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Framing Energy Efficiency with Pay Back Period: An Empirical Study to Increase Energy Consideration During Facility Procurement Processes

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PROMPTING LIFE CYCLE CONSIDERATIONS DURING THE PROCUREMENT PROCESS FOR GOVERNMENT FACILITIES EQUIPMENT: A CHOICE ARCHITECTURE APPROACH TO ENERGY REDUCTION

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ABSTRACT

The federal government is the largest energy user in the country and government facilities are responsible for 40% of their total energy emissions. Unfortunately, traditional methods to improve energy efficiency are not reducing emissions to meet the federal government's goal of 2.5% reduction per year. To complement more traditional approaches like executive orders, congressional acts, and mandates, the focus here is the procurement process for government facility equipment (e.g. HVAC, lighting systems). Based on behavioral science research, decision makers do not always fully understand or know the outcome of each possible choice, due to lack of time, information, or processing capability. The hypothesis is that choice architecture, meaning the way in which procurement options are structured, influences facility management procurement decisions. To test this hypothesis, engineering and building science students (n=56) were presented with three procurement scenarios. Each scenario provided four product choices at varying cost and energy efficiency. Half of the participants randomly received the normal government procurement form and the other half received a modified form prompting them to first calculate the payback period of each option compared to the baseline option. The results indicate a statistically significant difference ($p < 0.001$) between participants in the *control group* who *did not* choose the more expensive but more efficient product option and students in the *intervention group* who more frequently *did* choose the more expensive but more efficient product. If applied to all government procurement decisions for facilities, the savings would be approximately \$1.2 trillion. Obviously, not all government facilities are equivalent nor are they being upgraded all at once. By simply adding a prompt to government procurement forms asking users to calculate payback period before making a procurement decision appears to offer potential benefits without requiring additional acts of congress, executive orders, or mandates.

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INTRODUCTION

The federal government is the largest energy user in the country and government facilities are responsible for 40% of their total energy emissions (George and Joyce 2015). As a result, Executive Order 13693 was signed to reduce energy usage and greenhouse gas emissions within federal facilities. Mandates within federal agencies now require Leadership in Energy and Environmental Design (LEED) in new construction (“LEED Building Information” n.d.), and federal acts like the Energy Independence and Security Act have been put in place (Rahall 2007). However, these traditional methods to improve energy efficiency are not reducing emissions by the federal government’s goal of 2.5% annually (Gillingham et al. 2009; U.S. Department of Energy 2013).

Cognitive biases to energy and emission reduction may help explain why reaching such energy reduction goals is challenging, even with executive orders (EO’s), mandates, and decision tools like LEED (Sorrell 2015; Weber 2015; Wilson and Dowlatabadi 2007). For example, facilities level decision makers may not have the information or time to make decisions for energy reduction, a result of bounded rationality (Friedman 2002). Or facilities managers might be overly burdened with choices and options, and unsure which is the better product for energy efficiency, a scenario best described as choice overload (Schwartz 2004). This paper examines how facilities level energy decisions, specifically government facilities level decisions, may be influenced by choice architecture to encourage more consideration of energy efficiency. Choice architecture is the careful design of the environment in which people make choices (Thaler et al. 2014). Whether intentional or not, choice architecture is inherently present when making decisions about facilities, building design, or retrofits. Therefore, choice architecture can help alleviate or reduce the effects of cognitive biases during decision making (Shealy and Klotz 2016; Thaler et al. 2014). Specifically, the tested choice architectures in this research are intentional modifications to government procurement forms, which may alleviate cognitive bias that hinders selecting the most energy efficient product options during facility upgrade.

This paper begins with a short literature review of government facilities management decision making, then shifts to cognitive biases in behavioral decision making and tools from choice architecture to overcome or alleviate these biases. The next section reviews specific methods to test framing effects on energy efficiency decisions often affected by loss aversion, and is followed by the methods used to empirically test framing effects on facilities management decision making in the federal government procurement process for equipment purchases. The paper concludes by discussing the implications of the findings as well as next steps and opportunities for future research to explore behavioral decision making and choice architecture relevant to energy efficiency in “upstream” decisions about equipment procurement for government facilities.

