CHANGE ORDER INSURANCE POLICY (COIP) IN THE U.S. DESIGN AND CONSTRUCTION INDUSTRY: IS THERE ANY LIKELIHOOD OF ACCEPTANCE?

A Thesis
Presented to
The Academic Faculty

by

Louay Ghaziri

In Partial Fulfillment
of the Requirements for the Degree
MSc. Building Construction and Facilities Management in the
School of Building Construction

Georgia Institute of Technology
December 2016

CHANGE ORDER INSURANCE POLICY (COIP) IN THE U.S. DESIGN AND CONSTRUCTION INDUSTRY: IS THERE ANY LIKELIHOOD OF ACCEPTANCE?

Approved by:

Ennis Parker, AIA, RIBA, Advisor
Niles Bolton Professor of Practice
School of Building Construction
Georgia Institute of Technology

Dr. Daniel Castro
Chair
School of Building Construction
Georgia Institute of Technology

Dr. Xinyi Song
Assistant Professor
School of Building Construction
Georgia Institute of Technology

Date Approved: [11/3/2016]

To the student of the Georgia Institute of Technology, keep thriving and pushing yourselves beyond your limits. Always remind yourselves that only the sky is the limit.
"In the middle of every difficulty lies opportunity" Albert Einstein.
Progress and Service!

ACKNOWLEDGEMENTS

I would like to thank God for providing me with the strength and power to go through this process and get to this point in time. This truly was a life-changing experience, where all the suffering and long nights have made it all worth the reward of satisfaction at the end.

I would like to thank my father and mother for their continuous guidance and support, without whom I would not have been the man that I am today. Also, the support and motivation that my two sisters have provided me with have made everything worthwhile. To Layal, thank you for being there, bearing with me through every step of the way, and for your constant support and inspiration. I would also like to thank my mentor, Vic Maloof, for being such an inspiring role model, as well as Roy Beeson, who both tremendously helped me all throughout my gradual development in Atlanta on a personal and professional level.

For the most part, a big thank you to my advisor, Ennis Parker, for giving me the patience all throughout this challenging journey. I must say that this was such an adventure. Thank you Dr. Castro and Dr. Song for the continuous help and feedback. Thank you Brenda for continuously helping me get out of my comfort zone and pushing me past the boundaries I had occasionally limited myself to. Thank you to my friend Tony for helping me get through and better understand statistical analysis.

Finally, I would like to thank all my friends in the school of Building Construction at Georgia Tech for all the help, as well as all the professionals who helped me with the survey, research, and interview processes.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

Symbol	Meaning
$\sum$	Means the sum of
RRI	Risk Rating Index
CO	Change Order
COIP	Change Order Insurance Policy
CD	Construction Documents
DBB	Design bid build
GMP	Guaranteed Maximum Price
ROI	Return On Investment
AIA	American Institute of Architects
CMAA	Construction Management Association of America

SUMMARY

Throughout the construction industry and for a long period of time, the issue of change orders poses as an undesirable problem in maintaining the efficiency and cost of construction projects. This research study will investigate a new mechanism for dealing with such problems. Accordingly, it will propose sharing the risk of cost overrun as a consequence of change orders, with a third-party insurance company, which can also be known as Change Order Insurance Policy (COIP). In order to check for the possibility of implementing such a policy in the U.S. market, this study will primarily test for the acceptance rate of design and construction professionals spanning the industry. Accordingly, participants were chosen from a list of 25 top construction firms found in *The Atlanta Business Chronicle.* Two anonymous surveys were then administered to assess the extent to which construction-affiliated professionals accept the concept of using COIP. Accordingly, results showed that the majority of participants do not accept the idea of using such a policy. However, program managers and owners did portray higher acceptance rates, ass opposed to architects and contractors.

CHAPTER I

REVIEW OF LITERATURE

Introduction

The design and construction industry is considered to be one of the largest industries in the world. According to e-Builder (2016), the global construction in 2015 is valued at $8.5 trillion and projected to increase by almost 70%, in order to become worth $14.5 trillion in 2025. As a result, this will produce the largest industry following healthcare. In their animated video, *Changing the World One Building at a Time*, e-Builder (2016) specifies that the USA spent over $1 Trillion on construction in 2015. Also, the construction industry constitutes 3.7% of the GDP in the USA, 7% of the GDP in China, and 7.5% of the GDP in India. Therefore, in terms of the effect of this industry, one observes that it consequently produces 7.3 million jobs in the USA, 110 million jobs worldwide, and millions more in related businesses (e-Builder, 2016). However, the value of this industry is being undermined due to inefficiency, where large amounts of money being spent are wasted; “For every dollar spent up to 30 cents is lost to waste” (e-Builder, 2016). Such an issue diminishes the possible, significant impact that the industry can have on the world. Moreover, several studies that have been conducted by e-Builder (2016) indicate that for every hour spent working, fifteen minutes are lost, which will consequently lead to valuable money and time being wasted. Nevertheless, if construction-affiliated individuals are able to live up to the true potential of this industry and ideally reduce waste, a better world can then be created. For instance, reducing the cost and time needed to build a hospital will allow for more hospitals to be built for a lower price, meaning that more money can be allocated on better equipment, staff, and services, thus creating an environment where more people can be treated. Similarly, educational buildings may also produce a well-educated generation that can further improve efficiency (e-Builder, 2016). Therefore, due to a large number of limitations, it is essential to further explore this industry and understand the several factors that significantly limit its efficiency in the construction world.

With that being said, the issue of change orders is one of the most recognized problems in this industry, in terms of it being a primary source of delay and price overrun. Change orders that are primarily related to design errors, omissions, and construction errors, increase construction costs and schedule delays throughout many projects being executed in the U.S (Assaf & Al-Hejji, 2006; Levin, 1998). They are unpredictable and their number varies based on a number of factors. Therefore, this proposed study will contribute to the construction market's literature by examining the market's acceptance rate through a possible approach of reducing the risk associated with cost overrun as a result of change orders, as opposed to the cost of insuring change orders.

Change Order Overview

Definitions.

Prior to elaborating on the above-mentioned problem, one must first understand the dynamics of change orders and the way that they are traditionally implemented. According to the American Institute of Architects (2007), a change order is "a written instrument prepared by the Architect and signed by the Owner, Contractor, and Architect stating their agreement upon the following:

1- The change in the Work;

2- The amount of adjustment, if any, in the Contract Sum; and

3- The extent of the adjustment, if any, in the Contract Time."

Additionally, "any addition, deletion, or revision to project goals or scope are considered to be change orders; regardless of whether they increase or decrease the project cost or schedule" (Ibbs, Wong, & Kwak, 2001). Furthermore, Hinze (2000) defines change orders in his book, *Construction Contracts*, as "a change that carries with it a specific directive for the contractor to perform that work." In other words, a change order, according to Hinze (2000), is a *mini contract* set out to perform a specific work element by adjusting the main contract. As a result, it must satisfy all the prerequisites of the original contract. Lee, Huh, Sun, and Dance (2015) highlight that the characteristics and processes portrayed by the construction industry are quite varied, as opposed to non-farm industries (e.g., automotive and manufacturing industries) with standard characteristics, uniform lines of production, and systematic process. One must remember that no two projects can exhibit identical features, which means that a systematic process cannot be implemented on several buildings. Also, as buildings become increasingly more complex, the number of errors being made during design processes will also continue to increase. Moreover, the final result following the construction process, is the unique building that is tailored in order to satisfy the specific needs that the owner has initially set for the program. However, one obstacle that makes the process hard to systemize lies in the fact that owners generally want something different solely based on the satisfaction of their needs (Lee et al., 2015). When the project design is complex, change orders frequently occur, since the team is building this unique, complex building for the first time. On the other hand and in opposition to the construction industry, the automotive industry builds numerous applications of a sample till the final result is perfected, which is then lead into a large systematic production, in which recalls still occur in such a process (Lee et al., 2015).

Types of change orders.

Although there includes different types of change orders, not all of them negatively impact the project. In other words, some change orders may decrease the cost of a building due to a change of scope or reduction of area, while others may possibly double the price of a contract. According to Hinze (2000), change orders that do not impact the cost or schedule are referred to as *field changes*, which are often authorized by personnel in the field without the owner's approval.

1- One type of change order, *betterment,* refers to the point where a designer neglects an element in the design that is particularly essential to meeting the requirements initially set forth by the program. However, this will then leave the architect with no choice but to add the missing element, which is generally quite costly and time-consuming (Hinze, 2000). Therefore, this raises the question of whether an additional element solely characterizes an added scope or a necessary factor that significantly contributes to the project. This will consequently add to the cost of the project, since the owner is then required to add such an element as a change order (Hinze, 2000).

2- Another type of change order, also known as *cardinal changes*, are characterized as large changes that impact the scope of the building. Such changes are one of the main causes for occurring disputes. The courts frequently consider changes affecting less than 25% of the cost as changes within the scope of the contract, thus not considered as cardinal changes (Hinze, 2000). In some instances, since cardinal changes are considered to be quite large to a great extent, a new agreement has to be compromised in order to proceed with the processes attributed to a particular project. Moreover, the mentioned changes can equally impact both, the owner and contractor. Such changes can transform a medium-sized project into a large project, as a result of the bonding limits or capabilities of the contractor, such as transforming a low-rise building into a relatively high-rise building (Hinze, 2000).

3- *Owner-initiated change orders* are changes that the owner makes due to various reasons. However, such changes are not necessarily influenced by error or quality, but rather a change of heart by the owner. For the most part, the owner makes such decisions knowing and accepting the price and schedule associated with such changes (Hinze, 2000).

4- Finally, it is important to consider the most common type of change orders that often occurs in most of the projects. According to Riley, Diller, and Kerr (2005), such change orders are known as *field-generated change orders*, which are changes resulting from problems or errors that are discovered during construction and need to be redesigned or reworked, in order to function properly in the project. However, this research study is not going to deal with owner-initiated change orders (e.g., change of scope), since they are in control of the owner and program manager.

Timing of change orders.

In general, change becomes more expensive at a later, advanced phase in the project, as opposed to the earlier phases of the project's development. For instance, a change that occurs during the early design phase costs are relatively cheaper and requires less time than a later point in the design process where implementing change affects more disciplines and elements that require more time, thus more money. Moreover, a change that occurs during the programming phase (i.e., brainstorming phase) is cost-free, since the project has not started yet. On the other hand, as mentioned above, implementing change during a later phase of the project will be more costly, as opposed to the earlier stages. For instance, changing a wall's location after the wall is already built will require paying for the original price of wall once again, including labor and equipment costs. Accordingly, as shown in Figure 1, one is able to observe the relation of change cost and time. From Figure 1, it is evident that the later the change occurs, the higher the cost, and vice versa.

