Goal Framing to Encourage More Sustainable Engineering Design Decisions for the Built Environment Across Cultures

Dalya Nabil Fathy Ismael

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
In
Civil Engineering

Tripp Shealy, Chair
Michael J. Garvin
Annie R. Pearce
Andreas Hartmann

May 14th, 2019
Blacksburg, VA

Keywords: sustainability, built environment, choice architecture, goal framing

Goal Framing to Encourage More Sustainable Engineering Design Decisions for the Built Environment Across Cultures

Dalya Nabil Fathy Ismael

ABSTRACT

While regions like North America and Europe are increasingly recognizing the benefits of sustainable buildings and infrastructure, this awareness is still an obstacle in regions like the Middle Eastern and North African (MENA) region. The MENA region is one of the fastest developing in the world; however, it is the slowest in implementing sustainable construction practices. More focus needs to be given to emerging markets like the MENA region, which contribute one and a half times more global greenhouse gas emissions per capita than the U.S. The dissertation starts by identifying potential barriers to more sustainable design and construction in the MENA region, specifically among professionals in Kuwait. The results suggest that design and construction professionals in Kuwait undervalue sustainable design and construction practices that promote environmental sustainability compared to the U.S. This is potentially due to a lack of training and a limited awareness of the benefits. To help increase professionals sustainable design decisions, behavioral interventions to reframe sustainability rating systems that emphasize the benefits to people and finances are offered as a possible solution. In specific, goal framing is tested, which aims to emphasize the cascading benefits to society and long-term financial outcomes that environmental sustainability design provides. Goal framing was applied to the Envision rating system for sustainable infrastructure. Students (n=125), engineering professionals in the U.S. (n=42), and engineering professionals Kuwait (n=50) were randomly assigned either the original version of Envision or a modified version that included the intent for each credit framed to mention the benefits or consequences to people or finances. Goal framing the intent of credits about people and finances, not just the impact on the environment, increased participants motivation, and encouraged them to set higher goals for sustainable performance. A comparison among professionals in the U.S. and Kuwait is made while offering insight into the effectiveness of goal framing across cultures, where perceptions and value preferences for sustainable design likely vary. The effect of goal framing was

greater for professionals in Kuwait compared to professionals in the U.S., specifically those who hold a pro-social paradigm of the world. These findings have relevance to those who design, use, and mandate the use of rating systems during the design and construction process of buildings and infrastructure. Choice modifications that emphasize the impact of environmentally sustainable design on people and the long-term financial outcomes are more likely to increase their willingness to set high goals for sustainable design. These results are also useful for policymakers seeking alternatives to direct regulation, organizations engaged in city-level sustainability initiatives and institutes that support city and county level planning. Future research should continue to explore how engineering professionals make decisions and what behavioral decision theories can support design and engineering towards more sustainable outcomes.

Goal Framing to Encourage More Sustainable Engineering Design Decisions for the Built Environment Across Cultures

Dalya Nabil Fathy Ismael

GENERAL AUDIENCE ABSTRACT

The Middle Eastern and North African (MENA) region is one of the fastest developing in the world, however, some of its countries are the slowest in implementing sustainable construction practices. One of these countries is Kuwait, which contributes one and a half times more global greenhouse gas emissions per capita than the U.S. The dissertation starts by identifying potential barriers to more sustainable design and construction practices among professionals in Kuwait. The barriers identified are not technological, but behavioral, related to perceptions of risk and awareness. Behavioral science offers potential solutions to address these barriers through a concept called choice architecture. Professionals who design and construct our built environment use decision tools such as rating systems to inform their design decision making. These tools are inherently embedded with choice architecture. More intentional choice architecture among rating systems that align individual preferences and beliefs may increase the pursuit of more environmentally sustainable design solutions. One form of choice architecture is called goal framing, which describes the outcome of a choice as either a positive consequence of engaging in a behavior or a negative consequence of not engaging in a behavior. Goal framing was applied to the Envision rating system for sustainable infrastructure to emphasize how long-term sustainable outcomes align with decision makers immediate project needs, preferences, and values. Engineering professionals from the U.S. and Kuwait were randomly assigned either the original version of Envision or the goal framed version. The results indicate that goal framing the credits about people and finances, not just the impact on the environment, increased participants motivation and encouraged them to set higher goals for sustainable performance, specifically among professionals who hold a pro-social paradigm of the world. These findings have relevance to those who design, use, and mandate the use of rating systems during the design and construction process of buildings and infrastructure.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my advisor, Dr. Tripp Shealy for his patience and continuous support during my Ph.D. study. He has motivated and advised me with my research and writing skills, which allowed me to grow as a research scientist. I could not have imagined having a better advisor for my Ph.D. study.

I would like to thank the rest of my committee members: Dr. Michael Garvin, Dr. Annie Pearce, and Dr. Andreas Hartmann, for their insightful comments and encouragement. Their feedback challenged me to widen my research from various perspectives and strengthen the quality of my research.

Finally, I would like to thank my husband, Hisham, who was always by my side, supporting me in every possible way. This dissertation would not have been possible without your love, patience, and endless support. I would like to thank my parents, Nabil and Seham, and my older brothers, Hussam and Hishaam, for their continuous support in all aspects of my life. Finally, I would like to thank my love, and baby boy Adam, who filled my life with happiness when he arrived. Thank you for the many sleepless nights throughout my Ph.D. journey.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ATTRIBUTION

This foreword describes the contribution of each of the authors for the five manuscripts within this dissertation.

Chapter 2: *(In Press, Journal of Green Building)*

Dalya Ismael – developed the concept for the research, methodology, collected the data, completed statistical analysis, wrote the draft manuscript.

Tripp Shealy – helped validate the results, edited the manuscript.

Chapter 3: *(Published, Sustainability MDPI)*

Dalya Ismael – developed the concept for the research, methodology, collected the data, completed statistical analysis, wrote the draft manuscript.

Tripp Shealy – advised data analysis process, editing the manuscript.

Chapter 5: *(Draft Manuscript)*

Dalya Ismael – developed the concept for the research, collected data, completed the statistical analysis, and crafted the draft manuscript.

Tripp Shealy – provided feedback about the research concept and methods and provided multiple rounds of feedback and comments on the manuscript.

Chapter 6: *(Draft Manuscript)*

Dalya Ismael – developed the concept for the research, collected data, completed the statistical analysis, and crafted the draft manuscript.

Tripp Shealy – provided feedback about the research concept and methods and provided multiple rounds of feedback and comments on the manuscript.

Chapter 7: *(Draft Manuscript)*

Dalya Ismael – developed the concept for the research, collected data, completed the statistical analysis, and crafted the draft manuscript.

Tripp Shealy – provided feedback about the research concept and methods and provided multiple rounds of feedback and comments on the manuscript.

CHAPTER I

INTRODUCTION

Hundreds of billions of dollars are spent every year on the design and construction of the built environment (ASCE, 2013). These physical spaces and systems (i.e., roadways, water systems, buildings) contribute directly to sustainability outcomes such as resource consumption and climate-changing emissions (EIA, 2011). Present day decisions about the design and construction of our built environment create path dependence (Edwards et al., 2007). In other words, design and construction decisions today, dictate the future performance of these spaces and systems for generations.

Decision aids, ranging from rating systems to design software to building codes, are used to design, evaluate, and reward buildings and infrastructure projects that meet sustainability criteria. Embedded within any such decision aid is choice architecture, which refers to the way information is presented to a decision maker. Choice architecture is increasingly studied and applied to individual, consumer level decisions with positive outcomes related to retirement saving (EIA, 2011), organ donation (Johnson & Goldstein, 2003; Thaler & Benartzi, 2004) and consumer behavior (Goldstein et al., 2008; Levav et al., 2010).

Rating systems like the Envision Rating System for Sustainable Infrastructure (ISI, 2019) are filled with choice architecture, even when it is not intentionally designed. If the designers of these tools are unaware of decision biases and correcting interventions, they may unintentionally contribute to a process that leads away from more sustainable outcomes. LEED, for example, may inadvertently set goals that are too low (Jacowitz & Kahneman, 1995; Strack et al., 1988) thus discouraging the ambition needed to achieve sustainability performance that is technically and economically feasible (Klotz et al., 2010). The way these tools are designed has an impact on the future sustainability of the built environment. Yet, little is known about how these engineering and design decision tools influence decision making. Leading organizations recognize this interdisciplinary research gap that bridges decision science and engineering sustainability and the compelling reasons for bridging it (American Physical Society, 2008; U.S. National Science Board, 2009).

One way to help decision-makers’ during the design and construction process of the built environment to select more sustainable options is through choice architecture (Harris et al., 2016). Choice architecture reflects the fact that there are several ways to present a choice to decision-makers, and that what is chosen depends on how the choice is presented (Thaler & Sunstein, 2009). There are many forms of choice architecture to either make decisions easier or increase motivation to make a decision (Shealy & Klotz, 2017). One approach is through goal framing. Goal framing describes the outcome of a choice as either a positive consequence of engaging in a behavior or a negative consequence of not engaging in the behavior (Levin et al., 2002). Applied to rating systems it can emphasize how long-term sustainable outcomes align with decision makers immediate project needs, preferences, and values.

There are several reasons why applying goal framing to rating systems can help lead to more sustainable outcomes. First, goal framing uses persuasion to help users achieve their desired outcome. It works as a motivator in encourage action. This persuasive influence is achieved through helping people recognize and then pursue options congruent with their personal objectives. Goal framing is a popular approach in the field of communications because it can lead to an increase in trusting behavior (Levin et al., 2002). Goal framing also aligns outcomes about sustainability with user values and preferences which helps change how decision makers prioritize attributes during the design process for buildings and infrastructure. Goal framing creates modularity (Bargh et al., 2001) by affecting what decision makers cognitively attend to during decision making. This means goals provide value to decision makers, which can help override other aspects like monetary costs and long-term effects. Through overriding other aspects like monetary costs and long-term effects, goal framing can encourage pro-environmental behavior and lead to improved management of environmental problems (Steg & Vlek, 2009). Finally, goal framing increases attention and motivation (McClure, White, & Sibley, 2009), which helps decision makers recognize the benefits of sustainable credits within rating systems. Using this prior research as a testament, aligning goals or consequences of either a decision maker’s action or inability to take action, should help engineering professionals more quickly recognize the benefit of greater sustainability performance (Verhagen et al. 2012).

The adoption of greater sustainability performance is not only necessary in the United States but globally. Regions of the world like the Middle East and North Africa (MENA) are among the most rapidly developing. In order to better align decision making tools for sustainability, like rating systems, with decision makers stated values and preferences, their values and preferences first need to be defined. The next section provides a brief overview of the current state of sustainable design and construction of the built environment in a region of the world that historically, over the last half century has undervalued the benefits of sustainable design. The following section outlines the objective to test the effects of goal framing in the United States and in the MENA region, where values and preferences for sustainable design are likely not the same.

1.1 The Sustainable Built Environment in the Middle East and North African (MENA) Region

The adoption of sustainable design and construction practices, the use of rating systems, and market acceptance of sustainable design and construction is considerably lower in developing countries compared to the U.S. (CIB & UNEP-IETC, 2002; Marwa Heilman, 2016). The level of implementation of sustainable design and construction in industry is closely linked with the level of awareness (AlSanad, 2015), or lack of awareness, among decision makers and other stakeholder groups.

Awareness of sustainable design and construction of built environment spaces and systems is necessary globally, and specifically within the MENA region. Construction professionals in the MENA region operate in a unique culture that influence their decisions (AlSanad, Gale, & Edwards, 2011; Baloi, 2003; Davis, 2006; Star, 1999; Vinck, 2003). For example, in countries like Kuwait, energy and water utilities are highly subsidized by the government, and so environmental goals are typically not a concern. Engineering professionals in these contexts tend to undervalue sustainable design and construction practices that promote environmental sustainability. This is a stark contrast to design professionals in the U.S., where for over two decades the industry has increased adoption of sustainable design practices and resources (Meade & Presley, 2010).

1.2 Objective

The objective of the research presented in this dissertation is to measures the effect of a behavioral intervention on decisions about the built environment and compare the effects of the behavioral intervention across professionals in the United States and the MENA region. More specifically, the objective was to identify preferences and values of design professionals in the MENA region and use a technique called goal framing to help decision makers more quickly recognize how sustainable design aligns with their predefined preferences and values. Engineering professionals in regions of the world where energy is subsidized, might be more motivated to pursue sustainable design for the societal benefits opposed to the financial gains. These preferences are explored and modifications to the tools used during the design decision making process are tested. Aligning design choices with these preferences through goal framing can encourage greater adoption of sustainability performance. The following section outlines the chapters of this dissertation to meet this objective.

1.3 Outline of Chapters

The following chapters are organized as a series of independent papers each with their own abstract, introduction, body, and conclusion. There are seven subsequent chapters (including the conclusion chapter) that support each other to study the perceptions of sustainable design among engineering professionals in Kuwait, test a behavioral intervention on a decision-making tool to encourage more sustainable choices among professionals in Kuwait and the United States, and compare sustainability performance goals set between these professionals.

Chapter 2 highlights the importance of meeting global sustainable development goals. More focus on countries in the MENA region is necessary since awareness for sustainability in this global region is low. To identify how professionals' view sustainable design and construction, a survey was distributed to industry professionals in Kuwait. The results indicate professionals in Kuwait undervalue design and construction practices that promote environmental sustainability but prioritize design principles and features that contribute towards social sustainability. The results also indicate that there are sustainable practices that are not applicable to Kuwait but are currently being implemented. Implementing design techniques, technologies, and processes inappropriate for the geographic region can increase initial costs without providing long-term benefits, thus creating a negative perception about the benefits of sustainable design and construction (GORD, 2017). This chapter includes potential solutions that can help increase sustainability performance in Kuwait and future chapters tests these possible solutions.

Chapter 3 describes sustainable construction as being fundamentally different than traditional construction because it requires whole systems thinking and early collaboration across stakeholders. Construction professionals unfamiliar with this mindset can perceive sustainable construction as risky. To understand how the Kuwaiti construction industry perceives risks associated with sustainable construction, a survey with a list of risk elements associated with sustainable design and construction was given to industry professionals in Kuwait. The results specify risks that industry professionals in Kuwait perceive as having the highest probability of occurrence and highest possible negative impact on future projects. The lack of experience in sustainable design and construction appears to increase perceived risks among construction professionals in Kuwait. This perceived risk and higher cost for sustainable materials and equipment likely act as a barrier to adoption of new sustainable techniques and technologies. The chapter ends with possible solutions such as educational interventions, changes in risk allocation, and behavioral science to reframe upfront costs as long-term savings and reduce the high perceptions of risk.

Chapter 4 is intended to emphasize the need for more research merging behavior science and engineering. It highlights the perceptions of engineering professionals in Kuwait in terms of sustainable design practices and perceived risks. Then it introduces the path forward based on the outcomes of Chapter 2 and 3. Recommendations are described to help decision makers achieve better sustainability outcomes by tailoring behavioral interventions using the insight learned from Chapters 2 and 3. Specifically, the application of goal framing, a behavioral intervention to better align credits within rating system with users' preferences and values. The purpose is to help professionals place a higher priority on sustainable design and construction practices. Better aligning decision tools like rating systems to highlight the social and economic benefits of sustainability may reduce the barriers identified in the results of Chapters 2 and 3 among professionals in Kuwait. Framing can elicit greater awareness, enabling decision-makers to more quickly recognize the value sustainability adds to the design and construction of built environments.

Chapter 5 attempts to merge behavioral science and design for sustainability through the application of goal framing and the Envision rating system. Goal framing is presented in various fields of study as a potential strategy to improve decision making. It offers simple and cost-effective approaches to help achieve more desirable outcomes. Engineering professionals in Kuwait were provided with a decision scenario and asked to use Envision to make design decisions. Engineering professionals were randomly assigned either the goal framed version or the standard version of Envision. The results indicate that credits goal framed emphasizing the social or financial outcomes significantly improved engineering professionals' consideration for sustainability. Small interventions to how credits are framed can influence how professionals' interface with the decision process. The implication is that more thoughtfully designed decision tools are needed to encourage engineering professionals and others during the design and construction process to consider the higher levels of sustainable performance that is possible.

Chapter 6 continues to merge behavioral science and decision making for sustainability. This chapter measures the impact on design choices of changes to the framing of the Envision rating system among students and engineering professionals (e.g., architects, engineers, and builders) in the U.S. Similar to Chapter 5, participants use Envision to make tradeoffs about sustainability for a recreational park and holding facility project for reclaimed wastewater. Half of the participants randomly received the goal framed version of Envision, and the other half received the standard version of Envision. The results are similar to the professionals in Kuwait. Framing the intent of credits increased both students and professional's motivation to achieve high levels of sustainability performance.

Chapter 7 reports the difference in influence and effectiveness of goal framing between industry professionals in Kuwait and the United States. These industry professionals likely hold varying preferences and values about the environment, come from distinct cultures with varying social and institutional norms. The comparison shows that framing credits to highlight the effect on people or money increased motivation to set higher goals for sustainability greater among professionals in Kuwait compared to professionals in the U.S. Engineering professionals in Kuwait were more likely to value credits that were framed to emphasize benefits to people, whereas in the U.S., engineering professionals placed more value on credits that were framed to emphasize financial gains. The findings not only advance knowledge in engineering about how choice architecture applies to high-impact stakeholder decisions, but also more generally about how behavioral interventions vary across culture and context.

Chapter 8 stresses the need for more research merging behavioral science and engineering. Choice modifications to the tools used during the design and construction process can help increase the goals set for more environmentally sustainable design decisions across global regions. A more nuanced outcome of this dissertation is the comparison of behavioral interventions among professionals with different cultural values i.e., based on their ecological worldviews, political, social and economic differences, and their different drivers for sustainability. While similar results of choice interventions were found between professionals in Kuwait and the United States the size of the effect was higher among professionals in Kuwait. The professionals in Kuwait and the U.S. responded differently when credits emphasize social or financial outcomes. These differences suggest that custom choice modifications give context and predefined preferences and values of decision makers is necessary. The results from the previous chapters can help inform future versions of rating systems, but also other decision-making tools, intended for engineering stakeholder groups who design and construction our built environment.

References

AlSanad, S. (2015). Awareness, drivers, actions, and barriers of sustainable construction in Kuwait. *Procedia Engineering*, *118*, 969–983. https://doi.org/10.1016/j.proeng.2015.08.538

AlSanad, S., Gale, A., & Edwards, R. (2011). Challenges of sustainable construction in Kuwait: Investigating level of awareness of Kuwait stakeholders. *World Academy of Science, Engineering and Technology, International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering*, *5*(11), 753–760.

American Physical Society. (2008). Energy = Future: Think Efficiency. Retrieved December 6, 2017, from https://www.aps.org/energyefficiencyreport/report/aps-energyreport.pdf

ASCE. (2013). Failure to Act: The Impact of Current Infrastructure Investment on America’s Economic Future. Retrieved December 6, 2017, from https://www.infrastructurereportcard.org/wp-content/uploads/2016/05/2016-FTA-Report-Close-the-Gap.pdf

Baloi, D. (2003). Sustainable construction: challenges and opportunities. Retrieved December 6, 2017, from http://www.arcom.ac.uk/-docs/proceedings/ar2003-289-297_Baloi.pdf

CIB, & UNEP-IETC. (2002). *Agenda 21 for sustainable construction in developing countries: a discussion document* [Report]. Retrieved from CSIR website: https://researchspace.csir.co.za/dspace/handle/10204/3511

Davis, H. (2006). *The Culture of Building*. Oxford University Press, USA.

Edwards, P., J. Jackson, S., C. Bowker, G., & Knobel, C. (2007). *Understanding Infrastructure: Dynamics, Tensions, and Design*.

EIA. (2011). Total Energy Flow. Retrieved December 6, 2017, from http://www.eia.gov/totalenergy/data/annual/diagram1.cfm

Goldstein, D. G., Johnson, E. J., Herrmann, A., & Heitmann, M. (2008, December 1). Nudge Your Customers Toward Better Choices. Retrieved December 6, 2017, from Harvard Business Review website: https://hbr.org/2008/12/nudge-your-customers-toward-better-choices

GORD. (2017). Gulf Organization for Research and Development. Retrieved March 25, 2017, from http://www.gord.qa/trust-gsas-resource-center-overview

Harris, N., Shealy, T., & Klotz, L. (2016). How Exposure to “Role Model” Projects Can Lead to Decisions for More Sustainable Infrastructure. *Sustainability*, *8*(2), 130. https://doi.org/10.3390/su8020130

ISI. (2019). Institute for Sustainable Infrastructure |. Retrieved March 26, 2019, from https://sustainableinfrastructure.org/

Jacowitz, K. E., & Kahneman, D. (1995). Measures of Anchoring in Estimation Tasks. *Personality and Social Psychology Bulletin*, *21*(11), 1161–1166. https://doi.org/10.1177/01461672952111004

Johnson, E. J., & Goldstein, D. (2003). Do Defaults Save Lives? *Science*, *302*(5649), 1338–1339. https://doi.org/10.1126/science.1091721

Klotz, L., Mack, D., Klapthor, B., Tunstall, C., & Harrison, J. (2010). Unintended anchors: Building rating systems and energy performance goals for U.S. buildings. *Energy Policy*, *38*(7), 3557–3566. https://doi.org/10.1016/j.enpol.2010.02.033

Levav, J., Heitmann, M., Herrmann, A., & Iyengar, S. (2010). Order in product customization decisions: Evidence from field experiments. Retrieved December 6, 2017, from https://www0.gsb.columbia.edu/mygsb/faculty/research/pubfiles/2619/Levav,%20Heitmann%20et%20al%20JPE.pdf

Levin, I., Gaeth, G., Schreiber, J., & Lauriola, M. (2002). A New Look at Framing Effects: Distribution of Effect Sizes, Individual Differences, and Independence of Types of Effects. *Organizational Behavior and Human Decision Processes*, *88*, 411–429. https://doi.org/10.1006/obhd.2001.2983

Marwa Heilman, V. (2016). *Factors hindering the adoption of sustainable design and construction practices : the case of office building development in Dar es Salaam, Tanzania*. https://doi.org/http://dx.doi.org/10.18419/opus-9149

McClure, J., White, J., & Sibley, C. G. (2009). Framing effects on preparation intentions: distinguishing actions and outcomes. *Disaster Prevention and Management: An International Journal*, *18*(2), 187–199. https://doi.org/10.1108/09653560910953252

Meade, L., & Presley, A. (2010). Benchmarking for sustainability: an application to the sustainable construction industry. *Benchmarking: An International Journal*, *17*(3), 435–451. https://doi.org/10.1108/14635771011049380

Shealy, T., & Klotz, L. (2017). Choice Architecture as a Strategy to Encourage Elegant Infrastructure Outcomes. *Journal of Infrastructure Systems*, *23*(1), 4016023. https://doi.org/10.1061/(ASCE)IS.1943-555X.0000311

Star, S. L. (1999). The Ethnography of Infrastructure. *American Behavioral Scientist*, *43*(3), 377–391. https://doi.org/10.1177/00027649921955326

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behavior: An integrative review and research agenda. *Journal of Environmental Psychology*, *29*(3), 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004

Strack, F., Martin, L. L., & Schwarz, N. (1988). Priming and communication: Social determinants of information use in judgments of life satisfaction. *European Journal* *of Social Psychology*, *18*(5), 429–442. https://doi.org/10.1002/ejsp.2420180505

Thaler, R. H., & Benartzi, S. (2004). Save More Tomorrow™: Using Behavioral Economics to Increase Employee Saving. *Journal of Political Economy*, *112*(S1), S164–S187. https://doi.org/10.1086/380085

Thaler, R. H., & Sunstein, C. R. (2009). *Nudge: Improving Decisions about Health, Wealth, and Happiness*. Penguin.

U.S. National Science Board. (2009). Building a Sustainable Energy Future. Retrieved December 6, 2017, from https://www.nsf.gov/pubs/2009/nsb0955/nsb0955.pdf

Verhagen, E., Ketter, W., Rook, L., & Dalen, J. van. (2012). The impact of framing on consumer selection of energy tariffs. *2012 International Conference on Smart Grid Technology, Economics and Policies (SG-TEP)*, 1–5. https://doi.org/10.1109/SG-TEP.2012.6642391

Vinck, D. (2003). *Everyday Engineering: An Ethnography of Design and Innovation*.

CHAPTER 2

INDUSTRY PERCEPTIONS OF SUSTAINABLE DESIGN AND CONSTRUCTION PRACTICES IN KUWAIT

2.1 Abstract

To better meet global sustainable development goals will require more focus on countries in the Middle East and North African (MENA) region, like Kuwait, which contribute one and a half times more global greenhouse gas emissions per capita than the United States. Buildings contribute more than half of these emissions. Rating systems like LEED and BREEAM can help reduce energy emissions from buildings globally when used during construction, but these rating systems are not entirely applicable to Kuwait as they are not tailored for its geographic climate and social context, and there is currently no rating system tailored for energy efficient and environmentally sustainable buildings. The research presented in this paper measures the industry's perceptions about sustainable design and construction practices in Kuwait. A synthesized list of sustainable design and construction principles were developed from the six most common rating systems globally that are currently being used in the MENA region. Construction professionals (n = 131) from Kuwait were asked in a qualitative survey, which sustainable design principles and construction practices are the most applicable but are not being implemented. The majority of professionals responded that sustainable practices related to water use reduction and renewable energy sources are most applicable but are not currently being implemented. They also responded that sustainable practices related to bicycle facilities, green roofs, and rainwater harvesting are not applicable but are currently being implemented. The lack of training and limited awareness of the benefits of sustainable design and construction may be contributing to these backward practices. As a whole, professionals in Kuwait appear to undervalue sustainable design and construction practices that promote environmental sustainability. This study provides a benchmark, indicating a lack of shared viewpoints and illustrates the need for more common objectives and the need for training among design and construction professionals in the region.

2.2 Introduction

Kuwait is a small, oil-rich country in the Middle East, between Iraq and Saudi Arabia, but has one of the world's largest oil reserves. In the last 20 years, Kuwait’s population has grown by 137% (The World Bank, 2016), leading to an increase in demand for new buildings and infrastructure services. Kuwait is now a leader in the region for construction development (AlSanad et al., 2011). The number of construction permits rose 40% between 2007 and 2011 (Altoryman, 2014) and housing units increased by about 400% (Kuwait Central Statistical Bureau, 2018). Unfortunately, Kuwait compared to other countries in the Middle East and North African region (referred to as MENA), is one of the least committed to sustainable design and construction with the lowest rate of buildings in the region certified by third-party sustainability rating systems (AlSanad, 2015).

The last 20 years of available data from The World Bank (2016) about Kuwait indicates high environmental impacts, high energy use, increased air pollution, and waste creation. There was a 145% increase in carbon dioxide emissions and a 16% increase in electric power consumption per capita over the last 20 years (The World Bank, 2016). These rising emissions could partly be because Kuwait relies on desalination to produce potable water, which further contributes to electricity use and carbon emissions (M. A. Darwish, Al-Awadhi, & Darwish, 2008). The annual landfill waste of Kuwait’s construction industry has also doubled from 6,658,413 tons in 2009 to 12,103,364 tons in 2014 (Kuwait Central Statistical Bureau, 2018). These environmental impacts exceeded consumption per capita compared to countries like the United States.

Kuwait is not alone in contributing to high environmental impacts, in fact, many other countries in the MENA region have had an increase in energy consumption. Overall, the MENA region in the past 20 years has increased the total carbon dioxide emissions due to energy use by around 114% and per capita by 44% (The World Bank, 2016). While this region currently only contributes nearly six percent of the world’s carbon dioxide emissions, the trend suggests the region will continue to become a larger contributor of global emissions in the near future (World Energy Council, 2011).

While the global trend emphasizes sustainability (Xia, Zuo, Peng, & Yongjian, 2014), Kuwait, and the MENA region, lag behind. The United States Green Building

Council (USGBC) has announced the top ten countries outside the United States that are contributing significantly to sustainable building design and construction globally. China is on top of the list, followed by Canada and India, and only one country from the MENA region, the United Arab Emirates, is listed in tenth place (USGBC, 2016). While the term sustainable design and construction can vary widely, in this context, the term means contribute buildings and infrastructures to improve the well-being of people and the planet for generations (Parkin, 2000). The term sustainable design and construction builds from the landmark Brundtland Report (1987) that defines sustainability as the ability to ensure the well-being of current and future generations within the limits of the natural world.

A possible obstacle to more sustainable design and construction in the MENA region and specifically Kuwait is the high energy subsidization by the government. Nearly 85% of electricity costs are subsidized (AlSanad, 2015). Another possibility is education and training related to sustainable design and construction in the local industry (Pitts & Lord, 2007a). Additional possibilities include the lack of integration between projects, lack of life-cycle costing, and insufficient technical information for sustainable products (Sustainable Building Task Force, 2001). Countries like Kuwait need guidance to deliver more economic, socially, and environmentally sustainable buildings.

Rating systems for sustainable design and construction are one approach to provide guidance (Doan et al., 2017). They are designed to assist decision makers by providing a framework with precise criteria for assessing varying aspects of buildings or infrastructure (Bernardi, Carlucci, Cornaro, & Bohne, 2017). A few of their many benefits include reduced maintenance costs, improved employee productivity, and reduced health and safety costs (Ries, Bilec, Gokhan, & Needy, 2006). At the moment, there are only two buildings in Kuwait certified by the third-party rating system Leadership in Energy and Environmental Design (LEED) and a few others in the certification process. Since there is no rating system tailored for Kuwait’s context, rating systems like LEED that are currently being used might not be the most beneficial given the local geographic region and social context. For instance, energy and water-related credits constitute approximately 40% of the possible points on the LEED rating scale, but those aspects might not motivate industry professionals in Kuwait because energy and water are subsidized. Some credits are also not applicable to Kuwait due to its extremely hot weather such as bicycle facilities and walking proximity to other services, while other credits related to cultural aspects and historical sites that are a high priority in the MENA region are missing.

Industry professionals in regions like North America and Europe already recognize that sustainable buildings are financially beneficial because they offer increased property value (Blumberg, 2012; Dermisi, 2009), a longer project life cycle, and can improve occupant productivity (World Green Building Council, 2013b). At the same time, these buildings provide societal benefits, reduce strain on local infrastructure by conserving water, and create better air and water quality (World Green Building Council, 2013b). The long-term objective is to encourage similar adoption of these practices among building professionals in Kuwait and the entire MENA region.

The purpose of this research is to better understand the perceptions about sustainable design and construction among industry professionals in Kuwait and shed light on barriers keeping Kuwait from adopting tools, rating systems, and processes that contribute to more global sustainable design and construction practices. The research begins with a review of sustainable construction practices and provides an overview of the construction industry in the MENA region, and specifically Kuwait. Current existing global rating systems are then used to develop a list of sustainable design principles and construction practices. This list was used to measure perceptions of industry professionals in the Kuwaiti construction industry. The method for developing the survey instrument are outlined in the methods sections. The results provide insight into perceptions of sustainable design and construction practices in the Kuwaiti construction market. By understanding these perceptions, future research can then begin to test interventions to change individual behavior among building professionals and market value to more quickly adopt applicable sustainable design principles and construction practices in the region.

2.3 Background

Global organizations offer sustainable design guidelines and recommendations for international use, but they often lack specificity. For example, the United Nations Earth Summit, where international leaders meet to discuss global environmental issues, recommends 12 main design guidelines in Agenda 21 for consideration in international sustainable design and construction. The International Council for Research Innovation in Building and Construction (CIB) that facilitates international cooperation between governmental research institutes in the building and construction sector highlight seven principles for sustainable construction that can help assess and evaluate sustainable building elements. However, those international principles are for all types of sustainable construction and may not apply to all countries and contexts.

Rating systems typically have the same limitation. They may provide more detailed directives for sustainable design and construction practices; however, they are not universal and are typically designed with one country or global region in mind. Examples of rating systems that do not offer flexibility for different regions are the Comprehensive Assessment System for Built Environment Efficiency (CASBEE), Building Research Establishment Environmental Assessment Method (BREEAM), Green Star, and Leadership in Energy and Environmental Design (LEED) (AlWaer, Sibley, & Lewis, 2008). Consequently, the decision-making process of choosing sustainable design principles and construction practices to implement can be a risky choice. Adopting a rating system intended for another country's local historical, financial, cultural, technological, social or climatic context may be less beneficial for a country who was not the original intended user (Attia & Dabaieh, 2013; Pocock, Steckler, & Hanzalova, 2016). Some design principles and construction practices are likely not applicable or increasingly challenging to meet. Additionally, countries like Kuwait have a distinctive culture, that focuses on introducing architectural designs and landmarks that strongly reflect its culture, and this may not be the case across all countries.

In addition to the lack of flexibility of many rating systems, other characteristics and perceptions of rating systems include the lack of comprehensiveness, no relative importance of performance, the limited attention to functional variations in different types of buildings, and the structure of points given to credits (AlWaer et al., 2008). The structure of points or weight given to credits on a rating system may not represent the greatest need in the region. Kuwait, for example, has specific critical issues that warrant custom sustainable design principles and construction practices such as extreme heat. Extreme heat increases the time spent indoors, leading to high electricity consumption for air conditioning and other appliances, which contributes to more greenhouse gas emissions. A rating system specific to Kuwait should prioritize credits by weighting points assigned to insulation, energy efficient air-cooling equipment, passive cooling techniques, and indoor air quality. Currently, this all depends on the professionals' level of understanding and awareness towards what is applicable and their willingness to pursue new design principles and construction practices for their building projects.

In Kuwait, the majority of industry professionals have a low level of awareness about sustainability (AlSanad et al., 2011), which has an impact on the long-term performance of buildings and occupants. For example, many projects use recycled materials but do not consider that some of them could potentially emit volatile organic compounds (VOC) during or after installation (Pacheco-Torgal et al., 2012). Part of the problem is those responsible for the design and construction of buildings believe that their clients are more interested in other goals, such as reducing initial costs (Laustsen, 2008a), or they neglect developing project sustainability goals (Mukherjee & Muga, 2010).

Existing perceptions may also result in low sustainability progress. A common perception in the construction industry is sustainable buildings cost more than conventional buildings (Darko & Chan, 2016; Geng, Dong, Xue, & Fu, 2012; Sherwin, 2006). Sustainable buildings can include additional expensive technologies and higher labor costs (Geng et al., 2012), but the perceptions of increased cost are not always true. Sustainable buildings can save money, not just throughout the project's lifecycle by reducing energy and water consumption, and lowering long-term maintenance costs, but also upfront costs, especially if strategies for sustainability are integrated at an early stage of project planning (World Green Building Council, 2013b).

To encourage organizations to implement sustainable design principles and construction practices requires an understanding of what practices are being adopted in construction projects (Pearce, Shenoy, Fiori, & Winters, 2010), and professionals' perceptions of sustainability. In Ghana, the top barriers are resistance to cultural change, under commitment from government, and lack of professional knowledge (Ametepey, Aigbavboa, & Ansah, 2015). These barriers are not that different from perceived barriers in the United Kingdom more than a decade ago (Sourani & Sohail, 2011). Today, however, in more developed countries like the United States and the United Kingdom, stakeholders report having sufficient knowledge about sustainable design principles and construction practices and are also encouraged by their organizations to engage in sustainability-related topics (Ahn & Pearce, 2007). Literature is limited about the construction practices implemented in the MENA region, specifically Kuwait. This has resulted in a lack of consideration for local material availability and a lack of safety regulations for construction (Kartam et al., 2000), which has led to significant cost and time overruns within the residential market (Koushki & Kartam, 2004). A lack of consideration for sustainability may also contribute to similar adverse outcomes.

The purpose of this research is to understand industry perceptions of sustainable design principles and construction practices in Kuwait. This research also helps develop an understanding about which principles of sustainable design and construction practices industry perceives as highly applicable and which principles and practices industry perceives are already being implemented. The discussion and conclusion sections of this paper offer recommendations for greater adoption and more consideration for sustainable practices in the future. The research presented in the paper also adds to the growing body of literature about how global perceptions of sustainability influence local design and construction practices.

2.4 Research Questions

Five specific research questions contribute to help explain industry perceptions of sustainable design and construction practices in Kuwait:

1. What are the perceived barriers to more sustainable buildings in Kuwait?
2. What sustainable design principles and construction practices are perceived as *applicable* but are *not being implemented*?
3. What sustainable design principles and construction practices are perceived as *not applicable* but *are being implemented*?
4. What function of sustainable design and construction is perceived as the highest priority for the Kuwait building industry: to conserve or restore the environment, contribute to increased value for people, or provide financial benefit based on the perceived degree of applicability and degree of implementation?

5. Do significant differences exist in perceived value among professional groups (architects, site engineers, and project managers)?

The expectation is the low rate of progress towards sustainability in the Kuwaiti construction industry is, in part, due to a perception among industry professionals that sustainable design and construction costs more and this limits the adoption of these principles practices. The expectation is that cost is perceived to be higher because sustainable design principles and construction practices that are not relevant or applicable to Kuwait may be implemented, thus adding unnecessary costs and leading to negative perceptions about sustainable design and construction. Conversely, some practices that are applicable to the region may not be perceived as being implemented. The expectation is to find design principles and construction practices related to elements of finance and people to be of higher priority than those related to the environment. Yet, differences in priority likely exist between various professional groups like architects, site engineers, and project managers. The expectation is to find differences in opinion and perceived value about sustainable design principles and construction practices among these groups of professionals.

2.5 Methods

A survey instrument consisting of two sections was developed and validated to measure industry professionals' perceptions of sustainable design principles and construction practices. The purpose of the survey instrument was to measure perceived barriers to more sustainable buildings in Kuwait, understand the sustainable design and construction principles that are perceived as applicable and not applicable, and gauge which are believed to be implemented.

The first section of the survey included demographic questions, such as years of experience, job position, and type of organization. Another set of three questions asked respondents to describe their perceived level of awareness about the benefits of sustainable design and construction in Kuwait, the current percentage of projects in their organization that includes sustainable design and construction elements, and to identify top reasons for the contribution towards sustainable design and construction nationally. The possible reasons, obtained from literature, included: sustainable design and construction risks are more difficult to manage compared to conventional building design and construction projects (Robichaud & Anantatmula, 2011a), high governmental energy and water subsidies discourage consideration for sustainable design and construction practices, professionals do not understand the negative impacts of conventional design and construction practices, there is little organizational support to develop the skills needed for sustainable design and construction practices, higher cost compared to conventional design and construction (Darko & Chan, 2016), and little awareness or knowledge of sustainable benefits (AlSanad, 2015). Whether experts or novices in sustainable design and construction, the purpose of the survey was to measure perceived industry barriers and develop an understanding of the perceived applicability of sustainable design and construction principles. Understanding their perceptions could potentially be the cause of the lack of sustainable development in the country.

Section two included a synthesized list of sustainable design principles and construction practices asking respondents to indicate using two Likert scales the degree of applicability and implementation (1 = very low degree of current applicability/implementation and 5 = very high degree of current applicability/implementation). A Likert scale was used because of its ability to distinguish the extent of perceived applicability and implementation. This ordinal scale offers more choice than a binary response and offers the ability to aggregate responses compared to open-ended questions that introduce interpretation bias. This list was developed by first developing a list of rating systems for sustainable construction globally (Table 1). Rating systems used in certifications for buildings in the MENA region were then chosen to compare elements of design and construction practices. For example, LEED has certified projects in Kuwait and the U.A.E., so it was included in the cross-sectional comparison. In total, six rating systems were used in the development of survey questions. Design principles and construction practices that appeared in any of the rating systems were included in the survey. Elements of sustainable design and construction that were redundant across two or more rating systems were combined into a single element. Appendix A lists the synthesized design principles and construction practices used in the survey.

Table 1. Rating systems used to guide the design of survey questions for industry professionals

Number	Rating System	Categories	Certification Levels	Organization
1	Leadership in Energy and Environmental Design (LEED)	Location & Transportation, Sustainable Sites, Water Efficiency, Energy & Atmosphere, Material & Resources, Indoor Environmental Quality, Innovation, & Regional Priority	Certified Silver Gold Platinum	U.S. Green Building Council (USGBC)
2	Building Research Establishment Environmental Assessment Method (BREEAM)	Energy, Health & Wellbeing, Innovation, Land Use, Materials, Management, Pollution, Transport, Waste, & Water	Pass Good Very Good Excellent Outstanding	United Kingdom Building Research Establishment
3	The Pearl Building Rating System (PBRS)	Integrated Development Process, Natural Systems, Livable Buildings, Precious Water, Resourceful Energy, Stewarding Materials & Innovating Practice	1 Pearl 2 Pearl 3 Pearl 4 Pearl 5 Pearl	Department of Urban Planning and Municipalities
4	The Green Pyramid Rating System (GPRS)	Sustainable Sites Development, Water Saving, Energy Efficiency & Environment, Materials Selection & Construction System, Indoor Environmental Quality, Innovation & Design Process, & Recycling of Solid Waste.	Silver Pyramid Golden Pyramid Green Pyramid	Egyptian Green Building Council
5	The Global Sustainability Assessment System (GSAS)	Urban Connectivity, Site, Energy, Water, Materials, Indoor/Outdoor Environment, Cultural & Financial Value, & Management & Operations.	Level 0 Level 1 Level 2 Level 3	Gulf Organization for Research and Development (GORD)
6	The ARZ Building Rating System	Energy Performance, Thermal Energy, Electrical Energy, Building Envelope, Materials, Indoor Air Quality, Operations & Management, Water Conservation, & Bonus.	Certified Bronze Silver Gold	Lebanon Green Building Council (LGBC)

Before distributing the survey, the content was validated using a small group of industry professionals in Kuwait. Based on the professionals' feedback, some questions in section one were modified to improve clarity. Mainly, rewording questions and deleting redundancy. Related to the second section, another comment was to have the degree of applicability and degree of current implementation columns next to each other instead of below each other to reduce the time to complete the survey.

Survey distribution

The survey was distributed by email and in-person. Industry professionals were recruited from both the private and public sector of the Kuwaiti design or construction industry. All architecture design firms and construction companies in Kuwait were initially contacted to identify industry professionals working in the private sector willing to participate in the survey. Contacts for professionals were identified through emails to publicly listed email addresses on company websites and subsequent follow-up emails to administrative staff to develop a contact list. The criteria for participating was that industry professionals needed to be familiar with the current state of practice in Kuwait's design and construction market. Public sector professionals were identified through emailing publicly available email addresses associated with government departments that handle engineering and construction for the country. Using a similar process to identify private industry contact information, subsequent emails with administrative staff helped create a list of industry professionals with engineering and design background. In total, 195 industry professionals in Kuwait agree to participate. Out of the 195 distributed surveys, 131 responded (67%).

Data analysis

To identify the sustainable practices perceived as applicable but lacking implementation and vice versa, the survey responses were clustered into two different groups. The first group was named as "high degree of applicability and low degree of implementation." These were the principles and practices where 50% or more of respondents agreed 'high' or 'very high' applicability and 'low' or 'very low' degree of implementation. The same was done for the second group which was named "low degree of applicability and high degree of implementation."

To answer what are the perceived barriers to more sustainable buildings in Kuwait, the top ten reasons by frequency of being chosen for the low rate of progress are listed in the results. Similarly, to answer what sustainable design principles and construction practices are perceived as *applicable* but are *not being implemented* and which are perceived as *not applicable* but *are being implemented*, the top ten design principles and construction practices by frequency of being chosen are listed. Individual elements were clustered by their primary function, to either conserve or restore the environment, contribute to increased value for downstream users, or provide financial benefit for professionals. These clusters of elements were used to answer what function of sustainable design and construction is perceived as the highest priority for the Kuwait building industry. A one-way ANOVA test with Tukey post-hoc pairwise comparison was used to measure a significant difference between these clusters of elements related to conserving or restoring the environment, contributing to increased value for downstream users, or providing financial benefits for professionals. A one-way ANOVA test with Tukey post-hoc pairwise comparison was used because this statistical approach allows for the testing of multiple variables and produces fewer type one errors compared to multiple two-sample t-tests. An alpha of 0.05 was used to indicate a minimum level of significant difference. To measure the significant difference in response among architects, site engineers, and project managers, a Fisher's Exact Test was used to compare perceptions of high degree of applicability, and a Pearson's Chi-Squared Test was used to compare high degree of current implementation. A Fisher's Exact test and a Pearson's Chi-Squared Test were used to ensure that there are nonrandom associations between the professional groups and that the observed differences between were not by chance. A Fisher's Exact test was used when comparing perceived applicability because the data were categorical and unequally distributed between architects, site engineers, and project managers. A Pearson's Chi-Squared Test was used when comparing perceived implementation because the data were categorical and more equally distributed respondents.

