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ALLEVIATING BIASES IN INFRASTRUCTURE DECISIONS FOR SUSTAINABILITY: A SUMMARY OF FIVE EXPERIMENTS AND A CALL TO ACTION FOR THE ENGINEERING PROJECT MANAGEMENT RESEARCH COMMUNITY

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ABSTRACT

By blending theory from behavioral science and infrastructure project planning, we studied whether interventions to the choice structure of an infrastructure planning tool could alleviate biases in decision making for infrastructure planning about sustainability. We empirically tested interventions to the Envision rating system for infrastructure using simplified case studies which simulated a real-world decision environment. We found that endowing engineers with sustainability points to induce loss aversion and showing them an exemplary role model project produced significant gains in setting high goals for sustainability. The combined effect was greater than either intervention separately. While these types of interventions can be controversial when not disclosed, we found that pre-disclosing the interventions to participants did not diminish the results. We repeated the study with groups of decision-makers and found a similar effect on sustainability points. These results, combined with previous research, suggest that approaches from behavioral science (loss aversion, role models, and combined interventions) can translate to, and improve, multi-stakeholder infrastructure planning decisions. The results also advance understanding of underexplored areas in behavioral science: non-consumer decisions, combined interventions, pre-post disclosure, and the effect of choice interventions on group decision making. We hope to grow the interdisciplinary community studying these interventions, which hold great promise to improve infrastructure outcomes, yet require the unique expertise of the engineering project management community.

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INTRODUCTION

Cognitive biases are known to lead to irrational decision-making and behavioral interventions can help improve the decisions for end-users. For example, although an increase in one's salary would rationally lead them to increase their retirement savings, many people do not save enough to support their lifestyle after retirement. Asking people to commit in advance to allocating a portion of their future salary increases toward retirement savings (a form of a behavioral intervention) has been shown to help people save more money (Thaler & Benartzi, 2004). Similarly, framing organ donation as opt-out instead of opt-in increases the number of organ donors in a country (Johnson & Goldstein, 2003). Even sustainability choices, such as providing the fuel savings over time rather than mile per gallon, helps people better compare automobile efficiency across models (Larrick & Soll, 2008). Yet, far less is known about how similar behavioral interventions can help improve upstream multi-shareholder decisions about infrastructure. And, as the engineering project management community knows, these upstream decisions typically hold the greatest potential to shape the infrastructure for better or worse.

Prospect theory, the seminal work by Khaneman and Tversky (1979), explains how choice structuring can better fit a person's preferences and improve their decision making. More recent advances show that choice architecture, defined as intentionally crafting the way decisions are posed, can help decision-makers better achieve desired outcomes (Thaler, Sunstein, & Balz, 2014). By applying this theoretical perspective to infrastructure project planning, we can encourage stakeholders to make more informed decisions. And by better understanding how prospect theory and related choice architecture can effect decisions about infrastructure, those who plan, design, and build infrastructure can begin to recognize their own decision biases and be better able to manage their decisions. This is a necessary advancement towards needed understanding of decision making at large physical scales and on long time horizons (Brewer & Stern, 2004).

We recognize decisions about infrastructure are different from consumer decisions. Infrastructure decisions require active tradeoffs with multiple variables and uncertain consequences. They also require multiple stakeholders. The research described here targets multi-stakeholder decision making during infrastructure project planning. We begin by reviewing two of our previously published studies which employ choice architecture through the interventions of loss aversion and role models. We then report results from three additional studies that combined the interventions from the first two studies, pre-disclosed the intervention, and studied effects on group decision making.

BACKGROUND

The objective of this study is to understand how choice architecture, meaning the way decisions are posed, influence not just relatively simple consumer decisions, but also the upstream decisions about infrastructure project planning, which are complex, uncertain, and require multiple stakeholders to implement. In two previous studies, we developed interventions analogous to choice interventions successfully implemented in other fields (Dietz, Stern, & Weber, 2013; Kempton, Darley, & Stern, 1992; Meier & Whittier, 1983; Stern, 1985; Yates & Aronson, 1983). We begin by explaining our rationale behind these studies and results to provide supporting evidence for our three additional studies outlined in the methods section and reported results.