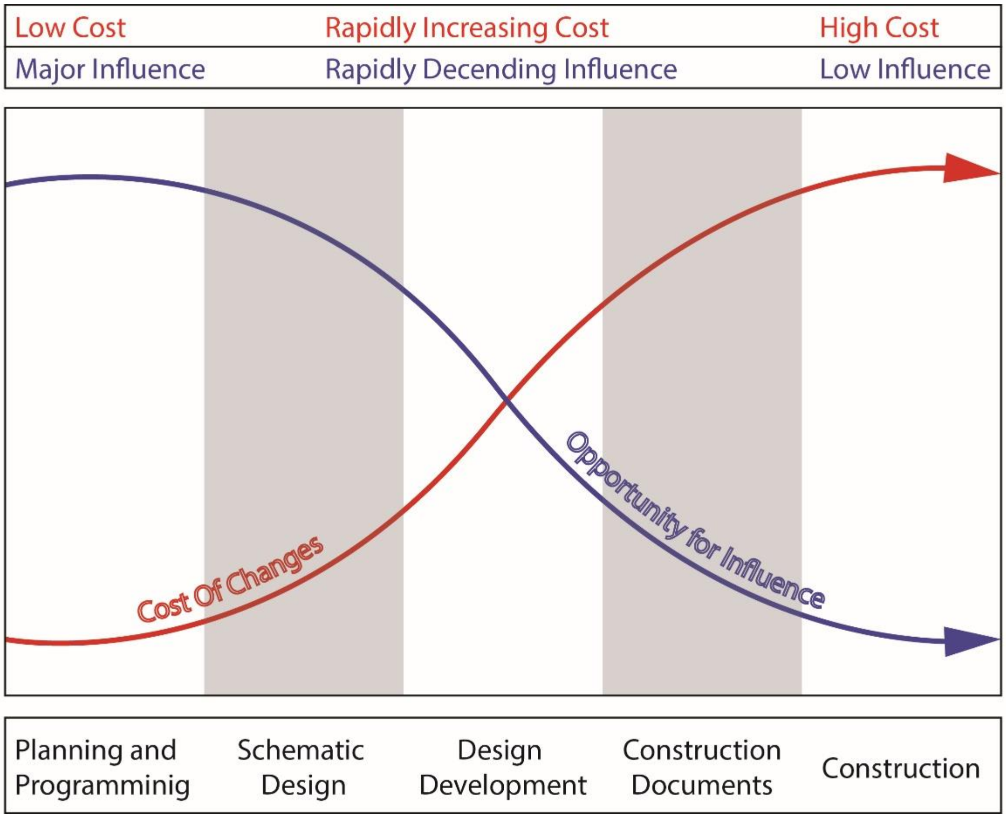


Figure 1. Cost of Change vs. Opportunity to Influence, Edith Cherry, FAIA, ASLA and John Petronis, AIA, AICP (2009).

Impact of change orders.

According to Serag, Oloufa, Malone, and Radwan (2010), change orders commonly represent between a 5 and 10% addition to the original contract price. For example, construction processes throughout the projects that have been undertaken in 2003, lie within the range of $870 billion. This means that $44 billion (i.e., 5%) is contributed to change orders. With that being said, in the US alone, the projected new construction in 2016 is $1.0721 trillion ("Statistics and Facts about Construction in the U.S.,"2016). Accordingly, $53.605 billion (i.e., 5%) are being paid for change orders. However, since one is unable to distinguish between the percentage of owner-initiated change orders from the percentage due to errors and omissions, not all the 5% can be treated as a total loss ("Statistics and Facts about Construction in the U.S.,"2016). Nevertheless, in terms of the discussed large numbers and percentages, the loss is still considered relatively large. According to e-Builder (2016), 84% of construction firms have project delays, 86% have projects over-budget, and 76% have claims. They also add that the average claim is more than $3 million (e-Builder, 2016). This highlights both, the severity of the problem and the need to find new ways to deal with it. Riley et al. (2005) state, "change orders are among the most significant sources of cost growth and disruption to field productivity on building construction projects."

Reasons pertaining to change orders.

In order to better understand the reasons pertaining to change orders, Riley et al. (2005) state, "the causes of change orders are known to depend on a variety of project conditions, including factors relating to the project size and complexity, the experience of the design team and construction team, and approach taken to change orders by contractors as a source of added revenue". Furthermore, Serag et al. (2010) and Naoum (1994) specify several causes of change orders, and they are as follows:

1- Lack of timely and effective communication,
2- Lack of integration,
3- Uncertainty,
4- A change of environmental and natural elements,
5- Increase in project complexity,
6- Errors,
7- Omissions, and

8- Scope changes

On a similar note, according to Al-Momani (2000), there are five major categories for change orders that can be summarized as follows:

1- ***Owner-initiated change orders.*** Scope changes are typically owner-initiated change orders, where the owner frequently chooses to include an element in the project as a result of not having thought about it at the beginning based on either one of two reasons, the initial planning may have missed an element or the requirements for the buildings may have been altered.

2- ***Changes due to errors and omissions.*** When architects or engineers miss something, make a mistake or leave something out that has to be corrected.

3- ***Time, cost, and quality.*** a**.** *Time.* If one falls behind schedule and in order to catch up, the owner may then choose to spend money on change orders.

   a. *Cost.* Increases in costs can primarily be attributed to both, time-consumption and quality.

   b. *Quality.* If the owner's needs are not ultimately satisfied, he/she may then choose to spend money on changing the techniques or part of the process, in order to produce better results. This can happen once the specs indicate a product that the owner has assumed meets expectations, when in reality this is not the case. As a result of the owner's dissatisfaction with the result, this may initiate the change, to produce a better level of quality. However, this is not always the case since it may also lower the quality. For example, substituting a high quality handrail for a lower quality handrail can be a change order that generally saves money.

“Cost by itself can be a driver but cost generally does not generate change orders unless one exceeds a budget on a project, where one has to issue a change order to cut its cost” (Jones & Laquidara-Carr, n.d.).

Inevitability of change orders.

One can understand that changes in a project are deemed inevitable, since the design team constitutes of human beings, and human errors can never be fully excluded. However, one may contemplate on the several reasons that architects are rarely ever held responsible for their mistakes. Such a claim can be argued in a sense that no individual is held to a standard of perfection that is unachievable, but rather to a logically defined *standard of care* (Munhall & Daly, 2011). This means that the architect is generally expected to work to a particular standard of performance. In *Standard of Care: Confronting the Errors-and-Omissions Taboo Up Front*, “some owners believe that any change order which due to an error or inconsistency in the design documents should be paid for by the architect, 100 percent, from the first dollar. However, neither the professional Standard of Care nor the nature of professional service would suggest that design has to be, or even can be, perfect. Nor does the law require perfection. Logically, then, some degree of human imperfection is to be expected. An allowance for this reality should be provided in the owner’s construction budget, while the architect should contractually be required to provide design revisions to correct any errors inconsistencies in their construction documents without additional compensation” (Munhall & Daly, 2011).

Furthermore, complicated projects demand that architects and engineers pay close attention to every detail, in order to ensure that their drawings are as nearly precise and accurate as possible. However, regardless of the number of times that the drawings are reviewed, mistakes/omissions will always be evident to a certain extent. Such incidents frequently occur in the construction phase, where thousands of drawings are divided and distributed to subcontractors that tackle them based on their specialty (Hegazy & Ersahin, 2001). A subcontractor normally goes through the smallest of details while constructing the building, to better understand the several methods for executing the drawings precisely and systematically. At this point, subcontractors may possibly detect the missing parts or errors that the design team has initially overlooked. Moreover, once subcontractors reach a point of uncertainty with the design team's intentions, a request for information (i.e., RFI) is automatically filed (Mohamed, Tilley, &Tucker, 1999; Hegazy & Ersahin, 2001). If such an incident does occur, the design team will then thoroughly identify an error closely or give a more detailed illustration of the drawing to the subcontractor. However, once an error is identified, the subcontractor will then file a change order request to the contractor, who will then forward it to the individual responsible (i.e., first choice is always the architect, before anyone else) in collaboration with the owner, for approving or disapproving the change order by signing the request (Hegazy & Ersahin, 2001).

Furthermore, architects are not usually held responsible for making errors, in the case that such errors do not deviate from the *standard of care*. According to the American Institute of Architects (2007), "The Architect shall perform its services consistent with the professional skill and care ordinarily provided by architects practicing in the same or similar locality under the same or similar circumstances. The Architect shall perform its services as expeditiously as is consistent with such professional skill and care and the orderly progress of the Project". In other words, the design team is expected to perform to the standard of care. Although it is generally assumed that some errors will most likely be made, their design must be crafted with care. The court compares the way other architects may deal with such situations, and questions whether another architect may have made similar errors. However, in the case that the standard of care is not exceeded, the architect is usually not held responsible for the errors that he/she makes, and the owner ends up paying the difference (Munhall & Daly, 2011). S. Jones (personal communication, February 17, 2016) believes that the way projects are managed takes a toll on the success or failure of that project. As an owner and in some instances, S. Jones (personal communication, February 17, 2016) may demand that the architect takes responsibility for their errors and omissions, in the case of making costly errors beyond the contingency range. However, architects usually have an errors and omissions insurance that protects them from the consequences of making such errors. In this situation, the architect is then left with making either one of the two following business decisions (Love & Irani, 2003):

1- Asking the insurance company to pay for the change order, thus putting himself/herself at risk of dealing with higher premium values in the future; in some cases, the insurance company may not even insure him/her.
2- Paying the change order value from his pocket amount (i.e., if it is a small value).

Nevertheless, in order to take the appropriate measures, the architect is expected to notify the insurance company of any potential claims that may occur as soon as he/she is aware of such a claim. In the case that the architect fails to do so, the insurance might be voided (Love & Irani, 2003).

On the other hand, the contractor that executes the changes does not always get compensated for them. In some instances, the changes may be a direct result of rejected work that is solely based on two factors: the presentation of poor quality or errors made by the contractor. According to Hinze (2000), in order for a contractor to charge the owner for additional work, the change should:

1- Not have been anticipated,
2- Was not open to observation, and
3- Could not have been discovered until the work is under construction.

In order to avoid future disputes regarding payments, the above-mentioned types of change orders are usually reported in the form of *official* written requests. Once a contractor provides the owner with a written change order request and a final price has been agreed upon, the owner will then have to sign that request declaring that he/she officially agrees on both, the change and its price. However, in order for contractors to ensure payments for the changes and keep the owner informed, the owner has to approve change orders in writing (Mohamed et al., 1999).