BACKGROUND

ENERGY EFFICIENCY IN GOVERNMENT FACILITIES

Decisions about energy use in government facilities are often influenced by government regulations. There are many regulations that must be considered, such as, EO 13432, 13693, and the Energy Independence and Security Act of 2007. Additional government requirements mandate considerations for life cycle costs, net zero, fossil fuel reduction, metering, and renewables (*Energy Policy Act of 1992* 1992, *Energy Policy Act of 2005* 2005, *Exec. Order No. 13423* 2007; Rahall 2007).

One of the frameworks required by the government for energy efficiency consideration is Leadership in Energy and Environmental Design (LEED), which helps prioritize energy efficiency during new construction and renovations. LEED, a rating system that seeks to implement sustainable measures, has market value (Blumberg 2012). In the commercial sector, for example, buildings that have LEED certification set a higher asking price and frequently have a higher occupancy rate (Dermisi 2009). LEED Gold and Platinum certified buildings have reduced building energy intensity compared to similar conventional buildings (Scofield 2013); however, most government buildings still in operation are not LEED certified (Menassa et al. 2011).

Another measure used to increase consideration for energy efficiency in government facilities is energy codes and congressional acts, such as the Energy Policy Acts of 1992 and 2005, and the Energy Independence and Security Act of 2007. These acts are intended to reduce energy usage throughout the government by introducing alternative energy tax credits, encouraging solar, wind, and ocean energy sources, reducing fossil fuel use, and providing metering for customers on request. Similarly, there are federal mandates to reduce energy use such as requiring ENERGY STAR purchases (Rahall 2007) and encouraging alternative energy sources (*Energy Policy Act of 2005* 2005) and motor efficiency standards (*Energy Policy Act of 1992* 1992). These efforts are intended to reduce the burden on energy consumers and promote energy independence, and have resulted in a 32% increase in alternative energy consumed from 2011 levels in all sectors; however, overall building energy consumption failed to decrease by 30% from 2008 levels as stated in E.O. 13432 (EIA 2014).

Finally, executive orders influence government energy use by setting standards, for example to reduce greenhouse gas emissions 2.5% each year until 2025 (*Executive Order (EO) 13693* 2015). However, executive orders do not state *how* to achieve the reductions or overcome the challenges that surround energy efficiency. Energy efficiency goals are well documented through the legislative history and EO's, but setting a standard and not providing methods or resources to achieve such standards may be counterproductive due to the cognitive burden placed on decision makers (Iyengar and Lepper 2000). Simply put, these conventional methods used by the government to instigate greater energy efficiency are providing marginal improvements, but not enough to meet energy goals (EIA 2014).

COGNITIVE BIAS

Thirty years of research in behavioral sciences provides evidence that the decision environment influences the outcome. Behavioral science research helps explain, for example, why homeowners selling in a down market may insist on a higher asking price (Genesove and Mayer 2001), why investors sell profitable stocks too soon and retain losing stocks too long (Odean 1998), and why consumers generally hold failing assets longer than winning assets (Carmon and Ariely 2000; Cummings et al. 1986; Knetsch 1989). There are numerous ways in which the decision environment influences the behavioral response: anchoring to decision tools, heuristics during complex decision tasks, numerous design options leading to an overload of information, and undervaluing gains because of loss aversion. This is not a complete list and more examples can be found in Johnson et al. (2012) and Weber and Johnson (2009). The purpose here is to illustrate various types of cognitive biases and how they relate to complex decisions in facilities management.

Decision makers are frequently influenced by previously established standards, whether or not they maximize utility, and rely on such anchors to make decisions. For example,

anchoring decisions (Jacowitz and Kahneman 1995) to random high numbers led to an increase in perceived achievement in LEED rating systems from building professionals (Klotz et al. 2010). Similarly, when decision makers encounter complex choices they often rely on a ‘rule of thumb’ or heuristic (Gigerenzer 2007). A heuristic occurs in situations where patterns, stereotypes, and preconceived notions guide decision and behavior. Heuristics can be helpful when making a snap decision, but harmful when the decision is complex and requires more consideration. At times decision makers can be overwhelmed by options to consider, and encounter choice overload. Often choice overload is cognitively overwhelming for the decision maker because they cannot weigh the costs and benefits of every option within the time allotted, and end up dissatisfied with the outcome (Iyengar and Lepper 2000).