2.6 Results

The number of survey respondents classified by professional groups is summarized in Table 2. Project managers and site engineers were nearly equal in number and comprise the majority of respondents. Almost half of the respondents (45%) indicated they have more than ten years of industry experience, 28% between 5-10 years, and 27% with less than five years. The types of organizations represented include 27% as the contractor, 25% as the client or client representative, and 18% as a design consultant. The remaining 30% was divided among subcontractors and suppliers. The typical project type was grouped as either residential, commercial/office, or industrial. Of the 131 respondents 17% work in the residential industry, 27% in the commercial industry, 29% in the industrial industry and 26% in all three.

Table 2. Number of participants classified by job title

Professional Group	**Number of Responses (%)**
Project Managers	49 (40)
Site Engineers	53 (43)
Architects	20 (16)

In addition, the survey asked for their level of awareness about sustainability. Only 19% of the respondents stated that their knowledge about sustainable design and construction practices is “Good,” 41% said “Moderate,” and the remaining 40% chose “Poor” or “Very Poor.” The majority (84%) were not accredited by any organization for sustainable design or construction practices.

Respondents were also asked about the status of sustainable design and construction building projects in their current company. Nearly half of the participants (47%) stated that their company hardly integrates sustainable design or construction practices in their projects (between 1%-19% of their company’s current projects). Only 3% of professionals stated their company incorporates sustainable design principles or construction practices 80 to 100% into their current design or construction projects.

What are the perceived barriers to more sustainable buildings in Kuwait?

Based on the perceptions of industry professionals, the low rate of progress towards sustainable design and construction in Kuwait is mainly due to lack of awareness or knowledge of benefits (51.9%), and the perceived higher cost compared to conventional buildings (42.7%). Table 3 lists the top ten reported reasons for the low rate of progress.

Table 3. Reported reasons for the low rate of progress towards sustainability in the Kuwaiti design and construction industry

Reasons	**Number of Responses (%)**
Little awareness or knowledge about the benefits of sustainable design and construction	68 (51.9)
Higher cost compared to conventional design and construction practices	56 (42.7)
Stakeholders do not understand the negative impacts of conventional design and construction practices	52 (39.7)
No organizational support to develop the skills needed for sustainable design and construction practices	33 (25.2)
There are high governmental energy and water subsidies	22 (16.8)
Sustainable design and construction risks are more difficult to manage	10 (7.6)

Note: More than one choice was allowed.

What sustainable design principles and construction practices are perceived as applicable but are not being implemented?

Table 4 includes the top 10 sustainable design principles and construction practices that are perceived by industry professionals as applicable to Kuwait but currently lack implementation. The sustainable design principles and construction practices with the highest levels of agreement between professionals are water use reduction, green building training, and skills development, use of renewable energy sources, amenities that control emissions and pollutants, waste recycling, air quality management, and using recycled materials. These sustainable practices are agreed on by nearly three-quarters of the respondents.

Table 4. Sustainable design principles and construction practices agreed among industry professionals that are applicable but are currently not being implemented in Kuwait.

Rank	Applicable design principles and construction practices not being implemented	Percentage Agreement
1	Water use reduction	88.7%
2	Sustainable building training and skills development	87.2%
3	Renewable energy sources (production)	87.0%
4	Amenities that control emissions and pollutants	83.9%
5	Employing waste recycling on site	81.5%
6	Construction air quality management	80.5%
7	Using recycled materials	76.4%
8	Ecological strategies	73.7%
9	Rapidly renewable materials	73.1%
10	Redevelopment of contaminated land	71.3%

Note: Results include the credits where there was 50% or more agreement between the professionals.

What sustainable design principles and construction practices are perceived as not applicable but are being implemented?

Several sustainable design principles and construction practices that professionals perceived as not applicable to Kuwait but are currently being implemented are shown in Table 5. The most predominate are bicycle facilities, green roofs, and rainwater harvesting with nearly 20% of respondents agreeing. Implementing sustainable practices and features that are not applicable to the country may discourage professionals since that may lead to unnecessary costs and no benefits.

Table 5. Sustainable design principles and construction practices agreed among industry professionals that are not applicable but are currently being implemented in Kuwait.

Rank	Not applicable sustainable design principles and construction practices being implemented	Percentage Agreement
1	Bicycle facilities	32.6%

2	Green roofs	20.8%
3	Rainwater harvesting	19.9%
4	Flood risk management	16.1%
5	Proximity to amenities	12.8%
6	Material fabricated on site	12.2%
7	Elevator power saving	9.9%
8	Protect or restore habitat	9.8%
9	Fossil fuel conservation	9.4%
10	Employing waste recycling workers on site	8.9%

What function of sustainable design and construction is perceived as the highest priority for the Kuwait building industry: to conserve or restore the environment, contribute to increased value for people, or provide financial benefit based on the perceived degree of applicability and degree of implementation?

To answer this question, sustainable design and construction practices were grouped into categories about their intended function to conserve or restore the environment, contribute to increased value for people, either now or in the future, or provide financial benefit. Industry professionals believe principles and practices broadly contributing to increased value for people (i.e., social sustainability) are perceived as more applicable for Kuwait compared to principles and practices to conserve or enhance the environment (e.g., environmental sustainability). These professionals also believe that principles and practices broadly related to social sustainability are the most implemented.

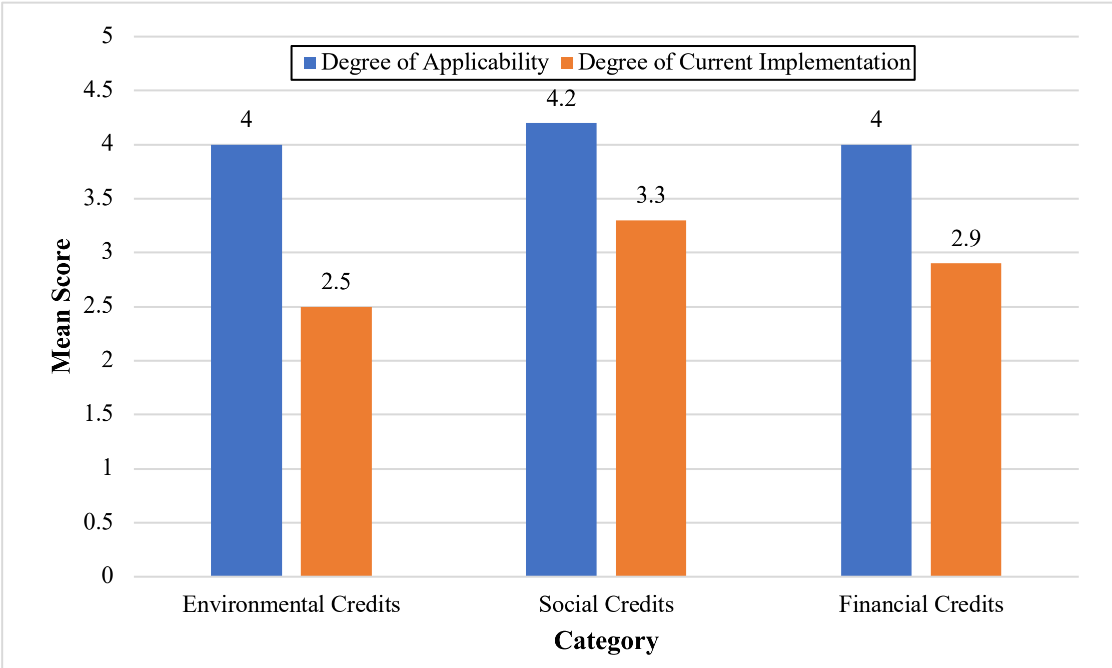


Figure 1. Comparison of overall mean scores for sustainable design and construction practices categorized by their intended function to conserve or restore the environment, contribute to increased value for people, or provide financial benefit according to their degree of applicability and degree of implementation (scores ranges from 1=0% to 5=100%).

The difference between the degree of applicability and degree of implementation in all the three categories is statistically significant as determined by one-way ANOVA ($p<0.001$). Post-hoc pairwise comparisons indicate that sustainable practices broadly related to increased value for people are significantly higher than the other two means broadly related to conserving or restoring the environment ($p=0.033$) and providing financial benefits ($p=0.023$). There is no difference between practices related to environmental sustainability and financial sustainability in the degree of applicability, but all pairwise comparisons for the degree of current implementation were significant ($p<0.001$ for each). The mean score for implementing principles and practices that increase value for people were significantly higher than conserving or restoring the environment and providing financial benefit.

Do significant differences exist in perceived value among professional groups (architects, site engineers, and project managers)?

Sustainable design principles and construction practices that are significantly different ($p<0.05$) in terms of perceived degree of applicability and perceived degree of implementation between professional groups are listed in Table 6 and 7. Table 6 lists five design principles that varied in terms of perceived applicability between project managers, site engineers, and architects. In specific, project managers and site engineers perceive all five sustainable practices as highly applicable whereas the majority of architects do not.

Table 6. Significant differences in degree of the perceived applicability between professional groups ($p<0.05$)

	Perceptions of High Degree of Applicability			
	Project Manager *n* (%)	Site Engineer *n* (%)	Architect *n* (%)	*p*-value
Green roofs				**0.008**[a]
Low (<50%)	15 (31)	9 (18)	13 (68)	
Average (50%)	5 (10)	14 (28)	4 (21)	
High (>50%)	29 (59)	28 (55)	2 (11)	
Environmental tobacco smoke control				**0.005**[a]
Low (<50%)	1 (2.0)	1 (2)	10 (56)	
Average (50%)	2 (4)	14 (27)	5 (28)	
High (>50%)	46 (94)	37 (71)	3 (17)	
Water metering				**0.044**[a]
Low (<50%)	1 (2)	0 (0)	9 (45)	
Average (50%)	3 (6)	13 (25)	7 (35)	
High (>50%)	44 (92)	40 (76)	4 (20)	
Acoustic performance				**0.027**[a]
Low (<50%)	3 (6)	8 (15)	9 (50)	
Average (50%)	7 (14)	10 (19)	5 (28)	
High (>50%)	39 (80)	35 (66)	4 (22)	
Intelligent building control system				**0.006**[a]
Low (<50%)	2 (4)	1 (2)	11 (58)	
Average (50%)	0 (0)	10 (19)	3 (16)	

High (>50%)	46 (96)	42 (79)	5 (26)

p-values were generated by [a]Fisher's Exact Test and percentages are rounded to the nearest integer.

Perceptions between professional groups also varied in terms of current implementation for four design principles and construction practices as shown in Table 7. Nearly 50% of project managers perceive that containers for site material waste, smoke control, and health, safety and welfare regulations have a high degree of current implementation, whereas architects perceive these practices have a low degree of implementation.

Table 7. Significant differences in perceptions of the degree of perceived current implementation between professional groups ($p<0.05$)

	Perceptions of High Degree of Current Implementation			
	Project Manager *n* (%)	Site Engineer *n* (%)	Architect *n* (%)	*p*-value
Containers for site material waste				**0.001**[b]
Low (<50%)	16 (33)	22 (42)	12 (60.0)	
Average (50%)	6 (12)	10 (19)	8 (40.0)	
High (>50%)	27 (55)	20 (39)	0 (0.0)	
Environmental tobacco smoke control				**0.022**[b]
Low (<50%)	13 (27)	29 (55)	10 (56)	
Average (50%)	13 (27)	11 (21)	5 (28)	
High (>50%)	23 (47)	13 (25)	3 (17)	
Health & safety & welfare regulations				**0.011**[b]
Low (<50%)	12 (25)	15 (28)	9 (47)	
Average (50%)	4 (8)	11 (21)	6 (32)	
High (>50%)	33 (67)	27 (51)	4 (21)	
Optimized use of natural light				**0.025**[b]
Low (<50%)	18 (37)	26 (49)	13 (68)	
Average (50%)	22 (45)	12 (23)	2 (11)	
High (>50%)	9 (18)	15 (28)	4 (21)	

P-values were generated by [b]Pearson Chi-square Test and percentages are rounded to the nearest integer.

2.7 Discussion

One of the barriers to adopting more sustainable design principles and construction practices in Kuwait is the perceived high initial cost by professionals. Based on a study of 61 barriers, the two highest mentioned barriers globally in 36 articles was also lack of education and awareness and the higher costs of constructing sustainably (Darko & Chan, 2016). The same appears to be true in Kuwait. Yet, perceptions about cost contradict several global studies that indicate buildings and infrastructure that include sustainable design principles and construction practices are less expensive than conventional buildings in the long run (Kats, 2003; Venkataraman & Cheng, 2018; World Green Building Council, 2013b).

Kuwait is highly profit-focused and predominately relies on traditional design-bid-build delivery methods, which means that design and construction contracts for new buildings and infrastructure are usually offered to the organization with the lowest bid price (AlSanad, 2015). Since sustainable design and construction is perceived as having higher costs, this likely discourages organizations from adopting these principles and practices on their own. After the bidding process may be an opportunity for project managers to value engineering sustainable design and construction practices into projects. For example, the United States based Portland General Electric and the engineering firm Burns & McDonnell were able to still meet sustainable design and construction requirements listed in the Envision Rating Systems for Sustainable Infrastructure during the construction of a wind turbine facility even after the hard bidding process was complete (McWhirter & Shealy, 2018). In fact, Burns & McDonnell's value engineering reduced the overall cost of the project.

Among professionals in Kuwait, several sustainable design principles and construction practices were perceived as not applicable, yet some believed they were being implemented, in particular, green roofs and rainwater harvesting. Including design features like green roofs and rainwater harvesting in a country that receives only two to five inches of rain a year is likely to cause negative perceptions of sustainable design and construction because of the added cost without added benefit. Other design strategies like passive cooling or technologies like photovoltaic panels that generate energy would likely bring more value as high temperatures, and sunshine persist year-round.

Professionals recognize the need for more education and awareness of sustainable design principles and construction practices. One approach to help professionals prioritize sustainable design principles and construction practices is through a sustainability rating system that is fitting for Kuwait's geographic location, priorities, and heritage. Based on respondents' perceptions of the most applicable design principles and construction practices, the rating system that includes the most design principles and construction practices is the Pearl Building Rating Systems (PBRS). Nine out of the top ten design principles and construction practices are included in PBRS. Sustainable design principles and construction practices that are intended to conserve or restore the environment compose 38.5% of the total possible points in PBRS. Providing more points to environmental credits may have a positive effect by nudging more consideration to conserve or restore the environment in this region. However, increasing the weight of environmental credits could deter adoption in the context of a lack of perceived applicability. Future research can begin to explore the effects of credit weighting among these decision tools (Shealy & Klotz, 2017).

Perceptions about sustainable design and construction practices appear to vary by profession in Kuwait. Design concepts like acoustic performance or intelligent building control system are possibly new and therefore come with inherent risk for construction professionals who have little prior experience which could be the reason for varied responses between architects and site engineers. Changes in project delivery methods, such as integrated project delivery (IPD), where professionals come together to share their body of knowledge may help in reducing perceived risk (Rahman & Kumaraswamy, 2005) and encourage systems thinking (Rubenstein-Montano et al., 2001). As a result, teams will be able to assess a wide range of impacts of sustainable design and construction practices across interconnected systems (Meadows, 2008) leading to better outcomes for the project (Ranaweera & Crawford, 2010). IPD has also shown that building connections between team members and enhancing team dynamics increases team flexibility (Lianying, Jing, & Shuguo, 2013).

Some rating systems like the Envision Rating System for Sustainable Infrastructure have incorporated a systems thinking approach in their tool (McWhirter & Shealy, 2018). Encouraging such thinking is especially important for developing countries that are new to sustainable design and construction because synergistic benefits may emerge among components or systems working together that are greater than either system or component by themselves (Sheffield et al., 2012). For example, integrated energy-efficient building design involves systems thinking and decision-making across several domains (Kanagaraj & Mahalingam, 2011).

Social behaviors and economic incentives in Kuwait may be leading to low environmental prioritization

Kuwait's governmental subsidies make energy extremely inexpensive for almost all market sectors. Consumers are charged a fixed amount of about 1 cent/kWh whereas the actual cost is around 10 cents/kWh to produce the energy (M. A. Darwish et al., 2008). Industry professionals in Kuwait likely overlook or discount the possible energy or water savings available through sustainable design and construction practices because of these subsidies. Lack of consideration when designing buildings and infrastructure creates locks in energy and water use for years to comes, even if these subsidies begin to reduce, and energy and water become more expensive in the region (Moerenhout, 2018).

Such subsidies for energy are not given to other countries like the United States that have been pursuing sustainable design and construction for longer periods of time. The financial burden of energy use creates a viable return on investment and likely increases motivation for energy efficient design compared to countries like Kuwait. Besides adjusting subsidy rates, another approach to motivate industry adoption might be through modifications of points structures of national rating systems (Shealy et al., 2016). For instances, framing risk differently can have an effect on design consideration for sustainability (Ismael & Shealy, 2018d).

Changes downstream, among users, can also have an effect but also requires shifts in behavior, society (Hoffman & Henn, 2008), priorities, and lifestyle (Wilson & Dowlatabadi, 2007). For example, social behaviors in the Kuwaiti culture work against sustainable development. One reason is the extremely hot climates, with temperatures reaching up to 130°F in mid-summer time which encourages the people to seek comfort indoors, consuming more energy through air-conditioning and lighting. More focus in designing community open spaces on the north facing façade of buildings or tree-shaded parks using high solar reflective materials might encourage more time spent outdoors and reduce high dependence on electricity (Chen et al., 2016). If people understand how their everyday lifestyle choices can have negative impacts, they use they can begin to see their energy contribution as something they can manage rather than merely accept (Hoffman & Henn, 2008).

How industry perceptions in Kuwait compare to perceptions in the United States more than a decade ago

The U.S. industry began implementing sustainable design principles and construction practices decades ago (Bourdeau, 1999). Initial industry barriers to adopting sustainable design principles and construction practices in the United States were similar to what Kuwait is experiencing today. Barriers such as the perceived upfront cost for sustainable design, lack of awareness about the benefits of sustainable construction, and an industry mentality for added external indicators of sustainability. Yet, at times, less appropriate sustainable design (e.g. solar panels without first investing in energy reduction measures) (Corbett & Muthulingam, 2007) contributed to slow adoption for nearly two decades (Yong Ahn, Pearce, Wang, & Wang, 2013; Jacomit, Silva, & Granja, 2009; Tollin, 2011). Today, however, there are more than 80,000 buildings certified by the United States Green Building Council's LEED rating system (Shutters & Tufts, 2016). LEED-certified buildings have a higher market value (Dermisi, 2009). Sustainable design and construction are included in request for proposals. Meeting LEED or Envision requirements adds very little to upfront costs for buildings or infrastructure, respectively (Dial, Smith, & Rosca, Jr., 2014; Mapp, Nobe, & Dunbar, 2011). Certification programs continue to evolve to become more stringent as the United States' market adopts more sustainable design principles and construction practices as industry standards.

Sustainable design in Kuwait is still in its infancy. A similar path for Kuwait compared to the United States means another decade or two before industry and market trends for sustainable design and construction reach status quo. Waiting another decade or two will further exacerbate local and global challenges for the environment and society. The barriers the United States faced are similar to those Kuwait is now experiencing today, which are predominately behavioral, not technical. In other words, engineering professionals know how to design energy efficient buildings and infrastructure that improve air quality and enhance the local community but are not doing so at the pace or scale to have a long-term impact on grand challenges (N.A.E., 2018). Recent advances in behavioral decision science can help Kuwait more quickly overcome these barriers compared to the United States. The next subsection outlines one approach to merging engineering for sustainability and behavioral science. Adopting principles and concepts from behavioral science has led to advances in other fields like medicine (Johnson & Goldstein, 2003b), insurance (Johnson, 1993), real estate (Genesove & Mayer, 2001), and financial investments (Thaler & Benartzi, 2004).

Choice architecture as an approach to nudge industry professionals towards more sustainable design

To help industry professionals make better decisions about design and construction practices, both researchers and practitioners can look to behavioral science (Shealy & Klotz, 2017). A better understanding of how decisions are made can inform the development of better tools and processes (Johnson et al., 2012). Choice architecture is one approach. It refers to the fact that there are always several ways to present choices to a decision-maker and this presentation influences how decision makers create preferences and ultimately make decisions (J. Anderson, 2010). Just as an attractive staircase in the atrium of an office building will increase the chances that workers will walk one or two levels up, rather than taking the elevator. A well-designed decision environment will increase the chances that decision-makers will not fall prey to poor decisions (Weber & Johnson, 2009).

Some examples of choice architecture applied to construction engineering and management decisions include the modification of rating systems (Ismael & Shealy, 2018a), embedding life cycle costs into decision options (Saad & Hegazy, 2015), and re-framing risk (Shealy, Ismael, Hartmann, & Buiten, 2017) and uncertainty (Buiten, Hartmann, & Meer, 2016) to appear more favorable. For instance, shifting the cognitive focus from the price of managerial intervention toward improved performance for a capital project between the Dutch Highway and Waterways Agency and a Dutch contractor removed status quo bias, which led to more realistic expectations and opportunities for the return on investment (Delgado & Shealy, 2017). Similarly, presenting uncertainty as an embedded attribute of each design option rather than a separate item mediates risky choice (Shealy et al., 2017).

Similar techniques to reframe design and construction decisions for more sustainable buildings can be applied to the Kuwait industry. The results suggest industry professionals in Kuwait prioritize design and construction principles about people more than the environment. Re-framing the intended outcome of design principles that benefit the environment to also highlight the long-term benefit to people may help increase awareness and motivation to include these elements and practices in design and construction. In other words, shifting the focus from one attribute, the environment, to another, about people, may influence how professionals allocate their cognitive attention and influence design and construction decisions.

Another approach is to frame elements of rating systems to include intended goals. Goal framing is when subjects are urged to engage in some activity by describing the advantages (or disadvantages) of participating in the activity (I. Levin et al., 2002). Thus, goal framing the benefits of action or inaction about design and construction for sustainability should increase consideration among engineering and construction decision makers. Goal framing is a popular approach in the field of environmental psychology because it can encourage pro-environmental behavior and lead to improved management of environmental problems (Steg & Vlek, 2009). Another study reframed information about biofuels and found it was effective to persuade people to contribute to the prevention and reduction of energy use (Van de Velde et al., 2010). Another benefit of goal framing is the effect does not appear to dissipate over time in multi-attribute decision tools like rating systems (Kim et al., 2014).

2.8 Conclusion

More focus needs to be placed on the MENA region to achieve sustainable design and construction goals globally. Countries like Kuwait that depend on high resources of capital are increasingly contributing to global sustainability challenges. Little progress is being made towards adopting sustainable design and developing construction practices relative to the pace seen in North America and Europe. The research presented in this paper highlights the main reasons for the slow progress of sustainable design and construction in Kuwait. By understanding how professionals in Kuwait perceive sustainable design and construction, especially those who are not experts in the field, researchers and practitioners can now begin to develop methods for corrective courses of action.

The results of this work suggest that the majority of industry professionals in Kuwait believe that the low rate of progress towards sustainable design and construction is due to the lack of awareness about sustainable design and construction benefits and the high upfront costs that sustainable design and construction requires. Many sustainable design principles and construction practices are perceived as highly applicable but lack implementation. More tailored rating systems might help guide these decision makers to incorporate more applicable design principles and construction practices. Based on industry perceptions about what is most of value to the region, the Pearl Building Rating Systems (PBRS) appears to best align with their preferences. Further modifications to the point structure of these rating systems may help nudge even more design changes. For instance, changing the default points to a perfect score and practitioners using the rating system lose points, rather than gain points, can have a significant effect on design outcomes (Shealy & Klotz, 2015a).

While results presented in this paper provide a roadmap for understanding the building industry's perceptions about sustainability in Kuwait, the next step is a better understanding of how decisions are made in actual projects. Modifications to the request for proposal process, an increase in education, or support from organizations can have a large effect on sustainable design and construction integration. If choice architecture is applied to rating systems for sustainability, reframing environmentally related credits to appear like they provide social benefits could be a targeted approach to change behavior among industry professionals in Kuwait because of their higher perceived focus on sustainable design practices that benefit down-stream users. Bridging behavioral decision science theories to the application in rating systems for sustainability has already shown progress among other decision instruments for sustainability in the U.S. (Harris et al., 2016; Shealy et al., 2016). The application of these strategies and observation of their effects is underexplored in other regions of the world, with varying cultures, beliefs, and social norms.

References

Ahn, Y. H., & Pearce, A. R. (2007). Green Construction: Contractor Experiences, Expectations, and Perceptions. *Journal of Green Building*, *2*(3), 106–122. https://doi.org/10.3992/jgb.2.3.106

Ahn, Y., Pearce, A. R., Wang, Y., & Wang, G. (2013). Drivers and barriers of sustainable design and construction: The perception of green building experience. *International Journal of Sustainable Building Technology and Urban Development*, *4*(1), 35–45. https://doi.org/10.1080/2093761X.2012.759887

AlSanad, S. (2015). Awareness, drivers, actions, and barriers of sustainable construction in Kuwait. *Procedia Engineering*, *118*, 969–983. https://doi.org/10.1016/j.proeng.2015.08.538

AlSanad, S., Gale, A., & Edwards, R. (2011). Challenges of sustainable construction in Kuwait: Investigating level of awareness of Kuwait stakeholders. *World Academy of Science, Engineering and Technology, International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering*, *5*(11), 753–760.

Altoryman, A. S. (2014, March 24). Identification and assessment of risk factors affecting construction projects in the Gulf region: Kuwait and Bahrain. Retrieved January 29, 2018, from https://www.escholar.manchester.ac.uk/uk-ac-man-scw:221966

AlWaer, H., Sibley, M., & Lewis, J. (2008). Different Stakeholder Perceptions of Sustainability Assessment. *Architectural Science Review*, *51*(1), 48–59. https://doi.org/10.3763/asre.2008.5107

Ametepey, O., Aigbavboa, C., & Ansah, K. (2015). Barriers to Successful Implementation of Sustainable Construction in the Ghanaian Construction Industry. *Procedia Manufacturing*, *3*, 1682–1689. https://doi.org/10.1016/j.promfg.2015.07.988

Anderson, J. (2010). Review of Richard Thaler and Cass Sunstein: Nudge: Improving Decisions About Health, Wealth, and Happiness. *Economics and Philosophy*, *26*, 369–376.

Attia, S., & Dabaieh, M. (2013). The usability of green building rating systems in hot arid climates: A case study in Siwa, Egypt. Retrieved from https://orbi.uliege.be/handle/2268/163946

Bernardi, E., Carlucci, S., Cornaro, C., & Bohne, R. A. (2017). An Analysis of the Most Adopted Rating Systems for Assessing the Environmental Impact of Buildings. *Sustainability*, *9*(7), 1–27.

Blumberg, D. (2012). LEED in the U.S. Commercial Office Market: Market Effects and the Emergence of LEED for Existing Buildings. *Journal of Sustainable Real Estate*, *4*(1), 23–47. https://doi.org/10.5555/jsre.4.1.kvn0813707k84106

Bourdeau, L. (1999). Sustainable development and the future of construction: a comparison of visions from various countries. *Building Research & Information*, *27*(6), 354–366. https://doi.org/10.1080/096132199369183

Brundtland, G., Khalid, M., Agnelli, S., Al-Athel, S., Chidzero, B., Fadika, L., … Others, A. (1987). *Our Common Future ('Brundtland report')*. Oxford University Press, USA. Retrieved from http://www.bne-portal.de/fileadmin/unesco/de/Downloads/Hintergrundmaterial_international/Brundtlandbericht.File.pdf?linklisted=2812

Buiten, M., Hartmann, A., & Meer, J. (2016). Nudging for Smart Construction: Tackling Uncertainty by Changing Design Engineers' Choice Architecture. Presented at the Engineering Project Organization Conference, Cle Elum, Washington, USA. Retrieved from http://www.epossociety.org/EPOC2016/papers/Buiten%20et%20al_EPOC_2016.pdf

Chen, Y., Liu, T., Xie, X., & Marušić, B. G. (2016). What Attracts People to Visit Community Open Spaces? A Case Study of the Overseas Chinese Town Community in Shenzhen, China. *International Journal of Environmental Research and Public Health*, *13*(7). https://doi.org/10.3390/ijerph13070644

Corbett, C. J., & Muthulingam, S. (2007). Adoption of Voluntary Environmental Standards: The Role of Signaling and Intrinsic Benefits in the Diffusion of the LEED Green Building Standards. Retrieved September 22, 2018, from https://www.ioes.ucla.edu/publication/adoption-of-voluntary-environmental-standards-the-role-of-signaling-and-intrinsic-benefits-in-the-diffusion-of-the-leed-green-building-standards/

Darko, A., & Chan, A. P. C. (2016). Review of barriers to green building adoption. *Sustainable Development*. https://doi.org/10.1002/sd.1651

Darwish, M. A., Al-Awadhi, F. M., & Darwish, A. M. (2008). Energy and water in Kuwait Part I. A sustainability view point. *Desalination*, *225*(1), 341–355. https://doi.org/10.1016/j.desal.2007.06.018

Delgado, L., & Shealy, T. (2017). Opportunities for greater energy efficiency in government facilities by aligning decision structures with advances in behavioral science. *Renewable and Sustainable Energy Reviews*. https://doi.org/10.1016/j.rser.2017.10.078

Dermisi, S. (2009). Effect of LEED Ratings and Levels on Office Property Assessed and Market Values. *Journal of Sustainable Real Estate*, *1*(1), 23–47. https://doi.org/10.5555/jsre.1.1.m5767u246873523q

Dial, R., Smith, B., & Rosca, Jr., G. (2014). Evaluating Sustainability and Resilience in Infrastructure: Envision, SANDAG, and the LOSSAN Rail Corridor. In *ICSI 2014* (pp. 164–174). Long Beach, California: American Society of Civil Engineers. https://doi.org/10.1061/9780784478745.015

Doan, D. T., Ghaffarianhoseini, A., Naismith, N., Zhang, T., Ghaffarianhoseini, A., & Tookey, J. (2017). A critical comparison of green building rating systems. *Building and Environment*, *123*, 243–260. https://doi.org/10.1016/j.buildenv.2017.07.007

Genesove, D., & Mayer, C. (2001). Loss Aversion and Seller Behavior: Evidence from the Housing Market. *The Quarterly Journal of Economics*, *116*(4), 1233–1260.

Geng, Y., Dong, H., Xue, B., & Fu, J. (2012). An overview of Chinese green building standards. *Sustainable Development*, *20*(3), 211–221. https://doi.org/10.1002/sd.1537

Harris, N., Shealy, T., & Klotz, L. (2016). How Exposure to “Role Model” Projects Can Lead to Decisions for More Sustainable Infrastructure. *Sustainability*, *8*(2), 130. https://doi.org/10.3390/su8020130

Hoffman, A. J., & Henn, R. (2008). Overcoming the Social and Psychological Barriers to Green Building. *Organization & Environment*, *21*(4), 390–419.

https://doi.org/10.1177/1086026608326129

Ismael, D., & Shealy, T. (2018a). Aligning Rating Systems and User Preferences: An Initial Approach to More Sustainable Construction through a Behavioral Intervention. *Construction Research Congress 2018*. https://doi.org/10.1061/9780784481301.071

Ismael, D., & Shealy, T. (2018b). Sustainable Construction Risk Perceptions in the Kuwaiti Construction Industry. *Sustainability*, *10*(6), 1854. https://doi.org/10.3390/su10061854

Jacomit, A., Silva, V., & Granja, A. (2009). Can sustainable buildings cost the same as conventional buildings?

Johnson, E. J. (1993). Framing, Probability Distortions, and Insurance Decisions. *Journal of Risk and Uncertainty*, *7*(1), 35–51.

Johnson, E. J., & Goldstein, D. (2003). Do Defaults Save Lives? *Science*, *302*(5649), 1338–1339. https://doi.org/10.1126/science.1091721

Johnson, E. J., Shu, S. B., Dellaert, B. G., Fox, C., Goldstein, D. G., Häubl, G., … others. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters*, *23*(2), 487–504.

Kanagaraj, G., & Mahalingam, A. (2011). Designing energy efficient commercial buildings—A systems framework. *Energy and Buildings*, *43*(9), 2329–2343. https://doi.org/10.1016/j.enbuild.2011.05.023

Kartam, N. A., Flood, I., & Koushki, P. (2000). Construction safety in Kuwait: issues, procedures, problems, and recommendations. *Safety Science*, *36*(3), 163–184. https://doi.org/10.1016/S0925-7535(00)00041-2

Kats, G. (2003). The Costs and Financial Benefits of Green Buildings. A Report to California's Sustainable Task Force. *Sustainable Building Task Force*, 1–120.

Kim, J., Kim, J.-E., & Marshall, R. (2014). Search for the underlying mechanism of framing effects in multi-alternative and multi-attribute decision situations. *Journal of Business Research*, *67*(3), 378–385. https://doi.org/10.1016/j.jbusres.2012.12.024

Koushki, P. A., & Kartam, N. (2004). Impact of construction materials on project time and cost in Kuwait. *Engineering, Construction and Architectural Management*, *11*(2), 126–132. https://doi.org/10.1108/09699980410527867

Kuwait Central Statistical Bureau. (2018). Central Statistical Bureau. Retrieved October 13, 2016, from https://www.csb.gov.kw/Default_EN

Laustsen, J. (2008). Energy efficiency requirements in building codes, energy efficiency policies for new buildings. Retrieved April 6, 2017, from http://indiaenvironmentportal.org.in/files/Building_Codes.pdf

Levin, I., Gaeth, G., Schreiber, J., & Lauriola, M. (2002). A New Look at Framing Effects: Distribution of Effect Sizes, Individual Differences, and Independence of Types of Effects. *Organizational Behavior and Human Decision Processes*, *88*, 411–429. https://doi.org/10.1006/obhd.2001.2983

Mapp, C., Nobe, M., & Dunbar, B. (2011). The Cost of LEED—An Analysis of the Construction Costs of LEED and Non-LEED Banks. *Journal of Sustainable Real Estate*, *3*(1), 254–273. https://doi.org/10.5555/jsre.3.1.m702v24r70455440

McWhirter, N. D., & Shealy, T. (2018). Teaching decision-making for sustainable infrastructure: a wind energy case study module. *International Journal of Sustainability in Higher Education*, *19*(5), 893–911. https://doi.org/10.1108/IJSHE-10-2017-0183

McWhirter, N., & Shealy, T. (2018). Pedagogy and Evaluation of an Envision Case Study Module Bridging Sustainable Engineering and Behavioral Science. *Journal of Professional Issues in Engineering Education and Practice*, *144*(4), 5018012. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000384

Meadows, D. H. (2008). *Thinking in Systems: A Primer*. Chelsea Green Publishing.

Moerenhout, T. (2018). Energy Pricing Reforms in the Gulf: A trend but not (yet) a norm. International Institute for Sustainable Development. Retrieved from https://www.iisd.org/sites/default/files/publications/energy-pricing-gulf-trend-but-not-norm.pdf

Motiar Rahman, M., & Kumaraswamy, M. M. (2005). Assembling integrated project teams for joint risk management. *Construction Management and Economics*, *23*(4), 365–375. https://doi.org/10.1080/01446190500040083

Mukherjee, A., & Muga, H. (2010). An integrative framework for studying sustainable practices and its adoption in the AEC industry: A case study. *Journal of Engineering and Technology Management*, *27*(3–4), 197–214. https://doi.org/10.1016/j.jengtecman.2010.06.006

N.A.E. (2018). National Academy of Engineering. Grand Challenges - Introduction to the Grand Challenges for Engineering. Retrieved September 22, 2018, from http://www.engineeringchallenges.org/challenges/16091.aspx

Pacheco-Torgal, F., Jalali, S., & Fucic, A. (2012). *Toxicity of Building Materials*. Elsevier.

Parkin, S. (2000). Contexts and drivers for operationalizing sustainable development. *Proceedings of the Institution of Civil Engineers - Civil Engineering*, *138*(6), 9–15. https://doi.org/10.1680/cien.2000.138.6.9

Pearce, A., Shenoy, S., Fiori, C., & Winters, Z. (2010). The State of Sustainability Best Practices in Construction: A Benchmark Study. *Journal of Green Building*, *5*(3), 116–130. https://doi.org/10.3992/jgb.5.3.116

Pitts, J., & Lord, M. (2007). Existing buildings: It's easier than you think to green the triple bottom line. Retrieved November 16, 2016, from http://scholarship.sha.cornell.edu/cgi/viewcontent.cgi?article=1081&context=crer

Pocock, J., Steckler, C., & Hanzalova, B. (2016). Improving socially sustainable design and construction in developing countries. *Procedia Engineering*, *145*, 288–295. https://doi.org/10.1016/j.proeng.2016.04.076

Ranaweera, R., & Crawford, R. H. (2010). Using Early-Stage Assessment to Reduce the Financial Risks and Perceived Barriers of Sustainable Buildings. *Journal of Green Building*, *5*(2), 129–146. https://doi.org/10.3992/jgb.5.2.129

Ries, R., Bilec, M. M., Gokhan, N. M., & Needy, K. L. (2006). The Economic Benefits of Green Buildings: A Comprehensive Case Study. *The Engineering Economist*, *51*(3), 259–295. https://doi.org/10.1080/00137910600865469

Robichaud, L. B., & Anantatmula, V. S. (2011). Greening Project Management Practices for Sustainable Construction. *Journal of Management in Engineering*, *27*(1), 48–57.

https://doi.org/10.1061/(ASCE)ME.1943-5479.0000030

Rubenstein-Montano, B., Liebowitz, J., Buchwalter, J., McCaw, D., Newman, B., & Rebeck, K. (2001). A systems thinking framework for knowledge management. *Decision Support Systems*, *31*(1), 5–16. https://doi.org/10.1016/S0167-9236(00)00116-0

Saad, D. A., & Hegazy, T. (2015). Behavioral economic concepts for funding infrastructure rehabilitation. *Journal of Management in Engineering*, *31*(5), 4014089. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000332

Shealy, T., Ismael, D., Hartmann, A., & Buiten, M. van. (2017). Removing certainty from the equation: Using choice architecture to increase awareness of risk in engineering design decision making. In *Working Paper Proceedings: 15th engineering project organization conference with 5th international megaprojects workshop*. EPOS. Retrieved from https://research.utwente.nl/en/publications/removing-certainty-from-the-equation-using-choice-architecture-to

Shealy, T., & Klotz, L. (2015). Well-Endowed Rating Systems: How Modified Defaults Can Lead to More Sustainable Performance. *Journal of Construction Engineering and Management*, *141*(10), 4015031. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001009

Shealy, T., & Klotz, L. (2017). Choice Architecture as a Strategy to Encourage Elegant Infrastructure Outcomes. *Journal of Infrastructure Systems*, *23*(1), 4016023. https://doi.org/10.1061/(ASCE)IS.1943-555X.0000311

Shealy, T., Klotz, L., Weber, E. U., Johnson, E. J., & Bell, R. G. (2016). Using Framing Effects to Inform More Sustainable Infrastructure Design Decisions. *Journal of Construction Engineering and Management*, *0*(0), 4016037. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001152

Sheffield, J., Sankaran, S., & Haslett, T. (2012). Systems thinking: taming complexity in project management. *On the Horizon*, *20*(2), 126–136. https://doi.org/10.1108/10748121211235787

Sherwin, D. (2006). Reducing the Cost of Green. *Journal of Green Building*, *1*(1), 46–54. https://doi.org/10.3992/jgb.1.1.46

Shutters, C., & Tufts, R. (2016). LEED by the numbers: 16 years of steady growth | U.S. Green Building Council. Retrieved September 22, 2018, from http://www.usgbc.org/articles/leed-numbers-16-years-steady-growth

Sourani, A., & Sohail (Khan), M. (2011). Barriers to addressing sustainable construction in public procurement strategies. https://doi.org/10.1680/ensu.2011.164.4.229

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behavior: An integrative review and research agenda. *Journal of Environmental Psychology*, *29*(3), 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004

Sustainable Building Task Force. (2001). Building better buildings: A blueprint for sustainable state facilities. Retrieved November 12, 2017, from http://www.dot.ca.gov/hq/energy/Building%20Better%20Buildings/Blueprint%202001.pdf

Thaler, R. H., & Benartzi, S. (2004). Save More Tomorrow™: Using Behavioral Economics to Increase Employee Saving. *Journal of Political Economy*, *112*(S1), S164–S187. https://doi.org/10.1086/380085

The World Bank. (2016). Kuwait Data. Retrieved February 7, 2017, from http://data.worldbank.org/country/kuwait

Tollin, H. M. (2011). Green Building Risks: It's Not Easy Being Green. *Environmental Claims Journal*, *23*(3–4), 199–213. https://doi.org/10.1080/10406026.2011.593442

USGBC. (2016). USGBC Announces International Ranking of Top 10 Countries for LEED | U.S. Green Building Council. Retrieved July 12, 2018, from http://www.usgbc.org/articles/usgbc-announces-international-ranking-top-10-countries-leed

Van de Velde, L., Verbeke, W., Popp, M., & Van Huylenbroeck, G. (2010). The importance of message framing for providing information about sustainability and environmental aspects of energy. *Energy Policy*, *38*(10), 5541–5549. https://doi.org/10.1016/j.enpol.2010.04.053

Venkataraman, V., & Cheng, J. (2018). Critical Success and Failure Factors for Managing Green Building Projects. *Journal of Architectural Engineering*, *24*.

https://doi.org/10.1061/(ASCE)AE.1943-

Weber, E. U., & Johnson, E. J. (2009). Mindful judgment and decision making. *Annual Review of Psychology*, *60*, 53–85.

Wilson, C., & Dowlatabadi, H. (2007). Models of Decision Making and Residential Energy Use. *Annual Review of Environment and Resources*, *32*(1), 169–203. https://doi.org/10.1146/annurev.energy.32.053006.141137

World Energy Council. (2013). World energy perspective: Energy efficiency policies – What works and what does not. Retrieved from https://www.worldenergy.org/wp-content/uploads/2013/09/WEC-Energy-Efficiency-Policies-executive-summary.pdf

World Green Building Council. (2013). The Business Case for Green Building - A Review of the Costs and Benefits for Developers, Investors and Occupants. Retrieved December 8, 2016, from http://www.worldgbc.org/files/1513/6608/0674/Business_Case_For_Green_Building_Report_WEB_2013-04-11.pdf

Xia, B., Zuo, J., Peng, W., & Yongjian, K. (2014). Sustainable Construction Trends in Journal Papers. https://doi.org/10.1007/978-3-662-46994-1_15

Zhang Lianying, He Jing, & Zhou Shuguo. (2013). Sharing Tacit Knowledge for Integrated Project Team Flexibility: Case Study of Integrated Project Delivery. *Journal of Construction Engineering and Management*, *139*(7), 795–804. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000645

CHAPTER 3

SUSTAINABLE CONSTRUCTION RISK PERCEPTIONS IN THE KUWAITI CONSTRUCTION INDUSTRY

Ismael, D.; Shealy, T. Sustainable Construction Risk Perceptions in the Kuwaiti Construction Industry. *Sustainability* **2018**, *10*, 1854.

3.1 Abstract

Sustainable construction is fundamentally different than traditional construction because it requires whole systems thinking, early collaboration across stakeholders, and core principles like reducing resource consumption, eliminating toxins, and applying life cycle costing. Construction professionals unfamiliar with this mindset and approach may perceive sustainable construction as risky. One of the global regions in need of more sustainable construction is the Middle Eastern and North African (MENA) region. The MENA region is one of the fastest developing in the world. However, it is the slowest one in implementing sustainable construction practices. Kuwait, in particular, contributes 53% more carbon emissions per capita than the United States. To understand how the Kuwaiti construction industry perceives risks associated with more sustainable construction, a survey was developed with 52 risk elements in which 131 industry professionals responded. The results indicate that industry professionals perceive a lack of public awareness as the risk element with the highest probability of occurrence. The risk element with the highest possible negative impact on future projects is designers' and contractors' inexperience with sustainable construction. Other risks were found to include a high initial cost for materials and overall project costs. Educational interventions, changes in risk allocation, and behavioral science to reframe upfront costs as long-term savings are offered as possible solutions.

