential neighbourhoods have more germs and animals that eat littered waste can be injured, poisoned by it, and can transmit disease (UBA, 2020b, 43). Besides the environmental aspect, littering harms the society since the quality of life is impaired by it. Affected public places lose aesthetics and become less attractive for residents. The negative impact on aesthetics of cities and natural landscapes does not only affect the overall quality of life for residents but can also make the affected places less attractive for tourists.

In addition to the unsightly cityscape, the associated dissatisfaction of the citizens and health danger for plants and animals, littering is problematic from a financial perspective as cleaning up litter in public spaces, parks, and streets requires significant resources and increases a municipality's cleaning costs. The municipal street cleaners in Germany dispose around 140 liters of street waste per inhabitant and year (VKU, 2020a, 1). Cleaning the parks and streets of littered waste, emptying public waste containers, and disposing the waste costs German cities and municipalities (the taxpayers) around 700 million euros per year (figure 1-1). Of this, the disposal of cigarette butts alone accounts for around 225 million euros and the disposal of disposable beverage cups costs around 120 million euros (VKU, 2020b, 23).

Figure 1-1: Littering cost for German cities and municipalities (in million euros per year)



Source: Own figure based on VKU, 2020a,b

It is important to notice that the sum of 700 million euros per year includes only the cleaning and disposal costs. In reality, littering is even more expensive: In addition to these direct costs which are caused by the collection of litter and cleaning of the areas, littering also causes indirect costs. Among others, these further costs include expenditures for preventive measures such as education and awareness-raising measures and the costs for an expansion of collection infrastructure (VKU, 2020a,b).

A further problem of unclean cities is that littered neighbourhoods can attract crime. According to the Broken Window Effect, relatively innocuous damage or soiling (e.g. a broken window in a vacant house) increases the likelihood of further soiling and damage. In other words, the more neglected an area appears, the less safe it is (Van der Weele et al., 2017). Wilson/Kelling (1982) argue that "(…) broken windows send a signal of indifference and lack of enforcement, leading to increased fear of crime and weakening of social controls, thus paving the way for bigger transgressions". The effect results from experiments in American suburbs. In fact, it has been proven that littering is more likely to occur on dirty places than on clean ones. If there is already some litter on the ground this condition lowers the inhibition threshold for further littering and once a certain level of pollution is reached even those people who normally behave correctly might start to litter as waste lying around suggests that littering is normal and is socially tolerated. In other words, the cleanliness condition of a trash can or dumpster has a strong influence on people's disposal/cleanliness behavior. If residents are exposed to clean trash cans or containers, they are more motivated to maintain this condition and to dispose waste correctly. Once a piece of garbage is lying in front of the trash can or container, the norm of cleanliness is interrupted and further freeloaders are attracted (Dur/Vollard, 2015). Studies like Schultz et al. (2013) provide empirical evidence that visible trash in public spaces invites citizens to litter more. A prerequisite for the practical implication of the broken window effect on littering is anonymity. As soon as the degree of anonymity is high (e.g. at night or in large crowds), even small signs of pollution are enough to trigger the broken window effect. The combination of consequences mentioned in this chapter indicates that

littering has tangible economic, environmental, and social costs. These costs underscore the importance of preventive measures, including public education, fines, and enforcement, as well as efforts to promote responsible waste disposal behavior. To reduce the amount of littering in Germany, several environmental political instruments have already been implemented.

2 Classical environmental policy instruments and their limits

In recent years, various political measures have been enacted to curb littering in Germany. On a European level, the above presented issue is, among others, addressed by the directive 2019/904/EU of the European Parliament and the council of the 5th June 2019 on reducing the impact of certain plastic products on the environment (Single-Use Plastics Directive). The directive requires EU member states to take appropriate measures to reduce the input of single-use plastic articles. The following types of measures are included in Articles 4 to 10 in the EU Single-Use Plastics Directive (2019/904/EU): Consumption reduction (Article 4), a restriction on putting single-use plastics into circulation (Article 5), labelling requirements (Article 7), an extended producer responsibility (Article 8(2) and (3)), separate collection (Article 9), product requirements (Article 6(5)), and awareness raising measures (Article 10) (Europäische Union, 2019, 11ff.).

The EU Single-Use Plastics Directive was transposed into the German national law, among others, in the following ways: Article 5 of the directive was implemented on 3rd July of 2021 with the Single-Use Plastic Prohibition Ordinance (EWKVerbotsV). Since then, single-use plastic products and products made of oxo-degradable plastic listed in §3 of the “EWKVerbotsV” are no longer allowed to be placed on the market. Violations constitute an administrative offense and can be punished with a fine of up to 100,000 euros (§4 EWKVerbotsV, §69 Para. 1 No. 8, Para. 3 KrWG) (Bundesministerium für Justiz, 2021a, 95). The Single-Use Plastic Labelling Ordinance (EWKKennzV) which also came into force on 3rd July of 2021, serves to implement Articles 6 and 7 of the EU Single-Use Plastics Directive. It regulates the composition of certain single-use plastic beverage containers and the labelling of certain single-use plastic products on the product itself or on the associated packaging (§1 EWKKennzV) (Bundesministerium für Justiz, 2021b).