The premise behind all of our interventions is that decision-makers, when faced with a decision, do not always immediately know the right choice, but rather perform an informal reasoning process, sometimes referred to as preference construction (Ariely & Norton, 2008; Slovic, 1995; Weber & Johnson, 2009). Decision makers often take short cuts during this process when constructing preferences about alternatives (Tversky & Kahneman, 1974). These short cuts can lead to cognitive biases in decision making. For example, when engineers use previous experience to justify current design, their decisions have been shaped by their prior experience. This can be a problem if a reluctance to depart from the norms of previous experience leads to undervaluing innovative solutions (Beamish & Biggart, 2010). Indeed, decision makers tend to overvalue past decisions and past costs when considering options about the future (Arkes & Blumer, 1985). This is one reason why failing infrastructure may be repaired when a better solution would be wholesale replacement ("Sunk infrastructure," 2007).

To shift cognitive focus away from decisions based on experience, sunk costs, or other cognitive biases, choice architects can provide more detailed descriptions of the options they want users to consider (Thaler et al., 2014). In essence, the extra description balances past experience by changing how information is collected then processed by the decision maker. This remedy is supported by query theory, in which choices are made based on a linear series of questions and these questions are dependent on the starting point, or default (Johnson, Häubl, & Keinan, 2007). Initial questions produce longer richer responses than later questions and, subsequently, this impacts the outcome (Weber et al., 2007). The extra description leads to more informed initial questions.

To better understand how preferences are constructed during infrastructure planning, we used the Envision rating system for sustainable infrastructure. Envision broadly applies to all types of infrastructure, i.e. roads, bridges, pipelines, railways, airports, dams, levees, landfills, and water treatment systems (Clevenger, Ozbek, & Simpson, 2013). Envision is used voluntarily by construction and design firms, and is also mandated by some local governments and municipalities. Envision awards points in 60 credits distributed under five categories. These points accumulate towards various levels of certification. The scale of points varies for each credit but all points accumulate moving from the improved through restorative levels. The objective of Envision is to move project teams from conventional practice to the highest achievable levels of sustainability defined as "restorative" ("Envision™ Sustainable Infrastructure Rating System," 2012). Achieving restorative does not correlate with a higher monetary cost. In fact, a project team can achieve points for reducing costs ("Envision™ Sustainable Infrastructure Rating System," 2012). A recent case study about Envision corroborates these cost savings when adopted early in project planning (Dial et al., 2014).

To more effectively meet Envision's objective to motivate engineers and other stakeholders to consider the highest possible levels of sustainability, we modified the rating system in two ways: endowing users with points; and providing users with a role model project to consider when making decisions about their project.

The first intervention, *endowing users* with points was modeled from loss aversion, which suggests people generally prefer not losing something to winning the exact same thing. In other words, loss provokes greater degrees of discomfort than a win provides satisfaction (Benartzi & Thaler, 1993; Tversky & Kahneman, 1981). Loss aversion helps explain why home sellers overprice a house in a down market (Genesove & Mayer, 2001) or why investors hold a losing stock too long (Odean, 1998). The starting point, or default, can frame the decision outcome as either a loss or gain (Dinner, Johnson, Goldstein, & Liu, 2010). An example is when car buyers first shown the "fully loaded" package perceive lesser models as having missing features, which seem like losses (Park, Jun, & MacInnis, 2000). Meanwhile, car buyers first shown the base model perceive those same features as add-ons. This effect takes little time to establish (Khaneman, Knetsch, & Thaler, 1990).

Accordingly, we modified the Envision rating system so that users could lose points as well as gain points. In the standard version, points are only added for sustainability. In the modified version, users start with 151 out of a possible 180 points. Additional points were still possible by achieving the highest level, restorative, but now achievement below the new starting point resulted in a loss of points.

Participants were given a presentation about the purpose of Envision and how to navigate the guidance manual and the online rating tool. A case study was presented about a redevelopment project in a rural Alabama town. Participants were instructed to act as the consulting engineer and make recommendations to the owner about site use, layout, accessibility, public space, and alternative modes of transportation. Details such as how to integrate alternative transportation were intentionally left open-ended to encourage participants to develop their own ideas. Each participant was instructed to use the online Envision rating system to help guide their decision making.