3.2 Introduction

Sustainable development goals usually focus on broad problems like climate change, energy reduction, and clean air and water. While these broad objectives are necessary, their abstractness can make it challenging for construction professionals to know how to achieve them [1]. This is because the techniques and approaches that are optimal for specific projects vary depending on the geographic location, regional energy sources, community characteristics, stakeholder priorities, and many other variables. In addition, sustainable construction, which refers to achieving social, financial, and environmental sustainability throughout a building's whole life-cycle [2] requires a higher level of collaboration between stakeholders when compared to traditional construction projects due to increased uncertainty [3,4]. This uncertainty is due to the complexity of project decisions, which are often made using prior held judgments and heuristics [5,6]. Without prior experience, the outcomes of sustainable choices can appear risky [7]. When adopting new techniques for sustainable construction, previously held judgments and heuristics must also change.

Currently held judgments and heuristics about sustainable construction do not always represent reality [8]. For example, the long-held perception that sustainable construction costs more financially upfront does not hold true today [9]. Cognitive biases such as risk aversion and status quo bias can lead to these overly generalized assumptions [10,11]. Better understanding of these perceptions, judgments, and heuristics can add value by offering opportunities to educate, increase awareness, and, most importantly, help stakeholders make more informed project level decisions.

Making more informed project level decisions means knowing what factors cause risk and which risks are worth taking [12]. Sustainable construction can appear overly risky when outcomes of value appear not to align with stated stakeholder objectives [13]. Prior research finds differences in stakeholder objectives can increase risk perceptions [14]. For instance, transaction costs are a real risk for general contractors when adopting sustainable construction practices, but this risk is often not a concern from the owners' perspective [15].

How risk and uncertainties vary between stakeholders, industry sectors (e.g., private or public), and global regions are still not well understood [16]. Risks about sustainable construction are particularly challenging to manage because much of the risk occurs upfront while the value comes later over time. The success of sustainable construction (e.g., eliminating impacts on the environment and natural resources, enhancing the health, well-being and productivity of occupants, creating new economic development, and applying a lifecycle approach during planning) heavily relies on contractors' willingness to adopt this new mindset and associated means and methods [17].

Regions of the world that were early to adopt sustainable design and construction practices continue to lead in global sustainable development. The number of new buildings in the United States certified by the Leadership in Energy and Environmental Design (LEED) rating system has grown exponentially in the last decade [18]. As more countries begin to adopt similar rating systems and tools for industry professionals, these industries will face similar barriers experienced by the United States construction market nearly a decade ago [9,19].

One of the global regions in need of sustainable construction is the Middle Eastern and North African (MENA) region. The MENA region is one of the fastest developing in the world. However, this region is slow in developing and implementing sustainable design and construction practices [20]. An early adopter of sustainable construction in this region who experiences a loss of profits or increased burden may have a lasting negative impact in the region's adoption of sustainable design and construction practices in the future [21]. Therefore, understanding the risks associated with sustainable construction prior to adopting these techniques can have a positive impact on the entire region.

Sustainable Construction in Kuwait and the MENA Region

Increasing adoption of sustainable construction practices in the MENA region is necessary for global sustainable development goals. For instance, greenhouse gas emissions are not isolated to merely one region or country but have a negative effect globally. In the past 20 years, the MENA region has increased carbon dioxide emissions by around 114% and per capita by 44% [22]. While this region currently only contributes approximately 6% of the world's carbon dioxide emissions, the trend suggests the region will become a larger contributor to global greenhouse gas emissions in the next century [23].

In comparison to its neighboring countries in the MENA region, Kuwait holds the lowest commitment to sustainable construction [20]. Per capita, residents contribute 53% more carbon dioxide emissions than residents of the United States [22]. This is partly because the country relies on energy-intensive desalination to produce potable water [24] and nearly 85% of electricity costs are subsidized [20]. Furthermore, Kuwait's construction industry has doubled their annual landfill waste in the past five years [25].

One explanation for the lack of commitment among the construction industry is the lack of awareness. Few professionals have experience in sustainable construction techniques and associated technology [20]. Lack of experience means there are fewer projects that demonstrate the benefits and, therefore, less motivation among industry professionals to try something new [26,27]. When awareness about the benefits of sustainable construction increase, the demand for more sustainable buildings and infrastructure also grow [28]. This demand helps drive further adoption and innovation helping these early adopters of sustainable design and construction reach even higher achievement in the future [29].

The lack of political support and incentives to adopt the design and construction techniques that promote sustainability from the Kuwaiti government is likely another reason for slow adoption of sustainable construction. Kuwait engineering design and construction professionals agree that government intervention through new standards and policy is necessary to accelerate adoption [20]. External involvement and additional incentives may help offset perceived risks and encourage market demand.

To help Kuwait and the MENA region more quickly adopt sustainable construction techniques, the purpose of the research reported in this paper is to assess current perceived risks within the industry. Knowing how sustainable construction is perceived can help design interventions, tools, and processes to help this industry overcome these perceived barriers or more efficiently manage them in the future.

3.3 Background

Sustainable construction is fundamentally different than traditional construction [30]. The purpose of sustainable construction is to create and operate a building based on core principles across the building's life cycle. Sustainable construction should reduce resource consumption, reuse resources, integrate recyclable resources, protect nature, eliminate toxins, apply life cycle costing, and focus on quality [31]. Achieving such high standards requires those involved in the design and construction process to "begin with the end in mind" [17]. This means setting specific goals and building features early during the feasibility stage that align with core sustainability principles.

Those involved in the design and construction process must also take a whole systems approach [32]. A whole systems approach encourages the consideration of interrelated components and people to optimize the performance of the entire building rather than an individual part [33]. For example, Rocky Mountain Institute, which is a consulting firm in the United States, uses a whole systems approach to optimize thermal mass of building envelopes and windows and other components to produce the most cost-effective passive building [34]. Whole systems requires establishing common goals that align incentives, encourage mutual learning, and sharing of information across stakeholder groups [35].

Adopting a whole systems approach and applying sustainable practices can appear risky compared to traditional construction especially for those that are new to sustainable construction. A broadly defined risk is the combination of the probability of an event and its outcomes [36]. Risk management is then the process by which risks are identified, quantified, and used to inform decision making and planning future events [37]. Risk management includes the ability to recognize risks with low probability and low impact compared to risks with high probability and high impact. For example, recognizing the likelihood of failure, delay of schedule, or increased cost by changing construction techniques to reduce the disruption of soils or the probability of success in installing more sensors in a building for enhanced monitoring and control.

Without prior experience, for instance, in changing commonly used materials for those with less embodied energy, errors can occur in judgment and lead to overly weighing probabilities of risks [38]. For example, sustainable construction can appear more expensive when construction professionals are unaware of these possible risks and, as a result, assign higher contingencies [15]. The opposite can also be true. The pseudo-certainty effect occurs when a decision maker perceives an outcome as certain while, in fact, it is uncertain [39]. The success of sustainable construction depends on the judgment of perceived risks and the development of an appropriate risk management plan [40,41]. Understanding the unique variation between conventional and sustainable projects is also essential for beginning to develop risk management techniques and interventions for sustainable construction that has neither overweight nor underweight risks.

Perceived risks to sustainable construction continue to emerge globally as developing countries begin to explore and adopt new techniques and technologies [26,27]. Countries in the MENA region like Kuwait that lack prior experience with sustainable construction techniques may fall into a trap of assigning higher contingencies, which increases the overall cost of the project and creates negative barriers to more sustainable construction projects in the future [42]. Overlooking possible risks leading to negative outcomes for the project team, also known as the pseudo-certainty effect, is also a possibility, which results in less incentive to adopt new techniques as industry norms in the future. Prior research in the MENA region discuss construction risks (e.g., in Kuwait see Reference [43], the U.A.E. see Reference [44], Qatar see Reference [45], and Bahrain see Reference [46]) but fall short in covering, discussing, or outlining possible risks related to new means and methods that incorporate principles of sustainable construction.

Improved ability for assessing risks can help shift industry professionals' focus to appropriately reduce the risk of failure for sustainable construction [47]. Prior research about sustainable construction practices in developed countries like Australia, the United States, and Europe do outline increased risks and recommendations [26] and novel contract structures to share the risk burden [48]. The lists of possible risks from these prior works were used to develop a survey instrument detailed in the methods section of this paper. The weighting of these risks may be different as a result of cultural values, regional or national economic incentives, and political interests [49]. Therefore, identifying the potential risk factors and weights of perceived probability plays a crucial role in enhancing the performance and accomplishing the successful delivery of the project.

Synthesis of Research about Risks Associated with Sustainable Construction

Risks associated with sustainable construction were gathered from prior literature and synthesized into categories broadly defined within the design and construction process of new buildings. The purpose of this literature review was to identify potential sustainable risks during a project's life-cycle. The review consisted of an extensive literature search of recently identified sustainable construction risks in other countries including, more specifically, the work from Reference [43] and Reference [46]. Inclusion criteria required research to be within 10 years (articles published from 2005 to 2015) since modern risk management has greatly evolved over the last decade. This review process follows a similar process of prior synthesized literature reviews [50].

More than 20 papers were included and used to develop the synthesized list presented in Table 1. Nine categories and 52 risk elements were organized from the literature. The nine categories include design, management, construction, material, technology, labor and equipment, external factors, finance, and certification. Risk elements associated with design include both inexperience when dealing with sustainable construction and changes as a result of sustainable construction. Management risks are related to design. Management includes risk elements upstream (clients) and downstream (subcontractors) from the general construction process. Lack of communication, lack of dispute resolution, and general planning are particular risk elements that were identified from prior studies [17,51,52]. Construction techniques, defects, and inexperience were also included as risk elements in the construction category. The categories material, technology, and labor and equipment include risk elements about prior knowledge, lack of experience, and non-compliance. Cost is always a concern and represented in both the external and finance categories through a lack of market demand and associated with payback period and cost overruns. Project certification was also identified as an incentive for pursuing sustainable construction and a possible barrier [53]. Energy models that do not align with actual energy performance are increasingly problematic in new sustainable buildings [54].

Table 8 was used to develop both the research questions and survey instruments to measure both perceived probability of occurrence and possible impact of these risk elements during construction projects in Kuwait that include sustainable design and construction principles.

Table 8. Synthesized list of construction risks associated with adopting techniques and technologies that promote sustainability.

Design	**External**
Design changes during construction [55]	Lack of market demand [56]
Slow response to meet design changes [26]	Lack of political support and incentives [49]
Design-team inexperience [57]	Lack of public awareness and knowledge [58]
Design defects which could result in failure to achieve certification [53]	Uncertain governmental policies [19]
Management	**Finance**

Lack of quantitative evaluation tools [59]	Cost estimation inaccuracy [46]
Not achieving client expectations [55]	Payback period is too long [60]
Difficulty in the selection of subcontractors who provide sustainable construction services [51]	Performance problems since sustainable building projects face a greater potential in failure (causing liabilities) [53]
Poor interrelationships between supply chain partners [26]	Increased soft costs due to delays in sustainable building completion [53]
Lack of upfront planning by all parties [17]	High cost of sustainable materials and equipment [51]
Sustainability measures not considered early by stakeholders [52]	Cost overrun due to lack of sustainable building knowledge [61]
Delays in resolving disputes [26]	High initial sustainable construction costs [26]
Slow approval processes due to sustainable specifications [26]	Investor cannot fund the high sustainability measure costs [61]
Outdated contractual agreements [62]	Costs of investment in skills development [57]
	High sustainable construction premiums [17]
Material	**Labor and Equipment**
Unavailability of sustainable building materials [63]	Handling recycled materials puts construction workers at safety risks [43]
Poor material quality [26]	Unavailability of specific equipment [15]
Uncertainty in the performance of sustainable materials [59]	Additional responsibilities for construction maintenance [59]
Non-complying products and materials [26]	Lack of practical experience [15]
Change in material types and specifications during construction [43]	Uncertainty with specialized sustainable equipment [51]
Technology	**Certification**
Challenges for operating renewable energy systems [63]	An event that causes the loss of certification [53]
Unacceptable performance of modern technologies [61]	Lower certification than what was expected due to design defects [53]
Technological failures [61]	Changing certification procedures [61]
Misunderstanding of sustainable technological operations [59]	Loss of financing or losing loans for not achieving certification [53]
Construction	
Unforeseen circumstances in execution of the sustainable project [51]	More complex construction techniques [60]
Safety issues [61]	Project delay [55]
Contractors' inexperience with sustainable buildings [57]	Incremental time caused by sustainable construction [59]
Construction defects [53]	(O'Connor, 2013)

3.4 Research Objective and Questions

The objective of the research presented in this paper is to understand what perceived risks are associated with sustainable construction techniques of new buildings in Kuwait and what possible methods industry professionals are currently using to overcome these perceived risks to avoid cost increases, time overruns, and long-term quality issues. The results of this research can be used by local and international industry professionals to develop a better understanding of the critical risk factors that are perceived to influence cost, time, and quality of construction projects. This understanding will lead to the development of risk management processes not only during the construction stages but also during the evolution of the design phase. Ultimately, by better understanding the risks associated with sustainable construction, the adoption rate of sustainable construction techniques and subsequent performance of the construction industry in the MENA will increase.

The three research questions are:

1. What sustainable construction risks do professionals in Kuwait believe have the highest probability of occurrence?
2. What sustainable construction risks do professionals in Kuwait believe have the highest negative impact on project outcomes?
3. How do perceptions of sustainable construction risks differ between those working in private and public sectors, across project types (residential, commercial, and industrial), across professions (design engineer, contractor, sub-contractor), and across years of experience?

The results offer answers to these questions and the discussion offers relevant risk management strategies from past research to support future implementation of sustainable design and construction.

3.5 Research Methodology

The survey to professionals in the Kuwaiti construction industry consisted of two sections. The first section asked general information about the respondents such as their professional experience, type of organization, and their familiarity with construction techniques and technologies that contribute to sustainability. The purpose of this section was to gather descriptive statistics about the sample population. The second section included the 52 risks identified from the literature review.

Respondents were asked to “Please evaluate the probability of the following risks based on the outcomes of sustainable construction projects.” Respondents were given a Likert scale (1 = very low probability and 5 = very high probability). Respondents were asked again to “Please evaluate the impact of the following risks based on how they negatively affect the outcomes of sustainable construction projects." Respondents were given a Likert scale (1 = very low impact and 5 = very high impact).

Prior to distribution of the survey, the survey was given to a focus group of five construction professionals in which each had 10 or more years of experience for content validity and to review and provide feedback about the questions. Changes made to the survey helped clarify the meaning of specific risks and certain wording was adjusted to more clearly communicate the meaning. For example, some of the risks were combined such as "design changes during construction" and "changes in work" since they were closely related to each other.

The survey was distributed to a national sample of professionals currently working in the construction industry in Kuwait. Professionals were selected randomly from a list of all construction companies in the country. A total of 195 surveys were sent to construction professionals and 131 surveys were returned (67% response rate).

Risk Assessment

The probability and impact of each risk was evaluated using a weighted score approach. This method was adopted from previous literature [43]. The weighted score approach in Equation (1) shows that, for every identified risk, the weighted score was calculated by adding the product of the number of respondents, x, with their corresponding selected Likert ranking, r.

$$S_{Wj} = \Sigma\, (x \times r) \tag{1}$$

where S_{Wj} is the weighted score, x is the number of respondents for each Likert rank, r is the corresponding Likert scale ranking, and j is a subscript index that represents p for probability or i for impact. A sample collected from the data in Table 2 shows that 17 out of 128 respondents ranked the identified risk element for "design changes during construction" with a Likert scale ranking of 5 (most probable) and the value (17 × 5 = 85) is the product. Similarly, nine individuals responded with a ranking of 1 (least probable) and the value (9 × 1 = 9) is the product. The total weighted score for this particular risk is 416, which is the summation of all the product values. Table 9 represents a sample on the probability of risk. The same equation was applied for the responses about the impacts of risk.

Table 9. Sample calculation of weighted scores for risk probability of design changes during construction.

Variable	**Design Changes during Construction**				
Likert Scale (r)	1	2	3	4	5
Number of respondents for each Likert Scale ranking (x)	9	21	40	40	17
Number of respondents multiplied by the Likert Scale ranking $(x \times r)$	9	42	120	160	85
Weighted Score, $S_{Wp} = \Sigma\ (x \times r)$			416		

The probability P and impact I are scaled weighted scores between 0 and 1 obtained by taking the percentage of the score with respect to maximum possible points for each category. In the sample calculation shown in Table 2, the maximum possible points for that risk is 640, which is obtained by multiplying the total number of respondents (x = 128) with the maximum Likert scale (r = 5). Equations (2) and (3) express this formulation below.

$$P = S_{Wp}/(x \times 5) \tag{2}$$

$$I = S_{Wi}/(x \times 5) \tag{3}$$

where S_{Wp} is the weighted score for risk probability and S_{Wi} is the weighted score of risk impact.

Equation (4) was used to calculate the product of both probability and impact of occurrence. The purpose was to quantify the degree of risk. This equation was adopted from Reference [64].

$$R = P \times I \tag{4}$$

where R is the degree of perceived risk measured between 0 and 1, P is the probability of the risk occurring measured between 0 and 1, and I is the degree of impact of the risk measured between 0 and 1. This method scales risks from high (close to 1) and low (close to 0) by considering both weighted probability and impact.

3.6 Results

The group of responses (n = 131) were contractors (27%), owners/clients (25%), construction consultants (18%), and subcontractors and suppliers (30%). Out of 131 surveyed, 45% indicated more than 10 years of experience in the construction industry, 29% had between five to 10 years of experience, and 27% had less than five years of experience. Most of the respondents came from organizations that have more than 100 employees (53%), 17% from organizations that have 50–100 employees, and 30% from organizations with less than 50 employees. Nearly 40% of respondents indicated their level of sustainability awareness was "poor" and only 19% perceived "good" awareness of sustainability concepts, procedures, and technologies. Nearly half of respondents (47%) reported that the current percentage of construction projects that include sustainable construction practices or technologies in their organization was between 0% and 19%. Half of the respondents (50%) indicated they work with the public sector, 32% with the private sector, and 18% are quasi-public sectors. Details of the main research findings are listed in the sub-sections below.

Risks That Have the Highest Probability and Impact of Occurrence

To identify the risks that have the highest probability and highest impact of occurrence, the respondents were asked to evaluate the risks based on their probability and impact of occurrence in construction projects in Kuwait. Table 10 presents the top 10 risks with the highest perceived probability in ascending order based on their total weighted scores. Lack of public awareness about the benefits of sustainable design and construction and high costs of sustainable material and equipment are perceived as the risks having the highest probability of occurrence in construction projects in Kuwait.

Table 10. The top 10 risks based on the highest expected probability.

Risks with Highest Probability of Occurrence		Weighted Score, S_{Wp}
1	Lack of public awareness about the benefits for sustainability	492
2	High costs of sustainable materials & equipment	488
3	High initial sustainable construction costs	472
4	Lack of market demand	471

5	Lack of practical experience	470
6	Lack of political support & incentives	455
7	Contractors inexperience with sustainable buildings	448
8	Unavailability of specific equipment	448
9	Unavailability of sustainable building materials in the market	446
10	Uncertain governmental policies	444

Table 11 includes the top 10 risks with perceived high expected impact. Notably, contractors' inexperience with sustainable construction practices and technologies had the highest potential risk according to respondents. The second risk associated with adopting sustainable construction practices was design team inexperience, which was followed by the unavailability of sustainable building materials and lack of practical experience. These top four risks are 4% greater (about 20 points on average) in total weighted score compared to the bottom six. In other words, while these top 10 are close in value, the top four appear most critical for the respondents. Contractor's inexperience with sustainable construction is nearly 8% greater from the fifth-ranked highest cost of sustainable materials and equipment.

Table 11. The top 10 risks based on the highest expected impact.

Risks with Highest Impact of Occurrence		**Weighted Score, S_{Wi}**
1	Contractors inexperience with sustainable construction	519
2	Design team inexperience	499
3	Unavailability of sustainable building materials in the market	496
4	Lack of practical experience	491
5	High costs of sustainable materials & equipment	481
6	Lack of political support & incentives	481
7	Design changes during construction	479
8	Non-complying products & materials	479
9	Poor material quality	476
10	Lack of public awareness	471

Table 12 presents the risks perceived as having a high degree of risk, *R* (combined high probability and high impact). The degree of risk is considered high if the value is closer to 1. The top five risks with similar total weighted scores (within 1% to 2% of each other), are high costs of sustainable materials and equipment, contractor's inexperience with sustainable construction, lack of practical experience, lack of public awareness, and high initial sustainable construction costs. The perceptions about higher upfront costs for sustainable materials and equipment are likely true in a country like Kuwait that is still early in the adoption of these materials and practices. However, increased awareness of the benefits may help offset or balance these higher up-front expenditures.

Table 12. The top 10 combined high probability and impact risks.

Risks with Highest Degree of Perceived Risk		**Degree of Perceived Risk, *R***
1	High costs of sustainable materials & equipment	0.61
2	Contractor's inexperience with sustainable construction	0.59
3	Lack of practical experience	0.58
4	Lack of public awareness	0.579
5	High initial sustainable construction costs	0.575
6	Unavailability of sustainable building materials in the market	0.55
7	Lack of market demand	0.548
8	Lack of political support & incentives	0.547
9	Cost estimation inaccuracy	0.536
10	Difficulty in the selection of subcontractors who provide sustainable construction practices	0.532

Risk Categories that Have the Highest Probability and Impact of Occurrence

The risk categories from Table 1 with the average highest perceived probability were external risks (e.g., public awareness and knowledge, government incentives, market demand) (mean Likert score = 3.7; 1 = very low probability/impact and 5 = very high probability/impact) and finance-related risks (e.g., cost of sustainable materials, schedule delays, payback period) (mean Likert score = 3.5). Scores were determined using the mean value of the Likert scale responses to each of the individual risks. An average of the Likert scale was calculated to compare between categories where there are several risks in each category, which can reveal the statistical differences. The perceived probability of risk occurrence in all risk categories was above average (more than 50%, mean scores above 3.0) except for the Certification category (mean score less than 3.0). The difference in mean scores between the categories (probability and impact) was statistically significant ($p < 0.001$). The one-way ANOVA test was used since it can determine the statistical difference between the means of two or more independent groups. The mean scores of the probability of each risk category are shown in Figure 2.

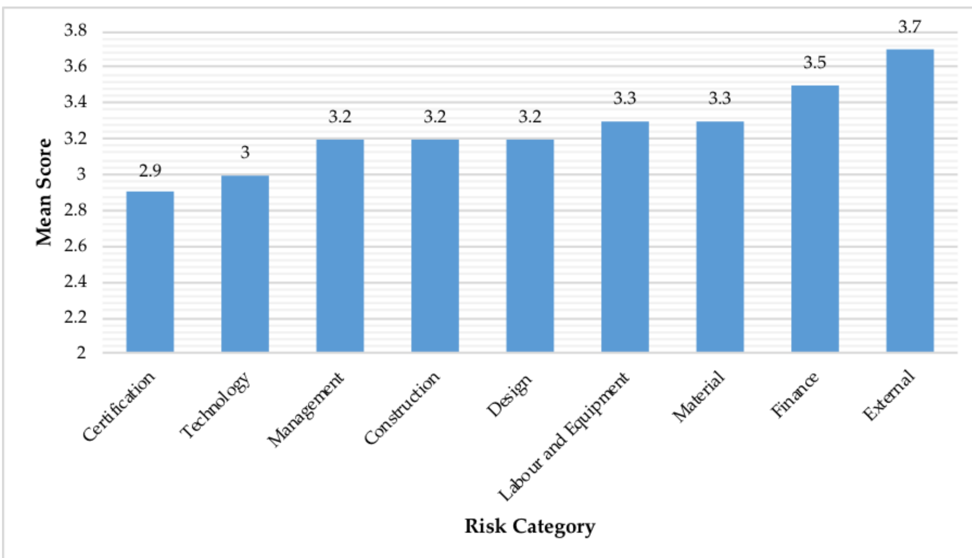


Figure 2. Mean scores for probability of risk categories (scores range from 1 to 5).

Respondents perceive risk impacts related to the materials such as unavailability of sustainable building materials, uncertainty of quality, and change orders for material as the highest possible impact for project outcomes. Design risks were also perceived as having a high potential impact including design changes during construction, design defects, and inexperience with sustainable design. The perceived risk impact in all risk categories was above average (more than 50%, mean scores above 3.0). The mean scores of the impact of each risk category are shown in Figure 3.

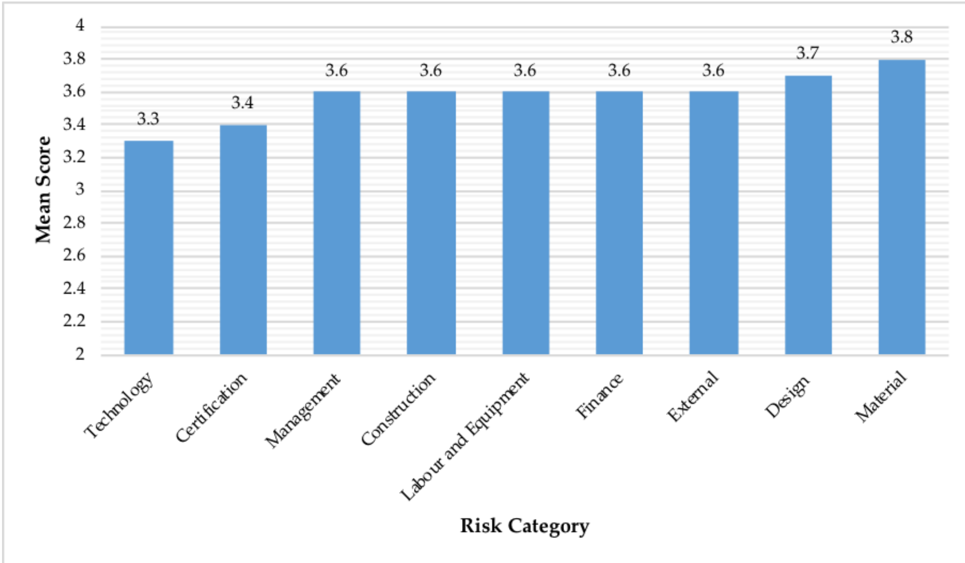


Figure 3. Mean scores for impact of risk categories (scores range from 1 to 5).

The results of each of the probability and impact of risk categories are significantly different. However, the top five categories are similar. This means the nine associated risk categories include risks associated with material, design, external factors, finance, labor, and equipment. The risks have the highest probability of occurrence and would cause the greatest impact on project outcomes. In terms of both probability and impact, the certification and technology categories are of the least concern for the respondents.

Perceptions of Construction Professionals in the Private Sector Compared to the Public Sector

The findings indicate no significant differences in the mean scores for all risk categories between the different titles of the professionals (project manager, site engineer, or architect), their practical experience (years), or their typical project types (residential, commercial, and industrial).

The only factor with a significant difference in response was whether their client base was private or public. The mean scores for the perceived probability of risk between private and public sectors were significantly different in the following categories: design ($p = 0.004$), construction ($p < 0.001$), management ($p = 0.017$), finance ($p = 0.013$), and technology ($p = 0.013$). Professionals working with the public sector perceive higher probabilities of risk in construction, management, finance, and technology but lower probabilities of risk compared to the private sector related to design. Risks associated with management were perceived as significantly higher by the public sector ($p = 0.023$) than the private sector. The other four categories had similar perceptions between respondents with public and private clients. The one-way ANOVA test was used to generate the *p*-values. Table 13 summarizes these results.

The difference in perceived probability and impact between construction professionals with public sector clients and private sector clients appear to relate to their level of awareness to sustainability in Kuwait. Between the two sectors, the private sector has a higher level of perceived sustainability awareness, which is illustrated in Figure 4. None of the respondents (whether public or private) believe that their knowledge of sustainable construction is "very good."

Table 13. Comparison of risk categories by sector types.

Risk Categories	**Public Sector**		**Private Sector**		***p*-Value**
	Mean	**(SD)**	**Mean**	**(SD)**	
Design related risks					
Probability of risk occurrence	3.2	(0.7)	3.5	(0.6)	**0.004**
Expected impact of risk	3.8	(0.8)	3.7	(0.6)	0.905
Construction related risks					
Probability of risk occurrence	3.4	(0.7)	3.1	(0.7)	**<0.001**
Expected impact of risk	3.7	(0.8)	3.6	(0.7)	0.477
Management related risks					
Probability of risk occurrence	3.4	(0.7)	3.0	(0.8)	**0.017**
Expected impact of risk	3.7	(0.6)	3.3	(0.7)	**0.023**
Finance related risks					
Probability of risk occurrence	3.7	(0.8)	3.3	(0.7)	**0.013**
Expected impact of risk	3.7	(0.8)	3.7	(0.7)	0.560
Technology related risks					
Probability of risk occurrence	3.3	(1.0)	2.7	(0.9)	**0.013**
Expected impact of risk	3.5	(1.0)	3.2	(0.9)	0.142

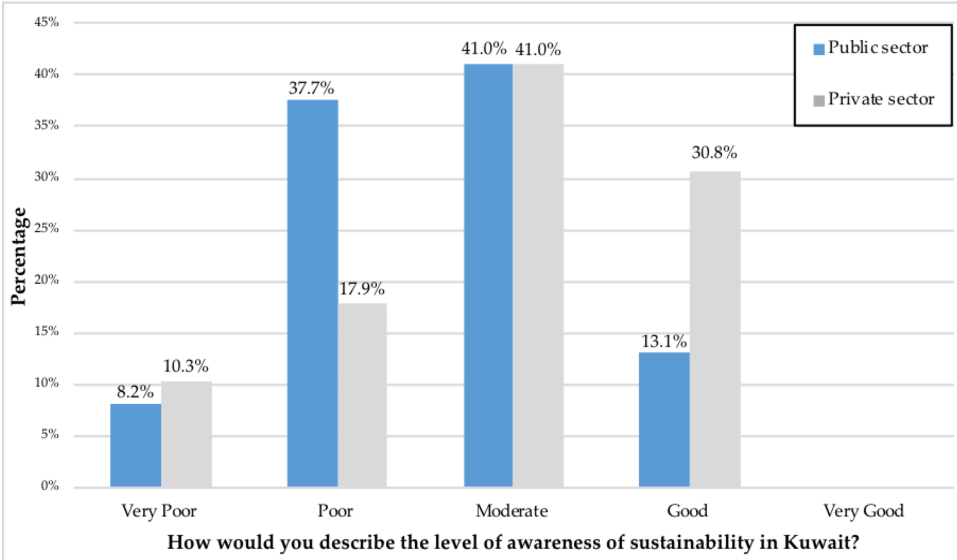


Figure 4. Level of awareness about sustainability among construction professionals in Kuwait that work with clients from the private and public sectors.

3.7 Discussion

Construction professionals in Kuwait that serve clients in the private sector appear to perceive less probability of risks related to construction, management, and finance when adopting sustainable techniques and technologies. These results are somewhat surprising compared to other regions and countries like the United States and Europe where government institutions were the early adopters of sustainable construction, which mandates the use of LEED and BREEAM, respectively, nearly two decades ago. The private sector may contribute to more innovative techniques and technologies with contract structures that help distribute risks among multiple stakeholder groups. The culture and ability to innovate because of distributed risk may explain why these differences occur between client types [64].

Another reason for the differences in perceptions between construction professionals that work with public or private sector clients is that the private sector in Kuwait tends to hire more non-Kuwaitis than the public sector. Industry professionals hired from outside of the country might bring experience and understanding of sustainability. The public sector predominately hires Kuwaiti citizens who, due to the currently low adoption rate of sustainable design and construction, are less likely familiar with sustainability principles and applications for construction [65]. This gap in sustainable awareness and experience may contribute to why construction professionals that work with private sector clients are less concerned about probabilities of risk related to sustainability compared to those that represent clients from the public sector.

Even with respondents in the private sector indicating “moderate” to “good” understanding of sustainable construction, risks associated with designer and contractors’ inexperience with sustainable construction rank highest and could negatively impact project outcomes. A tested solution to overcome these barriers is clients or project owners that recognize the benefits of incorporating sustainable design and construction techniques into their buildings and infrastructure and are motivated to request contractors and design teams with experience in sustainable projects [7]. Another strategy is through contracting sustainability experts. Experts may help general contractors recognize specialty issues and can help facilitate new markets or products that meet sustainability criteria. For example, risks identified in the results with high probability and impact such as unavailability of specific materials and equipment in the market can occur due to unforeseen procurement issue and lag times. Experts can help estimate additional times, delays, and scheduling issues that may arise because they have experience with these products [26].

Respondents also recognize the high costs of sustainable materials and equipment as high in probability and negative impact on future projects that adopt sustainability. Since this industry and region are new toward adopting sustainable construction, the higher cost of materials and equipment is similar to the greater cost of sustainable buildings in the United States and Europe nearly two decades ago when they were early in the adoption phase [9]. To bridge this gap, sharing knowledge across suppliers about what new standards and requirements mean and must be able to document is a possible strategy to reduce perceived risks over time [26,55]. Toyota, for example, groups suppliers together that use similar production processes to ensure that the information can be shared between them and is relevant for all [66]. Other interventions can be applied such as education and awareness programs for engineering professionals and public awareness programs. If these approaches are implemented, the major obstacle of lack of information on sustainable construction can be overcome.

Similar to higher costs of materials and equipment, broad categories of risk related to external factors such as the lack of market demand and lack of regional incentives as well as financial factors such as payback period and performance uncertainties are of greatest concern for these construction professionals. Prior research finds that material scarcity and availability to meet sustainability standards is a predominant factor and can directly impact costs [4]. Contingency premiums can work to reduce the cost for contractors and shift risk to clients and project owners [67].

Inherently, projects that include design and construction techniques for sustainability will incur more risks in the Kuwait construction industry because of the novelty and lack of experience among construction professionals. Traditional risk management strategies such as coordination with subcontractors, increasing workforce and equipment, producing programs using subjective decisions, and producing schedules that offer realistic resource procurement timelines [43] are helpful in traditional projects but may fall short when adopting sustainable construction practices. Achieving project goals for sustainability will require new technologies and strategies unfamiliar to the current workforce. Risk management programs should begin by addressing the barriers identified in the results of this paper. Regular training can help address the lack of awareness [26]. Innovative contract structures and employing those with experience in sustainable design and construction, especially in the public sector, can also help. The upfront cost is a real barrier especially for early adopters [60]. More focus on the benefits of sustainable design and construction may help balance the perceived high cost by educating suppliers and subcontractors and creating a network of professionals that supply the resources and materials that meet the standards for more sustainable materials.

Incorporating more nuanced techniques through behavioral science may also have an effect on construction professionals across cultures and regions, which are worth exploring [8]. For example, representing risks as embedded characteristics of engineering options can change the propensity of decision makers to take risks [68]. Framing risks as loss or gain can raise uncertainty awareness of decision-makers and can nudge construction professionals away from riskier, more uncertain options and towards less risky and certain options [69]. Including a feasibility example or a role model project for construction professionals to use as a guide can encourage higher levels of sustainability achievement [70]. However, these behavioral interventions have not been tested across cultures or with those less aware of sustainable design and construction.

The strength of the effect of framing interventions related to risk is limited to the values of the decision maker [71]. In other words, the effects of framing are larger when the concern or knowledge is low [72]. Participants with relevant experiences and more information on the subject may answer differently than those with limited awareness [12]. Therefore, professionals in Kuwait may be more influenced by framing or other behavioral interventions about risk than professionals in the United States or parts of Europe that have decades of experience and formed heuristics about sustainable construction. Future research can now begin to explore these possible interventions to shift perceptions and nudge contractors to incorporate sustainable design and construction techniques and technologies into building and infrastructure projects.

There are a few limitations to this study. First, the list of synthesized risks is not a comprehensive one since it includes risks from prior research published within the last 10 years only. The rationale for this choice is because risk management has evolved substantially over the last decade, but there could be some sustainability risks identified earlier or not included in this list that the construction industry faces today. Second, literature about sustainable construction risks in Kuwait and the MENA region is limited. There were only a few direct sources of reference from those countries. However, risks identified globally have been used in the literature review. The professionals did perceive many of these risk elements as having a high probability and impact of occurrence in Kuwait. Regardless of these limitations, this research identifies perceived risks in the Kuwaiti construction industry, which is a step forward in understanding and adopting more sustainable construction techniques.

3.8 Conclusions

The limited adoption rate for sustainable design and construction practices in the MENA region especially Kuwait is troublesome given that per capita residents in this region of the world produce 53% more greenhouse gas emissions than in the United States [22]. The lack of experience in sustainable construction appears to increase perceived risks among construction professionals. Industry professionals perceive that most risks of sustainable construction have high probabilities and impacts of risk occurrence. This perceived risk and higher cost for sustainable materials and equipment likely act as a barrier to adoption of new techniques and technologies. Other perceived risks include the lack of public awareness and practical experience, which are both related to knowledge and expertise. Differences in perceptions between sector types are significant. Construction professionals with clients in the private sector are less concerned with the probabilities and impacts of risk compared to the public sector specifically in risks related to finance, management, construction, and technology. Interestingly, project managers, site engineers, and architects showed no variation in their risk perceptions.

However, as important as the high probability and impact risks, are those with low probability and low impact. Time focused on these risks are potentially limiting the attention to risk with much higher negative effects. The construction professionals represented in this research overwhelming agreed risks related to technology and sustainability certification were low. Several sustainable risk management strategies can encourage more sustainable adoption and reduction of perceived risk. Contingency plans and shared risks with innovative contract structures can work to reduce the cost for contractors [57]. Sustainability experts can also help facilitate new markets or products that meet sustainability criteria and sharing knowledge across suppliers and subcontracts can spur industry support that, over time, reduces procurement costs and time [26,66]. Behavioral science approaches such as framing risks as gains in value instead of a loss or providing a role model project for teams to follow may also help nudge the industry forward in the adoption of sustainable construction techniques. Future research can now begin to measure the effect of new risk management strategies and behavioral interventions to change the perceptions identified in this paper and measure the adoption rate of sustainability in Kuwait and the entire MENA region [73].

References

1. Holden, E.; Linnerud, K.; Banister, D. The Imperatives of Sustainable Development. Sustain. Dev.2017, 25, 213–226.
2. Hill, R.C.; Bowen, P.A. Sustainable construction: Principles and a framework for attainment. Constr. Manag. Econ. 1997, 15, 223–239.
3. Reed, W.G.; Gordon, E.B. Integrated design and building process: What research and methodologies are needed? Build. Res. Inf. 2000, 28, 325–337.
4. Klotz, L.; Horman, M. Counterfactual Analysis of Sustainable Project Delivery Processes. J. Constr. Eng. Manag. 2010, 136, 595–605.
5. Beamish, T.D.; Biggart, N. Social Heuristics: Decision Making and Innovation in a Networked Production Market; Social Science Research Network: Rochester, NY, USA, 2010.
6. Klotz, L.; Mack, D.; Klapthor, B.; Tunstall, C.; Harrison, J. Unintended anchors: Building rating systems and energy performance goals for U.S. buildings. Energy Policy 2010, 38, 3557–3566.
7. Demaid, A.; Quintas, P. Knowledge across cultures in the construction industry: Sustainability, innovation and design. Technovation 2006, 26, 603–610. Shealy, T.; Klotz, L. Choice Architecture as a Strategy to Encourage Elegant Infrastructure Outcomes. J. Infrastruct. Syst. 2017, 23, 4016023.
8. Ahn, Y.H.; Pearce, A.R. Green Construction: Contractor Experiences, Expectations, and Perceptions. J. Green Build. 2007, 2, 106–122.
9. Samuelson, W.; Zeckhauser, R. Status quo bias in decision making. J. Risk Uncertain. 1988, 1, 7–59.
10. Kahneman, D.; Knetsch, J.L.; Thaler, R.H. Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias. J. Econ. Perspect. 1991, 5, 193–206.
11. Fischhoff, B.; Kadvany, J.D. Risk: A Very Short Introduction; Oxford University Press: Oxford, UK; New York, NY, USA, 2011; ISBN-13 9780199576203; ISBN-10 0199576203.
12. Yang, R.; Zou, P.; Wang, J. Modelling stakeholder-associated risk networks in green building projects. Int. J. Proj. Manag. 2015, 34.

13. Andi. The importance and allocation of risks in Indonesian construction projects. Constr. Manag. Econ. 2006, 24, 69–80.
14. Qian, Q.K.; Chan, E.H.W.; Khalid, A.G. Challenges in Delivering Green Building Projects: Unearthing the Transaction Costs (TCs). Sustainability 2015, 7, 3615–3636. [
15. Bryde, D.J.; Volm, J.M. Perceptions of owners in German construction projects: Congruence with project risk theory. Constr. Manag. Econ. 2009, 27, 1059–1071.
16. Robichaud, L.B.; Anantatmula, V.S. Greening Project Management Practices for Sustainable Construction. J. Manag. Eng. 2011, 27, 48–57.
17. Cidell, J. Building Green: The Emerging Geography of LEED-Certified Buildings and Professionals. Prof. Geogr. 2009, 61, 200–215.
18. Zou, P.X.W.; Zhang, G.; Wang, J. Understanding the key risks in construction projects in China. Int. J. Proj. Manag. 2007, 25, 601–614.
19. AlSanad, S. Awareness, drivers, actions, and barriers of sustainable construction in Kuwait. Procedia Eng. 2015, 118, 969–983.
20. Omran, A.; Mohd Shafie, M.W.; Osman Kulaib, H.M. Identifying Environmental Risk in Construction Projects in Malaysia: Stakeholder Perspective. Ann. Fac. Eng. Hunedoara 2015, 13, 89–92.
21. The World Bank Kuwait Data. Available online: http://data.worldbank.org/country/kuwait (accessed on 7 February 2017).
22. World Energy Council World Energy Perspective: Energy Efficiency Policies—What Works and What Does Not. Available online: https://www.worldenergy.org/wp-content/uploads/2013/09/WEC-Energy-Efficiency-Policies-executive-summary.pdf (accessed on 11 December 2017).
23. Darwish, M.A.; Al-Awadhi, F.M.; Darwish, A.M. Energy and water in Kuwait Part I. A sustainability view point. Desalination 2008, 225, 341–355.
24. Kuwait Central Statistical Bureau. Available online: http://www.csb.gov.kw/Socan_Statistic_EN.aspx?ID=18 (accessed on 13 October 2016).
25. Zou, P.X.W.; Couani, P. Managing risks in green building supply chain. Arch. Eng. Des. Manag. 2012, 8, 143–158.

26. AlSanad, S.; Gale, A.; Edwards, R. Challenges of sustainable construction in Kuwait: Investigating level of awareness of Kuwait stakeholders. World Acad. Sci. Eng. Technol. Int. J. Environ. Chem. Ecol. Geol. Geophys. Eng. 2011, 5, 753–760.
27. Eichholtz, P.; Kok, N.; Quigley, J.M. Doing Well by Doing Good? Green Office Buildings. Am. Econ. Rev. 2010, 100, 2492–2509.
28. Mang, P.; Haggard, B. Regenesis Regenerative Development and Design: A Framework for Evolving Sustainability. Available online: http://www.wiley.com/WileyCDA/WileyTitle/productCd-1118972864.html (accessed on 1 September 2017).
29. Rafindadi, A.D.; Mikić, M.; Kovačić, I.; Cekić, Z. Global Perception of Sustainable Construction Project Risks. Procedia Soc. Behav. Sci. 2014, 119, 456–465.
30. Kibert, C.J. Sustainable Construction: Green Building Design and Delivery; John Wiley & Sons: New York, NY, USA, 2016; ISBN 978-1-119-05517-4.
31. Harris, N.; Shealy, T.; Klotz, L. Choice Architecture as a Way to Encourage a Whole Systems Design Perspective for More Sustainable Infrastructure. Sustainability 2016, 9, 54.
32. Lovins, A.; Bendewald, M.; Kinsley, M.; Bony, L.; Hutchinson, H.; Pradhan, A.; Sheikh, I.; Acher, Z. Factor Ten Engineering Design Principles. Available online: http://www.10xe.orwww.10xe.org/Knowledge-Center/Library/2010-10_10xEPrinciples (accessed on 18 May 2018).
33. Yardi, R.; Archambault, T.; Wang, K.; Eubank, H. Home Energy Briefs: #9 Whole System Design. Available online: http://www.10xe.orwww.10xe.org/Knowledge-Center/Library/2004-21_HEB9WholeSystemDesign (accessed on 18 May 2018).
34. Blizzard, J.L.; Klotz, L. A framework for sustainable whole systems design. Des. Stud. 2012, 33, 456–479. Smith, N.J.; Merna, T.; Jobling, P. Managing Risk: In Construction Projects; John Wiley & Sons: New York, NY, USA, 2009; ISBN 978-1-4051-7274-5.