Loss aversion, another cognitive bias, is frequently observed when decision makers undervalue potential gains because of a fear of losing. In general, losses provoke greater degrees of discomfort than potential gains of similar value provide satisfaction (Kahneman and Tversky 1984; Schwartz 2000). Overcoming potential loss usually requires gains twice as great (Benartzi & Thaler, 1993); although the gain required has been observed as much as 14 times as much (Carmon and Ariely 2000). To address the consequences of loss aversion when making policy decisions, researchers suggest bundling policies together that involve both losses and gains (Milkman et al. 2012). Loss aversion is widely applicable across many fields: making accurate predictions about risk-seeking or risk-averse behavior in politics (Patty 2006), international relations (Berejikian 2002), and public support for military intervention (Nincic 1997). Framing military involvement as a protective mediation to avoid geopolitical loss (i.e. framing to avoid loss) is viewed more favorably by the public than a proactive intervention explained as benefiting foreign policy (i.e. framing to gain).

Similarly, loss aversion affects engineering decision making about infrastructure. Simply re-framing points in sustainability rating systems as a loss in achievement rather than a gain in achievement improved engineers’ consideration for sustainability. Engineers endowed points in the Envision Rating System set a 15% higher goal for energy and water reduction than when no points were endowed (Shealy et al. 2016). Such an increase could drastically affect possible outcomes. If applied to all U.S. infrastructure, a 15% reduction in greenhouse gas emissions would result in a reduction of over 2 billion tons of carbon dioxide (Shealy and Klotz 2015).

Of course, infrastructure decisions are subject to varying constraints, goals, and resources with different stakeholder schedules, agendas, mandates, and budget cycles. Furthermore, decisions about infrastructure are made in groups. A similar study investigated the effect of choice architecture on group decision making and found parallel results as individuals (Shealy et al. 2016). Thus, experts are similarly influenced by cognitive biases as consumers, which aligns with additional behavioral science research that suggests experts are influenced just as novices (Englich et al. 2006; Northcraft and Neale 1987).

Restructuring the decision environment can reduce the effects of cognitive biases during contract structuring for infrastructure development. For example, status quo bias led to underestimating project costs and overestimating financial returns on investment for a capital project between the Dutch Highway and Waterways Agency and a Dutch contractor. Redirecting biases towards improved performance instead of the price of managerial intervention helped remove status quo bias, leading to more realistic expectations and more opportunities for financial gains (van Buiten and Hartmann 2013).

The premise is that facilities managers are like other decision makers, bounded by rationality and prone to systemic cognitive errors, or biases, during decision making, and that

these biases lead to less than optimal (at times irrational) outcomes. Although much of the literature devoted to facilities management focuses on sustainable needs, reducing risk and uncertainty that contributes to ineffective project management, the solutions do not frequently include behavioral decision science (Delgado and Shealy, Under Review). Rather, the solutions seem to focus on increased public participation, training, and new policies for environmental protection.

Similar to how behavioral decision science research is leading to advances in medicine (Johnson and Goldstein 2003), finance (Fox and Langer 2005), and insurance (Johnson 1993), it can also help explain how cognitive biases influence facilities management decision making. For example, it can help explain how EOs increase risk in decision making by stipulating a LEED score that may act as an anchoring bias. And facilities managers, for instance, cannot make energy reduction decisions appropriately if they do not consider long-term costs – inadvertent loss aversion in facilities management which prevents energy savings (Hodges 2005). Another example, facilities managers have the potential to reduce energy consumption but are often left out of the conversation, which results in decisions that do not maximize utility due to imperfect information (bounded rationality) during design and construction. Figure 1 illustrates the link between approaches thus far to reduce energy, not meeting energy reduction targets, and potential cognitive biases which prevent decision makers from energy efficient decisions in facilities. By no means is this a full review of the potential cognitive biases represented in behavioral science literature or the only biases applicable to facilities management. Rather this is meant to introduce the concept of cognitive biases as they relate to facilities management. For more detail about cognitive biases about energy see Houde and Todd (2010). For more detail about how cognitive biases relate to infrastructure management see Shealy & Klotz (2016) and to reduce energy in facilities management see Delgado and Shealy (Under Review).

