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RESEARCH ARTICLE

Preferences of construction sector professionals for environmentally friendly energy: Testing the embedding effect in contingent valuation

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Abstract – Behavioural economics provides a framework for linking economic and psychological motivations, offering answers to decision-making situations that cannot be explained by the rational consumer model of neoclassical economics. The aim of the research is to identify two cognitive decision biases that arise in the contingent valuation method (CVM) through empirical analysis. The research is a quantitative survey, based on the responses of more than 100 respondents working in the Hungarian construction industry, which reveals the respondents' willingness to pay for energy efficiency investments. Participants were asked to evaluate an environmentally friendly heating system, a solar panel system, and a package combining the two. The results clearly showed the presence of an embedding effect, as the sum of willingness to pay for the separate components significantly exceeded the value of the combined package. This anomaly is consistent with the warm glow effect, which essentially means that one of the main motivating force behind the willingness to pay expressed in the responses is a feeling of moral satisfaction. The paired samples t-test confirmed the statistical significance of the embedding effect ($t(103) = -9.372$, $p < 0.001$), confirming that respondents' decisions were influenced not only by rational financial considerations but also by psychological factors. The results support previous international studies (e.g., Kahneman & Knetsch, 1992; Hoevenagel, 1996; Nunes & Schokkaert, 2003) and provide new empirical evidence for the combined occurrence of the embedding effect which in this context can be interpreted as a combined occurrence with the 'warm glow' phenomenon. The study also highlights that even among professionals with expertise, such as those working in the construction industry, decision-making biases can strongly influence preferences. The conclusions drawn from the research results highlight the methodological limitations of contingent valuation, which stem from psychological factors and decision-making biases and must be taken into account when evaluating environmental goods and developing related policies. Overall, the study contributes to the literature by bridging behavioural and environmental economics, providing empirical evidence on how moral motivation and cognitive biases can jointly distort willingness-to-pay estimates in sustainability-related decisions.

Keywords – embedding, warm glow, contingent valuation, construction sector

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1. INTRODUCTION

Behavioural science has identified roughly 200 cognitive biases that have a significant impact on our everyday decision-making mechanisms (Calikli and Bener, 2018). Behavioural economics is the interdisciplinary field that deals with the factors that influence consumer decisions. The term refers to one of the fundamental principles of the discipline, namely that neoclassical economics is flawed because it lacks relying on the findings of psychology. In contrast, behavioural economics integrates findings from behavioural science or psychology to offer answers to

decision-making situations that cannot be explained by the rational decision-making model of neoclassical economics. The rational consumer is therefore "not the only consumer" who makes decisions in certain situations and, logically, often comes into conflict with the consumer in behavioural economics, who is influenced by numerous decision-making biases (Varian, 2012).

The aim of this research is to identify and confirm the embedding effect, and to explore the 'warm-glow effect' as a potential explanation for this phenomenon. Cognitive decision-making errors have been identified in a quantitative study involving ecosystem assessment among more than 100 respondents working in the Hungarian construction industry and traced them back to behavioural economics phenomena. (The survey included some additional questions on environmental valuation of ecosystems and related willingness to pay, which were analyzed in a separate analysis.) This sector was selected because questions on willingness to pay (WTP) focused on improving the energy efficiency of residential buildings, and professionals working in this sector can therefore be considered a well-informed, professional sample for the subject.

Household energy consumption is a major contributor to global carbon dioxide emissions, accounting for approximately 26% of global energy-related emissions (IEA, 2024), thereby acting as a primary driver of climate change and associated ecological problems. The green energy investments examined in the study, such as energy-efficient heating and solar panels, are key to mitigating these effects. The use of these technologies directly contributes to reducing the use of fossil fuels, mitigating the ecological footprint of households, and promoting the achievement of broader environmental goals. Therefore, it is important to understand the decision-making mechanisms that motivate or hinder the implementation of these pro-ecological investments.

2. LITERATURE REVIEW

Behind the economic and psychological analysis of environmental problems lies a more fundamental phenomenon: the alienation between humans and nature. One key means of reducing this alienation is to raise awareness of and promote pro-environmental behaviour, which is not only a technical issue but also an ethical and cultural one (Arthi and Bhuvaneswari, 2023).

In environmental economics, environmental degradation appears as a negative externality, as an anthropogenic impact caused by a third party. It is an impact that is not intentionally caused by the polluter and, due to its nature, does not appear as the economic value of the damage, and therefore no compensation is paid for the environmental damage. According to Málovics (2009), this approach is based on determining the monetary value of nature at a given moment. Environmental economics uses the tools of economics to put a practical price on unintended environmental impacts (externalities) because they are highly effective.

