2013

Sustainable Building Codes: How the Perceptions of Building Code Officials Influence Their Intent to Adopt the International Green Construction Code

Aaron D. Sauer
Indiana State University

VITA

Aaron D. Sauer is a resident of Warrensburg, Missouri and is a faculty member at the University of Central Missouri. His industry experience includes over ten years as a construction professional working in the industrial and commercial building markets. Positions held include Estimator, Design Build Salesman, General Manager and President for a respected regional construction firm.

Educational degrees include a Ph.D. in Technology Management (Construction Management Specialization) from Indiana State University, Terre Haute (2013); a Master of Science in Technology Management from the University of Central Missouri, Warrensburg (2007); and a Bachelor of Science in Construction Science – Management Technology from Central Missouri State University, Warrensburg (1994).

Aaron D. Sauer is currently an Assistant Professor in the School of Technology at the University of Central Missouri. In addition to serving as a member of the Construction Management faculty he also participates in scholarly research in the fields of Technology Management and Construction Technology.

SUSTAINABLE BUILDING CODES: HOW THE PERCEPTIONS OF BUILDING CODE OFFICIALS INFLUENCE THEIR INTENT TO ADOPT THE INTERNATIONAL GREEN CONSTRUCTION CODE

A Dissertation

Presented to

The College of Graduate and Professional Studies

College of Technology

Indiana State University

Terre Haute, Indiana

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

---

by

Aaron D. Sauer

May 2013

Keywords: technology management, innovation diffusion, sustainable construction

International Green Construction Code

COMMITTEE MEMBERS

Committee Chair: Ronald C. Woolsey, Ph.D.

Graduate Coordinator, School of Technology

University of Central Missouri

Committee Member: Bradford Sims, Ph.D.

Dean, College of Technology

Indiana State University

Committee Member: David McCandless, Ed.D.

Associate Professor, Construction Management

University of Central Missouri

ABSTRACT

Sustainable practice is a prominent issue that is being driven by an array of contemporary concerns. The transition from traditional practices to sustainable design and construction will require action on many fronts. Change must occur in social, economic, and political-legislative spheres. In the design and construction field, a prominent aspect of the political-legislative landscape is building code enforcement. While sustainability is a prominent issue in the construction industry, it is frequently practiced on an elective basis. However, the International Green Construction Code (IGCC), developed by the International Code Council (ICC), will impose mandatory green construction standards in jurisdictions that choose to adopt the code. Building on the existing theories and literature, the problem of the study was to investigate how building code officials' perceptions of key attributes influence their intent to adopt the IGCC. The research design employed an online survey instrument for the collection of quantitative data. A random sample of building code officials from Illinois, Kansas, Missouri and Nebraska participated in the study. The data revealed that code officials' perceptions of relative advantage of the IGCC are the single significant predictor of intent to adopt. The majority of code officials also reported a preference for full adoption of the IGCC as opposed to a trial period where the code could be used on an elective basis. Based on the findings of this study, proponents of sustainable construction practices will be better prepared to promote the application of sustainable building regulations at the local level.

DEDICATION

This dissertation is dedicated to the countless individuals who have supported my academic, professional and personal growth over the past 40 years. The list is long and I apologize that I cannot name each one here.

I am grateful for the teachers and coaches that invest their lives in young people and encourage them to see something greater in themselves. In particular, I would like to thank Marcelle Stumpff Bennett and James Hargrave.

To my father Mike who passed away before I started this journey and my mother Kay, thank you for instilling a solid work ethic and modeling an upright way of living. Thanks also to Granny Pester for your constant support of my many endeavors. My sincere appreciation also goes out to Lynn and Jackie Harmon for their encouragement along the way.

Most importantly, I dedicate this dissertation to my wife Meridith, and my daughters Delaney and Adrienne who have sacrificed more than anyone over the past five years. Thank you for being patient when I was grouchy and for celebrating the little milestones along the way.

ACKNOWLEDGMENTS

I would like to acknowledge the extraordinary commitment of the members of my Dissertation committee, Dr. Ronald C. Woolsey, Dr. David McCandless and Dr. Bradford Sims. Your insight and encouragement is the foundation from which my research is built. I wish to offer a special thank you to Dr. McCandless for always reminding me that there was a light at the end of the tunnel.

I also want to extend my sincere appreciation to my colleagues in the Construction Management program at the University of Central Missouri. Thank you for taking up the slack when I was preoccupied with Doctoral studies. Last, but certainly not least, thanks to my statistics “Coach” Dr. David Kreiner.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

Sustainable practice is a prominent issue in the design and construction industries. In recent years the introduction of sustainable technologies, including both products and processes, has greatly changed the way many projects are developed and constructed. Although there is speculation that the trend towards "green" buildings is a passing fad (Downs, 1972) a diverse array of contemporary concerns including global climate change, corporate accountability, depletion of non-renewable energy reserves, rising energy costs, energy security, environmental deterioration, and environmental health (Fraj-Andrés & Martínez-Salinas, 2007; Kibert, 2008) provide fertile ground for the continued growth of sustainable design and construction practices in the foreseeable future.

The pursuit of sustainable practice in the built environment is not limited to the U.S. According to Kibert, (2008) sustainable development has been a worldwide movement that has been evolving for the last two decades. Similarly, the development and introduction of sustainable building codes is taking place around the world, receiving support from prominent organizations such as the United Nations (Hanna, 2011). Based on a review of the available literature, it could be argued that the U.S. lags behind much of the developed world in establishing and adopting sustainable building codes.

The transition from traditional practices to sustainable design and construction will require action on many fronts. As with other ecological issues, change must occur in social, economic, and political-legislative spheres (Fraj-Andrés & Martínez-Salinas, 2007). In the design and construction field, a prominent aspect of the political-legislative landscape is building code enforcement. In the U.S., building code adoption and enforcement is a process that is carried out at the local level with code officials, elected officials, designers, construction professionals, and the general public as primary constituents.

While sustainability is a prominent issue in the construction industry, it is frequently practiced on an elective basis at the discretion of the building owner with the assistance of the designer and contractor. This is especially true in cities not governed by statewide efficiency and environmental performance standards. However, the International Green Construction Code (IGCC) which was developed by the International Code Council (ICC) will impose mandatory green construction standards in jurisdictions that choose to adopt the code. Based on the widespread acceptance of the ICC model codes and the favorable climate for green construction, it is reasonable to assume that IGCC could have a significant impact on the construction industry within the next ten years.

Statement of the Problem

A wide range of contemporary problems face the design and construction industries. Scarce resources, high energy prices, environmental degradation, and poor indoor environmental quality are some of the issues that are directly related to how we construct and operate the built environment. In response, the fields of sustainable design and construction have emerged with solutions to combat many of these concerns.

While sustainability has gained much momentum in the past decade, the application of green techniques is still practiced to a great degree on an elective basis throughout the U.S. Social factors and economic realities continue to place pressure on non-adopters, pushing forward a gradual shift towards sustainability. However, a combination of social acceptance, economic viability, and legislative action will be necessary for a major transition in the U.S. and around the world (Fraj-Andrés & Martínez-Salinas, 2007).

In March of 2012 the ICC launched the IGCC which establishes minimum standards for environmental performance for new commercial construction and renovation projects. The new code is designed to overlay existing ICC model codes and includes provisions for the application of a wide range of green technologies and sustainable practices. While the IGCC shares many characteristics with existing building rating systems such as the Leadership in Energy and Environmental Design (LEED) standard developed by the U.S. Green Building Council (USGBC), it is unique in its intent to be used as a mandatory building code, not on an elective basis.

As an innovative code offering, the IGCC faces many barriers to adoption. Although the ICC family of model codes has achieved widespread adoption in the U.S., it is unknown to what extent the IGCC will be embraced by local jurisdictions. The adoption of green technologies has been the focus of increased study in recent years. These studies expand on a wealth of research dedicated to the diffusion of technological innovations. Building on the existing theories and literature, the problem of the study was to investigate how building code officials' perceptions of key attributes influence their intent to adopt the IGCC.

Purpose and Significance of the Study

Through the analysis of quantitative survey data, the study examined code officials' perceptions of five attributes of the IGCC. Existing diffusion theory has shown that individual perceptions of innovation attributes can be used to predict the rate of adoption (Rogers, 2003). Individual perceptions of innovation attributes have also been used to predict adoption behaviors and intent to adopt (Bolton, 1980; Labay & Kinnear, 1981; Ostlund, 1974; Ozaki, 2011; Strutton & Lumpkin, 1994). By exploring code officials' perceptions of the IGCC, one can reveal potential barriers to the adoption of the code standard. Based on the findings of this study, proponents of sustainable construction practices will be better prepared to address issues related to strategy formulation and policy development (Rogers). Ultimately this will serve to accelerate the adoption of the IGCC by assisting change agents in promoting the application of sustainable building regulations at the local level.

The significance of research aimed at understanding the diffusion and adoption of sustainable construction codes is tied to the wide range of critical concerns driving the sustainable construction movement and the proven effectiveness of green codes. As was previously stated, some of the concerns driving the sustainable design and construction movement include the global climate change, depletion of non-renewable energy reserves, rising energy costs, energy security and environmental deterioration. Empirical research has shown that the introduction of energy performance standards in building construction can begin to address these concerns. According to Aroonruengsawat, Auffhammer, and Sanstad (2012), the adoption of statewide energy codes has reduced per capita residential electricity consumption up to 4.98% annually. Ultimately, the need to understand the diffusion of green codes and the factors that

influence their adoption can be grounded in research that shows them to be effective in addressing the contemporary concerns facing this generation.

Research Questions

1. How do code officials rate their level of knowledge of the IGCC?
2. What are code officials' preferences towards adopting the IGCC as an elective standard versus a mandatory standard?
3. To what extent do code officials' perceptions of relative advantage influence their intent to adopt the IGCC?
4. To what extent do code officials' perceptions of the compatibility of the IGCC with their current practices and values influence their intent to adopt the IGCC?
5. To what extent do code officials' perceptions of the complexity of IGCC influence their intent to adopt the IGCC?
6. To what extent do code officials' perceptions about the observability of the IGCC influence their intent to adopt the IGCC?
7. What is the relationship of code officials' perceptions of relative advantage, compatibility, complexity, and observability and their intent to adopt the IGCC?
8. To what extent does the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC vary based on the size of a code official's community?

Research Hypothesis

Research questions 1 and 2 will be addressed with descriptive survey data. Research questions 3 through 8 will be addressed via null and alternative hypothesis 1 through 6.

1. H_{01}:$\mu_1 = \mu_2$. There is no statistical significant difference in intent to adopt based on code officials' perceptions of the relative advantage of the IGCC.

   H_{A1}:$\mu_1 \neq \mu_2$. There is a statistical significant difference in intent to adopt based on code officials' perceptions of the relative advantage of the IGCC.

2. H_{02}:$\mu_1 = \mu_{2.}$ There is no statistical significant difference in intent to adopt based on code officials' perceptions about the compatibility of the IGCC with their current practices and values.

   H_{A2}:$\mu_1 \neq \mu_{2.}$ There is a statistical significant difference in intent to adopt based on code officials' perceptions about the compatibility of the IGCC with their current practices and values.

3. H_{03}:$\mu_1 = \mu_{2.}$ There is no statistical significant difference in intent to adopt based on code officials' perceptions of the complexity of the IGCC.

   H_{03}:$\mu_1 \neq \mu_{2.}$ There is a statistical significant difference in intent to adopt based on code officials' perceptions of the complexity of the IGCC.

4. H_{04}:$\mu_1 = \mu_{2.}$ There is no statistical significant difference in intent to adopt based on code officials' perceptions of the observability of the IGCC.

   H_{A4}:$\mu_1 \neq \mu_{2.}$ There is a statistical significant difference in intent to adopt based on code officials' perceptions of the observability of the IGCC.

5. H_{05}: $\beta_j = 0$. There is no statistical significant relationship for intent to adopt the IGCC based on code officials' perceptions of relative advantage, compatibility, complexity, and observability.

H_{A5}: $\beta_j \neq 0$. There is a statistical significant relationship for intent to adopt the IGCC based on code officials' perceptions of relative advantage, compatibility, complexity, and observability.

6. H_{06}: $\Delta\beta_j = 0$. There is no statistical significant change in the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC based on the size of a code official's community.

   H_{A6}: $\Delta\beta_j \neq 0$. There is a statistical significant change in the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC based on the size of a code official's community.

Limitations and Assumptions

For the purpose of this study, the following limitations and assumptions are acknowledged:

1. The participants of this study were limited to jurisdictions that have adopted ICC model codes for new commercial construction and renovation projects.
2. The participants of this study were limited to building code officials which include senior code officials, plan reviewers, and building inspectors.
3. The participants of this study were limited to currently employed building code officials in Kansas, Missouri, Nebraska, and Illinois. The study was further limited to code officials from cities with a population of 5,000 or more inhabitants from the 2011 U.S. Census Bureau estimates.
4. The scope of the study was limited to the perceptions of building code officials and did not consider additional organizational factors that may influence the intent to adopt the IGCC.

5. The study was limited by the degree of reliability and validity of the survey instrument.
6. It was assumed that respondents would correctly interpret questions, answer questions honestly, and base answers on careful thought without influence of recent events as they completed the survey instrument. In addition, it was assumed that anonymity would negate respondent's inclination to respond in a manner that was socially desirable to improve their self-presentation.
7. It was assumed that respondents were able to separate their personal perceptions related to the IGCC from how they believed building owners and other design and construction constituents perceived the IGCC.
8. It was assumed the results of the study represent only the period of time from which the survey data was collected. Therefore, while inferences can be made about the population, they are limited to the period of time from when the survey data was collected.
9. The external validity of a study is greatly influenced by obtaining a representative sample of the population. While randomization was used in selecting the study participants, the researcher assumes that the external validity was not influenced by low response rates where respondents may not accurately represent the selected sample (Leedy & Ormrod, 2005; Rogelberg & Luong, 1998).

Definition of Key Terms

The following terms are used throughout the study. Some terms are used in a context that is unique to the study of technology diffusion and the IGCC. Where appropriate, operational definitions have been provided along with the associated reference information.

Adoption. According to Rogers, adoption is "a decision to make full use of an innovation as the best course of action" (2003, p.21). For the purpose of this study, the term "full use" can

be applied to an innovation in its entirety, or only select facets of an innovation. Innovations such as the IGCC have many facets, some of which may not be applicable to all jurisdictions based on regional conditions. Therefore, adoption can be applied to the full or partial use of the IGCC.

Building Codes. Formalized building rules that are adopted by ordinance at the local level. They "provide reasonable controls for the design, construction, use, occupancy and maintenance of buildings and their facilities and various components" (ICC, 2007, p.10). The term building codes will be used synonymously with building regulations, building rules, and building standards.

Built Environment. Refers to all "human made space in which people live, work, and recreate on a day to day basis" (Roof & Oleru, 2008, p.24). In reference to design and construction the term includes the traditional concept of buildings and incorporates parks, neighborhoods, transportation channels and other man-made endeavors.

Compatibility. "The degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of potential adopters" (Rogers, 2003, p.240).

Complexity. "The degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers, 2003, p.257).

Continuous Innovation. An innovation that has a minimal influence on existing patterns of use and consumption. Continuous innovations typically involve an existing product that is altered or expanded (Robertson, 1971).

Diffusion. The "process in which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas" (Rogers, 2003, p.5).

Discontinuous Innovation. A previously unknown idea, practice or object that requires the establishment of new patterns of consumption and use. (Robertson, 1971).

Innovation. An innovation is "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers 2003, p.12).

International Code Council. The International Code Council (ICC) is a non-governmental member based association that collaborates in the design of model codes and standards for the built environment.

International Green Construction Code. The International Green Construction Code (IGCC) is a model code created by the ICC that establishes minimum sustainability measures for new commercial construction and renovation projects. The code is intended to increase building efficiency, reduce waste, and promote health and safety for the construction workforce and building occupants.

Leadership in Energy and Environmental Design Standard. The Leadership in Energy and Environmental Design (LEED) standard is a framework for the sustainable design, construction, operation and maintenance of facilities. Developed by the USGBC, the standard is practiced on an elective basis by owners. Although not mandatory, independent third party verification is available for projects that follow the standard ("USGBC – What is LEED", 2012).

Observability. "The degree to which the results of an innovation are visible to others" (Rogers, 2003, p.258).

Overlay Code. An overlay code is designed to nest with existing model code instruments. The format of overlay codes align with existing codes and their adoption does not require modification to existing codes.

Relative Advantage. "The degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers, 2003, p.229).

Sustainability. Sustainability is a concept that encompasses a wide range of social, economic and environmental issues. At the core of sustainability is the concept of responsible stewardship. It incorporates systems that meet the needs of the present without compromising the quality of life for future generations and their ability to meet their own needs ("United Nations – Our Common Future", 1987).

Sustainable Building Code. A sustainable building code is the codification of sustainable practices for use in regulating the design and construction of the built environment.

Sustainable Construction. Sustainable construction is the application of sustainability principles to the construction, renovation and maintenance of facilities. The term "sustainable construction" will be used synonymously with the terms green building, green construction.

Sustainable Design. Sustainable design, also known as ecological design, describes the "application of sustainability principles to building design" (Kibert, 2008, p.9).

Trialability. "The degree to which an innovation may be experimented with on a limited basis" (Rogers, 2003, p.258).

Technology. "A system based on the application of knowledge, manifested in physical objects and organizational forms for the attainment of specific goals" (Volti, 1995, p.6).

U.S. Green Building Council. The U.S. Green Building Council (USGBC) is a not for profit organization that promotes sustainable and energy efficient buildings and communities. The USGBC maintains the LEED standard; facilitates third party verification of LEED projects; provides education and credentials for design and construction professionals; and engages in advocacy to support the diffusion of sustainable practices ("USGBC – About USGBC", 2012).

Summary

The transition to sustainable construction practice presents both challenges and opportunities for the design and construction industries. Sustainable innovations are not unique in that they must overcome significant barriers to achieve widespread diffusion and full market acceptance. However, they may hold the key to addressing many of the ecological, political, and social concerns facing the current generation.

In March of 2012 the ICC introduced the IGCC, an innovative sustainable building code standard. Designed to overlay the existing family of ICC building codes, the IGCC provides a framework for enforcing environmentally friendly design, construction, and operation of new commercial construction and renovation projects. Although the ICC model codes have enjoyed widespread adoption throughout the U.S. it is unknown to what extent and how rapidly the IGCC will be adopted by cities. Although the code adoption process includes many constituents at the local level, code officials stand out as key influential figures.

The existing literature shows that an individual's perceptions of certain attributes of an innovation can be used to predict adoption behavior (Bolton, 1980; Labay & Kinnear, 1981; Ostlund, 1974; Ozaki, 2011; Strutton & Lumpkin, 1994). Through the application of diffusion theory, the purpose of this study was to collect and analyze code official's perceptions of the IGCC in relation to their intent to adopt the code. By understanding how code official's perceptions influence their intent to adopt, change agents and proponents of sustainable construction practice will be better prepared to support the diffusion process.

Chapter One provided an introduction by stating the problem and reinforcing the purpose and significance of the study. The central research questions and associated research hypothesis

were also stated along with limitations, assumptions and a definition of key terms. Chapter Two will continue with a review of related literature and an exploration of key variables of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

Although they hardly resemble modern model building codes, the history of codes dates back thousands of years. Hammurabi, founder of the Babylonian Empire established a code of law that included provisions for the enforcement of building performance standards in approximately 2000 B.C. (International Code Council (ICC), 2007). The code of Hammurabi states that "if a builder has built a house for a man and his work is not strong, and if the house he has built falls in and kills the householder, that builder shall be slain" (ICC, p.9). The historical record shows that in 64 A.D., the burning of Rome destroyed much of the cities private residences. Following the conflagration, Emperor Nero set out principles of construction for "fire resistance, sanitation, and usefulness" that were carried out for the balance of the Roman Empire (ICC, p.3.)

In addition to the burning of Rome, history records many similar conflagrations such as the great fire of London in 1666 and the Chicago fire of 1871 that drove the creation of improved building codes and standards (Yatt, 1998). The extensive loss of life and property associated with irresponsible building practices points to the need for building laws. According to the ICC "it would be proper and safe to say that lives and property have been lost because of their absence" (2007, p.4). Sustainable construction codes have emerged in an era of increased ecological awareness and concerns over our very survival as living organisms on earth. While the growth of

traditional building codes has sprung from disaster and tragedy, one can hope that the transition to sustainable building practices will not require a similar catastrophe.

Building codes protect the public by establishing minimum standards of performance. According to the ICC, their primary intent is to "provide reasonable controls for the design, construction, use, occupancy and maintenance of buildings and their facilities and various components" (2007, p.10). The authority to adopt and enforce building codes is delegated to the states as a police power within the United States Constitution. In turn, each state has the authority to delegate this police power to local communities (Yatt, 1998).

Code Adoption Process

In municipalities that are not subject to statewide building regulations, the adoption of building codes is carried out by local elected officials. Elected officials serve the needs of their constituents and the overall jurisdiction in part by enacting ordinances, including building codes. In contrast, code officials are technical professionals who are appointed to carry out code enforcement (ICC, 2007). Code officials do not determine what codes a jurisdiction will follow, but they do provide support to elected officials who may have little knowledge of building rules. Therefore, while the agenda for building code adoption and revision is ultimately set by the elected officials (Building Officials & Code Administrators International, 1993), it is influenced by the code official who provides technical input and guidance related to building code measures.

Prior to adoption, new building codes are typically reviewed in collaborative process by an appointed board that includes code officials and other stakeholders including design professionals, contractors, building owners and representatives of the general public. The review process may also include a series of public hearings to receive input from those not chosen to

serve on the board. As the previous paragraph points out, code officials are not solely responsible for the code adoption process. However, their contributions as a technical expert who supports elected officials through collaboration with other code enforcement stakeholders sets them apart as a critical variable in the transition to sustainable building codes.

Sustainable Code Adoption in the U.S.

A discussion of sustainable building code adoption in the U.S. would be incomplete without a summary of the current state of affairs. For the purposes of this section, energy codes such as the International Energy Conservation Code (IECC) and ASHRAE 90.1 will be considered as a form of sustainable building code. However, it is necessary to recognize that the scope of the IGCC is much greater than building energy performance. It encompasses sustainable site practices, water conservation, indoor environmental quality and a host of other concerns. Therefore, the statewide adoption of a building energy code should not be considered as comparable to the adoption of the IGCC or similar code standard.

The first impression of anyone investigating trends in sustainable code adoption is the lack of uniformity found across the country ("Online Code Environment and Advocacy Network – State and federal policy", 2012). The Energy Policy Act of 1992 requires each state to establish energy standards for commercial building and to consider the adoption of residential energy code standards when appropriate. However, it does not attempt to standardize which energy codes are used and to what extent they are adopted. In the absence of a national mandate, each state has made unique progress towards promoting sustainable practice in the built environment. The Online Code Environment and Advocacy Network (OCEAN), hosted by the Building Codes Assistance Project (BCAP) provides interactive maps that reflect up to date information on the

status of energy code adoption for each of the 50 states. Based on the OCEAN website, the energy code adoption status for each state surveyed in this study will be summarized:

Illinois – The state of Illinois has adopted the 2009 IECC for residential projects and privately funded commercial projects. The 2007 ASHRAE 90.1 standard has been adopted for publically funded commercial buildings ("OCEAN - Illinois Energy Conservation Code", 2012).

Kansas – At present, Kansas has no statewide energy code requirements. Jurisdictions may voluntarily choose to adopt the 2006 IECC code if desired ("OCEAN – Kansas Commercial Building Code", 2012).

Missouri – At present, Missouri has no statewide residential or commercial energy code. Public buildings must adhere to the 2006 IECC ("OCEAN – Missouri", 2012).

Nebraska – The state of Nebraska has adopted the 2009 IEEC for residential and commercial building construction. For commercial buildings, the 2007 ASHRAE 90.1 standard is an allowable alternate path to compliance. All state buildings must comply with the 2009 IECC. Administrative amendments do apply to each code standard ("OCEAN - 2011 Nebraska Energy Code", 2012).

Although the Energy Policy act of 1992 requires states to adopt energy codes for commercial building, deadlines for adopting codes can be extended if a state shows it is making good progress towards adoption. As a result, some states, such as Kansas and Missouri, have not met the requirement. While Kansas and Missouri do not have statewide energy code standards, it does not mean that individual jurisdictions have not voluntarily adopted energy standards. As was previously noted, the ICC family of model codes has been widely adopted by local jurisdictions. Starting in 2000, the International Building Code (IBC) has referenced the IECC as part of the code standard. Therefore, when adopting the 2000 IBC or subsequent editions, some

jurisdictions have adopted the IECC by default. However, others have chosen to specifically strike this reference from their ordinances.