According to Hinze (2000), the court supports alternative methods of communication and deems them official (e.g., letters, transmittal notice, revised drawing, revised specifications, notations on shop drawings, job minutes, field records, and daily records). In other words, such methods may also prove that the owner, in the case of dispute, can approve of this change. However, according to S. Jones (personal communication, February 17, 2016), when contractors are responsible for the cause of the change due to making errors (e.g., field errors), owners can then place responsibility on contractors by demanding that they pay for such errors out of their own contingencies or fees. In some extreme cases in which contractors exhaust their contingencies or fees, owners may even demand that contractors pay the net worth of their company.

Type of Change Orders This Research is Addressing

This research proposal will not include owner-initiated change orders, since the owner is primarily in control of this area. Moreover, it will not include unforeseen conditions since they cannot be quantified and measured. However, it will primarily address the issue behind errors and omissions by proposing a solution for cost overrun caused by change orders. This will then be followed by empirically testing for the acceptance rate of construction-affiliated professionals towards the proposed study's policy.

Insurance Policies

As stated earlier, the construction industry is less efficient and has a lot of waste (e.g. time and money), as opposed to other industries (e.g., automotive and manufacturing industries). This means that the construction industry is generally more prone to greater risks, primarily in project costs, duration (Lee et al., 2015), as well as "health and welfare requirements" (Odeyinka, 2000). As a result, managing and limiting such risks is essential to the success of a project. Accordingly, the most frequently used method in risk management in the construction industry is transferring that risk to an insurance company in return to a premium, which can also be referred to as an *all-risk insurance policy* (Odeyinka, 2000).

Following this understanding, many different types of insurance policies are being used amongst professionals in the design and construction industry. Each primary entity constituting the industry (i.e., designers, builders, or owners), buy insurance policies to protect themselves against various construction risks (Lee et al., 2015). Three of the most common insurance policies that are being used are known as: Professional Liability insurance (i.e., PLI), General Liability insurance (i.e., GLI), and Builder's Risk insurance (i.e., BRI).

PLI, bought by designers (i.e. architects, engineers, etc.), is defined as obtaining "protection against any sum which they may be legally liable to pay arising from any claim for negligence or breach of professional duty" (Taylor, 2012). Allegations of breaches are primarily made against designers by owners, or in some instances by the builder. In other words, design professionals (i.e., architects and engineers) are responsible for producing services to a certain legal standard. However, since errors and omissions are frequently evident throughout the design phase of a project, this may then pose a significantly large financial risk and loss to the owner in terms of the architect's failure in correctly abiding by the standard of care and failing to correctly render the initial, agreed-upon design services of a project. In such a case, using PLI is essential for limiting the financial damages and costs that can have a detrimental effect on the design team, and subsequently on the owner and third-party entities (Liu, Li, Lin, & Nguyen, 2007; Taylor, 2012), as a result of faulty professional services.

Another type of insurance policy, known as GLI, "protects a company's assets and pays for obligations-medical costs, for example-incurred if someone gets hurt on your property or when there are property damages or injuries caused by you or your employees" (Beesley, 2012). In other words, using GLI ensures that construction properties and the security of employees are both covered, in addition to implementing a survival strategy in case of physical harm. However, it is essential for one to understand that there is a fine line that lies between GLI and PLI, whereby GLI primarily deals with *physical* damage/loss, while PLI primarily deals with *financial* damage/loss (Beesley, 2012; Liu et al., 2007).

Furthermore, and according to *The Architect's Handbook of Professional Practice*, BRI a "specialized form of property insurance that provides coverage for loss or damage to the work during the course of construction" (American Institute of Architects, 2013). Additionally, Malecki (2009) defines BRI as "coverage that protects a person's or organization's insurable interest in materials, fixtures and/or equipment being used in the construction or renovation of a building or structure should those items sustain physical loss or damage from a covered cause". Accordingly, contractors or owners frequently find it essential to buy this policy. It is more frequent to see the contractor being the buyer of such a policy since they are held responsible for delivering the building as a complete final product. Never the less, the owner in some cases (e.g. if the owner agrees to buy all insurance policies on the project) might be the one buying this policy. However, this type of insurance policy does not usually cover natural disasters (e.g., floods, earthquakes, and hurricanes). Moreover, this policy covers "all-perils basis, with the more modern term referred to as a 'special causes of loss' (or perils) form. On this basis, coverage applies to physical loss or damage from any cause of loss, unless the loss is limited or caused by a peril that is specifically excluded" (Malecki, 2009).

This research study aims to propose a new insurance policy that can be considered as an addition to the above-mentioned insurance policies (i.e. PLI, GLI, and BRI). It ensures coverage for financial losses due to errors and omissions of the team, instead of focusing on one party (e.g., Owners, Contractors, and Architects) in managing construction risks. However, this policy is not enough, on its own, to replace one of the above mentioned insurance policies. Never the less, this COIP has unique advantages in insuring errors and omissions cost related issues that the other three insurance policies do not cover.

CHAPTER II

PREVIOUS PROPOSED SOLUTIONS TO CHANGE ORDERS

Brief Overview

Since the type of change cannot usually be predicted, there is no one universal rule that can be attributed to all types of changes. In other words, each type change is unique and approached differently. For instance, a change caused by a clash between two systems (e.g., mechanical and structural systems) requires that engineers redesign and contractors modify or redo the work, which will typically require more material (Assaf & Al-Hejji, 2006). As a result, this will cost more in terms of time and material, in which the cost will be negotiated. In such a case, however, placing responsibility on either entity (i.e., engineer or contractor) is debatable, whereby one contemplates whether it is initially the engineer’s fault for creating a bad design or the contractor’s fault for not initially detecting the mistake during both, collaborations during the preconstruction phase or analysis of the construction documents for bid (Assaf & Al-Hejji, 2006). On the other hand, a change caused by incorrect execution may require that the contractor takes full responsibility and redo the work, in order to avoid the potential for miscommunication between the design and construction team. Those two abovementioned examples are a simple demonstration of the complexity of change orders and the ways they differ. Many disputes and much litigation are caused by change orders (Assaf & Al-Hejji, 2006).

Minimizing Risk of Change Orders

Once risk and contingency are appropriately managed as drawings are being produced, S. Jones (personal communication, February 17, 2016), an owner, believes that the effects of change orders can be significantly reduced. Accordingly, owners must carefully manage contingency so that they does not spend it all before the risk is eliminated. As a result, S. Jones (personal communication, February 17, 2016) finds that implementing such a method adds scope to the project without exceeding the cost, deeming the project successful at the end.

Similarly, when dealing with prices of the contractors' bids, getting unit pricing wherever possible is considered to be one of the most desirable methods in such a case. Unit pricing is beneficial for calculating a precise change cost, based on the quantity needed x unit price. In S. Jones (personal communication, February 17, 2016)'s opinion, carefully calculating unit prices of a project keeps elements intact. This means that the issue behind competitive prices on change orders is eliminated. Moreover, the owner will receive the same pricing at any point in time during the earlier or later phases of the project. However, a remaining factor associated with change orders is having allowances to deal with the damage caused by errors, omissions, and undefined elements (Jones & Laquidara-Carr, n.d.).

Discussion of Delivery Systems Impact on Change Orders

Although several proposed solutions for dealing with change orders are studied and examined by researchers, many methods for solving this problem date back to the 1900s (Callahan, 2005). In other words, the concept of change orders is one of the oldest issues dealt with in the construction industry. However, this proposed study primarily accounts for methods that are generally accounted for in present-day research (i.e., 2000-2016) that focuses on change orders and proposed solutions in the construction industry.

Riley et al. (2005) propose a general solution that is illustrated in the delivery method shown in Figure 2. According to them, the delivery method has a huge impact on the amount and type of change orders that are issued in a project. The use of the traditional method, known as *Design-Bid-Build*, causes many problems in terms of the communication and collaboration of the stakeholders. Accordingly, this constitutes one of the main reasons for existing errors and omissions in a project, since the design and construction process is primarily based on team collaboration, which is a factor that is minimally accounted for in this method (Riley et al., 2005). In the *Design-Bid-Build* method, the owner develops a program of requirements and then hires an architect to design a building. Once the architect becomes aware of the owner's needs (i.e., budget and schedule), the architect will then hire engineering consultants and fully design the building through several phases, until a full set of construction documents (i.e., plans and specifications) are produced. Once the construction documents are completed, the project is set for bid by multiple contractors. The contractors will use the construction documents to estimate the cost of the project, thus coming up with a bid amount. It is important to note that the contractors will be held on a tight schedule, which will typically lead to a less precise estimate. After selecting the lowest bidder, the contractor is then awarded the contract. Afterwards, the construction process starts and the architect monitors the performance of the contractor, which he then reports to the owner (Riley et al., 2005). However, as a result of not having been involved during the design process, the contractor is unaware of the basis of the decisions that are made during such a process, which may then result in the possibility of depreciating some aspects of this design. Additionally, the contractor's involvement with the construction documents in comparison to other methods that involve the contractor during the design process raises the possibility of missing design errors and omissions until they are encountered in the field (Riley et al., 2005). Once design-related issues emerge, the contractor will then notify the architect and a change order is likely to occur. As a result, such an issue is most likely to occur in this delivery method (Riley et al., 2005).

With that being said, this method is a logical and orderly process that is well understood throughout the industry. Moreover, a direct relationship between owners and architects is present in this process (Riley et al., 2005). This ensures that owners' perspectives are accounted for and ensures that they are fully in control of the design process. Finally, the price of the contract is set by competitive bidding, which reassures owners that they are receiving the lowest price (Riley et al., 2005).

However, not being informed of the price until after the design process is completed is considered to be a main concern associated with this process. Since the contractor is not present until the construction documents are finalized, the owner will not be able to know the project price till the late phases of the design process, where changes are expensive (Riley et al., 2005). Also, another main concern is the lack of collaboration between the contractor and architect. This can result in many field-generated change orders due to errors and omissions (Riley et al., 2005). Moreover, the contractors' input during the design process is important, since they can state their opinion on the design's relation to constructability and point out the way that it may affect it. In addition, they provide guidance on scheduling for both, construction and design (Riley et al., 2005).

Therefore, Riley et al. (2005) propose the use of *Design-Build*, which is a delivery method that allows the owner to sign a single contract with both, the design build team. The team will be comprised of a design team and contractor. Accordingly, this arrangement will allow the contractor and architect to collaborate from the beginning of the project, thus saving a lot on cost, time, and errors. However, the owner's contribution to such an arrangement is debated, since his/her presence in the decision-making process is questionable (Riley et al., 2005). In the case of litigation, *Design-Build* gives owners the right to blame one team, which ideally removes the risk off the owners themselves. Moreover, although owners are not fully informed of the decisions being made between architects and contractors during the design phase, it is essential for them to fully trust the two parties (i.e., architects and contractors) in order to work with them (Riley et al., 2005). It is also difficult to involve competitive pricing and performance, since only one firm is undertaking the entire process. Furthermore, architects are not always able to express their concerns on the final product, since they report to general contractors and not owners (Riley et al., 2005).