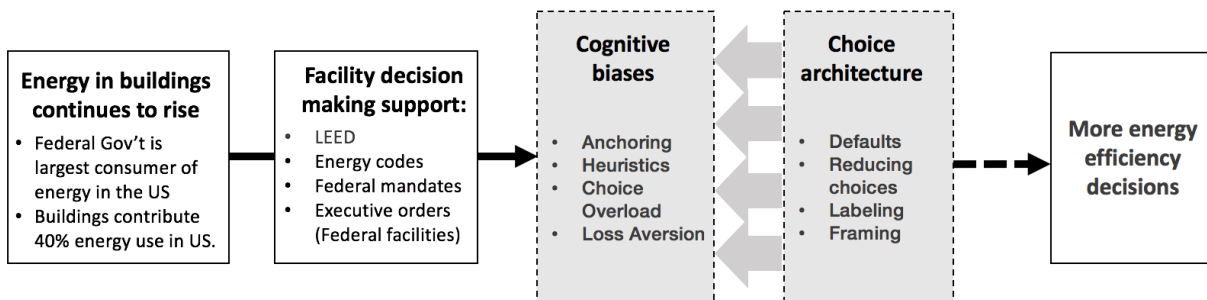


Figure 1: Addressing Cognitive Biases with Choice Architecture to Improve Building Energy Efficiency

CHOICE ARCHITECTURE

Choice architecture is a method to orient the decision environment to account for known cognitive biases and improve decision maker choice and autonomy; Figure 1 also illustrates this perspective. A principle of choice architecture is to construct choice information that helps decision makers better process the information. For example, when presented with a miles-per-gallon (mpg) metric, consumers wrongly assume that increases in mpg have a linear effect on fuel use and CO₂ emissions, suggesting that an increase from 10 to 20 mpg has the same benefit as going from 40 to 50 mpg. However, this is not true. The shift from 10 to 20 mpg reduces fuel use by 50%, whereas from 40 to 50 mpg, fuel use is reduced by only 20%. Restructuring the

information as a linear metric, such as gallons per mile, improves decision makers' ability to pick the most efficient option (Larrick and Soll 2008). As the mpg example highlights, choice architecture is a powerful tool to help restructure decisions about energy. Choice architecture is inherently embedded in every choice, whether the decision maker is aware or not. Several approaches or "tools" for choice architecture are discussed to illustrate their benefit. Included are defaults, choice reduction, labeling, and framing. This is not a complete list. For more see (Leonard 2008; Shealy and Klotz 2016; Thaler et al. 2010).

Defaults helped increase organ donation rates when the Department of Motor Vehicles' license form is preset to automatic enrollment, but the rates decreased when the default was set to non-enrollment (Johnson and Goldstein 2003). The choice is preserved; citizens can check either box but the starting point matters. Similarly, reducing the number of choices can help preserve choice. When decision makers encounter too many options, a situation called choice overload, they often avoid making the decision entirely. A study of Medicare patients found that reducing options from 100 to fewer than 10 resulted in improved patient satisfaction and medical outcome (Kling et al. 2008).

Another choice architecture tool is labeling. Labeling can provide a visual aid when the information is difficult to understand, and can reduce processing time for new information. ENERGY STAR uses labeling to increase consumer purchases of energy efficient appliances (Newell and Siikamäki 2013). Related to labeling is framing choices, which means modifying the presentation of information in a positive, negative, or neutral tone. There are two types of framing: attribute framing and goal framing (Heath et al., 1999; Krishnamurthy et al., 2001; Levin et al., 1998). The difference between attribute and goal framing is the object being highlighted. In attribute framing, the frame is focusing on the characteristic of an option or choice. For example, describing the success rate of surgery as 90% survival rate (positive) or 10% mortality rate (negative) is an example of attribute framing. Attribute framing is usually more effective when the characteristic is positively framed (Levin and Gaeth 1988). Goal framing relates behavior to obtaining the goal (Heath et al. 1999). For example, a positive frame is "If you get a mammogram, you take advantage of the best method for early detection of breast cancer"; a negative frame is "If you don't get a mammogram, you fail to take advantage of the best method for early detection of breast cancer." Surprisingly, goal framing is most effective when goals are negatively framed (Krishnamurthy et al. 2001). This occurs because the framing of choices as losses or gains in value is often more influential in decision making than the actual end point (Tversky and Kahneman 1981) because even when two presentation formats are formally equivalent, each may give rise to different psychological processes.

