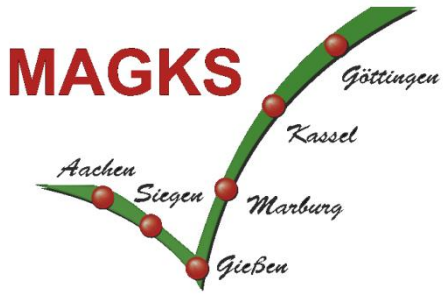

Joint Discussion Paper Series in Economics

by the Universities of

Aachen · Gießen · Göttingen
Kassel · Marburg · Siegen

ISSN 1867-3678

No. 13-2023

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This paper can be downloaded from

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Incentives for construction clients in Germany to choose concrete with recycled aggregates

Ellen Sterk

Abstract

Concrete with recycled aggregates ("R-concrete") offers a way to reduce the extraction of natural resources and to close material loops in line with political goals. However, market failures may hamper the efficient use of R-concrete in construction. Various policy instruments can be used in this situation to stimulate demand for R-concrete by construction clients and to correct market failures. This study aims to answer the question which instruments are potentially effective in this regard and how different client types differ in terms of their responsiveness to these instruments. The results show that all tested instruments have a positive effect in at least one of the client groups, but only financial incentives work over all groups. While information provision shows to have a positive effect on the likelihood to choose R-concrete (at least in some client groups), its effectiveness decreases with an increasing financial grant. Finally, client groups also differ in their general likelihood to choose R-concrete over conventional concrete. Conceiving of sustainability as an important criterion in construction projects increases this likelihood. This study offers a guideline for policy makers for the design of instruments in order to stimulate the use of recycled construction material.

1 Introduction

The need to close material cycles and, to this end, increase recycling has left the discussion table of scientists and climate activists and has entered the general public's awareness. It is also a political goal on a national and international level (Waste Framework Directive, 2008; *Koalitionsvertrag 2021 – 2025*, 2021; United Nations, 2015). An industry with a large potential in this regard is the construction industry. It claims around 75 % of the non-renewable resources extracted in Germany (Destatis, 2021) and produces more than half of the waste generated (Destatis, n.d.). One product that can help lower these numbers in line with the political goals is "R-concrete", which is short for "resource-saving concrete" or "recycling-concrete". The natural aggregates that are a component of conventional concrete, usually gravel and sand, are partly replaced by recycled aggregates from construction and demolition waste. Thereby, fewer primary resources are needed, less waste is produced, and landfill capacities are spared (Knappe et al., 2012, 2017; Wizgall & Knappe, 2011). R-concrete is already admissible for many applications in building construction in Germany and is considered to have the same characteristics as concrete with primary aggregates (Knappe et al., 2013). Nevertheless, it is hardly used in Germany (Jacob et al., 2021; Wizgall & Knappe, 2011).

Arguably, market failures are at work in the case of R-concrete that hamper its use: external costs and information asymmetry. Both will be elaborated on in the following sections. It is commonly accepted that market failures should be counteracted with policy interventions (Söderholm & Tilton, 2012). It has not yet quantitatively been tested which policy instruments are likely to increase the likelihood of construction clients to use R-concrete. This study aims to fill this gap using a factorial survey and a sample of three different groups of construction clients. These are private individuals, organizations, and developing companies[1]. While they all initiate and finance construction projects, they are different in ways that might influence their demand behavior. The instruments that are tested are a financial grant, an expedited permit process, free technical support, public recognition, and information provision. The results show that all tested instruments are effective for at least one of the client groups. Only a financial grant increases the likelihood to choose R-concrete in all three groups. While organizations respond to all instruments, developers and private individuals are only affected by a subset of them. Regarding a proposed mix of financial and informational instruments, we find that the provision of information is only effective when a concomitant financial grant is rather low. Developers are the group that is most likely to choose R-concrete overall. Finally, considering sustainability to be an important criterium in construction increases the likelihood to choose R-concrete. The results offer guidance to policy makers with the goal to shift demand from primary to recycled building material.

The paper is organized as follows: chapter 2 gives an overview of the literature on the market failures in the context of R-concrete and potential policy instruments to counteract these. It finishes with the hypotheses that we derive from the literature and that guide this study. Chapter 3 illustrates the method used and chapter 4 shows the corresponding results. These are discussed and put into context in chapter 5. Chapter 6 concludes this paper.

[1] While public authorities are a highly relevant group of construction clients as well, they are willfully excluded in this study. The regulatory environment under which they operate distinguish them from the other three groups, which is why they are considered in a separate study (work in progress).

2 Literature review and hypotheses

As stated above, one market failure that hampers the use of R-concrete are the external costs related to the production of conventional concrete. The extraction of natural resources produces externalities that are not taken into account by construction clients or considered in the price for conventional concrete (European Commission, 2014). Firstly, mining sand and gravel causes the emission of greenhouse gases (GHG). In Germany, 40 % of GHG emissions are ascribable to the extraction and first processing of natural resources (Lutter et al., 2022). These emissions can be reduced by recycling construction and demolition waste instead of mining natural resources (CDW; Marzouk & Azab, 2014). Resource extraction is further problematic in itself, since it entails damage to flora and fauna, pollution of ground water and soil, as well as noise and dust disturbance, to name a few impacts (Wijayasundara et al., 2018b). Moreover, it leads to resource depletion, the costs of which are quantified in the concept of scarcity rents. Scarcity rents represent the opportunity costs of extracting a unit of resources today instead of conserving it for the future. It indicates the costs of depleting a resource today such that its benefits are not available to future generations (Farzin, 1992). Naturally, using recycled aggregates instead of primary ones does not entail these issues. While the processing of waste into aggregates also produces emissions, the use of recycled aggregates has been shown to have a lower environmental impact than natural aggregates (e.g., Ding et al., 2016; Knoeri et al., 2013; Serres et al., 2016; Stürmer & Kulle, 2017). For example, Colangelo et al. (2021) conducted a life cycle analysis comparing several mixtures of concrete with varying shares of recycled aggregates to concrete with only natural aggregates. The impacts were considered in three areas: human health, ecosystem quality, and resource scarcity (RIVM, 2011). The results show that R-concrete is better from an environmental perspective and the benefits increase with an increasing share of recycled aggregates. Similar conclusions are reached by Mostert et al. (2021), who evaluate the demolition and construction of a city hall using R-concrete. They find a reduced footprint regarding material, water (for the case of dry processing), and climate due to reduced emissions from transport and energy use. However, the researchers emphasize that the environmental footprint of a project can only be evaluated individually per case. In line with this, the transport distance has repeatedly been found to be decisive for the environmental impact of aggregates (Ding et al., 2016; Ghisellini et al., 2018; Knoeri et al., 2013). Nevertheless, it is clear that using natural aggregates produces externalities that are not accounted for in the price of conventional concrete. Wijayasundara et al. (2018b) identified the avoidance of landfilling construction and demolition waste (CDW), extraction of natural resources, and transportation of waste and by-products as the main benefits of recycled aggregates in this regard. They quantified these external costs and found a net benefit between 9 and 28 % of the price of conventional concrete. In a different study, the same authors show that the internalization of these benefits would decrease the price of R-concrete with a share of 30 % recycled aggregates by 4 – 6 %. This reduction increases linearly with an increase in the share of recycled aggregates and renders the use of R-concrete compared to conventional concrete economically profitable (Wijayasundara et al., 2018a).