Development of the IGCC

The IGCC is a set of building rules that are designed to increase sustainable performance for commercial buildings. It is written in the form of a model building code which overlays the existing code offerings by the ICC. Unlike other green building standards such as LEED, the IGCC is designed to be a building rule, not an elective measure to certify building performance. Therefore, in jurisdictions where the code is adopted as code, either in full or as modified by the jurisdiction, all commercial building renovation and new construction projects must adhere to requirements set forth in the IGCC.

The official launch of the development of the IGCC was announced on June 29, 2009 ("ICC – News Release, June 29", 2009). Code development was a collaborative venture including representatives from the American Institute of Architects (AIA) and the American Society for Testing and Materials (ASTM). The code also recognizes American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 189.1 as an alternate path to compliance (Owens, 2010). The code development process included a series of public hearings and allowed for public comments in the development of the initial and final draft. Following voting at the final action hearing, the first official publication of the IGCC was made available in March 2012.

Innovation, Technology and Building Codes

To understand the challenges associated with the diffusion of the IGCC it is first necessary to frame the code as a type of innovation. As was previously stated, an innovation is "an idea, practice, or object that is perceived as new by an individual or other unit of adoption"

(Rogers, 2003, p.12). Within that definition, the application of the IGCC can best be described as a practice, the practice of sustainable techniques as required by the code. Rogers points out that the term "new" can have many connotations. An innovation can be objectively new as measured in time from its discovery or first use. However, an innovation may be in existence for a long time before individuals gain knowledge of it. Therefore, newness is a characteristic related to the perceptions of each individual. However, in the case of the IGCC, the fact that it was first released in March of 2012, objectively close to the time of this study, leaves little question about it being a new practice.

Although unique, the terms innovation and technology are often used as synonyms. This may be related to the application of concept of "newness" to both terms. By definition, innovations are new ideas, practices, or objects (Rogers, 2003), and in contemporary culture, the use of the term technology often implies something that is new or cutting edge.

The term technique, used in a previous paragraph to relate the IGCC to the practice of sustainable methods, shares its origin with the Greek root for the word technology. Whereas a technique can be defined as "a body of technical methods" (Merriam Webster, 2003, p. 2348), technology is "the science of the application of knowledge to a practical purpose" (Merriam Webster, p. 2348). Contemporary scholars have further refined and expanded the definition of technology. As was previously stated, technology can be defined as "a system based on the application of knowledge, manifested in physical objects and organizational forms, for the attainment of specific goals" (Volti, 1995, p.6). Technology is often described in terms of hardware and software (Rogers, 2003). Within Volti's definition, the hardware of technology is referred to as physical objects and the software is the organizational forms. Based on Volti's definition, the IGCC provides an ideal example of technology where the code combines the use

of physical objects (insulation, solar panels, grey water systems, etc.), with organizational forms (the framework of the IGCC code, storm-water management practices, networks of design and construction professionals) for the attainment of a sustainable built environment.

A Primer to Innovation Diffusion

The diffusion of new innovations is typically a slow process with no guarantee for success. History includes many examples where superior technologies were available long before their widespread adoption. Rogers (2003) describes how scurvy remained an epidemic in the British Navy for nearly two hundred years although doctors knew from an experiment conducted by Captain James Lancaster that three teaspoons of lemon juice per day for each sailor would eradicate the deadly condition. According to Rogers, "idea only" technologies, (such as the IGCC) diffuse even more slowly due to a low degree of observability.

However, some innovations are able to overcome resistance and gain acceptance at an accelerated rate. A recent example of a technology with rapid uptake is the internet where approximately 71% of adults in the U.S. adopted the technology between 1989 and 2002 (Rogers, 2003). The value in understanding the innovation diffusion process has been recognized by policy makers, marketing professionals, and technology experts. Curiosity of the factors that influence the adoption process has led to a significant body of research in the field.

Diffusion of Innovations in Organizations

A significant amount of research has been dedicated to understanding the diffusion and implementation of technological innovation. Early studies in this field focused primarily on individuals and their innovation characteristics. Techniques used to study individual behaviors were then applied to organizational settings as interest in organizational innovation grew (Rogers, 2003). Over time, however, researchers have developed dedicated theories that consider

the unique characteristic found in organizational environments. In recent years, the primary focus of research has been focused on how to make organizations more innovative. However, the innovation adoption process within organizations is discussed by Zaltman, Duncan, & Holbek (1973), Rogers (2003) and others.

According to Rogers (2003, p.404) "an organization is a stable system of individuals who work together to achieve common goals through a hierarchy of ranks and a division of labor… they handle large-scale routine tasks through a pattern of regularized human relationship". Although somewhat less stable due to election cycles for certain officials, the definition of an organization clearly applies to the general environment for most local governmental jurisdictions. Within local jurisdictions, the adoption of a new code can be classified as a collective innovation-decision (Rogers 2003). In collective innovation-decisions, the choice to adopt is made by a consensus of members within the organization. It is important to note that as a collective innovation-decision, adoption of new codes is not at the sole discretion of the code official. Therefore, the following paragraphs will review selected literature dedicated to organizational innovation.

Early studies showed that organizations share many similar characteristics with individuals in the adoption and implementation of innovations (Rogers, 2003; Zaltman et al., 1973). Both individuals and organizations follow a similar stage model in the innovation decision and implementation process. Individuals and organizations are also similar in that larger organizations (those with greater resources) and individuals with larger incomes tend to be more innovative than their counterparts with fewer resources (Rogers).

However, organizations also have unique characteristics that influence their innovation behaviors. They include individual leader characteristics, internal characteristics of

organizational structure, and external characteristics of the organization (Rogers, 2003). Leaderships' attitude towards change can impact the adoption of new innovations. Internal characteristics of organizational structure include centralization, complexity, formalization, interconnectedness, and organizational slack. Centralization is the degree to which a small number of individuals control the organization. Highly centralized organizational structures have a negative impact on adoption. Complexity deals with the level of knowledge or expertise of the organizations members. Complexity is shown to have a positive effect on adoption of innovation. Formalization deals with the how strictly an organization is tied to rules and procedures and can have a negative impact on adoption. Interconnectedness describes the flow of information within social systems. Where communication and social systems support the free flow of information and ideas, there is a positive relationship to innovation adoption. Organizational slack describes the availability of uncommitted resources in an organization. This variable that is closely related to an organization's size is a positive indicator of adoption. Organizations that exhibit external characteristics of system openness are shown to be more open to adopting innovation than isolated organizations. While the previous variables may have a positive or negative influence on the adoption of a new innovation, they can have an opposite effect on the actual implementation of an innovation. According to Zaltman et al. (1973), low centralization, high complexity, and low formalization may have a positive influence on the adoption of new innovation, but they may also serve as barriers to implementation.

An important variable frequently found in organizational innovation research is that of the innovation champion. According to Rogers (2003, p.414) an innovation champion "is a charismatic individual who throws his or her weight behind an innovation, thus overcoming indifference or resistance that the new idea may provoke in an organization". The importance of

innovation champions should not be overlooked because of their critical role in both the adoption and implementation of new innovations. According to Schön (1963, p.84) “The new idea either finds a champion or dies”.

As was previously stated, organizational innovation follows a sequence that researchers have described with a stage model. Figure 1 shows the five stages in the adoption and implementation of an innovation within an organization as proposed by Rogers (2003, p.421). For the purpose of this study, the primary focus will be on the first two stages, agenda-setting and matching, which conclude with the decision to adopt an innovation. The three stages following the decision to adopt are redefining/restructuring the innovation and the organization, clarifying the relationship between the innovation and the organization, and routinizing the innovation to support continued use.

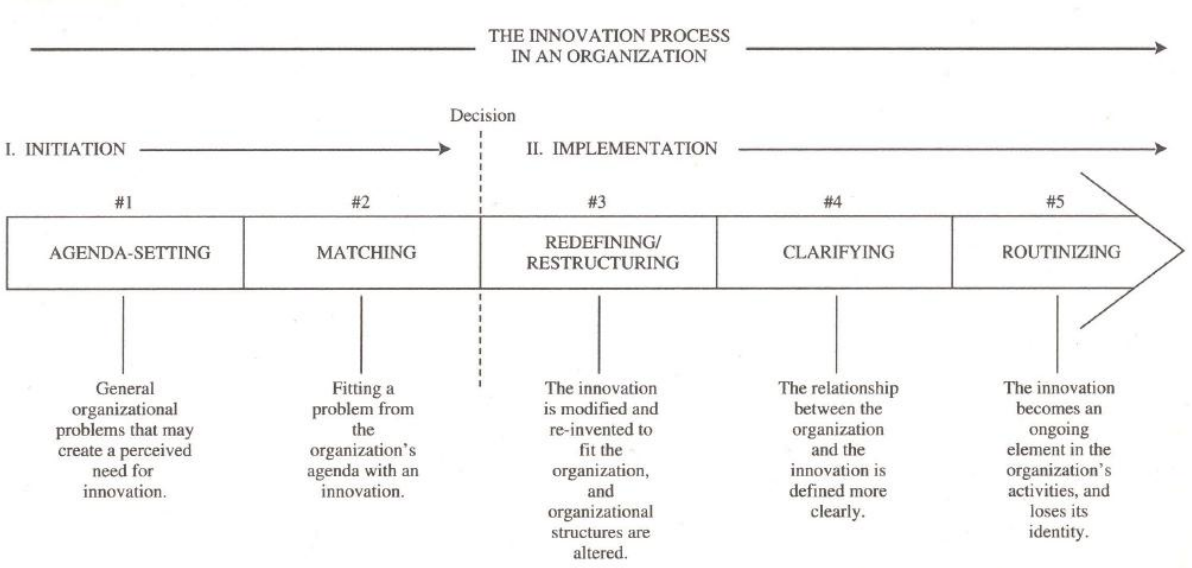

Figure 1. Stages of adoption in organizations.

In Rogers (2003) first stage, agenda-setting, problems and opportunities facing the organization are considered and a search is conducted to identify possible solutions for those demands. Zaltman et al. (1973) refer to these problems and opportunities as the performance gap.

In the second stage, matching, innovations are matched with problems and opportunities to determine the best fit. This stage is of critical importance as only innovations with a proper fit are able to survive the implementation stages (Goodman & Steckler, 1989). Following the second stage is the adoption decision. A positive decision to adopt moves the organization into the redefining/restructuring stage where the organization and the innovation undergo changes to improve the overall fit. The redefining/restructuring stage typically occurs on a limited scale and is followed by the clarifying stage where the innovation is introduced across the organization. In the redefining stage, the organization as a whole makes sense of the innovation and integrates it with the social system. Rogers' fifth and final stage is routinizing where the continued use of the innovation is reinforced.

Similar to the Rogers model, Zaltman et al. (1973) also proposed a five stage model for the innovation process within organizations. In the first stage, the organization must gain awareness and knowledge of the innovation. A thorough discussion of the importance of knowledge in the innovation adoption process is described in the following section. In the second stage, individuals within the organization form attitudes towards the innovation. Here is where individual perceptions of the attributes of the innovation play a critical role. Zaltman's focus in the second stage is on two types of attitudes towards the innovation, openness to the innovation and perceptions of potential for innovation. Openness to the innovation addresses members overall attitude towards change, which is greatly influenced by the leadership of the organization. Openness is also influenced by member's perceptions of relative advantage and how the innovation will benefit the organization. Member's perceptions of potential for innovation speak to the attributes of compatibility and complexity. If an innovation is too complex or dramatically different from current practice, members may form negative attitudes.

In Zaltman's third stage, organizations combine their knowledge and attitudes to form a decision. A favorable decision to adopt moves the organization into the fourth and fifth stages which are initial implementation and continued-sustained implementation of the innovation.

Although they are different, the organizational innovation models proposed by Rogers and Zaltman et al. share several common themes. Both initiate the innovation process with some form of a performance gap. Organizations either seek out innovations to address their needs or apply knowledge of innovations to create opportunistic improvement (Wildemuth, 1992). Initial knowledge of the innovation is essential in developing an overall awareness and additional knowledge forms the basis for some attitudes about the innovation. Both researchers focus on the attributes of innovations and individual perceptions of those attributes as a central component of the adoption decision process. Beyond the decision to adopt, both researchers also emphasize the importance of the implementation stages in the successful adoption of an innovation.

The previous paragraphs provide an overview of selected publications in the vast field of organizational innovation. Because the code adoption process takes place within an organizational setting, it is necessary to reflect on potential organizational influences. However, the focus of this study is the code official as an individual. Code officials play a unique role in the adoption of new building rules. According to Zaltman et al. (1973, p.13), "those factors influencing individual perceptions of innovation directly or indirectly influence the organization's perception". While they do not control the decision to adopt, they serve as the resident technical expert in support of the decision making body. In this capacity they can contribute greatly to the agenda setting stage in the innovation process. According to Walker (1977), "Those who manage to shape the legislative agenda… are able to magnify their influence many times over by determining the focus of attention and energy". In addition to agenda setting,

the code official can provide support in the matching stage of the innovation, thus further shaping the adoption process. Code officials are also uniquely positioned to act as an innovation champion for new building regulations such as the IGCC. In contrast, code officials can also act as a barrier to the adoption of new codes. Therefore, because code officials can play a critical role in the adoption of new building regulations, it is important to understand how their perceptions influence their intent to adopt the IGCC.

Diffusion of Innovation for Individuals

Many scholars have proposed frameworks to describe the innovation and adoption process for individuals. One of the most recognized is the five stage innovation-decision process model by Rogers (2003), which is included as Figure 2. The five stages include knowledge, persuasion, decision, implementation and confirmation. For the purpose of this study, the primary focus will be on the first two stages which lead up to the innovation adoption decision.

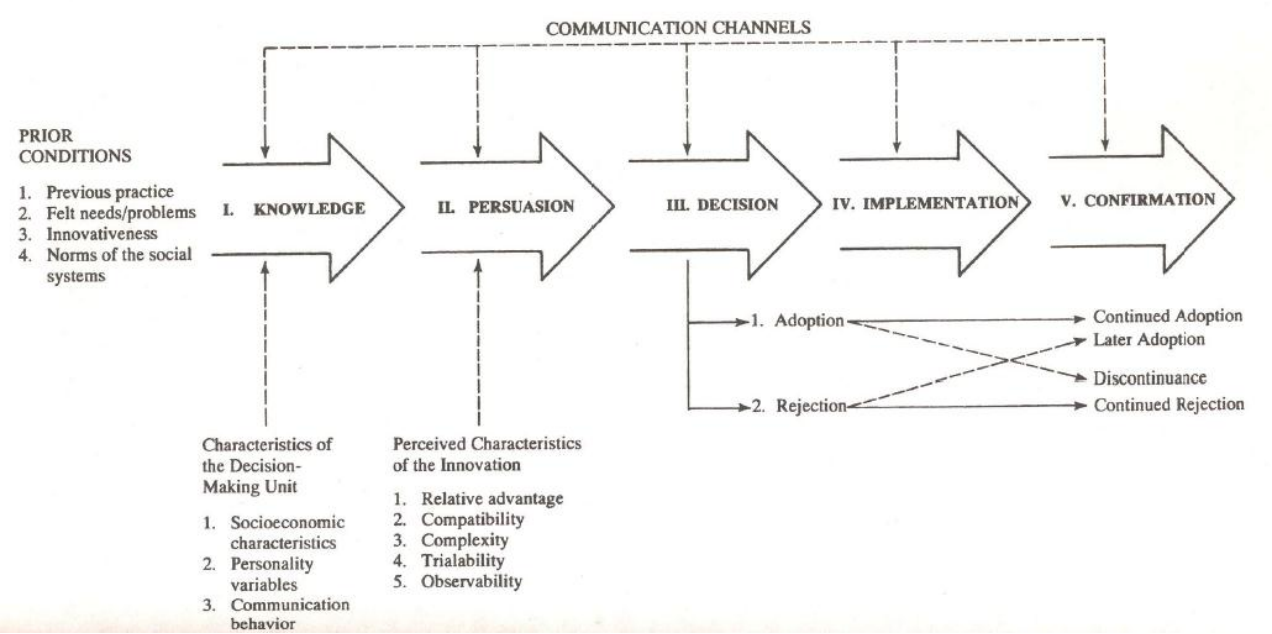

Figure 2. Stages of adoption for individuals.

In the first stage, individuals gain knowledge of an innovation's existence and how it functions (Rogers, 2003). By gaining knowledge, an individual is able to reduce uncertainty (which equates to risk) prior to the adoption decision. The importance of the information stage in the intent to adopt an innovation should not be overlooked. At the most elemental level, an individual cannot choose to adopt an innovation if they do not know if its existence. Beyond the initial knowledge of an innovation, individuals may choose to seek out additional knowledge which becomes the basis for forming an attitude towards the innovation. Rogers refers to knowledge beyond awareness of an innovation as "how to" and "principles" knowledge (Rogers, p.173). Individuals first seek to know how an innovation is used and may eventually wish to understand the underlying principles that allow the innovation to work.

The primary focus of this study was to determine how code officials' perceptions of the IGCC influence their intent to adopt. An explanation of the attributes of innovations that influence the rate of adoption is provided in the following paragraphs. However, it is important to note that code officials cannot form perceptions of the IGCC without some level of awareness and working knowledge of the code. Therefore, it was necessary to collect data on how knowledgeable code officials were of the IGCC.

In Rogers' (2003) second stage, individuals form attitudes, either favorable or unfavorable, about the innovation based on the knowledge they have gained. An individual is persuaded (either positively or negatively) based on how they interpret what they have learned about the innovation based on their past experience and influences from their social system. In the persuasion stage, individuals form perceptions about an innovation which ultimately become the basis for their innovation adoption decision. However, it is important to note that just because an individual has a generally positive attitude towards an innovation, it does not always translate

into a positive decision to adopt. Rogers refers to this as the "KAP-gap" (Rogers, p.176). Here, a disconnect forms between knowledge, attitudes and practices. The KAP-gap is a phenomenon that occurs frequently with sustainable innovations (Ozaki, 2011).

Individuals form attitudes towards innovations on many levels. Defining the attributes of innovations that influence the decision to adopt has been the focus of much research. Based on an extensive review of existing innovation adoption literature, Rogers (2003) identified five attributes of innovations that can be used to explain about half of the variance in the rate of adoption. They include relative advantage, compatibility, complexity, trialability and observability. The following paragraphs will discuss Rogers' five attributes of innovations and discuss how they relate to the intent to adopt the IGCC

Relative Advantage

Relative advantage is the measure to which an innovation is perceived to be better than its alternatives or the idea it supersedes (Rogers, 2003). Studies on relative advantage show that it is one of the strongest predictors of the rate of adoption for a new innovation. It can be considered in terms of a ratio of cost (financial, social, etc.) to the expected benefits of an innovation. Sub-dimensions of relative advantage include "economic profitability, low initial cost, a decrease in discomfort, social prestige, a saving of time and effort, and immediacy of reward" (Rogers, p.233). The following paragraphs will explore the sub-dimensions of relative advantage in respect to the IGCC.

Because the IGCC is an idea only regulatory innovation, relative advantage in terms of economic factors is not immediately apparent. Although they are subject to budgetary constraints, economic profitability is not a consideration for most code officials. However, it is reasonable to assume that economics could influence code officials' perceptions of the relative

advantage of the IGCC. From a fiduciary perspective, code officials may perceive a long term economic benefit for building owners resulting from improved building performance. In contrast, the perception of higher initial costs for owners may have a negative influence on perceived relative advantage. A final economic consideration could be the initial cost of implementation for the local jurisdiction.

According to Rogers (2003, p.229) "The nature of the innovation determines what specific type of relative advantage is important to adopters". Based on that statement, the subdimensions of decreased discomfort and saving time and effort do not appear to be applicable to the IGCC, except in relation to perceived complexity which will be discussed at a later time.

Because sustainability is a significant contemporary topic, it is reasonable to assume that social prestige could influence code officials' perceptions of the IGCC. Code official's wishing to differentiate themselves from other jurisdictions and promote a pro-sustainability image may have a positive perception of the IGCC. External pressure from the community or from peers in code enforcement may also influence code officials' perceptions of the IGCC based on social factors. These regional attitudes towards sustainability and regulation could have a positive or negative impact on perceived relative advantage.

Rogers (2003) presents the concept of a preventive innovation which is a new technique that can be adopted to prevent some future consequence. Preventive innovations face slow adoption rates because of the delayed benefit (if any) which speaks to the immediacy of the reward for adoption. Because it is unknown to what extent the adoption of the IGCC will have an impact on concerns such as global warming and energy shortages, and because those problems are so large and difficult to overcome (Downs, 1972), there is less of an immediate reward for

those who choose to adopt. In terms of relative advantage, code officials' perceptions of the immediacy of reward (benefit) from the IGCC could influence intent to adopt.

Perceptions of relative advantage may also be influenced by available alternatives to the IGCC. At present, the IGCC is the only sustainable building standard that is designed to overlay the existing ICC family of model codes. However, jurisdictions could choose to develop their own green code or modify certification systems such as the LEED standard.

Compatibility

Compatibility is defined as "the degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of potential adopters" (Rogers 2003, p.240). The more compatible an innovation, the more likely it is to be adopted. Consequently, compatibility can be used to predict the scope and rate of adoption of innovations. Three primary sub-dimensions of compatibility are socio-cultural values and beliefs, previously introduced ideas, and individual needs for the innovation.

Innovations that conflict with socio-cultural values and beliefs have little chance of being adopted, even if they are superior to existing techniques (Rogers, 2003). In terms of the IGCC, the topic of sustainability is a prominent issue in U.S. society. While there are strong opinions in support of and opposed to sustainable construction practices, the concept of sustainable practice and environmental responsibility appears to align with current values and beliefs. There do not appear to be groups advocating for lower building energy performance or more pollution in reservoirs and waterways. However, the concept of increased regulation is an issue that may be in conflict with strongly held values and beliefs in some areas. While some would support the concept of sustainable practice, they may not be in favor of forcing the regulation on the entire

population. Therefore, it was necessary to investigate code officials' perceptions of socio-cultural compatibility with the new code.

Previous experiences can also color an individual's perceived value of a new innovation (Rogers, 2003). Arensberg and Niehoff (1964) introduced the concept of innovation negativism and provide the example of Laotian wells in small villages. At first, the wells were a great success and a benefit to the community. However, after a year or two, many of the well pumps were broken and the local people did not have the knowledge or parts to make the required repairs. As a result, the wells ultimately became the "objects of jokes" leaving some to speculate that "it would have been better not to have drilled them" at all (Arensberg & Niehoff, p.125). If a similar innovation was adopted and met with failure in the past, it could influence the adoption of future opportunities. This could be a significant issue for the diffusion of the IGCC in that many people remember the green revolution of the 1970's which faded away with little lasting change. Therefore, in the context of compatibility, it was necessary to investigate code officials' perception of the code in light of their previous experience with sustainability efforts.

The final sub-dimension of compatibility relates to the overall need for the innovation. According to Rogers (2003, p.246) "When felt needs are met, a faster rate of adoption usually occurs". In the case of the IGCC, if code officials do not believe there is a strong need for sustainable regulations, there will be little motivation to pursue adoption. When considering the perceived need for green codes, it is necessary to separate the influence of mandates on the code official. According to BCAP, Nebraska and Illinois have adopted minimum statewide energy performance standards and Kansas and Missouri have not. Therefore, for code officials in Nebraska and Illinois, there will be some degree of perceived need for sustainable codes as a

result of the state mandate. When collecting perceptions on the need for the IGCC, it was necessary to consider the possible influence of state mandates.

Complexity

According to Rogers (2003, p.257), "The complexity of an innovation as perceived by members of a social system is negatively related to its rate of adoption". The personal computer and cellular telephone are innovations whose adoptions were greatly influenced by their perceived complexity. While the personal computer resembled a typewriter, it functioned much differently, especially when the first machines were introduced. Early adopters were quickly frustrated with computers due to poor technical manuals and weak customer support, contributing to slower adoption rates. Early cellular telephones, however, resembled and operated in the same way as traditional telephones which led to faster rates of adoption (Rogers). Although the IGCC shares many characteristics with existing green standards such as LEED, it is unclear how code officials will perceive its complexity. While the LEED standard is widely used in the U.S., it is primarily a tool for designers and contractors with little or no participation from the code officials. With little previous experience, code officials may perceive the application of the IGCC as highly complex which may lead to slower rates of adoption.

Another consideration is the perceived complexity associated with the adoption any new code standard. Separate from concerns over the IGCC, one would expect some level of apprehension based on the implementation of a completely new or significantly modified existing standard. This apprehension may have an influence on a code official's intent to adopt.

Trialability

Trialability refers to the degree to which an innovation can be applied and explored on a limited basis. According to Rogers (2003), innovations that can be used for a trial period adopt

more rapidly than those that are not divisible for trial. The trial process is important because users are able to create their own meaning for an innovation and re-invent it to match their individual needs (Rogers).

Based on the scope of the IGCC and because it is an idea only innovation that involves the participation of multiple constituents (building owners, design professionals, construction professionals and code officials), the code is not well positioned for trial applications. It would be impractical for code officials to select a small sample of projects to apply the IGCC on a trial basis. However, the ICC reports that many jurisdictions have adopted the IGCC as an elective standard as opposed to a mandated regulation ("ICC – News Releases", 2012). This phenomenon may be a means for jurisdictions to experiment with the code to re-invent it to meet their unique needs prior to full adoption.