35. Westland, J. The Project Management Life Cycle: A Complete Step-By-Step Methodology for Initiating, Planning, Executing & Closing a Project Successfully; Kogan Page Publishers: London, UK, 2007; ISBN 978-0-7494-4808-0.
36. Keller, C.; Siegrist, M.; Gutscher, H. The Role of the Affect and Availability Heuristics in Risk Communication. Risk Anal. 2006, 26, 631–639.
37. Tversky, A.; Kahneman, D. Choices, values, frames. Am. Psychol. 1984, 39, 341–350.
38. Hwang, B.; Ng, W.J. Are Project Managers Ready for Green Construction?—Challenges, Knowledge Areas, and Skills. In Proceedings of the CIB World Building Congress 2013, St Lucia, QLD, Australia, 5–9 May 2013.
39. Kerur, S.; Marshall, W. Identifying and managing risk in international construction projects. Int. Rev. Law 2012, 1.
40. Pearce, A.R. Sustainable capital projects: Leapfrogging the first cost barrier. Civ. Eng. Environ. Syst.2008, 25, 291–300.
41. Kartam, N.A.; Kartam, S.A. Risk and its management in the Kuwaiti construction industry: A contractors' perspective. Int. J. Proj. Manag. 2001, 19, 325–335.
42. El-Sayegh, S.M. Risk assessment and allocation in the UAE construction industry. Int. J. Proj. Manag. 2008, 26, 431–438.
43. Jarkas, A.M.; Haupt, T.C. Major construction risk factors considered by general contractors in Qatar. J. Eng. Des. Technol. 2015, 13, 165–194.
44. Altoryman, A.S. Identification and Assessment of Risk Factors Affecting Construction Projects in the Gulf Region: Kuwait and Bahrain. Ph.D Thesis, The University of Manchester, Manchester, UK, 30 April 2014.
45. Van Buiten, M.; Hartmann, A. Public-private partnerships: Cognitive biases in the field. In Proceedings of the Engineering Project Organization (EPOC 2013), Winter Park, CO, USA, 9–11 July 2013.
46. Shen, L.Y. Project risk management in Hong Kong. Int. J. Proj. Manag. 1997, 15, 101–105.
47. Douglas, P.M. Risk and Blame; Routledge: London, UK, 2013; ISBN 978-1-136-49004-0.

48. Alvaro, S.-C.; Alfalla-Luque, R.; Irimia Diéguez, A.I. Risk Identification in Megaprojects as a Crucial Phase of Risk Management: A Literature Review. Proj. Manag. J. 2017, 47, 75.
49. Hwang, B.-G.; Ng, W.J. Project management knowledge and skills for green construction: Overcoming challenges. Int. J. Proj. Manag. 2013, 31, 272–284.
50. Bal, M.; Bryde, D.; Fearon, D.; Ochieng, E. Stakeholder Engagement: Achieving Sustainability in the Construction Sector. Sustainability 2013, 5, 695–710.
51. Tollin, H.M. Green Building Risks: It's Not Easy Being Green. Environ. Claims J. 2011, 23, 199–213.
52. Swan, L.G.; Ugursal, V.I. Modeling of end-use energy consumption in the residential sector: A review of modeling techniques. Renew. Sustain. Energy Rev. 2009, 13, 1819–1835.
53. O'Connor, H. Architect's Professional Liability Risks in the Realm of Green Buildings. Available online: https://uk.perkinswill.com/research/architects-professional-liability-risks-in-the-realm-of-green-buildings.html (accessed on 28 April 2018).
54. Hwang, B.-G.; Tan, J.S. Green building project management: Obstacles and solutions for sustainable development. Sustain. Dev. 2012, 20, 335–349.
55. Azizi, M.; Fassman, E.; Wilkinson, S. Risks Associated in Implementation of Green Buildings. Available online: http://www.thesustainabilitysociety.org.nz/conference/2010/papers/Mokhtar-Azizi-Fassman-Wilkinson.pdf (accessed on 4 May 2017).
56. Aminu Umar, U.; Khamidi, D.M.F. Determined the Level of Green Building Public Awareness: Application and Strategies. In Proceedings of the International Conference on Civil, Offshore and Environmental Engineering, Kuala Lumpur, Malaysia, 12–14 June 2012.
57. Lam, P.T.; Chan, E.H.; Poon, C.S.; Chau, C.K.; Chun, K.P. Factors affecting the implementation of green specifications in construction. J. Environ. Manag. 2010, 91, 654–661.
58. Turner Construction 2014 Green Building Market Barometer. Available online: http://www.turnerconstruction.com/download-

document/turner2014greenbuildingmarketbarometer.pdf (accessed on 22 April 2017).

59. Arashpour, M.; Arashpour, M. A collaborative perspective in green construction risk management. In Proceedings of the 37th Annual Conference of Australasian Universities Building Educators Association (AUBEA), Sydney, Australia, 4–6 July 2012; UTS Publishing/University of New South Wales: Sydney, Australia, 2012; pp. 1–11.
60. Anderson, M.K.; Bidgood, J.K.; Heady, E.J. Hidden Legal Risks of Green Building. Fla. Bar J. 2010, 84, 35–41.
61. Dagdougui, H. Decision Support Systems for Sustainable Renewable Energy Systems and Hydrogen Logistics: Modelling, Control and Risk Analysis. Ph.D. Thesis, École Nationale Supérieure des Mines de Paris, Università degli studi di Genova, Genova, Italy, 2011.
62. Zhi, H. Risk management for overseas construction projects. Int. J. Proj. Manag. 1995, 13, 231–237.
63. Gulseven, O. Challenges to Employing Kuwaitis in the Private Sector. Available online: http://www.oxgaps.org/files/analysis_gulseven.pdf (accessed on 19 May 2017).
64. Dyer, J.H.; Nobeoka, K. Creating and Managing a High-Performance Knowledge-Sharing Network: The Toyota Case. Strateg. Manag. J. 2000, 21, 345–367.
65. Lapinski, A.R.; Horman, M.J.; Riley, D.R. Lean Processes for Sustainable Project Delivery. J. Constr. Eng. Manag. 2006, 132, 1083–1091. [CrossRef]
66. Van Buiten, M.; Hartmann, A.; van der Meer, J.P. Nudging for smart construction: Tackling uncertainty by changing design engineers' choice architecture. In Proceedings of the Engineering Project Organization Conference 2016, Cle Elum, DC, USA, 28–30 June 2016.
67. Shealy, T.; Ismael, D.; Hartmann, A.; van Buiten, M. Removing Certainty from the Equation: Using Choice Architecture to Increase Awareness of Risk in Engineering Design Decision Making. In Proceedings of the Engineering Project Organization Conference, Stanford, CA, USA, 5–7 June 2017.

68. Harris, N.; Shealy, T.; Klotz, L. How Exposure to "Role Model" Projects Can Lead to Decisions for More Sustainable Infrastructure. Sustainability 2016, 8, 130.
69. McClure, J.; White, J.; Sibley, C.G. Framing effects on preparation intentions: Distinguishing actions and outcomes. Disaster Prev. Manag. Int. J. 2009, 18, 187–199.
70. Newman, C.L.; Howlett, E.; Burton, S.; Kozup, J.C.; Heintz Tangari, A. The influence of consumer concern about global climate change on framing effects for environmental sustainability messages. Int. J. Advert. 2012, 31, 511–527.
71. Tang, O.; Nurmaya Musa, S. Identifying risk issues and research advancements in supply chain risk management. Int. J. Prod. Econ. 2011, 133, 25–34.

CHAPTER 4

AN INITIAL APPROACH TO MORE SUSTAINABLE DESIGN IN KUWAIT THROUGH A BEHAVIORAL INTERVENTION

4.1 Overview

The purpose of this chapter is to offer a behavioral approach to encourage more sustainable design decisions among professionals in Kuwait. Kuwait is a leader in the Middle East and North Africa (MENA) region for construction (AlSanad et al., 2011), yet compared to other countries in the MENA region, is the least committed to sustainable design and construction practices (AlSanad, 2015). Engineering professionals in Kuwait have the technological ability to construct buildings and infrastructure that consume far less energy and natural resources while still meeting the need of end users but are not doing so at the scale or pace to realize much needed transformational change. The lack of prioritization, lack of awareness, beliefs about climate change, industry norms, and incentives, are all potential non-technical barriers to more sustainable design and construction. The previous two chapters help clarify these barriers.

Chapter 2 highlights that the two most common reasons for not pursuing more sustainable design and construction practices in Kuwait is the lack of awareness or knowledge about the benefits, and the belief that higher costs are accompanied with more green design in comparison to conventional design. These results align with a prior study by Darko & Chan (2016), reporting that the two highest mentioned barriers globally in 36 articles were lack of education and awareness, and the higher costs of constructing green buildings. These perceptions contradict several studies that indicate sustainable design and construction methods actually cost less than conventional design and construction practices (World Green Building Council, 2013b).

The results from Chapter 2 also indicate that professionals in Kuwait undervalue design features and practices that reduce environmental impacts (both locally through reduced environmental degradation and globally from CO_2 emissions) compared to design features and practices that improve the experience for people and save money both now and in the future for themselves or their clients.

In Chapter 3, the results indicate that industry professionals perceive a lack of public awareness as the risk element with the highest probability of occurrence. Design professionals are concerned about how sustainable design features and construction practices will be perceived. Choosing sustainable design features and construction practices to implement can create a risky choice since there are no best design features or construction practices that fit all contexts, geographic regions, and climates. Installing the wrong types of features that do not contribute to energy reduction or improved comfort may be seen as greenwashing. Rating systems help because they provide a detailed directive for sustainable design and construction practices and offer a certification indicating a project meets an approved standard. Rating systems developed for the Middle East and North African (MENA) region like the Global Sustainability Assessment System (GSAS) and the ARZ building rating system, weigh culture, well-being and economic value, over environmental sustainability (GORD, 2017; LGBC, n.d.). While health and social well-being are necessary to include, prioritizing these benefits over environmental benefits by increasing the weighted value of credits can be controversial and lead to less prioritization for global benefits like reduction in carbon emissions and water use. In fact, this may lead to skewed perceptions of sustainability (Sappi, 2015). Parameters to assess sustainable buildings must include reduced energy consumptions and greenhouse gas emissions (Lowe, 2007). Even from a systematic approach, the environmental impacts must be evaluated equally to both money and people (Woolley et al.,1997).

Compared to the U.S., awareness of benefits for sustainability has increased exponentially, moving from incremental improvements to radically new approaches towards regenerative development (Mang et al., 2016). But if the last two decades are an indication, waiting for industry norms and practices in the MENA region to evolve, similar to the U.S., means greenhouse gas emissions, water use, and resource consumption will continue to increase over the next decade, or two.

4.2 Behavioral science to overcome potential behavioral barriers to sustainability

Behavioral science offers a promising approach to help overcome these non-technical barriers related to perception and lack of motivation among designers. Utility companies employ behavioral science to help save customers money through peer messaging. Peer messaging creates a benchmark for how much energy users consume compared to their neighbors. Similarly, eco-feedback devices monitor real-time energy use and provide this information to building occupants. Eco-feedback devices fill a knowledge gap and help consumers reduce their energy consumption. Much previous research related to behavioral science and energy use in buildings, and more broadly the built environment, is devoted to these type of downstream decision makers (Delgoshaei et al., 2017). However, occupants of buildings hold a relatively narrow amount of power in directing energy use in buildings. Most of a building's energy performance is predetermined by designers, yet behavioral influences, on their design decisions, is still underexplored (Klotz, 2011; Shealy & Klotz, 2014). Modifications to tools used during design and construction process can have a much greater impact on long-term energy savings than similar interventions on downstream users or occupants (Shealy & Klotz, 2015). Previous attempts demonstrate the possible benefits to help engineering professionals prioritize greater achievement for sustainability using defaults (Shealy et al., 2016), role models (Harris et al., 2016), and a combination of the two (Shealy et al., 2016).

4.3 Goal framing as a behavioral intervention

Behavioral science provides an approach called choice architecture that explains how options, or choices, are presented to the decision-maker and how this influences the outcome. Just as an architect designing a building recognizes the size and shape of the room, placement of windows and hallways influence how occupants navigate the space, a choice architect recognizes the design of the decision environment, the use of defaults, partitioning of options, and the number of choices, can influence the decision outcome. Whether intentionally designed or not, there is no neutral framework to present information. Some options must be first, attributes are or are not presented, and, just as in other domains, these factors are likely to influence decisions for sustainability.

An example of a choice architecture is framing. Framing is applied with success in household emissions (Gifford & Comeau, 2011), disease testing (Spence & Pidgeon, 2010), and food labeling (Levin et al. 1998). There are three types of framing: attribute framing, goal framing, and risky choice framing. In attribute framing, a characteristic or trait of an object is described in terms of either a positive or equivalent negative valence. Objects described in terms of a positive valence (e.g., 90% survival rate) are generally evaluated more favorably than objects described in terms of the corresponding negative valence (10% death rate). In goal framing, decision makers are shown a description of either the advantages of engaging in an action or the corresponding disadvantages of not engaging. In contrast, decision makers are more likely to engage when the disadvantages of not engaging are emphasized (Levin et al. 1998).

One of the characteristics of goal-framing is that it re-structures the situation in ways that involve selecting knowledge and preferences. Goal framing has a crucial influence on the formation of preferences as they provide more knowledge and awareness to the individual. Goal framing also works by increasing awareness of the benefits, improving recall, and when the goal aligns with predefined values and objectives, it is more likely to lead to behavior change.

The majority of existing rating systems mainly provide the required information to the user, without it specifically being related to each country's unique conditions, user preferences or beliefs. In Kuwait, the majority of professionals prefer design features and construction practice that improve the quality of life for downstream user and save money over design features and practices that contribute to an improved environment. Yet, environmental design has cascading benefits to the surrounding people and likely offers long term financial savings. In other words, they are all connected. Pursuit of environmental design is necessary for the other two pillars of sustainability, people and financial savings, to succeed.

Most rating systems for sustainability predominately focus on environmental outcomes. For instance, nearly 40 percent of credits on the rating system Leadership in Energy and Environmental Design (LEED) are framed about the environment. The intent of credits on the Envision rating system for sustainable infrastructure includes 37 percent framed about the benefit to the environment, with little mention to the tangential benefits to people or financial savings.

To illustrate how goal framing can help align design preferences for people and finances with environmental sustainability, Table 14 provides an example using credits from the Envision rating systems for sustainable infrastructure. The purpose of the framing is to better align credits with preferences and values. The results from Chapters 2 and 3 indicate industry professionals in Kuwait prioritize design and construction methods that more directly relate to financial and community needs compared to environmental conservation or restoration.

Table 14. Rating system credits before and after goal framing the intent

Credit	**Resource Allocation - 2.2 Reduce Construction Energy Consumption**
Intent (control)	Reduce greenhouse gases and air pollutant emissions by reducing energy consumption during construction.
Goal framed intent (intervention)	*Avoid breathing problems and air pollutant emissions by reducing energy consumption during construction.*
Credit	**Resource Allocation - 3.2 Reduce Operational Water Consumption**
Intent (control)	Reduce overall water consumption to meet water needs.
Goal framed intent (intervention)	*Reduce construction costs, maintenance costs, and labor costs by reducing overall water consumption over the project life.*

Prior literature from behavioral science suggests goal framing can create modularity by affecting what decision makers cognitively attend to. Goals provide value to decision makers, which may override other aspects like monetary costs or other short-term effects. In other words, goal framing may help decision makers place more value on credits about the environment even if they cost more to pursue. Reframing credit outcomes from environmental benefits to social and financial benefits may help emphasize outcomes decision makers care about related to their own pre-established preferences. Goal framing the added benefits about people can help highlight and possibly shift the focus from solely about money to other variables like occupant comfort or long-term financial savings that better align with stakeholder preferences.

The next chapter provides more justification for goal framing as an approach to overcome non-technical barriers to more sustainable design among engineering professionals. Like true randomized control trials, the hypothetical decision scenarios presented in the subsequent chapters approximate the actual decision setting about infrastructure and include a sample from the relevant population both in Kuwait and in the United States. The ensuing chapters further detail how the use of hypothetical outcomes and empirical method offers advantages: numerous and novel conditions are examined, results are obtained quickly, and detailed process data is more easily collected.

The results in Chapters 5, 6, and 7 compare the level of performance professionals believe is possible among 15 credits on the Envision rating system. The discussion sections provide some explanation about why and how professionals who received a modified version of Envision with credits framed to include the outcomes about people and money set higher goals for sustainability. To further control for social and environmental views, the New Ecological Paradigm Revised (NEP-R) scale was also used to control for different world views. Most pro-environmental behaviors require people to make decisions against their egoistic values to benefit the environment (Lindenberg & Steg, 2013). So, if the intent of credits are framed in ways that present social, financial or health goals, the expectation is industry professionals will more quickly recognize the benefit and be more encouraged to pursue them. Individuals who are motivated more by the effects on the environment (New Ecological Paradigm) instead of people or money (Dominate social paradigm) may be inversely affected by the modifications highlighting the outcome to people and finances (Rideout et al., 2005 cited in Ogunbode, 2013).

References

Ahn, Y., & Pearce, A. (2007). Green construction: Contractor experiences, expectations, and perceptions. Retrieved from https://www.researchgate.net/publication/288428195_Green_Construction_Contractor_Experiences_Expectations_and_Perceptions

Ahn, Y., Pearce, A. R., Wang, Y., & Wang, G. (2013). Drivers and barriers of sustainable design and construction: The perception of green building experience. *International Journal of Sustainable Building Technology and Urban Development*, *4*(1), 35–45. https://doi.org/10.1080/2093761X.2012.759887

AlSanad, S. (2015). Awareness, drivers, actions, and barriers of sustainable construction in Kuwait. *Procedia Engineering*, *118*, 969–983. https://doi.org/10.1016/j.proeng.2015.08.538

AlSanad, S., Gale, A., & Edwards, R. (2011). Challenges of sustainable construction in Kuwait: Investigating level of awareness of Kuwait stakeholders. *World Academy of Science, Engineering and Technology, International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering*, *5*(11), 753–760.

Attia, S. (2013). The usability of green building rating systems in hot arid climates. Retrieved November 27, 2016, from http://orbi.ulg.be/bitstream/2268/164015/1/ID%2312528_Final2.pdf

Chang, H., Zhang, L., & Xie, G.-X. (2015). Message framing in green advertising: the effect of construal level and consumer environmental concern. *International Journal of Advertising*, *34*(1), 158–176. https://doi.org/10.1080/02650487.2014.994731

Darko, A., & Chan, A. P. C. (2016). Review of barriers to green building adoption. *Sustainable Development*. https://doi.org/10.1002/sd.1651

Delgoshaei, P., Heidarinejad, M., Xu, K., Wentz, J. R., Delgoshaei, P., & Srebric, J. (2017). Impacts of building operational schedules and occupants on the lighting energy consumption patterns of an office space. *Building Simulation*, *10*(4), 447–458. https://doi.org/10.1007/s12273-016-0345-9

Gifford, R., & Comeau, L. A. (2011). Message framing influences perceived climate change competence, engagement, and behavioral intentions. *Global Environmental Change*, *21*(4), 1301–1307. https://doi.org/10.1016/j.gloenvcha.2011.06.004

GORD. (2017). Gulf Organization for Research and Development. Retrieved March 25, 2017, from http://www.gord.qa/trust-gsas-resource-center-overview

Harris, N., Shealy, T., & Klotz, L. (2016). How exposure to “Role Model” projects can lead to decisions for more sustainable infrastructure. *Sustainability*, *8*(2), 130. https://doi.org/10.3390/su8020130

Johnson, E. J., Shu, S. B., Dellaert, B. G. C., Fox, C., Goldstein, D. G., Häubl, G., … Weber, E. U. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters*, *23*(2), 487–504. https://doi.org/10.1007/s11002-012-9186-1

Klotz, L. (2011). Cognitive biases in energy decisions during the planning, design, and construction of commercial buildings in the United States: an analytical framework and research needs. *Energy Efficiency*, *4*(2), 271–284.

Krishnamurthy, P., Carter, P., & Blair, E. (2001). Attribute framing and goal framing effects in health decisions. *Organizational Behavior and Human Decision Processes*, *85*(2), 382–399. https://doi.org/10.1006/obhd.2001.2962

Levin, I. P., Schneider, S. L., & Gaeth, G. J. (1998). All frames are not created equal: A typology and critical analysis of framing effects. *Organizational Behavior and Human Decision Processes*, *76*(2), 149–188.

LGBC. (n.d.). ARZ Building Rating System. Retrieved September 26, 2016, from http://www.arzrating.com/

Lindenberg, S., & Steg, L. (2013). *Goal-framing theory and norm-guided environmental behavior*.

Mang, P., Haggard, B., & Regenesis. (2016). Regenerative development and design: A framework for evolving sustainability. Retrieved September 1, 2017, from http://www.wiley.com/WileyCDA/WileyTitle/productCd-1118972864.html

Ogunbode, C. A. (2013). The NEP scale: measuring ecological attitudes/worldviews in an African context. *Environment, Development and Sustainability*, *15*(6), 1477–1494. https://doi.org/10.1007/s10668-013-9446-0

Pitts, J., & Lord, M. (2007). Existing buildings: It's easier than you think to green the triple bottom line. *Cornell Real Estate Review*, *5*(1). Retrieved from http://scholarship.sha.cornell.edu/crer/vol5/iss1/9/?utm_source=scholarship.sha.cornell.edu%2Fcrer%2Fvol5%2Fiss1%2F9&utm_medium=PDF&utm_campaign=PDFCoverPages

Pocock, J., Steckler, C., & Hanzalova, B. (2016). Improving socially sustainable design and construction in developing countries. *Procedia Engineering*, *145*, 288–295. https://doi.org/10.1016/j.proeng.2016.04.076

Shealy, T., & Klotz, L. E. (2014). Encouraging elegant solutions by applying choice architecture to infrastructure project delivery. In *Construction in a global network*.

Shealy, T., Klotz, L., Weber, E., Johnson, E. J., & Bell Ruth Greenspan. (2016). Using framing effects to inform more sustainable infrastructure design decisions. *Journal of*

Construction Engineering and Management, *142*(9), 4016037. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001152

Shealy Tripp, & Klotz Leidy. (2015). Well-endowed rating systems: How modified defaults can lead to more sustainable performance. *Journal of Construction Engineering and Management*, *141*(10), 4015031. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001009

Spence, A., & Pidgeon, N. (2010). Framing and communicating climate change: The effects of distance and outcome frame manipulations. *Global Environmental Change*, *20*(4), 656–667.

Sustainable Building Task Force. (2001). Building better buildings: A blueprint for sustainable state facilities. Retrieved November 12, 2017, from http://www.dot.ca.gov/hq/energy/Building%20Better%20Buildings/Blueprint%202001.pdf

Van de Velde, L., Verbeke, W., Popp, M., & Van Huylenbroeck, G. (2010). The importance of message framing for providing information about sustainability and environmental aspects of energy. *Energy Policy*, *38*(10), 5541–5549. https://doi.org/10.1016/j.enpol.2010.04.053

World Energy Council. (2013). World energy perspective: Energy efficiency policies – What works and what does not. Retrieved from https://www.worldenergy.org/wp-content/uploads/2013/09/WEC-Energy-Efficiency-Policies-executive-summary.pdf

World Green Building Council. (2013). The Business Case for Green Building - A Review of the Costs and Benefits for Developers, Investors and Occupants. Retrieved December 8, 2016, from http://www.worldgbc.org/files/1513/6608/0674/Business_Case_For_Green_Building_Report_WEB_2013-04-11.pdf

CHAPTER 5

ALIGNING DECISION TOOLS WITH USER PREFERENCES: HOW GOAL FRAMING APPLIED TO RATING SYSTEMS CAN LEAD TO MORE SUSTAINABLE INFRASTRUCTURE

5.1 Abstract

Just as a building's architectural design influences the way people navigate through the building, choice architecture influences the way people make decisions. Rating systems for sustainability, like Leadership in Energy and Environmental Design and the Institute for Sustainable Infrastructure's Envision, are filled with choice architecture, which describes how choices are presented to the decision maker. Unintentional choice architecture (e.g., default scores, the framing of points, providing a descriptive norm) may inadvertently set goals that lead away from more sustainable outcomes. More intentional choice architecture among rating systems can align user preferences. For example, decision makers without strong conservational views about the world may discount environmental benefits that occur in the future and uncertain, because these benefits require a cost in the present. If benefits of sustainable building are framed around an appeal to protect the health and welfare of their children, this may reduce the tendency for people to over-discount future environmental preservation. One approach to redirect cognitive attention is through the intentional goal framing of rating systems. Goal framing is defined as describing the same choice in different ways to lead to changes in behavior. This research tests goal-framing to help those involved in the development process make decisions that lead to more sustainable outcomes with engineering professionals from Kuwait (n=50). Industry professionals were given a real-world design scenario and asked to use the Envision rating system to set sustainability goals for the project team. Half of the participants randomly received the modified version of Envision with credits goal framed to include more direct emphasis about the social and financial benefits of pursuing the credit. The results indicated that framing credits with emphasis on the social and financial benefits of each credit increases industry professional's willingness to set high sustainability goals on average by 23% ($p<0.01$).

Simply modifying the framing of credits increases professional's recognition of sustainability objectives that otherwise are overlooked. Those who design and use rating systems should be aware that the framing of credits significantly influences goal setting. This type of behavioral intervention is relatively low cost compared to policy changes, new mandates, or technology.

5.2 Introduction

Decision makers without strong conservational views are prone to discount environmental benefits during the design process of buildings and infrastructure (Weber, 2017). This is in part because benefits require a cost in the present and offer a delayed reward (Weber, 2017). Similarly, a narrow focus on one pillar of sustainable design, for instance, only on downstream occupant comfort can lead to short sided and non-energy efficient solutions (Murphy, 2012). For example, a limited scope to improve air quality may produce design solutions that increase HVAC loads to circulate air. However, approaching the problem from an environmental sustainability point of view, to reduce energy use may result in passive building design strategies that limit the need for mechanical HVAC systems and also provide mutual overlapping benefits like improved air quality through more outdoor air circulation.

Designers and stakeholders globally rely on decision aides like rating systems, design software, and building codes to help foster more overlapping and synergistic solutions that create benefit across the environment, people, and their client's financial goals. This is evident in the exponential growth of Leadership in Energy and Environmental Design (LEED) in the last two decades (Driza & Park, 2013), and the market response of green buildings globally, which in 2014 reached 81 billion U.S. dollars (Statista, 2017).

However, a closer look at the use of rating systems as decision aids among design professionals suggests that these tools can be used for external recognition (Clevenger, et al. 2013) through the pursuit of points and not long-term sustainable design (GORD, 2017). Designers and stakeholders predominately achieve just enough points for certification and little more (Nelson & Frankel, 2012; Roberts, 2010). The most frequently achieved design credits are those that relate to people and money not the environment (Ismael & Shealy, 2018b). An increase in the use of rating systems, like

LEED, occurs just as new, more strict versions of these tools are announced. In other words, the pursuit of specific design features in buildings is often driven by the structure of these tools and the policies around them.

The adoption and market acceptance of these tools are also not equal globally. Countries in the Middle East and North Africa (MENA) region, represent some of the least committed to sustainable design and construction globally (AlSanad, 2015). Yet, the opportunity for impact towards more sustainable design in this region is substantial. Kuwait alone contributes 53% more global greenhouse gas emissions than the United States per capita. The population has increased by 137% in the last decade (The World Bank, 2016), and housing units have grown by nearly 400% since 2007 (Altoryman, 2014).

Views about conservation and environmental sustainability vary globally (Schultz, 2002). In particular, views about sustainable design among professionals in the MENA region are driven by institutional and cultural norms (Mahgoub, 2007a). Energy and water costs are subsidized by governments (e.g. Kuwait, United Arab Emirates, and Saudi Arabia). These types of subsidies further shift focus away from energy and environmentally sustainable design to socially and financially beneficial design outcomes (Ismael & Shealy, 2018c). The key incentive for investing in sustainable design principles and construction practices from stakeholders in the MENA region is not to provide environmental benefits, but to provide the optimal experience to the end users (Ismael & Shealy, 2018c).

In order for sustainable buildings and large-scale infrastructure to be desirable, the tools used in the pursuit for more sustainable design should be described in terms of decision-makers' pre-established value preferences (Memmott & Keys, 2015). In other words, the tools used to motivate decision makers to pursue higher achievement in sustainable design should align with what decision makers value. What appeals to decision makers' conscience should be presented first, and then data about the benefits for the environment should follow (Lamia, 2006). Connections could be financial, spiritual, health-related, or technological (Hoffman & Henn, 2008) and then the environmental benefit and supporting data and documents should follow. For example, globally, engineering professionals are more engaged by terms like smart buildings or high performance than terms like green or energy efficient (Hoffman & Henn, 2008).

One approach to make the connections across financial, spiritual, health-related, or technological benefits and the environment is through intentional choice architecture within rating systems. Choice architecture refers to the way information is presented to a decision maker. It is increasingly studied and applied to individual, consumer level decisions with positive outcomes of behavior change related to retirement savings (EIA, 2011), organ donation (Johnson & Goldstein, 2003; Thaler & Benartzi, 2004) and consumer savings (Goldstein et al., 2008; Levav et al., 2010). Rating systems are inherently embedded with choice architecture. For example, the framing of points as losses or gain in value, the use of descriptive norms, or role model projects can inform design decisions among engineering professionals (Shealy & Klotz, 2015).

More intentional choice architecture among rating systems that align individual preferences, based on societal and cultural values, may increase the pursuit of more environmentally sustainable design solutions. The purpose of the research presented in this paper is to test the effect of choice modifications on the motivation of engineering professionals to pursue specific design options for sustainability. The specific choice modification is intended to emphasize the overlapping benefits for people and the economy that design credits about the environment provide. The background section provides more detail about the type of choice architecture modification and the underlying theory from behavioral science about how choice modifications affect cognition and mental processing.

5.3 Background

Motivation to pursue sustainability during the design process of buildings and infrastructure is largely driven by stakeholders' goals, incentives, and available information (Mukherjee & Muga, 2010). Stakeholders make decisions that do not optimally trade sustainability objectives against other outcomes when they are unaware of the long term impacts of their decisions (Abrahamse, 2007); when sustainability is not an objective, perhaps because of misaligned incentives or insufficient feedback on the consequences of decisions (Abrahamse, 2007); when they believe that the client is more interested in other goals, such as minimizing upfront costs (Laustsen, 2008b); or, when they have sustainability goals, but lack the time to allocate sufficient thought or attention to them (Mukherjee & Muga, 2010).

The involvement of people and their different interpretations of sustainable development is unavoidable (Berardi, 2013). In the pursuit of more sustainable design, integrated systems thinking is critical to help align goals and incentives (Godfrey, 2010). A systems-thinking approach is understanding the integration of a system that works collectively in a way to achieve the desired purpose (Stroh, 2015). It differs from traditional linear approaches by recognizing that environmental, financial, and social aspects are three pillars that complete each other (Sappi, 2015). If any pillar is unavailable or weak, the system as a whole is unstable.

However, most rating systems used to encourage more sustainable design of buildings and infrastructure over emphasize environmental outcomes (water and energy use) over social or financial benefits for their clients or downstream users. Nearly 40% of credits in LEED, 50% of credits in the Pearl Building Rating System (PBRS), and 57% of credits in the ARZ rating system are singularly framed about the environment. Envision, which is another rating system developed by the Institute of Sustainable Infrastructure (ISI), almost exclusively focuses on environmental aspects. Envision includes 37% of credit intents being environmentally related, and nearly 40% have no emphasis on the connection (mutual benefit or consequence) to the environment, human quality of life, or financial savings. Only 20% of the credit intents within Envision are about social benefits, and 3.4% emphasize the financial benefits for pursuing the design credit.

Stakeholders using Envision as a decision aid that have different preferences or values might not find the benefits mentioned about the environment motivating enough for them to implement. This may unintentionally discourage the even higher levels of sustainability performance that are possible. Aligning the goals on decision tools with user preferences may encourage higher levels of achievement.

More intentional choice architecture among rating systems can align individual preferences. Rating systems like Envision are filled with choice architecture, even when it is not intentionally designed. Framing is one approach of choice architecture. Framing describes the same choice in different ways in order to lead to changes in behavior, even though the underlying information and choices remain essentially the same (Cookson, 2000). Goal framing is a particular type of framing where choices are described in the outcome of either positive consequences of engaging in a particular behavior, or negative consequences of not engaging in a particular behavior (Gamliel & Herstein, 2007; Levin et al., 2002). Positive framing motivates people by offering a reward, whereas negative goal framing motivates people by imposing a penalty.

Prior work on goal framing has shown that tailoring mass media messages to specific audiences has a significant effect on beliefs and behavior (Wokje Abrahamse et al., 2005). Similarly, policy messages are more salient if they are framed for the political consumption of the "socially symbolic tribe" (Krishen et al., 2014). Thus, framing the benefits of action or inability to take action about design for sustainability should increase consideration among engineering design decision makers (Chaudhuri, Li, & Paichayontvijit, 2016). Goal framing is a popular approach in the field of persuasive communications because not only does it affect beliefs, but can also lead to an increase in trusting behavior (Levin et al., 2002).

Goal framing can also encourage pro-environmental behavior and lead to improved management of environmental problems (Steg & Vlek, 2009). A prior study reframed information about biofuels and found that it was effective to persuade people to contribute to the prevention and reduction of energy and environmental problems (Van de Velde et al., 2010). While not precisely framing, goal setting helped achieve around 22% reduction in electricity and gas use (Houde & Todd, 2010). Using this previous research as a testament, aligning goals or consequences of either action or inability of action with predefined objectives, should improve decision-making (Verhagen et al., 2012) because choices framed as goals become more aligned to the decision makers' preferences and beliefs (Sauro, 2014).

Goal framing increases attention, helps decision makers more quickly recognize benefits, and creates modulatory in preference construction

The effect of goal framing does not appear to dissipate over time in multi-attribute decision tools like rating systems (Kim et al., 2014). In fact, goal framing is expected to have an influence on the weight and attention that is given to each design credit. The intention of goal framing is to shift professionals' attention from environmental benefits to the associated social or financial benefits that these credits also provide. Through goal framing, the decision "weight" of these credits is expected to increase in comparison to the other credits that have not been goal framed (Levin et al., 2002). This can increase awareness of benefits to professionals as they read the intents, which allows them to connect to them more (Chaudhuri et al., 2016).

Goal framing does not change the high initial cost in countries that are new to more sustainable design. High initial cost is a real, and not often just a perceived barrier to sustainable development in countries in where sustainable design is in its infancy. For example, regions like the Middle East and North African (MENA) region may lack the supply chain and logistics to purchase and install sustainable materials (Zou & Couani, 2012), in addition to the highly subsidized energy and water utilities by their governments (AlSanad, 2015). The high subsidization does not motivate professionals in this region enough to consider the environmental benefits of sustainable buildings (Ismael & Shealy, 2018b). This cost barrier is not necessarily the case in countries like the U.S., where industry for over two decades has increased adoption of sustainable design practices and resources (Ahn et al., 2013). Through goal framing, the added benefits to people can help highlight and shift the focus from solely about money to other variables like occupant comfort or long-term financial savings that better align with stakeholder preferences. In other words, goal framing can create modularity by affecting what decision makers cognitively attend to. Goals provide value to decision makers, which may override other aspects like monetary costs and long-term effects. This specific type of goal framing is called *gain goal framing*. Gain goal-framing describes how decisions makes behavior changes in response to newly provided information about incentives (i.e., such as money, time, status) (Lindenberg & Steg, 2007). The purpose of gain goal-framing is to account for the decision maker's motives, and behavior change or decision outcomes, result from aligning outcomes with motive. Gain goal framing is different than hedonic and normative goal framing. Hedonic goal frame is to cater to how an individual feels. Factors that affect mood, energy level (tired or energetic) and social atmosphere are examples of behavior that hedonic goal framing tries to influence. Normative goal-frame is in opposition to hedonic goal framing because it implies acting altruistic. For example, making pro-environmental decisions without giving attention to cost or hedonic outcomes (Lindenberg & Steg, 2007).

Reframing credit outcomes from only environmental benefits (which could act as a normative goal framing) to social and financial benefits (through gain goal framing) may help emphasize outcomes decision makers care about related to their own pre-established preferences.

The research presented in this paper measures the effectiveness of gain goal framing to increase motivation to achieve high levels of sustainable design performance. More specifically, testing whether goal framing (1) helps users set higher goals for sustainability, (2) activating otherwise dormant objectives, such as the lack of environmental prioritization, and (3) providing awareness of sustainability benefits.

5.4 Research Questions

Informed by previous literature in behavioral science and design for sustainability, this research merges these disciplines through the application of goal framing to the Envision rating system. The effects of goal framing are tested as a method to encourage more consideration for sustainability during the design and decision-making process for built environments. The two research questions are:

1. Does goal framing encourage engineering professionals to set higher goals for sustainable performance?
2. What is the difference in effect when goal framing environmentally-related credits to include benefits about human quality of life and financial savings?

The **first hypothesis** is framing the intent of credits on the *original Envision* rating system to include more emphasis about the social or financial benefits, not just environmental benefits, will lead to higher goal setting among professionals. Framing credits on Envision to emphasize the outcome for people and economics will allow professionals to make more sustainable choices by quickly recognizing the benefits of a credit across all three pillars of sustainable design (economic, environmental, and social).

Restoration of the environment is not the concern for everyone, especially people with low levels of sustainability awareness (Newman and Howlett, 2012). The **second hypothesis** is that framing *existing environmentally related credits* about social and financial benefits/goals will lead to an observed change in decision making within engineering professionals in Kuwait. The environmental credits will be framed to emphasize the benefits these credits will provide to people and represent financial gains for the project. The purpose is to help the decision makers recognize and later recall the benefits (and consequences) these decisions have towards meeting their pre-defined values and objectives.

5.5 Research Methodology

To help those involved in the design and construction process for sustainable built environments, a modification to the choice architecture of the Envision rating system for sustainable infrastructure was tested with engineering professionals. Envision was chosen because it is designed to be applicable to a range of infrastructure types, i.e., roads, bridges, pipelines, railways, airports, dams, levees, landfills, and water treatment systems. Envision is unique in that there are multiple levels of achievement for each credit, from improved through restorative. This provided an opportunity to measure a change in the level of achievement perceived applicable among engineering professionals when changes were made to the choice architecture of Envision credits. Envision awards points in 64 credits distributed across five categories. These points accumulate towards various levels of certification. While initially developed for the U.S. and Canada, Envision is now being applied in countries around the world.

Engineering and construction companies in Kuwait were contacted through email offering to host a training session about the Envision rating system. Companies were identified through convenience sampling (Teddlie and Yu, 2007). Companies that responded with a willingness to learn more about Envision were invited to a lunch and learn training session. In total, three training sessions were offered. Participants represented multiple companies. Out of the 50 professionals that participated, 55% were designers, 18% were from academic institutions, 12% represented suppliers, 10% construction managers, and 4% contractors. Out of the 50 professionals, 65% indicated over 10 years of experience, 16% between 5 to 10 years of experience, and 18% had less than 5 years. The level of education of participants included mostly bachelor's degree (52%), some held a master's degrees (31%), and a few held doctorate degrees (10%) or only high school diplomas (6%).

The experiment began by introducing the Envision rating system to the group of engineering professionals. Participants learned about Envision and how to interpret each credit. Participants were then given guidance on how to rate a case study project. A case study was presented to them modeled on an actual Envision certified project in Los Angeles, California. The case study was a recreational park and stormwater facility. The main aspects of the project include a multi-purpose field, walking trails, adjacent parking lots, restroom and community facilities, and holding facility for 680,000 gallons of water per day. For the training session, details about the case study were changed to Kuwait. The California project was used because climate characteristics (warm temperatures) and soil types described by Envision in the case are similar to those typical in Kuwait. Also, similar wastewater and stormwater projects like the one from Los Angeles that provide public recreational access are also becoming more common in Kuwait, for example, in Riqqa, Sulaibia, Wafra, Umm Alhaiman, and Jahra. Engineering professionals in Kuwait, and the MENA region as a whole are more frequently being asked to design outdoor environments that include water features and walking trails like the California project. Using a case that was applicable to Kuwait was necessary to ensure professionals understood the case and were able to make informed judgements about the level of achievement applicable for the project.

The information about the project was presented to the engineering professionals in a Request for a Proposal (RFP). As part of the training, participants were asked to act as the sustainability engineer and to set goals for the project team given a list of 15 out of the 64 possible Envision credits. These credits were preselected based the ability of the actual project team in California to achieve high levels of sustainability and based on the current framing of the intent of the credit. Only credits that mentioned environmental benefits in their intent were selected because the purpose of the research was to test the effects of emphasize the financial savings or improvements in health or quality of life for pursuing the credit originally framed about the environment. Also, only 15 credits were used to reduce the amount of time and cognitive load required to complete the training.

Participants were instructed to choose between levels of achievement for each of the 15 credits and state why they believed this level could be achieved. To control for a ceiling effect (where users just choose the highest level every time), a tradeoff was created between points and effort. Users were asked to explain how or why they plan to meet that achievement level. The higher the number of points, the longer the written response required. The complete goal framing decision scenario is in Appendix B.

Like truly randomized control trials, this set of hypothetical decisions about sustainability approximate the actual decision setting from a sample of the relevant population. However, because they use hypothetical outcomes, this empirical method has additional advantages: numerous and novel conditions can be examined, results are obtained quickly, and detailed process data is more easily collected. Meaning the engineering solution is already identified, but the full project details are lacking.

During the training, half of the participants received the regular version of Envision, and the other half received the gain goal framed version. Every credit on Envision has an intent section, which is a short statement outlining the purpose of the credit. Before the participants saw the credits, they were presented with the following instructions: "*Before selecting a level of achievement read the INTENT of each credit carefully. Also, each of the credits contains a set of evaluation criteria, listed in the details/guidance link.*" This is to ensure that the participants read the intent, which has the goal framed or unframed objective of the credit. Table 15 shows an example of the modified intent framed to make the connection to financial benefits. The intent mentions possible financial loss for in action. The control version does not mention financial outcomes.

Table 15. Example of an Envision credit intent before and after goal framing

NW2.2 Manage Stormwater	
Before goal framing *(control)*	INTENT: Minimize the impact of development on stormwater runoff quantity, rate, and quality.
After goal framing *(financially framed)*	INTENT: Prevent damage to property by minimizing the impact of development on stormwater runoff quantity, rate, and quality.

The credits were framed to include outcomes related to cost savings or improved quality of life based on the detailed description provided within each credit. In other words, new information or constraints were not being added rather each credit was framed to make the benefits for pursuing the credit more salient. For example, the description of credit RA3.2 Reduce Operational Water Consumption mentions direct cost savings such as construction, maintenance and labor costs that can be achieved by pursuing this credit. The connection between financial savings and water consumption was imbedded in the description. The modified version of Envision made this connection more salient in the intent of the credit. In each of the modified credits no new information was added to the credit, instead the information about financial saving or benefit to the community was just made more prominent to the decision maker by emphasizing this connection in the credit's intent.