These tools are necessarily based on the monetary valuation of nature and cost-benefit analysis. They can be obtained through quantitative analyses, which serve to determine and interpret the preferences of stakeholders at a given moment. The methodology and applicability of environmental valuation are disputed by ecological economics. The doubts arise from two different reasons: one is the difficulty arising from the unique nature of ecosystems and, again, our knowledge available at a given moment in time, and the other can be traced back to social causes. (Málovics, 2009)

The monetary valuation of the environment can be performed using environmental valuation methods, which help reveal the value of use to consumers and in some cases non-use values as well. Marjainé et al. (2005) outlined the theoretical background and procedures applicable in Hungary in a comprehensive methodological guide, focusing on the total economic value framework, with particular emphasis on use value and non-use value.

In this study, respondents' individual preferences have been examined through their hypothetical market behaviour. The hypothetical nature appears twice in the contingent valuation: the consumer hypothetically pays for the good in question in an imaginary situation on a fictitious market. Their disadvantage, apart from their hypothetical nature, is that although they are capable of estimating non-use values, the validity of the results obtained is strongest when the asset under consideration has a clearly identifiable use value that is relevant to the respondent and supports the decision-making. (Szlávik, 2006)

According to Szlávik (2006), when an economically unquantifiable benefit is ignored, this can lead to distortions in the results. As a result, we cannot say with certainty that the value of natural capital, converted into monetary costs, is equal to the benefit or return to the consumer. (Csigéné, 2007, 2022; Torma, 2025)

Among the range of valuation methods based on stated preferences, contingent valuation is a widely used method. It is also referred to as a direct method, as it involves directly asking individuals how much they would be willing to pay for an environmental good or how much compensation they would accept for its loss. In this study, willingness to pay for the modernization of a heating system is measured among 104 respondents working in some segment of the construction industry.

The responses are typically influenced by factors such as place of residence, age, income level, and education. Various distorting effects or biases may arise when using the contingent valuation method. In such cases, respondents may consciously or unconsciously fail to indicate their actual willingness to pay, which may lead to further distortions in the survey. In another case, participants may categorically refuse to express the value of ecosystems in

monetary terms, which may be due to a number of factors explained later. The order of the questions, the motivation of the respondent, and their presumed knowledge or lack of information thereof may also cause bias.

Behavioural science and economics are linked to environmental valuation through the biases that occur during contingent valuation. The methodology of contingent valuation is particularly sensitive to these biases, since in a survey, in our case when asking about willingness to pay, the respondent hypothetically pays for the good in question, and at that point makes decisions that are not only based on rational reasons, but are often influenced by psychological and moral motivations. These influences are already addressed by behavioural economics. In the following, I will list the biases that may occur among the cognitive biases of behavioural science when evaluating the monetary value of a good.

In an earlier study (2003), Dupont divided respondents into three groups according to their relationship to the asset in question when examining the embedding effect. Those who had no connection, for example, did not use the asset in question, were more influenced by the order. The type of the questions also requires careful consideration when designing them. Open-ended questions can provide more precise values, but closed questions can reduce bias attributable to protest respondents, as the latter typically have a higher response rate (Halstead et al., 1992). At the same time, according to Bartus and Szalay (2014), closed questions are associated with a more cautious willingness to pay, especially if, in the event of a negative response, the interviewer continues to ask about lower prices until the respondent finally accepts it. However, the response is extremely sensitive to the opening value (Csigéné, 2007, 2023; Bartus and Szalay, 2014). Flachaire and Hollard (2007) linked and jointly examined starting point bias with respondents' uncertainty about their willingness to pay. Their main finding is that respondents who are uncertain about their willingness to pay are more likely to say yes to the amount offered in a closed question.

Anchoring bias occurs when predetermined response options influence respondents' decisions (Szlávik, 2013). It also matters whether we ask about the respondent's willingness to accept compensation or their willingness to pay. In the former case, the number of positive responses may be many times higher than in case of willingness to pay, even if there is no income limit. The difference between the two values decreases the more the question is market-oriented and refers to goods that can be easily expressed in monetary terms.

When comparing willingness to accept compensation and willingness to pay, a characteristic behavioural economic phenomenon can be observed, which is the loss aversion: the psychological pain of losing something is stronger than the pleasure of gaining it. For this reason, consumers expect much higher compensation (WTA) when selling an asset, they own than they would be willing to pay (WTP) to purchase it (Kahneman-Knetsch, 1992).

The US National Oceanic and Atmospheric Administration's panel (NOAA Panel) has also made recommendations on how to phrase questions, as framing effects are a fundamental cognitive decision-making bias (Levin et al., 1998; Homar and Cvelbar, 2021). The committee was established to examine and develop the methodological application of contingent valuation. Despite the advantages of open-ended questions, experts believe that mixed questions (open and closed ended) are the most effective for ecosystem valuation (Monostori, 2007).