Following this understanding, this study accounted for field-generated change orders in mechanical construction. Accordingly, Riley et al. (2005) study 120 built projects that are examined by same contractor, who has 598 change orders. As a result, both *Design-Build* and *Design-Bid-Build* projects appear to have a similar number of change orders.

Although the abovementioned results show a significant improvement in the frequency and magnitude of change orders, change orders are still occurring and affecting the cost overrun of the project. Additionally, since no two projects are exactly identical, it is quite difficult to compare construction projects and such a comparison will be deemed invalid. For instance, a *Design-Bid-Build* project may have been perceived as more complex than a *Design-Build* project, which makes the comparison invalid (Riley et al., 2005). Since projects are attributed with different and individual complexities, it is difficult to examine the different delivery methods. Also, the owner may disapprove of his/her minimal involvement in the design process. Furthermore, other delivery methods also reduce the chances of change orders to occur. For instance, *Construction Manager at Risk* (i.e., *CM-Risk*) is one of the most commonly used delivery methods (Riley et al., 2005).

In *CM-Risk*, the owner hires an architect and a construction manager at the beginning of the project. During the design phase, the construction manager serves as a consultant and collaborates with the architect by giving out the cost, execution, and complexity of a particular project. At that point, the construction manager is paid for pre-construction service. Once the design is ready for execution, the construction manager's services change from pre-constructing to supervising both, the subcontractors and construction process. This method will ideally increase the collaboration between parties, thus limiting the possibility of making errors. Moreover, the construction manager's input during the design process is important, since he/she will continuously provide information on cost throughout the gradual development of the design, which then allows the architect to continue designing within budget (Riley et al., 2005). Furthermore, the construction manager gives his input on the design's relation to constructability and points out the way in which it may affect it. He also provides guidance on scheduling for both, construction and design. Subcontractors that review drawings have to be aware of the drawings' requirements and their missing elements, and plan accordingly. Prior to the execution phase, a well-qualified contractor must be capable of thoroughly detecting an error made in the drawings. Such a privilege can be applied to *Design-Build* and *Integrated Project Delivery (i.e., IPD)*, but is is not evident in the traditional method (Riley et al., 2005). Although the owner loses the privilege of having competitive bidding at the contractor's level, this will still be evident at the subcontractor's level. As a result of collaborations taking place during the early phases of a project and the involvement of more than one stakeholder, the owner may find it difficult to blame one entity in the case of errors that appear at a later phase of the project. In *CM-Risk*, having the *Guaranteed Maximum Price* (i.e., *GMP*) issued earlier on in the project and before the construction documents are finalized, may cause problems at a later point in the project (Riley et al., 2005).

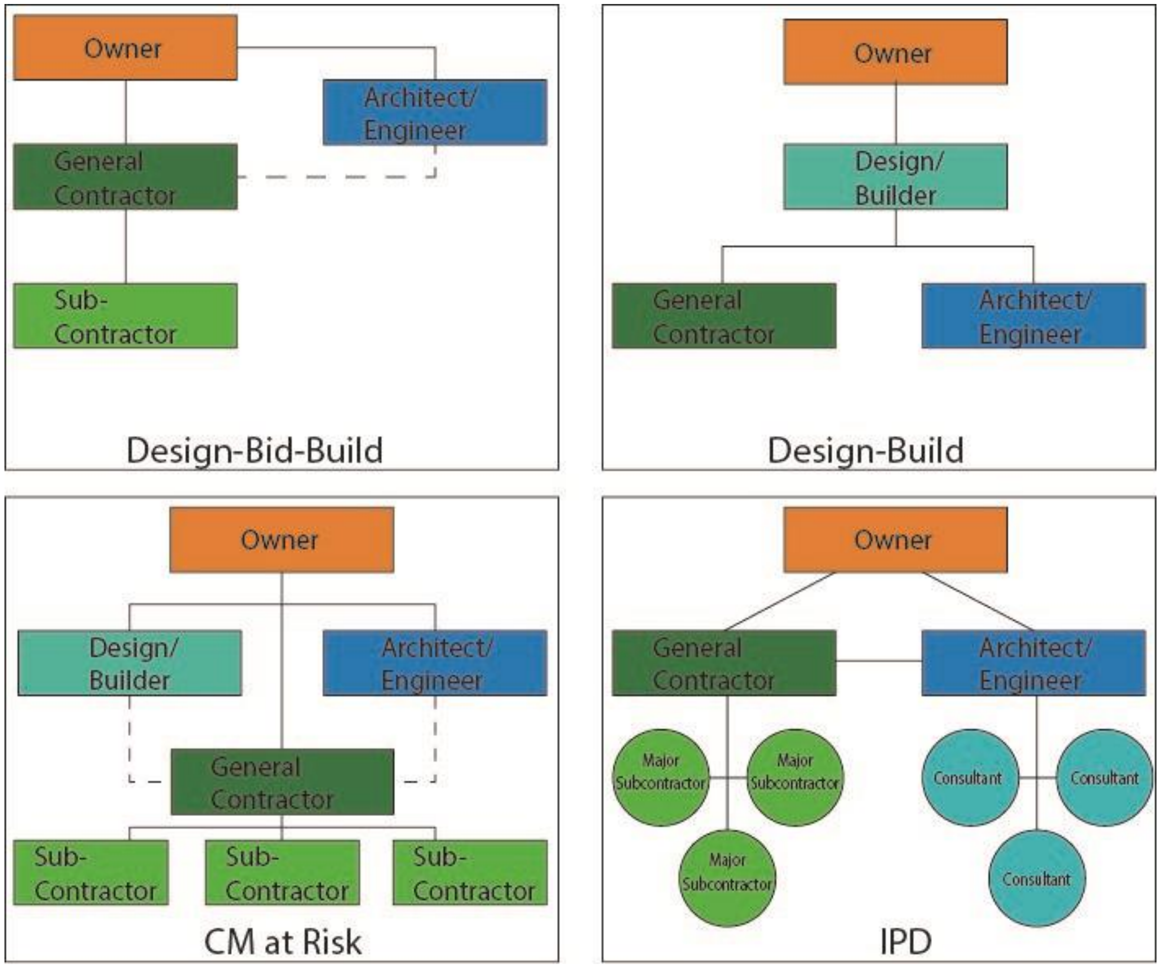


Figure 2. Delivery Methods Organizational Charts *(Riley et al., 2005)*.

Another relatively new method that is briefly mentioned above is known as *Integrated Project Delivery* (i.e., *IPD*) (Riley et al., 2005). This method is not commonly used yet, since it needs a sophisticated owner, in addition to an experienced architect and contractor. The general idea pertaining to *IPD* is that all primary stakeholders (i.e., owner, contractor, main subcontractors, and architects) share one contract during the early phases of the project. A multi-party agreement or a three-way contract is the first characteristic of *IPD* (Riley et al., 2005). The stakeholders (i.e., architect, owner, contractor, and subcontractors in some instances) sign the same contract. Accordingly, this requires trust and openness, in addition to generating a new method for agreement; the risks and rewards are shared. In other words, if the project is over budget, then everyone is equally responsible for paying extra with no blame. On the other hand, if the project is under budget, then everyone gets paid more. If the project lies within the exact budget, the parties get paid with the agreed-upon amount. As a result, this will promote collaboration between stakeholders, motivate them to reduce costs, eliminate future errors, and deliver the project in both, scope and schedule (Riley et al., 2005).

According to Goedert and Meadati (2008), although *Building Information Modeling* (i.e., *BIM*) is considered to be essential and helpful in reducing the risk of change orders in all delivery methods, it is considered to be one primary factor pertaining to the *IPD* method, since it facilitates communication and transparency (i.e., the main concepts of *IPD*). However, this type of delivery method is not suitable for all owners. Owners are required to be part of the team and contribute a great amount of their time and effort into the project. Since this method is still relatively new, not all states in the U.S. have adopted its general conditions and contracts, which means that a large amount of money is going to be spent on legal documents and lawyers, in order to develop a new contract structure. Also, since the stakeholders are chosen based on qualifications, *IPD* reduces price competition (Goedert & Meadati, 2008).

Although attempts are being made to solve many problems occurring throughout the design and construction industries, selecting different delivery methods will not solve the problem of cost overrun caused by change orders. In other words, delivery methods may reduce that damage, but the errors and changes will remain apparent. *IPD* and *CM-Risk* are potentially able to limit such problems and deliver projects more efficiently in comparison to other delivery methods. Nevertheless, using a delivery method as the only solution will not be enough to solve already existing problems nor prevent future ones from occurring. Therefore, a combination of an additional proposed solution and a delivery method increases the possibility of finding the *optimal solution* (Goedert & Meadati, 2008).

Option Mechanism

Lee et al. (2015) propose a new mechanism to try and solve the problem of cost overrun caused by change orders. In such situations, the primary problem is that the supplier (i.e., contractor) is not legally obliged to provide any additional services or duties that go beyond what the contract specifically states. Consequently, this will limit suppliers by remaining inbound with their contracts and not providing extra help. In other words, the signed contract does not oblige the contractor to put the effort in discovering problems that may possibly lead to change orders in the future, since this will require a great amount of time and effort. In other instances, some contractors may also choose to purposely ignore such problems, in order to benefit from them in the future by filing for change orders at a higher price (Lee et al., 2015).

The project is perceived as well known and understood, when the owner and contractor acquire sufficient amount of information on the exact price of the project (Lee et al., 2005). Lee et al. (2015) try to develop new way of dealing with change orders. According to them, once a change order occurs, the owner and contractor enter a bargaining process in order to set a new price for this existing change order. However, if the bargain fails and no price is agreed up, the contract will then be terminated, whereby the owner fires the contractor and pays him a cancelation fee. Afterwards, the owner initiates an auction to find a new contractor to replace the previous one. However, this method is dangerous, since the owner is uncertain of both, the expected price that will arise in the auction or if he/she will find a better price and another supplier (Lee et al, 2015).