After completing the decision scenario, participants were asked to answer questions about their experience. Participants responded to an open-ended, "*What was the most interesting takeaway in this experience?*" Given a five point Likert scale, from strongly agree to strongly disagree, participants were asked "*To what extent do you agree or disagree with the following: The decisions I made reflected my preferences and goal, I will use Envision in the future if the opportunity arises, I would recommend Envision to a friend, Envision has increased my awareness of sustainable benefits.*"

5.6 Results

Goal framing encouraged higher levels of achievement on the Envision rating system. The results are significant ($p < 0.01$) using a one-tail t-test indicating that framing Envision credits to emphasize the outcome to people and financial savings increases the level of achievement set by the engineering professionals. The average total score of the 15 credits among the professionals who received the current version of Envision (control) was 120.36 (SD = 39.8). The average total score among the professionals who received the modified version with intentional goal framing was 148.14 (SD = 32.49). This difference is illustrated in Figure 5. Goal framing led to a 23% increase in goals set by engineering professionals compared to those who received the current version of Envision.

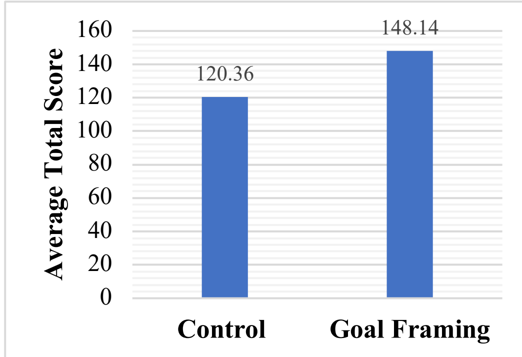


Figure 5. The average total Envision score was 23% higher when goal framed to emphasize the outcomes to people and financial savings

Design professionals perceived higher levels of achievement for sustainability was possible when credit intents were framed to emphasize financial and social benefits rather than environmental benefits. The results indicated that engineering professionals achieved more Envision points in all socially framed credits ($p = 0.02$) compared to when the intent solely mentions the environment. Professionals who received the modified intent for the credit *CR1.2 Reduce Greenhouse Gas Emissions* believed the maximum possible points was possible. On average, they set a 32% higher goal for achievement than the control group, as shown in Figure 6.

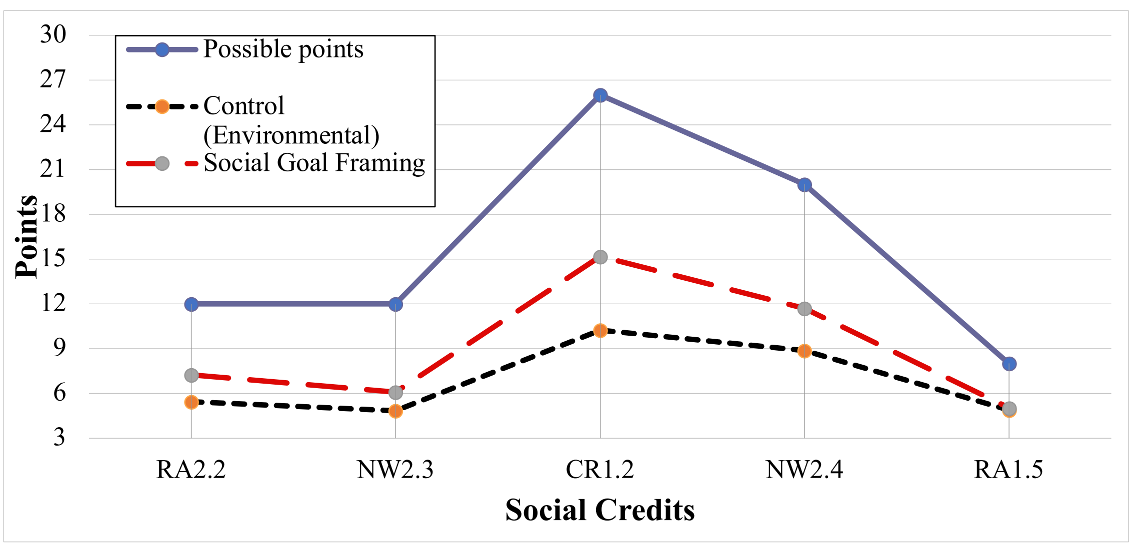


Figure 6. Participants achieved more Envision points when environmental credits are socially goal framed.

The financially framed credits compared with the control credits that merely mention the intent for the environment led to significantly (p = 0.04) higher goals in three out of the five credits. Credit *CR1.1 Reduce Net Embodied Carbon* led to a slight negative effect by 1.7%. Professionals who received the financially framed version of Envision set a higher goal for *Credit NW3.1 Enhance Functional Habitat*. This credit was the most different in goal setting among all of the financially framed credits. The respondents, on average, set a 19% higher goal in achievement compared to control group, as shown in Figure 7.

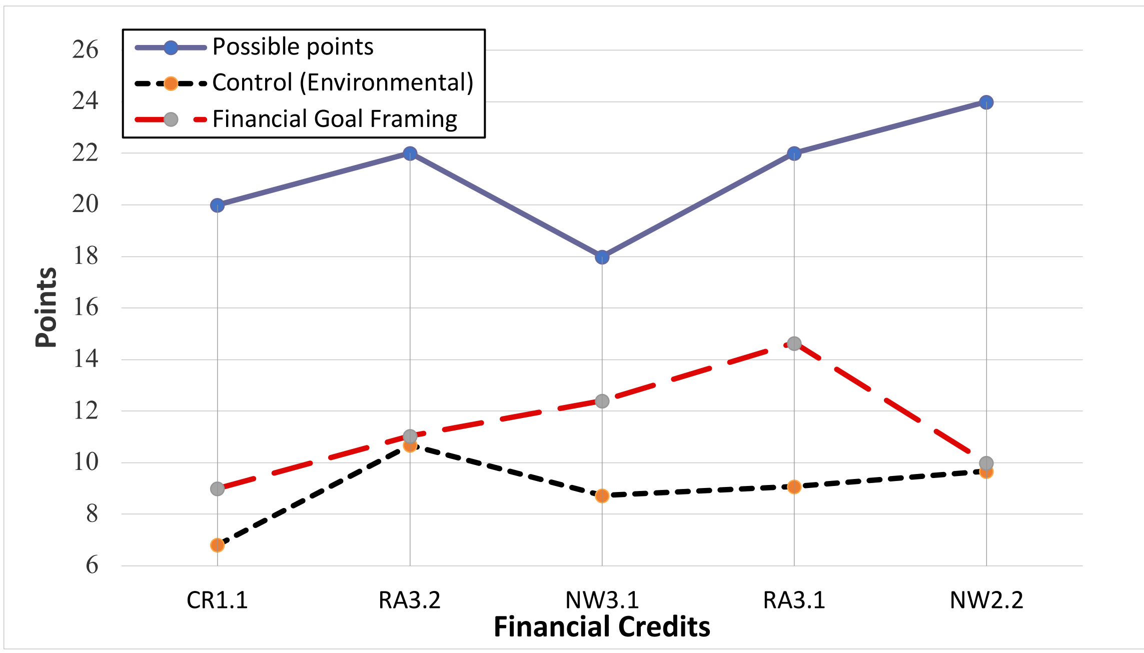


Figure 7. Participants achieved more Envision points when environmentally related credits are financially goal framed.

Engineering professionals gained greater awareness of sustainability using the goal framed version of Envision. The responses were coded based on keywords that have been used in response to the question "*What was the most interesting takeaway in this experience?*". Example responses of both types of responses are shown in Table 16. Appendix G lists more responses from the engineering professionals. Out of the 27 respondents in the goal framed group, 9% *more* participants mentioned an increase in levels of awareness and gaining more understanding of sustainability.

Table 16. Responses that indicated whether there was an increase in sustainability awareness

Responses indicate increased levels of sustainability awareness	**Responses that *do not* indicate increased levels of sustainability awareness**
I noticed the importance of sustainable awareness and its effect on the environment and society.	It would be interesting to implement Envision rating system for the first time in the Middle Eastern region.
I better understand sustainability concepts.	There is an increase in environmental problems.
I enhanced my awareness of sustainable benefits.	Envision approaches sustainability differently than LEED.
Learning about a new rating system like Envision.	Envision is simple and easy to use.
My awareness increased about the importance of environmental consideration.	
Learning about new rating systems that consider the environment.	

Professionals were asked if the decisions they made reflected their preferences and goals, 90% (42/52) “strongly agreed” or “agreed.” There was no significant difference between professionals who received the control or modified version of Envision. More than three-quarters of professionals (77%) believe cost is a barrier to sustainable construction, but the majority ranked “lack of awareness” as the number one barrier to sustainable construction (42%) followed by “high initial cost” then “lack of environmental prioritization.” More than half of the participants (53%) believe that after learning more about Envision that they would recommend it to a friend and that most of them (60%) will use Envision in the future if the opportunity arises. The goal framing intervention did not have an effect on their willingness to recommend Envision or willingness to use Envision in the future. Finally, all participants were asked directly if Envision has increased their awareness of sustainable benefits. Professionals who received the modified version of Envision were 22% *more* likely to agree or strongly agree compared to the control group.

5.7 Discussion

Most rating systems focus on emphasizing environmental goals, such as reducing greenhouse gas emissions. However, decision-makers need to be reminded of the tangential benefits that may be achieved from the pursuit of these environmental outcomes, especially in countries where there are lower levels of awareness about the benefits of sustainable design. Goal framing credits, especially about the environment to highlight the social or financial outcomes, leads to more consideration for sustainable design, an increase in awareness, and higher goal setting. The effect was significant. Simply framing credits to include the possible outcomes to people or financial savings led to an average of 23% increase in the goal setting for sustainability among professionals.

The effects were not consistent across all credits. No matter the framing, some credits appear a challenge to achieve. For example, steel cannot be obtained locally in Kuwait because it is unavailable. *RA3.2 Reduce Operational Water Consumption* had a minor increase in goal setting when framed about the financial gains, likely, because the government subsidizes water, so professionals are unable to find financial value in reducing overall water consumption.

The two credits where professionals who received the framing intervention pursued the highest possible level of achievement were *Credit NW3.1 Enhance Functional Habitats,* and *CR1.2 Reduce Greenhouse Gas Emissions*. When the credit *NW3.1 Enhance Functional Habitats* was framed about avoiding financial loss of land value, it aligned more with their project aims and motivated engineering professionals to identify methods for implementation. Similarly, the low levels of sustainability awareness among Kuwait professionals and their lack of experience with sustainable construction may contribute to discounting the effects of climate change in the future. But when this credit was framed to highlight the health issues of not implementing it, the frequency of professionals setting higher goals significantly increased.

Most professionals perceived high cost as a barrier to more sustainable performance. Yet, goal framing increased their willingness to do more towards sustainable design. In other words, goal framing increased the value placed on sustainable design. Goal framing helped decision-makers recognize the mutual benefits of sustainable design, and this increased their perceived value, which may help counterbalance the actual cost increase in regions like MENA region, where increased cost is a real concern.

There are a couple of limitations to this study. First, the participants knew this was a training session, and their decisions were made based on a hypothetical project scenario. However, when they were asked if the decisions they made reflected their preferences and goals, 90% strongly agreed or agreed. Second, participants were only given a limited amount of time to complete the decision scenario, which allowed for a more accelerated approach in decision-making than in real-world projects. Third, participants might have been influenced by those who shared their opinions with everyone. For example, some engineering professionals did not believe sustainable construction is possible in Kuwait and explained the reasons for that assumption throughout the training. This might have influenced their choices and the choices of those around them. However, both the control and intervention groups were likely equally affected because both groups heard the point of view from the small group of skeptical engineering and design professionals. Last, the modifications were being tested on a U.S. based rating system. This may be a cause of bias in the results because of the intended use of the system. Although, any embedded or inherent bias from using a U.S. based rating system would be in both the control and intervention groups among Kuwait professionals.

5.8 Conclusion

Studying the impact of choice architecture interventions, specifically goal framing, on high-impact decisions is a challenge that requires merged understanding of behavioral science and infrastructure sustainability. If those who plan, design, and build infrastructure recognize their own decision biases, they will better manage their own decisions and be more likely to develop the desire and tools to consider how their designs influence users' decisions. Using choice architecture, advancements can be made towards understanding sustainability decision-making at large physical scales and on long time horizons .

More specifically, the purpose of goal framing applied to this research is to offer an approach for a more support sustainable design, especially in a country like Kuwait where there is a high potential but current lack of integration of sustainable development. Possible impacts of this research are substantial. Suppose framing led to just 10% better performance on the Envision *Credit CR1.2 Reduce Greenhouse Gas Emissions*. Applied to all U.S. infrastructure, this represents a reduction of over 1.5 billion tons of CO_2 (estimate based on a per-capita carbon footprint of infrastructure of 53 tons) (Müller et al., 2013). Of course, infrastructure is not updated all at once so these reductions would be acquired over time. However, this is just for one of the 64 Envision credits. Intentionally designed framing interventions might promise similar gains in 63 other sustainability outcomes. While Envision is only used currently on a fraction of infrastructure projects, it is rapidly expanding.

Regardless of the success of Envision, this research can inform the many other infrastructure decision aids such as Building Information Modeling (BIM) and similar software programs and building codes. Ultimately, the purpose of this research is to illustrate the current inadequate understanding of how behavioral factors influence the crucial early-phase decisions in design and construction for sustainability. This research also forges a new research direction in decision biases, and corresponding interventions that influence upstream, multi-stakeholder decision making for sustainable built environments on a global scale.

References

Abrahamse, W. (2007). Energy conservation through behavioral change: Examining the effectiveness of a tailor-made approach. Retrieved April 17, 2017, from http://dissertations.ub.rug.nl/faculties/gmw/2007/w.abrahamse/?pLanguage=en&pFullItemRecord=ON

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, *25*(3), 273–291. https://doi.org/10.1016/j.jenvp.2005.08.002

AlSanad, S. (2015). Awareness, drivers, actions, and barriers of sustainable construction in Kuwait. *Procedia Engineering*, *118*, 969–983. https://doi.org/10.1016/j.proeng.2015.08.538

Altoryman, A. S. (2014, March 24). Identification and assessment of risk factors affecting construction projects in the Gulf region: Kuwait and Bahrain. Retrieved

January 29, 2018, from [Thesis]. Manchester, UK: The University of Manchester; 2014. website: https://www.escholar.manchester.ac.uk/uk-ac-man-scw:221966

American Physical Society. (2008). Energy = Future: Think Efficiency. Retrieved December 6, 2017, from https://www.aps.org/energyefficiencyreport/report/aps-energyreport.pdf

Bargh, J. A., Gollwitzer, P., Lee-Chai, A., Barndollar, K., & Trotschel, R. (2001). Automated will: Nonconscious activation and pursuit of behavioral goals. Retrieved September 25, 2017, from http://psycnet.apa.org/fulltext/2001-05428-004.pdf

Berardi, U. (2013). Clarifying the new interpretations of the concept of sustainable building. *Sustainable Cities and Society*, *8*, 72–78. https://doi.org/10.1016/j.scs.2013.01.008

Brewer, G., & Stern, P. (2005). *Decision Making for the Environment: Social and Behavioral Science Research Priorities*. Retrieved from http://www.nap.edu/catalog/11186/decision-making-for-the-environment-social-and-behavioral-science-research

Chaudhuri, A., Li, Y., & Paichayontvijit, T. (2016). What's in a frame? Goal framing, trust and reciprocity. *Journal of Economic Psychology*, *57*(Supplement C), 117–135. https://doi.org/10.1016/j.joep.2016.09.005

Clevenger, C., Ozbek, M. E., & Simpson, S. (2013). Review of sustainability rating systems used for infrastructure projects. *Proc. 49th ASC Annual Int*, 10–13.

Clevenger, C., Ozbek, M., & Simpson, S. (2013). Review of sustainability rating systems used for infrastructure projects. Retrieved December 7, 2017, from http://ascpro0.ascweb.org/archives/cd/2013/paper/CPRT88002013.pdf

Cookson, R. (2000). Framing Effects in Public Goods Experiments. *Experimental Economics*, *3*(1), 55–79. https://doi.org/10.1023/A:1009994008166

Darwish, M. (2005). Energy efficient Air conditioning: Case study for Kuwait. Retrieved June 17, 2017, from ResearchGate website: https://www.researchgate.net/publication/285816992_Energy_efficient_Air_conditioning_Case_study_for_Kuwait

Driza, P.-J. N., & Park, N.-K. (2013). Actual Energy and Water Performance in LEED-

Certified Educational Buildings. *Sustainability: The Journal of Record*, *6*(4), 227–232. https://doi.org/10.1089/SUS.2013.9850

Edwards, P., J. Jackson, S., C. Bowker, G., & Knobel, C. (2007). *Understanding Infrastructure: Dynamics, Tensions, and Design*.

EIA. (2011). Total Energy Flow. Retrieved December 6, 2017, from http://www.eia.gov/totalenergy/data/annual/diagram1.cfm

Gamliel, E., & Herstein, R. (2007). The effect of framing on willingness to buy private brands. *Journal of Consumer Marketing*, *24*(6), 334–339. https://doi.org/10.1108/07363760710822918

Godfrey, P. (2010). Using systems thinking to learn to deliver sustainable built environments. *Civil Engineering and Environmental Systems*, *27*(3), 219–230. https://doi.org/10.1080/10286608.2010.482656

Goldstein, D. G., Johnson, E. J., Herrmann, A., & Heitmann, M. (2008, December 1). Nudge Your Customers Toward Better Choices. Retrieved December 6, 2017, from Harvard Business Review website: https://hbr.org/2008/12/nudge-your-customers-toward-better-choices

GORD. (2017). Gulf Organization for Research and Development. Retrieved March 25, 2017, from http://www.gord.qa/trust-gsas-resource-center-overview

Hoffman, A. J., & Henn, R. (2008). Overcoming the Social and Psychological Barriers to Green Building. *Organization & Environment*, *21*(4), 390–419. https://doi.org/10.1177/1086026608326129

Houde, S., & Todd, A. (2010). List of behavioral economics principles that... Retrieved August 31, 2017, from https://scholar.google.com/scholar?hl=en&as_sdt=0,15&cluster=14527752442875364204

Ismael, D., & Shealy, T. (2018a). Aligning Rating Systems and User Preferences: An Initial Approach to More Sustainable Construction through a Behavioral Intervention. Retrieved September 22, 2018, from https://ascelibrary.org/doi/10.1061/9780784481301.071

Ismael, D., & Shealy, T. (2018b). Aligning Rating Systems and User Preferences: An Initial Approach to More Sustainable Construction through a Behavioral Intervention.

Construction Research Congress 2018. https://doi.org/10.1061/9780784481301.071

Johnson, E. J., & Goldstein, D. (2003). Do Defaults Save Lives? *Science*, *302*(5649), 1338–1339. https://doi.org/10.1126/science.1091721

Krishen, A. S., Raschke, R., Kachroo, P., LaTour, M., & Verma, P. (2014). Promote me or protect us? The framing of policy for collective good. *European Journal of Marketing*, *48*(3/4), 742–760. https://doi.org/10.1108/EJM-10-2011-0609

Laustsen, J. (2008). Energy efficiency requirements in building codes, energy efficiency policies for new buildings. *International Energy Agency (IEA)*, 477–488.

Levav, J., Heitmann, M., Herrmann, A., & Iyengar, S. (2010). Order in product customization decisions: Evidence from field experiments. Retrieved December 6, 2017, from https://www0.gsb.columbia.edu/mygsb/faculty/research/pubfiles/2619/Levav,%20Heitmann%20et%20al%20JPE.pdf

Levin, I., Gaeth, G., Schreiber, J., & Lauriola, M. (2002). A New Look at Framing Effects: Distribution of Effect Sizes, Individual Differences, and Independence of Types of Effects. *Organizational Behavior and Human Decision Processes*, *88*, 411–429. https://doi.org/10.1006/obhd.2001.2983

Mahgoub, Y. (2007). Architecture and the expression of cultural identity in Kuwait. *The Journal of Architecture*, *12*(2), 165–182. https://doi.org/10.1080/13602360701363486

Memmott, P., & Keys, C. (2015). Redefining architecture to accommodate cultural difference: designing for cultural sustainability. *Architectural Science Review*, *58*(4), 278–289. https://doi.org/10.1080/00038628.2015.1032210

Mukherjee, A., & Muga, H. (2010). An integrative framework for studying sustainable practices and its adoption in the AEC industry: A case study. *Journal of Engineering and Technology Management*, *27*(3–4), 197–214. https://doi.org/10.1016/j.jengtecman.2010.06.006

Müller, D. B., Liu, G., Løvik, A. N., Modaresi, R., Pauliuk, S., Steinhoff, F. S., & Brattebø, H. (2013). Carbon emissions of infrastructure development. *Environmental Science & Technology*, *47*(20), 11739–11746. https://doi.org/10.1021/es402618m

Murphy, K. (2012). The social pillar of sustainable development: a literature review and framework for policy analysis. *Sustainability: Science, Practice and Policy*, *8*(1), 15–

29. https://doi.org/10.1080/15487733.2012.11908081

Nelson, A. J., & Frankel, A. (2012). *Building Labels vs. Environmental Performance Metrics: Measuring What's Important about Building Sustainability*. Retrieved from http://realestate.dws.com/content/_media/Research_Sustainability_Metrics_in_the_Real_Estate_Sector-Oct_2012.pdf

Roberts, T. (2010, October 14). USGBC, LEED Targeted by Class-Action Suit. Retrieved February 1, 2019, from Building Green website: https://www.buildinggreen.com/news-analysis/usgbc-leed-targeted-class-action-suit

Sauro, J. J. (2014). *A content analysis of Kickstarter: The influence of framing and reward motivations on campaign success* (M.A., San Diego State University). Retrieved from https://search.proquest.com/docview/1540748067/abstract/C895853A230548D0PQ/1

Schultz, P. (2002). Environmental Attitudes and Behaviors Across Cultures. *Online Readings in Psychology and Culture*, *8*. https://doi.org/10.9707/2307-0919.1070

Shealy, T., & Klotz, L. (2015). Well-endowed rating systems: How modified defaults can lead to more sustainable performance. *Journal of Construction Engineering and Management*, *141*(10), 4015031. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001009

Statista. (2017). Green construction market size United States 2014 | Statistic. Retrieved June 15, 2017, from Statista website: https://www.statista.com/statistics/248060/value-of-us-green-building-market/

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behavior: An integrative review and research agenda. *Journal of Environmental Psychology*, *29*(3), 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004

Stroh, D. P. (2015). *Systems Thinking For Social Change: A Practical Guide to Solving Complex Problems, Avoiding Unintended Consequences, and Achieving Lasting Results*. Chelsea Green Publishing.

Thaler, R. H., & Benartzi, S. (2004). Save More Tomorrow^{TM}: Using Behavioral Economics to Increase Employee Saving. *Journal of Political Economy*, *112*(S1), S164–S187. https://doi.org/10.1086/380085

The World Bank. (2016). Kuwait Data. Retrieved February 7, 2017, from http://data.worldbank.org/country/kuwait

U.S. National Science Board. (2009). Building a Sustainable Energy Future. Retrieved December 6, 2017, from https://www.nsf.gov/pubs/2009/nsb0955/nsb0955.pdf

Van de Velde, L., Verbeke, W., Popp, M., & Van Huylenbroeck, G. (2010). The importance of message framing for providing information about sustainability and environmental aspects of energy. *Energy Policy*, *38*(10), 5541–5549. https://doi.org/10.1016/j.enpol.2010.04.053

Verhagen, E., Ketter, W., Rook, L., & Dalen, J. van. (2012). The impact of framing on consumer selection of energy tariffs. *2012 International Conference on Smart Grid Technology, Economics and Policies (SG-TEP)*, 1–5. https://doi.org/10.1109/SG-TEP.2012.6642391

Weber, E. U. (2017, January 10). Breaking cognitive barriers to a sustainable future [Comments and Opinion]. Retrieved December 7, 2017, from Nature Human Behaviour website: https://www.nature.com/articles/s41562-016-0013

CHAPTER 6

INTENTIONAL GOAL FRAMING OF RATING SYSTEMS CAN LEAD TO MORE SUSTAINABLE BUILT ENVIRONMENTS

6.1 Abstract

The planning, design, and construction of sustainable buildings and infrastructure is a complex process. Engineering design and construction teams commonly use decision tools, like rating systems, to manage the complexity that comes from the planning, design, and construction of sustainable buildings and infrastructure. However, the single focus on the environment for many credits within rating systems may unintentionally discourage the higher levels of sustainability performance that are possible because decision makers do not easily recognize mutual benefits between, for example, the natural world and risk reduction. To motivate users of rating systems to improve sustainability performance, shared benefits between the natural world and the effect on people and capital costs can be better reflected in the rating systems used to make design and project level decisions. Making the shared connection between value preferences about the environment, people, and money is a type of goal framing where the positive or negative outcomes of the same decision is presented (or framed). Framing leads to change in relative attractiveness among choices. The research presented in this paper tests how changes to the description of design credits within rating systems for sustainability can increase motivation among engineering professionals to not just meet the minimum but the highest levels of sustainability performance. The description of individual credits on the Envision rating system were modified to emphasize the connection between the credits intent about the environment to also highlight the impact to either people or money. The effect of the message reconstruction was measured with engineering professionals and students in the U.S. The results indicated that emphasizing the financial and social goals on credits from the Envision rating system (rather than focusing on the existing environmental goals), professionals in the construction industry made more sustainable choices leading to 28% higher scores. Goal framing increased awareness,

motivation and the recognition of sustainable credits and thus, increased their perceived value leading to a change in decision-making for sustainability. If goal framing is applied to all rating systems, then this will ultimately encourage more sustainable designs.

6.2 Introduction

The planning, design, and construction of sustainable buildings and infrastructure is a complex process (Ahern, 2018; Akadiri et al., 2012; Ding, 2008). It requires coordination across a multidisciplinary team, the focus on long term outcomes not just immediate gains, and pushing past status quo to develop new design solutions that equally balance societal benefit, economic growth, and environmental regeneration (Robichaud & Anantatmula, 2011b). The planning, design, and construction of sustainable buildings and infrastructure requires a systems thinking perspective (Godfrey, 2010). Systems thinking can help reduce complexity in construction projects. For example, the integration of two complex initiatives, sustainable design and constructability, at a systems-perspective assisted the implementation of the Pentagon renovation project, and helped achieve its overall project objectives (Pulaski, Pohlman, Horman, & Riley, 2003).

Engineering design and construction teams commonly use decision tools, techniques, and checklists to manage the complexity that comes from the planning, design, and construction of sustainable buildings and infrastructure (Dey & Ogunlana, 2004). For example, the work breakdown structure is an engineering management technique which helps reduce complexity by dividing the project into manageable increments to ensure the completeness of work (Martinelli & Milosevic, 2016). Checklists are also good practice as they communicate action items across the project team, ensure critical processes are not forgotten, and encourage consideration of the range of consequences of a decision (Martinelli & Milosevic, 2016).

Engineering tools like rating systems for sustainability, e.g., Leadership in Energy and Environmental Design (LEED) and the Envision Rating System for Sustainable Infrastructure, can also function as a checklist. They help ensure critical processes are not forgotten and that all the significant consequences of a decision are considered. They also help reduce the effects of the status quo bias on default options (Bond, Carlson, &

Keeney, 2008; Shealy et al., 2016). Rating systems account for an error in human memory called “output interferences,” where initial considerations obscure subsequent ones (Shealy & Klotz, 2017). However, even with these numerous benefits there is still room for improvement among rating systems. Too much reliance on rating systems can lead to error. For example, fixating on achieving points rather than efficiency leads to more buildings doing the bare minimum to achieve certification (Nelson & Frankel, 2012; Roberts, 2010). This is a problem because only buildings that meet the highest levels of certification actually produce energy savings (Scofield, 2013).

There are several possible reasons why more than half of buildings that use LEED do the bare minimum to achieve certification (Nelson & Frankel, 2012; Roberts, 2010). The first is the structure of these tools may not align with users stated preferences and goals (Doan et al., 2017). For example, 37% of design credits included on the Envision Rating System for Sustainable Infrastructure being with descriptions framed solely about the environment, and nearly 40% have no emphasis on the connection (mutual benefit or consequential) between the environment, human quality of life or financial savings. Design teams with more interest in meeting their communities immediate needs with infrastructure services and less focus on long-term environmental sustainability might not recognize the connection between design decisions or might be less committed to meeting credits framed solely about the environment. Although Envision recognizes in their manual that certain design credits are related to the triple bottom line of social, economic and environmental sustainability, this is not always reflected in the way design options are describe.

Engineering professionals using rating systems like Envision might hold different preferences or values for the environment, the impact to society, or the capital cost to construct the infrastructure (Ismael & Shealy, 2018c). The single focus on the environment for some credits within rating systems may unintentionally discourage the higher levels of sustainability performance that are possible because users do not easily recognize mutual benefits between, for example, the natural world and risk reduction. Users of the LEED rating systems are significantly more likely to pursue credits related to improving quality of life and planning and monitoring maintenance costs, compared to, reducing greenhouse gas emissions and protecting outdoor air quality (USGBC, 2019).

Professionals using rating systems that understand the social benefits that the credits provide (such as human health and general community development) may be more willing to adopt those design principles and increase their sustainable design performance (Lavy & Fernández-Solis, 2009).

To motivate users of rating systems to improve sustainability performance, shared benefits between the natural world and the effect on people and capital costs can be better reflected in the rating systems used to make design and project level decisions. For example, emphasizing how design to reduce the use of pesticides and fertilizers will not only contribute to protecting streams from contamination, but also avoid risks to human health from the toxic substances. Making the shared connection between value preferences about the environment, people, and money may work to incentivize users to achieve higher performance. Incentives like these are essential to promoting sustainable development that better meets immediate needs without discounting the immediate or long term effects on the environment (Olubunmi, Xia, & Skitmore, 2016).

Another example of varying perceptions is with engineering professionals in rapidly developing countries, like, Kuwait who believe that high initial costs of materials and overall project costs are considered as high project risks (Ismael & Shealy, 2018d). These perceptions about cost and risk can affect the decision-making process of engineering professionals, and may lead to fear of investing in non-traditional, more sustainable design. These perceptions can encourage choices that seem more financially profitable than environmentally sustainable.

The research presented in this paper tests how changes to the structure and description of design credits within rating systems for sustainability can increase motivation among engineering professionals to not just meet the bare minimum but the highest levels of sustainability performance. The intervention described in the background and methods section is intended to nudge engineering professionals to better recognize the shared benefits of design credits between the natural world and quality of life and help them more quickly recognize how these design credits align with their immediate project goals and future users and client needs.

6.3 Background

External and internal benefits provide motivation for sustainable performance (Corbett & Muthulingam, 2007). Organizations that are motivated by external factors adopt sustainable design practices in order to signal to their clients, and the public, of their company values (Corbett & Muthulingam, 2007). Adoption may also be driven by the pursuit of intrinsic benefits such as financial and/or environmental benefits that are a direct result of the sustainable design practices they employ (Corbett & Muthulingam, 2007). But benefits that align with the user or project goals are currently not emphasized on engineering decision tools with the same emphasis as environmental benefits that are attained far in the future. Decision makers may make design choices that lead to lower sustainability outcomes if the benefits that align with the users' immediate project goals and values are not easily recognizable. Choice interventions can be applied to rating systems to help make this connection easier to recognize and encourage higher achievement levels of sustainable performance.

Choice interventions targeted at decision makers using rating systems for sustainability can increase motivation for sustainability performance. For example, endowing users with a high number of points elicits a loss averse response. Decision makers work to not lose points, in order, to signal to others their sustainability performance (Shealy, Klotz, Weber, Johnson, & Bell Ruth Greenspan, 2016). Simply changing the default points, where decisions become about not losing points rather than gaining them leads to nearly a 30 percent increase in what design professionals perceive as possible for their design (Shealy & Klotz, 2015b). Similarly, demonstrating how others have achieved high levels of sustainability through descriptive norms changes how professionals perceive performance and shapes how they signal to the outside world (Shealy et al., 2018). Another intervention to change perceived ability is the exposure to role model projects (Harris et al., 2016a). Role model projects work by vividly illustrating how sustainable design creates new value and demonstrating how sustainable design is done among peer companies.

Similar to role model projects, simple highlighting economic and institutional benefits increases motivation among engineering professionals to adopt more credits resulting in overall higher sustainability achievement (Doan et al., 2017). Prioritizing the users' values through tailored messaging can change sustainability-related behavior among design professionals driven by external and internal benefits of sustainable design (Marshall, 2014). Prior literature from behavioral science suggests a values-driven message has more impact than messaging about "saving the environment" (Marshall, 2014). Just as the points and role model projects change perceptions about design and are reflected in engineering decisions, expressing the benefits and values that are associated with design principles for sustainability may encourage higher achievement.

Choice architecture

This concepts of tailoring choices around the intended recipient and their goals is often referred to as choice architecture (Thaler, Sunstein, & Balz, 2014). Choice architects have a significant influence on people's decisions, much like the architect of a building whose design, the placement of doors, corridors, and stairways, effects how occupants move through the building.

The intentional design or redesign of choice environments can be controversial (Bovens, 2009; House of Lords, 2011). However, just as there is no 'neutral' architecture that does not influence in some way how people navigate a building, there is also no neutral choice architecture. Some options must be first where attributes are or are not presented.

The types of choice architecture to improve decision making is typically divided into two categories (Johnson et al., 2013). The first category describes choice options that address the idea of how they can be presented, for example using defaults or partitioning of options. The second category structures choice options in a way that addresses what to present to decision-makers, for example reducing the number of alternatives, or goal framing.

The purpose of goal framing is contrasting positive consequences of engaging in a behavior (positive goal framing) with negative consequences of not engaging in the behavior (negative goal framing) (Levin et al., 1998). Choices can be worded in ways that highlight the positive or negative outcomes of the same decision, leading to changes in their relative attractiveness. Losses generally have stronger psychological effects than gains since they provoke greater degrees of discomfort than how potential gains of similar value provide satisfaction (Kahneman and Tversky 1984; Schwartz 2000). Prior research suggests that negative choices that reflect losses empower engineering professionals to set higher goals (Sauro, 2014; Shealy, Klotz, Weber, Johnson, & Bell Ruth Greenspan, 2016).

Other types of framing include attribute framing and risky choice framing. In attribute framing, the object of the frame is a trait of the decision option (Krishnamurthy et al., 2001). For example, hamburger meat is 80% lean (the presentation of a desirable attribute) versus 20% fat (absence of a desirable attribute). Levin, Schneider and Gaeth (1998) suggest that positive framing works better in this context because a positively framed options generate positive associations making the option seem more attractive than a negatively framed option. Risky choice framing involves a choice between two objects. For example, "if Program A is adopted, 400 people will die" is a negative risky choice frame whereas, "If Program B is adopted, 200 people will be saved" is a positive risky choice frame (Tversky & Kahneman, 1981).

Goal framing is a third type of framing, distinct from the other types of framing because it emphasizes the way in which choice-related behaviors *impact goal satisfaction* rather than the attribute of the choice itself. Goal framing links an action to an outcome (Levin, Schneider and Gaeth, 1998).

Goal framing works in various disciplines. In psychology, it increases levels of trust, reciprocity, and returns (Chaudhuri et al., 2016); in disaster prevention, it increases motivation and preventive actions (McClure et al., 2009); and in law and policy, it improves the view of consequence and appropriateness (Etienne, 2011).

Goal framing can encourage pro-environmental behavior and lead to improved management of environmental problems (Steg & Vlek, 2009). A study reframed information about a biofuels and found that it was effective to persuade people to contribute to the prevention and reduction of energy and environmental problems (Van de Velde et al., 2010). Similarly, goal setting helped achieve around 22% reduction in electricity and gas use (McCalley 2006; McCalley and Midden 2002; Houde & Todd, 2010).

Just as goal framing can encourage pro-environmental behavior, applying goal framing to rating systems could help decision makers seek higher sustainable performance. Decision makers may not fully understand the consequences or impacts of their choices, leading to outcomes that are contrary to their project's long-term interests. For example, a common solution to improving mobility is by widening a road, but this may also cut off or isolate neighborhoods. Another example is expanding service areas which may lead to sprawl that negatively impacts a town's sense of community. The outcomes of these solutions do not align with long-term sustainability goals such as safety, energy efficiency, resiliency, and enhancing connectivity within the community. Goal framing can help better connect individual credits to long-term sustainable objectives and provide a more comprehensive assessment to help them better evaluate choices.

Second, rating systems include design credits that provide benefits to all three aspects of the triple bottom line, but credits do not typically emphasize the shared benefits across the triple bottom line. Instead, credits within rating systems typically focus on environmental goals. This single focus on the environment for many design aspects may unintentionally discourage the higher levels of sustainability performance that are possible because users might hold different preferences or values for the environment. For example, prior research states that people are systematically biased in that they value immediate rewards more than they value future rewards (Strotz 1955; Thaler 1981; Loewenstein and Thaler, 1992, Houde & Todd, 2010). Similarly, most pro-environmental behaviors require people to make decisions against their egoistic values in order to benefit the environment (Lindenberg & Steg 2013). Goal framing the intended outcomes of the shared benefits across the triple bottom line can help decision makers more quickly recognize the benefits of sustainable credits by increasing attention and motivation.

Goal framing can also incentivize users to pursue a wider range of credits that contribute across multiple dimensions of sustainability. Incentives in the form of goals can drive the adoption of more sustainable buildings and infrastructure (Weeks, 2010). These incentives are essential to promoting sustainable building development (Olubunmi et al., 2016) since they compel stakeholders to actually incorporate sustainable techniques into their projects (DuBose, Bosch, & Pearce, 2007).

6.4 Research Questions

Engineering professionals hold varying perceptions of sustainable design and predefined project goals. Goal framing can help emphasize the connection (benefit or consequence) of each design credit originally about the environment to also help emphasize the connection to human quality of life or financial savings. The two research questions are:

1. How does goal framing influence engineering professionals' motivation to achieve more sustainable infrastructure outcomes?
2. What is the difference in effect when goal framing environmental credits to include social or financial benefits?

The hypothesis is small interventions to the written intent of design credits on the Envision rating system through goal framing will increase decision makers' perceived value leading to a higher score. Significance is defined as meeting a confidence interval of 95%. The amount of attention to each credit will also increase as decision makers take more time to consider various design options in order to achieve a higher level of achievement. The increase in attention and perceived value will be measured by the differences in Envision scores between the control version and the modified version (goal framed) of Envision.

The second hypothesis is goal framing credits on the Envision rating system that currently emphasize environmental outcomes to also emphasize the outcome on people and money will lead to a higher level of sustainability achievement. In specific, U.S. professionals are expected to score higher when credits are goal framed to emphasize financial savings. This framing will help decision-makers recognize the benefits more than when credits solely highlight environmental benefits.

6.5 Methods

Students and engineering professionals participated in separate one-hour training seminars to learn about Envision and practice using it with a case study project. The engineering case presented in the decision scenario was modeled on an actual Envision certified project in Los Angeles, California. The Envision rating system was chosen to test the effects of goal framing over the other numerous rating systems for sustainability because of the performance rating scale. Envision does not prescribe a solution like install a bike rack in order to meet community mobility but rather asks how the design solutions enhance, conserve, or restore mobility in the community. This flexibility allows more design freedom in their design choices. The training and case study were first offered to a group of 125 senior civil engineering students at Virginia Tech then offered to 42 engineering professionals in Virginia.

Engineering design firms and construction companies in Blacksburg and Christiansburg were contacted by email and were asked if company employees would be interested in learning more about the Envision rating system for sustainable infrastructure. Training sessions were offered to companies through lunch and learns. The research team provided participants with lunch and they spent 1.5 hours learning about Envision. In total three lunch and learns were hosted in the Blacksburg region. More than ten companies were represented in these lunch and learns. All participants were unfamiliar with Envision and mentioned that they had not used it before. About a third of the professionals had over 10 years of practical experience (39%), 5 to 10 years of experience (27%), and less than 5 years of experience (34%),

The Decision Scenario

The participants were introduced to a case study about a wastewater treatment project. The case study simulates a real-life scenario model on an Envision project from Los Angeles. The decision scenario asked participants to imagine themselves as a sustainability consultant, then review 15 credits from the Envision rating system and select the level of achievement believed to be attainable for each credit. The 15 credits were from three of the five Envision categories: Resource Allocation, Natural World, and Risk and Resilience. The case study was formatted as a Request for a Proposal (RFP). Participants learned about the project's intended goals, local governance, community and site programming through the RFP. Not all credits were included in the decision scenario due to the limited time that was provided. The credits that were included were preselected because of the applicability to the project.

The credits used in the decision scenario were credits achieved by the actual Envision certified project. Credits were selected based on the current framing of the intent. The purpose of the research was to frame the credits to emphasize the financial savings or improvements in health or quality of life for pursuing the credit. To test the effectiveness of the intervention only credits that mentioned environmental benefits were selected so that these credits could be re-framed. Also, to reduce the time and cognitive demand to complete the decision scenario, 15 out of the possible 64 credits were used in the training session.

For each credit, participants were required to provide a detailed explanation of how the project team could meet the level of achievement they chose. This written explanation allowed them to spend time thinking about the design options and prevented them from simply choosing the highest level of achievement in all credits without some type of cognitive cost. The cost for higher achievement was increased time and thought to consider and explain how to meet the higher level of sustainability. Participants had the option of selecting “not applicable” to any of the listed credits. If participant chose not applicable, they had to explain why. The structure of the decision scenario and explanation of how to achieve levels of sustainability performance is identical to the Envision website. Before an infrastructure project is submitted for review to the Institute for Sustainable Infrastructure (ISI), the project team must submit detailed explanations of how they intend to achieve the credits and provide evidence. The amount of evidence required increases with each level of achievement. This structure also follows previous choice architecture modifications and empirical studies testing the effects of choice architecture with professionals (Harris et al., 2016a; Shealy et al., 2018; Shealy & Klotz, 2015b).

Both students and engineering professionals were randomly assigned to receive one of the two versions of the Envision rating system. The control version displays the credits as shown on the actual Envision rating system, and the modified version included credits framed to emphasize the connection to either people or money, not just the environment. The process of either goal framing credits to emphasize improved quality of life or cost savings was based on the detailed description provided within each credit. No new information was being added to the credits rather each credit was framed to make the benefits of for pursuing the credit included in the description of the credit more salient. For example, the description of credit *RA3.2 Reduce Operational Water Consumption* mentions direct cost savings such as construction, maintenance and labor costs that can be achieved by pursuing this credit. The connection between financial savings and water consumption was embedded in the description. The modified version of Envision made this connection more salient in the intent of the credit. In each of the modified credits no new information was added to the credit, instead the information about financial saving or benefit to the community was just made more prominent to the decision maker by emphasizing this connection in the credit's intent.

Coding qualitative data

During the decision scenarios, participants must choose between "levels of achievement," and state why they believe this level can be achieved. To control for a ceiling effect (where users just choose the highest level every time), a tradeoff was created between points and effort. Users were asked to explain how or why they plan to meet that achievement level. The higher the number of points, the longer the written response is required. All the written responses were coded to identify a difference in reasoning and perceptions. The codes were categorized into financial and social categories based on their relativity to pro-social and pro-financial behaviors. The following subsections explain the coding steps. All of the qualitative data from the student responses of the decision scenario was downloaded into an excel database. The written responses were scanned, and each written response was assigned a code. The code response that emerged from the post-task survey related to two overarching themes which were Financial and Social as shown in Table 17.

Table 17. A sample of codes developed from the qualitative data

Financial codes	Social codes
Cost(s)/costing	Health/healthy
Money	Human(s)
Budget	Safety
Expensive/expense(s)/expenditure	Social/society
Finance(s)/Financial	People
Purchase(s)/purchased	Public
Price(s)	Team
Pay	Community/neighborhood

6.6 Results

How does goal framing influence engineering professionals' motivation to achieve more sustainable infrastructure outcomes?