If the market depicted these external costs connected to material scarcity and damaging environmental impacts, the price for natural aggregates would rise, which would lower demand and trigger the use of recycled aggregates instead. However, reality shows that in the case of environmental externalities, “the costs of harm do not affect prices unless the costs are added due to policy” (Allwood et al., 2011, p. 376). This statement is in line with the findings by Henckens et al. (2016). The researchers studied whether geological scarcity of minerals is reflected in their price development and found that this is not the case. Thus, instead of trusting market forces to ensure resource conservation, they recommend installing policy measures to increase the price of scarce materials. Policies “level the playing field” (Wilson, 1996, p. 389)

by internalizing externalities, so that these do not compromise the position of R-concrete on the market. These instruments either increase the price of primary materials, such as environmental taxes, or lower the price of recycled materials, such as subsidies (European Environment Agency, 2008; Li et al., 2020).

Besides externalities, information asymmetry additionally worsens the market situation for R-concrete. In this case, it is especially at play in the form of adverse selection. Adverse selection describes the situation in which one party, usually the seller, has more information about the product than the other party, usually the buyer. Generally, not all stakeholders in construction projects or the recycling industry have the same degree of access to relevant information (Forsythe et al., 2015; Li et al., 2020). Clients, for example, especially in the case of laypersons, have to trust their contractors and suppliers to deliver the best possible material that lives up to its promises. Even the contractors ordering (recycled) material most likely do not know about the quality of the recycled aggregates supplied by the recycler and used by the producer. In the case of R-concrete, construction clients do not have ready access to information about the quality or environmental impact of the material. Analogous to the famous example of lemons in the automobile market (Akerlof, 1970), this implies that sellers who offer a high quality are unable to attain an adequate price, since the quality is unobserved and sellers with lower quality products are favored (Nicolli et al., 2012). Adverse selection is especially likely to be significant in the construction and recycling industry, because the transactions are infrequent (especially for clients who are private individuals; Nicolli et al., 2012) and there are numerous stakeholders involved (Forsythe et al., 2015). If mainly aggregates of bad quality are sold, this would lead to a negative image of R-concrete and eventually a lack of demand.

That policy intervention is necessary to counteract market distortions is a common view and holds also for the case of construction material. Söderholm and Tilton (2012), for example, argue that policy instruments are desirable if market failures impact clients' purchasing decisions of material. Information asymmetry and environmental externalities are among the market failures he lists for this case. Public policy instruments are commonly divided into sticks and carrots, and sometimes sermons (Bemelmans-Videc et al., 2011). Sticks refer to mandatory regulations by the government, which oblige people to act in accordance with the specified rules. Carrots, in contrast, imply adding or removing resources as a form of incentive, such that the person concerned can choose whether to make use of the measure or not. An example are the financial incentives mentioned before. The final category, sermons, describes information instruments. These aim to stimulate 'good' or avoid 'bad' behavior by influencing the actors through knowledge transfer and persuasion.

This paper focuses on information provision (sermons) and incentives (carrots), the latter of which can be categorized in several ways. Several authors and institutions have proposed categories for green building incentives. For example, Olubunmi et al. (2016) distinguish between external and internal incentives. External incentives are provided by the government and entail specific conditions that need to be met. They are further subdivided into financial and non-financial incentives. Internal incentives refer to people's intrinsic motivation or interest in the activity, such as a positive influence on health or inspiration from leadership. The U.S. Green Building Council (2014) differentiates structural, financial, and other incentives. Structural incentives offer benefits in the process of construction, such as an increase in the admissible floor area ratio. Financial incentives are direct benefits in the form of a tax credit or grant. Finally, assistance from the municipality falls under other incentives.

Among these categories, financial or economic incentives, also called market-based instruments, have received the most attention among scholars. Several authors argue for their

implementation instead of regulations or so-called command-and-control measures. Market-based instruments (that are specific to environmental policy) "provide a stimulus to consumers and producers to change their behaviour towards more eco-efficient use of natural resources" (European Environment Agency, 2006, p. 5). They can take the form of tradable permits, environmental taxes, environmental charges, environmental subsidies and incentives, and liability and compensation schemes. The main argument for these instruments is that they are efficient and cost-effective (Duran et al., 2006; Grosskopf & Kibert, 2006; Jaffe & Stavins, 1995). They make use of the diversity of economic actors, since each one of them can choose whether to pay for the harm they afflict on the environment or change their production processes to avoid this harm, depending on which is the cheaper option (European Environment Agency, 2006; Mandell & Wilhelmsson, 2011). In contrast, regulations, such as environmental standards, are often costly and inefficient. The diversity in economic activities makes the same technology or process appropriate in one and inappropriate in another firm. Moreover, command-and-control instruments do not offer any incentive to improve one's environmental footprint beyond what is required (Stavins, 2003). In the specific case of recycling construction and demolition waste, too, market-based instruments have been proposed to be the optimal solution. Duran et al. (2006) developed a model using surveys, interviews, and existing data to determine the conditions that make recycling economically feasible. They find that viability is given when landfilling is more expensive than offering the waste for recycling and using primary aggregates is more expensive than using recycled aggregates. The authors conclude that market-based instruments, here taxes and subsidies, rather than command-and-control approaches are the best way to reach these conditions.

Financial incentives have been found to be effective in stimulating demand from construction clients (e.g., AlSanad, 2015; Darko et al., 2017; Diyana et al., 2013; Iheanyichukwu Joachim et al., 2014). For example, Pitt et al. (2009) asked building surveyors to rank potential drivers for sustainable construction and found financial incentives to be the most important one. Adams et al. (2017) also identified financial incentives to use secondary material as an enabler to implement a circular economy in the construction industry. Especially clients, compared to researchers, consultants, and contractors, ranked this factor highly. Similarly, Portnov et al. (2018) surveyed potential homebuyers regarding their preference for public policy measures for green building and found two forms of financial incentives to be at the top: tax reduction and subsidized loans and grants. In the same vein, a lack of financial incentives is often found to be hindering the advancement of sustainable construction and the use of secondary materials. Several researchers have identified a lack of (financial) incentives to be one of the main barriers for green building (e.g., Adams et al., 2017; Chan et al., 2009; Häkkinen & Belloni, 2011). For example, Darko and Chan (2017) reviewed 36 articles on barriers and challenges to the adoption of green building and found that a lack of incentives is among the top barriers, reported by 21 of the articles. Incentives seem to play a role for the use of R-concrete, too. Katerusha (2021) surveyed concrete producing companies and had them rate potential barriers on a scale from 1 to 100 (1 meaning not relevant at all and 100 meaning very relevant). The median score for the barrier of a lack of tax incentives was 76.5. In earlier research (Sterk, 2023), we asked construction clients about their perception of potential barriers for the use of R-concrete. The lack of incentives ranked 4th out of 10.