Moreover, Lee et al. (2015) develop a new mechanism, which is also known as *Option Mechanism*. In this method, the owner and the contractor enter a bargaining process that can lead to several outcomes. In other words, the buyer and supplier may not agree on a price, which can then result in terminating the contract and opening a new bargain that is similar to the initial process of opening an auction for a new contractor. However, if they do agree on a price, the owner will then offer an option of a *switch price* on a *take-it or leave-it* basis (Lee et al., 2015). The switch price is a cash payment that is provided to the contractor by the owner, in the case that the owner finds a better offer from another contractor at an auction. This payment is given to the initial contractor, to end their contract. However, the initial contractor is able to reject the switch payment and settle for bargained price instead, which will then allow him to continue the project, or he can accept the switch price, where the buyer will then move into the second phase. Prior to the second phase, the owner and the contractor first agree on the bargained price. At this point, both parties (i.e., owner and contractor) are not able to go back and change the price (Lee et al., 2015). Moreover, in this phase, the owner starts an auction with a reserve price with other contractors, to check if he/she is able to receive a more desirable price; the initial contractor does not have the right to participate in this auction. If a better price is found, the switch price will be paid to the initial contractor, thus terminating his contract; the owner then hires the winning contractor. On the other hand, in the case of no existing or better price, the owner then signs a contract that includes the bargained price, with the initial contractor (Lee et al., 2015). While practicing such a mechanism, the owner must be careful that he/she will not outsource the contractor nor open an auction, before the contractor bargains with the owner. However, this may pose a possible risk, since the contractor may choose to not cooperate nor participate in the bargain, which may give the owner a bad reputation (Lee et al., 2015). The *Option Mechanism* is illustrated in Figure 3.

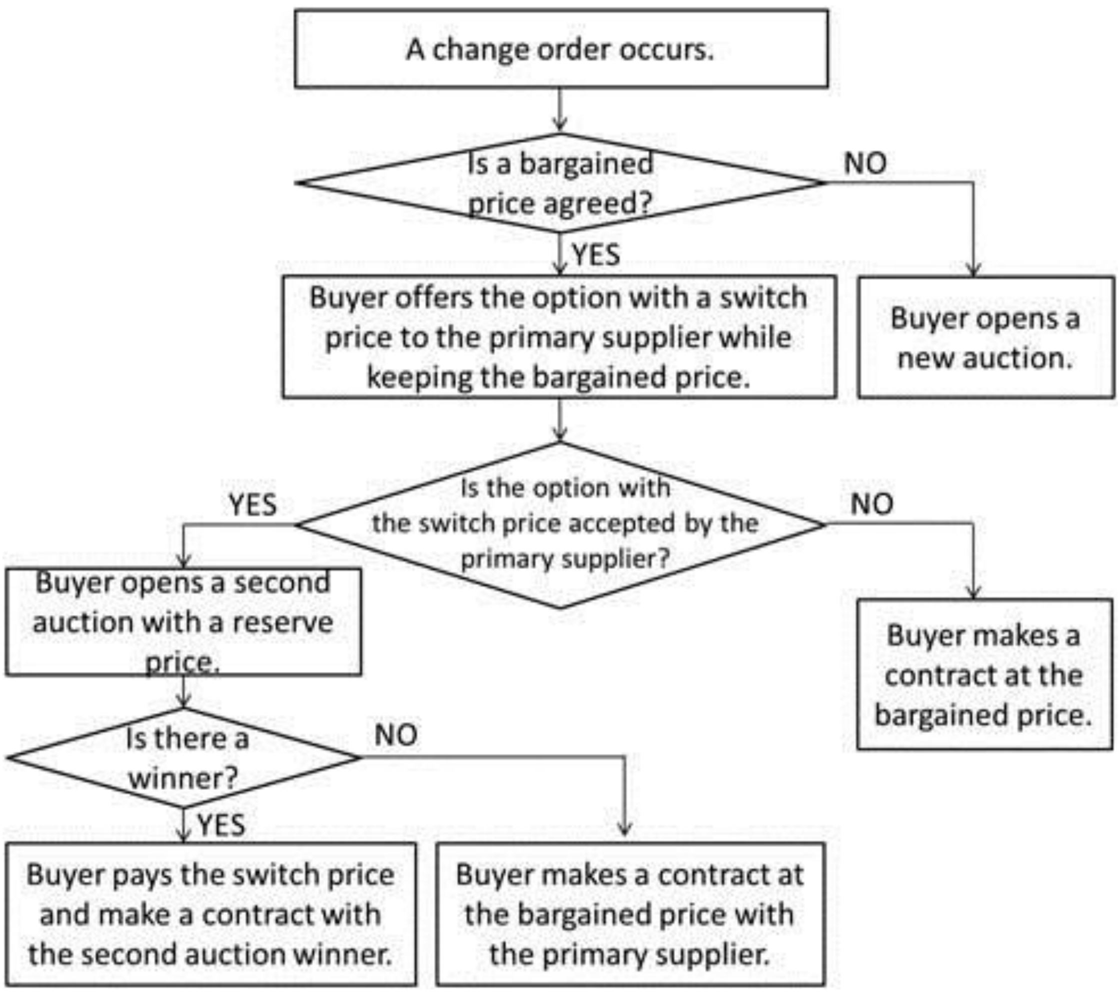


Figure 3. Option Mechanism (Lee et al., 2015).

In the occurrence of change orders, a small number of skeptical researches, if any, deal with changing the contractor as solution, since they still remain keen on finding a solution by bargaining. Lee et al. (2015)'s article is the one of the first to demonstrate the idea of changing a contactor through auction, while keeping the original contractor on board, in the case that the owner is not able to find a better price. However, Lee et al. (2015) did not consider the cost that the owner pays when he/she is not able to find a new contractor within the time frame provided. This can significantly affect the development of the project, in terms of costing time, which at times, can be more detrimental than the price.

The authors failed to take some key elements into consideration in this article. For example, stopping the project for a while and taking time to do an auction in the middle to the project life can be harmful and have a negative effect on the project schedule and quality. Moreover, they did not explain how they propose on transferring the project from on contractor to another. The idea of changing contractors might help the cost of the project but it can be a great threat to the consistency and quality of the project. Some contractors in the construction industry have different work methods than others. In this case it would be time consuming to shift from one contractor to another. Moreover, the contractors take risks into account when they agree to work on a project. When a contractor is replacing a previous contractor, who will take the risk or the blame if something goes wrong in the future? This makes it harder to blame one contractor is case of errors. In addition, this method doesn't take into account the quality and qualifications of the contractor, rather it only looks at the price and bids they offer. The owner would be picking who is cheaper rather than who is more qualified and can deliver a better quality product.

Finally, the contractor initially proposes a price or a bid for the project based on the limited knowledge that is provided to him at the time. This price might not be sufficient for him in the future after he knows what the project really is about and how much it would really cost. When a change order is issued, the supplier would be far more involved and understanding of the project than at the beginning, thus we cannot expect him to price the project the same way he priced it when his knowledge was limited. These are the main concerns I have about this proposed mechanism and what I think would prevent it from affecting the project positively.

Collar Option

Another approach that limits the cost overrun caused by change orders is the *Collar Option*. Lee and Kim (2015) discuss a zero-cost model that is derived from financial engineering and correspondingly try to apply it in the construction industry. They then attempt to replace the contract cost with the collar option, such as insurance, in order to solve the change order problem without having to pay a premium.

The collar option is usually used in currency trade. According to Lee and Kim (2015), an option is a form of security that gives the owner the right to sell or buy an asset in the future at a preset price. Accordingly, there are two types of options:

- *Put option*: gives the owner the right to sell a stock at a fixed price for a certain time.
- *Call option*: gives the owner the right to buy a stock at a fixed price.

The collar option is more complex than the two types mentioned above. In the construction industry, the buyer is usually perceived as the owner and the seller is usually perceived the contractor. Figure 4 illustrates the way in which collar option works.

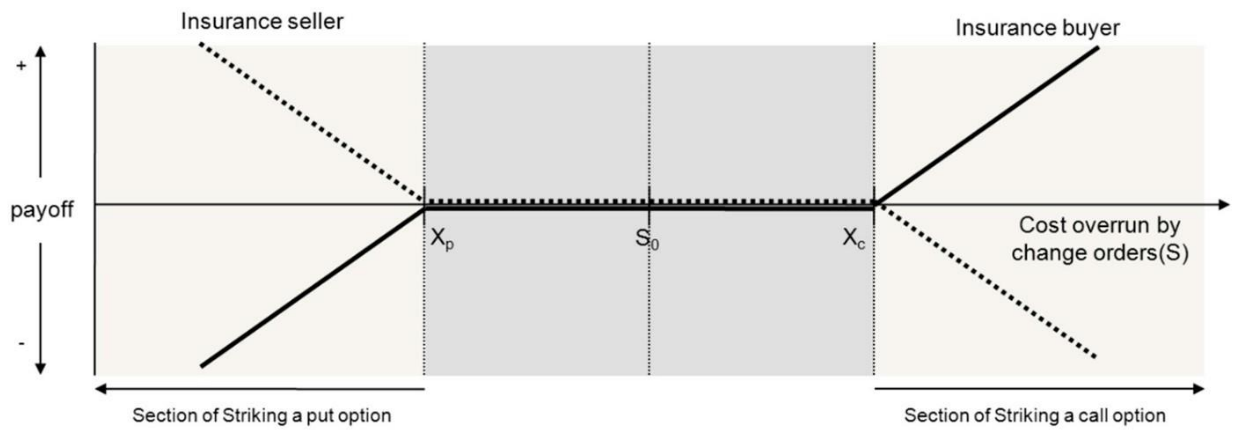


Figure 4. Concept of material contract model based on collar option (Lee & Kim, 2015).

In this model, S_0 represents the current cost. S_0 lies in the area between the unusual call option according to increase in price overrun, X_C (i.e., the buyer's insurance), and the unusual put option according to the decrease of price overrun, X_P (i.e., seller's insurance). This model works in a way that once S_0 goes past X_C, the buyer is then able to implement the call option, whereby the contractor handles the extra cost (Lee & Kim, 2015). Accordingly, the level cost of insurance for the contractor becomes the difference between S_0 and X_C. Whereas if S_0 goes lower than X_P, the contractor is then able to implement the put option, whereby the owner pays the difference between S_0 and X_P. However, when S_0 lies between X_P and X_C, the cost of insurance is equal to zero (Lee and Kim, 2005). The insurance premium is not fixed, but instead represents the amount that the owner pays if S_0 goes lower than X_P, or the amount that the contractor pays if S_0 goes pastX_C. As a result, this will ideally motivate the contractor to provide more desirable prices, in order to get paid the difference between S_0 and X_P (Lee & Kim, 2015). The maximum and minimum payments that are made by the seller and buyer can be shown in the gray area of Figure 5. In other words, the owner is assured that the cost will definitely lie on some point in the grey area. Figure 5 illustrates changes in the cost of the owner in relation to the cost of the contractor. Moreover, it is essential to mention that $X_P$and X_C have to be symmetrical with respect to S_0 in order to insure fairness (Lee & Kim, 2015).