The results from the student sample indicate that goal framing can help decision makers recognize benefits of sustainable credits within Envision by increasing attention and motivation. The total time taken to complete the decision scenario for each version was measured. The students spent more time to consider various design options in order to achieve a higher level of achievement. On average, participants spent 33% more time to complete the goal framed version compared to the control version. As a result, the 61 students that received the goal framed version scored 14% more points for sustainability than the 62 students in the control group (p<0.01) as shown in Figure 8.

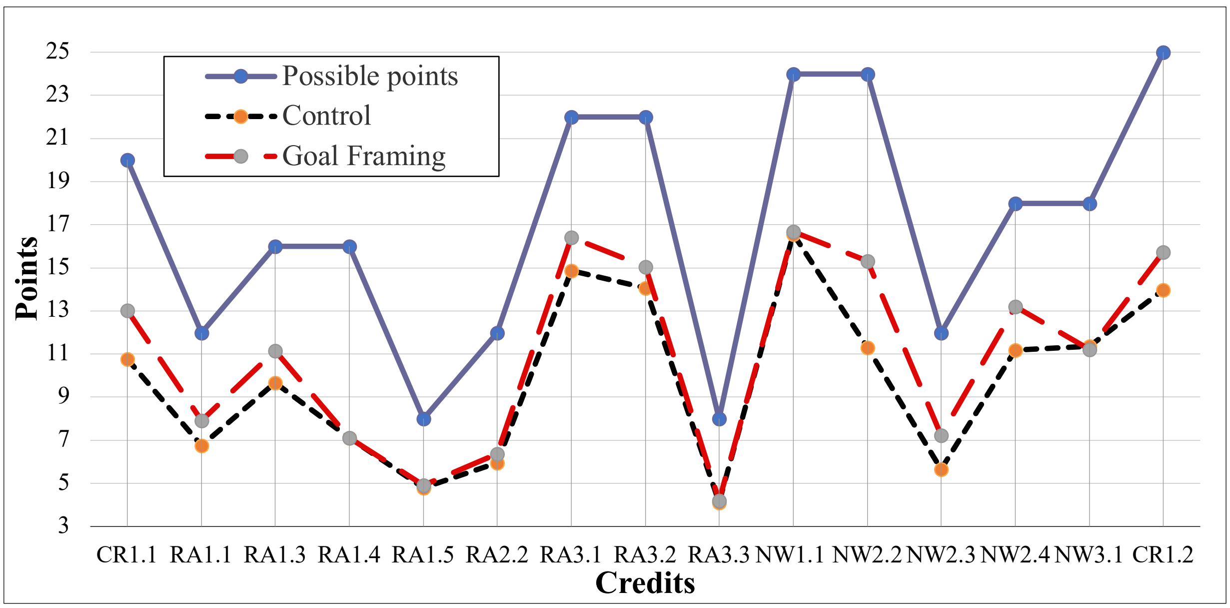


Figure 8. Students achieved more points when presented with the goal framed version of Envision

What is the difference in effect when goal framing environmental credits with social or financial benefits?

Goal framing the social benefits increased student scores by 14%. The benefits of implementing the credit appears easier to recognize compared to when the same credit is solely about environmental benefits. The socially framed credit that had the largest effect was *NW2.4 Protect Surface & Groundwater Quality*, and the credit with the least effect was *RA1.5 Balance Earthwork on Site* as shown in Figure 9.

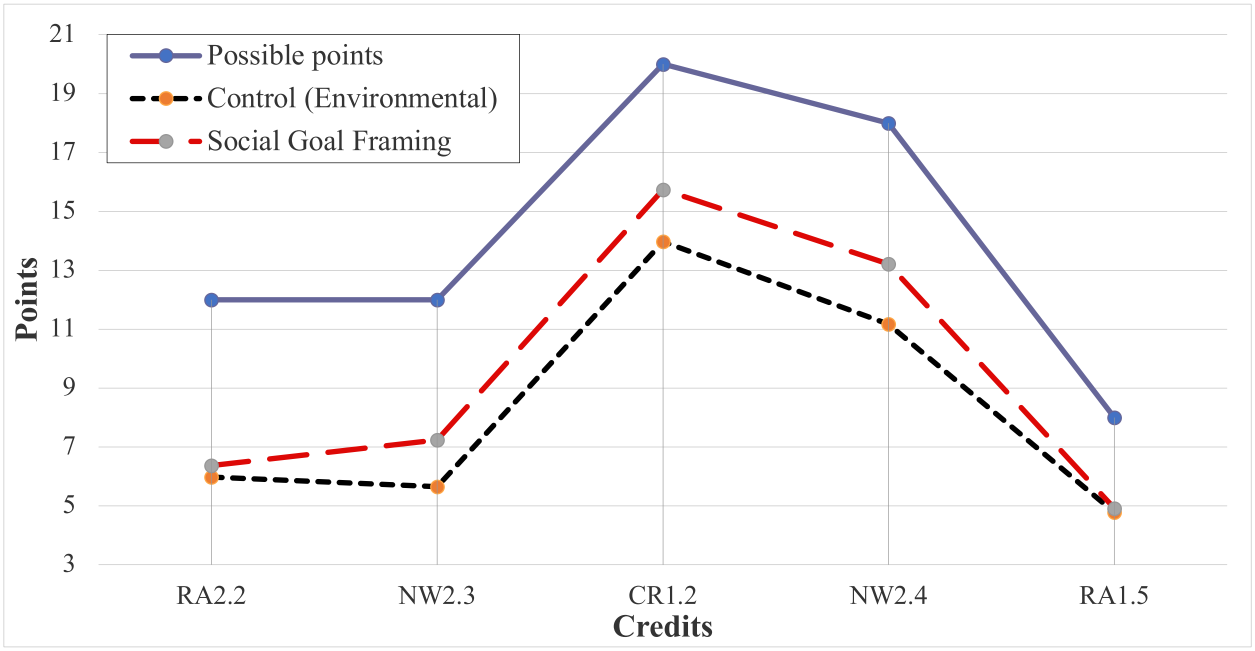


Figure 9. The effect of socially goal framing environmentally related on Envision with students

Goal framing the financial benefits to pursue each credit increased student scores by 14%, similar percent increase as when credits were framed to include the benefits for society. The financially framed credit that had the largest effect were *NW2.2 Manage Storm Water,* and the credit that framing had no effect in goal setting was *NW3.1 Enhance Functional Habitats* as shown in Figure 10.

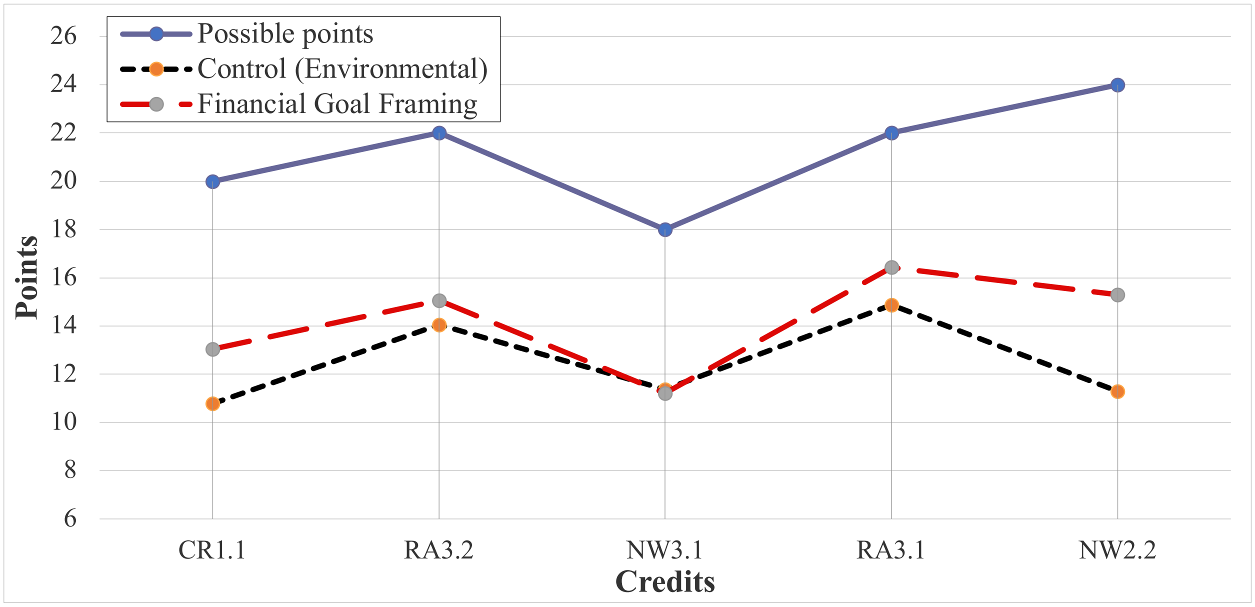


Figure 10. The effect of financially goal framing environmentally related credits on Envision with students

The explanations to achieve each credit were coded for mentions of the benefit to society or money and compared between the control and intervention groups. For example, the following response *"This saves costs because you do not have to import more earthwork"* was code as mentioning *cost*, and was listed as part of the financial category listed in Table 18, whereas *"...which will help the people in the surrounding area"* was coded as mentioning *people* and was listed as part of the social category in Table 19. The coding of explanations was performed independently by two reviewers.

The frequency of financially and socially related statements between those who received the control and those who received the goal framed version of Envision increased on average by 16% and 36% respectively. The increase in number of justifications after goal framing is an indication of the positive effects of goal framing on decision making. Goal framing helped decision-makers recognize the benefits of the credits across more dimensions of sustainability to support the full objectives of the project.

Table 18. Frequency of codes mentioning financial savings after goal framing about monetary savings

Envision Credits with Goal Framing to emphasize Financial connection	Frequency of Justifications that mention Financial Codes in the Control Group	Frequency of Justifications that mention Financial Codes in the Goal Framed Group	Percentage Increase
CR1.1	90	104	16%
RA1.3	20	26	30%
RA1.4	29	34	17%
RA3.1	28	37	32%
RA3.2	66	74	12%
RA3.3	49	49	0%
NW1.1	76	77	1%
NW2.2	40	65	63%
NW3.1	20	14	-30%
Average	46.44	53.33	15.66%

While the number of statements related to finances increased by approximately 16% on average, the effect was not equally distributed across all credits. A large effect was observed in *NW2.2 Manage Storm Water* and there was no difference in the credit *RA3.3 Reduce Construction Water Consumption*. The credit *NW3.1 Enhance Functional Habitats* actually had an inverse effect. A possible reason for this inverse effect could be because participants were only given a short span of time to make design choices, which forced more accelerated decision-making than in real-world design projects. This credit requires the project team to identify existing habitat types on or near the project site and evaluate whether maintaining biodiversity and functional habitats will actually add value to the region.

Table 19. Frequency of codes mentioning people after goal framing about the impact on society

Envision Credits with Goal Framing to emphasize Social connection	Frequency of Justifications that mention Social Codes in the Control Group	Frequency of Justifications that mention Social Codes in the Goal Framed Group	Percentage Increase
RA1.1	79	91	13%
RA1.5	16	31	94%
RA2.2	39	41	5%

NW2.3	41	68	66%
NW2.4	58	69	19%
CR1.2	32	37	16%
Average	44.166	56.166	35.5%

Similarly, the statements emphasizing social benefits increased by an average of 36% but was not equal across all credits. A large effect was observed in *RA1.5 Balance Earthwork on Site* and *NW2.3 Reduce Pesticide and Fertilizer Impacts*.

How does goal framing influence engineering professionals' motivation to achieve more sustainable infrastructure outcomes?

The results from the U.S. professionals sample indicate that similar to the students results, goal framing Envision credits allowed professionals (n = 43) to make more sustainable choices as shown in Figure 11. Designers, and professionals working in academic institutions and construction management firms comprised the majority of respondents. Approximately 40% of the respondents indicated they have more than ten years of industry experience, 27% between 5-10 years, and 34% with less than five years. After removing two outliers from the sample, the goal framed group achieved 28% (SD = 35.52) more points than the control group (p<0.01) who received the current version of the Envision rating system. This percent increase in sustainability with professionals was higher compared to the students.

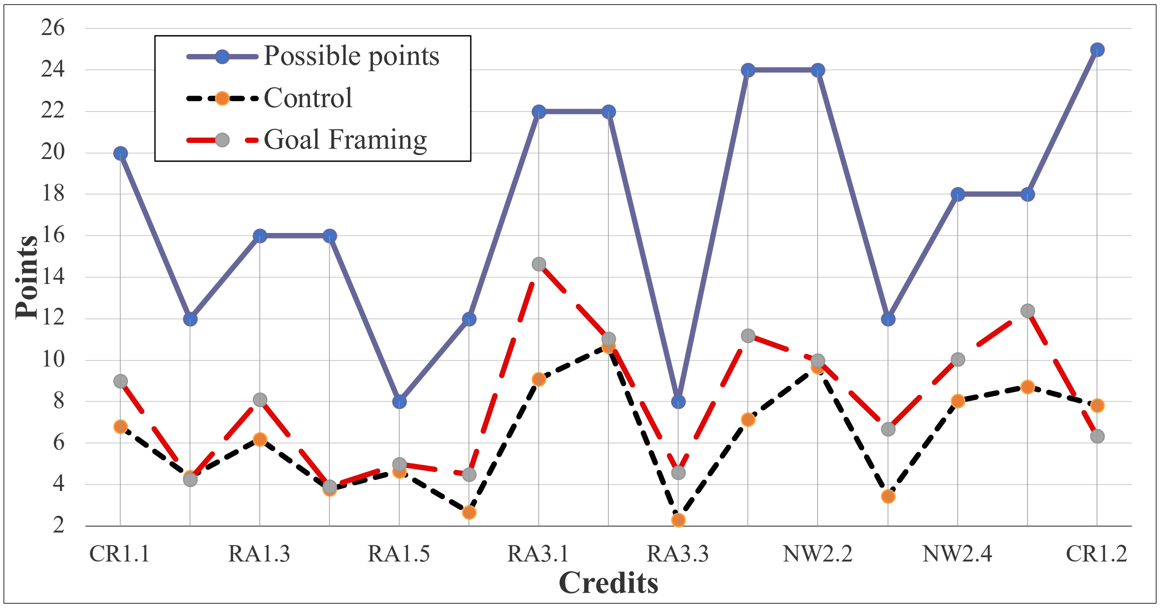


Figure 11. U.S. professionals achieve more points when presented with the goal framed version of Envision

What is the difference in effect when goal framing environmental credits with social or financial benefits?

Goal framing credits to include the benefit to society led to a 23% increase in Envision scores than the control group. The effect of goal framing for each credit is illustrated in Figure 12. However, the results were not significant (p = 0.1). The non-significant results might be due to the inverse effect related to credit *CR1.2 Reduce greenhouse gas emissions*.

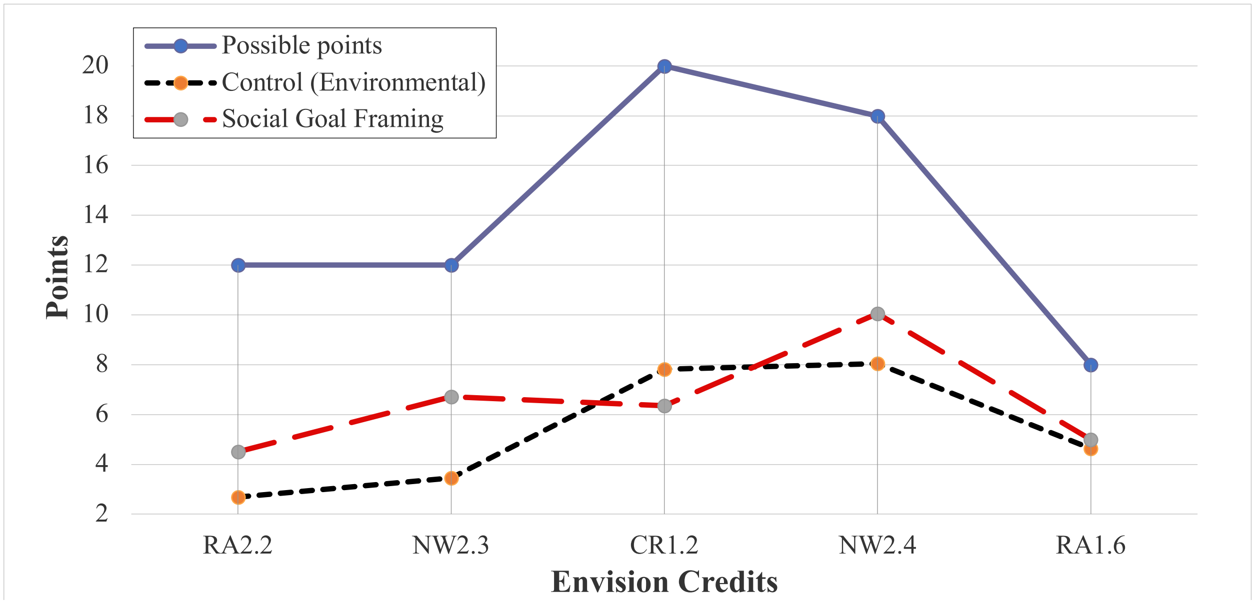


Figure 12. The effect of socially goal framing environmentally related credits on Envision with U.S. professionals

Goal framing credits to include the financial benefit led to a 27% percent increase in Envision score compared to the control group, which received the original intent of the credit framed solely to emphasize the benefit to the environmental. The effect was significant (p = 0.03). The largest effect was on credit *RA3.1 Preserving water resources*, and the lowest effect was on *NW2.2 Manage stormwater* as shown in Figure 13.

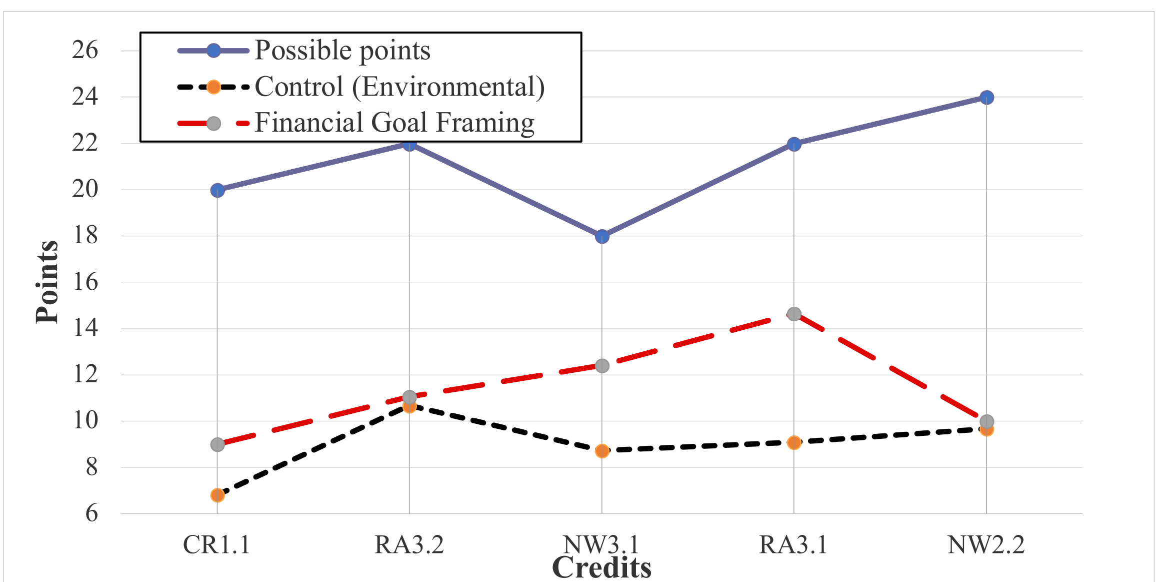


Figure 13. The effect of financially goal framing environmentally related credits on Envision with U.S. professionals

6.7 Discussion

Envision and other forms of rating systems share a common purpose, to help project teams enhance overall design performance. However, most of these rating systems are attentive towards environmental factors with less emphasis on the connection (benefit or consequence) to human quality of life or financial savings. The goal framed version of Envision encouraged more consideration of the tangential benefits to people and money during the design and decision-making process.

The purpose of goal framing is to emphasize the benefits (or consequences) so that decision-makers recognize the outcomes of their decision. Goals can become focal as an automatic reaction to cues (Bargh et al., 2001). When they are focal, they create modularity by affecting what decision makers cognitively attend to. This means, goals, provide value to the decision maker, which may override other aspects like monetary cost or other long-term effects.

Additionally, goal framing sets defined goals that better align rating systems with project objectives. The goal framed credits of Envision helped decision-makers recognize the benefits of sustainable design and encouraged them to set higher sustainable performance goals. Prior research states that setting a goal can serve as a reference point to the reader (Heath et al. 1999). Setting goals or reference points makes decision makers risk averse when their performance is above the reference point, and risk-seeking when their performance is below (worse than) the reference point (Shinkle, 2012). This might have led to why participants who received the goal framed version of Envision achieved higher sustainability outcomes because of the opportunities they found when reading the goals (reference points) were mentioned.

The written responses from those who received the goal framed version had a higher frequency of socially and financially-related codes compared to the responses from the those who received the control version of Envision. Participants appear to be able to better recognize the benefits after reading the modified version of Envision compared to those who received the control.

Project costs are a concerning factor during the design process of infrastructure. When credits were framed about money, professionals were more likely to set higher goals for sustainability. Decision makers are often systematically biased to focus on immediate costs over future gains. For example, homeowners are often unwilling to pay higher cost of an energy efficient appliance even if it saves them money on electricity and includes a payback period under five year (Strotz 1955; Thaler 1981; Loewenstein and Thaler, 1992, Houde & Todd, 2010). Goal framing within Envision helped play to this known bias, encouraging decision-makers to identify ways to save money in the present.

Framing the credit *RA1.5 Balance Earthwork on Site* to include the impact on people had the smallest increase in goal setting. The small effect might be because most earthwork operations occupy only a short period of the total project duration (Belayutham et al., 2017), which may lead to discounting its significance. However, there are many negative impacts of these earthwork operations such as increased noise and congestion, loss of landscape characteristics, increased fuel consumption, and increased greenhouse gas and air pollutant emissions (Institute for Sustainable Infrastructure, 2018). The goal framing intervention may not have been salient enough to make this connection or less critical than other credits the decision makers were considering pursuing. The effects of goal framing were not standard across all credits. Why the effect was greater on some credits than others needs further exploration. A possible explanation is a ceiling effect where whether framed or not the context of the project only leads to a certain level of possible achievement.

Framing the credit *NW2.2 Manage stormwater* to include the monetary impacts had the smallest increase among the financially framed credits with U.S. professionals. Engineering professionals may see water conservation through stormwater management requires advanced tools and technology to tackle. This in return can be perceived as high cost relative to what they may yield in profit. Although, construction projects require stormwater runoff permits issued by the U.S. Environmental Protection Agency (EPA), professionals may also perceive this as an obstacle to overcome.

Framing the credit *RA3.1 Preserving water resources* to include financial goals had the largest increase among the financially framed credits with U.S. professionals. This credit is described in Envision as reducing the negative net impacts on freshwater availability, quantity and quality at a watershed scale. While water conservation is a critical aspect, all projects that impact water quantity or quality should positively contribute to the greater watershed (Institute For Sustainable Infrastructure, 2018) and the opportunity to make financial savings. When the credit was framed to emphasize the financial outcome, it highlighted the cost savings that could be achieved, which helped professionals to connect both environmental and financial values to the project goals.

Additionally, there are federal environmental laws and regulations that are responsible for protecting water resources such as the Clean Water Act (CWA) and the Resource Conservation and Recovery Act (RCRA). Meeting those requirements is necessary to avoid penalties and other financial challenges, which may have been part of the decision makers consideration.

Framing the credit *NW2.3 Reduce pesticide and fertilizer impacts* to include the impact on people had the largest increase in goal setting among professionals. Prior research suggests that fertilizers and pesticides have potential negative implications on the environment and human health (Udeigwe et al., 2015). Some of the health implications include neurological defects, cardiovascular risks, cancers, skin allergies and others (Udeigwe et al., 2015). When these consequences were presented, professionals recognized the severity of health-related outcomes and harm to personal health relative to other consequences. This appears to have helped nudge them to set higher goals for sustainability achievement. In order to formulate effective sustainability practices, knowledge of financial and health impacts is required (Saha et al., 2017), which is what goal framing offers.

6.8 Conclusion

In any kind of decision making, the simple reframing of a choice or question can produce a completely different answer from the same person. Rating systems like Envision are filled with design choices. Those designing rating systems and other engineering decision tools within the infrastructure construction industry need to understand how decisions are made, and when appropriate, apply interventions to help guide the user towards their project objectives. Extensive research on framing and choice architecture as a whole enables more accurate predictions of decision outcomes.

Across domains, the intent of goal framing is to highlight the benefits of an action, or consequences due to in ability to take action (Gamliel & Herstein, 2007). Using goal framing to highlight the consequences of action or inability to take action about design for sustainability increased motivation among those designing and constructing the built environment. Goal framing also improves recall which was reflected in the frequency on financially and socially related statements for those who received the goal framed version of Envision.

By highlighting the benefits to other aspects of sustainability such as improved quality of life and financial gains, the shift in emphasis from the environment to social and financial benefits increased the users' sustainability performance. Professionals were more encouraged to choose higher levels of sustainability achievement because it influenced how the participants interpreted design options which had a positive effect on the design outcome. The goal framing intervention resulted in an increase in perceived sustainability performance by 28% with industry professionals. Such an increase could have a drastic effect on possible sustainability outcomes. For example, a 15% reduction in greenhouse gas emissions could result in a reduction of more than 2 billion tons of carbon dioxide if applied to all U.S. infrastructure (Shealy & Klotz, 2015b).

The broader contribution of this research is the application of choice architecture to high-level decision making for infrastructure. The application of goal framing to the Envision rating system encourages more sustainable design by helping decision makers to making better choices. By understanding the effect of goal framing on rating systems, future research can begin to implement and test additional behavioral interventions to encourage sustainable design principles and construction practices. The effects of goal framing may be subjective to user values. Applied in a different context or geographic region where culture and social norms are different may have an effect on the results. Future research can begin to compare the effects of similar goal framing between cultures. More interdisciplinary studies involving behavior science and engineering like this research are needed to improve our understanding of complex decisions and how stakeholders make tradeoffs, and in order to help guide engineering professionals towards their predefined project objectives.

References

Ahern, J. (2018). Green infrastructure for cities: The spatial dimension. *Cities of the Future: Towards Integrated Sustainable Water and Landscape Management*.

Akadiri, P. O., Chinyio, E. A., & Olomolaiye, P. O. (2012). Design of A Sustainable Building: A Conceptual Framework for Implementing Sustainability in the Building

Sector. *Buildings*, *2*(2), 126–152. https://doi.org/10.3390/buildings2020126

Bond, S. D., Carlson, K. A., & Keeney, R. L. (2008). Generating objectives: Can decision makers articulate what they want? *Management Science*, *54*(1), 56–70.

Bovens, L. (2009). The Ethics of Nudge. In *Theory and Decision Library*. *Preference Change* (pp. 207–219). Retrieved from https://link.springer.com/chapter/10.1007/978-90-481-2593-7_10

Chaudhuri, A., Li, Y., & Paichayontvijit, T. (2016). What's in a frame? Goal framing, trust and reciprocity. *Journal of Economic Psychology*, *57*(Supplement C), 117–135. https://doi.org/10.1016/j.joep.2016.09.005

Corbett, C. J., & Muthulingam, S. (2007). Adoption of Voluntary Environmental Standards: The Role of Signaling and Intrinsic Benefits in the Diffusion of the LEED Green Building Standards. Retrieved September 22, 2018, from Institute of the Environment and Sustainability at UCLA website: https://www.ioes.ucla.edu/publication/adoption-of-voluntary-environmental-standards-the-role-of-signaling-and-intrinsic-benefits-in-the-diffusion-of-the-leed-green-building-standards/

Dey, P., & Ogunlana, S. (2004). Selection and application of risk management tools and techniques for build-operate-transfer projects. *Industrial Management & Data Systems*, *104*(4), 334–346. https://doi.org/10.1108/02635570410530748

Ding, G. K. C. (2008). Sustainable construction—The role of environmental assessment tools. *Journal of Environmental Management*, *86*(3), 451–464. https://doi.org/10.1016/j.jenvman.2006.12.025

Doan, D. T., Ghaffarianhoseini, A., Naismith, N., Zhang, T., Ghaffarianhoseini, A., & Tookey, J. (2017). A critical comparison of green building rating systems. *Building and Environment*, *123*, 243–260. https://doi.org/10.1016/j.buildenv.2017.07.007

DuBose, J. R., Bosch, S. J., & Pearce, A. R. (2007). Analysis of State-Wide Green Building Policies. *Journal of Green Building*, *2*(2), 161–177. https://doi.org/10.3992/jgb.2.2.161

Etienne, J. (2011). Compliance Theory: A Goal Framing Approach. *Law & Policy*, *33*(3), 305–333. https://doi.org/10.1111/j.1467-9930.2011.00340.x

Godfrey, P. (2010). Using systems thinking to learn to deliver sustainable built environments. *Civil Engineering and Environmental Systems*, *27*(3), 219–230. https://doi.org/10.1080/10286608.2010.482656

Harris, N., Shealy, T., & Klotz, L. (2016). How Exposure to ”Role Model” Projects Can Lead to Decisions for More Sustainable Infrastructure. *Sustainability*, *8*(2), 130. https://doi.org/10.3390/su8020130

Houde, S., & Todd, A. (2010). List of behavioral economics principles that... Retrieved August 31, 2017, from https://scholar.google.com/scholar?hl=en&as_sdt=0,15&cluster=14527752442875364204

House of Lords. (2011). Behaviour Change - Second Report. Retrieved December 6, 2017, from https://publications.parliament.uk/pa/ld201012/ldselect/ldsctech/179/179.pdf

Institute For Sustainable Infrastructure. (2018). Envision Version 3. Retrieved December 14, 2018, from https://sustainableinfrastructure.org/envision-version-3/

Ismael, D., & Shealy, T. (2018a). Aligning Rating Systems and User Preferences: An Initial Approach to More Sustainable Construction through a Behavioral Intervention. *Construction Research Congress 2018*. https://doi.org/10.1061/9780784481301.071

Ismael, D., & Shealy, T. (2018b). Sustainable Construction Risk Perceptions in the Kuwaiti Construction Industry. *Sustainability*, *10*(6), 1854. https://doi.org/10.3390/su10061854

Johnson, E. J., Shu, S. B., Dellaert, B. G. C., Fox, C. R., Goldstein, D. G., Haeubl, G., … Weber, E. U. (2013). *Beyond Nudges: Tools of a Choice Architecture* (SSRN Scholarly Paper No. ID 2277968). Retrieved from Social Science Research Network website: https://papers.ssrn.com/abstract=2277968

Lindenberg, S., & Steg, L. (2013). *Goal-framing theory and norm-guided environmental behavior*. Retrieved from http://www.rug.nl/research/portal/publications/goalframing-theory-and-normguided-environmental-behavior(0dd9a78b-d343-403b-a743-2a44f4d94d84).html

Marshall, G. (2014). Don’t Even Think About It. Retrieved February 12, 2019, from Bloomsbury Publishing website: https://www.bloomsbury.com/uk/dont-even-think-about-it-9781620401330/

Martinelli, R. J., & Milosevic, D. Z. (2016). *Project Management ToolBox: Tools and Techniques for the Practicing Project Manager*. John Wiley & Sons.

McClure, J., White, J., & Sibley, C. G. (2009). Framing effects on preparation intentions: distinguishing actions and outcomes. *Disaster Prevention and Management: An International Journal*, *18*(2), 187–199. https://doi.org/10.1108/09653560910953252

Nelson, A. J., & Frankel, A. (2012). *Building Labels vs. Environmental Performance Metrics: Measuring What's Important about Building Sustainability*. Retrieved from http://realestate.dws.com/content/_media/Research_Sustainability_Metrics_in_the_Real_Estate_Sector-Oct_2012.pdf

Olubunmi, O. A., Xia, P. B., & Skitmore, M. (2016). Green building incentives: A review. *Renewable and Sustainable Energy Reviews*, *59*, 1611–1621. https://doi.org/10.1016/j.rser.2016.01.028

Pulaski, M., Pohlman, T., Horman, M., & Riley, D. (2003). Synergies between Sustainable Design and Constructability at the Pentagon. *Construction Research Congress*. https://doi.org/10.1061/40671(2003)49

Roberts, T. (2010, October 14). USGBC, LEED Targeted by Class-Action Suit. Retrieved February 1, 2019, from Building Green website: https://www.buildinggreen.com/news-analysis/usgbc-leed-targeted-class-action-suit

Robichaud, L. B., & Anantatmula, V. S. (2011). Greening Project Management Practices for Sustainable Construction. *Journal of Management in Engineering*, *27*(1), 48–57. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000030

Saha, J. K., Selladurai, R., Coumar, M. V., Dotaniya, M. L., Kundu, S., & Patra, A. K. (2017). Impact of Different Developmental Projects on Soil Fertility. In J. K. Saha, R. Selladurai, M. V. Coumar, M. L. Dotaniya, S. Kundu, & A. K. Patra (Eds.), *Soil Pollution - An Emerging Threat to Agriculture* (pp. 251–269). Retrieved from https://doi.org/10.1007/978-981-10-4274-4_10

Sauro, J. J. (2014). *A content analysis of Kickstarter: The influence of framing and reward motivations on campaign success* (M.A., San Diego State University). Retrieved from https://search.proquest.com/docview/1540748067/abstract/C895853A230548D0PQ/1

Scofield, J. H. (2013). Efficacy of LEED-certification in reducing energy consumption and greenhouse gas emission for large New York City office buildings. *Energy and Buildings*, *67*, 517–524. https://doi.org/10.1016/j.enbuild.2013.08.032

Shealy, T., Johnson, E., Weber, E., Klotz, L., Applegate, S., Ismael, D., & Bell, R. G. (2018). Providing descriptive norms during engineering design can encourage more sustainable infrastructure. *Sustainable Cities and Society*, *40*, 182–188. https://doi.org/10.1016/j.scs.2018.04.017

Shealy, T., & Klotz, L. (2015). Well-endowed rating systems: How modified defaults can lead to more sustainable performance. *Journal of Construction Engineering and Management*, *141*(10), 4015031. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001009

Shealy, T., & Klotz, L. (2017). Choice Architecture as a Strategy to Encourage Elegant Infrastructure Outcomes. *Journal of Infrastructure Systems*, *23*(1), 4016023. https://doi.org/10.1061/(ASCE)IS.1943-555X.0000311

Shealy, T., Klotz, L., Weber, E., Johnson, E. J., & Bell Ruth Greenspan. (2016). Using framing effects to inform more sustainable infrastructure design decisions. *Journal of Construction Engineering and Management*, *142*(9), 4016037. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001152

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behavior: An integrative review and research agenda. *Journal of Environmental Psychology*, *29*(3), 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004

Thaler, R. H., Sunstein, C. R., & Balz, J. P. (2014). *Choice Architecture* (SSRN Scholarly Paper No. ID 2536504). Retrieved from Social Science Research Network website: https://papers.ssrn.com/abstract=2536504

Udeigwe, T. K., Teboh, J. M., Eze, P. N., Hashem Stietiya, M., Kumar, V., Hendrix, J., … Kandakji, T. (2015). Implications of leading crop production practices on environmental quality and human health. *Journal of Environmental Management*, *151*, 267–279. https://doi.org/10.1016/j.jenvman.2014.11.024

USGBC. (2019). USGBC | U.S. Green Building Council. Retrieved April 6, 2019, from https://new.usgbc.org/

Van de Velde, L., Verbeke, W., Popp, M., & Van Huylenbroeck, G. (2010). The importance of message framing for providing information about sustainability and environmental aspects of energy. *Energy Policy*, *38*(10), 5541–5549. https://doi.org/10.1016/j.enpol.2010.04.053

Weeks, J. A. (2010). *Understanding the issues of project cost and time in sustainable construction from a general contractor's perspective: case study* (Thesis, Georgia Institute of Technology). Retrieved from https://smartech.gatech.edu/handle/1853/33914

CHAPTER 7

A COMPARISON OF THE EFFECTS OF GOAL FRAMING ON ENGINEERING PROFESSIONALS ACROSS CULTURES

7.1 Abstract

Engineering sustainability tools like sustainability rating systems are used to guide the design process. The structure of these tools can influence design decisions. For example, default points and descriptive norms increase the value placed on individual credits. Default points and descriptive norms change how decision makers construct preferences. In cultures and geographic regions where energy and the environment are less of a priority, choice modifications to the tools used during the design process can help engineering professionals increase their goals for more environmentally sustainable design. Goal framing is a technique from behavioral science that describes the structure of information to focus on the desired outcome. The description of individual credits on the Envision rating system were modified to emphasize the connection between the credits intent about the environment to also highlight the impact to either people or money. The effect of the message reconstruction was measured between engineering professionals in the U.S. and Kuwait. The results show that goal framing credits to also highlight the effect on people or money, not just the environment, increased engineering professionals' motivation to set high goals for sustainability by 23 percent. The effect was greater for professionals in Kuwait compared to professionals in the U.S. by 28 percent between groups. Engineering professionals in Kuwait were significantly more likely to value credits that were framed to emphasize benefits to people, whereas engineering professionals in the U.S. placed more value on credits that were framed to emphasize financial gains. These findings highlight the upstream influence of goal framing of engineering decision making and the differences between cultures.

7.2 Introduction

Rating systems are used as design decision tools to evaluate, grade, and reward buildings and infrastructure projects that meet sustainability criteria. Rating systems are used by engineering professionals to help prioritize design attributes of a project, and make decisions to enhance sustainability, performance However, rating systems often have constraints that may prevent decision makers from achieving high levels of sustainability performance. The Leadership in Energy and Environmental Design (LEED) rating system may inadvertently set sustainability goals that are too low (Jacowitz & Kahneman, 1995; Strack et al., 1988) thus discouraging the ambition needed to achieve sustainability performance that is technically and economically feasible (Klotz et al., 2010).

Rating systems are not tailored to account for cultural differences among engineering professionals globally. For example, the application of LEED rating system to a project in the Middle-East may lead to choices of credits that do not add value to sustainability outcomes. Cultural values and external factors likely play a role in sustainability performance. For example, green roofs and rainwater harvesting are credits that are not appropriate to Kuwait due to its extreme hot climate. The applicability of credits to different contexts needs to be taken into consideration otherwise the reliance on rating systems can lead to error. Another example of how rating systems might not support maximum sustainability performance is when decision makers fixate on points rather than efficiency leading to more buildings doing the bare minimum to achieve certification (Nelson & Frankel, 2012; Roberts, 2010). This is a problem because only buildings that meet the highest levels of certification actually produce energy savings (Scofield, 2013).

One way to address these problems is by aligning decision tools with what decision makers care about. This can be done by a behavioral intervention called framing. Broadly, framing is defined as an intervention that describes the same choice problem in different ways to lead to changes in behavior, even though the underlying information and choices remain essentially the same (Cookson, 2000). Goal framing is a particular type of framing in which choices are described in the outcome of either positive consequences of engaging in behavior, or negative consequences of not engaging in the behavior (Levin et al., 2002). Positive framing motivates people by offering a reward, whereas negative goal framing motivates people by imposing a penalty.

Prior work on goal framing demonstrates how tailoring mass media messages to specific audiences has a significant effect on beliefs and behavior (Wokje Abrahamse et al., 2005). Similarly, policy messages are more salient if they are framed for the political consumption of the “socially symbolic tribe” (Krishen et al., 2014). An example of a goal framed message in the field of healthcare is: ‘If you take treatment A, you will get a 50% chance of getting better results,’ compared to simply, ‘take treatment A’ (Krishnamurthy et al., 2001). Goal framed messaging that aligns outcomes about sustainability with user values and preferences may help change how decision makers prioritize attributes during the design process for buildings and infrastructure. In other words, goal framing can help decision makers recognize how sustainability aligns with their intended goals.

Prior research indicates that there are three elements that should converge at the same time for an individual’s behavior to change: motivation, ability, and a prompt (Fogg, 2009). This means that if a behavior does not change, at least one or more of those three elements is missing. Goal framing can encourage behavior change in professionals by allowing all three factors to be present at the same instant. The first element, motivation, is increased through goal framing by presenting the goals and benefits of each credit to the decision maker. Tailoring the goals to align with the decision maker’s cultural values and project goals which will activate the second element, ability, since it will be feasible to achieve. The third element, prompt, can be activated by goal framing since the credits become more persuasive. As a results this allows the decision maker to take action since the focus is directed towards an outcome rather than a choice (Fogg, 2009). Motivation, ability, and prompt all work together to produce the target behavior which is more sustainable outcomes.

Choice architecture

Embedded within any such rating system is choice architecture, which refers to the way information is presented to a decision maker. Goal framing is a type of choice architecture that can be applied to rating systems to help engineering professionals recognize the mutual benefits of design features that benefit the environment and community. Rating systems like Envision and LEED are filled with choice architecture, even when it is not intentionally designed. If those who structure these rating systems are unaware of biases and correcting interventions, they may unintentionally contribute to a process that leads away from more sustainable outcomes.

Generally, applying behavioral interventions on engineering decision tools can increase sustainability performance. For example, endowing users with a high number of points within rating systems motivates them not to lose points, as opposed to gaining the same number of points which encourages higher levels of sustainability (Shealy, Klotz, Weber, Johnson, & Bell Ruth Greenspan, 2016). Similarly, demonstrating how others have achieved high levels of sustainability through descriptive norms changes how professionals perceive performance and shapes how they signal to the outside world (Shealy et al., 2018). Another intervention to change motivation is the exposure to role model projects (Harris et al., 2016a). Exposure to role model projects when making design decisions about future projects activates the internal drivers for sustainability because they illustrate how sustainable design can create new value. In general, choice architecture interventions applied to rating systems can encourage higher sustainability performance.

Choice architecture modifications to rating systems can improve decisions globally

The construction industry in a country like the U.S. has evolved over the last decade and awareness of sustainability benefits has been on the rise (Mang et al., 2016). More than a decade ago, stakeholders in the U.S. perceived that they were encouraged by their organizations to engage in sustainability-related topics (Y. H. Ahn & Pearce, 2007). More recently, World Green Building Council (2013) also stated that there is an increasing awareness and market value in the U.S. around certification and assessment tools for sustainability. This increase in sustainable construction is also evident in the exponentially growing number of LEED-certified projects, and the increase of the green building market in 2014 that reached 81 billion U.S. dollars (Statista, 2017). But these statistics do not hold consistent globally. The adoption of sustainable design and construction practices, the use of rating systems, and market acceptance of sustainable design and construction is considerably lower in developing countries compared to the U.S. (CIB & UNEP-IETC, 2002; Marwa Heilman, 2016). The level of implementation of sustainable design and construction in industry practice is closely linked with the level of awareness (AlSanad, 2015), and the lack of awareness, both among decision makers and community stakeholder groups, can complicate adoption, and create disengagement or lack of consideration among stakeholders.

The low levels of awareness of benefits from incorporating sustainable design and construction techniques can create a misalignment in industry practices. The few projects that implement sustainable design techniques in the Middle East are adopting practices that may not best align with regional climate variations and cultural constraints. Implementing inappropriate design techniques, technologies, and processes can increase initial project costs without providing long-term benefits, thus creating a negative perception about the benefits of sustainable design and construction (GORD, 2017).

This type of focus on sustainable design and construction of spaces and systems in the built environment is necessary, specifically within the Middle East: countries like Kuwait that contribute 53% more global greenhouse gas emissions than the U.S. per capita (Ismael & Shealy, 2018d). Engineering professionals in the Middle East operate in a unique culture that influences their decisions (Baloi, 2003; Davis, 2006; Star, 1999; Vinck, 2003). While there is a growing concern and awareness about environmental sustainability globally, in Kuwait, for example, professionals using sustainability rating systems do not consistently consider credits that are directly linked to environmental benefits. These professionals do, however, prioritize socially-related benefits such as occupant health and comfort (Ismael & Shealy, 2018b).