Other incentives – non-financial ones – have received much less attention. The structural incentives that are listed by the U.S. Green Building Council (2014) are an expedited review/permitting process and density and height bonuses. The former implies a prioritization by the municipality of permits that comply with certain green building standards. This can not only save time, but also costs on the side of the construction client, while there are no costs involved for the municipality. The latter structural incentive refers to an increase in the allowed

floor area ratio or similar metrics. The American Institute of Architects (Rainwater et al., 2012) also lists these as commonly implied incentives by local U.S. governments. Other incentives include technical or marketing assistance. Technical assistance is provided in the form of trainings and support with planning and certification, especially for developers. Marketing assistance builds on the positive influence a green building certification can have for the clients' reputation or image (Rainwater et al., 2012; U.S. Green Building Council, 2014). Lacetera and Macis (2010) showed the effectiveness of this latter type of incentive in the setting of pro-social behavior. They find that symbolic prizes are effective in encouraging blood donations, especially when awarded publicly.

The third category of public policy instruments – sermons (information provision) – are also of interest for stimulating the demand for R-concrete. First, information-based instruments are the most straightforward solution for information asymmetries. As explained above, potential buyers of R-concrete do not have access to the same information that recycling and producing companies have. Sermons could help to level out this imbalance. Secondly, in a previous paper, we found that the main barriers for construction clients to demand R-concrete are based on a lack of information. These were a lack of knowledge, not knowing the material, and uncertainty regarding the norms and regulations (Sterk, 2023). Raising clients' awareness of R-concrete (and recycled materials generally) and its properties and possibilities for application through information could tackle these issues. Finally, knowing and understanding an environmentally friendly construction product or practice has been found to increase clients' willingness to pay (WTP) for it (e.g., Portnov et al., 2018; Zalejska-Jonsson, 2014). Our previous study has shown this for the case of R-concrete. Respondents who were familiar with the material were more likely to choose R-concrete and were willing to pay more for increasing the share of recycled aggregates. Familiarity was conceptualized as having heard of R-concrete before. This suggests that awareness of the existence of the material is already highly beneficial, which information provision could achieve.

One potentially effective type of sermon to tackle information asymmetry is a third-party label or certification, as proposed by Bennear and Stavins (2007). As such, a label certifying the quality and/or sustainability related aspects of R-concrete could be useful. In support of this, we previously found that a label providing proof that R-concrete is equal to conventional concrete in quality is a top driver for clients to demand R-concrete. We also tested their willingness to pay for an environmental label and found it to be positive (Sterk, 2023). This is in line with other research that found consumers to be willing to pay more for products, among which building materials, with eco-labels (e.g., Shen, 2012; Ward et al., 2011). Another conceivable sermon is an information campaign, which transfers knowledge. For example, Zhang et al. (2016) asked Chinese residents for their WTP for green housing, then showed them information cards displaying the performance of green and non-green housing on some indoor environmental indicators and then asked again. The WTP of those participants that currently do not live in a green building increased significantly. The authors argue that there was no meaningful increase for participants living in green buildings because they likely already had knowledge of the information provided. A similar result was found by Khan et al. (2020), who asked potential homebuyers in Pakistan about their attitude towards sustainable housing before and after being exposed to information on the subject. They find that this information has a positive effect on their respondents' willingness to change from conventional to sustainable housing as well as their willingness to pay for the latter. Mandell and Wilhelmsson (2011) also argue for information campaigns to increase the demand for sustainable housing. They assume that clients who understand themselves to be environmentally aware are better informed on the impact their behavior has on the environment. They find that these clients have a larger WTP

for sustainable housing and therefore conclude that information campaigns, which raise environmental awareness among the relevant actors, are justified.

To sum up, there are two types of market failures at work that impede the use of R-concrete: environmental externalities and information asymmetry. These two market failures are jointly ameliorating, according to Bennear and Stavins (2007), meaning that correcting one of them also lessens the negative impacts of the other. As an example, the authors name energy labels as a measure which provides consumers with information on energy usage and costs and which also lower energy consumption. A mix of instruments is seen to be a more efficient measure when several market failures are at work (Bennear & Stavins, 2007; de Serres et al., 2010; European Environment Agency, 2006; Wilson, 1996). Specifically, at least one measure should be applied per market failure (Goulder & Parry, 2008). In the particular case of environmental externalities and information asymmetry, a combination of some sort of (financial) incentive, such as a tax, and information disclosure requirements, such as a third party label, is recommended (Bennear & Stavins, 2007). A similar mix is suggested to be most efficient by Mandell and Wilhelmsson (2011). As described above, they find higher WTP estimates for environmentally aware clients, which speaks for the implementation of information campaigns. However, these differences were mostly found for environmental attributes that require only small investments. Therefore, in order to stimulate the demand for a broader range of attributes, information should be combined with economic incentives.

The above overview suggests that policy instruments could help to stimulate the demand for R-concrete. R-concrete keeps resources in the loop, which is one of the main principles of a circular economy (CE). The concept of a CE has been criticized to have various meanings, but it is most often understood as combining the principles of reduce, reuse, and recycle with the goals of economic prosperity and environmental quality (Kirchherr et al., 2017). Researchers agree that "the transition to a circular built environment is key to achieve a resource-effective and sustainable society" (van Stijn & Gruis, 2020, p. 636). However, there seems to be a lack of policy interventions to support this transition (Hossain et al., 2020). Both Hossain et al. (2020) and Osobajo et al. (2022) conducted literature reviews on CE in the construction industry and both found that there has been only limited research on policy interventions that can help to establish this transition. Thus, more research is needed in order to identify which policy instruments could help establish a CE in the construction industry. Specifically, as Osobajo et al. (2022) suggest, quantitative methods should be applied, since 92 % of the articles reviewed by the authors are based on qualitative methods. Furthermore, there is a need for studies that evaluate policy mixes in specific industries (Rosenow et al., 2016) and, to the best of our knowledge, none of these studies has been conducted for the case of R-concrete. This paper aims to combine these research endeavors by quantitatively analyzing the potential effectiveness of policy instruments (and their mix) for the application of construction products and principles that are in line with the concept of a CE and does so by using the specific case of R-concrete.

Many incentives have been proposed and partly already applied to stimulate the demand for green buildings. The market failures at work that impede the use of R-concrete suggest that these incentives could also be beneficial in this particular case. However, to the best of our knowledge, it has not yet been tested whether these could be effective or which ones are likely to have the greatest impact. This research aims to fill this gap focusing on a range of policy

instruments: a financial grant, an expedited permitting process, free technical assistance, marketing assistance, and information provision[2]. The respective hypotheses are the following:

H1.1 A grant increases the likelihood of clients to demand R-concrete.

H1.2 An expedited permit process increases the likelihood of clients to demand R-concrete.

H1.3 Free technical support from the municipality increases the likelihood of clients to demand R-concrete.

H1.4 Public recognition and promotion increase the likelihood of clients to demand R-concrete.

H1.5 Information provision increases the likelihood of clients to demand R-concrete.

Up until this point, construction clients have not yet been further distinguished. Generally, they are defined as the ones who initiate and finance a construction project (Hartmann et al., 2008). However, construction clients differ in ways that might systematically affect their attitude towards and propensity to choose R-concrete as well as their responsiveness to incentives. Our previous work has confirmed that client groups differ in their consumption behavior of R-concrete (Sterk, 2023) and they will therefore also be distinguished here. The three groups are developers, organizations, and private individuals. The study aims to answer the question whether these groups differ in terms of their likelihood to choose R-concrete over conventional concrete and in terms of their responsiveness to potential incentives. In our earlier study, we found that private individuals experience barriers for the use of R-concrete to a higher extent and have a lower WTP for it than the other two groups. Moreover, they chose the conventional concrete option more often in a discrete choice experiment (Sterk, 2023). We expect to find a similar pattern in the factorial survey applied in this study.