On a municipal level, measures aimed at reducing littering are wide-ranging: The classic measures include, above all, bans such as on spitting out chewing gums, stubbing out cigarettes on the ground, or other forms of contaminating the ground, as well as leaving trash or objects near trash containers. Since littering is an administrative offense, fines are imposed in case of incorrect behavior. In Cologne, an improper disposal of cigarette butts, for example, is subject to a fine of up to 150 euros (Stadt Köln, 2019). In Berlin, a careless dispose of a cigarette costs 120 euros and in Essen the fine amounts to 100 euros (ARAG, 2023). The problem is, however, that it is almost impossible to control who throws away which trash. For this reason, the effectiveness of this type of sanction is highly limited.

In some municipalities, waste disposal supervisors or "waste watchers" have been deployed to control and improve urban cleanliness. In addition to the regulatory measures, some German cities and municipalities have implemented other measures against littering such as waste logistics measures in the form of increasing the number and volume of waste containers or awareness-raising measures and educational work (UBA, 2020a). However, in Germany there does not seem to be a reducing tendency of the amount of littered waste: Evaluations of an online survey of experts show that littering has increased between 2015 and 2020. Almost a third of surveyed experts estimate that the proportion of litter picked up as part of regular street

cleaning is between 10 and 25 percent (UBA, 2020a). As the last two chapters showed, classical instruments such as controls and sanctions against litterers are limited in solving the problem. (How) can measures against littering become more effective in Germany? Are there alternative solution approaches? A better understanding of the German citizens' reasons for littering and their barriers towards correct waste disposal behavior can be the starting point for change.

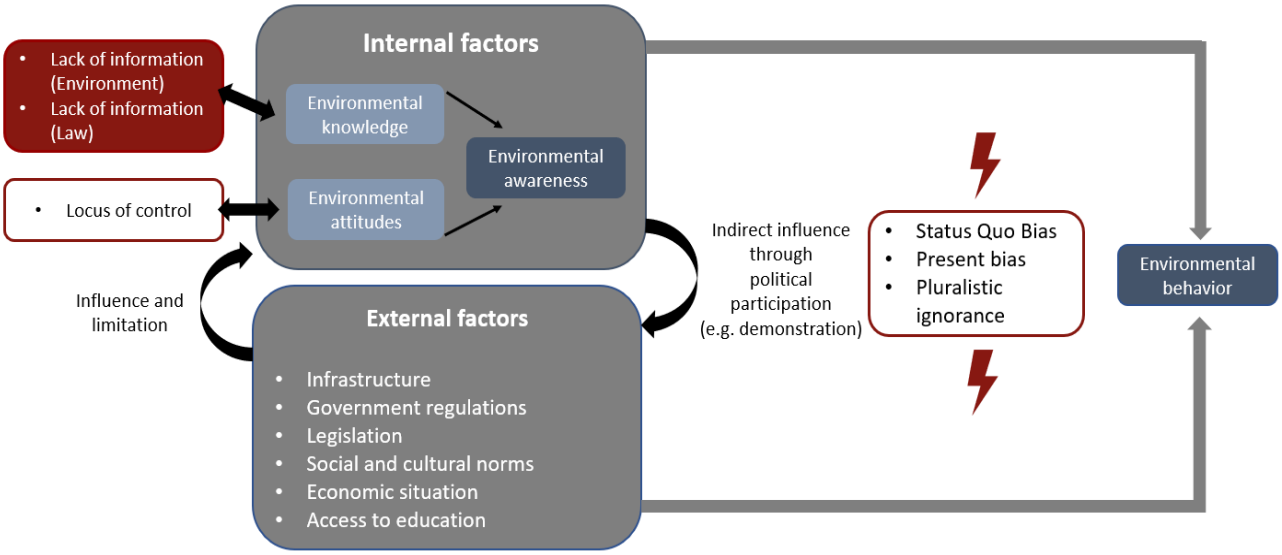
3 Behavioral economic explanations for littering

To prevent or to reduce littering it is important to understand the causes behind it. (Incorrect) waste disposal behavior is a typical example of a public good dilemma, which is also known under the terms "tragedy of the commons" or "tyranny of small decisions". Small and temporary decisions by individuals cumulatively can lead to a suboptimal outcome in the market. The outcome is sometimes not only suboptimal, but also undesirable: consumers might have behaved differently if they had been given the big decision that necessarily results from the many small decisions made by individual consumers. The tragedy of the common occurs in the context of common goods or property from the use of no one can be excluded (e.g. public use of streets and parks). Because of the general availability, such common goods tend to be overused (e.g. littering of public spaces) (Kahn, 1966).

A social dilemma arises because everyone has an individual (short-term) advantage to maximize the use of the resource while all individuals are better off if each individual cooperates and only uses the resource sparingly or correctly (e.g. responsible waste disposal behavior) (Dawes, 1980). The short-term interests of the individual (wanting to get rid of litter quickly) are opposed to the interests of the community (desire to live in a clean environment). For example, if a smoker wants to dispose his cigarette but cannot find an ashtray in his immediate vicinity, the option of improper disposal is available to him at a low cost (usually no sanctions are expected) and a high personal benefit (no penalties and the cigarette does not have to be carried further). The general public, on the other hand, incurs high costs as a result of the pollution of the environment and the reduction of urban quality.