Flachaire and Hollard (2007) assume that individuals do not have a single willingness to pay, but rather a range of values that are acceptable to them. Their extent of the effect is well represented by the devaluation of the individual components. The statistically confirmed average of the individual components and the average of the combined package show the implicit willingness to pay for the parts, and through this, the regular embedding examined by Hoevenagel (1996).

This methodology helps to evaluate non-market goods due to their intangible nature. The results obtained using the developed model prove that respondents tend to give positive answers to closed questions even in the presence of the aforementioned uncertainty. The rationale behind this way of thinking is "coherent arbitrariness" (Ariely et al., 2008), according to which preferences are only fluid at first, but later become fixed and anchored, no longer dependent on external influences. Arbitrariness here refers to the fact that when faced with a new situation, we often base our decisions on irrelevant information, like an anchor. After that, our decisions become coherent, as they are made in line with this anchor. Ariely et al. (2008) calls this the phenomenon of self-referentiality, in which one's own previous behaviour becomes a reference point that the individual considers rational. From this, a seemingly stable system of preferences emerges on an originally random basis, suggesting that evaluations are based on genuine internal values.

Moral motivation is a common cause of bias in responses. In their article, Basu and Srinivasan (2021), similarly to Szabó (2011), cite morally motivated behaviour as a reason, whereby respondents set their willingness to accept compensation higher in the case of public goods in order to prevent damage. Respondents may therefore tend to overestimate or underestimate their willingness to pay depending on how they assess the impact of their response on actual payments or decision-making. They may overestimate if they believe that expressing a higher willingness to pay will increase the likelihood of their preferred environmental program being implemented. They may also underestimate their actual willingness to pay if they associate the program's outcome with higher taxes or costs which they would like to prevent. In this case, strategic

behaviour can be assumed, leading to strategic bias. (Szlávik, 2006)

Another reason for the influence on decisions, which can also be traced back to moral reasons as discussed above, is the effect of warm glow, which is a well-known phenomenon in economics. It often happens that respondents want to do the right thing and therefore hypothetically pay more than they are actually willing to pay. It refers to the moral satisfaction or personal benefit that an individual derives from giving, regardless of the outcome, i.e., classically, regardless of whether the amount of public good actually increases. In this case, according to Nunes and Schokkaert (2003), the individual's contribution is present twice in the utility function: once as a contribution to the increase in public welfare and secondly as private welfare, as a feeling of satisfaction. In their article, they examined willingness to pay for a national park in Portugal and the impact of biases arising during the valuation. The warm-glow effect was clearly evident in the scores related to motivations, and its effect was empirically confirmed. The satisfaction of the research participants did not increase with the amount of money “spent” per unit. This suggests that subjects who are subject to this bias have a predetermined framework, albeit not in relation to the amount spent on protecting the ecosystem, but in relation to the degree of satisfaction caused.

After all, the more we spend on one good, the less we have left for others. This predefined interval is a phenomenon that has also been confirmed in other studies about biases. At this point, we can draw parallels with Ariely's (2017) concept of "mental accounting" or opportunity costs. Ariely argues that at the beginning of each month, all consumers have a financial plan in mind for how much they will spend on everyday expenses such as food, clothing, rent, utilities—and in our case, charity, or environmental protection. This also confirms that consumers have a predetermined budget for their willingness to pay.

Responses based on satisfaction are less unconscious than we might think at first glance. In a study conducted in 2013, respondents were asked follow-up questions about their willingness to pay for the protection of a Natura 2000 protected wetland in Greece. Of the five possible reasons, the researchers clearly attributed three to the "warm glow" effect: moral satisfaction, a general willingness to protect the environment, and a sense of personal responsibility (Grammatikopoulou and Olsen, 2013).

In addition to moral satisfaction, classic economic incentives also point in a similar direction. Since Pigou's economic incentives (1920), we have known that even a lower tax or a minor restriction on polluters shifts the emission function towards a socially efficient level. Following this logic, we must not forget consumer habits that are primarily driven by financial and material considerations but have the unintended effect of reducing pollution. (Bain et al. 2016) Similarly, environmental efforts should not necessarily be considered "greenwashing" in the social responsibility of a highly polluting company, even if the impact of the sustainability activity is significantly smaller than the external costs of the polluting activity. In fact, it is the task of experts to draw consumers' attention to the positive environmental side effects of considerations made with the hope of economic impact.

However, this does not mean that decisions are made solely on rational grounds. In environmental communication, it is precisely emotional and subconscious influences that become decisive, and it is by building on these that it becomes possible to influence consumer behaviour. According to Jerit et al. (2024), it is worthwhile to build communication that relies on internal, emotional rewards to raise environmental awareness of. The warm glow effect can help experts in this regard and promote the effectiveness of subsequent interventions (Jerit et al., 2024). Halvorsen (2004) relates to this finding, but on a more general level: at the household level. According to the author, the volume of recycling in households can also be increased and encouraged by triggering feelings of consumer satisfaction.