H2 Private individuals are less likely to choose R-concrete compared to organizations and developers.

We expect to see differences in the client groups' responsiveness to the policy instruments. The group of private individuals appeared to be more price sensitive when it comes to R-concrete (Sterk, 2023), which is likely to make them more responsive to financial incentives, such as a grant, than organizations or developers. Regarding an expedited permitting process, it is unclear which of the client groups is likely to be most affected, since the length of the process is not necessarily dependent on the type of building and the saying 'time is money' holds true for all groups. Whether technical support is an attractive offer to the client probably depends on their knowledge of and experience with R-concrete. Since it is developers' profession to construct buildings, one can assume that they have more technical expertise overall, potentially including R-concrete. Therefore, we expect that this incentive is least effective in the group of developers. Developers and organizations are motivated to use environmentally friendly products and practices by reputation and image considerations (Diyana et al., 2013; X. Zhang et al., 2011). Our previous work supports this notion, as being driven to use R-concrete by a positive effect to one's image was ranked higher by organizations and developers than by private individuals

[2] Note that the financial grant, expedited permitting process, free technical assistance, and marketing assistance are referred to as *incentives*, while the term *(policy) instruments* includes all incentives as well as the provision of information.

(Sterk, 2023). Followingly, public recognition and promotion is assumed to be most effective in these groups. Finally, we expect that the provision of information on R-concrete has the biggest effect on private individuals. This group is the least knowledgeable and experienced regarding construction material, including R-concrete, since most of them are only construction clients once in their life. In contrast, most of the organizations in our sample are responsible for several buildings and developers act as construction clients on a daily basis. Thus, we assume that private individuals are the least informed on R-concrete, which our previous study has confirmed: only a little more than a fifth of them had ever heard of R-concrete before (compared to roughly two thirds in both other groups). In addition, not knowing the material showed to be the second most important barrier to its use in this group (Sterk, 2023). Furthermore, Zhang et al. (2016) also find that their information treatment on environmental factor of green buildings only worked for those clients who were not themselves living in and therefore knowledgeable about green buildings. Accordingly, we expect private individuals to be most responsive to the provision of information. The resulting hypotheses are the following:

H3.1 A grant increases the likelihood to demand R-concrete more for private individuals than for organizations and developers.

H3.2 An expedited permit process increases the likelihood to demand R-concrete differently for different client groups.

H3.3 Free technical support from the municipality increases the likelihood to demand R-concrete more for private individuals and organizations than for developers.

H3.4 Public recognition and promotion increase the likelihood to demand R-concrete more for organizations and developers than for private individuals.

H3.5 Information provision increases the likelihood to demand R-concrete more for private individuals than for organizations and developers.

3 Methodology

3.1 Research Strategy & Data Collection

A two-part online survey among construction clients was conducted, which distinguished between three groups of clients: developers, organizations, and private individuals. In order to validate the practicability of the incentives that we test in this study, several interviews were conducted with industry experts. The survey started with item-based questions on demographics, familiarity with R-concrete, and barriers and drivers for their use. As a first experimental treatment, respondents were then randomly assigned to one of two groups: the treatment group received a text with detailed information about R-concrete and its advantages, while the control group did not receive this information. Then, a discrete choice experiment followed. This experiment is the focus of previous work (Sterk, 2023) and will not be discussed here in detail. The focus of this paper is the subsequent factorial survey, which will be described below. The questionnaire concluded with some item-based questions on the role of sustainability generally and in the construction project(s). Only the questions concerning demographic information differed considerably between the three groups. Most of the other questions were only adapted in wording to suit the type of respondent. For details on the

inclusion criteria, interviews, barriers and drivers, and the full survey transcripts, the interested reader is referred to our preceding article (Sterk, 2023).

Factorial surveys date back to Rossi (1951) and combine the advantages of surveys and experimental research. In factorial surveys, hypothetical situation descriptions (so-called vignettes) are presented to the participants. They are then asked how likely they would be to act in a certain way based on this situation. Several aspects of these descriptions are varied in their levels, which allows the researcher to identify the influence of a single aspect on the choice.

In this study, the factorial survey aims to test the effectiveness of potential incentives to increase the demand for R-concrete by construction clients (H1.1 – H1.4 and H3.1 – H3.4). Participants are asked to imagine that they are currently building their house with an architect and are awarding individual contracts. They have to decide between using R-concrete or using conventional concrete and should assume that R-concrete can be used in all applications and that it doesn't differ from conventional concrete in terms of quality or performance. Finally, they are asked to assume that R-concrete is around 10 % more expensive compared to conventional concrete, everything else being equal. Then, a vignette is presented. The vignette describes potential incentives that the client gets when building with R-concrete. These are a financial grant, prioritized treatment of the building permit, free technical support, and promotion. The grant can take the values of 0 % (no grant), 50 %, 100 % and 150 %, describing how much of the additional costs of R-concrete compared to conventional concrete it covers. The other three aspects are binary such that they can only take the values of yes (being provided) or no (not being provided). The following is an exemplary vignette (the variable aspects are highlighted in bold):

> If you build your house with R-concrete, you will receive a **grant, which covers half of the extra expenses** for R-concrete compared to conventional concrete (50 %). Your building permit using R-concrete will **not be treated with priority** by the municipality. You will receive **free technical support** or counsel regarding the application of R-concrete from the municipality. The city will **promote** you and your house (e.g., through an award or a posting on the website or in the newspaper), if you build with R-concrete.

The question following the vignette is how likely participants are to choose R-concrete under these conditions. The answer scale ranged from 0 (extremely unlikely) to 100 (extremely likely).

With four varying aspects, one of which has four levels and the other three have two levels, 32 vignettes can be created. To avoid cognitive fatigue only one vignette was presented to every participant. The study by Auspurg et al. (2009) found that the first judgement is reliable and is confirmed by the following when there are several vignettes per respondent. This result speaks to the validity of presenting only one vignette. The vignettes were chosen according to the principle of drawing from an urn without replacement. This way, every vignette was presented to a roughly equal number of participants.

For details on the pilot study conducted beforehand as well as the survey administration, please refer to Sterk (2023).

3.2 Analysis

The data are analyzed using the following linear regression model:

$$\text{likelihood to choose R-concrete} = \beta_0 + \beta_1 \text{ grant} + \beta_2 \text{ prioritization} + \beta_3 \text{ support} + \beta_4 \text{ promotion} + \beta_5 \text{ information} + \beta_6 z_i + \epsilon$$

where β_0 is the constant, β_{1-5} are the coefficients belonging to the policy instruments, β_6 is an exemplary coefficient for z_i, an individual characteristic of the respondents. Finally, ϵ is the error term. Since we have different subgroups in our sample, we are likely to face heteroscedasticity. The model is conceptualized as an ordinary least squares regression and analyzed using the statistical software Stata. The presence of heteroscedasticity was tested using White's test for homoskedasticity against unrestricted forms of heteroskedasticity (White, 1980). We find different variances of the error term in the regression models that combine all three client groups and therefore apply standard errors robust to heteroscedasticity. These are known as the Huber/White/sandwich estimate of variance (Huber, 1967; White, 1980). Although White's test does not suggest we face heteroscedasticity in other regression models, we apply robust standard errors in all regressions in an effort to be conservative.