To consciously change the behavior described, an understanding of what really influences people in their environmental behavior must be created. The following chapter serves to trace the reasons for environmentally harmful behavior based on behavioral economic insights. Environmental behavior is influenced by a variety of factors: These include internal influencing factors such as individual environmental knowledge and environmental attitude. Environmental knowledge refers to the knowledge about the relationships, the condition, and the functioning of certain ecosystems (Ernst, 1994; Schahn, 1996). Environmental attitude can be defined as a person's attitude towards environmental protection issues, as well as his or her personal basic orientations and values in the ecological context (Kuckartz, 2008). Together, environmental knowledge and environmental attitude lead to a certain degree of environmental awareness (figure 3-1).

Figure 3-1: Reasons for environmental-harmful behavior



Source: Own figure based on Hecking/Buchholz, 2020, 36

In addition to the internal factors, there are external influences such as the infrastructure, government regulations and legislation (as mentioned in chapter 2), social and cultural norms, the economic situation and access to education. The model described so far implies that a certain environmental awareness always leads to the same environmental behavior in case of fixed external factors. Would a person be aware of the environmental consequences of improper disposal of waste like cigarette butts and the external infrastructure would allow a proper disposal such as an ashtray nearby, this person would always dispose the cigarette butt correctly according to the theoretical model. This idea corresponds to the assumptions of classical neo economics, among other things, that people always act rational and are not subject to self-control problems. However, the actual complexity of human decision-making architecture goes beyond the described theoretical causality. The environmental behavior of people is influenced by numerous other factors, including biases and heuristics. These additional influencing factors are marked in red in figure 3-1.

One essential issue is a lack of information on the consequences of the individual environmental-harmful actions, as well as a lack of information on the law. Some people might throw their cigarette butts on the ground simply because they do not know that it is forbidden to do so. The criminal relevance of such an offense is not widely discussed in public and is not regularly communicated via publicly accessible channels. Moreover, environmentally harmful behavior can be due to a lack of awareness of the ecological consequences of own actions. In other words, not everyone is sufficiently informed about the environmental consequences of littering. This problem is reinforced by people's tendency to not always believe in being able to really change something in the large context. This phenomenon is known under "locus of control", the degree to which people believe they have control over the outcome of the events in their lives, as opposed to external forces beyond their control. People let by an internal locus of control interpret the success or non-success of a result on their own actions in the form of effort or competence while people with an external locus of control believe that the success or non-success of a result is primarily dominated by outside forces such as luck, fate, or others forces (Rotter, 1966). In the context of environmental behavior, skepticism regarding the positive impact of one's own personal consumption or behavior as a contribution to environmental protection can be seen as a motivational barrier. The consequence of this barrier is twofold: The conviction that the

own actions do little to save the world from environmental problems like littering acts as a motivational barrier, discourages people from engaging in sustainable behavior. Moreover, an external locus of control leads people to underestimate the negative consequences of their own behavior. Here, the above implied social dilemma posed by collective actions or public goods becomes apparent (tyranny of small decisions). While the individual can benefit from the short-term overuse of resources or incorrect waste disposal behavior like littering, the long-term future costs affect all group members, including the one who littered.

In addition to that, people are influenced by behavioral biases. One example is the status quo bias which is people's tendency to adhere to the current state of affairs and to avoid new actions (Kahnemann/Tversky, 1992). Among others, the status quo bias can be used to explain the improper disposal of cigarette butts. Littering is often caused by bad habits. According to the motto "Because I've always done it that way", people throw their cigarette butts on the floor, although they may have been informed of the consequences. In case of habitual negative environmental behavior, the status quo bias can be interpreted as a barrier to positive behavior change.

A further decisive reason for the problematic development described in chapter 1 is the present bias, the behavioral tendency to focus on short-term pleasure. People tend to prefer smaller-sooner rewards over larger-later ones, a tendency which prevents them from persisting to their long-term goals, such as consistently acting environmentally friendly and avoid littering (Markmann, 2018). Due to the high level of convenience, an improper disposal of waste such as cigarettes results into a high short-term benefit for the citizen (e.g. smoker). Objectively speaking, this short-term convenience benefit is lower than the ecological benefit of proper disposal, but it has an immediate effect and possibly outweighs the greater but only long-term visible benefit of a single environmentally friendly disposal which is a clean cityscape.