Other authors, such as Mallett (2012), argue that guilt is also a strong motivating force that can be used in communication to highlight the consequences of consumer actions. If we start from the premise that emotions associated with environmental protection form a bridge between knowledge and action, this also explains why it is important to use them in environmental communication. (Carmi et al., 2015)

However, these theoretical assumptions may encounter serious obstacles in practice. Csutora (2012) points to the problem of the behaviour impact gap, whereby there is not always a significant relationship between environmentally conscious behaviour and its actual environmental benefits. The problem outlined above is a widely debated phenomenon in relation to consumer attitudes. According to Csutora (2012), socio-economic factors such as income have a much stronger influence on environmental impact than conscious, "green" actions. Environmentally conscious behavior is often limited to marginal activities with little impact, and its potential positive results can be offset by other consumption decisions or external factors.

Kollmuss and Agyeman have previously (2002) examined the external and internal barriers that prevent willingness to consume and live sustainably from translating into action. They found that there is no single, simple explanation or model that can explain the gap between environmentally conscious attitudes and actions. Bamberg and Möser (2007) interpret environmentally conscious behaviour as a causal chain, which the model actually explains as "the emergence of action", without addressing the effects it causes. The starting point is altruism and knowledge, with control and personal norms also playing a role.

However, all these considerations lead to another phenomenon that is perhaps most characteristic of the contingent valuation methodology: the embedding effect. The embedding effect appears as an independent bias in

contingent valuation, but it becomes clear in the following that it may be partly motivated by the warm glow effect. Empirical research focuses on analyzing this phenomenon because embedding fundamentally calls into question the validity of the methodology used to measure willingness to pay.

According to Venkatachalam (2004), the phenomenon of embedding means that the willingness to pay (WTP) for a given good can vary widely depending on whether the good is valued on its own or as part of a broader package. Numerous sources seek and find evidence of the effect of embedding in contingent valuation. One example is Desvouges et al. (1993), who in their experiment found the same willingness to pay among respondents for saving 200, 20,000, and 200,000 bird species. Marjainé (2001), based on Hoevanagel (1996), distinguishes two types of embedding. Perfect embedding occurs when a specific good receives a similar willingness to pay as a larger good that includes it, while the regular embedding is when the willingness to pay for a given asset is lower when derived from the willingness to pay for a more comprehensive asset than when it is valued on its own.

Riganti (2022) argues that the severity of embedding bias depends largely on the nature of the good in question. According to Riganti, this cognitive bias is less problematic in the case of cultural goods, as respondents consider cultural heritage to be less substitutable. Similar to the research by Baldin and Bille (2024), it can be assumed that embedding is not always the result of cognitive decision bias. In their article (2024), they explain the reality that the local museum is indeed more useful to the respondents than all Danish museums combined.

While in the case of warm glow we saw that respondents' decisions are often influenced by unconscious, emotional factors, the embedding effect is often attributed to conscious, rational interpretation. Randall and Hoehn (1993) entered into a scientific debate with the earlier authors in their article. In defense of the CVM methodology criticized by Kahneman and Knetsch, the authors argue that embedding is a general economic phenomenon based on scarcity and substitutability. This classical economic approach is reinforced by Jacobsen and Hanley (2009). They point out that the marginal utility of environmental goods decreases as a function of substitute goods and income, and thus also the willingness to pay for them. Randall and Hoehn, on the other hand, argue that embedding as such is not a distorting effect, but a relevant economic condition to which the value of goods must be adjusted. They point out that due to the limited income of households and the substitutability of goods, a reduction in the value of a program is necessary if it is presented to consumers as part of a larger package.

The combined examination of the distorting effects of warm glow and embedding is common in the literature on the limitations of contingent valuation despite the fact that they can be interpreted as separate distortions. This duality—the emotional motivation of warm glow and the rational economic explanation of embedding—suggests that the two biases may reinforce each other in influencing willingness to pay.

According to Bishop (2018), the warm glow effect is most prevalent in voluntary donations. As soon as taxes are imposed, people feel much less satisfaction and the distorting effect "warm glow" diminishes. Kahneman and Knetsch (1992) have previously addressed the relationship between moral satisfaction and the embedding effect in perhaps the most influential critique of contingent valuation. In their study, the authors point out that respondents do not purchase goods, but rather the good feelings associated with doing "good deeds". They attribute the effect of embedding to the same phenomenon: as previous articles examining various biases have shown, satisfaction is not an "indivisible good" in this case either. With a slight exaggeration, it can be stated that respondents do not differentiate between protecting a smaller lake and protecting the wildlife of several larger lakes, nor do they feel greater satisfaction from the latter. This is because, as lay respondents, they are not actually assessing the value of the lake but rather expressing their willingness to pay for environmental protection. In their research, participants assign the total amount they are willing to pay to the smaller good in itself. Later, however, as part of a larger "protection package," they associate their willingness to pay with the previous smaller asset. Diamond and Hausmann (1994) agree with scholars who reject direct valuation due to the embedding effect, also because of the phenomenon attributable to the warm glow effect.