Because the concept of trialability does not fit with the code adoption process, it provides little value as a variable in predicting intent to adopt. Incorporating the concept into a survey instrument would likely confuse respondents which could influence their participation on the balance of the survey. However, collecting perceptions on trialability in the form of descriptive statistical data would be of value in understanding the use of elective code standards in the transition process to mandated sustainable building codes. Therefore, the issue of trialability and the transition to sustainable regulations was explored through descriptive survey analysis.

Observability

Innovations that are difficult to observe and communicate to others diffuse slower than easily observed innovations (Rogers, 2003). Technologies that manifest themselves as a physical object, such as a new construction tool, are highly observable. Potential adaptors can see the new innovation and watch how it performs in practice. Less observable innovations such as new

software or systems or management practices are less visual and require more conceptualization on the part of potential adopters. This ultimately leads to slower rates of adoption.

As an idea only innovation, the IGCC is likely to display a low level of observability for potential adopters. However, it was unknown how the perceived observatiblity would influence code officials' intent to adopt. The adoption of any new code would involve similar low levels of observability. In that sense, the IGCC is no different from a new plumbing or life safety code standard. Based on the nature of code officials' responsibilities and the code adoption process, low levels of observability may not have a significant impact on intent to adopt. Therefore, it was necessary to consider how perceptions of observability influence code officials' intent to adopt the IGCC.

Innovation Theory in Practice

The foundational theories of Rogers (2003) and Zatman, Duncan & Holbek (1973) have been in publication since the late 1960's. Since that time, many studies have been completed that apply the innovation diffusion stage models and perceived attributes of innovations in predicting adoption behaviors. The following paragraphs will discuss research related to this area of specialization.

One of the first notable studies to use an individual's perceptions of the attributes of innovations to differentiate between adopters and non-adopters was conducted by Ostlund (1974). According to Ostlund, prior to the application of perceptual attributes, innovation studies primarily relied on personal characteristics of the innovator to predict adoption behavior. In addition to Rogers five attributes, Ostlund investigated the personal characteristics of "venturesomeness, cosmopolitanism, social integration, social mobility, privilegedness, interest polymorphism, general self-confidence (self-esteem) in problem solving and psychosocial

matters, family income, respondent education, social status of the husband's occupation, and respondent age" (Ostlund, p.24). The focus of the study was an innovative self-layering desert mix and the population was Boston area housewives. Two discriminant models were compared, one that included both perceived attributes and personal characteristics, and one that used perceived attributes alone. The results showed that the combined model correctly identified 80% of the validation sample group. However, using perceptual attributes alone correctly identified 79% of respondents, a minimal decrease of 1%. Further investigation showed only the personal characteristic of venturesomeness and family income were statistically significant. Based on the results, Ostlund concluded that perceived attributes were strong predictors of innovative behavior (purchase of new products) and that personal characteristics under investigation had little to offer in the discriminant function. Ostlund also reported the rank order of the importance of the perceived characteristics starting with relative advantage, compatability, complexity, observability and trailability. Relative advantage and compatability were by far the strongest predictor factors. In closing, Ostlund provided valuable insight on addressing methodological difficulties that could bias study findings. The studies conducted by Ostlund collected perceptions after the innovation adoption decision had been made contributing to potential "post decision dissonance" (p.29). To avoid this concern, researchers have measured an individual's intent to adopt an innovation (Bolton, 1980; Ozaki, 2011), prior to an adoption decision. However, it must be acknowledged that intent to adopt does not always translate into adoption behavior (Ozaki).

Bolton (1980) applied diffusion theory in the study of emerging internet technologies. The innovation under investigation, Channel 2000, allowed trial users to access the local library, a computerized encyclopedia, a community calendar and home banking services through their

television set over a telephone line connection. In addition to investigating perceptions of innovations attributes (relative advantage, compatability, complexity, trailability, and observability), Bolton also attempted to model intent to adopt based on life style factors, consumer creativity measures and demographic data. The discriminant analysis did show that all five perceptual variables and several of the lifestyle factors including shopping trends, TV usage, banking frequency, computer usage and encyclopedia usage were significant at the univariate level. However, at the multivariate level, only relative advantage and compatibility were statistically significant in predicting potential adoption of the innovation.

In a study conducted in 1994, Strutton & Lumpkin applied Rogers' five attributes to examine differences between discontinuous and continuous innovations. Robertson (1971, p.7) defines a discontinuous innovation as one that is substantially new and "involves the establishment of new consumption patterns". In contrast, a continuous innovation typically involves a modification to an existing product and "has the least disrupting influence of established consumption patterns" (Robertson, p.7). For marketing professionals and change agents, the subtle difference is quite important. The majority of existing studies focused primarily on discontinuous innovations. However, in practice, the majority of innovations presented to the general public are continuous in nature. The author's hypothesized that adoption decisions for continuous innovations, classified as low involvement innovations, would be based on a fewer number of attributes with a divergent emphasis from Rogers five innovation attributes.

In support of the existing literature, Strutton & Lumpkin (1994) found that Rogers (2003) five attributes were good predictors of adoption behaviors based on the discontinuous innovation (self-diagnosis devices). However, adoption behavior for the continuous innovation (generic

drugs vs. name brand drugs) was more accurately predicted based on a fewer number of attributes with emphasis placed on different sub-dimensions of each attribute. The study provides valuable insight for change agents and marketing professionals. In determining a diffusion strategy, it is important to first consider the type of innovation, continuous vs. discontinuous. In regards to the current study, the IGCC is best classified as a discontinuous innovation. Although the code overlays the existing family of ICC model codes, it will require a significant shift in behavior patterns in the plan review and inspection phases of a project. In addition, these changes will be felt by a large number of stakeholders including the code officials, design professionals and construction professionals.

Innovation Theory – Green Technologies

In the 1970's, sustainable technologies in general and solar energy in particular were significant contemporary topics. However, sustainable technologies were not adopted on a wide scale and many who chose to adopt innovations such as solar power, did not sustain their use of the innovations. Innovation theory has subsequently been applied to sustainable innovations to better understand their diffusion and adoption.

Labay and Kinnear (1981) explored the application of perceptual attributes from diffusion theory and demographic characteristics to identify trends in adoption behaviors and predict the adoption of residential solar energy systems. The study considered three distinct groups that included adopters, knowledgeable non-adopters and un-knowledgeable non-adopters. Based on the demographic data collected (age, income, education, occupational status, and family life status), Labay and Kinnear found significant differences in all categories between adopters and the control group of un-knowledgeable non-adopters. However, there was no significant difference between adopters and knowledgeable non-adopters. When considering the

attributes of the innovation, the results showed significant differences between adopters and un-knowledgeable non-adopters based on relative advantage, compatibility, complexity. Differences in perceptions of observability and trailability were not statistically significant. Similar to the demographic characteristics, adopters and knowledgeable non-adopters were generally similar and distinctly different than non-knowledgeable non adopters. However, significant differences were identified based on complexity and observability between adopters and knowledgeable non-adopters. When both demographic data and perceptual attributes were used in discriminant analysis to predict adoption behavior, both constructs yielded statistically significant equations. However, the perceived attributes proved to be more effective in classifying potential adopters, 62% as opposed to 56% with demographic data.

The results of the Labay and Kinnear study provide valuable insight for the current study. Although hypothesis testing for demographic data is not a component of the study, the findings of Labay and Kinnear suggest that demographic data may also be useful in predicting intention to adopt. The study also points to difficulties in finding differences between adopters and knowledgeable non-adopters. Therefore, controlling for knowledge of the IGCC may have a significant interaction in modeling intent to adopt.

Ozaki (2011) studied the factors that influence a consumer's intent to adopt a green electricity tariff in the UK. The green tariff is an innovative energy service that allows consumers to pay a premium for electricity that was generated in part by sustainable technologies. In developing a survey instrument, Ozaki combined innovation diffusion, cognitive behavior, normative behavior, and consumption theories. The results of the study found a significant positive correlation between individual intent to adopt and social influences (a sub-dimension of relative advantage), ease of adoption (complexity), and access to information (knowledge).

Ozaki (2011) also reports that individuals with a “green bias” were hesitant to adopt the tariff and individuals with a strong intent to adopt were still indecisive. Similar results were reported by Fraj-Andres and Martines-Salinas (2007). Ozaki concluded that the lack of social norms, the lack of personal relevance, perceived inconvenience, uncertainty about the quality, and a lack of information contributed to non-adoption.

Based on the literature presented in this and the previous sections, it appears that individual perceptions of innovation attributes can be good predictors of adoption or intention to adopt. The literature also reveals that relative advantage compatibility and complexity are typically the strongest predictors. However, observability and trialability can also have statistically significant correlations to adoption as well.

Summary

Traditional building codes play an important role in protecting property and the safety of individuals. Looking ahead, the IGCC and similar sustainable building codes are positioned to address some of the social, economic, and environmental problems facing the world. In the U.S., the power to adopt and enforce building codes is handed down from the federal government to individual states that typically pass the power down to individual cities. At the local level, building code officials work with building owners, designers, and contractors to interpret and enforce building codes. Although they are not solely responsible for the adoption process, code officials are central figures that influence the formation of local ordinances and can serve as advocates for the adoption of new code standards.

In March of 2012 the ICC made available the first full edition of the IGCC. The IGCC is an innovative code for commercial buildings that introduces mandatory standards to promote

sustainable building performance. The IGCC is designed to overlay existing ICC model codes which have been widely adopted in the U.S.

As with any innovation, there is no guarantee that the IGCC will enjoy widespread diffusion and adoption. However, the available literature does provide insight for change agents and proponents of the new code. Although the code adoption process can be characterized as a collective innovation decision within an organization, scholars acknowledge the influence of individuals in forming organizational perceptions towards an innovation.

A significant amount of literature has been dedicated to the study of innovation diffusion. Foundational models by Rogers (2003) and Zaltman, Duncan and Holbek (1973) describe the innovation adoption process for organizations and individuals. These models emphasize the role of individual perceptions in the formation of attitudes that eventually influence adoption decisions. Based on an extensive literature review, Rogers (2003) proposed five attributes of innovations that are highly effective in predicting rate of adoption. They include relative advantage, compatibility, complexity, observability, and trialability. An individual's perceptions of these attributes have been used by subsequent researchers to predict innovation behavior and intent to adopt.

Existing literature shows that the type of innovation influences which attributes are the best predictors of intent to adopt. Relative advantage, compatibility, and complexity typically rank as the strongest predictors. Observability and trialability can have statistically significant correlations, but usually play a lesser role in prediction equation modeling. Similar trends are seen across a wide range of innovation offerings, including sustainable innovations.

In Chapter Three, the research design and methodology will be presented. A descriptive survey will be used to collect data on the variables explored in the Review of Related Literature.

A random sampling procedure will be employed to mitigate the impact of sampling bias. In addition, a combination of descriptive and inferential statistics will be used to test the research hypothesis.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

The purpose of this study was to determine how the perceptions of code officials influence their intent to adopt the IGCC. Based on the findings, proponents of sustainable construction practices will be better prepared to address issues related to strategy formulation and policy development (Rogers, 2003). Ultimately this will serve to accelerate the adoption of the IGCC and promote the application of sustainable building regulations at the local level.

According to Rogers (2003), individuals' perceptions of an innovation have a significant impact on whether or not an innovation is adopted. The literature review identified five attributes of innovations that influence the rate of adoption. They include relative advantage, compatibility, complexity, trialability and observability. These attributes have also been used by researchers to model adoption behavior and intent to adopt.

Due to the low level of trialability associated with the IGCC, that variable was excluded from hypothesis testing. However, perceptions of trialability in the form of descriptive statistical data were collected in an effort to better understand the use of elective code standards in the transition process to mandated sustainable building codes. The survey instrument collected data on code officials' perceptions of the four remaining attributes in relation to the intent to adopt the IGCC. Descriptive data was also collected for demographic variables and overall knowledge of the IGCC.

An existing survey instrument was adapted to measure the independent and dependent variables under investigation. A combination of descriptive and inferential statistics including a t-test for independent samples and multiple regression analysis was used to extract meaning from the data and answer the following research questions and hypothesis statements:

Research Questions

1. How do code officials rate their level of knowledge of the IGCC?
2. What are code officials' preferences towards adopting the IGCC as an elective standard versus a mandatory standard?
3. To what extent do code officials' perceptions of relative advantage influence their intent to adopt the IGCC?
4. To what extent do code officials' perceptions of the compatibility of the IGCC with their current practices and values influence their intent to adopt the IGCC?
5. To what extent do code officials' perceptions of the complexity of IGCC influence their intent to adopt the IGCC?
6. To what extent do code officials' perceptions about the observability of the IGCC influence their intent to adopt the IGCC?
7. What is the relationship of code officials' perceptions of relative advantage, compatibility, complexity, and observability and their intent to adopt the IGCC?
8. To what extent does the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC vary based on the size of a code official's community?

Research Hypothesis

Research Questions 1 and 2 will be addressed with descriptive survey data. Research Questions 3 through 8 will be addressed via null and alternative hypothesis 1 through 6.

1. H_{01}:$\mu_1 = \mu_2$. There is no statistical significant difference in intent to adopt based on code officials' perceptions of the relative advantage of the IGCC.

   H_{A1}:$\mu_1 \neq \mu_2$. There is a statistical significant difference in intent to adopt based on code officials' perceptions of the relative advantage of the IGCC.

2. H_{02}:$\mu_1 = \mu_2$. There is no statistical significant difference in intent to adopt based on code officials' perceptions about the compatibility of the IGCC with their current practices and values.

   H_{A2}:$\mu_1 \neq \mu_2$. There is a statistical significant difference in intent to adopt based on code officials' perceptions about the compatibility of the IGCC with their current practices and values.

3. H_{03}:$\mu_1 = \mu_2$. There is no statistical significant difference in intent to adopt based on code officials' perceptions of the complexity of the IGCC.

   H_{03}:$\mu_1 \neq \mu_2$. There is a statistical significant difference in intent to adopt based on code officials' perceptions of the complexity of the IGCC.

4. H_{04}:$\mu_1 = \mu_2$. There is no statistical significant difference in intent to adopt based on code officials' perceptions of the observability of the IGCC.

   H_{A4}:$\mu_1 \neq \mu_2$. There is a statistical significant difference in intent to adopt based on code officials' perceptions of the observability of the IGCC.

5. H_{05}: $\beta_j = 0$. There is no statistical significant relationship for intent to adopt the IGCC based on code officials' perceptions of relative advantage, compatibility, complexity, and observability.

   H_{A5}: $\beta_j \neq 0$. There is a statistical significant relationship for intent to adopt the IGCC based on code officials' perceptions of relative advantage, compatibility, complexity, and observability.

6. H_{06}: $\Delta\beta_j = 0$. There is no statistical significant change in the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC based on the size of a code official's community.

   H_{A6}: $\Delta\beta_j \neq 0$. There is a statistical significant change in the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC based on the size of a code official's community.

Population and Sample

The population for this study was code officials in the states of Illinois, Kansas, Missouri, and Nebraska from cities with a population of over 5,000 inhabitants according to U.S. Census Bureau estimates from 2011. From Chapter One, the term code official includes all members of the code enforcement department excluding administrative staff. This includes but is not limited to senior code officials, plan reviewers, and building inspectors.

Several factors influenced the selection of the four states which were the focus of this study. A primary consideration was the manageability of the overall scale of the study. By limiting the study to four states, the researcher attempted to increase participant response rates through direct communications from the researcher via e-mail and telephone solicitation. While limiting the study to four Midwestern states limited the ability to infer the results across the U.S.,

it did provide the opportunity to focus on a unique region of the country where construction trends tend to lag behind the East and West coast regions. Another factor that influenced the selection of the four states in this study was their similarity in latitude and central location which relates to annual climate conditions, and thus, regional environmental priorities. Limiting the study to cities with a population of over 5,000 inhabitants also reduced the inferential power of the study. However, it increased the likelihood that the cities selected to participate would have at least one building code official. A listing of all cities with a population of over 5,000 inhabitants was found at the U.S. Census Bureau website (2012). The number of cities with a population of over 5,000 inhabitants in Illinois was 340, in Kansas was 60, in Missouri was 141, and in Nebraska was 32 with a total count of 573. However, the true size of the population was difficult to estimate because it was unknown how many cities employ code officials and if they employ more than one.

According to Leedy and Ormrod (2005, p.198), external validity of descriptive survey research can only be attained if the "sample is truly representative of the population". This can be achieved through probability sampling and the application of random selection techniques. Within probability sampling, it is the researcher's intent that each segment of the population is represented in the sample. Random selection is used to ensure that each member of the population has an equal chance of being selected for participation. Based on the comprehensive city listing for the four states under investigation, each city was assigned a number starting with the number one and running consecutively until each city was numbered. A random number generator was then used to select the sample from the overall population. Because the researcher did not seek to identify differences between the four states, no effort was be made to ensure

equal representation in the sample group. Furthermore, the random selection process should yield similar proportions to the total number of cities in each state.

The identification of the desired sample size was confounded by many factors. A primary concern for the researcher was collecting enough responses to establish two distinct groups with enough respondents in each group to detect a difference (Gay, 1976). Maintaining somewhat equal group sizes was also a concern in anticipation of using an independent sample T-test where unequal group sizes could impact the homogeneity of variance assumption (Hayden, 2008).

Establishing a sample size is directly related to the statistical conclusion validity of a study (Dattalo, 2008). The power of a study is a measure of the probability of detecting an effect (Dattalo), and is related to the desired Type 1 error rate, Type 2 error rate, and the sample size. Statistical power analysis allows researchers to determine sample size a priori, based on estimated levels of effect size and the desired power of the study. Power analysis can also be calculated a posteriori based on the actual sample size. Formulas for performing a power analysis are based on the type of statistical technique to be used in hypothesis testing.

In order to perform a power analysis a priori a researcher must specify the amount of difference between groups is necessary to identify a practical difference, and estimate the standard deviation of the population (Dattalo, 2008; Fink, 2006; Gay, 1976). Fink recommends consulting with experts to determine estimates for the desired difference between groups and reviewing similar previous studies to estimate the standard deviation. However, the researcher acknowledged that there was no way to verify the accuracy of these estimates prior to conducting the study.

Based on the stated concerns, the research determined that it was not practical to accurately estimate the minimum required sample size a priori. However, the literature did

provide some insight on how to address the question of sample size. A general 'rule of thumb' is "the larger samples size the better" (Cohen, Manion, & Morrison, 2007, p. 101). This guideline must be balanced with practical concerns related to the overall cost and time required to collect the sample data (Dattalo, 2008). According to Gay (1976), for causal-comparative studies, a minimum of 15 subjects per group is necessary, but 30 are recommended. Roscoe (1969) suggests that "sample sizes larger than 30 and less than 500 are appropriate for most research" and that for multivariate research the "sample size should be several times (preferably 10 times or more) as large as the number of variables in the study"

Following the previous guidelines, the researcher established the minimum desired sample size at 100 subjects. Ideally this would allow for more than 30 subjects in each of the two groups for each independent variable. 100 subjects would also be greater than the 10 times the five variables to be used in the multiple regression analysis (relative advantage, compatibility, complexity, observability and size of community). A power analysis was performed following the collection of the data to verify the required sample size in respect to the desired Type 1 and Type 2 error rate.

One of the drawbacks to using questionnaires in descriptive survey research is the possibility for a low response rate (Leedy & Ormrod, 2005). Therefore, because 100 responses were sought, a greater number had to be solicited. Acquiring the desired number of responses was also complicated because the researcher did not know how many, if any code officials were employed at each city. Based on an estimated response rate of 50% (Leedy & Ormrod), and an estimate of one response per city, the researcher randomly selected 200 cities from the 573 available.

Variables

The study included independent and dependent variables identified in the literature review (reference Chapter Two for more information). The use of each variable in the research methodology is explained in the balance of this section.

- Independent variables
    1. State where code official is employed – categorical
    2. Years of experience as a code official – categorical
    3. Years of post-secondary education - categorical
    4. Highest degree earned - categorical
    5. Size of the community were the code official is employed – categorical, criterion coded for multiple linear regression analysis
    6. Current title - categorical
    7. Knowledge of the ICC – categorical
    8. Cumulative perceptions of relative advantage – interval
    9. Cumulative perceptions of compatibility – interval
    10. Cumulative perceptions of complexity – interval
    11. Cumulative perceptions of observability – interval
    12. Perceptions of trialability - ordinal
- Dependent variable:
    1. Intent to adopt the IGCC - interval

Research Design

A descriptive research design employing a combination of correlational and descriptive survey elements was used to guide the study (Leedy & Ormrod, 2005). Correlational designs

allow researchers to examine how changes in one or a combination of variables are related to changes in another variable. Descriptive survey designs can be used to learn about the characteristics and opinions of a group. In this study, the researcher collected data from a random sample of code officials in Illinois, Kansas, Missouri and Nebraska to draw inferences about the greater population which are all code officials in those states. While descriptive research allows one to extrapolate meaning and apply it on a broad scale, it is important to note that data collected only represents a single moment in time. Therefore, results from a single survey should not be "accepted for all time as a constant" (Leedy & Ormrod, 2005, p.184).

Descriptive research designs are also based on self-report data which can present many challenges. At the most basic level, participants must understand the questions being asked of them in order to capture the desired data (Schwarz, 1999). In some instances, respondents may provide responses they "think we want to hear" rather than their honest perceptions (Leedy & Ormrod, 2005, p.184). Schwarz (p.103) also identifies concerns with self-report data based on respondents desire to be "cooperative communicators". In this role, respondents seek to contribute to the research by taking meaning from the researcher's epistemic interest and the survey instrument in forming their answers. Additional pitfalls noted by Schwarz include edited responses based on social desirability and self-presentation and the formation of on the spot opinions that can be colored by recent events rather than a thoughtful consideration of the question. Survey research can also be biased by low response rates if there is a difference between respondents and non-respondents (Rogelberg & Luong, 1998). These limitations to the study were previously noted in Chapter One.

Data Instrumentation and Collection

The data for this study were collected by a survey instrument adapted by the researcher. The available literature reveals a number of survey instruments that have been designed to examine Rogers' five attributes of innovations and similar diffusion theories (Bolton, 1980; Labay & Kinnear, 1981; Ostlund, 1974; Ozaki, 2009). However, citing concerns over the lack of requisite levels of validity and reliability in previous works, Moore and Benbasat (1991) developed an instrument to explore the adoption of information technology innovations. The items used in the instrument were verified for convergent and discriminate validity through a four round process by a panel of judges. The reliability of the scales was verified by three separate field tests checked with factor analysis and discriminate analysis. According to Rogers, the instrument created by Moore and Benbasat, when properly adapted "can be applied to any particular innovation that is adopted by any set of individuals (2003, p.224). While the Moore and Benbasat instrument is of great value to the present study, it is clearly designed to address product innovations rather than process oriented innovations such as the IGCC. Therefore, components of the instrument were revised based on the review of literature presented in Chapter Two.

Four of Rogers (2003) attributes of innovations were used as independent variables for hypothesis testing for this study. They include relative advantage, compatibility, complexity, and observability. The size of a code officials' community was also used as an independent variable in testing the relationships with intent to adopt. Although trialability was not used in hypothesis testing, descriptive statistical data was also collected for this attribute. Respondents were asked to rank their perceptions of the five attributes on a six point Likert scale. Responses raged from one (definitely disagree) to six (definitely agree). For negatively worded items, responses were

recoded to be in agreement with the directionality of positively worded items prior to data analysis.

The dependent variable to be investigated in this study is code officials' intent to adopt the IGCC. This is in contrast to seeking differences between actual adopters and non-adopters of the code. The researcher chose this approach because the first complete version of the IGCC became available less than a year from the time of the study. Due to standardized review cycles followed by most cities and the long adoption process, it was determined that cities had not been allowed a reasonable time to complete the adoption process. This would impose a significant bias in any sampling procedure. Therefore, the researcher chose to explore "measures of potential adoption" (Bolton, 1980). Measures of potential adoption have been regularly used in innovation diffusion studies (Bolton, 1980; Ostlund, 1974; Ozaki, 2011). Intent to adopt the IGCC was measured by a modified purchase probability scale developed by Juster (1966). The scale provides both qualitative and quantitative means to assess the likelihood of adopting the IGCC within a specified period of time. Respondents were asked to rate their intent to adopt the code within the next two years, within the next five years, and within the next ten years.

A copy of the final survey instrument adapted by the researcher is included as Appendix A. Prior to being administered the survey instrument was examined for reliability by a panel of industry experts representing code officials, architects, professional constructors, and academia. Any questions and concerns identified by the industry experts over items in the adapted instrument were addressed and when appropriate, incorporated into the final survey instrument.