4 Results

1587 construction clients took part in our survey, of which 758 completed it. 802 respondents answered the factorial survey. 11, 47, and 42 % of those are developers, organizations, and private individuals, respectively. The groups in our sample are representative of the respective groups in the population of construction clients. For details on the sample, the interested reader is directed to our preceding article (Sterk, 2023).

In the baseline specification with only the policy instruments as independent variables and all three client groups taken together, four of the five instruments have a positive and significant effect on the likelihood to choose R-concrete (see model (1) in Table 1). These are the financial grant, the building permit being treated with priority, free technical support, and information provision. Being awarded or promoted when building with R-concrete does not seem to have any effect in the overall sample. Thus, four (H1.1, H1.2, H1.3, H1.5) of our five hypotheses are confirmed when regarding the entire sample of construction clients. Comparing the general likelihood of the three groups to choose R-concrete, we find our hypothesis (H2) confirmed. Developers as well as organizations are generally more likely to choose R-concrete compared to private individuals. The difference to developing companies is nearly twice as large as that of the difference to organizations: the mean likelihood to choose R-concrete is 12 and 7 percentage points higher for developers and organizations than for private individuals, respectively[3].

Table 1: Regression results of influence of incentives on likelihood to choose R-concrete

	(1) Baseline	(2) Incl. interaction term
Grant	0.203***	0.250***

[3] The groups score values of 62 (private individuals), 69 (organizations), and 75 (developers) on a scale from 0 ("extremely unlikely") to 100 ("extremely likely").

	(0.0180)	(0.0258)
Prioritization	7.221***	7.326***
	(1.949)	(1.943)
Assistance	8.297***	8.188***
	(1.962)	(1.955)
Publicity	1.400	1.646
	(1.956)	(1.950)
Information	6.151**	12.97***
	(1.963)	(3.473)
Information x Grant		-0.0902*
		(0.0358)
Client groups[4]		
Developers	12.28***	12.33***
	(3.094)	(3.077)
Organizations	6.614**	6.805**
	(2.109)	(2.102)
_cons	36.48***	32.83***
	(2.878)	(3.206)
N	802	802

Standard errors in parentheses
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

For the specific mix of market failures at work in the case of R-concrete (environmental externalities and information asymmetry), a combination of a financial incentive and an information-based instrument has been proposed. Information provision has been proposed to be "rather a complement than a substitute to economic policy instruments if one strives for more substantial changes in behaviour" (Mandell & Wilhelmsson, 2011, p. 16). Therefore, we also test the effectiveness of the grant and the provision of information in combination. To do so, we include an interaction term between these two variables in our regression model. Model (2) in Table 1 shows the results. The estimated coefficient is negative, meaning that the effect of information decreases with an increasing grant. Table 2 gives the corresponding marginal effects. As can be seen, respondents who received information and are not offered any grant are almost 13 percentage points more likely to choose R-concrete than respondents who were not offered a grant and did not receive any information. This effect is reduced when information is combined with a grant. Given a grant that covers 50 % of the additional costs of R-concrete compared to conventional concrete, individuals that received the information are 8.5 percentage points more likely to choose R-concrete than those who did not receive the information. The effect declines to 4 percentage points when a grant of 100 % is offered. Finally, at the maximum value of the grant, when the additional costs are more than compensated for, the effect of information seems to vanish completely (and the effect becomes insignificant). In the same way, the marginal effect of a grant is smaller when combined with information than when it is offered alone (0.25 vs. 0.16).

[4] Private Individuals are the base category.

Table 2: Marginal effect of the provision of information at different levels of a grant

Grant	**Marginal effect of information provision**
0 %	12.97***
50 %	8.46***
100 %	3.95+
150 %	- 0.56

When looking at the client groups separately, differences between them become apparent (see Table 3). In the group of developers, all coefficients of the policy instruments show a positive sign, but only the financial grant and information provision have a statistically significant effect on their likelihood to choose R-concrete. Note that in the case of information provision, the coefficient is only marginally significant. In contrast, all instruments have a positive as well as significant effect in the group of organizations. Finally, in the group of private individuals, the financial grant, prioritized treatment, and technical support equally have a positive and significant effect. The coefficient for being promoted or awarded when building with R-concrete even has a negative sign, although this effect is not statistically significant. Including the interaction term of a financial grant and information does not notably change these results. It is only significant in the group of organizations. The results including the interaction term can be found in Table A1 in the appendix.

Table 3: Regression results of influence of incentives on likelihood to choose R-concrete in separate groups

	(1) Developers	(2) Organizations	(3) Private Individuals
Grant	0.200*** (0.0438)	0.164*** (0.0262)	0.246*** (0.0285)
Prioritization	1.778 (5.474)	5.948* (2.754)	9.982** (3.154)
Assistance	7.090 (5.310)	7.359** (2.776)	9.380** (3.160)
Publicity	1.784 (5.507)	5.664* (2.767)	-3.409 (3.160)
Information	10.14+ (5.357)	6.720* (2.789)	4.706 (3.151)
_cons	50.00*** (7.720)	44.74*** (3.868)	34.42*** (4.024)
N	87	378	337

Standard errors in parentheses
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table 4 shows the marginal effects of changes in the policy instruments on the likelihood to choose R-concrete in the overall sample as well as in the separate client groups. Marginal effects are only calculated for the effects that are statistically significant. An increase in the financial grant of 50 percentage points has the biggest effect on private individuals: it increases their likelihood to choose R-concrete by 6 percentage points. This confirms our respective hypothesis (H3.1). The lowest effect, with an increase by 4 percentage points, is found in the group of organizations. Adding the incentive of being treated with priority regarding one's building permit also has a larger effect on private individuals (10 percentage points) than on organizations (6 percentage points). Thus, the responsiveness of the client groups differs indeed (H3.2), with private individuals showing the greatest effect followed by organizations, while developing companies do not seem to respond to a prioritized permitting process. This same pattern, although smaller in size, is observed for the incentive of free technical support (9 vs. 7 percentage points for private individuals and organizations, respectively). This is in line with our expectation that these two groups respond more to this incentive than developers do (H3.3), whose likelihood to choose R-concrete does not seem to be affected by it at all. The incentive of publicity, which was only found to be effective for organizations, increases their likelihood to choose R-concrete by 6 percentage points. This finding only partly confirms our hypothesis regarding this incentive (H3.4), since we also expected developers to respond to it. Finally, being informed has the biggest effect in the group of developing companies (10 percentage points) followed by organizations (7 percentage points) and seems not to be influential in the group of private individuals. Since we expected to find the opposite pattern (private individuals responding most and developing companies responding least to information), our final hypothesis (H3.5) is not confirmed.