Recognizing the occurrence of warm glow and embedding effects as methodological errors in contingent evaluation, it became necessary to eliminate them as thoroughly as possible.

According to Marjainé (2001), contingent ranking may be a solution to eliminate the embedding effect that occurs in contingent valuation. In this case, respondents are not asked to state their willingness to pay directly, but to rank the goods or scenarios according to their preferences. Choice modelling is another method for dealing with distortions. Baldin and Bille (2024) used an advanced statistical method to separate truly biased respondents from those who were rational but had different preferences for some reason. This is hidden class modelling, The essence of this approach is that respondents are not treated as a homogeneous group, but rather statistically distinct subgroups ("classes") are identified based on the patterns revealed by their responses.

The warm glow phenomenon is difficult to isolate and verify using statistical tests. A study by Crumpler and Grossmann (2008) points out that in real life, even in a questionnaire survey, it is almost impossible to separate genuine willingness to pay from altruism. Although according to Rolfe et al. (2000), if the good is broken down into attributes and respondents are forced to compromise on the weighting of each attribute, the warm glow effect can

also be mitigated. Another solution, if we do not want to deviate from the contingent valuation methodology, is to provide an accurate and comprehensive description of the good we want to valuate (Brown et al., 1995; Csigéné, 2008). However, according to Krajnyik (2008) and Kovács (2018), too much information or perfect information can also lead to bias in a questionnaire survey.
Since it is common for several biases to occur simultaneously, the presence of one should imply an investigation of other related influencing factors and biases. Almost all of the cognitive decision-making errors listed above can be traced back to the same source, which is the "framework" in which the question is presented to the respondent.

The factors listed above, which cause bias in case of contingent valuation, interact with numerous other psychological, behavioural, and social factors to influence the decisions made.

The examination of embedding bias is primarily related to public goods and hypothetical environmental products, with little empirical evidence available in relation to construction investments. However, energy efficiency decisions in this sector are of particular economic and environmental importance, so it is justified to test the validity of distortions in this sample in our research. According to the hypothesis, respondents' willingness to pay for individual components of energy efficiency investments (heating modernization, solar panel installation) is significantly higher than their willingness to pay for a combined package, which can be attributed to the embedding effect.

The following table presents the most important conclusion of the literature review focusing on the two most prominent biases: embedding effect and "warm glow" effect.

Authors, year of publication, geographical scope are also presented in Table 1 below.

Table 1 Literature Review of the Embedding and Warm Glow Effects in Contingent Valuation Studies

Author(s)	**Year**	**Cognitive bias examined**	**Geographical scope**	**Subject**	**Context and findings**
Baldin & Bille	2024	Embedding effect	Denmark	Museums	Embedding is not necessarily the result of cognitive bias; local museums may actually be more useful to respondents than all Danish museums combined.
Bishop	2014	Warm glow effect	N/A	Donations vs. taxes	The "warm glow" effect is more significant in the case of voluntary donations, while in the case of taxes, satisfaction is much lower, so the effect is reduced.
Crumpler & Grossman	2008	Warm glow effect	Minnesota (USA)	Red Cross donations	The warm-glow effect was tested on Red Cross donations. They found that in real life, even in questionnaire surveys, it is almost impossible to separate genuine willingness to pay from altruism.
Desvousges et al.	1993	Embedding effect	Georgia (USA)	Migratory birds	Respondents showed the same willingness to pay to save 200, 20,000, and 200,000 bird species, which is a classic example of the embedding effect.
Diamond & Hausmann	1994	Embedding effect	N/A	General CVM criticism	Due to the embedding effect, the authors reject direct methods.
Dupont	2003	Embedding effect	USA/Canada	Improving water quality in Great lakes	The order of questions and the embedding effect have a greater influence on the responses of respondents who have no connection to the product being examined.
Grammatikopoulou & Olsen	2013	Warm glow effect	Greece	Natura 2000 wetland protection	When examining willingness to pay, three of the explanatory factors were clearly linked to the "warm glow" effect: moral satisfaction, general environmental attitude, and a sense of personal responsibility.