Because human subjects were employed for this study, the researcher sought approval from the Institutional Review Boards at Indiana State University and the University of Central Missouri prior to data collection. Based on the descriptive survey methodology, the study was

eligible for exempt status. Due to the exempt status, legally effective informed consent from all participants was not required. However, an informed consent document that explains the purpose of the research, that participation is completely voluntary and that all responses will be kept confidential was provided to each participant as part of the online instrument. A sample of the informed consent document is included as Appendix B.

The researcher attempted to contact one code official in each of the cities that make up the sample group via telephone. As part of the phone call the researcher collected e-mail address information and requested participation in the study. A copy of the telephone script used to collect e-mail addresses is included as Appendix C. Once the e-mail addresses were collected, members of the sample group received an e-mail invitation to participate in the study with a link to the online survey instrument. A copy of the e-mail invitation is included as Appendix D. The sample group was asked to complete the online instrument one time only.

As was previously noted, one concern with survey questionnaires is the low rate of response (Leedy & Ormrod, 2005; Rogelberg & Luong, 1998). Two weeks following the initial e-mail request the researcher sent a follow up e-mail requesting participation of those who had not already completed the survey instrument. A copy of the follow up e-mail is included as Appendix E. Four weeks following the initial e-mail request for participation the researcher closed the online link to the survey instrument and collected the raw data for analysis.

Data Analysis

Data analysis for this study included a combination of descriptive and inferential statistics. IBM SPSS Statistics Version 19 was used for data analysis. The raw data coding scheme is included with the survey instrument in Appendix A. Descriptive statistics techniques

were used to organize the raw data and search for "patterns and meaning" (Leedy & Ormrod, 2005) in the data set not addressed through the research questions.

For hypothesis statements three through six, an independent samples t-test was used to test for differences in the mean scores of an independent variable with two groups based on the dependent variable. The independent variables were relative advantage, compatibility, complexity, and observability; and the dependent variable was code officials' intent to adopt the IGCC. From the survey results, each of the independent variables was separated into two groups based on the mean score from all responses. For the independent variable relative advantage, there were a total of 96 points possible. Based on the six point Likert scale answer format, the mean score for all respondents was 51.76. Respondents with a total score less than 51.76.5 made up one group and were considered to have lower than average perceptions of relative advantage. Respondents with a score greater than 51.76.5 made up the second group and were considered to have higher than average perceptions of relative advantage. The remaining independent variables were grouped in a similar manner based on the mean value of the responses for each variable. The dependent variable, intent to adopt, was interval level data based on an eleven point scale response format. The three assumptions for the independent samples t-test are a normal distribution of the dependent variable, homogeneity of variance between groups and that the two samples are unrelated; therefore, independent (Field, 2009; Mason, Lind, & Marchal, 1988).

For research question seven, a multiple linear regression procedure was used to determine if a statistical significant relationship exists for code officials' intent to adopt the IGCC based on perceptions of relative advantage, compatibility, complexity, and observability. A single round, forced enter procedure was employed to identify significant variables. According to Field (2009), the following assumptions apply to the multiple regression procedure:

1. The independent variables must be ratio or dichotomous categorical level data. The dependent variable must be ratio level, continuous, unbounded data.
2. The independent variables cannot have a variance of zero.
3. The independent variables should not display multicollinearity.
4. Independent variables must be uncorrelated with external variables excluded from the model.
5. The variance of the residual terms should be constant (homoscedasticity).
6. The residual terms for any two observations should be uncorrelated.
7. The residuals are random, normally distributed, and have a mean of zero.
8. All of the values of the dependent variable are independent.
9. The relationship between the dependent variables and independent variables are linear.

It is important to note that while the multiple regression procedure may indicate a relationship between variables, it does not prove causation (Hayden, 2008). For research question eight, a two-step multiple linear regression procedure was used to test if including the size of a code official's community improved the ability of the model from the previous question to predict intent to adopt.

When applying parametric statistical techniques it is necessary to state the desired level of statistical significance from the study. The significance represents the risk associated with not being "100% confident that what you observe in an experiment is due to the treatment" (Salkind, 2007, p.177). For the social sciences a commonly accepted significance level is a Type 1 error rate of .05 (Field, 2009). Due to the low level of risks associated with the application of the findings of this study the researcher selected .05 as the significance level for hypothesis testing. It is important to note that the Type 1 error rate is related to the power of the study based on the

size of the sample and the effect size. Observed power calculations will be provided for the t-tests and multiple linear regression procedures as part of the data analysis.

Summary

In Chapter Three the research design and methodology for the investigation of code officials' perceptions of the IGCC were described. In addition to re-stating the research questions and hypothesis statements; an explanation of the population and sample, data instrumentation and collection, and data analysis techniques were also provided. It is the intent of the researcher that a thorough explanation of methodology employed will facilitate a better understanding of the data analysis presented in Chapter Four and the conclusions presented in Chapter Five. The detailed methodology will also facilitate the future replication of this study as the present study only addresses a four state area within the U.S.

CHAPTER FOUR

RESULTS

This chapter will present the results of the online survey of code officials from Illinois, Kansas, Missouri and Nebraska on their perceptions of the IGCC. The results will be reported in nine parts. The first part will present demographic data and the results of any survey questions not related to the research questions. The remaining eight parts are dedicated to addressing the research questions presented in the first chapter:

1. How do code officials rate their level of knowledge of the IGCC?
2. What are code officials' preferences towards adopting the IGCC as an elective standard versus a mandatory standard?
3. To what extent do code officials' perceptions of relative advantage influence their intent to adopt the IGCC?
4. To what extent do code officials' perceptions of the compatibility of the IGCC with their current practices and values influence their intent to adopt the IGCC?
5. To what extent do code officials' perceptions of the complexity of IGCC influence their intent to adopt the IGCC?
6. To what extent do code officials' perceptions about the observability of the IGCC influence their intent to adopt the IGCC?

7. What is the relationship of code officials' perceptions of relative advantage, compatibility, complexity, and observability and their intent to adopt the IGCC?
8. To what extent does the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC vary based on the size of a code official's community?

Research questions 1 and 2 were addressed with descriptive survey data. Research questions 3 through 8 will be addressed via null and alternative hypothesis 1 through 6.

1. H_{01}:$\mu_1 = \mu_2$. There is no statistical significant difference in intent to adopt based on code officials' perceptions of the relative advantage of the IGCC.

   H_{A1}:$\mu_1 \neq \mu_2$. There is a statistical significant difference in intent to adopt based on code officials' perceptions of the relative advantage of the IGCC.
2. H_{02}:$\mu_1 = \mu_2$. There is no statistical significant difference in intent to adopt based on code officials' perceptions about the compatibility of the IGCC with their current practices and values.

   H_{A2}:$\mu_1 \neq \mu_2$. There is a statistical significant difference in intent to adopt based on code officials' perceptions about the compatibility of the IGCC with their current practices and values.
3. H_{03}:$\mu_1 = \mu_2$. There is no statistical significant difference in intent to adopt based on code officials' perceptions of the complexity of the IGCC.

   H_{03}:$\mu_1 \neq \mu_2$. There is a statistical significant difference in intent to adopt based on code officials' perceptions of the complexity of the IGCC.
4. H_{04}:$\mu_1 = \mu_2$. There is no statistical significant difference in intent to adopt based on code officials' perceptions of the observability of the IGCC.

H_{A4}:$\mu_1 \neq \mu_2$. There is a statistical significant difference in intent to adopt based on code officials' perceptions of the observability of the IGCC.

5. H_{05}: $\beta_j = 0$. There is no statistical significant relationship for intent to adopt the IGCC based on code officials' perceptions of relative advantage, compatibility, complexity, and observability.

   H_{A5}: $\beta_j \neq 0$. There is a statistical significant relationship for intent to adopt the IGCC based on code officials' perceptions of relative advantage, compatibility, complexity, and observability.

6. H_{06}: $\Delta\beta_j = 0$. There is no statistical significant change in the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC based on the size of a code official's community.

   H_{A6}: $\Delta\beta_j \neq 0$. There is a statistical significant change in the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC based on the size of a code official's community.

Survey Results

This section will present a summary of the survey results with associated descriptive statistics. Descriptive analysis for Research Questions 1 and 2 will be addressed in the following section. The statistical techniques used in this section were used to organize the data and search for underlying "patterns and meaning" (Leedy & Ormrod, 2005 p. 245).

A total of 59 code officials participated in the online survey. However, some of the participants chose not to answer all of the questions. For the summary of the survey results, missing values were excluded. For each of the statistical tests used for the study, cases were

excluded listwise. This means that if a question was left blank, the case was excluded from the analysis (Field, 2009). The total number of valid cases was reported with each analysis.

Table 1 presents the frequencies from Survey Question 1. Table 1 can be used to examine how the sample group aligns with the overall population. In Chapter Three it was reported that for the population, 59% of the cities were from Illinois, 10% were from Kansas, 25% were from Missouri and 6% were from Nebraska. These percentages align very closely with the obtained data and indicate that the participation rate and random selection method did not significantly impact the proportions of the responses.

Table 1

State Residency.

State	Frequency	Percent
Illinois	35	60.3
Kansas	8	13.8
Missouri	12	20.7
Nebraska	3	5.2

58 Respondents completed this question

Table 2 shows the frequencies from Survey Question 2 reporting the number of years of experience as a code official. Over 90% of respondents had greater than 5 years of experience and of those, 27.1% reported over 20 years of experience.

Table 2

Years Experience.

Years Experience	Frequency	Percent
0 – 5 Years	5	8.6
5 – 10 Years	21	36.2
10 – 20 Years	16	27.6
Over 20 Years	16	27.6

58 Respondents completed this question

Table 3 shows the frequencies for Survey Question 3 reporting the number of years of post-secondary education for each code official. 93% of the participants reported completing a minimum of 2-4 years of postsecondary education.

Table 3

Post-Secondary Education.

Years Completed	Frequency	Percent
0 – 1 Years	4	7.0
2 – 4 Years	32	56.1
5 – 6 Years	13	22.8
7 – 8 Years	4	7.0
9 + Years	4	7.0

57 Respondents completed this question

Table 4 shows the frequencies for Survey Question 4 reporting the highest degree earned. The survey respondents represented a wide range of educational backgrounds. 8.8% reported no post-secondary degree, 31.5 % reported completing a certificate or associate's degree. 54.4% of the participants reported completing a bachelors or master's degree. Those that selected "Other" reported completing multiple degrees or technical training programs.

Table 4

Highest Degree Earned.

Degree	Frequency	Percent
None	5	8.8
Certificate	10	17.5
Associate	8	14.0
Bachelor	24	42.1
Masters	7	12.3
Other	3	5.3

57 Respondents completed this question

Table 5 shows the frequencies for Survey Question 5 reporting the size of the community in which the code official worked.

Table 5

Size of Community.

Population	Frequency	Percent
5,000 – 10,000	11	19.3
10,000 – 20,000	15	26.3
20,000 – 50,000	17	29.8
Over 50,000	14	24.6

57 Respondents completed this question

Table 6 shows the frequencies for Survey Question 6 reporting the title that best describes the current responsibilities of each code official.

Table 6

Current Title.

Title	Frequency	Percent
Building Official	36	64.3
Plan Reviewer	4	7.1
Building Inspector	8	14.3
Senior Code Official	8	14.3

56 Respondents completed this question

Survey Question 7 asked code officials to report which code they enforce for new commercial construction and renovation projects. 100% of participants indicated that they were using the ICC model codes.

Survey Question 8 asked code officials if their city required new commercial construction and renovation projects to adhere to an energy or sustainable building code. Of the 58 responses, 41 (70.7%) reported that they did require energy codes and 17 (29.3%) reported no code requirement. The follow up question for code officials who answered yes to Survey Question 8 asked them to report which energy or sustainable code their city required. Of the 41 participants that reported requiring energy codes, 37 used the IECC, 3 indicated that they used "Other" codes, and one did not answer the question. Of the 3 participants that reported the use of "Other" codes one specified a customized code developed by their city, one specified modifications to the existing IECC code with allowance for approved alternate paths to compliance such as the ASHRAE standard and one did not indicate which code was used. None of the participants reported using the IGCC as a required code. The follow up question for code officials who answered no to Survey Question 8 asked if their city was currently promoting the use of an energy or sustainable building code standard for new commercial construction and renovation projects on an elective basis (not-mandatory). Of those 17 participants that reported not requiring energy codes, 3 reported that their city promoted the use of energy or sustainable codes on an elective basis. Each of those three participants reported using the IECC as the elective standard. None of the participants reported using the IGCC as an elective code option.

Survey Questions 13, 14, and 15 asked code officials to rank their intent to adopt the IGCC within the next 2, 5 and 10 years respectively. Responses included eleven options ranging from no chance, almost no chance (1 in 100) to certain, practically certain (99 in 100). Tables 7,

8 and 9 show the frequencies for code officials' intent to adopt the IGCC over the next 2, 5 and 10 years respectively.

Table 7

Intent to Adopt, 2 Years.

Intent to Adopt	Frequency	Percent
No Chance, Almost No Chance (1 in 100)	18	32.7
Very Slight Possibility (1 in 10)	12	21.8
Slight Possibility (2 in 10)	5	9.1
Some Possibility(3 in 10)	8	14.5
Fair Possibility (4 in 10)	2	3.6
Fairly Good Possibility (5 in 10)	3	5.5
Good Possibility (6 in 10)	2	3.6
Probable (7 in 10)	5	9.1

55 Respondents completed this question

Table 8

Intent to Adopt, 5 Years.

Intent to Adopt	Frequency	Percent
No Chance, Almost No Chance (1 in 100)	12	21.8
Very Slight Possibility (1 in 10)	10	18.2
Slight Possibility (2 in 10)	5	9.1
Some Possibility (3 in 10)	7	12.7
Fair Possibility (4 in 10)	7	12.7
Fairly Good Possibility (5 in 10)	5	9.1
Good Possibility (6 in 10)	2	3.6
Probable (7 in 10)	4	7.3
Very Probable (8 in 10)	2	3.6
Almost Sure (9 in 10)	1	1.8

55 Respondents completed this question

Table 9

Intent to Adopt, 10 Years.

Intent to Adopt	Frequency	Percentage
No Chance, Almost No Chance (1 in 100)	7	12.7
Very Slight Possibility (1 in 10)	8	14.5
Slight Possibility (2 in 10)	8	14.5
Some Possibility (3 in 10)	7	12.7
Fair Possibility (4 in 10)	6	10.9
Fairly Good Possibility (5 in 10)	3	5.5
Good Possibility (6 in 10)	3	5.5
Probable (7 in 10)	4	7.3
Very Probable (8 in 10)	3	5.5
Almost Sure (9 in 10)	4	7.3
Certain, Practically Certain (99 in 100)	2	3.6

55 Respondents completed this question

To look for trends over time the researcher organized responses into three groups. Because the 11 point scale did not allow for equal groupings of possible responses, the researcher selected the first four options ranging from no chance, almost no chance (1 in 100) to some possibility (3 in 10) as the low intent to adopt group. The mid-range group included the possible responses of fair possibility (4 in 10) to good possibility (6 in 10). The high intent to adopt group included all responses from probable (7 in 10) to certain, practically certain (99 in 100).

Table 10 compiles the data on intent to adopt in 2, 5 and 10 years based on the three groupings.

Table 10

Intent to Adopt Over Time.

Grouping	2 years	5 years	10 years
Low Intent to Adopt	43	34	30
Mid-Range Intent to Adopt	7	14	12
High Intent to adopt	5	7	13

When comparing the extreme values of low intent to adopt and high intent to adopt from the two year time horizon to the 10 year time horizon, the low intent to adopt group decreases by 13 respondents and the high intent to adopt group increases by 8 respondents. As would be expected, the trend reflected in this table is a greater intent to adopt over time. Additional analysis would be necessary to confirm a statistically significant trend in intent to adopt over time. Based on the three options, the 10 year time horizon includes the greatest overall variance in intent to adopt. For this reason, it was used as the dependent variable for hypothesis testing.

Research Question 1: Knowledge of the IGCC

Research Question 1 asked "How do code officials rate their level of knowledge of the IGCC?" Survey Question 12 provided four response options that included little or no knowledge, some knowledge, above average knowledge, and highly knowledgeable. Table 11 presents the frequencies from Survey Question 12 where a total of 42 responses were collected. Table 11 shows that none of the code officials surveyed reported being highly knowledgeable of the

IGCC. However, nearly 60% of participants reported that they had at least some knowledge of the code.

Table 11

Knowledge of the IGCC.

Level of Knowledge	Frequency	Percent
Little or No Knowledge	17	40.5
Some Knowledge	21	50.0
Above Average Knowledge	4	9.5

42 Respondents completed this question

In Chapter two, the literature reveals how knowledge of a technology influences the formation of attitudes and thus perceptions of an innovation. Therefore, intent to adopt is directly related to awareness and "how to" knowledge (Rogers, 2003) of a technology. Further discussion and possible implications based on code officials' level of knowledge of the IGCC are included in Chapter Five.

Research Question 2: Elective vs. Mandatory Adoption of the IGCC

Research Question 2 asked "What are code officials' preferences towards adopting the IGCC as an elective standard versus a mandatory standard?" Survey Questions 44 through 46 addressed this question and asked code officials to report their perceptions related to the trialability of the code. Each question employed a six point Likert scale answer format with responses ranging from strongly disagree to strongly agree. The following paragraphs will report the response frequencies from these three questions.

Survey Question 44 asked "Prior to adopting the International Green Construction Code (IGCC) or similar sustainable building code as a mandatory standard, it would be necessary to adopt the code on an elective basis for a trial period." Table 12 presents the frequencies from Survey Question 44 and shows that a total of 49 responses were collected. Of those responses, 30 (61.2%) code officials indicated some level of disagreement with the question and 19 (38.8%) reported some level of agreement with the question.

Table 12

Trialability of the IGCC #1.

Perceptions of Trialability	Frequency	Percent
Strongly Disagree	4	8.2
Disagree	14	28.6
Somewhat Disagree	12	24.5
Somewhat Agree	11	22.4
Agree	6	12.2
Strongly Agree	2	4.1

49 Respondents completed this question

Survey Question 45 asked "The transition to a mandatory sustainable code such as the International Green Construction Code (IGCC) would not require a trial period where the code would be applied on an elective basis." Question 45 is the same as question 44 except that the direction of the answer format is changed. Table 13 presents the frequencies from Survey Question 45 and shows that a total of 47 responses were collected. Of those responses, 20 (42.6%) code officials indicated some level of disagreement with the question and 27 (57.4%)

reported some level of agreement with the question. As would be expected, these responses are similar to those for question 44 when corrected for agreement with the answer format.

Table 13

Trialability of the IGCC #2.

Perceptions of Trialability	Frequency	Percent
Strongly Disagree	3	6.4
Disagree	4	8.5
Somewhat Disagree	13	27.7
Somewhat Agree	14	29.8
Agree	11	23.4
Strongly Agree	2	4.3

47 Respondents completed this question

Survey Question 46 asked "Adopting the International Green Construction Code (IGCC) on an elective basis would be more trouble than it is worth. I would prefer full adoption of a new code and no elective trial period." This question aligns with question 45. Table 14 presents the frequencies from survey question 46 and shows that a total of 48 responses were collected. Of those responses, 19 (39.6%) code officials indicated some level of disagreement with question and 29 (60.4%) reported some level of agreement with the question. As one would expect, these responses are similar to those from previous questions when corrected for agreement with the answer format.

Table 14

Trialability of the IGCC #3.

Perceptions of Trialability	Frequency	Percent
Strongly Disagree	1	2.1
Disagree	7	14.6
Somewhat Disagree	11	22.9
Somewhat Agree	14	29.2
Agree	9	18.8
Strongly Agree	6	12.5

48 Respondents completed this question

Results

Research Question 2 asked "What are code officials' preferences towards adopting the IGCC as an elective standard versus a mandatory standard?" For the analysis of the questions, responses were separated into two groups based on their agreement or disagreement with the question. For all three questions the majority of code officials reported being against the adoption of the IGCC or similar sustainable code standard on an elective basis (question 44, 61.2%; question 45, 57.4%; question, 46, 60.4%). Therefore, based on the cumulative percentages for survey questions related to Research Question 2, the majority of code officials would prefer to adopt the IGCC as a mandatory standard without an elective trial period. Further discussion and possible implications based on code officials' perceptions of the trialability of the IGCC are included in Chapter Five.

Research Question 3: Intent to Adopt – Relative Advantage

Researcher Question 3 asked: "To what extent do code officials' perceptions of relative advantage influence their intent to adopt the IGCC?" The following null and alternative hypothesis statements were formulated to address this research question. An independent samples t-test was used to test the hypothesis statements.

H_{01}:$\mu_1 = \mu_2$. There is no statistical significant difference in intent to adopt based on code officials' perceptions of the relative advantage of the IGCC.

H_{A1}:$\mu_1 \neq \mu_2$. There is a statistical significant difference in intent to adopt based on code officials' perceptions of the relative advantage of the IGCC.

Summary Statistics

A total of 55 responses were collected for the dependent variable intent to adopt the IGCC. The mean score for intent to adopt among code officials was 4.82 (see Table 9 for frequencies). A total of 51 complete responses were collected for perceptions of relative advantage. Based on 16 questions with six points possible per question, the mean score for perceptions of relative advantage was 51.76. This mean score was used as the grouping value to identify individuals with low perceptions of relative advantage (less than 51.76), and high perceptions of relative advantage (greater than 51.76).

Power Analysis

Once the sample size was determined and the size of individual groups of the independent variable was established, a power analysis was completed. The power analysis indicates the ability of the test to detect an effect (Field, 2009). G*Power version 3.1 by Faul, Erdfelder, Lang & Buchner (2007) was used for power calculations. The compromise test was used to calculate the implied power of the independent samples t-test. Based on a two tailed test;

a medium effect size (.50); a Type-1 to Type-2 ratio of 1 (equal risk associated with each type of error); a group one sample size of 29 and a group two sample size of 22 (see Table 15 for group size); the calculated power of the test was .74. The observed power is less than the recommended target of .80 offered by Field (2009). However, a 74% chance of not committing a Type-2 error for a medium level effect is acceptable for the current study.

t-test Assumptions

The three assumptions for the independent samples t-test are a normal distribution of the dependent variable, homogeneity of variance between groups and that the two samples are unrelated; therefore, independent (Field, 2009; Mason, Lind, & Marchal, 1988). Normality did not need to be tested for the grouping variable.

Figure 3 shows the histogram for the dependent variable intent to adopt the IGCC. From the histogram it appears that the data are positively skewed.

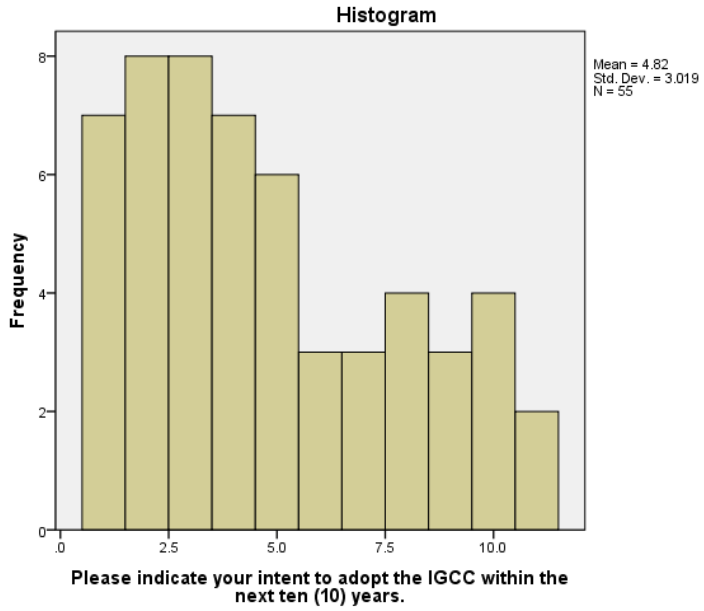

Figure 3. Histogram, intent to adopt.

Figure 4 shows a normal Q-Q plot of residual weights for intent to adopt. Within the Q-Q plot, many of the observed values appear to trend away from the slope of the normal distribution.

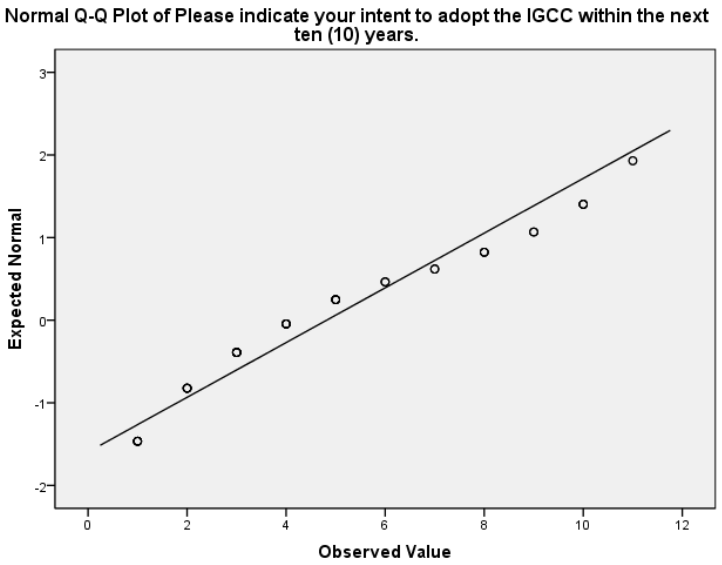

Figure 4. Q-Q plot, intent to adopt the IGCC.