Upon logging into the software, participants were randomly assigned to one of two versions of the rating system and asked to record their explanation for how to achieve Envision credits. Their explanation had to meet 100-word character minimum for improved level of achievement and 300-character minimum for restorative, with intermediate levels spaced at 50 character intervals. Credits marked as not applicable also required an explanation. Our intent with these character minimums was to require participant effort during the study and reduce the likelihood that participants would maximize points by thoughtlessly selecting the highest levels of achievement for every credit. In essence, the cost of deciding to achieve more points was time and cognitive energy. This aligns with the Envision rating system, which also requires answering additional questions and providing additional documentation for meeting higher levels of achievement.

When tested with 65 engineering professionals, we found that the group given the modified version with a potential to lose points (n=32) scored an average of 66% of the total possible points compared with the control group's (n=33) 51% (Shealy, Klotz, Weber, Johnson, & Bell, 2016). In responses to a post task survey, 95% of participants believed their scores were realistic and achievable. In other words, simply restructuring the point system could significantly improve engineers' sustainability goals.

The second intervention tested whether providing decision makers a role model project that scored highly on the Envision rating system could act as an example to endorse similarly high goals. This intervention was based on the *role model effect*, which suggests the largest benefits of a role model come when individuals are presented with a person, or in our case a project, relevant to their own *and* when the role model's success seems attainable (Lockwood & Kunda, 1997). Marx and Ko (2012) studied the effect of role models in a stereotyped context. Female participants were asked to evaluate a female job candidate, which served as a role model with either a high or low level math competence. The participants were then given a math exam. Those exposed to a similar, high competency, role model performed better on the math exam than those exposed to a similar low competency role model (Marx & Ko, 2012). When compared to individuals presented with a negative role model for a specific goal, those presented with a positive role model consistently outperform the one shown the negative role model.

To mimic similar social influence on decision making for infrastructure planning, each credit on the Envision rating system added an example to explain how Psomas Engineering achieved a high score on the South LA Wetlands Project. For instance, the role model project for credit QL 2.3: Minimize Light Pollution read, “Psomas Engineering achieved Restorative. The project team conducted an assessment of lighting needs and found only security lighting along the pedestrian walkways was needed. The project uses solar lights with cut-off lenses to reduce both lighting energy requirements and light spillage.”

When tested with engineering professionals, the group given the role model version (n=27) achieved 74% of the points, which was 20% more points than the control group (n=26) (p=0.003) (Harris, Shealy, & Klotz, 2016). This difference is equivalent to two levels of certification in Envision, from a silver certification to platinum. As with the endowed points example, the results from the role model project studies indicate that simply restructuring infrastructure planning decisions can influence the outcome, at least for initial goal setting, which is the purpose of Envision.

As mentioned earlier, engineering decisions about infrastructure are not the same as decisions about buying product or services that are typically used in behavioral science and economic experiments to understand consumers. Both of our studies use a real case studies and decisions are being made by professional engineers who make similar decisions everyday. While these decisions hold no consequences for the decision maker, there is also no reason to inaccurately respond. Post task surveys indicate over 95% of all participants believed an engineering team could meet their recommendations. The average participants’ years of work experience was 10 years.

HYPOTHESES

Building on these previous studies we developed and tested three additional interventions to choice structures using the Envision rating system for sustainable infrastructure. Similar to the first two studies, the infrastructure decisions take place early in planning stages and are closely associated with goal setting. Below, are rationale and hypotheses for each of the three studies: (1) combined intervention, (2) pre-disclosure, and (3) group decision making.

(1) Combined Intervention

We combined the endowed points and role model project from the previous studies to test the combined influence on decision making about infrastructure. We hypothesize the combined intervention will help engineers consider and set even higher goals for sustainability than either single intervention because these interventions influence separate cognitive processes. Endowing users with points and restructuring choices as a loss or gain in value is a passive intervention because decision makers are likely unaware of the changes in framing (Bovens, 2009; Loewenstein, Bryce, Hagmann, & Rajpal, 2014). The role model is an explicit endorsement intended to draw decision makers’ attention to a preferred option.