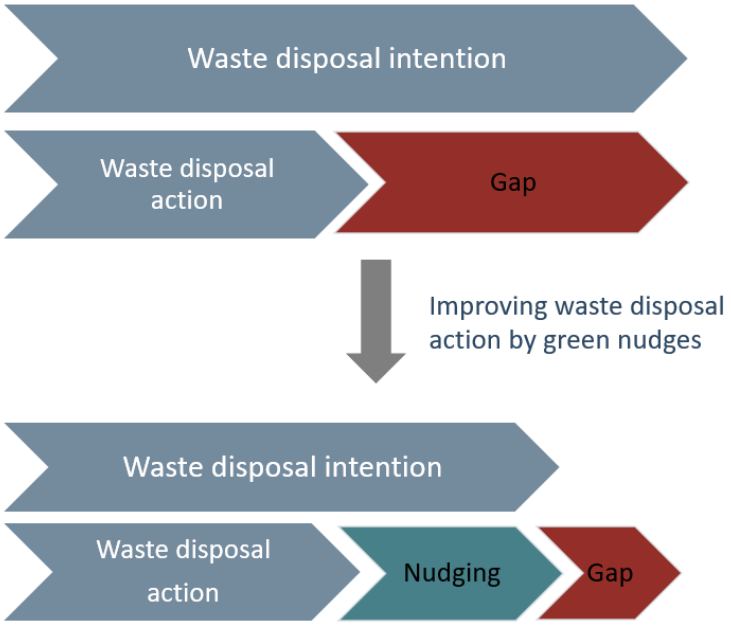
Another relevant behavioral tendency is the so-called "pluralistic ignorance" which describes a situation in which members of a group assume that the majority accepts a norm of behavior although in reality, most people reject it (Miller/McFarland, 1987). From the behavior of their fellow humans, people infer the generally applicable norm and adapt their own behavior to it (Chumg et al., 2020). For instance, if a smoker sees other people leaving their cigarette butts on the ground, he or she might come to the wrong assumption that other people evaluate this behavior as okay. Based on this wrong impression on the norm that applies (that littering is environmental harmful and should be avoided) people come to decisions which contradict the actual norm. This behavioral tendency makes the broken windows effect described in chapter 1 so dangerous (Hecking/Buchholz, 2020, 36).

This chapter showed that littering is often caused by bad habits. Even if there is an economic penalty for littering, usually a kind of fine, it would need to be enforced regularly to really impact people's habits and automatic behavior. Since the classic environmental instruments such as prohibitions and economic incentives reach their limits of effectiveness and are not yet able to sufficiently influence German citizens' behavior positively, alternative measures must be taken.

4 (How) can green nudges reduce littering?

Based on an analysis of recent field experiments, it will be investigated to what extent the use of green nudging can reduce littering in Germany. The idea to use the insights of behavioral economics to motivate citizens towards better decisions without limiting their freedom of choice is known under the concept "libertarian paternalism". This approach's main tool is the so-called "nudge" which is any measure that "(…) alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler/Sunstein, 2008, 6). In other words, nudges are subtle cues with the goal to facilitate good choices. Nudges can be deployed by governments, authorities, institutions, and companies or in case of littering by local municipalities and NGOs. The effect of nudges on different environmentally relevant behaviors (e.g. saving energy) is empirically proven by a large number of studies, among others, by Tiefenbeck et al. (2014) or Dolan/Metcalfe (2015). Nudges specifically designed to facilitate more ecologically sustainable behavior are called green nudges. In addition to motivating more sustainable food nutrition, mobility, and resource choices (Enste/Potthoff, 2021), the nudge approach can also be used to support people in adopting correct waste disposal behavior to act against the above-described problem of littering. Nudge techniques such as the appeal to social norms or targeted attention control (salience) can improve waste disposal action and can thereby narrow the above-discussed mind-behavior gap, the gap between what people want and what they do (figure 4-1).

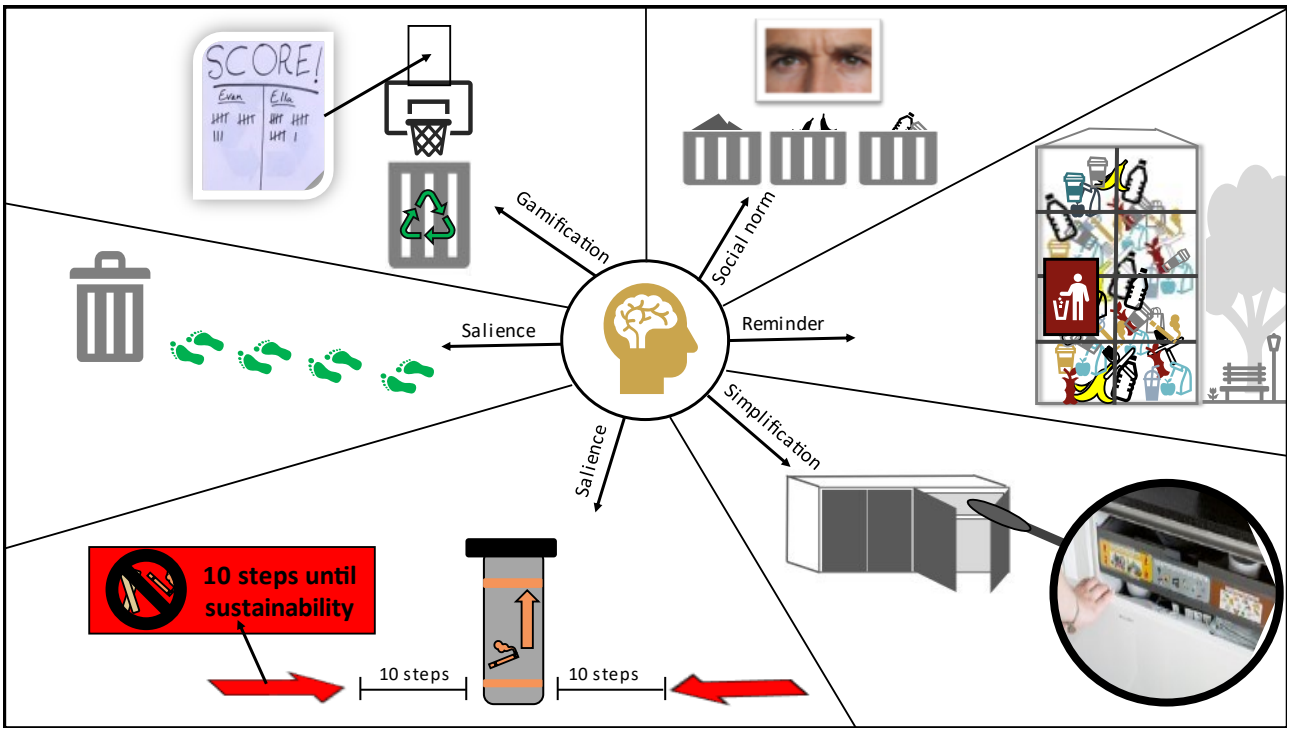
Figure 4-1: Nudging to narrow the mind-behavior-gap