Concerns over the normality of the data are confirmed with the Shapiro-Wilk test ($p = .001$) and the Kolmogorov-Smirnov test ($p = .003$). Based on the histogram, Q-Q plots and the results of the two normality tests, it appears that the values for intent to adopt the IGCC are not normally distributed and the assumption of normality is violated. However, to further investigate the normality of the dependent variable we can apply the "rule of thumb for skewness" and kurtosis which states that a skewness value more than twice the standard error of skewness is significantly skewed (Hayden, 2008). For intent to adopt the IGCC the skewness value is .554 which is less than twice the standard error of skewness of .322. The kurtosis value is -.860 which is also less than twice the standard error of kurtosis of .634. Based on the rule of thumb the distribution does not display significant skewness or kurtosis. By applying the central limit theorem (Field, 2009) one can assume that the sample would display a normal distribution as the sample size increases.

The equality of variance assumption is evaluated with the Levene's Test ($p = .082 > .05$). Based on the significance value, the assumption of equal variances is not violated. The data collection methodology supports the assumption that the individual responses for the two groups are unrelated; therefore, independent.

t-test Results

The t-test for independent samples was used to test Research Hypothesis 1. The grouping value was the mean score for perceptions of relative advantage. Based on the 51 responses, a mean score of 51.76 was calculated. Table 15 shows a summary of the group statistics for the two groups. Using 51.76 as the grouping value, 22 responses had a total score below 51.76 (low perceptions of relative advantage) and 29 responses had a total score above 51.76 (high perceptions of relative advantage). The mean score for intent to adopt the IGCC in the low group was 3.14 with a standard deviation of 2.232. The mean score for intent to adopt the IGCC in the high group was 6.52 with a standard deviation of 2.681.

Table 15

Group Statistics, Relative Advantage.

Group	Frequency	Mean	Standard Deviation
High Perceptions of Relative Advantage	29	6.52	2.681
Low Perceptions of Relative Advantage	22	3.14	2.232

The independent samples t-test was used to see if there was a significant difference in intent to adopt the IGCC based on code officials' perceptions of relative advantage. The results

of the independent samples t-test was $t_{(49)} = 4.786$, p = .000 (2-tailed). Therefore, the null hypothesis is rejected and the alternate hypothesis is retained.

It was previously noted that there are concerns about the assumption of normality for the dependent variable. According to Wilcox (2005) the t-test can be biased in cases with a departure from a normal distribution. Therefore, the violation of the assumption does bring into question the hypothesis test result. To address this concern the researcher conducted an additional nonparametric test to investigate the difference between code officials with low and high perceptions of relative advantage.

Mann-Whitney U Test

Because the assumption of a normal population for the dependent variable intent to adopt is violated based on the sample collected, it is appropriate to apply nonparametric test procedures to further test for differences between the two groups. According to Norušis, (2009) the Mann-Whitney U test is an alternative to the independent samples t-test. Instead of comparing the mean values for the two groups the Mann-Whitney U test compares a ranking of the individual values in each group (Field, 2009; Norušis, 2009). Using the mean score of 51.76 as the grouping value for high or low perceptions of relative advantage and the dependent variable intent to adopt the IGCC, the result of the Mann-Whitney U test was Z = -4.266, p = .000 (2-tailed). Therefore, the results of the nonparametric Mann-Whitney U test are consistent with the results of the independent sample t-test rejecting the null hypothesis that there is no difference between the two groups.

Research Question 4: Intent to Adopt – Perceptions of Compatibility

Research Question 4 asked "To what extent do code officials' perceptions of the compatibility of the IGCC with their current practices and values influence their intent to adopt

the IGCC?" The following null and alternative hypothesis statements were formulated to address this research question. An independent samples t-test was used to test the hypothesis statements.

H_{02}:$\mu_1 = \mu_{2.}$ There is no statistical significant difference in intent to adopt based on code officials' perceptions about the compatibility of the IGCC with their current practices and values.

H_{A2}:$\mu_1 \neq \mu_{2.}$ There is a statistical significant difference in intent to adopt based on code officials' perceptions about the compatibility of the IGCC with their current practices and values.

Summary Statistics

A total of 55 responses were collected for the dependent variable intent to adopt the IGCC. The mean score for intent to adopt among code officials was 4.82 (see Table 9 for frequencies). A total of 52 complete responses were collected for perceptions of compatibility. Based on six questions with six points possible per question, the mean score for perceptions of relative advantage was 18.54. This mean score was used as the grouping value to identify individuals with low perceptions of compatibility (less than 18.54), and high perceptions of compatibility (greater than 18.54).

Power Analysis

Once the sample size was determined and the size of individual groups of the independent variable was established; a power analysis was completed. The power analysis indicates the ability of the test to detect an effect (Field, 2009). G*Power version 3.1 by Faul, Erdfelder, Lang & Buchner (2007) was used for power calculations. The compromise test was used to calculate the implied power of the independent samples t-test. Based on a two tailed test; a medium effect size (.50); a Type-1 to Type-2 ratio of 1 (equal risk associated with each type of

error); a group one sample size of 32 and a group two sample size of 20 (see Table 16 for group size); the calculated power of the test was .74. The observed power is less than the recommended target of .80 offered by Field (2009). However, a 74% chance of not committing a Type-2 error for a medium level effect is acceptable for the current study.

t-test Assumptions

The three assumptions for the independent samples t-test are a normal distribution of the dependent variable, homogeneity of variance between groups and that the two samples are unrelated; therefore, independent (Field, 2009; Mason, Lind, & Marchal, 1988). Normality did not need to be tested for the grouping variable.

With the analysis of Research Question 3 it was determined that the dependent variable intent to adopt the IGCC was positively skewed. Normality tests indicated that the assumption of a normal distribution is violated. However, the distribution does not display significant skewness or kurtosis and by applying the central limit theorem (Field, 2009) one can assume that the sample would display a normal distribution as the sample size increases.

The equality of variance assumption is evaluated with the Levene's Test ($p = .543 > .05$) Based on the significance value, the assumption of equal variances is not violated. The data collection methodology supports the assumption that the individual responses for the two groups are unrelated; therefore, independent.

t-test Results

The t-test for independent samples was used to test Research Hypothesis 2.
The grouping value was the mean score for perceptions of compatibility. Based on the 52 responses, a mean score of 18.54 was calculated. Table 16 shows a summary of the group statistics for the two groups. Using 18.54 as the grouping value, 20 responses had a total score

below 18.54 (low perceptions of compatibility) and 32 responses had a total score above 18.54 (high perceptions of compatibility). The mean score for intent to adopt the IGCC in the low group was 4.20 with a standard deviation of 3.122. The mean score for intent to adopt the IGCC in the high group was 5.53 with a standard deviation of 2.817.

Table 16

Group Statistics, Compatibility.

Group	Frequency	Mean	Standard Deviation
High Perceptions of Compatibility	32	5.53	2.817
Low Perceptions of Compatibility	20	4.2	3.122

The independent samples t-test was used to see if there was a significant difference in intent to adopt the IGCC based on code officials' perceptions of compatibility. The results of the independent samples t-test was $t_{(50)} = 1.590$, $p = .118$ (2-tailed). Therefore, the null hypothesis is retained.

It was previously noted that there are concerns about the assumption of normality for the dependent variable. According to Wilcox (2005) the t-test can be biased in cases with a departure from a normal distribution. Therefore, the violation of the assumption does bring into question the hypothesis test result. To address this concern the researcher conducted an additional nonparametric test to investigate the difference between code officials with low and high perceptions of compatibility.

Mann-Whitney U Test

Using the mean score of 18.54 as the grouping value for high or low perceptions of compatibility and the dependent variable intent to adopt the IGCC, the result of the Mann-Whitney U test was Z = -1.883, p = .060 > .05 (2-tailed). Therefore, the results of the nonparametric Mann-Whitney U test are consistent with the results of the independent sample t-test in retaining the null hypothesis that there is no difference between the two groups.

Research Question 5: Intent to Adopt – Perceptions of Complexity

Research Question 5 asked "To what extent do code officials' perceptions of the complexity of IGCC influence their intent to adopt the IGCC?" The following null and alternative hypothesis statements were formulated to address this research question. An independent samples t-test was used to test the hypothesis statements.

H_{03}:$\mu_1 = \mu_{2.}$ There is no statistical significant difference in intent to adopt based on code officials' perceptions of the complexity of the IGCC.

H_{03}:$\mu_1 \neq \mu_{2.}$ There is a statistical significant difference in intent to adopt based on code officials' perceptions of the complexity of the IGCC.

Summary Statistics

A total of 55 responses were collected for the dependent variable intent to adopt the IGCC. The mean score for intent to adopt among code officials was 4.82 (see Table 9 for frequencies). A total of 50 complete responses were collected for perceptions of complexity. Based on six questions with six points possible per question, the mean score for perceptions of complexity was 20.78. This mean score was used as the grouping value to identify individuals with low perceptions of complexity (less than 20.78), and high perceptions of complexity (greater than 20.78).

Power Analysis

Once the sample size was determined and the size of individual groups of the independent variable was established, a power analysis was completed. The power analysis indicates the ability of the test to detect an effect (Field, 2009). G*Power version 3.1 by Faul, Erdfelder, Lang & Buchner (2007) was used for power calculations. The compromise test was used to calculate the implied power of the independent samples t-test. Based on a two tailed test; a medium effect size (.50); a Type-1 to Type-2 ratio of 1 (equal risk associated with each type of error); a group one sample size of 23 and a group two sample size of 27 (see Table 17 for group size); the calculated power of the test was .74. The observed power is less than the recommended target of .80 offered by Field (2009). However, a 74% chance of not committing a Type-2 error for a medium level effect is acceptable for the current study.

t-test Assumptions

The three assumptions for the independent samples t-test are a normal distribution of the dependent variable, homogeneity of variance between groups and that the two samples are unrelated; therefore, independent (Field, 2009; Mason, Lind, & Marchal, 1988). Normality did not need to be tested for the grouping variable.

With the analysis of Research Question 3 it was determined that the dependent variable intent to adopt the IGCC was positively skewed. Normality tests indicated that the assumption of a normal distribution is violated. However, the distribution does not display significant skewness or kurtosis and by applying the central limit theorem (Field, 2009) one can assume that the sample would display a normal distribution as the sample size increases.

The equality of variance assumption is evaluated with the Levene's Test ($p = .304 > .05$). Based on the significance value, the assumption of equal variances is not violated. The data

collection methodology supports the assumption that the individual responses for the two groups are unrelated; therefore, independent.

t-test Results

The t-test for independent samples was used to test Research Hypothesis 3. The grouping value for the t-test was the mean score for perceptions of complexity. Based on the 50 responses, a mean score of 20.78 was calculated. Table 17 shows a summary of the group statistics for the two groups. Using 20.78 as the grouping variable, 27 responses had a total score below 20.78 (low perceptions of complexity) and 23 responses had a total score above 20.78 (high perceptions of complexity). The mean score for intent to adopt the IGCC in the low group was 4.41 with a standard deviation of 2.693. The mean score for intent to adopt the IGCC in the high group was 6.00 with a standard deviation of 3.104.

Table 17

Group Statistics, Complexity.

Group	Frequency	Mean	Standard Deviation
High Perceptions of Complexity	23	6.00	3.104
Low Perceptions of Complexity	27	4.41	2.693

The independent samples t-test was used to see if there was a significant difference in intent to adopt the IGCC based on code officials' perceptions of complexity. The results of the independent samples t-test was $t_{(48)} = 1.943$, $p = .058$ (2-tailed). Therefore, the null hypothesis is retained.

It was previously noted that there are concerns about the assumption of normality for the dependent variable. According to Wilcox (2005) the t-test can be biased in cases with a departure from a normal distribution. Therefore, the violation of the assumption does bring into question the hypothesis test result. To address this concern the researcher conducted an additional nonparametric test to investigate the difference between code officials with low and high perceptions of complexity.

Mann-Whitney U Test

Using the mean score of 20.78 as the grouping value for high or low perceptions of complexity and the dependent variable intent to adopt the IGCC, the result of the Mann-Whitney U test was $Z = -1.850$, $p = .064 > .05$ (2-tailed). Therefore, the results of the nonparametric Mann-Whitney U test are consistent with the results of the independent sample t-test in retaining the null hypothesis that there is no difference between the two groups.

Research Question 6: Intent to Adopt – Perceptions of Observability

Research Question 6 asked "To what extent do code officials' perceptions about the observability of the IGCC influence their intent to adopt the IGCC?" The following null and alternative hypothesis statements were formulated to address this research question. An independent samples t-test was used to test the hypothesis statements.

H_{04}:$\mu_1 = \mu_{2.}$ There is no statistical significant difference in intent to adopt based on code officials' perceptions of the observability of the IGCC.

H_{A4}:$\mu_1 \neq \mu_{2.}$ There is a statistical significant difference in intent to adopt based on code officials' perceptions of the observability of the IGCC.

Summary Statistics

A total of 55 responses were collected for the dependent variable intent to adopt the IGCC. The mean score for intent to adopt among code officials was 4.82 (see Table 9 for frequencies). A total of 49 complete responses were collected for perceptions of observability. Based on four questions with six points possible per question, the mean score for perceptions of observability was 7.94. This mean score was used as the grouping value to identify individuals with low perceptions of observability (less than 7.94), and high perceptions of observability (greater than 7.94).

Power Analysis

Once the sample size was determined and the size of individual groups of the independent variable was established, a power analysis was completed. The power analysis indicates the ability of the test to detect an effect (Field, 2009). G*Power version 3.1 by Faul, Erdfelder, Lang & Buchner (2007) was used for power calculations. The compromise test was used to calculate the implied power of the independent samples t-test. Based on a two tailed test; a medium effect size (.50); a Type-1 to Type-2 ratio of 1 (equal risk associated with each type of error); a group one sample size of 31 and a group two sample size of 18 (see Table 18 for group size); the calculated power of the test was .72. The observed power is less than the recommended target of .80 offered by Field (2009). However, a 72% chance of not committing a Type-2 error for a medium level effect is acceptable for the current study.

t-test Assumptions

The three assumptions for the independent samples t-test are a normal distribution of the dependent variable, homogeneity of variance between groups and that the two samples are

unrelated; therefore, independent (Field, 2009; Mason, Lind, & Marchal, 1988). Normality did not need to be tested for the grouping variable.

With the analysis of Research Question 3 it was determined that the dependent variable intent to adopt the IGCC was positively skewed. Normality tests indicated that the assumption of a normal distribution is violated. However, the distribution does not display significant skewness or kurtosis and by applying the central limit theorem (Field, 2009) one can assume that the sample would display a normal distribution as the sample size increases.

The equality of variance assumption is evaluated with the Levene's Test ($p = .483 > .05$). Based on the significance value, the assumption of equal variances is not violated. The data collection methodology supports the assumption that the individual responses for the two groups are unrelated; therefore, independent.

t-test Results

The t-test for independent samples was used to test Research Hypothesis 4. The grouping value was the mean score for perceptions of observability. Based on the 49 responses, a mean score of 7.94 was calculated. Table 18 shows a summary of the group statistics for the two groups. Using 7.94 as the grouping value, 18 responses had a total score below 7.94 (low perceptions of observability) and 31 responses had a total score above 7.94 (high perceptions of observability). The mean score for intent to adopt the IGCC in the low group was 5.39 with a standard deviation of 3.256. The mean score for intent to adopt the IGCC in the high group was 5.00 with a standard deviation of 2.887.

Table 18

Group Statistics, Observability.

Group	Frequency	Mean	Standard Deviation
High Perceptions of Observability	18	5.39	3.256
Low Perceptions of Observability	31	5.00	2.887

The independent samples t-test was used to see if there was a significant difference in intent to adopt the IGCC based on code officials' perceptions of observability. The results of the independent samples t-test was $t_{(47)} = -.434$, $p = .666$ (2-tailed). Therefore, the null hypothesis is retained.

It was previously noted that there are concerns about the assumption of normality for the dependent variable. According to Wilcox (2005) the t-test can be biased in cases with a departure from a normal distribution. Therefore, the violation of the assumption does bring into question the hypothesis test result. To address this concern the researcher conducted an additional nonparametric test to investigate the difference between code officials with low and high perceptions of observability.

Mann-Whitney U Test

Using the mean value of 7.94 as the grouping value for high or low perceptions of observability and the dependent variable intent to adopt the IGCC, the result of the Mann-Whitney U test was $Z = -.344$, $p = .731 > .05$ (2-tailed). Therefore, the results of the

nonparametric Mann-Whitney U test are consistent with the results of the independent sample t-test in retaining the null hypothesis that there is no difference between the two groups.

Research Question 7: Intent to Adopt Relationships

Research Question 7 asked: "What is the relationship of code official's perceptions of relative advantage, compatibility, complexity, and observability and their intent to adopt the IGCC?" The following null and alternative hypothesis statements were formulated to address this research question.

H_{05}: $\beta_j = 0$. There is no statistical significant relationship for intent to adopt the IGCC based on code official's perceptions of relative advantage, compatibility, complexity, and observability.

H_{A5}: $\beta_j \neq 0$. There is a statistical significant relationship for intent to adopt the IGCC based on code official's perceptions of relative advantage, compatibility, complexity, and observability.

Summary Statistics and Correlations

For Research Question 7, code officials' intent to adopt the IGCC was used as the dependent variable and code officials' perceptions of relative advantage, compatibility, complexity, and observability were used as the independent, predictor variables. Table 19 shows the descriptive statistics associated with the dependent variable and each of the independent variables. The total number of valid cases listwise is 49. Therefore, 49 responses are the basis for the multiple regression model. The total of 49 cases is very near the amount recommended by Roscoe (1969) for multivariate research, who suggested ten times the number of variables in the study (10 cases * 5 variables = 50). It is important to note that the mean score for each of the independent variable cannot be directly compared because of the varying number of questions

for each variable on the survey instrument. For Relative Advantage there were 16 questions with a maximum possible value of six points per question based on the Likert scale response option (96 points possible). For Compatibility there were six questions (36 points possible); for Complexity there were six questions (36 points possible); for Observability there were four questions (24 points possible).

Table 19

Summary Statistics, Model Variables.

Variable	Frequency	Mean	Standard Deviation
Intent to Adopt the IGCC	55	4.82	3.019
Perceptions of Relative Advantage	51	51.76	8.444
Perceptions of Compatibility	52	18.54	4.483
Perceptions of Complexity	50	20.78	3.935
Perceptions of Observability	49	7.94	2.839

Table 20 shows the Pearson correlation coefficients for the dependent variable and each independent variable. From the table we see that code officials' intent to adopt the IGCC (dependent variable) has a significant positive correlation with relative advantage and compatibility. Within the independent variables we see significant correlations between relative advantage and compatibility, relative advantage and complexity, compatibility and complexity,

and complexity and observability. The significant correlations between the independent variables indicate the need to check for multicollinearity as part of the multiple regression procedure.

Table 20

Hypothesis 5, Pearson Correlation Results.

Variable	Intent to Adopt	Relative Advantage	Compatibility	Complexity	Observability
Intent to Adopt	1.000	.691*	.515*	.071	-.092
Relative Advantage	.691*	1.000	.731*	.307*	.004
Compatibility	.515*	.731*	1.000	.242*	-.027
Complexity	.071	.307*	.242*	1.000	.249*
Observability	-.092	.004	-.027	.249*	1.000

(* = $p < .05$)

Power Analysis

A power analysis was completed based on the size of the sample obtained for the study. The power analysis indicates the ability of the test to detect an effect (Field, 2009). G*Power version 3.1 by Faul, Erdfelder, Lang & Buchner (2007) was used for power calculations. The calculation method was the compromise test for linear multiple regression with a fixed model. Based on a medium effect size (.15); a Type-1 to Type-2 ratio of 1 (equal risk associated with each type of error); a sample size of 49 (listwise); and four predictor variables the calculated power of the test is .79. The observed power is less than the recommended target of .80 offered by Field (2009). However, a 79% chance of not committing a Type-2 error for a medium level effect is acceptable for the current study.

Multiple Regression Results

To test the null hypothesis a single round forced enter, multiple linear regression procedure was applied in SPSS. The results of the regression model will be reported first followed by a summary of the tests of the relevant assumptions.

The multiple linear regression model applied code officials' intent to adopt the IGCC as the dependent variable and code officials' perceptions of relative advantage, compatibility, complexity, and observability as the independent, predictor variables. The results of the ANOVA procedure for the F statistic shows that the model is statistically significant $F(4,44) = 11.134$, $p < .01$. Therefore, the null hypothesis is rejected.

Based on the criteria for constructing the model, the only significant independent variable was relative advantage. Compatibility, complexity, and observability were not found to make a significant contribution to the regression equation. Table 21 shows the values of the coefficients including the constant for the regression procedure.

Table 21

Hypothesis 5, Coefficients.

Variable	B	SE B	β
(Constant)	-5.767	2.394	
Relative Advantage	.257	.057	.718*
Compatibility	.016	.111	.022
Complexity	-.108	.089	-.140
Observabiltiy	-.063	.116	-.059

Note: $R^2 = .503$, * = $p < .001$.

The model summary reports a multiple correlation coefficient of R = .709. The R^2 value is .503, indicating that 50.3% of the variability in intent to adopt is accounted for by the model. The adjusted R2 provides insight into the predictive power of the model and reveals the amount of variance that would be accounted for "if the model had been derived from the population from which the sample was taken" (Field, 2009, p. 221). The adjusted R^2 value is .458, a decrease of .045. Therefore, based on the sample size of 49, the adjusted R^2 value indicates a 4.5% difference between variability predicted by the sample and the overall population.

Multiple Regression Assumptions

Field (2009) offers the following list of assumptions for the multiple regression analysis:

1. The independent variables must be ratio or dichotomous categorical level data. The dependent variable must be ratio level, continuous, unbounded data.
2. The independent variables cannot have a variance of zero.
3. The independent variables should not display multicollinearity.
4. Independent variables must be uncorrelated with external variables excluded from the model.
5. The variance of the residual terms should be constant (homoscedasticity).
6. The residual terms for any two observations should be uncorrelated.
7. The residuals are random, normally distributed, and have a mean of 0.
8. All of the values of the dependent variable are independent.
9. The relationship between the dependent variables and independent variables are linear.

In response to assumption 1, the independent variables are cumulative scores, representing ratio level data for each of the four categories (relative advantage, compatibility, complexity, and observability). The dependent variable collected by means of the purchase

probability scale (Juster, 1966) also meets the criteria for quantitative analysis. In response to assumption 2, each of the independent variables display non-zero variance as was shown in Table 19 by their mean and standard deviation scores.

Assumption 3 addresses multicollinearity of the independent variables. An initial review of the correlation coefficients in Table 20 shows a significant correlation between relative advantage and compatibility, relative advantage and complexity, compatibility and complexity, and complexity and observability. Field (2009) provides a 'ball park' guideline that correlations stronger than .80 indicate concerns of multicollinearity. The highest correlation, .731 between relative advantage and compatibility, is below the .80 threshold. Field (2009) and Norusis (2009) also suggest using the tolerance value and its reciprocal, the variance inflation factor (VIF) to investigate multicollinearity. Tolerance and VIF coefficients are shown in Table 22. According to Field (2009) tolerance coefficients below .20 and VIF coefficients above 10 indicate areas of concern. With each of independent variables below this threshold, the assumption of multicollinearity is not violated.

Table 22

Hypothesis 5, Collinearity Coefficients.

Variable	Tolerance	VIF
Relative Advantage	.447	2.238
Compatibility	.463	2.158
Complexity	.843	1.186
Observability	.930	1.076

Assumption 4 states that independent variables must be uncorrelated with external variables. The literature review revealed the five attributes of innovations as identified by Rogers (2003), four of which are used to test Research Question 7. Research Question 8 will also consider the size of a code official's community as an independent variable. Although there is no way to guarantee that correlations with external variables do not exist, the researcher is aware of the potential impact on the study and has made an effort to eliminate any possible influence.

Assumption 5 states that the variance of the residual terms should be constant. This assumption is tested by reviewing a scatterplot to visually verify that the data are randomly arranged and evenly disbursed around zero (Field, 2009). Figure 5 shows a scatterplot with the residual values. Although the left portion of the plot shows gradual increase in variance from left to right, the balance of the plot shows randomly and evenly disturbed values. There is also no indication of a non-linear relationship between the dependent variable and the independent variables. Therefore, the assumption of homoscedasticity is not violated.