Table 4: Marginal effects of changes in the incentives on the likelihood to choose R-concrete

	Overall	**Developers**	**Organizations**	**Private individuals**
Grant (+ 25 pp)	+ 10.16	+ 10.00	+ 8.21	+ 12.32
Prioritization (no/yes)	+ 7.22	–	+ 5.95	+ 9.98
Assistance (no/yes)	+ 8.32	–	+ 7.36	+ 9.38
Publicity (no/yes)	–	–	+ 5.66	–
Information (no/yes)	+ 6.32	+ 10.14	+ 6.72	–

In the discrete choice experiment in our earlier work (Sterk, 2023) we found that the propensity to choose R-concrete over primary concrete is positively influenced by a high valuation of sustainability in construction, feeling responsible for considering sustainability in one's project, and being familiar with R-concrete. Table 5 shows that this result only holds for the case of valuing sustainability in the factorial survey. Ceteris paribus, respondents who ranked sustainability as a criterium in construction higher are more likely to choose R-concrete. Feeling responsible for considering it or being familiar with the material do not seem to influence the choice here.

Table 5: Regression results with individual characteristics in the overall sample

	Baseline
Grant	0.191***

	(0.0179)
Prioritization	7.098***
	(1.951)
Assistance	6.622***
	(1.979)
Publicity	0.649
	(1.949)
Information	5.712**
	(1.969)
Client groups	
Developers	9.808**
	(3.246)
Organizations	4.393+
	(2.250)
Sustainability	0.234***
	(0.0442)
Familiarity	1.766
	(2.077)
Responsibility	3.560
	(2.354)
_cons	19.61***
	(4.216)
N	770

Standard errors in parentheses
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

For the influence of individual characteristics in the separate client groups, the interested reader is referred to Table A2, Table A3, and Table A4 in the appendix.

Finally, we ran a series of robustness checks to validate the results presented above (see Table A5 in the appendix). First of all, the model was run on subsamples that exclude extremely fast respondents based on different criteria. These are provided by the software SoSci Survey (Leiner, 2021). In models (2) and (3), respondents are excluded that have a value of more than 100 and 50, respectively, on the indicator DEG Time. These values represent thresholds above which data can be classified as of lower quality and which denote two different levels of strictness. 46 and 135 respondents are excluded, respectively. Another indicator offered by the software is a relative speed index (Time RSI) and is a more elaborate measure. Using it as an inclusion criterium, 43 respondents are excluded (see model (4)). In model (5), the subsample consists of only those respondents who finished the entire survey, meaning that 46 respondents drop out. Finally, two more robustness checks with respect to the effect of information provision are carried out. They exclude participants who stayed on the information page for an unusually short time. The first criterium applied excludes participants who spent less time on the information page than one standard deviation below the median time spent. This removes 35

participants from the sample. The second criterium is based on reading speed and identifies respondents who are unlikely to have read the entire text in the time they spent on the respective page based on average reading times[5]. This applies to 143 cases. Overall, Table A5 in the appendix shows no meaningful differences between the baseline model and the robustness checks such that the results reported above can be considered robust.

5 Discussion

Our results showed that all tested instruments are effective in increasing the likelihood to choose R-concrete in at least one of the client groups. Only one of the instruments was effective in all three groups: the financial grant. In earlier research (Sterk, 2023) we found that construction clients have a positive willingness to pay (WTP) for recycled aggregates, but that this WTP does not equal the price premium currently seen on R-concrete. Moreover, additional costs were found to be a nontrivial barrier in that study. We saw only very minor differences in the ranking between the groups. Thus, additional costs of R-concrete generally can be considered an issue among construction clients, which explains why a grant covering (a part of) these costs is effective in all three groups. This is also in line with previous research on sustainable construction in finding that financial incentives are a critical driver for clients (e.g., Adams et al., 2017; Pitt et al., 2009).

A prioritized permitting process as well as free technical assistance when using R-concrete was found to be effective only for organizations and private individuals. On the one hand, it is rather surprising that developers were not found to be responsive to a reduction of the processing time for their building permits. Being professional construction clients, they have the highest potential in terms of saved time. On the other hand, however, developers are less dependent on the permit in continuing their work, since they most likely have several construction projects running at the same time. Organizations and private individuals, in contrast, usually only commission a building occasionally or even only once in their life. Thus, every day without a permit is a day that they cannot proceed. Because these two groups are not involved with constructing buildings on a regular basis, they lack the expertise and technical knowledge that developers are likely to have. Therefore, it seems in line with expectations that they are responsive to free technical assistance and developers are not. The incentive of being publicly promoted when using R-concrete was only found to be effective in the group of organizations. We expected this outcome for the same reason that we did not expect it for the group of private individuals: organizations, unlike private individuals, are dependent on their image and reputation for their economic survival. However, this applies to developers, as well. As Diyana et al. (2013) pose in their model of motivation for developers to engage in green building, one important factor is their image. Two motivational aspects are encompassed in this factor: green certifications and awards and recognition. These are considered to increase developers' reputation and competitiveness. Our earlier work (Sterk, 2023) supports this view: developers (as well as organizations) are driven to use R-concrete by its positive effect on their image. It is therefore somewhat surprising that this incentive did not seem to have an effect on developing companies. Ariely and his colleagues found a crowding-out effect of extrinsic motivators such as financial incentives on people's image motivations. In other words, behaving pro-socially out of image considerations can be impeded when being publicly incentivized for that behavior (Ariely et al., 2009). However, if that was the case here, we would expect to find an interaction effect of the promotion incentive and financial grant, which was not the case. It remains an open

[5] A threshold value of 40 seconds was calculated using the upper end of the adult average reading time (350 words per minute).

question to be studied under which conditions image incentives are effective especially for developers.

The final instrument that we tested in terms of its effectiveness is information provision. Again, organizations were positively influenced by the information on R-concrete we provided. An even larger effect of information was found in the group of developers, although we will interpret this with caution since the respective result was only marginally significant. We did not find any effect of information in the group of private individuals. This group is arguably the one least informed about R-concrete. Only around 23 % had heard of the material before participating in the survey (compared to 66 and 64 % in the groups of developers and organizations, respectively). Therefore, we expected to find the biggest effect of information in this group, while the opposite is true. A potential explanation for why the information provision in our study was not effective in all groups is linked to its form and/or timing. Firstly, it is conceivable that other forms of information provision, such as visual material, are more effective than a simple text. Secondly, it could be that the time between receiving the information and potentially acting on it was too short to actually internalize its meaning. Finally, being exposed to the information repeatedly is also likely to have a bigger and more sustained effect. While these reasons would apply equally to all groups, it could be that the groups' different level of pre-knowledge acted as a moderator here. Potentially, our information treatment was not strong enough to affect those clients who were totally unaware of R-concrete before the survey but served as a reminder to those who already had some pre-knowledge. Further research should investigate under which conditions information provision is most likely to be effective and the role pre-knowledge plays in this relationship.

This analysis shows that, in order to optimize efficiency and cost-effectiveness, incentives offered to the different types of clients should be chosen selectively. The exception are financial grants, which would stimulate all clients to choose R-concrete. Beyond that, one could consider offering information to developers and a prioritized permitting process and/or technical assistance to private individuals. Although all tested incentives would increase organizations' likelihood to choose R-concrete, it may not be realistic to offer them all at once. If one must choose, free technical assistance and provision of information are good candidates since they have the strongest effect. Another perspective could be to select client groups to be targeted. If one had to select only one group for a financial grant, choosing private individuals would yield the highest effect size among the three groups. A look at the number of building permits granted to the three groups would support this choice, since private individuals account for roughly 5 times as many permits as organizations and as developers do. However, the floor space and cubic content of the buildings by organizations exceed those by private individuals and developers by far (Destatis, 2022). This is unsurprising when considering that private individuals mainly build one-family dwellings, while organizations construct office buildings or warehouses. An approximation of the amount of concrete used by these groups would be necessary in order to conclude in which group a grant would have the biggest effect in terms of environmental impacts.