Source: Own figure

Which concrete nudge examples do exist and are already tested in practice? Figure 4-2 gives a visualizing overview on possible nudge interventions. As one can see on the left side of the figure, one example are nudges which aim at increasing salience of ashtrays and waste bins. According to estimations of the World Health Organization improperly disposed cigarette butts account for 30 to 40 percent of global littering, making it the largest share of litter picked up in cities and on beaches (WHO, 2017). Due to the toxins they contain, improperly disposed cigarette butts are a highly relevant ecological problem. By making ashtrays and trash cans more salient the amount of cigarette butts on the ground can be reduced.

Figure 4-2: Green nudge examples



Source: Own figure

In a recent field experiment, Hecking/Buchholz (2020) tested the effectiveness of such a nudge by documenting the ratio of improperly to properly disposed cigarette butts before and after the use of the nudge. The field experiment was conducted in front of an Irish pub in the downtown of Bonn. The implemented nudge comprised several elements: A normal ashtray was redesigned in terms of colour (orange, white) and was made visually more salient. In addition to the colour change, some graphic elements were applied to the ashtray: an orange cigarette symbol centred on the ashtray, and two orange arrows pointing from the bottom to the top (in the direction of the disposal container's part of disposing the cigarette). A visualization of this nudge can be found at the left corner in figure 4-2:

In a quantitative survey prior to the start of the field experiment, some people indicated to not always being able to find an ashtray nearby as a reason for improperly disposing cigarettes on the ground. Therefore, it is assumed that smokers do not always notice all ashtrays nearby. To increase the attention to the ashtray, two wooden, red painted arrows with the inscription "Just 10 steps to sustainability" were placed ten steps before and behind the ashtray on the ground and pointed to it. This message addresses people's behavioral tendency to not sufficiently include long-term benefits in their decisions (present bias) (chapter 3). As people are limited in their capacity of information intake and processing, special attention was paid to an intuitively understandable formulation of the message. The first part of the formulation ("Only 10 steps [...]") aimed at reducing the subjectively perceived costs of proper disposal by showing the people that the distance to the next ashtray is not great. The second part of the formulation ("[…] to sustainability") reminded the people of the long-term benefits of proper disposal (sustainability) and promoted a consideration of this when making the decision where to dispose the cigarette. In this way, the formulation served as a reminder and appealed to the environmental awareness of the participants. In addition to the text, there was a small graphic on the arrows which depicted a person throwing a cigarette butt on the ground. This image was circled and crossed out in the style of a prohibition sign (Hecking/Buchholz, 2020, 30f.). After the intervention phase, the

cigarette butts were collected from the ground and from the ashtray and were counted. The experiment's results demonstrated a noteworthy reduction in littering. The percentage of cigarette butts improperly discarded on the ground decreased from 52.2 percent without the intervention to 27.3 percent with it. This indicated an increased utilization of the ashtray, resulting in a rise in proper disposal from 47.8 percent to 72.7 percent. However, the study underlies some methodological limitations due to a limited sample representativeness, a lack of knowledge on the exact sample composition and the fact that some subjects were under the influence of alcohol. For these reasons the findings should be interpreted cautiously but they do imply a potential, positive effect of such a nudge.

Another salience-based nudge is to place green footprints on the ground in a way that they lead to trash bins. Gerlach et al. (2019) tested the effectiveness of such a nudge in a field experiment in Cologne. The attention focusing measure (footprints) was accompanied by a poster campaign: Through the message "Cheers for trash? Of course, if it falls in it" (in German: "Beifall für Abfall? Klar, wenn er reinfällt!") correct waste disposal behavior was advertised in a humorous way. This type of advertising correct waste disposal behavior was intended to appeal especially to young people and young adults, as they are the group of people who litter most often (VKU, 2016) and therefore can be regarded as a specific relevant target group in the context of littering. The amount of littered waste was measured at the beginning of the study (baseline, pre-study), one month after setting the footprint nudge (post study 1) and one month after the start of the poster campaign (post study 2). To assess the objective urban cleanliness, the cleanliness status of the three examined streets in Cologne was recorded by the employees of the AWB (Cologne's cleaning company) two days a week using the software-supported quality assurance system "DSQS" (INFA) which is the standard quality assurance system for street cleaning. The random on-site measurements according to defined criteria provide a differentiated overview of the cleanliness state of a city. In addition to that, the daily amount of waste in the waste containers and the daily amount of littered waste were weighed on five days in the respective study week. From this, a ratio between the correctly disposed amount of waste in waste containers and the amount of littered waste was determined.