(2) Pre-Disclosure

Across fields, modifications to choice structures are viewed as a method to improve the decision process (Sunstein, 2015a, 2015c; Thaler & Sunstein, 2008). However, intentionally designing or redesigning of choices can still be controversial because of the potential for choice architects to promote decisions that are in their best interest as opposed decisions in the best interest of the decision maker (Bovens, 2009; Sunstein, 2015b). Of course, there is no such thing as neutral choice architecture, so it is better that the choice architecture is considered rather than ignored. Disclosing the choice architecture further eases concerns about people being manipulated. Preliminary results from consumer-level decisions show no appreciable impact from disclosing the intervention (Loewenstein et al., 2014). Accordingly, our second hypothesis is that *pre-disclosing* the combined intervention to decision makers before they begin the simulated infrastructure planning process will not diminish the effects of the intervention because whether the decision maker is aware or not, preferences about options are still developed based on query theory (linear series of questions) and these questions are dependent on the starting point.

(3) Group Decision Making

Our final study measured the combined intervention on *group decision making.* In part because it is more difficult to study, group decision making is often not considered in studies about consumer decision making and therefore research on the effects are limited (Sunstein & Hastie, 2015). And while much economic theory is based on the principle of utility maximization of individuals (Khaneman & Tversky, 1979), in practice, infrastructure project planning is a social process that involves constant negotiation among many stakeholders including attempts to infer and predict the preferences of other stakeholders. We hypothesize the intervention will still help decision makers increase sustainability goals, but the group dynamics will also affect the decision making which may reduce or magnify the outcome. Understanding how behavioral interventions translate to a group setting is critical to identify the potential benefits of choice architecture to infrastructure project planning. These studies can also inform more general theories about how choice architecture operates as we study the conditions under various settings.

METHODS

All three studies follow a similar method and procedure as our two studies described in the background section. Engineering students participated in a training seminar which included an introduction to the Envision rating system and a case study. Participants were shown how to navigate the guidance manual and the online rating tool. Background information about the case study project's intended goals, local governance, community and site programing were also included. In the first two studies, individual participants were asked to imagine themselves as a consultant for an infrastructure redevelopment project. In this role, participants reviewed 10 credits of the Envision rating system and selected the level of achievement they believed was possible. For each credit they were required to provide a detailed explanation of how the project team could meet these points. In our last study, groups of four engineering students discussed each credit together to make a unified decision.

Participants were randomly assigned to the control or intervention group when they first login to the replica version of Envision. Participants saw their initial score, the total possible points, and scroll down the page to view each credit. Just as in the original version, a link directed users to Envision's detailed explanations of how to meet achievement levels. Each level of achievement required an explanation with a minimum character count. As with our previous studies, our intent with these character minimums was to require effort to reduce the likelihood that participants would maximize points by rashly selecting the highest levels of achievement for every credit. Similarly, written explanation of at least 100 word characters in length is required for the lowest level of achievement and 300 characters for the highest.

By comparing responses between the control and intervention groups, we are able to measure the collective effect on decision making in terms of the difference in points. Each study was tested for normal distribution visually and using frequency diagrams before performing a t-test to identify a significant ($p < 0.05$) difference between control and intervention group scores. Possible outliers in the results were also considered, defined as a cumulative score outside two standard deviations from the mean, however, the results include the outliers because removing them only increased the statistical significance of the results.

For the combined intervention study, we added the endowed points and role model project from the previous two studies that were outlined in the background section. One difference between the previous studies and this one is the number of points endowed to participants was set to the highest possible level, restorative, for each credit instead of conserving. This was done to stay consistent with the role model project that met the restorative level of achievement.

Just as in the previous two studies, participants learned about the purpose of Envision through an in-person presentation. The same case study about a redevelopment project in a rural Alabama town was used in these experiments. Participants were instructed to act as the consulting engineer and make recommendations to the owner about how to achieve Envision credits.