Aim of this paper

Choice architecture interventions can be tailored to intentionally target decision-makers and to encourage adoption of sustainable design and construction practices. More intentional choice architecture among rating systems can align individual preferences across cultures. Specifically, goal framing can help decision-makers recognize the benefits of sustainability credits across all three dimensions of sustainability (economic, environmental, and social). The overall objective of this research is to understand the influence of choice architecture modifications on construction decisions across cultures, and how goal framing can impact professionals differently based on their distinct ecological worldviews, political, social and economic differences, and their different drivers for sustainability. In cultures and geographic regions where energy consumption and the impacts on the environment are less of a priority, choice modifications to the tools used during the design process of the built environment can help increase the goals set for more environmentally sustainable design. This paper measures the effects of choice architecture on design decisions for sustainability with engineering professionals in two countries: the U.S. and Kuwait. Other countries are also relevant, especially those Gulf, Arab, and developing countries that share similar values, lifestyles, and experiences with Kuwait.

7.3 Background

Decision-makers are influenced by goals, incentives, and available information (Mukherjee & Muga, 2010). Stakeholders may make decisions that do not optimally trade sustainability objectives against other outcomes, when they are unaware of the impact of their decisions on sustainability (W. Abrahamse, 2007); when sustainability is not an objective, perhaps because of misaligned incentives or insufficient feedback on the consequences of decisions (W. Abrahamse, 2007); when they believe that the client is more interested in other goals, such as minimizing upfront costs (Laustsen, 2008b); or, when they have sustainability goals, but lack the time to allocate sufficient thought or attention to them (Mukherjee & Muga, 2010).

Design of the built environment has been studied from an individual 'decision-based design' perspective, which is based on decision-makers acting in their own best interests (Hazelrigg, 1998; Lewis, Chen, & Schmidt, 2006). In practice, however, design decision making about the built environment is a social process that involves constant negotiation among many stakeholders and the ability to correctly infer and predict the preferences of other stakeholders (Bucciarelli, 1995). Like decision-based design, economic theory is based on the principle of utility maximization, but the most accurate economic models now account for influences leading to decisions that do not optimize utility (Camerer, Loewenstein, & Rabin, 2003). Similarly, decision-based design is evolving (Lewis et al., 2006) to improve on the idea of rationality as solely maximizing utility, and consider that individuals' rationality is bounded by time and cognitive limitations (Frey & Lewis, 2005), including in high-stakes decisions (Zsambok & Klein, 1997).

The built environment is an image of the local culture and identity. Cultural aspects began to be recognized and explored in fields like sustainability, engineering, and architecture decades ago (Rapoport, 1969). As the topic of sustainable development evolved, researchers became more interested in the aspect of culture as another dimension of sustainability (Memmott & Keys, 2015). The involvement of culture as part of the sustainable development process the built environment shows that different groups of people are diverse, and so their requirements can be met differently (Memmott & Keys, 2015).

Cultural values and beliefs can be extremely different between individuals from different societies. Those factors shape their identities and are reflected in the designs of their built environments (Mahgoub, 2007a). Encompassing cross-cultural contexts is currently considered an essential aspect of sustainability (Memmott & Keys, 2015), and a significant part of the environmental, financial and social dimensions of sustainable development.

In Kuwait, engineering and architecture went through intense changes that were as a result of the discovery of oil during the 1940s, and the economic wealth generated by its business (Mahgoub, 2007a). Policy changes, emerging industries, economic growth, and access to cheap energy are all reasons of Kuwait's rapid development.

Cultural differences in society leads and represents what we build. Social, political, and economic drivers in a region can shape engineering and architectural design. In a global region like the Middle East, emphasis on meeting the people's needs is often a higher priority than conserving energy or reducing environmental impact of design (Ismael & Shealy, 2018). The de-emphasis on environmental design is because of a market dominance in oil and cultural values shaped by unprecedented growth in the last several decades (Mahgoub, 2007). This is partly driven by the rapid growth to better society, and the socio-economic and political situation.

Decision makers without strong conservational views about the world may discount environmental benefits that occur in the future, in part, because these benefits require a cost in the present (Weber, 2017). This variation is largely due to the peoples social values (Milfont, Wilson, & Diniz, 2012). But views about conservation and environmental sustainability in Kuwait vary compared to other countries like the U.S. (Milfont, Duckitt, & Cameron, 2007; P. W. Schultz, 2002). For example, in many Western societies, there is an increasingly positive attitude towards environmental issues (Dunlap, Van Liere, Mertig, & Jones, 2000). This could be a result of the increase in affluence and security attained by Western societies since the end of the Second World

War (P. W. Schultz, 2002) where people now prioritize a higher quality of life and a healthy environment (Inglehart 1995).

Environmental goals are not the concern for everyone (Newman and Howlett, 2012), and views on sustainability will vary across societies and cultures. This difference in environmental preferences may influence people's behavior (Gardner & Stern, 1996). The New Ecological Paradigm Revised (NEP-R) scale can be used to measure an individual's endorsement of a "pro-ecological" world view. The NEP-R measures endorsement of the environmental paradigm or worldview, as well as attitudes, beliefs, and values about "humanity's ability to upset the balance of nature, the existence of limits to growth for human societies, and humanity's right to rule over the rest of nature (Dunlap et al., 2000)." The NEP-R is helpful when differences in behavior or attitudes are believed to be explained by underlying values, a world view, or a paradigm (M. Anderson, 2012). Several groups of people from different countries have adopted the NEP-R scale to measure environmental paradigms (Dunlap et al., 2000).

7.4 Research Questions

Most pro-environmental beliefs require people to make decisions against their egoistic values to benefit the environment (Lindenberg & Steg 2013). The application of goal framing may help with those individuals who discount the environment. For example, decision-makers with pro-social attitudes may change behavior when credits are goal framed to emphasize the social and economic benefits these credits provide. The two research questions of this study are:

1. *How does goal framing influence engineering professionals in the U.S. and Kuwait?*
2. *What are the effects of goal framing on engineering professionals with varying ecological worldviews?*

Goal framing is expected to lead to higher sustainability outcomes among professionals in countries where culturally more value is placed on human and financial benefits compared to countries where culturally more value is given to the environment. If the credits are framed in ways that present positive outcomes for society and financial benefits, these professionals will recognize the benefits, and will be more motivated to pursue higher levels of sustainability achievement for their projects. The **first hypothesis**

(H1) is goal framing credits about the associated social and financial benefits (rather than predominantly about the environment) will have a high influence on professionals in countries with lower sustainability awareness. Meaning, goal framing credits with have a higher effect with Kuwait professionals.

The effect of goal-framing will be higher for professionals who are less conscious of the environment. Meaning, goal framing is expected to have a larger effect if individual decision makers hold a pro-social paradigm of the world. Pro-social or pro-environmental individuals are defined using the pre-developed NEP-R scale. The **second hypothesis (H2)** is that industry professionals that are pro-NEP (pro-environmental) are more likely to set higher goals for sustainability when given the modified version of Envision than professionals given the control version of Envision compared to those who are pro-DSP (pro-social), and vice-versa.

7.5 Methodology

Engineering design firms and construction companies in Virginia and Kuwait were contacted by email and were asked if company employees would be interested in learning more about the Envision rating system for sustainable infrastructure. Companies were selected through convenience sampling (Teddlie and Yu, 2007). Training sessions were offered to companies through a "lunch and learn" format. Participants were provided lunch for their time to learn about Envision. In total three lunch and learns were hosted with more than ten companies participating in Virginia. The same solicitation process was used in Kuwait. Engineering and construction companies were contacted through email. Similarly, three training sessions were offered, and participants represented multiple companies. None of the professionals in Kuwait or the Virginia who participated in the training session were not familiar with the Envision Rating System.

In order to measure how goal framing influences professionals from different cultural, economic and political backgrounds, engineering professionals in Kuwait (n = 50) and in the U.S. (n = 42) were given the same case study and asked to make decisions using the Envision rating system. Information about professionals from Kuwait and U.S. are summarized in Table 20.

Table 20. Details of the professionals

	Kuwait	U.S.
Number of professionals	n = 50	n = 42
Practical experience		
Less than 5 years	18.4%	34.1 %
5-10 years	16.3%	26.8%
Over 10 years	65.3%	39%
Organization		
Designer	55.1%	61.1%
Contractor	4%	2.8%
Supplier	12.2%	2.8%
Construction management	10.2%	5.6%
Academic institution	18.4%	27.8%
Highest degree		
High school degree	6.3%,	4.9%,
Bachelor’s degree	52.1%	58.5%
Master’s degree	31.3%	34.1%
Ph.D. degree	10.4%	2.4%

The Decision Scenario

During the lunch and learn, participants learned more about Envision, how to navigate the guidance manual, and interpret each of the 64 possible credits. Participants in Kuwait and the United States were then given the same case study project. The case study was about a redevelopment of a recreational park and holding facility for reclaimed wastewater. The case was based on an actual Envision Certified Project in Los Angeles, California. The project was chosen because climate characteristics and soil types described by Envision are similar to those typical in Kuwait. Similar wastewater and stormwater projects like the one from Los Angeles that provides public recreational access are also becoming more common in Kuwait, for example, in Riqqa, Sulaibia, Wafra, Umm Alhaiman, and Jahra. Engineering professionals in Kuwait, and the MENA region as a whole, are more frequently being asked to design outdoor environments that include water features and walking trails. Using a case that was applicable to both countries was necessary to ensure professionals understood the decision scenario.

The decision scenario was set up by asking participants to act as the sustainability engineer for the project team and make design decisions using the Envision manual and rating tool. Participants were instructed to review 15 credits and select the level of achievement they believed was the most appropriate for the project team to try to meet. The 15 credits were pre-selected based on their applicability to the actual project in California. Also, only 15 out of the 64 credits were used to reduce the amount of time and cognitive load required to complete the decision scenario. These 15 credits were framed to only mention the environmental benefits. The modifications reframed the credits to also emphasize the financial savings or improvements in health or quality of life.

The credits were framed to include outcomes related to cost savings or improved quality of life-based on the detailed description provided within each credit. For example, the description of credit *RA3.2 Reduce Operational Water Consumption* mentions direct cost savings such as construction, maintenance and labor costs that can be achieved by pursuing this credit. The connection between financial savings and water consumption was imbedded in the description. The modified version of Envision makes this connection more salient in the intent of the credit. An important distinction to make is that the modified credits do not add *new information* to the credit, rather the information about financial saving or benefit to the community that is embedded in the description of the credit was just made more prominent to the decision maker by emphasizing this connection in the credit's intent.

Half of the participants in each group (Kuwait and the U.S.) were randomly assigned the conventional version of Envision, and the other half received the goal framed version that emphasized outcomes for society and monetary benefits, not just the environment. During the decision-making process, participants choose between levels of achievement, and were required to state why they believed this level of achievement is possible achieved. To control for a ceiling effect, where users just choose the highest level every time, a tradeoff between points and effort was created through this explanation process. Users had to explain how or why they planned to meet that achievement level. The greater the number of points, the longer the written response required. Writing an explanation allowed them to spend time thinking about the design options and prevented them from simply choosing the highest level of achievement in all credits without some type of cost.

Post-task survey part one

Once the process of the decision scenario was complete, participants completed the New Ecological Paradigm - Revised Scale (NEP-R) questions to identify their ecological worldviews. The NEP-R scale is focused on beliefs about humanity's ability to upset nature, the existence of limits to human economic growth and development, and humanity's right to rule over the rest of nature (Dunlap et al., 2000). The scale is constructed of fifteen statements that measure agreement or disagreement. Responses to these fifteen statements are then used to identify the individuals' ecological worldview. Agreement with the eight odd-numbered items on the scale and disagreement with the seven even-numbered items indicate pro-NEP responses. A pro-ecological worldview or "a more environmentally conscious worldview," is reflected by a high score on the NEP Scale and is referred to as a New Environmental Paradigm (NEP). A more social worldview where humans focus more on political, economic, and technological variables (Kilbourne, Beckmann, & Thelen, 2002), is reflected by a low score on the NEP Scale, and is referred to as a Dominant Social Paradigm (DSP). The DSP is further defined by Milbrath & Fisher, (1984) as "the values, metaphysical beliefs, institutions, habits, etc. that collectively provide social lenses through which individuals and groups interpret their social world" (p. 7).

The response distribution of the statements was determined using frequency analysis. In order to evaluate the effects of goal framing with professionals that are either pro-NEP or pro-DSP, the average scores of each group was calculated by summing the professionals' total scores from each group (the DSP and the NEP separately), then dividing it by number of pro-NEP or pro-DSP professionals. Equations (5) and (6) express this formulation below. This method was adopted from Ogunbode (2013).

$$\text{NEP Average Score} = \sum \text{Individual Total Envision Scores} / N_{NEP} \tag{5}$$

$$\text{DSP Average Score} = \sum \text{Individual Total Envision Scores} / N_{DSP} \tag{6}$$

where N_{NEP} represents the number of pro-NEP professionals, and N_{DSP} represents the number of pro-DSP professionals for both the control and goal framed versions.

To calculate the statistical significance of the results, a two-tailed *t*-test for independent means was used to compare the average Envision scores between pro-NEP and pro-DSP professionals, and calculate significance between the results. In this case the independent variable was the ecological worldview of each professional, and the dependent variable was the average Envision scores.

Post-task survey part two

A series of six questions followed to further understand professionals' perceptions of Envision. The aim of these questions was to learn what type of goals they were targeting through their decisions. The questions were used to capture possible change in perceptions about Envision between professionals who received the control of modified version of Envision. The participants responded to the questions listed below using a Likert scale, from strongly disagree (1) to strongly agree (5):

1. The decisions I made reflected my preferences and goals.
2. Envision has increased my awareness of sustainable benefits.
3. I mainly choose credits that enhance quality of life (health/wellbeing).
4. Environmentally-related credits are just as important as financial and social benefits.
5. High initial cost is still a barrier to sustainable construction.
6. The environment, the community's wellbeing and finances are all equally important to sustainability.

7.6 Results

The results indicate that goal framing had a significant effect on what professionals in the U.S., $t(19)=-14.47$, ($p<0.01$), and professionals in Kuwait, $t(46)=-2.74$, ($p<0.01$), believed was possible in terms of sustainability performance for the project. Professionals in both the U.S. and Kuwait that received the goal framed version of Envision believed significantly higher levels of achievement were possible to meet. The percent increase among engineering professionals in Kuwait that received the goal framed version of Envision compared to the control group in Kuwait was 23%. Among professionals in the U.S., the difference between the intervention group and control group was 28%. The scores of the two samples are shown in Table 21. While the percent increase among professionals in the U.S. was higher, the total mean score among the control and intervention groups of professionals in Kuwait was greater. In other words, professionals in Kuwait set higher goals for sustainability than professionals in the U.S with or without the modified version of Envision.

Table 21. Goal framing credits (both social and financial combined) led to higher sustainability outcomes among professionals in Kuwait

	Kuwait		**U.S.**	
	Control	**Goal framing**	**Control**	**Goal framing**
Total Mean Score	124.44	144.27	95.41	121.75
Standard Deviation	39.80	32.49	38.57	35.52

Professionals in Kuwait scored significantly, t(45)=2.64, ($p < 0.01$), more than professionals in the U.S. who also received the goal framed version of Envision. The percent increase among professionals in Kuwait that received the modified version of Envision compared to professionals in the U.S. who received the modified version was 18.5%. Illustrated in Figure 14, the effect of goal framing was greater among credits framed to emphasize the outcome on people compared to long term cost savings for either the client or the community. Professionals in Kuwait placed a 32% higher priority on credits when the intent was framed to emphasize the outcome on people compared to professionals in Kuwait who received the current version of Envision that only mentioned the impact to the environment. The inverse occurred for professionals in the U.S. Those in the U.S. who received the modified version of Envision were more likely to set higher goals when the credit emphasized the financial outcome. When the intent of Envision credits were framed to emphasize long term cost savings for either the client or the community, professionals in the U.S. placed a 27% higher priority on these credits compared to professionals in the U.S. who received the control version.

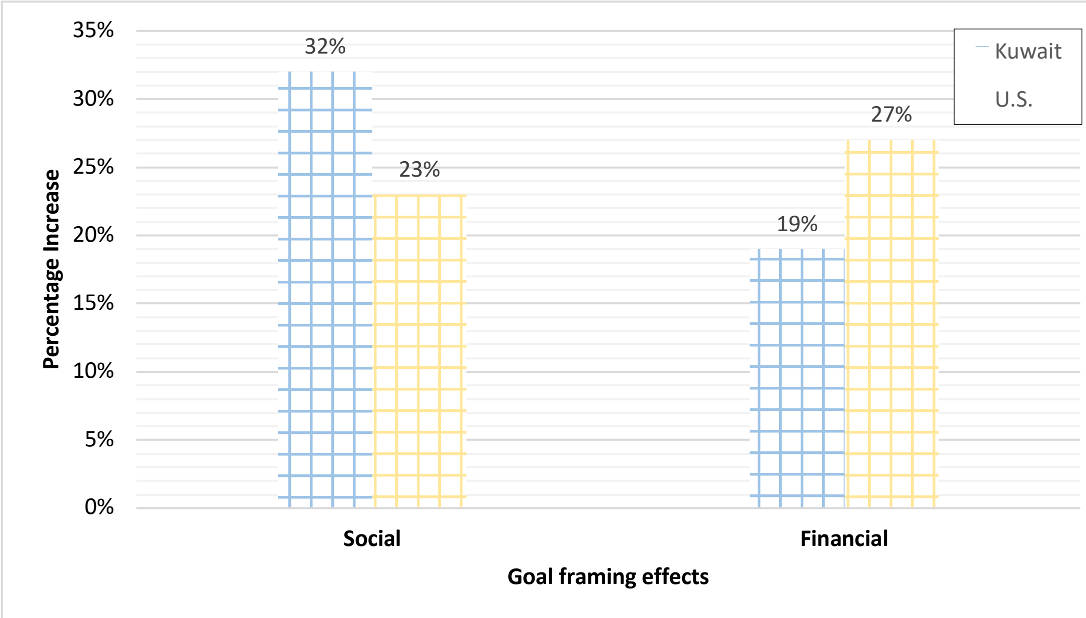


Figure 14. Social and financial goal framing effects on professionals in the U.S. and Kuwait

When comparing only the credits framed to more specifically emphasize the outcome on people among professionals in Kuwait, those who received the intervention set significantly higher levels of achievement, t(4)=-2.72, (*p*=0.026). However, the difference among professionals in the U.S. was not significant, t(4)=-1.48, (*p*=0.1). The difference in goal setting for credits that emphasized the impact on people is illustrated in Figure 15.

Motivating professionals to consider the credit *CR1.2 Reduce Greenhouse Gas Emissions* by emphasizing the outcome about people led to the highest increase in goal setting among professionals in Kuwait with a 48% increase in Envision points compared to the control group. However, goal framing the intent of the credit to emphasize the outcome on people had a negative effect on professionals in the U.S. *CR1.2 Reduce Greenhouse Gas Emissions* by emphasizing the outcome about people led to an 18% lower achievement level among U.S. professionals compared to the control group.

Emphasizing the outcome on people and society for the credit *NW2.3 Reduce Pesticide & Fertilizer Impacts* led to the highest increase in goal setting among professionals in the U.S., with a 94% increase in Envision points between the control and intervention group. Professionals from both countries scored the lowest on credit *RA1.5*

Balance Earthwork on Site when the outcome was framed to include the outcome on people a society. The intervention led to only an 8% and 3% increase in goal setting for professionals in the U.S. and Kuwait, respectively.

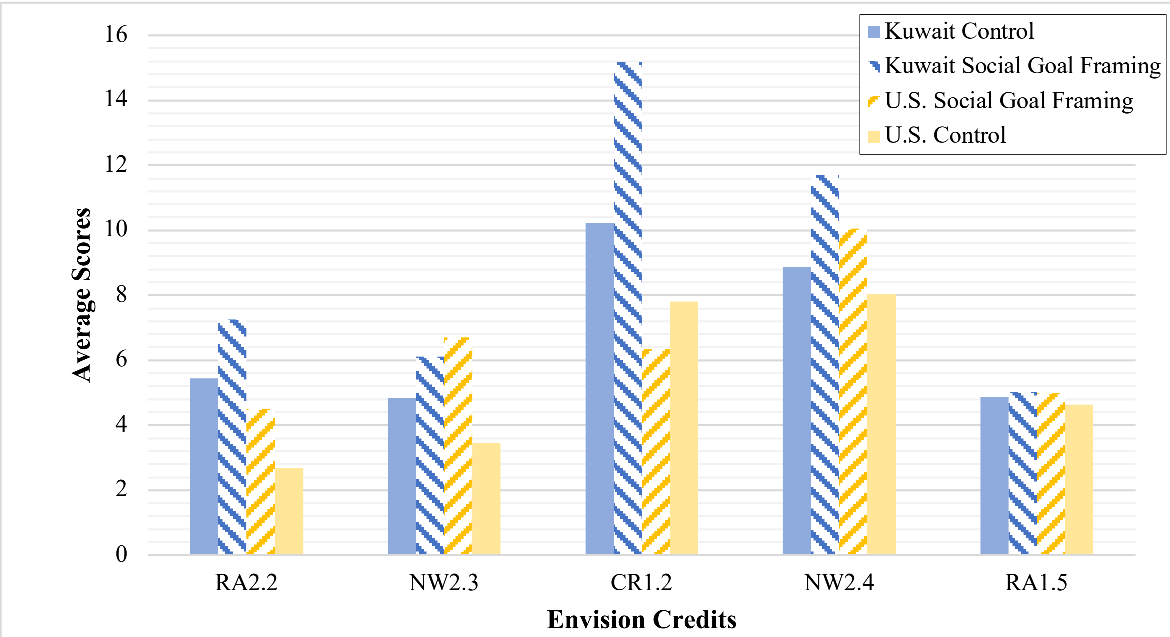


Figure 15. Effects of social goal framing on individual credits with Kuwait and U.S. professionals

Framing the intent of credits to include financial outcomes significantly increased the goals professionals in the U.S. (p=0.03) and Kuwait (p=0.04) set for the project. The results for each credit are illustrated in Figure 16. While the increase in goal setting was significant between groups ($p<0.01$) differences exist in the effectiveness among credits. Emphasizing the outcome on financial savings for the credit *NW3.1 Enhance Functional Habitats*, led to the highest increase in goal setting among professionals in the Kuwait, with a 59% increase in goal setting compared to the control group. While framing the intent about financial savings on credit *RA3.1 Preserve Water Resources* led to the largest effect on U.S. professionals, with a 61% increase in score.

The lowest effect observed among professionals in Kuwait is credit *RA3.2 Reduce Operational Water Consumption*, with just a 4% increase in goal setting. For professionals in the U.S., the credit with the lowest observed effect was *NW2.2 Manage Storm Water*, with less than 4% increase in goal setting. Framing the intent of credits about money on credit *CR1.1 Reduce Net Embodied Carbon* had a negative effect among professionals in Kuwait (1.7%) though this individual difference was not significant.

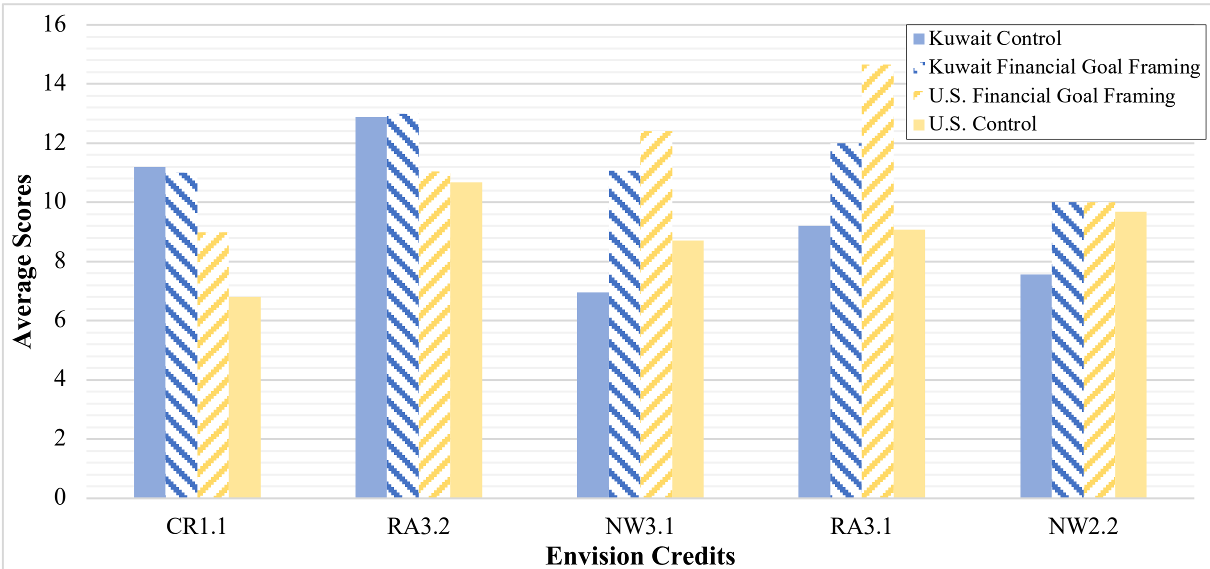


Figure 16. Effects of financial goal framing on individual credits with Kuwait and U.S. professionals

Post-task survey

The results of the post-task survey provide clarification on professionals' perceptions of Envision and how their responses reflect the realness of the decisions made during the decision scenario. Professionals in the U.S. and Kuwait both strongly agree that the decisions they made reflect their preferences and goals (83% and 90% respectively). There was no significant difference in responses between professionals that received the modified version or the control version of Envision in Kuwait or the U.S.

Approximately half of professionals in the U.S. and Kuwait would like to use Envision again. The responses were not significantly different whether they received the control or modified version of Envision.

There is a difference in how professionals in Kuwait and the U.S. respond to the statement "Envision has increased my awareness of sustainable benefits." Nearly 70% of professionals in Kuwait said their awareness of benefits for sustainable design increased. While only 17% of U.S. professionals agreed with the statement. The professionals that received the modified version were significantly more likely to agree with this statement than those that received the control version.

More than 25% of professionals in the U.S. and Kuwait were unsure or disagreed that the environment, the community's wellbeing, and financial savings are all equally important to sustainability. However, professionals that received the goal framed version were more likely to agree than those that received the control version, though the difference was not significant: 78% of professionals in Kuwait who received the goal framed version of Envision agreed with this statement compared to 70% who received the control.

More than 70% of professionals in the U.S. and Kuwait agreed or strongly agreed that high initial costs are still a barrier to sustainable design and construction. Although, a smaller number of professionals in both the US and Kuwait who received the goal framed version agreed with this statement compared to those who received the control.

Nearly 45% of professionals in the U.S. disagreed that their Envision choices were based on solely enhancing quality of life. While in Kuwait, 83% of professionals who received the goal framed version agreed that their Envision choices were based on solely enhancing quality of life. Only 56% of those that received the control agreed with this statement.

Barriers to Sustainable Construction

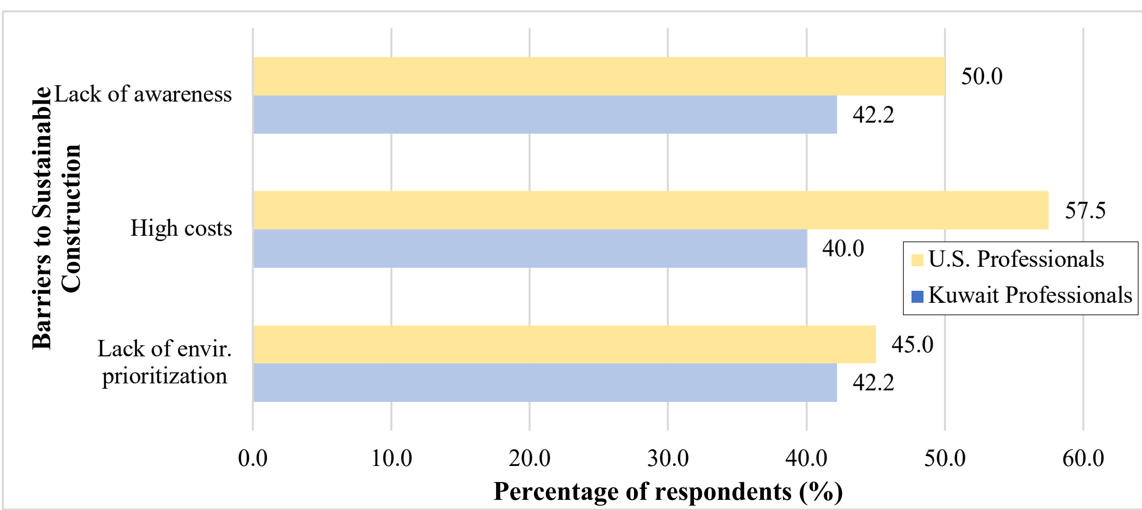


Figure 17. Barriers to sustainable construction as perceived by Kuwait and U.S. professionals.

The perceived barriers to more sustainable design vary by country. The majority of professionals in Kuwait ranked *lack of awareness* and nearly 42 percent ranked *lack of environmental prioritization* as the highest barrier to more sustainable design. U.S. professionals ranked *high initial costs* as the highest barrier. The results are illustrated in Figure 17. The difference in perceived barriers was not different between the control or intervention groups among professional in Kuwait or the U.S.

RQ2: What are the effects of goal framing on engineering professionals with varying ecological worldviews?

The overall frequency and mean distributions of NEP scores reveal that the majority of professionals in both the U.S. and Kuwait have pro-ecological world views (i.e. hold a New Ecological Paradigm). However, there are considerable variations in responses in Kuwait. More than 20% are unsure about statements 1-4 (Limits, Anti-Anthropocentrism, Balance, and Anti-Exemptionalism) and from 8-14 (Balance, Anti-Exemptionalism, Eco-Crisis, Limits, and Anti-Anthropocentrism). The mean scores for the eight odd-numbered pro-NEP items range from 2.7 to 4.4. The mean scores for the seven even-numbered Dominate Social Paradigm (DSP) range from 2.5 to 4.3. Frequency distributions on the pro-NEP statements show that 39 professionals (78%) conform to a NEP world view, whereas only 11 professionals (22%) conform to a DSP world view. More details about the Kuwait distribution of NEP scores are provided in Appendix C.

There is a tendency for U.S. respondents to endorse pro-environmental beliefs. Yet, considerable variations in the responses are also high. The response “unsure” about the 15 statements, was over 20% about each of the items from 1, 3-4 (Limits, Balance, and Anti-Exemptionalism) and from 8-14 (Balance, Anti-Exemptionalism, Eco-Crisis, Limits, and Anti-Anthropocentrism). The mean scores for eight odd-numbered pro-NEP items range from 2.6 - 4.5, whereas the mean scores for seven even-numbered DSP items range from 2.5 - 4.4. Frequency distributions on the pro-NEP statements show that more than three-quarters of the professionals (79%) agreed on these statements, whereas only 21% were pro-DSP. More details about the U.S. distribution of NEP scores are provided in Appendix D.

There were 34 professionals in the U.S. and 39 in Kuwait with a NEP world view, and just 9 professionals in the U.S. and 11 in Kuwait with a DSP world view. The low number of professionals with a DSP world view was unexpected, especially in Kuwait because prior study finds that professionals in Kuwait prioritize design features and construction practices that benefit people and their clients over the environment (Ismael & Shealy, 2018). One possible explanation for why most engineering professionals in Kuwait hold pro-environmental world views is because of their likely professional training in engineering and construction outside of the country that might emphasize or teach about environmental impacts from engineering. No matter the reason, or self-selection into the training, the number of DSP and NEP were equally distributed between the control and intervention groups and the effects of goal framing between the control and modified groups were normally distributed and met the 95% confidence interval for significance.

In order to evaluate the effect of goal framing with professionals that either hold a NEP or DSP world view, the average scores of each group, either NEP or DSP were compared using equations (5) and (6) mentioned in the Methods section. The averages scores among participants in each group are normally distributed. The significance of the results between the pro-NEP and pro-DSP professionals was calculated using a two-way ANOVA test for independent samples with Tukey posthoc pairwise comparison.

Framing credits to include more emphasis about people or money increased the level of achievement set by professionals in both Kuwait and the U.S. Professionals in Kuwait with a NEP world view that received the intervention set a 22% higher goal for sustainability performance than the control. Whereas professionals with a DSP world view set a 31% higher goal for sustainability than professionals that received the control version of Envision. The results are significant [$F(1, 46) = 6.72$, $p=0.01$]. These results demonstrate that framing the intent has an effect on what individuals perceive is possible no matter their ecological world view. Though, the effect among professionals in Kuwait was greater among when they had a dominant social paradigm. The results listed in Table 22 express these findings for professionals in Kuwait. More specifically, when the financial and social credits were compared based on the professional's world views, the results did not indicate an increase in sustainability performance for the NEP/DSP who received the goal framed version.

Table 22. Average Envision scores for pro-NEP and pro-DSP professionals in Kuwait.

Kuwait Professionals		Average Envision Score	Standard Deviation
Pro-NEP	Control	123	32.48
	Goal Framed	149	30.19
Pro-DSP	Control	111	47.65
	Goal Framed	145	45.41

The U.S. professionals with NEP and DSP world view average scores are shown in Table 23 U.S. professionals with a NEP world view that received the goal framed version scored 19% higher than those who received the goal framed version. However, professionals with a DSP world view who received the goal framed version scored 101% higher than those who received the control. The results are significant [F(1,36)=8.62, p = 0.0058)]. Professionals who hold a NEP world view are more likely to set high goals for sustainability when the credits are framed to emphasize the environmental outcome over the impact on society or monetary outcomes. Professionals in the U.S. who hold a DSP worldview were significantly more likely to set higher goals for sustainability when given the goal framed version of Envision than professionals who hold a NEP world view.

The results described in Table 23 were further delineated by separating the effect of the financial and socially framed credits among professionals with varying world views. Credits framed about financial outcomes that were given to professionals with a DSP world view led to a 37% higher sustainability score than the control group with DSP world views. In other words, the increase in goal setting was the greatest among financially framed Envision credits with professionals who hold a DSP world view.

Table 23. Average Envision scores for professionals in the U.S. with NEP and DSP world views

U.S. Professionals	Average	Standard

		Envision Score	Deviation
Pro-NEP	Control	101	39.43
	Goal Framed	120	27.41
Pro-DSP	Control	73	27.25
	Goal Framed	147	35.96

7.7 Discussion

The strength of the effect of goal framing is limited to the values of the decision maker (McClure et al., 2009). Activating those values appears to motivate behavior change (Steinhorst et al. 2015). Engineering professionals who received the goal framed version of the Envision rating system were significantly more likely to set higher goals for sustainability. The effects of goal framing changed preferences about sustainability choices and as a result, lead to better sustainability performance goals.

Although results of this research are significant, and a large difference is observed cumulatively across all credits, there are credits with a lower, or no, effect in changing goals compared to others. For example, the percent increase in goal setting among professionals in both countries that received the modified version was the lowest for credit *RA1.5 Balance Earthwork on Site* when the intent emphasized the outcome on people and society. A possible reason for the low percent increase is because credit RA1.5 has a relatively low maximum possible achievement level (8 points) compared to other credits, like *NW2.2 Reduce greenhouse gas emissions*, which offers 24 possible points. The small effect from goal framing could be due a ceiling effect. Professionals who received the modified version set a goal to achieve 5 out of 8 points (that is a 62.5% achievement level). Another possible reason for the small effect is the effort and time given to this credit among professionals compared to other credits that were worth more possible points. Less time and focus may have led to a smaller percent difference between the control and intervention group. However, more research is needed to fully understand why this variability exists.

Another credit with varying effects across both countries is example is *CR1.2 Reduce Greenhouse Gas Emissions.* Motivating professionals to consider this credit by emphasizing the outcome about people led to the highest increase in goal setting among professionals in Kuwait. A possible reason is because since Kuwait professionals have low levels of awareness about sustainability (AlSanad, 2015), and connecting the health goals of achieving the credit to the environmental outcomes, allowed them to more quickly recognize and be more aware of the benefits of the credit across the different dimensions of sustainability. In other words, aligning with their multiple motives (Kaplan, 2000). Another possible explanation is due to cultural differences. Kuwait places a high value on quality of life, health care, and caring for others compared to the U.S. (Hofstede, 2019). The Kuwait society considers quality of life as a sign of success, which is not the same in the U.S (Hofstede, 2019). Typical behavioral patterns of people in the U.S. indicate that they are more driven by competition, achievement, and monetary success (Hofstede, 2019). Emphasizing how the credit about greenhouse gas emissions also effects health may better align with the multiple motives of professionals in Kuwait compared to professionals the U.S.

Another explanation of the effect could be awareness of sustainability. Newman et al., (2012) suggests that the effects of environmental goal framing are larger when the decision makers' awareness about climate change and environmental degradation is low. Participants with relevant experiences and more information on the subject may answer differently than those with limited awareness (Pelletier & Sharp, 2008). This could explain the significant increase in high sustainability goals among professionals in Kuwait compared to the U.S. with or without the intervention to Envision. However, when comparing the effects of goal framing between control and intervention groups the percent increase is similar.

Cultural values of individuals are correlated with their behavior (Steg et al. 2014) and this may contribute to the observed differences between professionals in Kuwait and the U.S. Professionals in Kuwait prioritized credits that emphasized societal benefits, whereas, U.S. professionals prioritized credits that emphasized financial benefits. The responses to the post-task survey provide some explanation. The majority of professionals in Kuwait agreed that enhancing quality of life was one of their main goals during the decision scenario. Nearly three-quarters of U.S. professionals agreed that high initial cost is still a barrier to sustainable construction.

Prior descriptive statistics about professionals in Kuwait identify that they believe three main factors inform building design and their architectural identity: (1) the culture of the society, (2) climatic conditions, and (3) religion (Mahgoub, 2007a). Culture is a matter of great importance to Kuwaiti citizens due to the invasion and liberation experience in 1990. This history contributes to attitudes and a renewed interest developed in expressing a unique cultural identity, which translates into engineering and architectural design (Mahgoub, 2007a). Similarly, society in Kuwait lacks the awareness and interest to reduce energy consumption due to the 85% energy subsidies from the government (AlSanad, 2015). This high subsidization might explain why energy is taken for granted and environmental sustainability is less of a concern during design, construction and maintenance of the built environment.

The climatic conditions and other external factors like geographical location, are also possible reasons why Kuwait professionals were significantly more motived by socially framed credits. Kuwait's climate is hot and dry. Engineering professionals prioritize building features that improve health and comfort to respond to the climatic conditions (Edwards, Sibley, Hakmi, & Land, 2004).

Religion may also play a role. In Kuwait, religion dictates certain sociocultural customs and practices that need to be considered early in the design phase of a new building or infrastructure project (Mahgoub, 2007b). Those influences are reflected on their building and design choices and are highly valued compared to any environmental or financial benefit (Edwards et al., 2004). Examples of these practices can be maintaining the privacy of occupants especially for women, or building a cluster of spaces to accommodates for an extended family since one of the norms is close proximity to family (Edwards et al., 2004; Mahgoub, 2007b). Engineering professionals recognize the necessity to consider individual needs for privacy, family interaction, and space orientation (Ismael & Shealy, 2018d).

Conversely, professionals in the U.S. prioritized financial benefits. One explanation is energy and water costs in the U.S. are not subsidized. There is a strong incentive to reduce energy consumption and save costs. Large financial return on investments can be made through proper engineering and design for energy savings. So, in order to encourage higher sustainability performance, it is important to pre-define norms and standards that are required to translate financial, social and environmental aspects of sustainability into different contexts that are essential to consider these sustainable implications.

Environmental goals are not a major concern for everyone. Goal framing the intent of credit to not only include the environmental implications but benefits to people and financial savings for the client or downstream users had a substantial effect on professionals who hold a pro-social paradigm of the world. Professionals in both the U.S. and Kuwait who hold a dominant social paradigm of the world scored higher in goal framed credits than those with a New Ecological Paradigm (NEP). In the U.S., those with NEP world view set higher initial goals for sustainability when using the control version of Envision than those who received the modified version of Envision. The difference in goals for sustainability is because the credits framed to highlight the social and financial benefits increased motivation. Understanding differences in environmental preferences can lead to more customized goal setting. More customized decision tools through goal framing and other choice interventions can help ensure intended outcomes.

There are a number of limitations to this study. First, the decision scenario was tested on the participants individually rather than in groups. Although in actual construction projects the whole team is involved in these decisions but testing within groups can increase the number of variables that group dynamics present. The primary objective was to measure if goal framing leads to more sustainable outcomes across cultures, without influence of group dynamics. Future work can build on these results to consider the effects of goal framing with groups. Prior literature reports the effects of choice architecture on groups as similar that of individuals (Shealy et al., 2019). Second, only participants who were interested in Envision participated. This may have caused bias in the sample since an accurate reflection of the population should include participants who are not interested in sustainable design and construction. However, those who are interested in learning about Envision are likely the types of people that will be using Envision in the real world and influenced by the change in framing. Last, the case study chosen for the decision scenario was an actual certified project in California, but participants in this research were from Virginia. The difference across regions may have had an effect on their decisions. The reason the California project was used as the case is because the authors had full access to its credit documentation. This helped in selecting realistic credits to include in the decision scenario.

7.8 Conclusion

Applying choice architecture methods like goal framing to the design process of buildings and infrastructure can have a significant effect on the goals that engineering professionals set for sustainability. Goal framing works similar to the effects of priming, by helping to think in a certain way. Goal framing heightens awareness between pre-established values and certain choice options (Bargh, J., 2006). In the context of Envision, goal framing helped engineering professionals representing two different countries set higher goals for sustainability, likely by, connecting pre-established values and norms to outcomes of participating in and achieving high levels of sustainability (Memmott & Keys, 2015). The credits were framed in ways that present social, or financial goals, which helped motivate professionals to recognize the credits, and pursue them at higher levels of performance. The value placed on particular credits differed among professionals in the U.S. and Kuwait. Engineering professionals in Kuwait placed more value when credits highlighted the benefit to people whereas professionals in the U.S. placed greater value on credits goal framed to emphasize the financial benefits. Recognizing that decision makers have culturally-specific values about sustainability will help improve design decision tools, particularly rating systems for sustainability.

The results from the research presented in this paper suggest a heavy emphasis on environmental sustainability among rating systems appears to be a factor affecting goal setting among engineering professionals (Stern, 2000). Pro-environmental behavior is also influenced, or motivated, by various forms of non-environmental concerns. For instance, a desire to save money, or a desire for comfort can lead designers to pro-environmental solutions (Siegwart Lindenberg & Steg, 2007). Pursuit of sustainable solutions requires consideration of all three dimensions of sustainability and aiming for a sustainable built environment requires more than just disconnected incentives. The findings presented in this paper suggests the need for more consideration in how constraints are being approached.

The research presented in this paper can help guide the design process of rating systems to tailor interventions using this knowledge and help connect design decisions to the desired sustainability outcomes. This research also advances behavioral decision science by expanding how behavioral interventions are interpreted and cognitively processed across cultures and regions with varying norms, perceptions, and values. The findings improve the application of goal framing, and more broadly choice architecture, to upstream decision making for sustainable design. This approach can more easily be implemented than policy or economic interventions. While the intervention was applied to Envision, the approach of modifying the intent of the credit can be applied to update many existing rating systems.

References

Abrahamse, W. (2007). Energy conservation through behavioral change: Examining the effectiveness of a tailor-made approach. Retrieved April 17, 2017, from http://dissertations.ub.rug.nl/faculties/gmw/2007/w.abrahamse/?pLanguage=en&pFullItemRecord=ON

Ahn, Y. H., & Pearce, A. R. (2007). Green Construction: Contractor Experiences, Expectations, and Perceptions. *Journal of Green Building*, *2*(3), 106–122. https://doi.org/10.3992/jgb.2.3.106

AlSanad, S. (2015). Awareness, drivers, actions, and barriers of sustainable construction in Kuwait. *Procedia Engineering*, *118*, 969–983. https://doi.org/10.1016/j.proeng.2015.08.538

Anderson, M. (2012). New Ecological Paradigm (NEP) Scale. *Berkshire Encyclopedia of Sustainability*, *6*, 260–262.