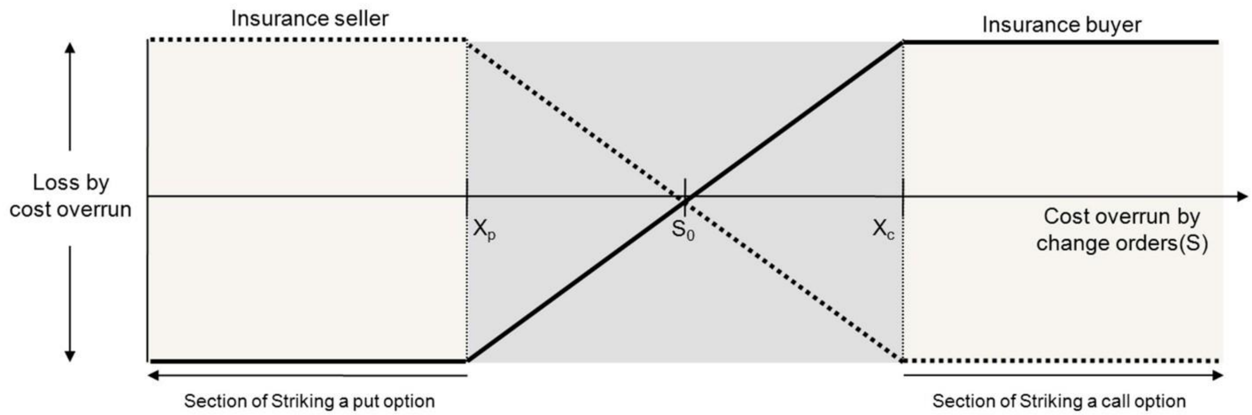


Figure 5. Range of loss caused by cost overrun when the collar option model is applied (Lee & Kim, 2015)

In other words, one can assume that a contractor and an owner are implementing the collar option mechanism on a project. In such a case, the contractor estimates that the concrete in this particular project will cost $1,000,000. The $1 million represents S_0. The owner and contractor then decide to place the unusual call and put options at $900,000 and $1,100,000 respectively. This means that X_C = $900,000 and X_P = $1,100,000. One can then assume that the contractor's price came in at $1,200,000, which is greater than X_P = $1,100,000, whereby the owner will then pay X_P = $1,100,000 and the contractor will pay the difference (i.e., 1,200,000 – 1,100,000 = 100,000), which is equal to $100,000. Accordingly, this difference is now considered to be the premium that the contractor paid. However, if the opposite has happened, where the contractor's price comes in at $800,000, which is lower that X_C = $900,000; the owner will pay the difference (i.e., 900,000 – 800,000 = 100,000). This difference is also considered the premium that the owner will pay in normal insurance conditions. Finally, if the price comes in to be between X_C = $900,000 and X_P = $1,100,000, the owner will pay the amount and no one will then be required to pay extra money in premiums.

After testing their theory, Lee and Kim (2015) saw that the results show that the average of change orders is 4.57% of the cost of construction. This number can be considered the X_c and any loss over this number is considered unexpected loss. The results then show that 46% of the cost overrun is higher than the strike price of call option (X_c) which means that 46% of the time the owner benefits from this process. 53% showed cost overrun was lower than the strike price of put option (X_P) which means that 53% of the time the contractors benefit from this. Whereas 1 % was between the strike price of both put and call option. As the numbers show, the contractor can make a profit from using this method and the buyer can limit his cost. In their opinion, Lee and Kim (2015) think that this method should be implemented by construction management companies since they usually are the risk takers. This can be an incentive for construction management companies for better performance and lower prices. This may be useful and work on *CM-Risk* for pricing variations before the final *GMP*.

This model was designed for change orders caused by price overruns due to change in original price and did not take into consideration other factors that can cause change orders, even though they are listed in the literature review. This model would not work on factors, like design errors or site conditions. This is a good model and solution for the proposed problem but it cannot be generalized over other elements in the process. Moreover, the proposed solution protects the owner and puts a huge risk on the contractor/seller. In worst case scenarios, the owner will receive no additional savings but no losses at the same time; whereas the contractor has a high probability of suffering from big losses if the price overrun exceeds the ensured amount. In case of inflation, the results for a contractor might be dramatic. This might lead to high losses for the contractor and sometimes bankruptcy. This would lead to disputes between the seller and buyer. In addition, if a contractor is bankrupt, this would affect the project negatively and would result in worse outcomes than the effect of change orders. Exceptions should be made for such extreme cases. Finally, this method limits the insurance to both parties. In other word there is no insurance company involved in sharing the risk. The contractor and owner agree between each other to the terms of what their insurance will include. This will still provoke the problem of each party caring for themselves first rather than the project. The contractor will want to keep the price from exceeding his insured limit and the owner does not care since he is not paying extra. Instead of bringing both sides on the same team and goal, each side has its own self to worry about.

Those are some of the attempts that were trying to deal with the issue of change orders. The unique thing about these approaches is that they actually propose a solution, even if it has some flaws in it. Other approaches do not try to solve the problem of change orders rather than facilitating for the stakeholders the ability to predict or make an assumption about the probability of change orders happening and their impact.

Prediction of Change Orders

While analyzing changes and their effects, Hölttä and Otto (2005) find that some changes lead to the *ripple effect*, which refers to a change that can cause the tasks performed after or before it to change as well. In this model (i.e., *activity-based DSM system*), the ripple effect can be predicted at an early stage in the project. This model analyzes the relationship between activities and their dependency on each other. It uses rework scope of activity in order to represent the main causes of change in the *activity-based DSM*. This allows project managers to predict the probability and frequency of changes that can happen in a project. Moreover, change criteria can be used to predict the risk level associated with each change (Hölttä &Otto, 2005). Additionally, probability density function and cumulative probability function can be used to calculate the change probability. This system is useful for identifying the inner relationships of activities that form the schedule, identify the activities that have high levels of change risk that might affect other activities, identify causes of change, and help the project management team take appropriate measures while planning the project schedule and cost (Hölttä &Otto, 2005)

While this is a very useful tool to help reduce the effect of change orders, it may have more potential when combined with insurance. This model predicts the probability of a change occurring but cannot exactly change, thus the risk is still there. However, if insurance companies use this model to analyze the risk and measure the probability of change happening, one is able to define an appropriate premium that the insurance company can take, based on the risk. Moreover, paring an insurance policy with the right delivery method and tools will create a significantly more way of dealing with change orders that are caused by cost overrun.

CHAPTER III

PROPOSED SOLUTION

Hypotheses

After conducting the literature review and analyzing previous proposed methods for dealing with change orders, a common issue that arises in the majority of mentioned proposals is their lacking of coordination and quantification of risks. Generally, insurance plays a big role in controlling/managing risks. From health insurance to car insurance, home insurance, or even life insurance, people always resort to such services for the main purpose of managing risks. In some instances, individuals purchase the insurance *just in case*, which demonstrates that that even a healthy human being with a significantly low chance of seeking medical care, buys an insurance to cover this existing, minimal risk.

In terms of the construction industry, this can be implemented to cover the price overrun caused by change orders. At this point, insurance companies are providing services to cover professional liability, whereby no new theoretical approach is being examined to insure the cost of a project. If the concept of Change Order Insurance Policy (i.e., COIP) is initiated, then the acceptance rates of program managers and owners will ideally appear to be higher than architects and contractors.

In this research proposal, insurance companies will insure the price of the project so that when change orders occur, the price that the stakeholders are paying for will not be affected, but rather the insurance company will pay that additional cost. Therefore, exploring the advantages of such an approach is essential to better understand the use of COIP.

The most apparent advantage associated with using such a process is based on the elimination of negative effects pertaining to change orders, by carefully clarifying and identifying proposed aspects of project pricing. Since making errors is inevitable, change orders are always going to exist in a project. Therefore, instead of trying to stop such errors from occurring, this proposed theory accepts the fact that such errors can never be fully extinguished and will instead try to limit the frequency of errors in a project. Therefore, since money is the primary cause of litigation, this approach will attempt to neutralize this risk. As a result, collaboratively working on a project with no arising conflicts due to price will ideally stimulate increased interest in teamwork and transparency between stakeholders.

Implementing this proposed theory raises many questions and will examine several fields, such as insurance policies, legal issues, contracts, and stakeholder relations. In other words, this proposed research study will analyze the abovementioned fields and propose an insurance policy called Change Order Insurance Policy (i.e., COIP). This policy will be used as an example to test the market's acceptance towards the concept of insuring change orders. However, the proposed COIP will not be tested, but is rather developed only for the purposes of market testing.

Proposal Theories

Risk management.

Since cost overrun caused by change orders is a risk, it is logical to quantify, predict, and deal with it in a similar way to other risks. According to Vallecoccia (2016), a lecturer at the Georgia Institute of Technology "Risk is an external or internal factor that has some probability of impacting the success of your project”. According to him, there are four options to deal with risks:

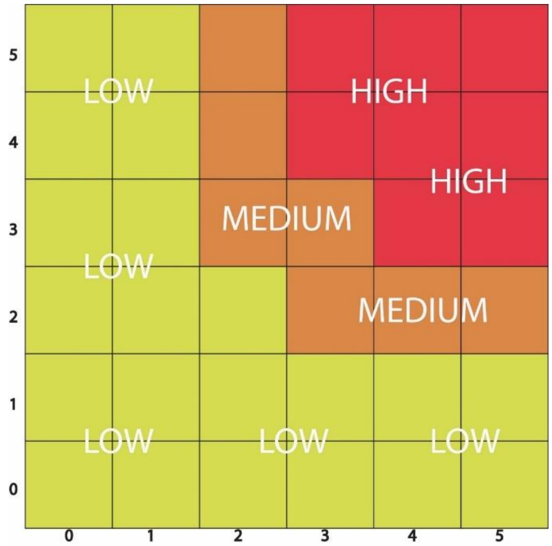
1) Eliminate: remove the risk completely so that it would not have an effect on the project. None of the proposed solutions aims to eliminate the problem of change orders. In fact, it is nearly impossible to eliminate this problem since humans are not perfect and there will always be mistakes in the final result.
2) Accept: acknowledge the risk and deal with if it occurs. This method will just accept the consequences and effects of the risk. It is usually used when the risk does not have a huge impact on the project. None of the previous solutions proposes to accept the risk caused by change orders since it carries a huge impact on the cost of the project.
3) Mitigate: lessen the risk by reducing the probability or impact that it carries. This also can be in a form of a contingency plan. Most of the proposed solutions try to mitigate the risk caused by change orders. All solutions, so far, try to limit or lessen the damage that change orders has in the project.
4) Transfer: shifting the risk to a third party. Usually the thirds party is an insurance company that accepts the risk in exchange for a premium. Even though the collar option talks about insuring the project, it is not transferring the risk to a thirds party rather than shifting it from the owner to the contractor, which still damages the project.