The results of the study show that after the introduction of the nudges and the supplementation of the poster campaign significant improvements in urban cleanliness were measured, while no significant changes or improvements could be seen in the control area over the entire study period. This positive effect of the combination of the footprint and poster measure was found by objective cleanliness criteria according to DQDS parameters. The lower the value measured by DQDS, the better is a city's cleanliness: The value of the baseline condition in experimental area 1 (11.47) declined to 10.18 one month after implementing the footprint nudge (post condition 1), but it slightly increased again to 10.93 one month after the start of the poster campaign (post condition 2). If one considers the ratio between the weighted amount of correct and incorrect waste in containers there is a clear tendency: In experimental area 1, the percentage share of littered waste of all waste significantly decreased from 17.3 percent in the baseline condition to 16.9 percent (post 1) and to 15.0 percent one month after implementing the poster campaign (post 2). The experiment thus shows that the implementation of footprints on the ground which lead to trash cans can support urban cleanliness (Gerlach et al., 2020, 36f.).

Another potential behavioral intervention is to hang a poster with observing eyes over trash areas (figure 4-2). Several studies confirm that a pair of observing eyes can promote prosocial behavior, in other words, people tend to behave "better" when they are watched. The mechanism works independently of an accompanying text, which implies that the eyes work on their own without any words. However, important aspects

are a direct (Manesi et al., 2016), open look and a serious expression (Bateson et al., 2015). Among others, Gangl et al. (2021) investigated the effect of such a poster on people's waste behavior. The pair of eyes was printed in colour on a poster of A1 size. The results of the field experiment show that the eye poster leads to a significant improvement in ground cleanliness: Given an average pollution level of 2.11 (1= very clean, 7= very dirty) in the baseline, the study found that in case of 47 percent of 359 waste containers the eyes led to an improvement rather than to a steady or worsening soiling level compared to the control group. These results remain significant even when the difference between trash rooms and places, the effect of full trash containers, and the number of residents is controlled for. This means that the poster with printed eyes can improve people's waste disposal behavior regardless of infrastructural conditions (Gangl et al., 2021, 38).

Further examples of nudges which aim at reducing littering are waste columns in a public and enlivened place in a city, such as near a marketplace. In this glass column, waste thrown on the street is collected over a certain period and displayed like a work of art. Through this visualization, people are made aware of the problem of mismanagement of waste (littering). This nudge works by increasing the visibility of the amount of waste. A visualization of such a reminder nudge can be found on the right side of figure 4-2. In addition to public places, litter-reducing nudges can also be implemented in other places such as offices, schools, or kindergartens. To increase correct waste disposal behavior in offices, one can put concrete waste labels on the trash cans (garbage labelling): To implement this nudge, existing trash cans are marked with coloured tape on the handle and simple symbols for the corresponding types of trash. This facilitates the assignment of each type of trash and makes it easier to separate trash (figure 4-2) (Green Nudging, 2023).

Through the so-called "gamification" approach, correct waste disposal can be aimed at in a playful, fun-oriented way and thus can specifically address children and adolescents. For instance, in kindergartens or schools, a small basketball hoop can be attached above the trash can or recycling garbage can, and the game then looks like this: Everyone gets a point for each piece of trash thrown in the correct garbage can. To increase motivation for correct disposal behavior, one can attach a scoreboard to record the points. When a child reaches a certain number of points, a small prize is awarded. This can be a sticker, a sweet or something similar (figure 4-2).

5 Recommendations for action for more cleanliness in cities

5.1 Use green nudges to prevent littering

The field of behavioral economics provides empirical evidence that people do not always act rational, have self-control problems, do not absorb all information given to them and tend to be subject to a gap between their will towards correct waste disposal and actual waste disposal behavior (mind-behavior-gap) (chapter 3). Sustainably changing German citizens' behavior in a way that littered waste substantially reduces therefore requires a more differentiated perspective than a purely legal approach (chapter 2). Green nudges, as analysed in chapter 4, can make a significant contribution towards closing the mind-behavior-gap. Based on the insights presented in chapters 2 to 4, the following behavioral-economical recommendations can be given to representatives of German cities and local municipalities, especially those responsible for cleanliness in the city and public green places and leaders and employees responsible for street cleaning:

- **Implement visual and humoristic cues near trash bins**

We recommend to place trash bins in public places (e.g. in parks) in such a way that they are highly visible and easily accessible. People should be nudged towards proper waste disposal by making it more convenient for them. Visual and humoristic cues near trash bins remind citizens to dispose their waste properly in a friendly and humoristic way. These cues can be posters with messages like "Beifall für Abfall? Na klar, wenn er reinfällt" or "Gib Müll nen Korb" or visual hints in the form of footprints on the ground leading to trash bins.