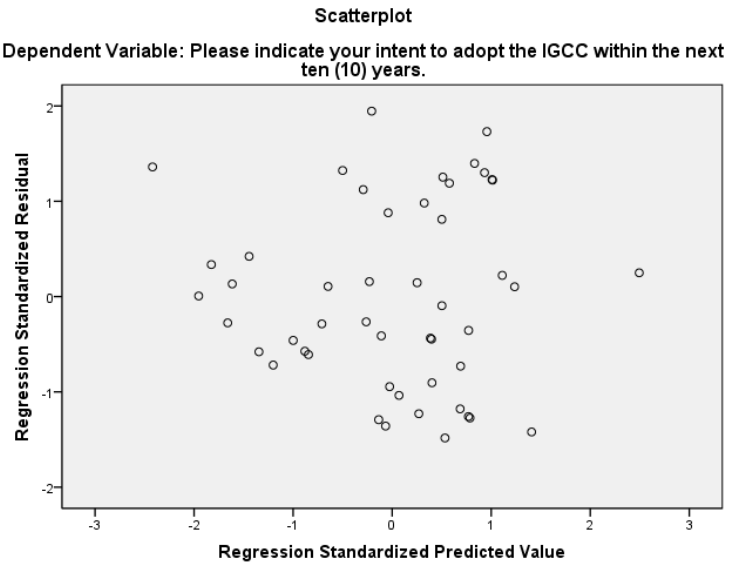

Figure 5. Hypothesis 5, scatterplot with residual terms.

Assumption 6 states that the residual terms for any two observations should be uncorrelated. This assumption is tested with the Durbin-Watson test (Field, 2009; Norusis, 2009). Possible values range from zero to four, with a value of two indicating no correlation between the residuals. The resulting value of the Durbin-Watson test is 1.991 indicating that the assumption is not violated.

Assumption 7 states that the residuals are random, normally distributed, and have a mean of zero. To test this assumption we can review a histogram and cumulative probability plot of the residuals (Field, 2009). Figure 6 shows the histogram with the residuals from the model. The residual values do not display an ideal normal distribution, however, the mean score is near the desired mean score of zero.

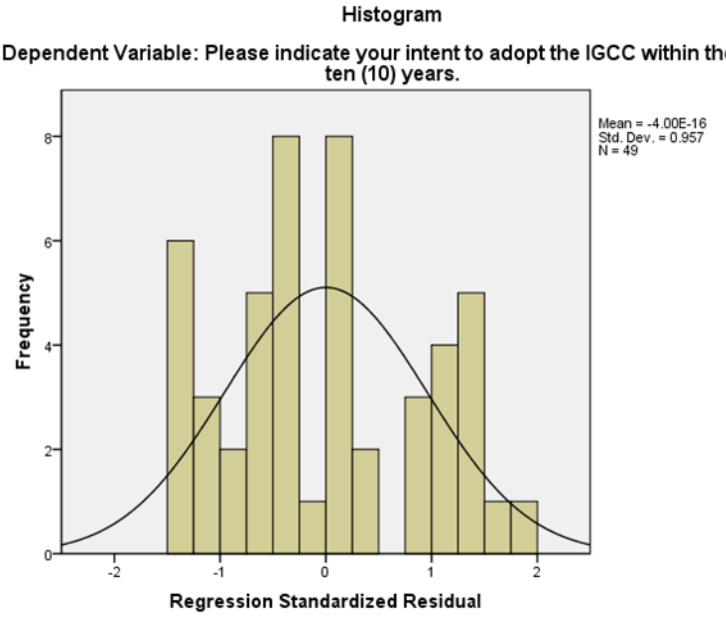

Figure 6. Hypothesis 5, histogram with residual values.

Figure 7 shows the P-P plot of the standardized residual values. The plot does show minor deviation from the straight line representing a normal distribution. Normality tests are inconclusive with the Kolmogorov-Smirnov test supporting a normal distribution and the

Shapiro-Wilk test indicating a non-normal distribution (Shapiro-Wilk p = .032, Kolmogorov-Smirnov p = .200). Although there are concerns that the residual values do not display a normal distribution, the findings are inconclusive and for the purpose of this study it is assumed that assumption 7 is not violated.

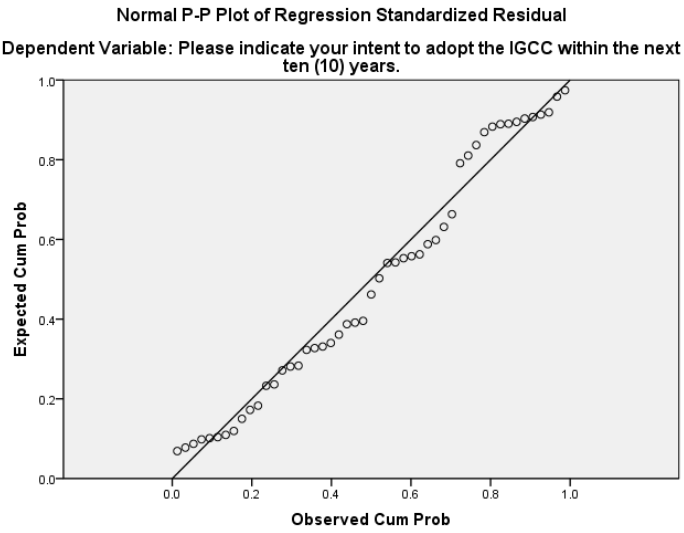

Figure 7. Hypothesis 5, P-P plot with residual values.

Assumption 8 states that all of the values of the dependent variable are independent. The data collection methodology supports this assumption. Assumption 9 states that the relationship between the dependent variables and independent variables are linear. This can be verified by viewing the partial plots of the dependent variable and each predictor.

Figure 8 shows the partial regression plots for each independent variable. For relative advantage the plot shows the positive linear relationship with intent to adopt as is indicated by the correlation coefficient. There is no indication of a non-linear relationship. For compatibility, complexity and observability each plot shows varying strengths of correlations with the dependent variable and none of the plots indicate non-linear relationship.

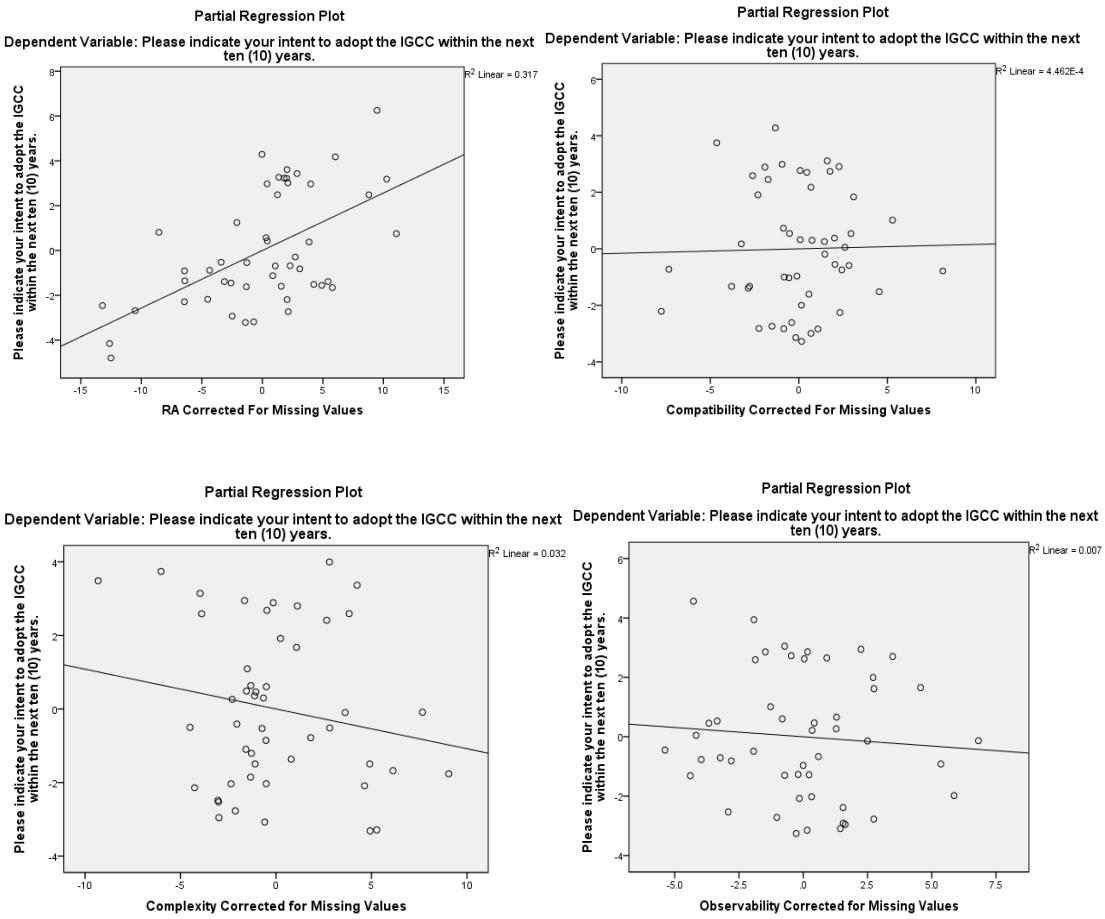

Figure 8. Hypothesis 5, partial plots of residuals.

Summary and Regression Equation

A forced enter linear regression technique was employed to test hypothesis statement five looking for a significant relationship between code officials' intent to adopt the IGCC and their perceptions of relative advantage, compatibility, complexity, and observability. Based on the data collected, a statistically significant model is present, $F(4,44) = 11.134$, $p < .01$. Therefore, the null hypothesis is rejected and the alternate hypothesis is retained: $H_{A5} : \beta_j \neq 0$. The final regression equation for the full regression model follows:

$$\text{Intent to Adopt} = -5.767 + (.547 * \text{Relative Advantage}) + (.016 * \text{Compatibility}) + (-1.08 * \text{Complexity}) + (-.063 * \text{Observability})$$

However, relative advantage was the single significant independent predictor variable.

Research Question 8: Size of Community Relationship

Research Question 8 asked "To what extent does the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC vary based on the size of a code official's community?" The following null and alternative hypothesis statements were formulated to address this research question.

H_{06}: $\Delta\beta_j = 0$. There is no statistical significant change in the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC based on the size of a code official's community.

H_{A6}: $\Delta\beta_j \neq 0$. There is a statistical significant change in the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC based on the size of a code official's community.

Criterion Coding Categorical Data

In order to test the influence of the size of code officials' communities on the regression model it was necessary to recode the categorical data. Schumacker (1993) proposes the following method for criterion coding categorical variables. In the survey instrument, there were four options for size of the community in which code officials work (5,000 – 10,000; 10,000 – 20,000; 20,000 – 50,000; and over 50,000 residents). A new criterion variable was created with each of the four size options reduced to individual vectors. Individual vectors represented code officials' mean intent to adopt for each size community. The application of the criterion coding technique required a manual adjustment to the ANOVA table to account for additional degrees of freedom that were eliminated by the use of a single criterion variable.

Summary Statistics and Correlations

The descriptive statistics for intent to adopt and perceptions of relative advantage are the same as previously reported in Table 19 and there is no value in reporting the descriptive statistics for the dummy coded categorical variable size of community. Table 23 shows the Pearson correlation coefficients for the dependent variable and each independent variable. From the table we see that code officials' intent to adopt the IGCC (dependent variable) has a significant positive correlation to relative advantage and compatibility. Within the independent variables we see significant correlations between relative advantage and compatibility, relative advantage and complexity, compatibility and complexity, and complexity and observability. The significant correlations between the independent variables indicate the need to check for multicollinearity as part of the multiple regression procedure.

Table 23

Hypothesis 6, Pearson Correlations Results.

Variable	Intent to Adopt	Relative Advantage	Compatibility	Complexity	Observability	Size of Comm.
Intent to Adopt	1.000	.694*	.522*	.055	-.085	.126
Relative Advantage	.694*	1.000	.732*	.305*	.006	.233
Compatibility	.522*	.732*	1.000	.244*	-.027	-.039
Complexity	.055	.305*	.244*	1.000	.257*	.163
Observability	-.085	.006	-.027	.257*	1.000	.190
Size of Comm.	.126	.223	-.039	.163	.190	1.000

Power Analysis

A power analysis was completed based on the size of the sample obtained for the study. The power analysis indicates the ability of the test to detect an effect (Field, 2009). G*Power version 3.1 by Faul, Erdfelder, Lang & Buchner (2007) was used for power calculations. The calculation method was the compromise test for linear multiple regression with a fixed model, R2 increase. Based on a medium effect size (.15); a Type-1 to Type-2 ratio of 1 (equal risk associated with each type of error); a sample size of 48 (listwise); 8 total predictor variables and 4 variables tested in the increase round the calculated power of the test is .79. The observed power is less than the recommended target of .80 offered by Field (2009). However, a 79% chance of not committing a Type-2 error for a medium level effect is acceptable for the current study.

Multiple Regression Results

To test the Hypothesis Statement six, a two-step, hierarchal multiple linear regression procedure was applied in SPSS. The results of the regression model and change statistics will be reported first followed by a summary of the tests of the relevant assumptions

The first step included intent to adopt as the dependent variable and perceptions of relative advantage, compatibility, complexity and observability as independent variables. The second step included the criterion coded variable for size of community as independent variable. Both steps used the forced enter procedure for all independent variables. For the first step only relative advantage was statistically significant below the .05 level, $F(4,43) = 11.247$, $p < .01$. For the second step relative advantage was again the only statistically significant predictor below the .05 level, $F(7,40) = 5.978$, $p < .01$. Table 24 shows the values of the coefficients including the constant for the two step procedure.

Table 24

Hypothesis 6, Coefficients.

	B	SE B	B
Step 1			
Constant	-5.516	2.381	
Relative Advantage	.254	.056	.718*
Compatibility	.024	.110	.034
Complexity	-.123	.089	-.160
Observability	-.049	.116	-.047
Step 2			
Constant	-5.575	3.518	
Relative Advantage	.253	.061	.717*
Compatibility	.025	.117	.035
Complexity	-.123	.091	-.160
Observability	-.049	.119	-.047
Size of Community	.016	.676	.003

Note: $R^2 = .511$ for Step 1, $\Delta R^2 = .000$ for step 2 ($p > .05$). * $p < .001$

The focus of Research Question 8 is how the size of the community impacts the relationship between code officials' intent to adopt and perceptions of relative advantage, compatibility, complexity and observability. To test the null hypothesis it is necessary to review the change statistics in the model summary. The change statistics report on the change in the R^2 value between steps in the model. Table 24 shows that the R^2 for step one is .511 and the change

in the R^2 for step two is .000. Therefore, there is no increase in the ability of the model to predict intent to adopt by adding size of community as a predictor variable. The change in the F statistic between the two steps is .001 ($p > .05$). Therefore, we retain the null hypothesis that there is no statistical significant change in the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC based on the size of a code official's community.

Multiple Regression Assumptions

The same assumptions presented for a multiple regression in the analysis of Research Question 7 will also be tested for Research Question 8. In response to assumption number 1, the independent variables for the first step are cumulative scores, representing ratio level data for each of the four categories (relative advantage, compatibility, complexity, and observability). Size of community which is the independent variable added in the second step is criterion coded categorical data. The dependent variable collected by means of the purchase probability scale (Juster 1966), also meets the criteria for quantitative analysis. In response to assumption 2, each of the independent variables display non-zero variance as was shown in Table 19 by their mean and standard deviation scores. The criterion coding for size of community introduces variance for the categorical level data.

Assumption 3 addresses multicollinearity of the independent variables. An initial review of the correlation coefficients in Table 23 shows a significant correlation between relative advantage and compatibility, relative advantage and complexity, compatibility and complexity, and complexity and observability. Field (2009) provides a 'ball park' guideline that correlations stronger than .80 indicate concerns of multicollinearity. The highest correlation, .732 between relative advantage and compatibility, is below the .80 threshold. Field (2009) and Norusis (2009)

also suggest using the tolerance value and its reciprocal, the variance inflation factor (VIF) to investigate multicollinearity. Tolerance and VIF coefficients are shown in Table 25. According to Field (2009) tolerance coefficients below .20 and VIF coefficients above 10 indicate areas of concern. With each of independent variables below this threshold, the assumption of multicollinearity is not violated.

Table 25

Hypothesis 6 Collinearity Coefficients.

Variable	Tolerance	VIF
Relative Advantage	.391	2.556
Compatibility	.419	2.386
Complexity	.836	1.196
Observability	.900	1.111
Size of Community	.828	1.208

Assumption 4 states that independent variables must be uncorrelated with external variables. The literature review revealed the five attributes of innovations as identified by Rogers (2003), four of which were used in to test Research Question 8. Although there is no way to guarantee that correlations with external variables do not exist, the researcher is aware of potential impact on the study and has made an effort to eliminate any possible influence.

Assumption 5 states that the variance of the residual terms should be constant. This assumption is tested by reviewing a scatterplot to visually verify that the data are randomly arranged and evenly disbursed around zero (Field, 2009). Figure 9 shows a scatterplot with the residual values. Although the left portion of the plot shows gradual increase in variance from left

to right, the balance of the plot shows randomly and evenly disturbed values. There is also no indication of a non-linear relationship between the dependent variable and the independent variables. Therefore, the assumption of homoscedasticity is not violated.

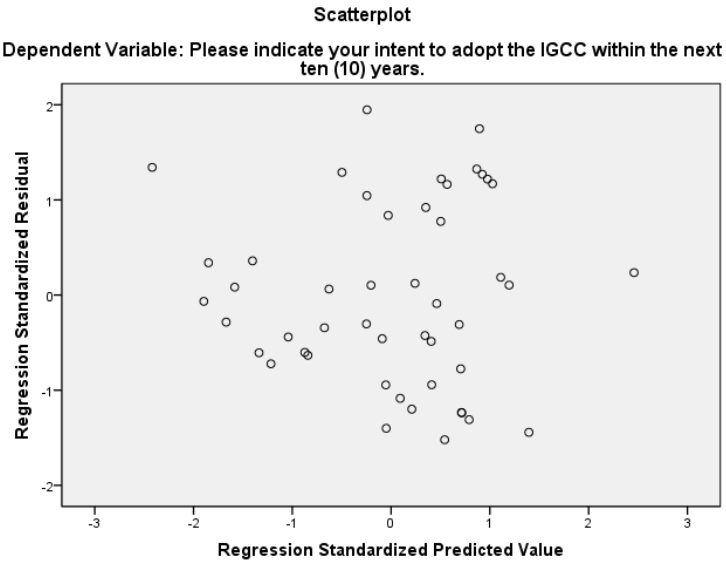

Figure 9. Hypothesis 6, scatterplot with residual terms.

Assumption #6 states that he residual terms for any two observations should be uncorrelated. This assumption is tested with the Durbin-Watson test (Field, 2009; Norusis, 2009). Possible values range from zero to four, with a value of two indicating no correlation between the residuals. The resulting value of the Durbin-Watson test is 1.76 indicating that the assumption is not violated.

Assumption #7 states that the residuals are random, normally distributed, and have a mean of zero. To test this assumption we can review a histogram and cumulative probability plot of the residuals (Field, 2009). Figure 10 shows the histogram with the residuals from the model. The residual values display a normal distribution and the mean value is very near the ideal mean score of zero.

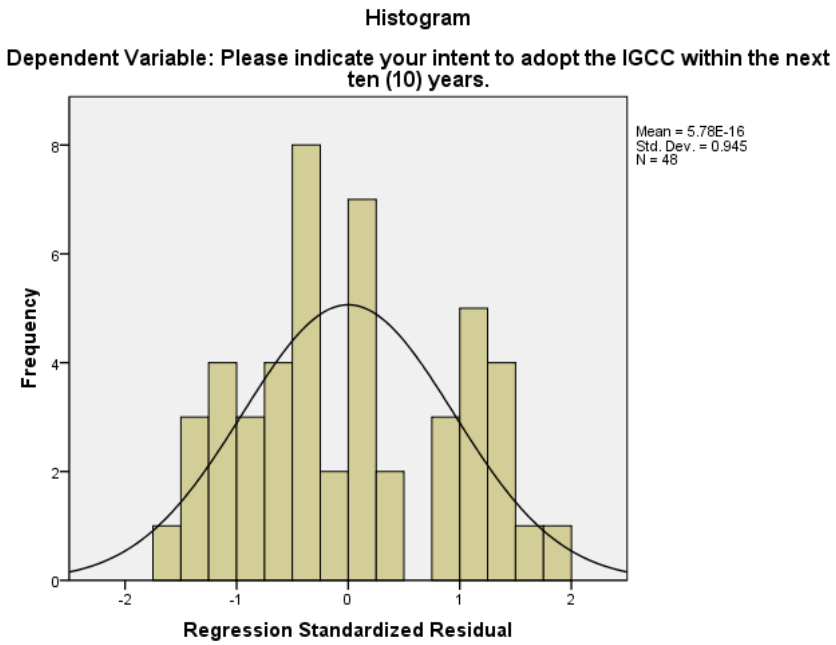

Figure 10. Hypothesis 6, histogram with residual values.

Figure 11 shows the P-P plot of the standardized residual values. There is only minor deviation from the straight line representing a normal distribution. The combined graphs of the residuals indicate that the assumption is not violated. Normality tests of the residuals support this conclusion (Shapiro-Wilk p = .063, Kolmogorov-Smirnov p = .200).

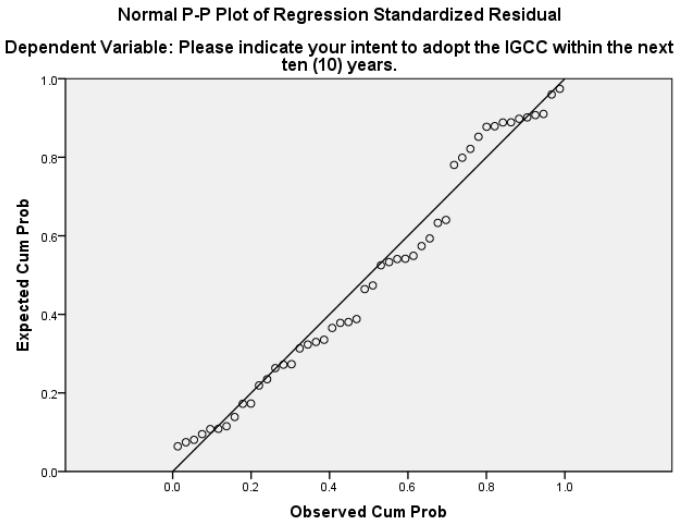

Figure 11. Hypothesis 6, P-P plot with residual values.

Assumption #8 states that all of the values of the dependent variable are independent. The data collection methodology supports this assumption. Assumption 9 states that the relationship between the dependent variables and independent variables are linear. This can be verified by viewing the partial plots of the dependent variable and each predictor. Figure 12 shows the regression plots for each independent variable. With the exception of relative advantage, the independent variables do not show a strong linear relationship with intent to adopt. However, there is no indication of a non-linear relationship.

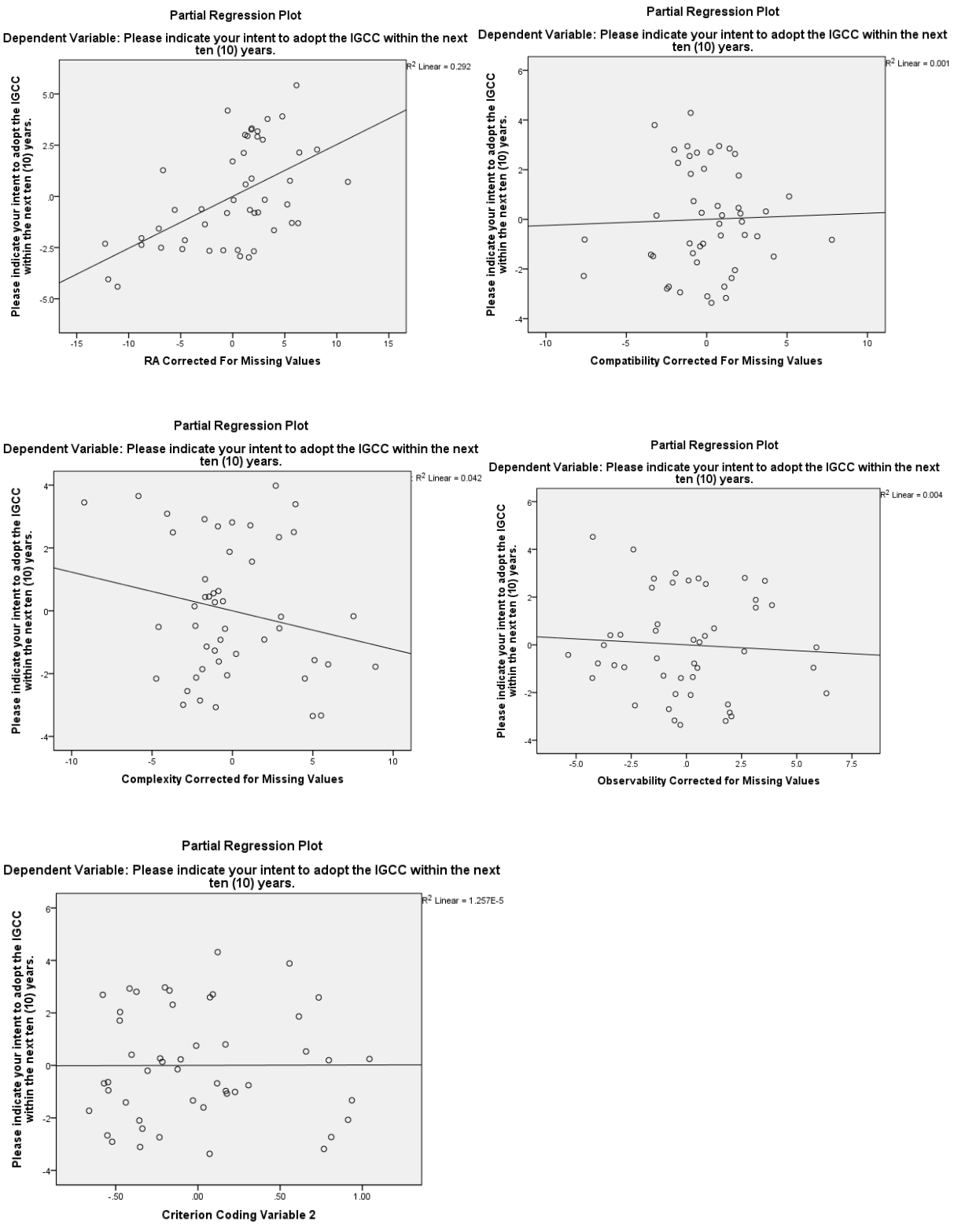

Figure 12. Hypothesis 6, partial plots of residuals.