These examples of choice architecture "tools" are intended to outline the growing field of behavioral decision science and the many applications of choice architecture to account for cognitive biases. In this paper, specific focus is placed on framing effects because the same type of preference construction is likely true for energy decision makers. Framing effects that overemphasize immediate rather than long-term savings may lead to suboptimal decisions. The next sections present the research question and hypothesis based on this literature review of cognitive biases and choice architecture, then provide an overview of the research methods used to measure how framing energy savings as a gain instead of a loss (compared to initial cost) can influence product purchasing choices during procurement.

RESEARCH QUESTION AND HYPOTHESIS

The cheapest products for facilities are not always the most energy efficient; typically, energy efficient products cost more upfront to pay for their efficiency over time. With recent technological advances and automation, the payback period continues to shrink. Take two comparable HVAC systems for example: an efficient system initially costs \$197,500 and consumes 114,941 kWh/yr of energy, while a less efficient model has an initial cost of \$157,000 and consumes 206,440 kWh/yr of energy. A quick payback period calculation (full process explained in more detail in the methods section) yields approximately a four-year pay pack period, which provides 16 years of saved energy expenses assuming a 20-year lifespan.

Directly related to this HVAC example, the research question is can framing procurement options with higher upfront monetary costs as long-term gains shift decision makers' consideration in product choice for facilities? The hypothesis is that product choices framed as long-term savings significantly increase decision makers' choice of the most energy efficient option. Significance for this study is defined as a 95% confidence interval. The hypothesis was tested with decisions about HVAC systems, galley freezers, and lighting.

To support the main hypothesis, five questions about beliefs and preferences about energy efficiency were included to understand the participants' point of view and, if needed, control for varying beliefs about energy and greenhouse gas emissions.

METHODS

DECISION SCENARIOS

Decision scenarios about actual procurement choices were developed from form 4200.1.2 CG (Rev. 2-84), used in the Department of Homeland Security, and distributed to students in engineering and building science at Virginia Tech and Colorado State (n=56). These students are not facility managers, but within the next six months could become facility managers or energy decision makers for the types of decisions posed in these scenarios. Additionally, the students were all currently studying risk in engineering or building science, and were thus well qualified to act as engineers. Previous research that uses both engineering students and experts finds no significant difference between the groups in their engineering design decision making (Shealy et al. 2016b). No matter, students acting as a proxy for government facility procurement agents is still a limitation. Though, government facility procurement agents may likely bring added biases than students. For example, status quo bias is prevalent among engineers (Brown, 2014). Actual decision makers considering whether to break from the status quo may perceive such choices as more risky and uncertain than in these decision scenarios that pose no real threat (Dinner, Johnson, Goldstein, & Liu, 2010; Fox & Langer, 2005). Thus, results from this study, controlling for additional expert biases and real world risk, may produce more conservative findings than in the real world. Thus, future research should consider testing with actually procurement agents. This study and methods provide a foundation for this future work.

The scenarios included four product options (for each HVAC, galley freezer, and lighting) that started at the lowest cost but highest energy usage (conventional). The options gradually increased in cost and decreased in energy usage to the most efficient. The "least efficient but cheapest upfront" option and "most efficient but expensive upfront" option were real product choices. The two additional choices in between these were generated by interpolating between the conventional and most efficient options. The scenario options were listed as Option A, B, C, and D, but randomized within the scenario to prevent participants from

detecting a pattern. Option A, the exception to this rule, was always the conventional least efficient option to keep payback period calculations consistent for the intervention group explained in the next several paragraphs.