The idea of involving a third party, such as an insurance company, to share the risk is not something new to the industry. However, this is only applied in the cases of tangible risks and not change order effects. Therefore, there are multiple dimensions that need to be studied before this can be applied.

Measuring the risk of change orders is essential in order for an insurance company to know if it is worth taking the risk on from the owner and to come up with an appropriate premium. One of the effective risk management tools to measure risk is the detailed approach known as *Risk Matrix*, which measures the impact with respect to probability of the risk occurring (i.e., Table 1). The way use the risk matrix is by first listing all possible risks that can possibly be encountered. Afterwards, one can then estimate the probability of this risk to happen (i.e., x-axis) and the impact that this risk holds on the project (i.e., y-axis). By doing so, the level of severity (i.e., High, Medium, Low) can be deduced.

Table 1

Risk Matrix



Odeyinka (2000) demonstrates an alternative method for measuring risk. He analyzes the effectiveness of the use of insurance in construction risk management. Odeyinka (2000) issues a total of 100 questionnaires for different size construction contractor companies in Nigeria (i.e., small, medium, and large companies). The respondents are considered to be qualified company directors or construction managers. The data that is obtained is analyzed using risk premium index. The questionnaires are generated to recognize the importance placed by the contractors on perceived risk sources in construction. This is referred to as *risk rating index* (i.e., RRI). The importance placed by the contractors is as follows, (*RRI*) = $\sum_{i=1}^{i=5} E_i P_i$ where E_i is the extent of premium and P_i is the percentage of respondents.

Qualification of clients.

Ranasinghe (1998) discusses a way of implementing some of the lessons taken from the insurance industry. He explains that a mechanism with 12 assessment features is applied, and is comprised of 7 of management features and 5 risk features respectively. Each feature is scored on a scale of 0 to 4 with 0 being the lowest and 4 being the highest. Once the results are analyzed, superior clients with a score of 33 or more (i.e., out of 48), have a 99.95% of achieving the goal without any claim from the insurance. Consequently, the *most acceptable* policy lies within the 33-30 score range. Those have a 99.18% of finishing the project with no claim. The acceptable classification is the group that has a minimum of 26 points; they have a 12% chance of having claim. The less acceptable classification has points between 22 and 25; they have 19-50% chance of having a claim. Finally, the last classification is the unacceptable classification that scores lower than 22 points; they have a probability higher than 50% of having claims. As a result, the insurance firm will not accept to take over such an evident risk (Ranasinghe, 1998).

Similar approaches.

A company known as *RIB that is* in collaboration with an insurance company called *Munich Re*, is trying to implement an approach that is similar to this research study's proposed theory. RIB have developed a software called *i-TWO*, which is a platform that incorporates the BIM model and virtually constructs the building by primarily running 5D-simulations, clash detection, and quantity takeoff. Munich Re teams with RIB to provide cost insurance for projects that are well developed through i-TWO. Therefore, in order to better understand their approach of limiting cost overrun and their techniques for insuring the final cost of the project, B. Roman (i.e., employer at Munich Re) notes that it is essential to categorize change orders and carefully understand them, since some of the change orders are insurable, while others are not (personal communication, February 29, 2016). He continues with first explaining the causes of cost overrun and then the primary approaches that Munich Re's takes towards cost insurance. B. Roman (personal communication, February 29, 2016) finds that the main causes for cost overrun are as follows:

1- Owner's desire is not clear, which leads to missing desired project features and insufficient specifications.
2- Developing a *GMP* or an estimate, before reaching a reliable construction design.
3- Construction document based on an incomplete or faulty design.

Moreover, B. Roman points out that, at times, selecting a contractor based on a lower price in the bidding process, rather than qualifications, will not always work in favor of project cost, specifically at a later point in the project (i.e., change orders arise) (personal communication, February 29, 2016). Although hiring a contractor that is asking for a higher price seems less economic, the overall cost of the project (i.e., including future change order claims) seems to be lower with a costlier but qualified contractor, as opposed to lowest bidder contractor. This information, according to B. Roman, was based on a study done by Munich Re and a similar study by the German government (personal communication, February 29, 2016).

Furthermore, risk management plays a vital role in predicting changes and future problems. Primary reasons pertaining to this claim include the mistrust that arises between parties, stakeholders prioritizing their individual interests, the lack of collaboration, and the lack of dispute resolution (Akintoye & MacLeaod, 1997).

According to a research study investigating 200 risks that Munich Re have dealt with, results show that the design and estimating phase (i.e., pre-design) are the most important phases for controlling cost overrun, since the cost is originally set during these two phases. Project management then comes in third, since cost is controlled and coordinated between stakeholders to ensure everyone still remain within budget (i.e., project management phase) (B. Roman, personal communication, February 29, 2016).

The technique that i-TWO mainly uses to deal with such problems is combining all stakeholders in one same room (i.e., *i-Two 5D Lab*) during the early stages of the project, in order to induce collaborative work, organize thoughts, and plan a work process. These three processes are then followed by systematically working on one cloud-based model (i.e., one central database), which is then transformed to an *i-Two control Tower* at a later stage in the project (i.e., the construction phase). In the i-Two Control Tower, one is able to create a 5D simulation, which is virtually constructing the building in 3D + Time + Cost to see whether any errors appear in construction. Accordingly, this all takes place before the actual construction begins, which gives the team a chance to check, coordinate, and eliminate any surprising elements that may appear during the construction process (B. Roman, personal communication, February 29, 2016). This technique will give an accurate estimate of the project and limit the chances of cost overrun.

As mentioned earlier, the effect of change increases as the project advances, while the opportunity to influence the owner decreases as the project advances. Similarly, there is an inverse relationship between cost overrun and cost certainty. At beginning of the project, there is a high risk of cost overrun, which gradually decreases throughout the project. On the other hand, cost certainty is at its lowest at the beginning of the project, but gradually increases as the end of the project approaches. By the end of the project, 100% cost certainty and 0% risk for cost overrun will be apparent (i.e., Figure 6). The cost at the end of the project life is known as *As-Built price*. Moreover, during the early stages of the design phase, the difference between the *As-Built price* and the *estimated price* using i-TWO include the construction claims and elements that Munich Re can insure (B. Roman, personal communication, February 29, 2016).

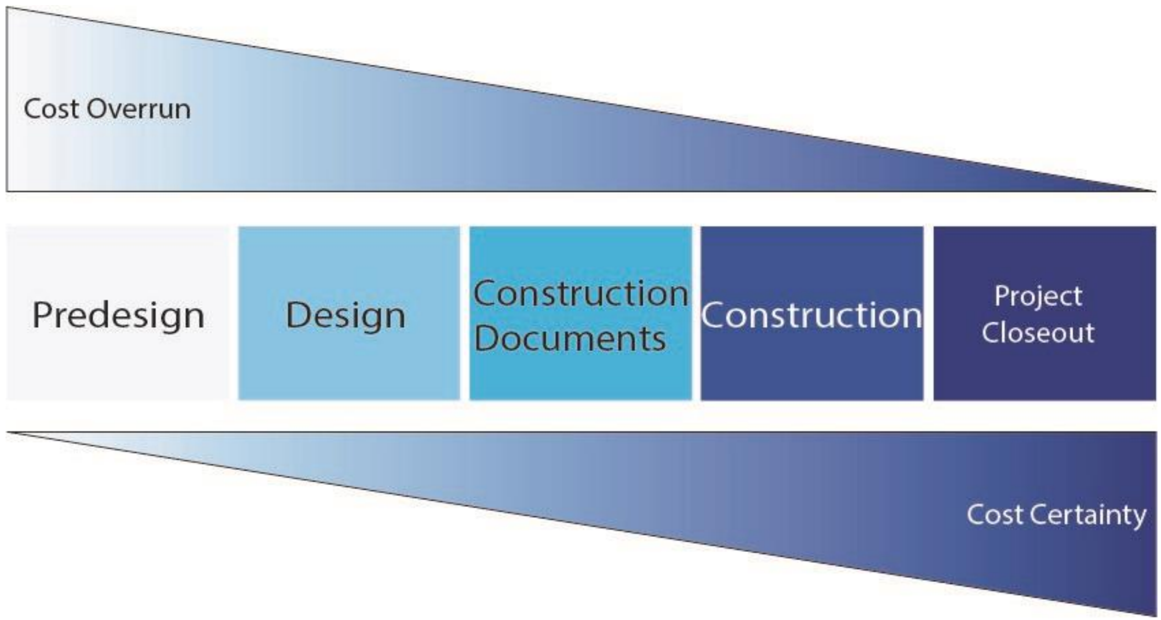


Figure 6. Chance for cost overrun vs cost certainty through the project life.

However, Munich Re will not pay the difference, whereby the difference will be considered the primary objective of the insurance (B. Roman, personal communication, February 29, 2016). In other words, one can assume an unfortunate scenario where the estimate of the project will cost $10 million, but many claims are filed and the *As-Built price* appears to $11 million. In an ideal situation, the insurance company is supposed to pay the difference (i.e., $1 million) to the owner. However, this is not always the case. The way Munich Re operates and runs this approach is that the $1 million will be considered the objective of the insurance. However, this does not mean that the owner will get this much money back. An insurance deductible will be included which means they will try to understand the reason for this cost overrun. Unless the reason for the cost overrun is the owner, Munich Re will not cover this cost overrun. However, even if it is the owner's fault, the insurance company will evaluate if the owner had performed based on the agreement in the contract (being involved as much as required or providing accurate information as asked) and this performance will affect the insurance deductible value. If there is a high deductible based on poor performance from the owner, the insurance company will cover a minimal amount of the claims.

In their approach, Munich Re’s insurance only covers the owner. This is where my proposal and their approach primarily differ. In their philosophy, one should not relieve stakeholders from their risk and responsibility so that they keep doing their jobs as well and efficiently as possible. If you relieve them form their risk, they might experiment with the product or give a less perfected outcome. The reason Munich Re keeps a deductible also on the owner is to keep them from feeling they don’t have any risk which, in their opinion, ensures they perform better. However, I believe that professionals would still perform their jobs well since their reputation and ethics are involved. Nevertheless, taking their point of view in mind, one can include the stakeholders in the insurance without relieving them form the risk. Architects, for instance, are still required to perform based on the standard of care. If the insurance company includes architects, they can examine claims and only cover change orders that are due to errors and omissions made by architects, who are still performing under the standard of care. However, if the architect did a mistake that is not considered within the standard of care (other architects would not have done this mistake in that situation), the insurance then has the right not to cover the claim and make the architect pay for it, which is what professional liability insurance covers. Moreover, in the same manner that Munich Re holds a deductible on the owner, this can also be applied for contractors and architects. Where claims are addressed on one to one basis to see the performance of the stakeholder and then decide whether to cover or not or even hold a deductible on this claim.