For the pre-disclosure study, we explained the interventions within the rating system to half of the participants prior to them making decisions. The control group in this study was not aware of the interventions. We pre-disclosed the intervention on the first page of the Envision rating system, which read, "In order to encourage higher Envision scores, we modified your interface with the Envision rating system in two ways: (1) We added the high-scoring example project (typically there is no example project on the standard interface) and (2) we pre-set your point scores to the conserving level of achievement (typically there is no pre-set)."

For the group study, we measured the effects of choice architecture when groups of four participants were asked to work as a team to make a decision about levels of achievement. Similar procedures were followed as in previous studies. Teams were randomized to receive the control version or the combined intervention version.

The number of participants in each of the studies are listed in Table 1. The loss aversion and role model studies were replicated with students and professionals, and we expect that the results of the other studies, which were conducted on students, are also transferable to professionals. In fact, the loss aversion treatment when replicated with professionals was more significant with professional than with students (Shealy & Klotz, 2015; Shealy et al., 2016). The transferability of choice architecture interventions between relative novices and experts is noted by others drawing similar conclusions (Englich, Mussweiler, & Strack, 2006; Northcraft & Neale, 1987). Nonetheless, the students that participated in this study were senior engineering students and will be making similar decision with real world impact in less than a year.

Table 1: Number of Professionals and Student Participants in Each Study

Intervention	Endowment	Role Model	Combined	Pre-Disclosure	Groups
Number of Participants	65	54	48	56	116

RESULTS

Engineering students in the **combined** study given the endowed points and role model project (x=24) scored 23% more points than students given the standard version (x=24) of Envision. The combined group was able to achieve 79% of points while the control group achieved 56%. The combined intervention group outperformed the control group on every credit by an average of 4 points. This is more than either the endowed intervention or role model project separately. The difference between the combined intervention compared to the control was significant (p=0.0001).

Our **pre-disclosure** study found that the intervention did not diminish the effect on how engineering students' constructed preferences about planning decisions for infrastructure. The results were almost identical (p=0.6) compared to disclosing the choice intervention after the study. Figure 1 shows both the pre and post disclosure groups were able to achieve more than the control group. Similar to the post disclosure, the pre-disclosure group outperformed the control group on every credit by an average of 3 points. The credits ranged from questions about quality of life for the community (QL) to natural world that include questions about local habitat (NL), and climate and risk, which includes questions about reducing greenhouse gas emissions and avoiding vulnerabilities from a changing climate.