Baloi, D. (2003). Sustainable construction: challenges and opportunities. Retrieved December 6, 2017, from http://www.arcom.ac.uk/-docs/proceedings/ar2003-289-297_Baloi.pdf

Bucciarelli, L. (1995). Designing Engineers. *European Journal of Engineering Education*, *20*(3), 385–386. https://doi.org/10.1080/03043799508928289

Camerer, C., Loewenstein, G., & Rabin, M. (2003). Advances in Behavioral Economics. Retrieved December 6, 2017, from Princeton University Press website: https://press.princeton.edu/titles/7607.html

CIB, & UNEP-IETC. (2002). *Agenda 21 for sustainable construction in developing countries: a discussion document* [Report]. Retrieved from CSIR website: https://researchspace.csir.co.za/dspace/handle/10204/3511

Cookson, R. (2000). Framing Effects in Public Goods Experiments. *Experimental Economics*, *3*(1), 55–79. https://doi.org/10.1023/A:1009994008166

Davis, H. (2006). *The Culture of Building*. Oxford University Press, USA.

Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). New Trends in Measuring Environmental Attitudes: Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale. *Journal of Social Issues*, *56*(3), 425–442. https://doi.org/10.1111/0022-4537.00176

Edwards, B., Sibley, M., Hakmi, M., & Land, P. (2004). *Courtyard Housing: Past, Present and Future*. Taylor & Francis.

Fischhoff, B., & Kadvany, J. D. (2011). *Risk: a very short introduction*. Oxford; New York: Oxford University Press.

Fogg, B. (2009). A Behavior Model for Persuasive Design. *Proceedings of the 4th International Conference on Persuasive Technology*, 40:1–40:7. https://doi.org/10.1145/1541948.1541999

Frey, D., & Lewis, K. (2005). *The Deciding Factor: Design engineers make decisions for a living. Research looks for ways to make the process go smoother*. Retrieved from http://does.eng.buffalo.edu/index.php?option=com_jresearch&view=publication&task=show&id=26

GORD. (2017). Gulf Organization for Research and Development. Retrieved March 25, 2017, from http://www.gord.qa/trust-gsas-resource-center-overview

Harris, N., Shealy, T., & Klotz, L. (2016). How Exposure to ”Role Model” Projects Can Lead to Decisions for More Sustainable Infrastructure. *Sustainability*, *8*(2), 130. https://doi.org/10.3390/su8020130

Hazelrigg, G. A. (1998). A Framework for Decision-Based Engineering Design. *Journal of Mechanical Design*, *120*(4), 653–658. https://doi.org/10.1115/1.2829328

Ismael, D., & Shealy, T. (2018a). Sustainable Construction Risk Perceptions in the Kuwaiti Construction Industry. *Sustainability*, *10*(6), 1854. https://doi.org/10.3390/su10061854

Ismael, D., & Shealy, T. (2018b). Retrieved September 22, 2018, from https://ascelibrary.org/doi/10.1061/9780784481301.071

Jacowitz, K. E., & Kahneman, D. (1995). Measures of Anchoring in Estimation Tasks. *Personality and Social Psychology Bulletin*, *21*(11), 1161–1166. https://doi.org/10.1177/01461672952111004

Kilbourne, W. E., Beckmann, S. C., & Thelen, E. (2002). The role of the dominant social paradigm in environmental attitudes: a multinational examination. *Journal of Business Research*, *55*(3), 193–204. https://doi.org/10.1016/S0148-2963(00)00141-7

Klotz, L., Mack, D., Klapthor, B., Tunstall, C., & Harrison, J. (2010). Unintended anchors: Building rating systems and energy performance goals for U.S. buildings. *Energy Policy*, *38*(7), 3557–3566. https://doi.org/10.1016/j.enpol.2010.02.033

Laustsen, J. (2008). Energy efficiency requirements in building codes, energy efficiency policies for new buildings. *International Energy Agency (IEA)*, 477–488.

Levin, I., Gaeth, G., Schreiber, J., & Lauriola, M. (2002). A New Look at Framing Effects: Distribution of Effect Sizes, Individual Differences, and Independence of Types of Effects. *Organizational Behavior and Human Decision Processes*, *88*, 411–429. https://doi.org/10.1006/obhd.2001.2983

Lewis, K. E., Chen, W., & Schmidt, L. C. (Eds.). (2006). *Decision making in engineering design*. New York: ASME Press.

Lindenberg, S., & Steg, L. (2007). Normative, Gain and Hedonic Goal Frames Guiding Environmental Behavior. *Journal of Social Issues*, *63*(1), 117–137. https://doi.org/10.1111/j.1540-4560.2007.00499.x

Mahgoub, Y. (2007a). Architecture and the expression of cultural identity in Kuwait. *The Journal of Architecture*, *12*(2), 165–182. https://doi.org/10.1080/13602360701363486

Mahgoub, Y. (2007b). Hyper Identity: The Case of Kuwaiti Architecture. *International Journal of Architectural Research: ArchNet-IJAR*, *1*(1), 70–85. https://doi.org/10.26687/archnet-ijar.v1i1.9

Marwa Heilman, V. (2016). *Factors hindering the adoption of sustainable design and construction practices: the case of office building development in Dar es Salaam, Tanzania*. https://doi.org/http://dx.doi.org/10.18419/opus-9149

McClure, J., White, J., & Sibley, C. G. (2009). Framing effects on preparation intentions:

distinguishing actions and outcomes. *Disaster Prevention and Management: An International Journal*, *18*(2), 187–199. https://doi.org/10.1108/09653560910953252

Memmott, P., & Keys, C. (2015). Redefining architecture to accommodate cultural difference: designing for cultural sustainability. *Architectural Science Review*, *58*(4), 278–289. https://doi.org/10.1080/00038628.2015.1032210

Milbrath, L. W., & Fisher, B. V. (1984). *Environmentalists: Vanguard for a New Society*. SUNY Press.

Milfont, T. L., Duckitt, J., & Cameron, L. D. (2007). "A Cross-Cultural Study of Environmental Motive Concerns and Their Implications for Proenvironmental Behavior": Erratum. *Environment and Behavior*, *39*(2), 284–284. https://doi.org/10.1177/0013916506297970

Milfont, T. L., Wilson, J., & Diniz, P. (2012). Time perspective and environmental engagement: a meta-analysis. *International Journal of Psychology: Journal International De Psychologie*, *47*(5), 325–334. https://doi.org/10.1080/00207594.2011.647029

Mukherjee, A., & Muga, H. (2010). An integrative framework for studying sustainable practices and its adoption in the AEC industry: A case study. *Journal of Engineering and Technology Management*, *27*(3–4), 197–214. https://doi.org/10.1016/j.jengtecman.2010.06.006

Nelson, A. J., & Frankel, A. (2012). *Building Labels vs. Environmental Performance Metrics: Measuring What's Important about Building Sustainability*. Retrieved from http://realestate.dws.com/content/_media/Research_Sustainability_Metrics_in_the_Real_Estate_Sector-Oct_2012.pdf

Ogunbode, C. (2013). The NEP scale: Measuring ecological attitudes/worldviews in an African context. *Environment Development and Sustainability*, *15*, 1477–1494. https://doi.org/10.1007/s10668-013-9446-0

Rapoport, A. (1969). *House form and culture.* In *Foundations of Cultural Geography Series.* Retrieved from https://s3.amazonaws.com/academia.edu.documents/34196680/76688196-House-Forms-and-Culture-1969-Amos-Rapoport.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=154809

7165&Signature=fOZl%2BT%2Bdv4Y653lvbwXyiDCNlEs%3D&response-content-disposition=inline%3B%20filename%3DA_project_of_Volunteers_in_Asia_House_Fo.pdf

Roberts, T. (2010, October 14). USGBC, LEED Targeted by Class-Action Suit. Retrieved February 1, 2019, from Building Green website: https://www.buildinggreen.com/news-analysis/usgbc-leed-targeted-class-action-suit

Schultz, P. W. (2002). Environmental Attitudes and Behaviors Across Cultures. *Online Readings in Psychology and Culture*, *8*(1). https://doi.org/10.9707/2307-0919.1070

Scofield, J. H. (2013). Efficacy of LEED-certification in reducing energy consumption and greenhouse gas emission for large New York City office buildings. *Energy and Buildings*, *67*, 517–524. https://doi.org/10.1016/j.enbuild.2013.08.032

Shealy, T., Johnson, E., Weber, E., Klotz, L., Applegate, S., Ismael, D., & Bell, R. G. (2018). Providing descriptive norms during engineering design can encourage more sustainable infrastructure. *Sustainable Cities and Society*, *40*, 182–188. https://doi.org/10.1016/j.scs.2018.04.017

Shealy, T., Klotz, L., Weber, E., Johnson, E. J., & Bell Ruth Greenspan. (2016). Using framing effects to inform more sustainable infrastructure design decisions. *Journal of Construction Engineering and Management*, *142*(9), 4016037. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001152

Shepherd, H. (2011). The Cultural Context of Cognition: What the Implicit Association Test Tells Us About How Culture Works1. *Sociological Forum*, *26*(1), 121–143. https://doi.org/10.1111/j.1573-7861.2010.01227.x

Star, S. L. (1999). The Ethnography of Infrastructure. *American Behavioral Scientist*, *43*(3), 377–391. https://doi.org/10.1177/00027649921955326

Statista. (2017). Green construction market size United States 2014 | Statistic. Retrieved June 15, 2017, from Statista website: https://www.statista.com/statistics/248060/value-of-us-green-building-market/

Strack, F., Martin, L. L., & Schwarz, N. (1988). Priming and communication: Social determinants of information use in judgments of life satisfaction. *European Journal of Social Psychology*, *18*(5), 429–442. https://doi.org/10.1002/ejsp.2420180505

Vinck, D. (2003). *Everyday Engineering: An Ethnography of Design and Innovation*.

Weber, E. U. (2017, January 10). Breaking cognitive barriers to a sustainable future [Comments and Opinion]. Retrieved December 7, 2017, from Nature Human Behaviour website: https://www.nature.com/articles/s41562-016-0013

World Green Building Council. (2013). The Business Case for Green Building. Retrieved February 7, 2017, from http://www.worldgbc.org/

Zsambok, C., & Klein, G. (1997). Naturalistic Decision Making. *Journal of Behavioral Decision Making*, *12*(4), 340–341. https://doi.org/10.1002/(SICI)1099-0771(199912)12:4<340::AID-BDM341>3.0.CO;2-4

CHAPTER 8

CONCLUSION

Potential barriers to more sustainable design and construction were measured in chapters two and three. The results about professionals in the country of Kuwait were compared to prior literature about professionals in the United States. The results suggest that professionals in Kuwait appear to undervalue sustainable design and construction practices that promote environmental sustainability compared to the U.S. due to the lack of training and limited awareness of the benefits. More focus needs to be given to emerging markets like Kuwait and others in the Middle East and North African region (MENA), which contribute one and a half times more global greenhouse gas emissions per capita than the United States. Educational interventions, changes in risk allocation, and behavioral science to reframe sustainability credits are offered as possible solutions. The tools these professionals use during the design decision making process to encourage sustainability should better reflect what these professionals' value.

Choice architecture, as defined by Thaler & Sunstein (2009), reflects the fact that there are several ways that a choice can be presented to the decision-maker, and that the decisions made often depend on how the choices are presented. Some options must be first, attributes are or are not presented, and, just as in other domains, choice architecture can influence design and construction decisions and overcome cognitive barriers for sustainability. In Chapter 4, a choice architecture approach called goal framing was introduced as a technique to apply to rating systems for sustainability. The purpose of the goal framing intervention was to emphasize the cascading benefits to society and long-term financial outcomes that environmental sustainability design provides.

The intent of credits within the Envision rating system were modified to emphasize the outcome on human health and financial savings for pursuing the credit. The purpose was to motivate engineering professionals to more quickly recognize how the outcome aligns with their prior stated goals and objectives that were uncovered in chapters two and three. The goals set among professionals in Kuwait and U.S. who received the modified version of Envision, and those that did not, were compared.

Initially, it may seem that goal framing adds constraints (e.g., not just reducing water but your solution must also save money). However, goal framing, and more specifically gain goal framing, is meant to elicit additional motives (e.g., money savings, improvements to health) rather than constraints. Increasing motivation through multiple motives (i.e., do not just pursuing credits for the environment but also for money and health benefits) may influence a change in behavior. Professionals' who received the modified version of Envision set higher goals when multiple motives were present. The results help confirm the modified intents were perceived as goals and not constraints because of the higher levels of sustainability achievement that they set.

Comparing among professionals in Kuwait and the U.S. offered insight into the effectiveness of goal framing across global regions, where perceptions and value preferences for sustainable design likely vary. In cultures and geographic regions, like Kuwait, where energy and the environment are less of a priority compared to human quality of life and comfort, and where professionals hold low environmental worldviews, the goal framing intervention increased what these professionals' thought was possible to achieve. In Kuwait, the effect was greatest when framed to emphasize outcomes to people. In the U.S., the effect of goal framing was greatest when framed to emphasize financial outcomes for their clients or downstream users. By highlighting the mutual benefits of environmental sustainability such as improved quality of life and financial gains, engineering professionals were significantly more likely to set higher sustainability performance goals. Goal framing increased their motivation and awareness between pre-established values and certain choice options. Decision-makers recognized the benefits of the credits across all dimensions of sustainability to support the full objectives of a sustainable project which was reflected in both their Envision scores and their written explanations.

Pro-environmental behavior is also influenced, or motivated, by various forms of non-environmental concerns. For instance, a desire to save money, or a desire for comfort can lead designers to pro-environmental solutions (Siegwart Lindenberg & Steg, 2007). The pursuit of sustainable solutions requires consideration of all three dimensions of sustainability and aiming for a sustainable built environment requires more than just disconnected incentives. The findings suggest the need for more consideration in how constraints are being approached.

Values and beliefs can be extremely different between individuals from different societies, with varying economic and institutional incentives, social norms, and geographic constraints. These factors shape their identities and are reflected in the design of their built environments (Mahgoub, 2007a). Designing choice architecture with an understanding of values and beliefs across cultures, and aiming to create a “good fit” between the design and the user, appears to be worth the extra effort than a one-size fits all intervention (Memmott & Keys, 2015). The results presented in this dissertation suggest varying levels of effect between professionals in the U.S. and Kuwait. Culture may contribute to these differences because it often drives what is prioritized (Memmott & Keys, 2015), and by using decision tools that are carefully designed for their intended users, stakeholders can more quickly see how design for sustainability aligns with their pre-established goals and preferences, in return set higher goals for sustainability outcomes.

8.1 Practical Implications

From a practical point of view, this research has important implications for engineering decision making. Engineering professionals should recognize how small modifications to decision environments influence motivation. The results provide direction for how to elicit varying responses among decision makers. More simply, decision makers often have multiple motivations, knowing which motivation to align with can have effects on decision making. Realigning credits within rating systems that make the benefits about money or health more salient can have a drastic effect on infrastructure design. For instance, suppose this type of gain goal framing reported in this dissertation led to just 10% better performance on the Envision credit “Reduce Greenhouse Gas Emissions” (the results presented here suggest 23 to 28% better performance), applied to all U.S. infrastructure, this represents a reduction of over 1.5 *billion* tons of CO_2 (Shealy & Klotz, 2015b). Since infrastructure is not updated all at once, these reductions would be acquired over time. However, this is just for one of the 64 Envision credits. Intentionally designed goal framing interventions might promise similar gains in 63 other sustainability outcomes within Envision.

The findings presented in this dissertation also have implications for other types of decision-making processes and tools used in engineering. The simple reframing of a choice or question can produce a completely different answer from the same person. Rating systems, like Envision and others, are filled with design choices. Those designing rating systems and other engineering decision tools for the design and construction industry need to understand the influence of choice architecture, and when appropriate, apply interventions to help guide users towards their objectives. The findings offer new insights about the nuances of choice architecture modifications and the need to understand the user group.

8.2 Theoretical Contribution

The broader contribution of this research is the application of choice architecture to high-level decision making for infrastructure. The application of goal framing to the Envision rating system encouraged more sustainable design by helping decision makers set higher goals for sustainability. There are three main theories that this research contributes to: the theory of goal framing (Levin, Schneider, and Gaeth, 1998), multiple motives theory (Kaplan, 2000), and the theory of planned behavior (Ajzen, 1985).

This research demonstrates that the theory of goal-framing (Levin, Schneider, and Gaeth, 1998) not only applies to downstream consumer decision making but extends to upstream decisions about infrastructure. More specifically, gain goal framing can alter motivation among engineering professionals. This also adds a new contextual dimension to the body of knowledge of about goal framing by comparing its effects across cultures. Gain goal framing is effective in both the U.S. and Kuwait, countries with very distinct cultural differences (Hofstede, 2019). While the overall effect was similar, differences are pronounced in the emphasis of gain goal framing between people and money. Engineering professionals in Kuwait were more likely to set high goals for sustainability when credit intents were framed to include outcomes about people. This aligns with the Hofstede model, which says Kuwait society places a high value on quality of life, health care, and caring for others compared to the U.S. (Hofstede, 2019). The increase in goal setting may be a result of Multiple Motives Theory that explains how motives interact to influence behavior, and which motives are dominant in specific situations (Kaplan, 2000).

The intervention tested in this research applies the theory of multiple motives to increase cognitive attention to environmental sustainability by making the connection to people or money more salient and less attention to the background goals (about the environment which are achievable in the long run). The findings demonstrate how the theory of goal framing and multiple motives theory are effective in changing motivation among engineering professionals about the environment.

This research also supports and extends to the Theory of Planned Behavior (Ajzen, 1985). The Theory of Planned Behavior states that attitude and subjective norms shape an individual's behavior. People are motivated by self-interests. Decision makers choose alternatives with the highest personal benefits. When the intent of credits are framed to include the potential losses for themselves, their clients, or downstream users, decision makers were more likely to set higher goals for sustainability. Framing is essential to promoting sustainable development because of it can compel stakeholders to set significantly higher project goals. This research demonstrates this effect and how the theory of planned behavior functions together with goal framing to inform design decisions among engineering professionals.

Overall, engineering decision tools should not be exclusively focused on environmental motives in order to promote pro-environmental behaviors. In line with the Theory of the Commons (Dietz, 2005), focusing on specific contexts where self-interest can be encouraged in the service of the environment can play an important role in promoting collective environmental action. This research contributes to engineering sustainability by demonstrating how professionals across cultures are motivated differently to achieve higher sustainability performance. This research also demonstrates how to promote change in behavior through a relatively simple choice architecture modification which uses intrinsic motivators that are proven to be more effective than extrinsic motivations. In other words, highlighting self-enhancing reasons is an effective process to shape individuals' perspectives (Bardi and Schwartz, 2003) and to incentivize global behavioral change towards a more sustainable future that encompasses a broader spectrum of engineering professionals across different systems of varied values and concerns.

8.3 Future research

The outcomes of this research lay the foundation for future research testing the effects of goal framing within engineering decision tools. Specifically, more research is needed on gain goal framing within rating tools like Envision. There was considerable variability between credits. Future research should help identify why this variability exists through think-aloud protocols and capturing the time decision makers spend evaluating each credit. Gain goal framing is just one type of goal framing. Future research can also test the effects of hedonistic and normative methods for goal framing and compare to the results reported in this research.

While the intent of this framing intervention was to change motivation, there may be other factors that prevent more sustainable design. Combing gain goal framing with, for example, default choices may increase motivation and perceived ability and lead to even higher goals for sustainability. These behavioral interventions can also be tested in a group setting instead of with individual professionals. Testing the effects among groups can provide more realistic outcomes because design and construction project occur through group decisions. Controlling for groups in the research reported from this study provides a baseline effect among individuals.

More generally, future research is needed to understand how decision makers make tradeoffs. Interdisciplinary studies like this one that combine behavioral science and engineering can help build more accurate models about complex decision-making processes from a descriptive, rather than normative perspective. A better understanding how of these relatively small choice interventions influence decision making can lead to better tools to guide engineering professionals towards their predefined project objectives.

8.4 Reflections

Looking back at my three years of working towards my Ph.D. I came to the realization that I truly enjoyed this experience. Although it was difficult at times to balance between teaching, research, self-care, friends, and family (including a baby), but I was able to manage the work better than I thought I could. This process has helped me grow and learn more than I had ever imagined. The writing process was a slow (and sometimes frustrating) process, but I was always encouraged by the people around me, particularly my advisor who continuously provided me with constructive feedback and I enjoyed sharing thoughts and developing ideas with him. In addition to the improvement in my writing skills, my research and presentation skills have also greatly developed, and I now feel much more confident in the pursuit of an academic career. I made an original contribution to knowledge by applying existing theories to new areas of knowledge. This would not have been possible without the advice and support of my advisor which has given me the opportunity to be prepared and excited to be more involved in academic research about behavioral decision science and sustainable infrastructure. I feel ready to tackle new challenges in research and create a similar experience for students that I had throughout my Ph.D. process.

References

American Physical Society. (2008). Energy = Future: Think Efficiency. Retrieved December 6, 2017, from https://www.aps.org/energyefficiencyreport/report/aps-energyreport.pdf

Brewer, G., & Stern, P. (2005). Decision Making for the Environment: Social and Behavioral Science Research Priorities. Retrieved from http://www.nap.edu/catalog/11186/decision-making-for-the-environment-social-and-behavioral-science-research

Lindenberg, S., & Steg, L. (2007). Normative, Gain and Hedonic Goal Frames Guiding Environmental Behavior. Journal of Social Issues, 63(1), 117–137. https://doi.org/10.1111/j.1540-4560.2007.00499.x

Mahgoub, Y. (2007). Architecture and the expression of cultural identity in Kuwait. The Journal of Architecture, 12(2), 165–182. https://doi.org/10.1080/13602360701363486

Memmott, P., & Keys, C. (2015). Redefining architecture to accommodate cultural difference: designing for cultural sustainability. Architectural Science Review, 58(4), 278–289. https://doi.org/10.1080/00038628.2015.1032210

Shealy, T., & Klotz, L. (2015). Well-endowed rating systems: How modified defaults can lead to more sustainable performance. Journal of Construction Engineering and Management, 141(10), 4015031. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001009

Thaler, R. H., & Sunstein, C. R. (2009). Nudge: Improving Decisions about Health, Wealth, and Happiness. Penguin.

U.S. National Science Board. (2009). Building a Sustainable Energy Future. Retrieved December 6, 2017, from https://www.nsf.gov/pubs/2009/nsb0955/nsb0955.pdf

APPENDICES

APPENDIX A - Synthesized list of sustainable design principles and construction practices

List of Sustainable Design Principles and Concepts	Rating Systems					
	LEED	**BREEAM**	**PBRS**	**GPRS**	**GSAS**	**ARZ**
Conserve or restore the environment						
Containers for site materials waste		✔		✔		✔
Employing waste recycling workers on site		✔		✔		✔
Remediation of contaminated land			✔			
Bicycle facilities	✔	✔				
Proximity to amenities					✔	
Light pollution reduction	✔	✔			✔	
Shading of adjacent properties					✔	
Amenities that control emissions & pollutants		✔		✔	✔	
Environmental tobacco smoke control	✔		✔	✔		
Ecological strategies		✔				✔
Energy metering (monitoring & reporting)	✔		✔	✔	✔	✔
Renewable energy production	✔		✔	✔		
Water use reduction	✔		✔	✔	✔	
Water metering	✔					
Water leak detection			✔	✔	✔	
Passive distillation systems				✔		✔
Water pollution		✔		✔	✔	
Fossil fuel conservation					✔	✔
Use of rapidly renewable materials			✔	✔		
Use of recycled materials			✔	✔	✔	✔
Elimination of exposure to toxic materials			✔	✔		
Rain water harvesting			✔	✔		
Green roofs	✔					✔

Increased value or quality for people						
Construction air quality management			✔			
Acoustic performance	✔	✔	✔	✔	✔	✔
Optimized use of natural light						✔
Healthy ventilation delivery			✔	✔	✔	✔
Safe & secure environment			✔			✔
Innovative cultural & regional practices			✔	✔		
Health, safety & welfare regulations				✔		
Protect or restore habitat	✔		✔	✔	✔	
Respect sites of historic interest				✔		
Training and skills development		✔				
Control of health risks				✔		✔

Provide financial benefit now or in the future						
Sourcing of raw materials	✔					
Providing a periodic maintenance schedule				✔		✔
Use of regionally procured materials			✔	✔	✔	✔
Design for disassembly			✔		✔	
Intelligent building control system					✔	✔
Identified and separated storage areas				✔		
Use of higher durability materials			✔	✔		
Flood risk management		✔				
Design for materials reduction			✔			
Elevator power saving						✔
Materials fabricated on site				✔	✔	✔

APPENDIX B – Goal Framing Decision Scenario

Name: ______________________________

Envision Rating System

This decision scenario will take no more than 30 minutes to complete and your input will be a valuable contribution towards this research. The results of this research will help us provide recommendations to existing rating systems for sustainability.

Please indicate by checking the appropriate box whether we can include your results in research:

☐ YES ☐ NO

Request for Proposal

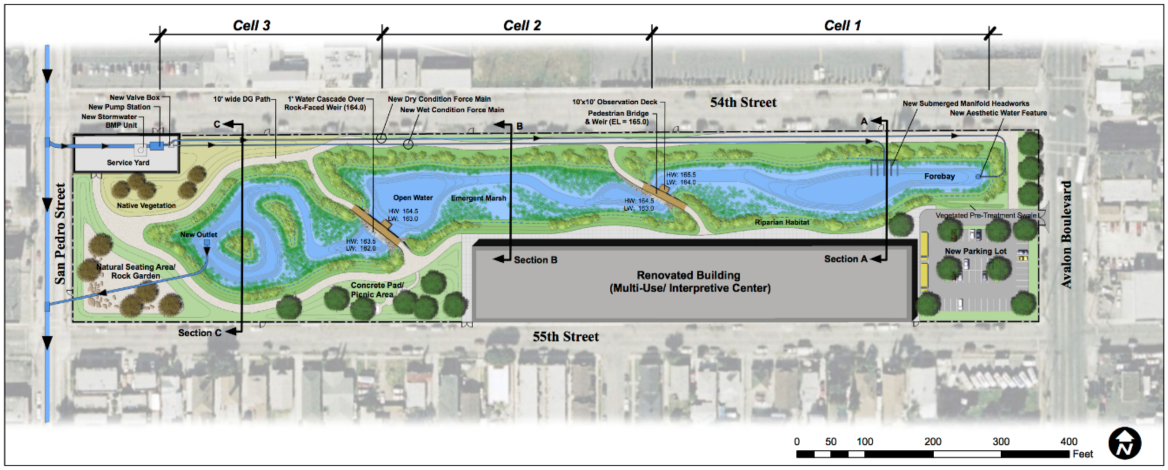
1. Brief Project Overview

Your company has been hired to construct a new Recreational Park and Holding Facility for Reclaimed Wastewater. The purpose of the park is dual purpose, to redevelop an existing underused site and hold treated wastewater. The treated wastewater can help replenish depleting ground aquifers.

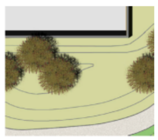

2. Project Details

The 9-acre park will help transform an underutilized part of the city and provide a "green" space for residents. The park will also serve to hold and treat reclaimed wastewater and storm water. This reclaimed water will provide irrigation to the facility and help replenish ground aquifers that are receding at an unprecedented rate. Below is a list of aspects the project should provide:

- Multi-purpose fields and walking trails
- Adjacent parking lots
- Restroom and community facilities
- Landscaping to treat water and provide shading
- Reclaimed wastewater holding facility for 680,000 gallons per day
- Preserving and restoring existing habitats and important natural resources
- Locally sourced materials

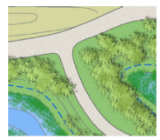


Rock Garden Area

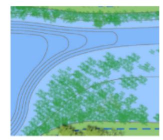


Native Vegetation Area

Park/Picnic Area



Riparian Habitat



Emergent Marsh Habitat

The project will include construction of trails, two pedestrian bridge structures over the water, interpretive signs, picnic and seating areas, an asphalt or concrete parking area, and fire-lane around the south building. The south building will be renovated in the future and used as a community center for the park.

<u>Part 1:</u> You should act as the sustainability engineer to review the project's scope of work and recommend which sustainability credits from the Envision rating system shown below can be achieved. For each credit, select a level of achievement and include a short explanation in the notes section why you think its suitable.

#		Credits	Levels of Achievement				
1	CR1.1	Reduce Cost by Reducing Energy Intensity of Materials	5	10	15	20	-
	Intent	Reduce transportation costs over the project life by using less material that requires transportation from the manufacturer to the site.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
2	RA1.1	Protect Human Health by Supporting Sustainable Procurement Practices	2	4	7	12	-
	Intent	Protect human health by developing sustainable procurement policies and programs to source materials and equipment from manufacturers and suppliers.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
3	RA1.3	Avoid Waste Cost by Diverting Operational Waste from Landfills	4	7	10	16	-
	Intent	Avoid extra costs by beneficially reducing and reusing operational waste and divert waste streams from disposal to recycling.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
4	RA1.4	Avoid Waste Cost by Diverting Construction Waste from Landfills	1	4	7	11	16
	Intent	Avoid losing value of recyclable materials by diverting construction waste streams from disposal to recycling and reuse.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
5	RA1.5	Reduce Traffic Congestion Around Site by Balancing Earthwork on Site	2	4	6	8	-
	Intent	Decrease noise and congestion in the area by minimizing the movement of soils and other excavated materials off site.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
6	RA2.2	Reduce Breathing Problems by Reducing Construction Energy	1	4	8	12	-
	Intent	Avoid breathing problems and air pollutant emissions by reducing energy consumption during construction.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
7	RA3.1	Prevent Financial and Resource Waste by Preserving Water Resources	2	4	9	17	22

	Intent	Prevent large financial and resource waste by reducing the net impacts on fresh water availability, quantity, and quality at a watershed scale.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
8	RA3.2	Reduce Cost Through Efficient Operational Water Consumption	4	9	13	17	22
	Intent	Reduce maintenance and labor costs by reducing overall water consumption over the project life.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
9	RA3.3	Reduce Cost Through Efficient Water Consumption During Construction	1	3	5	8	-
	Intent	Reduce construction costs by minimizing potable water consumption during construction.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
10	NW1.1	Prevent Loss of Value to Sites of High Ecological Importance	3	7	12	16	24
	Intent	Prevent the loss of value to the community by avoiding the placement of projects and temporary works on a site that has been identified as being of high ecological value.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
11	NW2.2	Prevent Property Damage by Managing Storm-water	2	4	9	17	24
	Intent	Prevent damage to property by minimizing the impact of development on storm-water runoff quantity, rate, and quality.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
12	NW2.3	Avoid Risks to Human Health by reducing the quantity, toxicity, bioavailability, and persistence of pesticides and fertilizers.	1	2	5	9	12
	Intent	Avoid risks to human health by reducing the quantity, toxicity, bioavailability, and persistence of pesticides and fertilizers.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
13	NW2.4	Avoid Health Issues by Protecting Surface and Ground Water Quality	2	4	9	14	18
	Intent	Avoid health issues from contact with contaminated water by preserving water resources and incorporating measures to prevent pollutants from contaminating surface and groundwater.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
14	NW3.1	Avoid Loss of Value by Enhancing Functional Terrestrial Habitats	2	5	9	15	18

	Intent	Avoid the loss of value to the region by preserving and improving the functionality of the site and the surrounding natural habitat.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						
15	CR1.2	Avoid Health Problems by Reducing Greenhouse Gas Emissions	5	8	14	18	25
	Intent	Reduce health problems caused by particulate matter in greenhouse gas emissions produced during the operation of the project.	Improved	Enhanced	Superior	Conserving	Restorative
	Notes:						

Part 2 - General Information

Please complete the following by selecting the appropriate answer according to your background information and experience.

<table>
<tr><td rowspan="1">Practical Experience</td><td>Less than 5 years</td><td>◯</td><td>5-10 years</td><td>◯</td><td>Over 10 years</td><td>◯</td></tr>
<tr><td rowspan="3">What is the type of organization you currently work in?</td><td>Client</td><td>◯</td><td>Designer</td><td>◯</td><td>Main Contractor</td><td>◯</td></tr>
<tr><td>Sub-contractor</td><td>◯</td><td>Supplier</td><td>◯</td><td>Construction Management</td><td>◯</td></tr>
<tr><td>Academic Institution</td><td>◯</td><td colspan="4">Others, please specify: ______________________________</td></tr>
<tr><td rowspan="2">What is the highest degree of education you have completed?</td><td>High School degree</td><td>◯</td><td>Bachelor’s degree</td><td>◯</td><td>Master’s degree</td><td>◯</td></tr>
<tr><td>Doctorate degree</td><td>◯</td><td colspan="4">Other: ___________________</td></tr>
<tr><td colspan="7">To what extent do you agree or disagree with the following?</td></tr>
<tr><td colspan="3">The decisions I made reflected my preferences and goals.</td><td colspan="4">(Not at all) 1 2 3 4 5 (Very much)</td></tr>
<tr><td colspan="3">I will use Envision in the future if the opportunity arises.</td><td colspan="4">(Not at all) 1 2 3 4 5 (Very much)</td></tr>
<tr><td colspan="3">I would recommend Envision to a friend.</td><td colspan="4">(Not at all) 1 2 3 4 5 (Very much)</td></tr>
<tr><td colspan="3">Envision has increased my awareness of sustainable benefits.</td><td colspan="4">(Not at all) 1 2 3 4 5 (Very much)</td></tr>
<tr><td colspan="3">I mainly choose credits that enhance quality of life (health/wellbeing).</td><td colspan="4">(Not at all) 1 2 3 4 5 (Very much)</td></tr>
<tr><td colspan="3">I mainly choose credits that reduce project costs.</td><td colspan="4">(Not at all) 1 2 3 4 5 (Very much)</td></tr>
<tr><td colspan="3">Environmentally-related credits are just as important as financial and social benefits.</td><td colspan="4">(Not at all) 1 2 3 4 5 (Very much)</td></tr>
<tr><td colspan="3">High initial cost is still a barrier to sustainable construction.</td><td colspan="4">(Not at all) 1 2 3 4 5 (Very much)</td></tr>
<tr><td colspan="3">The environment, the community’s wellbeing and finances are all equally important to sustainability.</td><td colspan="4">(Not at all) 1 2 3 4 5 (Very much)</td></tr>
<tr><td colspan="7">In your opinion, rank the following barriers to sustainable construction from 1 to 3 in order of highest (1) to lowest (3).</td></tr>
<tr><td colspan="7">◯ Lack of environmental prioritization among stakeholders</td></tr>
<tr><td colspan="7">◯ High initial cost to construct</td></tr>
<tr><td colspan="7">◯ Lack of sustainability awareness among the project team</td></tr>
<tr><td colspan="7">What was the most interesting takeaway in this experience?</td></tr>
<tr><td colspan="7"></td></tr>
</table>

Part 3 – The New Ecological Paradigm - Revised Scale (NEP-R Scale)

Using a Likert scale, indicate the strength of your agreement with each of the following statements below (1 strongly disagree and 5 strongly agree):

Code	Statement	Likert Scale				
1	We are approaching the limit of the number of people the Earth can support.	1	2	3	4	5
2	Humans have the right to modify the natural environment to suit their needs.	1	2	3	4	5
3	When humans interfere with nature, it often produces disastrous consequences.	1	2	3	4	5
4	Human ingenuity will ensure that we do not make the Earth unlivable.	1	2	3	4	5
5	Humans are seriously abusing the environment.	1	2	3	4	5
6	The Earth has plenty of natural resources if we just learn how to develop them.	1	2	3	4	5
7	Plants and animals have as much right as humans to exist.	1	2	3	4	5
8	The balance of nature is strong enough to cope with the impacts of modern industrial nations.	1	2	3	4	5
9	Despite our special abilities, humans are still subject to the laws of nature.	1	2	3	4	5
10	The so-called "ecological crisis" facing humankind has been greatly exaggerated.	1	2	3	4	5
11	The Earth is like a spaceship with very limited room and resources.	1	2	3	4	5
12	Humans were meant to rule over the rest of nature.	1	2	3	4	5
13	The balance of nature is very delicate and easily upset.	1	2	3	4	5
14	Humans will eventually learn enough about how nature works to be able to control it.	1	2	3	4	5
15	If things continue on their present course, we will soon experience a major ecological catastrophe.	1	2	3	4	5

APPENDIX C - Kuwait professionals: Frequency Distributions, Mean, and Standard Deviations for the 15 NEP-R Scale Statements

	Do you agree or disagree that:	SA	MA	U	MD	SD	Mean	S.D.
1.	We are approaching the limit of the number of people the earth can support	6.1%	18.4%	32.7%	20.4%	22.4%	2.7	1.2
2.	Humans have the right to modify the natural environment to suit their needs	18.4%	28.6%	20.4%	18.4%	14.3%	3.2	1.3
3.	When humans interfere with nature it often produces disastrous consequences	26.5%	32.7%	28.6%	10.2%	2%	3.7	1.0
4.	Human ingenuity will ensure that we do NOT make the earth unlivable	16.3%	26.5%	36.7%	6.1%	14.3%	3.2	1.2
5.	Humans are severely abusing the environment	37.5%	39.6%	8.3%	8.3%	6.3%	3.9	1.2
6.	The earth has plenty of natural resources if we just learn how to develop them	49%	38.8%	8.2%	4.1%	0%	4.3	0.8
7.	Plants and animals have as much right as humans to exist	57.1%	34.7%	6.1%	0%	2%	4.4	0.8
8.	The balance of nature is strong enough to cope with the impacts of modern industrial nations	6.1%	20.4%	24.5%	28.6%	20.4%	2.6	1.2
9.	Despite our special ability's humans are still subject to the laws of nature	32.7%	28.6%	34.7%	2%	2%	3.9	1.0
10.	The so-called "ecological crisis" facing humankind has been greatly exaggerated	2%	16.3%	36.7%	18.4%	26.5%	2.5	1.1
11.	The earth is like a spaceship with very limited room and resources	12.2%	24.5%	28.6%	20.4%	14.3%	3.0	1.2
12	Humans were meant to rule over the rest of nature	8.2%	12.2%	28.6%	28.6%	22.4%	2.6	1.2
13.	The balance of nature is very delicate and easily upset	24.5%	42.9%	24.5%	6.1%	2.0%	3.8	1.0
14.	Humans will eventually learn enough about how nature works to be able to control it	14.3%	24.5%	30.6%	18.4%	12.2%	3.1	1.2
15.	If things continue on their present course, we will soon experience a major ecological catastrophe	36.7%	38.8%	10.2%	8.2%	6.1%	3.9	1.2

[a]Question wording: "Listed below are statements about the relationship between humans and the environment. For each one, please indicate whether you STRONGLY AGREE, MILDLY AGREE, are UNSURE, MILDLY DISAGREE or STRONGLY DISAGREE with it."

[b]Agreement with the eight odd-numbered items and disagreement with the seven even-numbered items indicate pro-NEP responses.

[c]SA = Strongly Agree, MA = Mildly Agree, U = Unsure, MD = Mildly Disagree, and SD = Strongly Disagree.

APPENDIX D - U.S. professionals: Frequency Distributions, Mean, and Standard Deviations for the 15 NEP-R Scale Statements

	Do you agree or disagree that:	SA	MA	U	MD	SD	Mean	S.D.
1.	We are approaching the limit of the number of people the earth can support	6%	16%	31%	22%	25%	2.6	1.2
2.	Humans have the right to modify the natural environment to suit their needs	19%	29%	19%	19%	13%	3.2	1.3
3.	When humans interfere with nature it often produces disastrous consequences	23%	33%	29%	10%	6%	3.6	1.1
4.	Human ingenuity will ensure that we do NOT make the earth unlivable	17%	25%	40%	4%	13%	3.3	1.2
5.	Humans are severely abusing the environment	40%	38%	8%	8%	6%	4.0	1.2
6.	The earth has plenty of natural resources if we just learn how to develop them	52%	36%	8%	4%	0%	4.4	0.8
7.	Plants and animals have as much right as humans to exist	60%	30%	8%	0%	2%	4.5	0.8
8.	The balance of nature is strong enough to cope with the impacts of modern industrial nations	8%	21%	21%	31%	19%	2.7	1.2
9.	Despite our special ability's humans are still subject to the laws of nature	35%	27%	35%	2%	2%	3.9	1.0
10.	The so-called "ecological crisis" facing humankind has been greatly exaggerated	2%	16%	37%	18%	27%	2.5	1.1
11.	The earth is like a spaceship with very limited room and resources	12%	25%	27%	19%	17%	3.0	1.3
12	Humans were meant to rule over the rest of nature	8%	13%	27%	31%	21%	2.6	1.2
13.	The balance of nature is very delicate and easily upset	29%	39%	24%	6%	2.0%	3.9	1.0
14.	Humans will eventually learn enough about how nature works to be able to control it	16%	20%	30%	22%	12%	3.1	1.2
15.	If things continue on their present course, we will soon experience a major ecological catastrophe	38%	38%	12%	6%	6%	3.9	1.2

[a]Question wording: "Listed below are statements about the relationship between humans and the environment. For each one, please indicate whether you STRONGLY AGREE, MILDLY AGREE, are UNSURE, MILDLY DISAGREE or STRONGLY DISAGREE with it."

[b]Agreement with the eight odd-numbered items and disagreement with the seven even-numbered items indicate pro-NEP responses.

[c]SA = Strongly Agree, MA = Mildly Agree, U = Unsure, MD = Mildly Disagree, and SD = Strongly Disagree.

APPENDIX E - A comparison table of responses to the nine statements for Kuwait and U.S. professionals

Statements		**Control**		**Goal Framed**	
		% of Kuwait respondents	**% of U.S. respondents**	**% of Kuwait respondents**	**% of U.S. respondents**
Statement 1: The decisions I made reflected my preferences and goals	Strongly disagree	0%	5%	0%	5%
	Disagree	0%	5%	0%	5%
	Unsure	9%	5%	13%	5%
	Agree	57%	33%	30%	37%
	Strongly agree	35%	38%	57%	37%
Statement 2: I will use Envision in the future if the opportunity arises.	Strongly disagree	0%	5%	0%	5%
	Disagree	9%	18%	4%	5%
	Unsure	35%	18%	43%	37%
	Agree	30%	45%	43%	16%
	Strongly agree	26%	9%	9%	21%
Statement 3: I would recommend Envision to a friend.	Strongly disagree	4%	0%	0%	5%
	Disagree	9%	18%	9%	0%
	Unsure	39%	14%	39%	47%
	Agree	30%	41%	43%	16%
	Strongly agree	17%	27%	9%	21%
Statement 4: Envision has increased my awareness to sustainable benefits	Strongly disagree	9%	5%	0%	6%
	Disagree	22%	5%	4%	11%
	Unsure	17%	14%	26%	50%
	Agree	26%	45%	61%	11%
	Strongly agree	26%	14%	9%	6%
Statement 5: I mainly choose credits that enhance quality of life (health/wellbeing).	Strongly disagree	0%	5%	0%	0%
	Disagree	0%	5%	0%	11%
	Unsure	26%	41%	17%	22%
	Agree	26%	36%	48%	39%
	Strongly agree	30%	5%	35%	11%
Statement 6: I mainly choose credits that reduce project costs.	Strongly disagree	4%	9%	0%	0%
	Disagree	13%	27%	4%	28%
	Unsure	39%	23%	39%	11%
	Agree	22%	27%	13%	44%
	Strongly agree	22%	9%	43%	11%
Statement 7:	Strongly disagree	0%	0%	0%	0%

Environmentally related credits are just as important as financial and social benefits.	Disagree	0%	0%	4%	6%
	Unsure	22%	50%	9%	17%
	Agree	43%	32%	35%	50%
	Strongly agree	26%	5%	48%	11%
Statement 8: High initial cost is still a barrier to sustainable construction.	Strongly disagree	9%	5%	0%	11%
	Disagree	9%	14%	9%	6%
	Unsure	13%	9%	13%	11%
	Agree	30%	50%	17%	17%
	Strongly agree	35%	14%	65%	33%
Statement 9: The environment, the community's wellbeing and finances are all equally important to sustainability.	Strongly disagree	4%	0%	4%	0%
	Disagree	4%	0%	4%	17%
	Unsure	22%	23%	13%	11%
	Agree	22%	50%	26%	39%
	Strongly agree	48%	14%	52%	22%