- **Change the placement and presentation of ashtrays**

To prevent cigarette-based littering, we advise representatives of German cities and local municipalities to provide public places with more salient ashtrays (e.g. in orange) and arrows on the ground which lead to the ashtray. This tool should be implemented in public places where people tend to smoke but do not see or do not reach an ashtray because it is too far away from them or poorly visible. While salient ashtrays are implementable in any public place, the proposed arrows on the ground are only useful in public places which do not use to be over-crowded because otherwise, the arrows on the ground might not be visible enough to be effective.

- **Communicate litter-addressed messages by temporal framing**

Frame waste disposal messages in a way that the long-term consequences of littering or the long-term benefits of correct waste disposal are highlighted. For example, use messages like "Protect the environment for future generations" or "10 steps until sustainability" to encourage more responsible behavior and to overcome people's tendency to present bias.

- **Make use of descriptive social norms**

As chapter 3 indicated, people are strongly influenced by the behavior of others. This behavioral tendency can be exploited by highlighting the positive behavior of the majority. For example, signs or messages like "Most of your fellow citizens in this area dispose their trash responsibly" can create a social norm that discourages littering and prevents pluralistic ignorance. Another way to use the power of social norms is to add a poster of watching eyes above garbage cans.

- **Employ feedback mechanisms**

Implement feedback mechanisms that inform people about the impact of their actions. For instance, public glass columns filled with waste placed in a vivid place (e.g. marketplace in a city) can show the negative consequences of littering and connect people's actions to their consequences.

- **Utilize pictorial labels**

Use pictorial labels on trash cans not only in public places but also for trash cans in offices, schools, or kindergartens to simplify proper disposal methods. This helps individuals to understand how to dispose the items correctly, thus reducing confusion and possibly also littering.

- **Use gamification**

To specifically address children and adolescents, it can be recommended to implement gamification elements in kindergartens or schools, for instance, in the form of a small basketball hoop attached above the trash can or recycling garbage can. The motivation to proper disposal can be reinforced by implementing a scoreboard to record the points. For instance, one piece of trash thrown in the correct garbage can equals one point. Once a certain number of points is reached, a small prize such as a sticker or a sweet is awarded (figure 4-2).

5.2 Improve general waste management by using AI-tools to remove litter

The presented green nudges do not cost a lot but can contribute towards preventing littering in Germany if they are implemented nationwide and achieve the effects found in the experiments mentioned in chapter 4. In view of the partially limited effects found in the experiments, however, green nudges cannot replace classical instruments of environmental policy: Nudging is most effective when it complements other anti-littering measures, such as environmental education or fines. However, even in case of a combination of classical instruments (chapter 2) and green nudging (chapter 4) it is unrealistic to assume that the entire amount of littering (chapter 1) will disappear in Germany. Therefore, in addition to tools that aim at preventing littering (chapter 5.1), it is important to create infrastructure that quickly removes littered trash. To avoid the dangers of the broken windows effect described in chapter 1, garbage is to be disposed as quickly as possible if it cannot be prevented. This requires an expansion of a city's cleaning capacities.

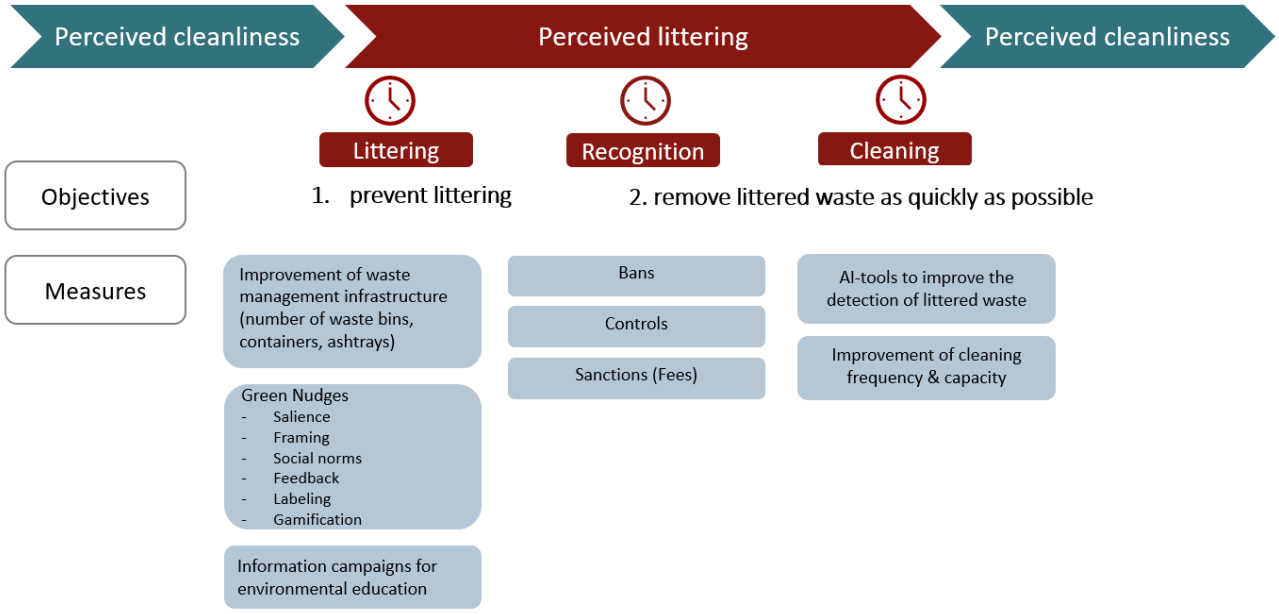
A quick removal of trash requires a rapid detection of it. For the purpose of a fast identification of waste, modern technologies like artificial intelligence systems (AI) are suitable. For example, the artificial intelligence “Objection Detection” recognizes objects of a certain class (cars, people, buildings) in one image and can count certain types of waste such as cigarettes or pizza boxes by street, district, park, or city and can thereby identify waste hotspots. This function could be applied for the purpose of urban cleanliness. By recognizing individual types of waste by location, time, type and quantity, AI solutions can create more transparency in a very fast way and should therefore be used in cities and municipalities in the future (Sukel et al., 2020). In 2022, practical tests of such technologies were carried out in various German cities. For instance, a sweeper equipped with the “Cleenr technology” recognizes cigarette butts and other rubbish on streets and paths. The detected waste is then documented by its type and quantity with location and time when it was found. The web interface of this AI-tool thereby identifies litter hotspots. Moreover, there is a connection to the cleaning order system of the city’s cleaning service (Cleenr GmbH, 2022). As they recognize waste in a fast way, document unfavorable, missing and/or defective infrastructure, suggest new infrastructure and thereby optimize cleaning intervals, -routes, -times, and -intensities, artificial intelligence tools have the