Research Question 8 Summary

A two-step, hierarchal multiple linear regression procedure was used to test Hypothesis Statement six that looked for a significant change in the relationship between code officials' perceptions of relative advantage, compatibility, complexity and observability and intent to adopt the IGCC based on the size of a code official's community. The first step included relative advantage, compatibility, complexity and observability as independent variables and the second step added size of community as a criterion coded categorical independent variable. There was no change in the R^2 values between the first and second step indicating that size of community did not increase the ability of the model to predict intent to adopt. This is confirmed by the F-ratio change statistic of .01 ($p > .05$). Therefore, the null hypothesis that there is no change in the relationship is retained.

Summary

Chapter Four has presented a summary of the online survey of code officials and their perceptions of the IGCC. The demographic data and general survey questions provide insight on characteristics of the population under investigation. For Research Question 1 nearly 60% of code officials reported at least some knowledge of the IGCC. For Research Question 2 the majority of code officials reported a preference for the full adoption of the code rather than offering a trial period where the IGCC could be used on an elective basis.

Research Questions 3 through 6 investigated code officials' intent to adopt based on their perceptions of relative advantage, compatibility, complexity and observability. The independent samples t-test presented a statistically significant difference between groups with low and high perceptions of relative advantage based on their intent to adopt the IGCC. However, there was no

difference between groups with low and high perceptions of compatibility, complexity and observability based on their intent to adopt the IGCC.

For Research Question 7 a multiple regression analysis was used to test for a statistically significant relationship between code officials' perceptions of relative advantage, compatibility, complexity and observability and their intent to adopt the IGCC. In the final regression model, only relative advantage was shown to be a significant predictor of intent to adopt. Research Question 8 considered the relationship of the size of code officials' communities and their perceptions of relative advantage, compatibility, complexity and observability. The results of the two step multiple regression analysis did not indicate that size of community improved the ability of the model to predict code officials' intent to adopt. Further discussion and interpretation of these findings is included in Chapter Five.

CHAPTER FIVE

FINDINGS RECCOMENDATIONS AND CONCLUSIONS

The transition to a more sustainable built environment will require change in social, economic, and political-legislative spheres (Fraj-Andrés & Martínez-Salinas, 2007). The current study investigated the adoption of sustainable building codes which are one component of the political-legislative environment. The focus of the research was the IGCC, a new sustainable code offering from the ICC which became available in March 2012. This chapter will review the problem of the study, the research design and methodology. The findings of the study will also be discussed along with implications for the construction industry and recommendations for further research.

Problem, Research Design and Methodology

Although ICC model codes have enjoyed widespread adoption throughout the U.S., it is unknown to what extent the IGCC will be accepted by local jurisdictions. Furthermore, proponents of the IGCC have little data from which to formulate effective strategies to promote the adoption of the code. Following the available technology diffusion literature, the five-stage innovation decision model by Rogers (2003) and associated attributes that influence adoption were identified as the theoretical foundation for the study. Building on Rogers' work, several previous studies have used perceptions of relative advantage, compatibility, complexity, trialability and observability to model adoption behavior or intent to adopt an innovation (Bolton,

1980; Labay & Kinnear, 1981; Ostlund, 1974; Ozaki, 2011; Strutton & Lumpkin, 1994). Applying the existing theories and literature, the problem of the study was to investigate how the perceptions of building code officials influence their intent to adopt the IGCC.

The purpose of the study was to build a foundation of knowledge from which proponents of the IGCC and sustainable building codes can effectively address issues related to strategy formulation and policy development. The significance of the study cannot be overlooked based on the host of ecological concerns associated with the built environment. In addition, research has shown that the application of sustainable building regulation can be effective in addressing some of the contemporary ecological concerns facing this generation (Aroonruengsawat, Auffhammer, and Sanstad, 2012).

The following research questions were used to address the problem of the study:

1. How do code officials rate their level of knowledge of the IGCC?
2. What are code officials' preferences towards adopting the IGCC as an elective standard versus a mandatory standard?
3. To what extent do code officials' perceptions of relative advantage influence their intent to adopt the IGCC?
4. To what extent do code officials' perceptions of the compatibility of the IGCC with their current practices and values influence their intent to adopt the IGCC?
5. To what extent do code officials' perceptions of the complexity of IGCC influence their intent to adopt the IGCC?
6. To what extent do code officials' perceptions about the observability of the IGCC influence their intent to adopt the IGCC?

7. What is the relationship of code officials' perceptions of relative advantage, compatibility, complexity, and observability and their intent to adopt the IGCC?
8. To what extent does the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC vary based on the size of a code official's community?

The following hypothesis statements were formulated to address research questions 2 through 8:

1. H_{01} There is no statistical significant difference in intent to adopt based on code officials' perceptions of the relative advantage of the IGCC.
2. H_{02} There is no statistical significant difference in intent to adopt based on code officials' perceptions about the compatibility of the IGCC with their current practices and values.
3. H_{03} There is no statistical significant difference in intent to adopt based on code officials' perceptions of the complexity of the IGCC.
4. H_{04} There is no statistical significant difference in intent to adopt based on code officials' perceptions of the observability of the IGCC.
5. H_{05} There is no statistical significant relationship for intent to adopt the IGCC based on code officials' perceptions of relative advantage, compatibility, complexity, and observability.
6. H_{06} There is no statistical significant change in the relationship between perceptions of relative advantage, compatibility, complexity, and observability and intent to adopt the IGCC based on the size of a code official's community.

A descriptive research design employing a combination of correlational and descriptive survey elements was used to guide the study. From the existing literature, a survey instrument created by Moore and Benbasat (1991) was adapted to collect data on code officials' perceptions

of relative advantage, compatibility, complexity and observability. A six point Likert scale with answers ranging from strongly agree to strongly disagree was used to measure perceptions of each attribute. The survey also asked code officials to report their knowledge of the IGCC, intent to adopt the code and preferences towards adopting the code on an elective basis as opposed to mandatory enforcement. Prior to being administered, the survey instrument was examined for reliability by a panel of industry experts representing code officials, architects, professional constructors and academia. Concerns identified by the expert panel were addressed and incorporated into the final survey instrument. Prior to contacting the sample group, internal review board approval was obtained from Indiana State University and the University of Central Missouri.

The population for the study was code officials from Illinois, Kansas, Missouri and Nebraska. A random sample of 200 cities with a population of greater than 5,000 inhabitants was selected to be invited to participate in the online survey. Each city was contacted by telephone to collect e-mail addresses for code officials. An invitation e-mail informed code officials of the purpose of the study and explained their rights as research participants. The invitation also included a link to the online survey instrument. A total of 59 code officials participated in the study.

Once the data collection was closed, the raw data was compiled for analysis with SPSS software. The coding scheme for each question is embedded in the survey instrument shown in Appendix A. A combination of descriptive and inferential statistical techniques was used to analyze the data. Research Hypothesis 1 through 4 used an independent samples t- test and Mann-Whitney U Test. Research Hypothesis 5 & 6 used a multiple regression analysis

technique. A Type-1 error rate of .05 was used for hypothesis testing. G*Power software was used to perform a power analysis for each research hypothesis based on the obtained sample size.

Discussion of Findings

A total of 59 code officials from Illinois, Kansas, Missouri and Nebraska participated in the online building code survey. Chapter Four presented the general results and the analysis of the research questions. The following paragraphs will report a summary of the findings from this study.

Finding 1

Because the IGCC is new code offering, Research Question 1 was presented to collect data on how knowledgeable code officials were of the IGCC. Based on the 42 responses, 40.5% reported little or no knowledge, 50% reported some knowledge and 9.5% reported above average knowledge of the code. None of the respondents reported being highly knowledgeable of the IGCC.

While it is encouraging to note that nearly 60% of code officials had at least some knowledge of the code, the fact that 40.5% reported little or no knowledge indicates that there is an opportunity promote awareness and provide education to the building code community. Based on the role that knowledge plays in forming attitudes towards and innovation (Rogers, 2003), proponents of the IGCC should not overlook the unique opportunity to shape a positive opinion towards the code. It is also important to consider the potential consequences for failing to engage code officials who have yet to gain a working knowledge of the code.

Finding 2

Research Question 2 explored code officials' preferences towards adopting the IGCC on an elective basis as opposed to adoption as a mandatory standard. According to Rogers (2003),

the ability to use an innovation on a trial basis can accelerate the adoption process. However, complex "idea only" technologies in the regulatory environment (like the IGCC) do not lend themselves to trial periods. Rather than using a trial period, the ICC has reported many jurisdictions adopting the IGCC on an elective basis ("ICC – News Releases", 2012). These reports seem to indicate that the transition to the IGCC would require an initial period for use on an elective basis.

Three questions in the survey instrument addressed the adoption of the IGCC on an elective basis. For each of the three questions the majority of code officials reported a preference for full adoption of the IGCC without an elective trial period. However, none of the questions showed an overwhelming preference for full adoption versus using an elective trial period. Table 26 shows the findings of survey questions 44, 45 and 46.

Table 26

Elective vs. Mandatory Adoption.

Survey Question	Opposed to Elective Period	In Favor of Elective Period
44	61.2%	38.8%
45	57.4%	42.6%
46	60.4%	39.6%

Therefore, while some cities may choose to first adopt the code on an elective basis, the data do not show this to be a necessary step in the transition to widespread adoption. While these results appear to contradict press releases from the ICC reporting numerous cities that have adopted the code on an elective basis, there is no corresponding data available on the number of cities who are waiting to move to full adoption without an elective period.

Finding 3

Research Question 3 explored how perceptions of relative advantage influence code officials' intent to adopt the IGCC. A t-test for independent samples was used to test the null and alternative hypothesis statements. The results of the t-test indicated that there was a significant difference between code officials with low perceptions of relative advantage and code officials with high perceptions of relative advantage based on their intent to adopt, $t_{(49)} = 4.786$, $p = .000$ (2-tailed). Therefore, the null hypothesis was rejected and the alternate hypothesis was retained. While the assumption of normality of the dependent variable was violated, the distribution did not show significant skewness or kurtosis. To address concerns over the violation of the normality assumption, a non-parametric Mann-Whitney U test was also performed. The results of the Mann-Whitney U test confirmed the t-test results, $Z = -4.266$, $p = .000$ (2-tailed).

The results of the hypothesis test are consistent with the contemporary literature that shows relative advantage to be one of the most significant predictors of adoption behavior and intent to adopt (Bolton, 1980; Labay & Kinnear, 1981; Ostlund, 1974; Ozaki 2011).

Finding 4

Research Question 4 explored how perceptions of compatibility influence code officials' intent to adopt the IGCC. A t-test for independent samples was used to test the null and alternative hypothesis statements. The results of the t-test indicated that there was no significant difference between code officials with low perceptions of compatibility and code officials with high perceptions of compatibility based on their intent to adopt, $t_{(50)} = 1.590$, $p = .118$ (2-tailed). Therefore, the null hypothesis was retained. As with Research Question 3, a Mann-Whitney U test was performed and the results confirmed the t-test, $Z = -1.883$, $p = .060 > .05$ (2-tailed).

Although compatibility is typically found to be a strong predictor of adoption behavior second only to relative advantage (Bolton, 1980; Ostlund, 1974) the results of this study do not show a significant relationship. It is important to note that the hypothesis test used the cumulative score for perceptions of compatibility. Therefore, it is possible that one or more of the sub-dimensions of compatibility (Rogers, 2003) could have a significant influence on intent to adopt. This issue will be addressed in greater detail in the Recommendations for Future Research.

Finding 5

Research Question 5 explored how perceptions of complexity influence code officials' intent to adopt the IGCC. A t-test for independent samples was used to test the null and alternative hypothesis statements. The results of the t-test indicated that there was no significant difference between code officials with low perceptions of complexity and code officials with high perceptions of complexity based on their intent to adopt, $t_{(48)} = 1.943$, $p = .058$ (2-tailed). Therefore, the null hypothesis was retained. As with Research Questions 3 and 4, a Mann-Whitney U test was performed and the results confirmed the t-test, $Z = -1.850$, $p = .064 > .05$ (2-tailed).

The existing literature indicates that complexity is a strong predictor of adoption behavior (Labay & Kinnear, 1981; Ostlund, 1974; Ozaki, 2011). However, not only was there no significant difference in intent to adopt based on perceptions of complexity, the Pearson correlation coefficients (Table 20) shows that complexity had the lowest correlation with intent to adopt. In addition, the correlation coefficient of complexity with intent to adopt was also positive. This is an unexpected result as one would assume a negative relationship between

adoption behavior and perceptions of complexity (higher perceptions of complexity lead to lower intent to adopt). This is especially true for an entirely new code standard such as the IGCC.

One explanation for the findings could be found in code officials' level of knowledge of the IGCC. From Finding 1 we see that 40.5% of code officials reported little or no knowledge of the IGCC. The balance reported some knowledge and none reported being highly knowledgeable. Therefore, as knowledge of the IGCC increases, it is possible that the relationship between perceptions of complexity and intent to adopt could change as well.

Finding 6

Research Question 6 explored how perceptions of observability influence code officials' intent to adopt the IGCC. A t-test for independent samples was used to test the null and alternative hypothesis statements. The results of the t-test indicated that there was no significant difference between code officials with low perceptions of observability and code officials with high perceptions of observability based on their intent to adopt, $t_{(47)} = -.434$, $p = .666$ (2-tailed). Therefore, the null hypothesis was retained. As with Research Questions 3,4 and 5 a Mann-Whitney U test was performed and the results confirmed the t-test, $Z = -.344$, $p = .731 > .05$ (2-tailed).

The results of the hypothesis tests appear to be consistent with the existing literature. Although observability can be a significant predictor of adoption (Ostlund, 1974), many studies report the variable as not significant (Bolton, 1980; Labay & Kinnear. 1981). However, proponents of sustainable building codes should not overlook opportunities to promote successful adoption efforts and to share lessons learned in the adoption process.

Finding 7

Research Question 7 investigated the relationship between intent to adopt and perceptions of relative advantage, compatibility, complexity and observability. Rather than consider each attribute individually as was done with Research Questions 3 through 6, Question 7 included all four attributes in a multiple linear regression model. The findings indicate that there is a significant relationship for predicting intent to adopt, $F(4,44) = 11.134$, $p < .01$. Therefore, the null hypothesis was rejected and the alternate hypothesis was retained. However, relative advantage was the only significant predictor variable. The final regression equation for intent to adopt based on the full regression model was:

$$\text{Intent to Adopt} = -5.767 + (.547 * \text{Relative Advantage}) + (.016 * \text{Compatibility}) + (-1.08 * \text{Complexity}) + (-.063 * \text{Observability})$$

Table 20 reported the Pearson correlations coefficients for each of the four attributes and intent to adopt. Relative advantage and compatibility had significant correlation coefficient values and complexity and observability coefficients were not significant. It is interesting to note that although compatibility has a significant correlation with intent to adopt, it was not a significant predictor in the full regression model. Therefore, after accounting for the shared variance with relative advantage, compatibility no longer made a significant contribution to the model equation.

Although it is surprising that compatibility did not make a significant contribution to the regression model, the findings are not inconsistent with the literature review. Ostlund (1974) reported relative advantage to be a stronger predictor of adoption than compatibility. Several studies also reported that complexity and observability were weaker predictors of adoption (Bolton, 1980, Ostlund, 1974).

Finding 8

Research Question 8 explored the influence of the size of a code official's community on the relationship between relative advantage, compatibility, complexity and observability and intent to adopt the IGCC. The results of the two step, hierarchal multiple linear regression procedure showed that size of community did not improve the ability of the model to predict intent to adopt, F change = .001 ($p > .05$). Therefore, the null hypothesis was retained.

Not only was there no significant change in the model based on size of community, the R^2 values for the first and second step were identical indicating that the procedure was unable to detect any change in the predictive power of the model. These findings are surprising as one would expect code officials from larger communities to have more organizational slack (Rogers, 2003) and thus be more open to innovations.

Implications for Practice

The results of this study will benefit proponents of the IGCC who apply the findings towards effective strategy formulation and policy development. As the focus of the study was four Midwestern states, individuals from outside of this region should be cautious in applying the findings. However, the knowledge gained should serve as a starting point from which a more comprehensive understanding is established. The findings may also be of assistance to individuals wishing to promote the adoption of similar sustainable building codes or any type of building regulation.

While the majority of participants reported some knowledge of the IGCC, proponents should continue efforts to increase code officials' knowledge of the code. This should include general awareness knowledge and more comprehensive knowledge of how the code is applied. When contacting code officials to collect their e-mail address, many reported that they had

received a complimentary copy of the IGCC from the ICC. It appears that this technique was effective in increasing the awareness knowledge of the new code.

The study also provides a better understanding of how code officials view the elective adoption of the code as opposed to mandatory enforcement. The findings indicate that the majority of code officials prefer full adoption of the code over a phased adoption process that includes an initial elective period. Although this is in contrast to numerous reports of jurisdictions adopting the ICC on an elective basis, it is not inconsistent with a logical understanding of the code adoption process. It requires a significant amount of effort for code officials to learn a new code and to develop a working knowledge with designers and contractors. Once the commitment has been made to learn the new code it would be inefficient to apply that knowledge on a select number of projects at the discretion of the building owner. However, approximately 40% of respondents did indicate a preference for an elective period prior to mandatory adoption. Therefore, proponents of the IGCC should also be aware that adoption on an elective basis is an important step for many code officials.

Based on the survey results, proponents should focus on promoting the relative advantage of the IGCC. Relative advantage was the single attribute that was significant in predicting intent to adopt. The survey instrument explored several sub-dimensions of relative advantage. They include economic impacts for building owners, social pressure and prestige associated with adoption, benefits over alternative code options, immediacy of benefits from adoption and economic impacts for cities that choose to adopt. These sub-dimensions should be taken into consideration in promotion efforts.

While relative advantage was the single significant predictor, perceptions of compatibility and complexity should not be overlooked. Compatibility was shown to have a

strong correlation with intent to adopt. Although it would be difficult to influence perceptions of compatibility, it appears to be a good indicator of where to focus resources when promoting sustainable codes. At present, perceptions of complexity do not appear to be a barrier to adoption. However, as a more comprehensive knowledge of the code is acquired, it is possible that perceptions of complexity could ultimately influence intent to adopt. This observation is supported by anecdotal comments from code officials that will be discussed in the Recommendations for Future Research.

The findings indicate that taking account for the size of a code official's community does not improve the ability to predict intent to adopt. While a significant result would have been beneficial in knowing where to allocate resources for promoting the code, it is encouraging to see that communities of any size appear to be candidates for adoption.

Finally, it is important to reiterate that while code officials were the focus of this study, they are not solely responsible for the adoption of new codes. Elected officials, designers, contractors and the community at large also play a role in changes to the regulatory environment. Change agents should not overlook the larger organization context in the strategy formulation process.

Recommendations for Future Research

The research conducted for this study was designed to provide a better understanding of how code officials view sustainable building regulations like the IGCC and how those views could shape adoption behaviors. In addition to answering key questions related to this topic, additional avenues for further research were also uncovered. The following recommendations are offered to promote the expansion of the body of knowledge in technology management, construction technology and building code studies.

The population for the current study included code officials from Illinois, Kansas, Missouri, and Nebraska. While the findings do provide valuable new knowledge, it is not prudent to assume that they are equally applicable across the U.S. A large scale replication of the current study incorporating all 50 states would provide more generalizable information from which to draw inferences.

A larger sample group would also allow for a more in depth investigation of the unique sub-dimensions of each of the five attributes of innovation without a loss of statistical power. The current study included 32 questions for the 4 attributes under investigation. Based on the 59 responses obtained for the current study, any analysis of the individual questions would yield a low statistical power. However, a larger sample group would allow a researcher to consider which components of relative advantage are the best predictors of intent to adopt. One could also consider each of the non-significant attributes in greater detail to see, for example, if some aspects of complexity are actually significant predictors of intent to adopt.

Prior to data collection the researcher contacted each of the cities in the sample group to introduce the study and collect e-mail addresses. While this phase of the study was not intended for data collection, many of the code officials provided voluntary feedback and expressed a desire for additional research related to building codes. Several code officials expressed concerns over the increased complexity of the ICC model codes. More than one code official commented that “you have to be a registered Architect or Engineer to keep up with the new codes”. As an anecdotal observation, it appeared that these concerns were mainly voiced by code officials from smaller communities. Another potential area of study that was also identified by code officials was the transition from traditional prescriptive codes to performance based codes.

A final area for further research would be an investigation of the relationship of code officials' level of knowledge of the IGCC and the four attributes of an innovation. The literature review identified that knowledge of an innovation plays a critical role in the formation of perceptions of attributes. While the existing survey instrument was designed to collect data to explore this relationship, an error in the online survey design did not allow the researcher to link code officials' knowledge of the code to their perceptions of relative advantage, compatibility, complexity and observability. Future investigations could explore how varying levels of knowledge of the IGCC influence code officials' intent to adopt.

Summary

Building regulations will be an important component of the transition to a sustainable built environment. Although they are not the sole decision maker, code officials play a critical role in shaping the regulatory environment at the local level and thus were the focus of this inquiry. This study built on previous research in the field of technology diffusion and should be used to support the efforts of proponents of the IGCC. The findings should also provide a foundation for much needed research related to sustainable building code diffusion and adoption.

REFERENCES

Arensberg, C. M., & Niehoff, A. H. (1964). *Introducing social change: A manual for Americans overseas.* Chicago, IL: Aldine Publishing Company.

Aroonruengsawat, A., Auffhammer, M., & Sanstad, A. H. (2012). The impact of state level building codes on residential electricity consumption. *Energy Journal, 33*(1), 31-52. doi:10.5547/ISSN0195-6574-EJ

Bolton, W. T., Jr. (1981). *The perception and potential adoption of channel 2000: Implications for diffusion theory and videotex technology* (Doctoral dissertation). Available from ProQuest Dissertations and Theses database. (UMI No. 303151846)

Building Officials & Code Administrators International, Inc. (1993). *BOCA International: The model code of choice.* Country Club Hills, IL: Building Officials & Code Administrators International, Inc.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). New York: Routledge.

Dattalo, P. (2008). *Determining sample size: Balancing power, precision, and practicality.* New York: Oxford University Press, Inc.

Downs, A. (1972). Up and down with ecology – the "issue-attention cycle". *Public Interest, 28*, 38-50.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175-191. Retrieved from http://www.springer.com/psychology/cognitive+psychology/journal/13428

Field, A. (2009). *Discovering statistics using SPSS (and sex and drugs and rock 'n' roll)* (3rd ed.). London: Sage Publications Ltd.

Fink, A. (2006). *How to conduct surveys: A step-by-step guide* (3rd ed.). Thousand Oaks, CA: Sage Publications Inc.

Fraj-Andrés, E., & Martínes-Salinas, E. (2007). Impact of environmental knowledge on ecological consumer behavior: An empirical analysis. *Journal of International Consumer Marketing, 19*(3), 73-102. doi:10.1300/J046v19n03_05

Gay, L. R. (1976). *Educational research: Competencies for analysis and application.* Columbus, OH: Merrill Publishing Co.