The objective was to test how prompting consideration for payback period influenced procurement choices: either choosing the low-cost option (with high energy use) or the higher upfront cost option (with more long-term savings because of less energy use) or one of the two options in between. The “rational” option was defined as the choice that maximizes energy savings. This option had the lowest energy usage with a payback period under five years compared to the cheapest option which had a much longer payback period.

The decision scenarios were developed and validated with engineering students. A small group (n=9) was used to check face validity following a think-aloud protocol. The scenarios were intended to imitate typical real-world decisions about facility upgrades, which often lack complete information about future energy savings. Participants (n=56) were given specification sheets about products (e.g. HVAC, galley freezer) and asked to indicate on the government procurement form which was most appropriate for a mock facility. Participants were given the government procurement form in paper version, not an electronic version; half of the participants received the control version and the other half received the intervention procurement form that ask to calculate pay back period. Both groups of students from Virginia Tech and Colorado State were split in half, meaning half of the students from Virginia Tech received the control and the other half the intervention option, and likewise for Colorado State. All participants were given four HVAC options, four freezer options, and four lighting system options. For example, freezer option A was the conventional option. If participants were given the intervention version, they were required to first record the annual energy use on the specification sheets, then calculate the payback period by calculating the difference between the cost of the conventional option A and another option (B, C, or D), and dividing that by the difference of annual energy cost between the same two options. For instance, option A cost \$6840 and used 14,400 kWh/yr, and option B cost \$7,700 and used 7637 kWh/yr; using \$0.111 as the annual energy cost per kWh, the calculation follows, and yields a 1.15 yr pay back period. This pay back period indicates the time it will take for the energy savings to recoup the initial cost of the option.

$$\frac{\$7700 - \$6840}{\$0.111 \times (14,400 - 7637)} = 1.15 \text{ yrs}$$

All the options’ specification sheets were identical except for the energy consumption and initial cost. Table 1 shows the upfront monetary costs for each HVAC, freezer, and lighting option and Table 2 shows the energy use (kWh/yr) for each option.

Table 1: Capital Cost for HVAC, Lighting and Freezer Product Options

Product Option	HVAC	Lighting	Freezer
Conventional	\$157,000	\$2,099	\$6,840
Less Efficient	\$176,084	\$5,000	\$7,700
Efficient	\$188,306	\$5,300	\$7,950
Most Efficient	\$197,500	\$5,500	\$8,043

Table 2: Energy use per year (kWh/yr) of the options shown in Table 1

Product Option	HVAC	Lighting	Freezer
Conventional	206,440	102,000	14,400
Less Efficient	168,626	42,237	7,637
Efficient	142,384	25,217	5,270
Most Efficient	114,941	17,500	4,050

BELIEFS AND PREFERENCES

The last section of questions asked participants about their beliefs and preferences towards energy and greenhouse gas emissions using a Likert scale (strongly agree, agree, neutral, disagree, and strongly disagree). The questions were:

1. I believe that climate change is effecting the planet adversely.
2. I personally value short-term cost savings over environmental performance.
3. Others value short-term cost savings over environmental performance.
4. I always consider payback period prior to purchasing an item that consumes energy.
5. I always calculate potential CO₂ emissions prior to purchasing an item that consumes energy.

STATISTICAL ANALYSIS

The decision scenario questions (HVAC, galley freezer, lighting) were multiple choice and the results were categorical. A scale was assigned to the categorical data, based on the payback period and energy consumption of each choice, giving the quickest payback period option a value of “1” and the longest payback period a value of “4.” The response options were equally distributed, meaning that the difference between option 3 and 4 is equal to the difference between 1 and 2. Thus, the data was ordinal and responses evaluated based on percent frequency. A Wilcoxon Ranks Sum test was used to calculate a significant difference between the control and intervention group based on the framing intervention. The R language and environment for statistical computing was used for statistical analysis (R Core Team 2012).

RESULTS

The purpose of the decision scenarios and additional questions was to test whether framing procurement decisions as long-term energy savings by requiring payback period calculations before making a choice influenced the decision outcome.