potential to optimize the cleaning infrastructure, can lead to more transparency and greater efficiency in waste management. Cities and municipalities should therefore increasingly integrate artificial intelligence tools in the cleaning processes.

5.3 Implement a mix of instruments to combat littering

As a first prerequisite it is crucial to provide an adequate number of trash bins in public areas, parks, and streets (improvement of infrastructure). Secondly, it must be ensured that these bins are easily visible and conveniently located (green nudges). Nonetheless, cities should keep launching public awareness campaigns to educate people about the environmental and social consequences of littering. In addition, cities and municipalities should regularly organize community clean-up events, where volunteers come together to pick up litter in public spaces. This promotes a sense of responsibility among residents and sensitizes them to the problem (information campaigns). Figure 5-1 summarizes the recommended mix of instruments:

Figure 5-1: Mix of instruments to combat littering



Source: Own figure

To sum up, an interdisciplinary approach including the valuable insights of behavioral economics should be used to encourage citizens towards more responsible waste disposal behavior to make German cities and municipalities cleaner. Green nudges can play an additional role in solving the problem because they have the potential to cause a rethink in the population at relatively low cost and without coercion. By subtly influencing people's choices and creating an environment that encourages responsible waste disposal behavior, green nudges can contribute to cleaner German cities and municipalities. However, we recommend cities and local municipalities to use the recommended green nudges not as a “one-size-fits-all-solution” but rather as a cost-effective extension of the classical environmental policy toolkit.

Most effective in solving the littering problem in Germany is a mix of instruments and a mix of responsibilities: In addition to the cities and municipalities, public or private institutions like universities, schools and companies should implement feasible green nudges as presented in chapter 4. To strive for responsible waste

disposal behavior and environmental consciousness from an early age, environmental education should be included in schools and kindergartens. To sustainably combat littering in Germany, a combination of litter-preventing and litter-reducing measures is required (figure 5-1). Moreover, the tools should be tailored to the specific needs and littering challenges of the individual city or municipality. We recommend using green nudges in combination with classical instruments like information campaigns, bans and penalties, accompanied by an enlargement of cleaning capacities and an integration of modern artificial intelligence solutions in the cleaning process. Littering must be addressed at different levels (federal, local) and through different approaches (behavioral economic and classical environmental policy tools). In view of the variety of costs which are caused by littering (economic, environmental, and social costs) (chapter 1) it is important to look for solutions and to invest time and effort to combat littering in Germany. In this way, the environment can be preserved, public health and safety can be enhanced, and the overall quality of life for residents and visitors in Germany can be improved.

Abstract

The demand for cleanliness in cities is increasing: "Littering" - the illegal littering of public spaces - does not only cause costs for the environment and society, but also has significant financial consequences through increased cleaning costs. Much of the littering consists of "to-go" packaging, plastic bottles, and cigarette butts. Currently, the problem is predominantly addressed with laws, fines, and education campaigns. Politicians and the media are also putting the appearance of cities on the agenda, but classic instruments such as controls by municipal law enforcement officers and harsh sanctions against "litterers" are reaching their limits in solving the problem. In addition to classic environmental policy instruments, the tools of behavioral economics can make a complementary contribution in solving the problem: by influencing people's daily habits, green nudges can encourage people to reduce littering, thereby improving urban cleanliness.

List of figures

Figure 1-1: Littering cost for German cities and municipalities (in million euros per year) 6
Figure 3-1: Reasons for environmental-harmful behavior 9
Figure 4-1: Nudging to narrow the mind-behavior-gap 11
Figure 4-2: Green nudge examples 12
Figure 5-1: Mix of instruments to combat littering 17

List of references

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