Goodman, R. M., & Steckler, A., (1989). A model for the institutionalization of health promotion programs. *Family and community health. 11*(4), 63-78.

Hanna, G. B. (2011). Energy efficiency building codes for Egypt. *Journal of Energy and Power Engineering, 5*(12), 1134-1141.

Hayden, M.A. (2008). *Multi-factor ANOVA and multiple regression.* Terre Haute, IN: Quality Council of Indiana.

International Code Council (2007). *Building department administration* (3rd ed.). Country Club Hills, IL: ICC Publications.

International Code Council (2012). *News Releases*. Retrieved from http://www.iccsafe.org/newsroom/Pages/IGCCNews.aspx

International Code Council (2009). *News Release, June 29, 2009*. Retrieved from http://www.iccsafe.org/newsroom/News%20Releases/0629_IGCC.pdf

Juster, T. F. (1966). Consumer buying intentions and purchase probability: An experiment in survey design. *Journal of the American Statistical Association, 61*(315), 658-696.

Kibert, C. J. (2008). *Sustainable construction: Green building design and delivery* (2nd ed.). Hoboken, NJ: John Wiley & Sons, Inc.

Labay, D. G., & Kinnear, T. C. (1981). Exploring the consumer decision process in the adoption of solar energy systems. *Journal of Consumer Research, 8*, 271-278.

Leedy, P.D., & Ormrod, J.E. (2005). *Practical research: Planning and design* (8th ed.). Upper Saddle River, NJ: Pearson Education Inc.

Mason, R.D., Lind, D.A., & Marchal, W.G. (1988). *Statistics: An introduction* (2nd ed.). Orlando, FL: Harcourt Brace Jovanovich, Inc.

Merriam-Webster (1993). *Webster's third new international dictionary of the English language unabridged*. Springfield, MA: Merriam-Webster Inc.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research, 2*(3), 192-222.

Norušis, M. J. (2009). *PASW statistics 18: Statistical procedures companion.* Upper Saddle River, NJ: Prentice Hall Inc.

Online Code Enforcement and Advocacy Network (2012). *Illinois energy conservation code*. Retrieved from http://energycodesocean.org/code-information/illinois-energy-conservation-code

Online Code Enforcement and Advocacy Network (2012). *Kansas commercial building code.* Retrieved from http://energycodesocean.org/code-information/kansas-commercial-building-code

Online Code Enforcement and Advocacy Network (2012). *Missouri.* Retrieved from http://energycodesocean.org/state-country/missouri

Online Code Enforcement and Advocacy Network (2012). 2011 *Nebraska energy code.* Retrieved from http://energycodesocean.org/code-information/2011-nebraska-energy-code

Online Code Enforcement and Advocacy Network (2012). *State and federal policy.* Retrieved from http://energycodesocean.org/research-topic/state-and-federal-policy

Ostlund, L. E. (1974). Perceived innovation attributes as predictors of innovativeness. *Journal of Consumer Research*. *1*(2), 23-29.

Ozaki, R. (2011). Adopting sustainable innovation: What makes consumers sign up to green electricity? *Business Strategy and the Environment*, *20*(1), 1-17. doi:10.1002/bse.650

Owens, B. (2010). LEED & green building codes. *ASHRAE Journal*, *52*(6), S6-S8.

Robertson, T. S. (1971). *Innovative behavior and communication*. New York: Holt, Rinehart and Winston, Inc.

Rogelberg, S. G., & Luong, A. (1998). Nonresponse to mailed surveys: A review and guide. *Current Directions in Psychological Science*, *7*(2), 60-65. doi:10.1111/1467-8721.ep13175675

Rogers, E.M. (2003). *Diffusion of innovations* (5th ed.). New York: The Free Press.

Roof, K., & Oleru, N. (2008). Public health: Seattle and King County's push for the built environment. *Journal of Environmental Health*, *71*(1), 24-27.

Roscoe, J.T. (1975). *Fundamental research statistics for the behavioral sciences* (2nd ed.). New York: Holt, Rinehart and Winston.

Salkind, N. J. (2007). *Statistics for people who (think they) hate statistics* (Excel ed.). Thousand Oaks, CA: Sage Publications, Inc.

Schön, D. A. (1963). Champions for radical new inventions. *Harvard Business Review, 41*(2), 77-86.

Schumacker, R. E., Williams, J. D. (1993). Teaching ordinal and criterion scaling in multiple regression. *Multiple Linear Regression Viewpoints*, *20*(1), 25-31. Retrieved from http://mlrv.ua.edu/

Schwarz, N. (1999). Self-reports: How the questions shape the answers. *American Psychologist, 54*(2), 93-105. doi:10.1037/0003-066X.54.2.93

Strutton, H. D., & Lumpkin, J. R. (1994). An applied investigation or Rogers and Shoemaker's perceived innovation attribute typology when marketing to elderly consumers. *Journal of Applied Business Research, 10*(1), 118-131.

United Nations (1987). *Report of the world commission on environment and development: Our common future*. Retrieved from http://www.un-documents.net/wced-ocf.htm

U.S. Census Bureau (2012). *State and county quick facts.* Retrieved from http://quickfacts.census.gov/qfd/index.html

U.S. Green Building Council (2012). *About USGBC.* Retrieved from http://www.usgbc.org/DisplayPage.aspx?CMSPageID=124

U.S Green Building Council (2012). *What is LEED.* Retrieved from http://new.usgbc.org/leed

Volti, R. (1995). *Society and technological change* (3rd ed.). New York: St. Martin's Press.

Walker, J. L., (1977). Setting the agenda in the U.S. Senate: A theory of problem selection. *British Journal of Political Science. 7*, 423-445.

Wilcox, R. R. (2005). *Introduction to robust estimation and hypothesis testing* (2nd ed.). Burlington, MA: Elsevier.

Wildemuth, B. M. (1992). An empirically grounded model of the adoption of intellectual technologies. *Journal of the American Society for Information Science*, *43*(3), 210-224.

Yatt, B. D. (1998). *Cracking the codes.* New York: John Wiley & Sons, Inc.

Zaltman, G., Duncan, R., & Holbek, J., (1973). *Innovations and organizations.* New York: John Wiley and Sons.

APPENDIX A: SURVEY INSTRUMENT WITH SPSS CODING

Welcome Page

Welcome and thank you for participating in the study.

Many of the following questions deal with the International Green Construction Code (IGCC). The International Green Construction Code (IGCC) is a relatively new code offering by the International Code Council (ICC) and should not be confuses with the International Energy Conservation Code (IECC).

Some participants have been reluctant to participate because they have very little knowledge of the International Green Construction Code (IGCC). However, it is important to collect surveys from code officials with both high and low levels of knowledge of the code and their associated perceptions of sustainable building codes.

Thank you again for your participation. Please proceed to the next page.

Demographic Data Page

The following question will collect general demographic data. Please answer each question before moving ahead to the next page.

1. What State do you work in?
    - Illinois (1)
    - Kansas (2)
    - Missouri (3)
    - Nebraska (4)

2. How many years of experience do you have as a building code official?
    - 0 – 5 years (1)
    - 5 – 10 years (2)
    - 10 – 20 years (3)
    - Over 20 years (4)

3. Post-Secondary education level (number of years completed).
    - 0 – 1 (1)
    - 2 – 4 (2)
    - 5 – 6 (3)
    - 7 – 8 (4)
    - 9 + (5)

4. What is your highest degree earned?
    - None (1)
    - Certificate (2)
    - Associate (3)
    - Bachelor (4)
    - Masters (5)
    - Doctorate (6)
    - Other (please specify) (7)

5. What is the approximate size of the community in which you work?
    - 5,000 – 10,000 (1)
    - 10,000 – 20,000 (2)
    - 20,000 – 50,000 (3)
    - Over 50,000 residents (4)

Building Code Data Page

The following question will collect data related to your role as a Building Code Official and the use of building codes in your city. Please answer each question before moving ahead to the next page.

6. Which of the following best describes your current title and responsibilities?
    - Building Official (1)
    - Plan Reviewer (2)
    - Building Inspector (3)
    - Senior Code Official (4)

7. Does your city currently use the International Code Council (ICC) model codes for commercial new construction projects?
    - Yes (1)
    - No (2)

Required Energy and Sustainable Code Page 1

8. Does your city require commercial new construction and renovation projects to adhere to an energy or sustainable code?
    - Yes (go to question 9) (1)
    - No (go to question 10) (2)

Required Energy and Sustainable Code Page 2

9. Please indicate which energy or sustainable building code your city requires for commercial new construction and renovation projects.
    - o International Energy Conservation Code (IECC) (2)
    - o International Green Construction Code (IGCC) (3)
    - o Other (please specify) (4)

Elective Energy and Sustainable Code Page 1

10. Does your city currently promote the use of an energy or sustainable building code standard for commercial new construction and renovation projects on an elective basis (not mandatory)?
    - o Yes (go to question 11) (2)
    - o No (go to question 12) (3)

Elective Energy and Sustainable Code Page 2

11. Please indicate which energy or sustainable building code your city promotes for commercial new construction and renovation projects on an elective basis.
    - o International Energy Conservation Code (IECC) (2)
    - o International Green Construction Code (IGCC) (3)
    - o Other (please specify) (4)

Knowledge of the International Green Construction Code (IGCC) Page

12. The International Green Construction Code (IGCC) is a relatively new offering by the International Code Council. It is a distinct code standard and separate from the International Energy Conservation Code (IECC) that has been in existence for many years. Using the following options, please rate your level of knowledge of the International Green Construction Code (IGCC).
    - o Little or No Knowledge (1)
    - o Some Knowledge (2)
    - o Above Average Knowledge (3)
    - o Highly Knowledgeable (4)

Intent to Adopt Page

The following three questions will explore your intent to adopt the International Green Construction Code (IGCC).

13. The adoption of a new code is a collective decision that is made with many individuals. However, if you had the sole discretion to adopt building codes for your city, please indicate your intent to adopt the International Green Construction Code (IGCC) within the next two (2) years.
    - o No chance, almost no chance (1 in 100) (1)
    - o Very slight possibility (1 in 10) (2)
    - o Slight possibility (2 in 10) (3)
    - o Some possibility (3 in 10) (4)
    - o Fair possibility (4 in 10) (5)
    - o Fairly good possibility (5 in 10) (6)
    - o Good possibility (6 in 10) (7)
    - o Probable (7 in 10) (8)
    - o Very probable (8 in 10) (9)
    - o Almost sure (9 in 10) (10)
    - o Certain, practically certain (99 in 100) (11)

14. The adoption of a new code is a collective decision that is made with many individuals. However, if you had the sole discretion to adopt building codes for your city, please indicate your intent to adopt the International Green Construction Code (IGCC) within the next five (5) years.
    - o No chance, almost no chance (1 in 100) (1)
    - o Very slight possibility (1 in 10) (2)
    - o Slight possibility (2 in 10) (3)
    - o Some possibility (3 in 10) (4)
    - o Fair possibility (4 in 10) (5)
    - o Fairly good possibility (5 in 10) (6)
    - o Good possibility (6 in 10) (7)
    - o Probable (7 in 10) (8)
    - o Very probable (8 in 10) (9)
    - o Almost sure (9 in 10) (10)
    - o Certain, practically certain (99 in 100) (11)

15. The adoption of a new code is a collective decision that is made with many individuals. However, if you had the sole discretion to adopt building codes for your city, please indicate your intent to adopt the International Green Construction Code (IGCC) within the next ten (10) years.
    - o No chance, almost no chance (1 in 100) (1)
    - o Very slight possibility (1 in 10) (2)
    - o Slight possibility (2 in 10) (3)
    - o Some possibility (3 in 10) (4)
    - o Fair possibility (4 in 10) (5)
    - o Fairly good possibility (5 in 10) (6)
    - o Good possibility (6 in 10) (7)
    - o Probable (7 in 10) (8)
    - o Very probable (8 in 10) (9)
    - o Almost sure (9 in 10) (10)
    - o Certain, practically certain (99 in 100) (11)

Relative Advantage Page 1

Please answer the following questions about the relative advantages (disadvantages) of adopting the International Green Construction Code (IGCC). Note: The following questions deal with the International Green Construction code (IGCC) and should not be confused with perceptions of the International Energy Conservation Code (IECC).

16. Adopting the International Green Construction Code (IGCC) will benefit building owners through lower energy costs and improved environmental conditions.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

17. Adopting the International Green Construction Code (IGCC) will hurt the image of my city.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

18. The initial costs associated with building in accordance to the International Green Construction Code (IGCC) will be prohibitive for building owners.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

19. Adopting the International Green Construction Code (IGCC) would be more beneficial than alternative sustainable codes such as the LEED Standard and the International Energy Conservation Code (IECC).
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

20. The initial cost associated with adopting the International Green Construction Code (IGCC) will be prohibitive for my city.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

Relative Advantage Page 2

Please answer the following questions about the relative advantages (disadvantages) of adopting the International Green Construction Code (IGCC). Note: The following questions deal with the International Green Construction code (IGCC) and should not be confused with perceptions of the International Energy Conservation Code (IECC).

21. Adopting International Green Construction Code (IGCC) will have a minimal initial cost for my city.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

22. Adopting the International Green Construction Code (IGCC) will have little impact or may diminish my image among my peers in the code enforcement community.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

23. Benefits associated with adopting the International Green Construction Code (IGCC) are not immediate and will only be apparent after many years.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

24. Adopting the International Green Construction Code (IGCC) will have a minimal impact on the initial cost of construction for building owners.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

25. Alternatives to the International Green Construction Code (IGCC) such as the LEED Standard and the International Energy Conservation Code (IECC) are better suited to my city.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

Relative Advantage Page 3

Please answer the following questions about the relative advantages (disadvantages) of adopting the International Green Construction Code (IGCC). Note: The following questions deal with the International Green Construction code (IGCC) and should not be confused with perceptions of the International Energy Conservation Code (IECC).

26. Adopting the International Green Construction Code (IGCC) will improve the image of my city.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

27. Sustainable building regulations such as the International Green Construction Code (IGCC) have a minimal benefit for owners in respect to energy costs and the environment.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

28. Adopting the International Green Construction Code (IGCC) will improve my image among my peers in the code enforcement community.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

29. Building owners, my city and the world will begin to realize benefits shortly after adopting the International Green Construction Code (IGCC).
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

30. I feel pressure from the local community to adopt a comprehensive sustainable building code such as the International Green Construction Code (IGCC).
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

31. Members of my community are opposed to comprehensive sustainable building regulations such as the International Green Construction Code (IGCC).
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

Compatibility Page 1

Please answer the following questions about the compatibility of the International Green Construction Code (IGCC) with your current practices and values. Note: The following questions deal with the International Green Construction code (IGCC) and should not be confused with perceptions of the International Energy Conservation Code (IECC).

32. Adopting sustainable codes such and the International Green Construction Code (IGCC) is compatible with the culture of my city.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

33. Any type of additional regulation including the International Green Construction Code (IGCC) would be resisted by my city.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

34. The International Green Construction Code (IGCC) is a solution that is compatible with the current needs of my city.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

Compatibility Page 2

Please answer the following questions about the compatibility of the International Green Construction Code (IGCC) with your current practices and values. Note: The following questions deal with the International Green Construction code (IGCC) and should not be confused with perceptions of the International Energy Conservation Code (IECC).

35. My city is open to additional regulation in the form of the International Green Construction Code (IGCC) or other comprehensive sustainable building codes.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

36. The culture of my city is not consistent with sustainable codes such as the International Green Construction Code (IGCC).
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

37. There is little need for the International Green Construction Code (IGCC) or similar comprehensive sustainable building codes in my city.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

Complexity Page 1

Please answer the following questions about the complexity (ease of use and adoption) of the International Green Construction Code (IGCC). Note: The following questions deal with the International Green Construction code (IGCC) and should not be confused with perceptions of the International Energy Conservation Code (IECC).

38. I believe that the International Green Construction Code (IGCC) will be difficult to use.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

39. Learning new code standards is easy for me.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

40. I expect that following the International Green Construction Code (IGCC) will require a lot of extra effort.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

Complexity Page 2

Please answer the following questions about the complexity (ease of use and adoption) of the International Green Construction Code (IGCC). Note: The following questions deal with the International Green Construction code (IGCC) and should not be confused with perceptions of the International Energy Conservation Code (IECC).

41. As a code official, my role in administering the International Green Construction Code (IGCC) is clear and understandable.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

42. Overall, I believe that the International Green Construction Code (IGCC) will be easy to use.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

43. Adopting a new code standard is often frustrating for me as a code official.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

Trialability Page

Please answer the following questions about the trialability (ability to experiment with) of the International Green Construction Code (IGCC). Note: The following questions deal with the International Green Construction code (IGCC) and should not be confused with perceptions of the International Energy Conservation Code (IECC).

44. Prior to adopting the International Green Construction Code (IGCC) or similar sustainable building code as a mandatory standard, it would be necessary to adopt the code on an elective basis for a trial period.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

45. The transition to a mandatory sustainable code such as the International Green Construction Code (IGCC) would not require a trial period where the code would be applied on an elective basis.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

46. Adopting the International Green Construction Code (IGCC) on an elective basis would be more trouble than it is worth. I would prefer full adoption of a new code and no elective trial period.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

Observability Page 1

Please answer the following questions about the observability (ability to observe the benefits) of the International Green Construction Code (IGCC). Note: The following questions deal with the International Green Construction code (IGCC) and should not be confused with perceptions of the International Energy Conservation Code (IECC).

47. I have been able to observe other cities that have adopted the International Green Construction Code (IGCC) or similar comprehensive sustainable code standard.
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

48. It is difficult to observe how other code officials are using the International Green Construction Code (IGCC).
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

Observability Page 2

Please answer the following questions about the observability (ability to observe the benefits) of the International Green Construction Code (IGCC). Note: The following questions deal with the International Green Construction code (IGCC) and should not be confused with perceptions of the International Energy Conservation Code (IECC).

49. I have not observed other cities that have adopted the International Green Construction Code (IGCC) or similar sustainable code standard.
    - o Strongly Agree (1)
    - o Agree (2)
    - o Somewhat Agree (3)
    - o Somewhat Disagree (4)
    - o Disagree (5)
    - o Strongly Disagree (6)

50. It is easy for me to observe how other code officials are using the International Green Construction Code (IGCC).
    - o Strongly Agree (6)
    - o Agree (5)
    - o Somewhat Agree (4)
    - o Somewhat Disagree (3)
    - o Disagree (2)
    - o Strongly Disagree (1)

APPENDIX B: INFORMED CONSENT LETTER

Sustainable Building Codes: How the Perceptions of Building Code Officials' Influence their Intent to Adopt the International Green Construction Code

You are being invited to participate in a research study about how building code officials view sustainable building codes and their intent to adopt sustainable codes. This study is being conducted by Aaron Sauer (Principal Investigator) and Dr. Ronald C. Woolsey (Faculty Advisor), from the College of Technology at Indiana State University. This study is being conducted as a dissertation as part of a Doctorate program. No external or internal funding support is being provided.

You were selected as a possible participant in this study because you have been identified as a building code official from Illinois, Kansas, Missouri, or Nebraska. All participants have been randomly selected from a comprehensive list of cities with a population over 5,000 inhabitants.

There are no known risks if you decide to participate in this research study. There are no costs to you for participating in the study. The information you provide will be used to promote the adoption of new code standards across the country. The questionnaire will take about fifteen minutes to complete. The information collected may not benefit you directly, but the information learned in this study should provide more general benefits.

This survey is anonymous. Do not fill in your name at any point in the survey. While absolute anonymity cannot be guaranteed over the Internet, no efforts will be made by the researcher to collect your IP address or any other identifiable information. It is the intent of the Principal Investigator that no one will be able to identify you or your answers, and no one will know whether or not you participated in the study. Individuals from the Institutional Review Board may inspect these records. Should the data be published, no individual information will be disclosed.

Your participation in this study is voluntary. By proceeding to the next page and completing and the survey, you are voluntarily agreeing to participate. If you do not wish to participate, please close your web browser to exit the survey. You are free to decline to answer any particular question you do not wish to answer for any reason.

If you have any questions about the study, please contact:

Aaron Sauer; Principal Investigator; 104 East Hunt Ave.; Warrensburg, MO 64093 (660) 543-8214; sauer@ucmo.edu

Dr. Ronald C. Woolsey; Faculty Advisor; University of Central Missouri, Grinstead 009F; Warrensburg, MO 64093; (660) 543-4340; woolsey@ucmo.edu

If you have any questions about your rights as a research subject or if you feel you've been placed at risk, you may contact the Indiana State University Institutional Review Board (IRB) by mail at Indiana State University, Office of Sponsored Programs, Terre Haute, IN 47809, by phone at (812) 237-8217, or by e-mail at irb@indstate.edu. You may also contact the University of Central Missouri Human Subjects Protection Program by mail at Ward Edwards 1800, Warrensburg MO 64093, by phone at (660) 543-4621, or by e-mail at www.ucmo.edu/hs.

Indiana State University
Date of IRB Approval: 10/01/2012
IRB Number: 378989-1

University of Central Missouri
Date of IRB Approval: 10/09/2012

APPENDIX C: TELEPHONE SCRIPT

The following script was followed when contacting building code officials to request their e-mail address and make them aware of the building code study:

1. Request to visit with the Senior Code Official.
2. I am a doctoral student at Indiana State University and I am currently completing my dissertation that deals with sustainable building codes and the International Green Construction Code. As part of the research study I am contacting current building code professionals to participate in an online survey of their perceptions of green building codes and the International Green Construction Code. The survey should take about 15 minutes to complete.

   Today I am seeking your e-mail address so that I can send out a formal invitation to participate in the study along with the link to the online survey instrument. Your participation in the study is completely voluntary and you can withdraw at any time without penalty.
3. Can I have your e-mail address to send you the survey link?

APPENDIX D: INVITATION E-MAIL

Dear Colleague:

I am a doctoral student at Indiana State University and I am currently completing my dissertation entitled, "Sustainable Building Codes: How the Perceptions of Building Code Officials Influence their Intent to Adopt the International Green Construction Code". As part of this study, I am contacting building code professionals from Illinois, Kansas, Missouri and Nebraska to complete an online survey regarding their perceptions of green building codes. Your city has been randomly selected from all cities in those four states with a population of greater than 5,000 inhabitants.

At this time I am seeking your permission to participate in the study and to take the online survey. The survey should take approximately 15 minutes to complete. Your participation is completely voluntary and you may withdraw from the study at any time without penalty. You may decline to answer any question on the survey for any reason.

If you are willing to participate in the study please navigate to the link shown at the end of this message. Carefully read the informed consent document that is the first page of the survey. In order to keep the survey anonymous, I will not ask you to sign the informed consent document. By proceeding and starting the survey you will indicate your agreement with the informed consent document.

In addition to your participation I would also like to invite all other code officials at your city to complete the online survey. Please forward this invitation to other building code officials (plan reviewers, inspectors, and senior code officials) at your place of work. Do not forward the invitation to code officials outside of your city. While multiple code officials from each city are encouraged to participate, each code official should complete the survey only once.

Sustainable building codes are a new phenomenon that will benefit from continued research. I hope that you will be able to find the time to complete the survey and promote a greater understanding to the code adoption process.

If you have any questions about this research project, please contact me at (660) 543-8214, or sauer@ucmo.edu. You may also contact my Faculty Advisor, Dr. Ronald C. Woolsey at (660) 543-4340, or Woolsey@ucmo.edu. Thank you for your time and your participation.

Sincerely,

Aaron Sauer
Ph.D. Candidate
Indiana State University

Survey Link:

https://www.surveymonkey.com/s/2X5YSGG

APPENDIX E: FOLLOW UP E-MAIL

Dear Colleague:

Approximately two weeks ago I sent you an invitation to participate in a research study for a doctoral dissertation. The title of the study is "Sustainable Building Codes: How the Perceptions of Building Code Officials' Influence their Intent to Adopt the International Green Construction Code". This e-mail is a follow up to the first message.

If you were able to complete the survey instrument I want to thank you for your time and participation. The results of the study will provide greater insight into the adoption of sustainable building codes. Please do not complete the survey a second time. If you have not had time to complete the study I would ask you to follow the link at the end of this message to the survey website. The survey link will be closed within the next two weeks so please do not delay.

The survey should take approximately 15 minutes to complete. Your participation is completely voluntary and you may withdraw from the study at any time without penalty. You may decline to answer any question on the survey for any reason. Please carefully read the informed consent document that is the first page of the survey. In order to keep the survey anonymous, I will not ask you to sign the informed consent document. By proceeding and starting the survey you will indicate your agreement with the informed consent document.

Thank you for sharing your time and expertise. If you have any questions about this research project, please contact me at (660) 543-8214, or sauer@ucmo.edu. You may also contact my Faculty Advisor, Dr. Ronald C. Woolsey at (660) 543-4340, or Woolsey@ucmo.edu. Thank you for your time and your participation.

Sincerely,

Aaron Sauer
Ph.D. Candidate
Indiana State University

Survey Link:

https://www.surveymonkey.com/s/2X5YSGG