In order to tackle the combination of environmental externalities and information asymmetry, a mix of a financial incentive and an information-based instrument is recommended. Interestingly, the provision of information has shown to become less effective with an increasing financial grant. In fact, when a potential grant exceeds the additional costs of R-concrete compared to conventional concrete, information does not seem to have any effect at all on the probability of choosing R-concrete. This finding is contrary to the common expectation that a combination of incentives and information is more effective than the sum of the individual instruments especially in the case of pro-environmental behavior (e.g., Stern,

1999). Rosenow et al. (2016) categorize the interactions of single policy instruments into complementary (the effect of the combination is larger than the effects of the instruments individually), neutral (the effect of the combination is equal to the effects of the instruments individually), and overlapping (the effect of the combination is smaller than the effects of the instruments individually). They state that "information measures have a reinforcing impact on all other policy types" (p. 8), referring to a complementary interaction. One example of such other policy measures the authors name are financial grants, as used in our study. In contrast, we find an overlapping interaction effect. Another study in support of this combination is of Bryan and Kandulu (2011), who develop an optimal policy mix using deliberative multi-criteria evaluation in a case study involving measures against water pollution. According to the authors, a mix is especially promising when the adoption of the desired behavior is impeded by multiple factors, as is the case for the demand for R-concrete. The mix they find to be optimal in their case consists of information provision, followed by incentives and then regulation. This sequence (exempt the regulation) is also present in our study[6], although the time in between the information and the incentive was of course much smaller than it is intended to be in reality. Drews et al. (2020) categorize possible interaction effects of incentives and nudges[7] into *no synergy* equivalent to a neutral interaction by Rosenow et al. (2016), *positive synergy* (equivalent to a complimentary interaction), and *weak negative synergies* (equivalent to an overlapping interaction) and backfire (the effect of the combination is smaller than the effect of one of the instruments individually). The researchers stress that it is only possible to determine which effect is present when all four possible treatments (only incentive, only nudge, no instrument, both incentive and nudge) are tested. Due to the experimental nature of the factorial survey, we cover all possible combinations in our study. Figure 1 shows the results including all three levels of a potential grant. As can be seen, we are dealing with a weak negative synergy, as the combination of the grant and information is larger than each instrument alone but does not equal or even exceed the sum of their individual effects[8]. The authors also offer an explanation for weak negative synergies: crowding out of motivation. As applied to our case, the information in our study offers intrinsic motivation, which is based on environmental consciousness. In contrast, the financial grant is a classic extrinsic motivator. Motivational crowding-out "refers to the idea that a monetary incentive weakens […] any intrinsic motivation an individual has for undertaking an action" (Drews et al., 2020, p. 3). This is supported by the fact that information was found to decrease in effectiveness the higher the financial grant is. Thus, our results suggest that a financial grant tends to diminish the positive effect that environmental consciousness (raised through information about the environmental advantages of R-concrete) has on clients' likelihood to choose R-concrete. Because these incentives, especially a financial grant, is likely to be only offered temporarily, it is important to consider what happens after it is removed. If motivational crowding-out is indeed at work here, it might be the case that the intrinsic motivation does not recover but remains at a lower level (Drews et al., 2020). In line with our finding, Portnov et al. (2018) found a financial incentive to have a negative effect on their respondents' willingness to pay for green building. A crowding-out effect is one of the potential explanations the authors offer. In conclusion, combining a (high) financial grant and information should be carefully considered. This is in line with previous research that advocates for the deliberate coordination of instrument mixes (Bennear & Stavins, 2007; J. Zhang et al., 2019).

[6] Respondents, after being assigned to the treatment or control group, did or did not receive the information text, then completed a discrete choice experiment and then the factorial survey, which presented the other policy instruments. For details, see chapter 3.

[7] Nudges are "interventions in the choice environment to induce behavioural change without reducing freedom of choice or altering economic incentives" (Drews et al., 2020, p. 1).

[8] If the marginal effect of information in the case of a grant of 150 % was statistically significant, we would face backfire. However, because it is not, we are dealing with a weak negative synergy (see Table 2).

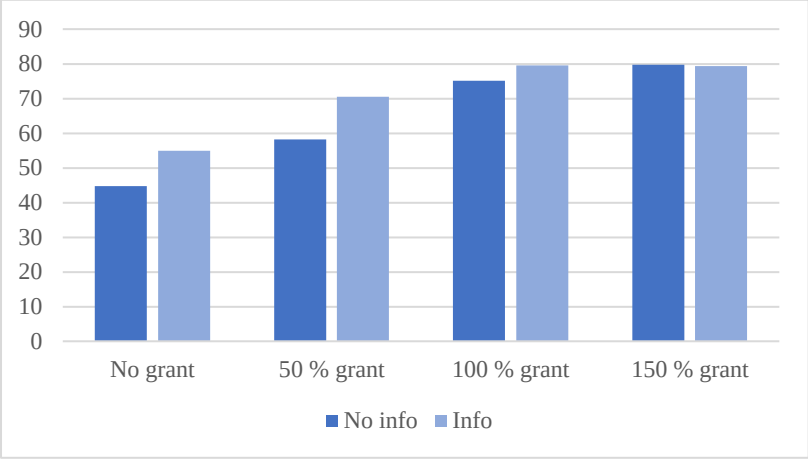

Figure 1: Effects of information provision and financial grants of different extents.

The results regarding differences between client groups suggest that developers and organizations are more likely to choose R-concrete than private individuals are. This is the same pattern that we observed in our earlier work (Sterk, 2023). This difference can partly be ascribed to the differences in the valuation of sustainability as a criterion in construction between the groups. Developers and organizations both have a higher score than private individuals in this regard (D: 74.95, O: 78, P: 68.95) and the differences are statistically significant (D vs. P: $t(419) = 1.9$, $p = .0029$; O vs. P: $t(708) = 4.77$, $p = .000$). Controlling for sustainability renders the difference between organizations and private individuals only marginally significant (see Table 5). However, the difference between developers and private individuals remains strong, even when controlling for familiarity and responsibility. Especially regarding the familiarity with the material, there are substantial differences between these two groups: only 23 % of private individuals, but 66 % of developers had heard of R-concrete before. Nevertheless, this does not seem to influence the likelihood to choose R-concrete (see Table 5). In fact, this is in line with the finding that information provision is effective for developers but not for private individuals. The results suggest that awareness of R-concrete does not influence the likelihood to choose it. This is, however, in contrast to our findings in previous work, where familiarity and responsibility both showed to positively influence the likelihood to choose R-concrete as well as the willingness to pay for it (Sterk, 2023). This suggests that the format of the question might have influenced the results in this regard. Future research should investigate this effect further.