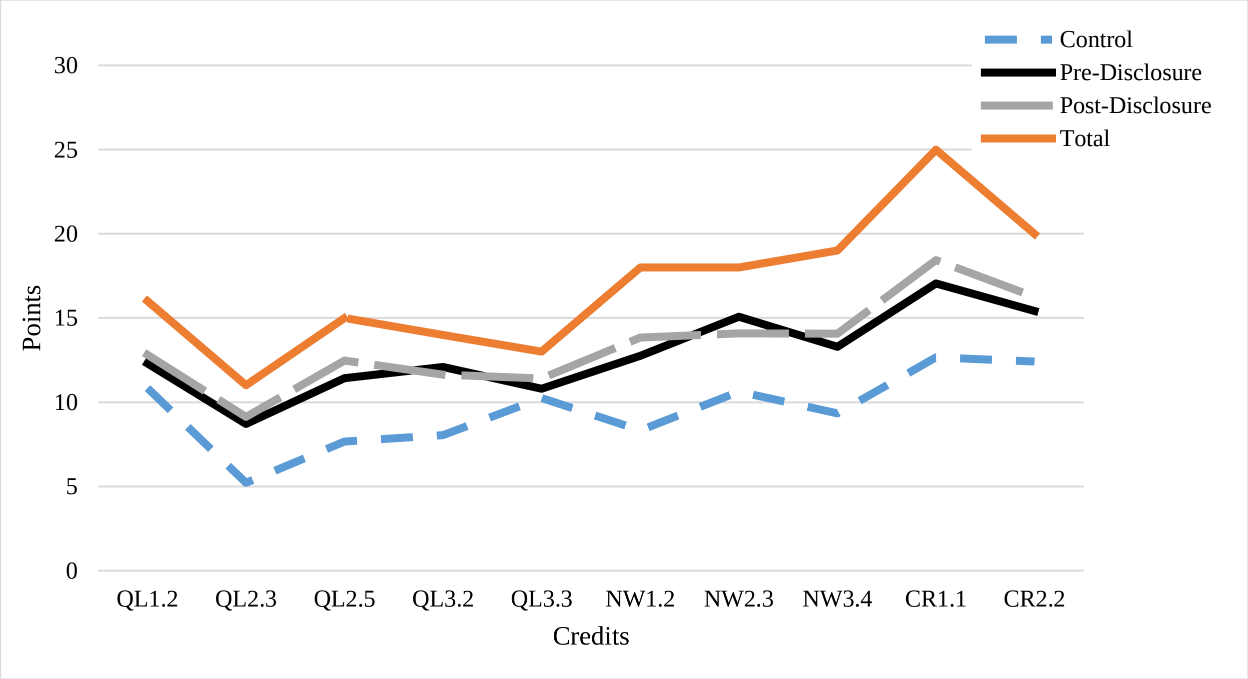

Figure 1: Pre-disclosure does not diminish the effect of choice architecture on setting high goals for sustainability

In the study of **groups**, teams of four given the combined intervention (x=12) out performed teams of four given the control version (x=17) by 14%. The combined group averaged 75% of the total points while the control averaged 61%. The combined group scored on average 2.5 points more than the control group on every credit. The results were significant ($p=0.04$), yet with more variability than all of the individual decision making studies. The percent difference between control and intervention was less in groups compared to our previous individual decision making studies, but this was because the highest percent achieved from any of the control groups that did not receive an intervention was when decisions were made in teams. We measured for statistical difference between the combined study control group and group decision making control but the difference did not meet our 95% confidence interval ($p>0.01$). Meaning, making the decisions in groups without any other intervention did not significantly change the outcome. Only when adjusting the choice architecture was a difference in score noticed.

The combined study significantly ($p < 0.05$) improved consideration for the highest levels of sustainability compared to the endowment study and the combined study results were less varied (SD=32 compared to SD=42). The average achievement from participants in the combined study was higher than the participants given just the role model project in our previous study, but the difference ($p > 0.1$) did not meet our confidence interval. The combined and role model results had similar variance (SD=32 compared to SD=28).

Table 2: Architecture Interventions Lead to Higher Goals for Sustainability

Intervention	**Control Points Achieved**	**Intervention Points Achieved**	**Difference**	**p**	**n**
Endowment	51%	66%	15%	<0.01	65
Role Model	54%	74%	20%	<0.01	54
Combined	56%	79%	23%	<0.001	56
Pre-Disclosure	79%*	76%	3%	0.6	56
Groups	61%	75%	14%	0.04	116

*Still received the choice architecture intervention but was not made aware prior to the study.

The findings from all five studies are summarized in Table 2 to illustrate that each intervention – endowment effect, role model project, and combined helped decision makers set a higher goal for sustainability during infrastructure planning using Envision. Implementing any of these interventions would significantly improve decision makers' consideration for sustainability. Pre-disclosing the intervention and making the decision as team did not diminish the effects of the interventions.

DISCUSSION

The objective of Envision and other rating systems is to increase the consideration for sustainability during infrastructure planning. This research illustrates methods to better meet this objective. Structuring the decision processes to align with tested behavioral science theories can improve multi-stakeholder decision making about infrastructure. Both engineering professionals and student engineers achieved more points when endowed points and provided a role model project. The combined effect was significant whether decisions were made in groups or individually.

The previous two studies, endowment and role model project, similarly improved Envision users' goals for achievement towards sustainability. When added together the results were more significant than either version alone. In this case, the combined choice architecture approach appears to elicit complementary cognitive process that together improve decision making.