Hoevenagel	1996	Embedding effect	Netherlands	Preservation of grasslands and forests	Determines the difference between perfect embedding and regular embedding.
Halvorsen	2004	Warm glow effect	Norway	Household recycling	Warm glow can enhance the attitude and motivation for household recycling without involving any financial motivation factors.
Jacobsen & Hanley	2009	Embedding effect	Scotland	Nature goods	The reduction of marginal utility depends on substitutability and income. This determines embedding effect.
Jerit et al.	2024	Warm glow effect	USA	Communicatio n about protecting the environment	Warm glow can increase the effectiveness of environmental messages and voluntary participation.
Kahneman & Knetsch	1992	Warm glow effect	Canada	Common goods	Respondents are not „buying" public goods, but rather the good feeling that comes with „doing good," moral satisfaction.
Marjainé	2001	Embedding effect	Hungary	Hungarian eco-systems	Determines the types of embedding effect. The author gives a solution for the phenomenon which is the contingent ranking method.
Nunes & Schokkaert	2001	Warm glow effect	Portugal	National parks	The individual's contribution appears twice in the utility function: once as an increase in public welfare, and secondly as private well-being, or a feeling of satisfaction.
Randall & Hoehn	1993	Embedding effect	N/A	Embedding as a general economic phenome-non	Embedding is a general phenomenon in economics based on scarcity and substitutability and is not necessarily the result of cognitive bias.
Riganti	2022	Embedding effect	Italy	Cultural goods	According to Riganti, embedding as a cognitive bias is less problematic in the case of cultural goods, as respondents consider cultural heritage to be less substitutable.
Venkatachalam	2004	Embedding effect	N/A	N/A	He defines the embedding effect as the phenomenon whereby willingness to pay (WTP) for a given good can vary depending on whether the respondent evaluates the good on its own or as part of a broader package.

Source: own compilation, 2025

3.METHODOLOGY OF PRIMARY RESEARCH

The research methodology consisted of a review of the literature and a quantitative questionnaire survey. The questionnaire was administered in April 2025 among employees in the Hungarian construction industry under the title "The relationship between sustainability in the construction industry and biodiversity."

The main objective of the research was to identify and empirically examine cognitive decision-making biases arising in the contingent valuation methodology. Accordingly, the sampling strategy was based on targeted but non-representative sampling, which, however, did not pose a methodological constraint in view of the research objective. The criterion for the group of respondents was that their workplace was related to the construction industry. The expectation was to examine a group of experts who were well versed in the subject as private individuals and who completed the questionnaire as individuals and not on behalf of their company or workplace, as the aim of the research was to determine individual preferences.

The questionnaire was created online using Google Forms and the responses arrived between the 3rd of March to the 4th of April 2025. Totally 245 experts were contacted by e-mail. A total of 104 responses were received for the survey, resulting in a response rate of 42.4%. The questionnaire consisted of 36 questions, mostly multiple-choice and decision-making questions in alternating order. In some cases, it was possible to justify the answer as a personal opinion. In the case of general demographic data, e.g., when specifying gender and income level, it was possible to refuse to answer, which many respondents did in the case of questions related to income.

Sixty-three percent of respondents were men, and in most cases, their household's net monthly income per capita fell

between HUF 350,000 and HUF 500,000. In terms of place of residence, the capital city was the most common, along with privately owned apartments. Among those employed in the building industry, a high proportion were engineers (47%), employees of real estate construction companies (17%), professional service providers, and consultants (13%), and finally NGOs and higher education employees (6%). The largest number of questionnaires (37) were completed by managers, who make up almost 36% of the sample. They are followed by those working in professional positions, who make up 33% of the sample, and finally by sole traders (16%) and middle managers (15%).

The questions on willingness to pay focused on the energy consumption of residential buildings, so the selection of the sample group is well justified by the group of professionals working in the construction industry.

Respondents were asked to state their willingness to pay (WTP) for three distinct scenarios: (1) installing a new, environmentally friendly heating system, (2) installing a solar panel system, and (3) a combined package including both. Instead of open-ended values, participants selected from predefined price intervals tailored to the expected market costs of the investments, ranging from 0 HUF up to over 8,000,000 HUF.

The questions asked in the questionnaire are not only used to measure consumers' willingness to pay and accept compensation but are also suitable for measuring other environmentally conscious attitudes, the results of which will be interpreted later and form the basis for other researches.

Initially, a pilot test was conducted to formulate the questions in a more understandable way. During this process, the original questionnaire was tested on a smaller sample of four items. The aim was to collect feedback in order to refine the comprehensibility of the questions, and a few editorial errors were also corrected.

Where multiple answers were allowed for certain questions, the number of answers was maximized.

A significant interpretability problem arose in the case of the question asking about household income, which originally read as follows:
"Which of the following ranges best reflects the approximate total net monthly income per capita of the household? (...)"

Feedback revealed that it was not clear to respondents what type of household was being referred to: an average Hungarian household, the respondent's own income, or the household in which they lived. Accordingly, the question was clarified as follows:
"Which of the following ranges best reflects the approximate total net monthly income per capita in your household?"

The results of the pilot test confirmed that the questionnaire was suitable for measuring the phenomena to be analyzed.

4.RESULTS AND DISCUSSION

In the survey, we tested respondents' payment preferences in relation to the development of an energy-efficient heating system using three different questions. The questions and the distribution of responses can be seen in Figures 1-3 below. The vertical axis shows the intervals of willingness to pay, while the horizontal axis shows the number of responses for each interval in each diagram.