6 Conclusion

R-concrete offers a way to reduce the extraction of natural resources as well as the generation of construction and demolition waste. While construction clients are willing to pay more for recycled aggregates in concrete, there is still a gap between their WTP and the current price premium. Market failures in the form of environmental externalities and information asymmetries are at work here. Therefore, policy instruments are necessary to increase the demand for R-concrete among construction clients. This study set out to investigate which instruments could be effective in this regard. The results show that at least one client group is responsive to each of the tested instruments – a financial grant, an expedited permitting process, free technical assistance, marketing assistance, and information provision. Only a financial grant is effective in all three groups. The recommended combination of a financial incentive and the provision of information is indeed effective but should be implemented with care. The effect of information vanishes once the financial incentive turns into a bonus such that it exceeds

the additional costs of R-concrete compared to conventional concrete. Developers are overall the most likely to choose R-concrete, followed by organizations and then private individuals. Finally, understanding sustainability as an important criterion in construction increases this likelihood.

It has become clear that it is inefficient to offer policy instruments to all construction clients equally (except for the case of a financial grant). Instead, different client groups should be targeted using different instruments. Moreover, a policy mix, especially including a financial incentive and information provision, should be coordinated carefully in order to avoid inefficiencies. Needless to say, the design and provision of policy instruments always depend on the resources the authorized bodies have available. Notwithstanding, the current results might offer some guidance as to where the resources are spent most efficiently. In addition, this study showed that non-financial incentives that involve little to no costs can also be effective instruments to stimulate the use of recycled construction material. The results can serve municipalities to pick the most efficient and cost-effective subset of instruments in their endeavor to support resource-efficient construction.

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Appendix

Table A1: Regression results of influence of incentives on likelihood to choose R-concrete in separate groups including interaction term

	(1) Developers	(2) Organizations	(3) Private Individuals
Grant	0.256***	0.233***	0.260***
	(0.0681)	(0.0374)	(0.0415)
Prioritization	2.402	6.140*	9.974**
	(5.388)	(2.735)	(3.156)
Assistance	7.149	6.999*	9.385**
	(5.329)	(2.752)	(3.164)
Publicity	2.092	5.799*	-3.283
	(5.470)	(2.744)	(3.178)
Information	18.46+	16.54***	6.744
	(9.852)	(4.915)	(5.464)
Information x Grant	-0.111	-0.130*	-0.0269
	(0.0827)	(0.0522)	(0.0574)
_cons	45.36***	39.80***	33.33***
	(9.107)	(4.349)	(4.699)
N	87	378	337

Standard errors in parentheses
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table A2: Regression results with individual characteristics in sample of developers

	Developers		
	(1)	(2)	(3)
Grant	0.200***	0.203***	0.205***
	(0.0438)	(0.0429)	(0.0466)
Prioritization	1.778	1.525	2.280
	(5.474)	(5.512)	(6.521)
Assistance	7.090	4.533	4.821
	(5.310)	(5.302)	(5.953)
Publicity	1.784	3.751	0.789
	(5.507)	(5.264)	(5.766)
Information	10.14+	10.27+	9.253
	(5.357)	(5.418)	(6.277)

Role of sustainability		0.293+	0.289
		(0.151)	(0.174)
Sustainability goals		5.476	6.765
		(6.151)	(7.336)
Founding year			0.0613
			(0.0948)
Yearly turnover			-2.861
			(7.376)
Employees			6.605
			(7.766)
_cons	50.00***	20.47	-103.9
	(7.720)	(20.63)	(180.1)
N	87	84	75

Standard errors in parentheses
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table A3: Regression results with individual characteristics in sample of organizations

	Organizations		
	(1)	(2)	(3)
Grant	0.164***	0.157***	0.157***
	(0.0262)	(0.0266)	(0.0299)
Prioritization	5.948*	5.680*	6.574*
	(2.754)	(2.766)	(3.161)
Assistance	7.359**	6.660*	6.402*
	(2.776)	(2.784)	(3.224)
Publicity	5.664*	5.237+	5.601+
	(2.767)	(2.783)	(3.255)
Information	6.720*	6.023*	6.836*
	(2.789)	(2.812)	(3.268)
Role of sustainability		0.232**	0.185*
		(0.0770)	(0.0847)
Sustainability goals		1.939	3.878
		(3.092)	(3.608)
Type of business			
Non-profit			-2.870
			(5.109)
Public			-4.355

			(5.913)
Founding year			-0.0103
			(0.0160)
Yearly turnover			4.758
			(5.449)
Employees			-3.717
			(5.511)
_cons	44.74***	25.85**	46.32
	(3.868)	(9.924)	(35.41)
N	378	360	286

Standard errors in parentheses
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table A4: Regression results with individual characteristics in sample of private individuals

	Private Individuals	
	(1)	(2)
Grant	0.246***	0.244***
	(0.0285)	(0.0303)
Prioritization	9.982**	10.91***
	(3.154)	(3.277)
Assistance	9.380**	9.031**
	(3.160)	(3.268)
Publicity	-3.409	-3.888
	(3.160)	(3.220)
Information	4.706	5.521+
	(3.151)	(3.244)
Male		-4.406
		(3.281)
Age		4.819
		(3.720)
Graduate degree		7.736*
		(3.558)
Household income		-3.650
		(3.743)
Children		3.824
		(3.651)

_cons	34.42*** (4.024)	30.41*** (5.373)
N	337	309

Standard errors in parentheses
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table A5: Robustness checks

	(1) Baseline	(2) DEG Time 100	(3) DEG Time 50	(4) Time RSI	(5) Finished	(6) Info Time (SD)	(7) Info Time (wpm)
Grant	0.203***	0.204***	0.223***	0.213***	0.202***	0.205***	0.213***
	(0.0180)	(0.0183)	(0.0186)	(0.0180)	(0.0185)	(0.0182)	(0.0194)
Prioritization	7.221***	7.008***	6.814***	7.441***	5.977**	7.766***	7.723***
	(1.949)	(1.993)	(2.037)	(1.974)	(1.993)	(1.979)	(2.143)
Assistance	8.297***	8.059***	8.500***	8.679***	8.312***	8.266***	6.925**
	(1.962)	(2.005)	(2.038)	(1.985)	(2.001)	(1.995)	(2.145)
Publicity	1.400	1.024	1.639	1.632	1.707	1.106	1.348
	(1.956)	(2.002)	(2.033)	(1.976)	(1.996)	(1.989)	(2.150)
Information	6.151**	6.971***	5.608**	5.215**	6.648***	6.774***	8.635***
	(1.963)	(2.011)	(2.046)	(1.990)	(2.002)	(1.984)	(2.150)
Client groups							
Developers	12.28***	10.47**	8.602**	11.68***	10.85***	10.88***	9.709**
	(3.094)	(3.178)	(3.281)	(3.102)	(3.124)	(3.190)	(3.454)
Organizations	6.614**	5.105*	3.756+	5.977**	5.574*	5.644**	5.342*
	(2.109)	(2.174)	(2.217)	(2.142)	(2.159)	(2.148)	(2.316)
_cons	36.48***	38.01***	39.17***	36.81***	37.95***	36.82***	37.03***
	(2.878)	(3.000)	(3.112)	(2.919)	(3.008)	(2.918)	(3.041)
N	802	756	667	759	756	767	659

Standard errors in parentheses
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001