DECISION SCENARIOS

All participants from both schools were split into two groups. The control group made procurement decisions without being required to calculate payback period, and the intervention group was required to calculate payback period on the procurement form before making a product choice. The first scenario asked participants to choose a replacement HVAC system for their facility. The results indicate a significant difference in selections ($p=0.0002$) between the

control group and intervention group. Participants who received the framing intervention selected the most efficient option (25/27), as indicated in Figure 2, while the control group was less decisive.

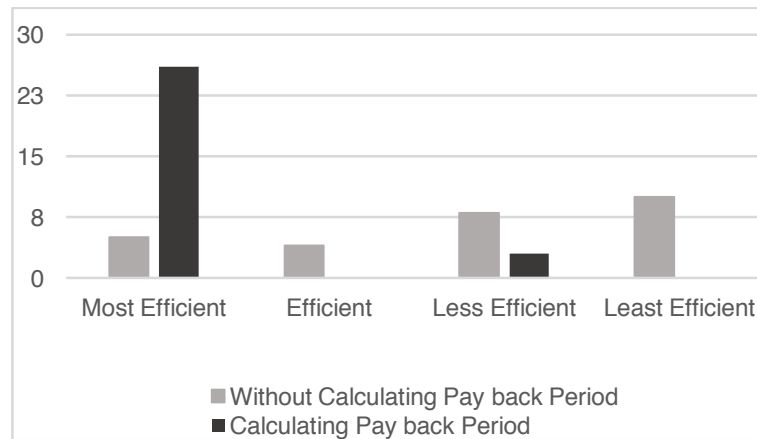


Figure 2: HVAC Choices for Control Group vs. Intervention Group

The next decision scenario asked students to replenish a stock of lights. Results indicated a statistically significant difference ($p=0.0002$) between the control and the intervention group. The control group was split between lighting options but 23 of the 25 participants that received the framing intervention (23/25) chose the most efficient option, as shown in Table 3. The third decision scenario asked participants to install a new large freezer unit. The results indicate a statistically significant change in responses between the control and intervention group in this scenario as well ($p=0.0005$). The control group mostly selected the least efficient option (11/26), and the group that received the framing intervention selected the most efficient option (20/21). A summary of results from these decision scenarios are provided in Table 3. Note that not all of the participants answered all of the scenarios.

Table 3: Product Options Chosen by Individuals in Control and Intervention Groups

Product Option	HVAC Control	HVAC Interv.	Lights Control	Lights Interv.	Freezer Control	Freezer Interv.
Conventional	10	0	9	0	10	0
Less Efficient	8	2	2	0	0	0
Efficient	4	0	5	0	6	1
Most Efficient	5	25	7	23	5	20

The results of the behavior and preference questions found that 86% (42/49) of participants believe that climate change is adversely effecting the planet but only 40% (20/50) of participants indicated they normally calculate payback period prior to making product purchases related to energy in real life. Furthermore, 78% (39/50) of participants responded they do not

consider potential CO₂ emissions prior to purchasing a product that consumes energy. These responses further suggest that prompting decision makers to consider energy use and payback period can help change their typical mental process when making purchasing decisions.

DISCUSSION

The results from the decision scenarios and additional sections demonstrate that restructuring the decision environment using known choice architecture tools can improve decision making about energy efficiency in facility management. The implications of this research are that small “tweaks” to the federal procurement form for facility equipment may help alleviate cognitive biases. Decision makers do not always understand the outcome of each choice, due to lack of time, information, or processing capability to evaluate each option (Simon 1957). As a result, decision makers often choose options with less than optimal outcomes (Friedman 2002). The results of this study indicate that simply adding a prompt to the procurement form asking users to calculate payback period before making a procurement decision may lead to choosing more energy efficient products.

Calculating the payback period appears to help decision makers realize the annual energy costs of a ‘cheaper’ upfront option, and the potential savings of an ‘expensive’ option. In these scenarios, the rational choice that maximizes utility over the life span of the product was the most efficient option, which happened to have the highest price tag. Once annual energy costs and payback periods were calculated, decision makers appeared better able to understand the shorter payback periods and long-term savings associated with each option. This helped the decision makers choose the more efficient option, which quickly outweighed the potential short-term savings.