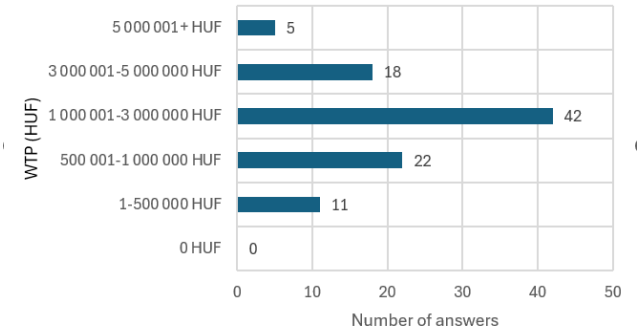

Figure 1: How much would you be willing to spend on installing a new, environmentally friendly heating system in your home? (Source: own compilation)

The first figure shows that most respondents (around 42) would spend between HUF 1,000,001- and HUF 3,000,000 on installing a new, environmentally friendly heating system.

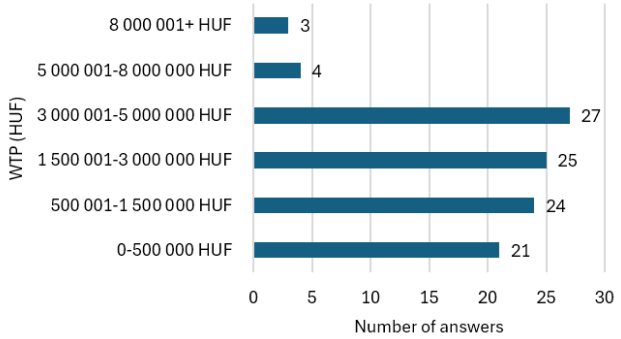

Figure 2: How much would you be willing to spend on installing a solar panel system in your home? (Source: own compilation)

In the second figure, we asked respondents about their willingness to pay for solar panels. Compared to the previous figure, the responses here are more evenly distributed. Most respondents would be willing to pay between HUF 3,000,001 and HUF 5,000,000 to have a solar panel system installed in their home. The ranges below this were also popular among respondents, suggesting that there is no single, clearly preferred range for respondents.

Figure 3 shows the payment preferences for the package that includes combined energy modernization. The distribution peaks in the range of HUF 1,500,001–3,000,000, which 32

respondents indicated as their willingness to pay. The more concentrated distribution is consistent with the independent evaluation of the heating system (Figure 1) and shows a marked difference compared to the wider spread of preferences given for solar panel systems.

The main hypothesis of the research was to statistically verify the presence of the embedding effect, which phenomenon is not only a methodological bias, but also influences the economic interpretation of the evaluation, therefore its statistical testing is justified. The embedding effect can be tested classically by comparing the sum of the willingness to pay for the parts with the willingness to pay for the complete heating modernization package. To analyze the results, we performed a hypothesis test using a paired t-test. The data was prepared in Microsoft Office Excel, and statistical analysis—including paired t-tests—was performed using IBM SPSS Statistics 30 software.

Table 2 summarizes the descriptive and inferential statistical results of the test.

The average of the components, i.e., the sum of the willingness to pay for heating modernization and solar panel systems (M=4.3582, SD=3.16645), significantly exceeded the average willingness to pay for the combined package (M=2.5120, SD=1.78600).

The t-test showed a highly significant result (t103=-9.372, p< 0.001).

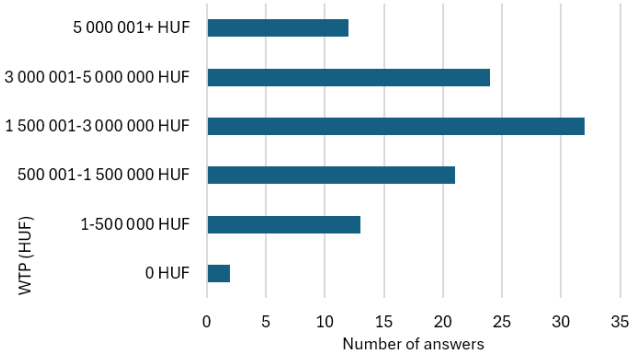

Figure 3: How much would you be willing to spend on installing a new, environmentally friendly heating system if it were part of a comprehensive green energy development project that included a solar panel system? (Source: own compilation)

Table 2 Outcome of T-test

Variable	Average (million HUF)	Standard deviation (million HUF)	t-value	df	p-value
Combined package	2.5120	1.7860	-9.372	103	< 0.001
Sum of components (heating system + solar panel)	4.3582	3.16645			

Source: own compilation

The alternative hypothesis was thus accepted, as the result clearly indicates the presence of an embedding effect: respondents are willing to spend much more on the sum of individual elements of modernization than on the combined package. The null hypothesis, according to which there is no significant difference between the two values, can be rejected.