We tested whether pre-disclosing the choice architecture to participants had an effect on decision making and found no significant difference in results. A possible explanation is that the purpose of Envision is to encourage consideration for sustainability and therefore the changes in choice architecture are consistent with decision makers' interests and objective. While the endowed points are less explicit than the role model project, both changes are guided by objective and legitimate motives to help users make more informed decisions using theory and rationale from behavioral science. Informing the decision maker why the choice environment was changed appears not to affect their preference construction and we saw no participant bias, meaning participants adjusting their choices to what they think the experimenters expect, because all groups, the control, pre-disclosure, and post-disclosure groups, were told that Envision is a tool to help them meet higher project level sustainability. Being informed about the change in choice architecture resulted in similar decision outcomes when not informed.

Making decisions in groups may improve the percent of Envision points achieved even without the choice architecture interventions; however, the results were not significant enough to meet our confidence interval. We plan to collect more data to explore whether group decisions are leading to more ambitious sustainability goals. We did not measure possible confounding variables or take note of group dynamics during the study rather we randomized groups to receive either the control or intervention in effort to reduce the probability that confounding variables influenced the results. Future studies will record possible confounding variables and make note of group dynamics for comparison to these findings.

Based on all five studies, a ceiling of what is actually achievable through the interventions we tested appears to be around 74% of the Envision points (the average of all five groups given the choice intervention). One explanation for this ceiling is that meeting a higher score may not be appropriate for the infrastructure project. Another explanation is that Envision users believe achieving one step below the highest level of achievement is more acceptable and so they satisfice to meet a high, but not the highest, level of achievement. Or, perhaps, different choice architecture interventions could raise the Envision achievement even higher. Because how these decisions are made remains unclear, future studies should include more nuanced observation of the decision process to understand dynamics during decision making.

Each choice intervention improved engineers' decision making for higher achievement in sustainability but the variance in achievement by credit is not equal. For example, the intervention group scored on average 5 points more when deciding about how to reduce green house gas emissions but only 1 point more when deciding how to enhance public space. This credit level variance is likely due to the total number of points possible for each credit. The credit about how to enhance public space (QL3.3) is worth a total of 13 points while the credit about greenhouse gas emissions (CR1.1) is worth a total of 25. Because more points are available the total amount of points being recommended can be greater and this difference is reflected in the variance measured and reported in the results.

There are some notable limitations to our approach: we isolate a single decision point to empirically measure the effects of choice architecture interventions; and we only measure the quantitative difference in measured outcome and not the observed decision process. Still, while we do not know how these decisions hold over time, starting with a higher goal in the planning phase can only help the sustainability outcome of the project long term. And because the training session was about Envision, participants may have been susceptible to social acceptability bias, setting higher sustainability goals than they otherwise would have in order to provide answers that align with the training content. However, any such bias would be constant across the control and experimental group, and therefore not affect our primary conclusions, which are based on differences between the groups.

CONCLUSION

Better understanding the decision making influence of tools like Envision (and countless other similarly structured sustainability rating systems) will help avoid scenarios where unanticipated behavioral or decision barriers limit achievement. This study builds on previous research in behavioral science but differs in several ways. Interventions based on behavioral science are applied almost exclusively at the individual consumer level, which is a critical oversight in light of their potential impact to decisions about infrastructure. We empirically examined how modifications to choice architecture impact upstream infrastructure planning decisions. We also studied whether pre-disclosure of the choice architecture interventions diminishes their effect and whether choice architecture translates to group decision making. We found that combined interventions by endowing decision makers with points and providing them a role model project significantly improved their consideration for sustainability. Pre-disclosing the choice architecture intervention did not affect the results. And group decisions appear similarly affected by the choice architecture as individuals.

These upstream decisions about infrastructure determine large scale and long-term environmental benefits, including decreased energy use and carbon emissions. While there is no one-size-fits-all solution to infrastructure needs, this research approach would seem to be broadly transferrable across projects to remove unnecessary barriers in the process to unleash the ingenuity of experts to achieve more desired results. Compared to the costs of infrastructure itself, simply restructuring choices is a relatively inexpensive approach to support more informed decisions. These types of interventions are also less intrusive than legal responses. Through more empirical studies and field experiments the engineering project management research community can begin to predict decision outcomes based on these and other cognitive biases and better improve decision making for infrastructure project planning and the stakeholders these project serve.

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