Thus, the results indicate prompting decision makers in facility upgrades to first calculate payback period enables them to better account for potential loss aversion (in the form of upfront cost) in energy products by framing the long-term gains (energy savings) as a gain of much greater value. These results have implications for widespread application, especially as government organizations try to find low-cost options to achieve their goals of energy efficiency. Since each situation is different, an all-encompassing conclusion cannot be drawn about the effectiveness of framing payback period over initial cost in every scenario, but the results of these scenarios are promising.

Despite the fact that 86% of the participants believe climate change is negatively effecting the planet, many do not think to consider the long-term energy consumption of the product they buy. Specifically, 60% of participants either were neutral or indicated they do not calculate long-term energy costs before making purchases that include energy use, while 78% indicated they do not consider CO₂ emissions. Here is an opportunity to help meet national energy goals. When decision environments require participants to consider long-term savings, they are more likely to choose the product option that saves more over time compared to the option that is cheaper upfront. With this knowledge, decision environments can be re-framed with long-term energy savings more prominent, which may help narrow the gap between intent and actual savings.

This experiment was done with student groups and not professional facility managers, although these engineering students could likely be making these types of decisions after graduation. This experiment was conducted under controlled settings more closely related to a laboratory than the real world, which would include more than four product choices, real money at stake, and additional institutional barriers. Therefore, future experiments should include

multiple iterations with actual facility managers managing real facilities. One potential downside, not tested, is normalization, where the intervention is no longer useful because decision makers become accustomed to the intervention. Determining if there is a “useful” life on choice interventions would also be helpful.

CONCLUSION

Despite government’s conventional efforts to reduce energy consumption, and decision makers’ commitment to energy reduction, energy consumption has not decreased to levels set by previous mandates and legislation. One likely reason for the gap between energy efficiency mandates and actual reductions in energy consumption is cognitive biases that prevent facilities managers from recognizing the energy efficient options.

Facility management decisions about energy efficiency compete for time against other managerial duties, potential cognitive biases (Wilson 2008; Wilson and Dowlatabadi 2007), and institutional barriers (Beamish and Biggart 2012). As in other fields, like finance (Thaler and Benartzi 2004), medicine (Johnson and Goldstein 2003), and infrastructure (Shealy et al. 2016b), choice architecture can help overcome biases and barriers to improve decision making outcomes. This study provides evidence that procurement decision environments influence product selection and that more conscious effort to design these processes may enable decision makers to more easily see the utility beyond initial cost.

To be clear, the objective of this study was not to favor one option over another but enable more awareness of the long term consequences of their decision. Long term energy efficiency is likely not a priority for an owner who is not the operator, but, for government facilities, the owner is the operator. Therefore greater awareness of the life cycle costs when making procurement decisions is in their own best interest. Prompting this awareness is of minimal risk and not coercive. At all times, the decision maker retains freedom of choice. While it is tempting to think that choices can be presented in a “neutral” way, the reality is that there is no neutral architecture. Any way a choice is presented will influence how the decision-maker chooses.

Although tested in a lab experiment, these results have direct application in the real world. Simply changing the procurement form to require considering payback period and energy savings of each product before making a procurement decision could lead to significant energy savings. If the three tested decision scenarios about HVAC systems, lighting, and galley freezer were applied to one government facility, the savings of those facilities would be 88%. Applied to all HVAC, freezer, and lighting products in government facilities throughout the country (we examined products that government buildings would likely use according to the Dept. of Energy), the savings would be approximately \$1.2 trillion (U.S. Department of Energy 2013). Obviously, not all government facilities are equivalent, nor are they being upgraded at all once. Yet the benefit of this approach is that restructuring a procurement form requires no new mandates, congressional acts, or executive orders.

Furthermore, the applications of additional choice architecture to help reduce energy consumption in buildings are immense. Future research could test how reducing choices helps account for choice overload when choosing energy-related products, and how defaults may account for status quo bias and heuristics where decision makers rely on past decisions about product choices. Ultimately, better understanding of how decisions are made can help to more quickly reach energy efficiency goals. A greater focus on the decision process can help redesign the decision environment to make energy efficient decisions easier for facility managers. The

intended outcome of this research is to spur further research that will apply behavioral decision science to effect lasting reductions of energy consumption in facilities, and more broadly, throughout the built environment.

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