The extent of the effect is well represented by the devaluation of the individual components. The statistically confirmed average of the individual components and the average of the combined package show the implicit willingness to pay for the parts, and through this, the regular embedding examined by Hoevenagel (1996).

This can be traced back to the strategic bias mentioned above, which, according to Mitchell and Carson (1989), is more observable—in the case of the Danish article (Baldin-Bille, 2024), due to local interest—while in our case it can be attributed to direct involvement. Thus, if the respondent prefers solar panels over heating systems for some reason, they will be directly affected by the overvaluation of solar panels.

The results also suggest a hypothesis where a group motivated by a warm glow effect might exist, consisting of those who experience the classic embedding effect. Under this interpretation, a “rational” group interested exclusively in solar panels would likely be distinct from those interested exclusively in energy efficiency, based on different motivations, which could be explored further with additional questions.

The embedding effect demonstrated by the results may suggest the influence of the warm-glow phenomenon. When confronted with the first question, respondents might not only price the technology itself, but also the feeling that by investing in energy-efficient, more sustainable heating solutions, they can do something themselves to contribute to a “cleaner planet.” The first "purchasable" option is sufficient to satisfy this desire. Therefore, by the time respondents reach the third, combined question, it is possible, that they have already mentally exhausted their "budget" for satisfaction, allowing the rational consumer to “emerge.” The willingness to pay given in response to this question is then plausibly based on realistic financial considerations.

From another perspective, based on Ariely and Kreisler (2017), we can infer the phenomenon of “mental accounting” from the responses. Heating is considered a necessary expense for consumers and is based on prudence.

In contrast, the willingness to pay for solar panels can be considered a more emotional decision, a kind of "status-related green investment". Therefore, when consumers are asked about the two goods separately, they account for them in two different mental accounts, but in the third question, they are forced to spend from a third, "major investment" account, which is clearly associated with higher costs. At this point, they are confronted with the real alternative cost of their decision, which they are not forced to consider when the costs are sharply delineated. A new factor thus seems to enter the decision-making process: renunciation.

The individually stated higher willingness to pay can also be traced back to the behavioural impact gap described by Csutora (2012): although consumers are willing to contribute to environmental protection, the drastic decline in willingness to pay in response to the third question reveals that this intention is not necessarily put into practice.

5.CONCLUSION

The primary objective of the research was to overview relevant literature and empirically examine the embedding effect and its underlying causes among Hungarian construction industry professionals in the context of cognitive biases occurring during contingent valuation (CVM). The hypothesis that respondents would show a higher willingness to pay (WTP) for separate components of energy-saving investments (heating modernization, solar panels) than for a package containing both was confirmed. The results of the paired t-test ($t(103) = -9.372$, $p < 0.001$) clearly and highly significantly confirmed this assumption. The research empirically confirmed the significance of the embedding effect in the contingent valuation of energy efficiency investments.

This result supports the widespread view in the literature that, contrary to the rational decision-making model of neoclassical economics, cognitive decision biases influence economic decisions in practice.

The drastic devaluation of components in terms of willingness to pay illustrates the phenomenon of "regular embedding" first described by Hoevenagel (1996). Based on the results, the "warm-glow" effect assumed in the research as the psychological mechanism is consistent with the phenomenon This interpretation suggests that respondents may not have performed rational summation of the components but instead "exhausted their mental framework" for moral satisfaction by "purchasing" the first good deed.

This supports the view that, contrary to the neoclassical economic model, cognitive decision-making biases, such as the presumed warm glow effect in the present study, can have an influence on economic decisions in practice.

Contingent valuation as an environmental valuation tool is therefore highly questionable due to its methodological limitations. The biases identified suggest that CVM results reflect the general attitude of the population towards environmental protection and their willingness to donate rather than the precise economic value of a specific good. (Kahneman and Knetsch, 1992)

Emphasizing the limitations of the research, it can be stated that the analysis was based on a specific, non-representative sample (Hungarian construction industry professionals), so the generalizability of the results is limited. Nevertheless, it is exactly the professional nature of the sample that makes the results particularly interesting, as it shows that these cognitive biases can be strongly prevalent even among a highly educated group with expertise on the subject.

These potential errors and their elimination raise new research questions, some of them already targeted by earlier empirical studies. One promising direction for future research could be the application of hidden class modelling to our sample, as suggested by Baldin and Bille (2024), in order to statistically separate the rational and "warm glow" motivated respondent groups. In addition, it would be worthwhile to examine CVM supplemented with alternative methods, such as choice modelling or contingent ranking, to obtain an even more nuanced picture of the complex process of environmental goods' valuation. The research shed new light on the "price of good intentions", lending support to the view that this price is not solely the result of rational considerations but is also influenced by complex interplay of psychological motivations and cognitive biases.

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