Even though i-TWO motivates stakeholders to collaborate early on in the project and to work as a team, the insurance policy allows the chance for the opposite to happen. The policy insures the owner primarily, which by its turn makes the insurance company check whether the mistake is insurable or the responsibility of any of the other stake holders, which in that case doesn't get covered by the insurance. This will provoke a sense of competition rather than collaboration since every stakeholder is still worried about protecting themselves against the blame of others. This comes from the fact that the insurance policy does not cover every stakeholder evenly, which, in my opinion, is supposed to happen for this policy to benefit from its full potential.

The important part, that i-TWO has in this process in managing owner-initiated change orders. Although Munich Re does not insure owner initiated change orders, i-TWO is capable in a little amount of time to calculate the change in price for owner initiated change orders in addition to the change in time or schedule. So if an owner requests a change in scope, the team can easily model the change and run a cost estimate (i.e., based on unit prices from contractors) and time estimate and present it to the owner with the two options, the original scope with price and time versus the new model with the updated price and time. Then the owner can decide based on the accurate information provided, understanding that how this change can affect the cost and schedule of the project.

Insurance companies' business model.

From an insurance company's perspective, insuring a project for a premium that has a high chance of having claims (i.e., higher than the value of the premium) is not considered an adequate business model. In other words, insurance companies are in initially involved in this business to make money, and the only way this can be guaranteed depends on their ability to sell premiums and have claims that constitute less than their premium cost. Accordingly, B. Roman (i.e., employer at Munich Re) explains the way Munich Re deals with such issues. In their research, Munich Re finds that the average cost overrun for a project usually lies within 20%. In this case, assuming that they want to run a profitable business, they have to ask for a 25% premium, which no owner would accept (B. Roman, personal communication, February 29, 2016).

Munich Re uses this platform to reduce the risk as much as possible. Therefore, after virtually constructing the project through the use of i-TWO, the assumption is that that there is approximately 1 to 2% risk (B. Roman, personal communication, February 29, 2016). Accordingly, this can then make the project insurable, where 2% will be a fair, middle ground premium for both, the insurance company and the owner. In this way, RIB and Munich Re will be controlling the risk factor and reducing the total project price, in the case that it does exceed their estimates, it will still then remain within the budget (i.e., including insurance coverage). Therefore, limiting the risk as much as possible through the use of available technologies (e.g., i-TWO) is the key to creating an insurable project for owners and insurance companies.

The essential prerequisites for such a model to work are having all stakeholders use one platform and one BIM model that include all the building information. The collaboration is also accounted for, in which all stakeholders meet regularly to collaboratively raise concerns and solve them. Additionally, the contractor has to be included in the design phase to provide input and feedback associated with cost, schedule and constructability techniques at an early point in the design phase. Moreover, a sufficient risk management assessment has to be done early on in the project. Overall, Munich Re ensures effective project management outcomes by the team, as a result of requiring the use of i-TWO and BIM modeling tools throughout the developing phases of the project (B. Roman, personal communication, February 29, 2016). However, this is solely based on their studies (i.e., limited and cannot be generalizable), which means that one cannot generally conclude that the techniques used to control cost overrun may actually appear to be just as effective when implemented on other projects, as opposed to not using these techniques.

G. Bundschuh, a lawyer and insurance broker at *Greylin*g (i.e., a division of EPIC), explains that a similar approach did exist for a while, but was never sustainable enough for insurance companies (personal communication, March 1, 2016). Similar to abovementioned discussion, the insurance premium is relatively high. However, even at such a high rate, insurance companies have still not been able to make profit from such policies since, at that time, only high-risk projects have initially bought these policies, which have not been perceived as adequate business models for the insurance companies. Moreover, the policy has not been widely spread or adopted by owners, which made it almost impossible for insurance companies to make profits out of it. The acceptance rate and narrow market adoption rate have also played a vital role in the failure of this policy before. In other words, insurance companies usually produce money from low-risk projects that help them cover the claims of a risky project. Accordingly, if the insurance company only deals with high-risk projects, then they will most likely run out of business as a result of such high-risk claims. However, if this policy is widely spread and adopted by different risk level projects, it may become a successful tool for dealing with change orders.

Many factors have changed throughout the construction industries and still continue to change at an exponential rate. In the available technology and mentality in the design and construction industries, this model can be utilize and solve the problem of cost overrun in projects. In order to do so, one must first understand whether or not the market is ready to widely adopt such a policy. If so, the following questions are raised:

1- Who would the potential buyers of the policy be?
2- What premiums are they willing to pay for this policy?

Accordingly, responses to such questions are important in order for insurance companies to understand its target market and create a fully developed insurance policy.

CHAPTER IV

APPLYING THE COIP

Brief Overview

To better understand the main concept of this study's proposed policy, this chapter will explain it in more detail. However, this cannot be identified as a fully developed policy, since it still remains a proposed, theoretical concept. Accordingly, the following criteria portray several ways that the proposed model can successfully be implemented.

Managing the People

In order to produce an effective, proposed policy in the construction industry, the participating parties have to be willing to accept it with an open mind, in addition to being fully committed to the idea (Egbu, 2004). Since construction projects involve a large number of parties, stakeholders, and are often complex, it is important to divide tasks into a hierarchal structure. Accordingly, professions such as construction management and program management have been developed in order to create specialized individuals with many essential elements consistently remain intact (Egbu, 2004).

Teams of individuals typically complete projects. Often, the overall *project team* is divided into *Macro-level* teams of people (e.g., by discipline or responsibility-such as designers and builders), which are in turn also divided into a smaller team to perform more specific tasks (e.g., creative design teams, technical detailing design teams, general builders, specific trade builders, etc.) (Egbu, 2004). In order to ensure the success of the overall project, project managers have to ensure that all team members are performing to the best of their abilities and working efficiently. According to Braley (2015), the project manager is expected to envision the project's successful completion and outcome. Afterwards, he/she is required to articulate that vision *to/for* the team for two main reasons: understanding what is *possible* and what is *expected*. During the early phases of a project, this *vision* is essentially a reality that does not yet exist. Consequently, program managers are required to help and inspire the team members to recognize their potential and perform to the best of their abilities. Once this understanding is achieved, which will then allow this vision to turn into reality (Egbu, 2004; McKean, 2011). Project managers manager fulfill their leadership responsibilities by working throughout the project term to create and sustain a work environment for the team members can in fact work to continue performing to the best of their abilities, whereby the vision is then sustained and enhanced (Egbu, 2004).

In some instances, however, this may pose a problem to a many project managers that want to implement a new model or strategy. In other words, in the absence of the team's enthusiasm and motivation towards this new approach, the chances of success are significantly lower (McKean, 2011). Additionally, McKean (2011) also explains that design and construction industries are not generally open to change.

What/Who Does the Policy Cover?

One of the most vital things for this policy to work is for buyers (i.e., Architects, Contractors and Owners) to clearly understand it. This policy is aimed to provide a set payment (i.e., insurer's premium) that is agreed upon by both, the stakeholders and insurance company at the beginning of the project. This payment will replace the unanticipated payments frequently result from change orders that appear at a particular phase during the development of a project.

The proposed policy (i.e., COIP) does *not* cover owner-initiated change orders. Additionally, CIOP will not cover unforeseen conditions, since they cannot be quantified. The COIP will cover change orders caused by *errors* and *omissions*. Regardless of the individual responsible, such change orders will be covered as long as they fully meet the conditions and requirements that are included in the policy.

Moreover, this policy will cover all stakeholders, in addition to being bought and paid for by all parties, who are involved in the project and impact change orders. This primarily includes architects, contractors, and owners. In some cases, however, major subcontractors and consultants may also be included depending on the project. This point is crucial for the success of the policy.

In previous chapters, Munich Re's (i.e., owner) approach (B. Roman, personal communication, February 29, 2016) in insuring that one party of the project, has been analyzed. Several concerns regarding the effects of this have also been discussed. In other words, a contradiction between Munich Re's (personal communication, February 29, 2016)'s expressed aims and the expressed aims of the policy is evident. Moreover, inviting stakeholders to collaborate and work together is essential for reducing risk and substantially making less errors due to the production of coordinated and high quality data. According to Sunil, Pathirage, and Underwood (2015), "the quality of data and its management is vital to successful cost management of construction projects". This is only applicable when collaboration is present. On the other hand, the insurance policy that is proposed by Munich Re does not significantly account for the importance of the elements of a collaborative process (B. Roman, personal communication, February 29, 2016). It is quite difficult for individuals to collaborate and work openly with one another, while simultaneously protecting themselves from each other (i.e., stakeholders). Since their insurance policy primarily protects the owner, architects and contractors will become concerned with being accused of making errors and omissions. In such a case, stakeholders will be on the lookout trying to deflect the blame from them.

However, since all stakeholders are categorized under one insurance policy in COIP, protecting themselves against each other will no longer be one of their concerns, since they will ideally share the same interests. Additionally, all stakeholders are insured under one policy and do not have to concern themselves with the individual responsible for making an error.

Reducing Risks

As mentioned earlier, reducing the risk plays a vital role in this policy. It helps the insurance company run a profitable business, while simultaneously making the policy affordable for the buyers. In order to minimize risk, the team is required to utilize some of the tools that are already available in the market (Riley et al., 2005). The insurer will be requiring that:

1- BIM is utilized comprehensively

2- Lean principals are adopted

3- Risk management tools are acquired

4- *CM-Risk* is implemented

Optimizing the use of BIM.

"Building Information Modeling (BIM) is an intelligent 3D model-based process that equips architecture, engineering, and construction professionals with the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure" (Autodesk, 2016). Building Information Modeling (i.e., BIM) is one of the widely discussed phenomena in the construction industry. This tool has been improving and benefiting the industry at an exponential rate (Goedert & Meadati, 2008). For instance, the UK has set 4/4/2016 as the start date for using BIM on all of its public projects. However, not all parts of industry have adopted the use of BIM (Chinyio & Olomolaiye, 2009). According to Hardin and McCool (2015), the percent of contractors that adopt BIM increased from 17% in 2007 to 70% in 2012. Although BIM is being increasingly adopted, it still isn't fully utilized yet.

However, solely using BIM is not the goal of this research study. The goal is to utilize it, in order to benefit from the suitable data and coordination outcomes that BIM is capable of developing. A study analyzing the return on investment (i.e., ROI) of high engagement BIM users, in comparison compared to low engagement BIM users between the years 2009 to 2012. As a result, the study shows that 64% of the low engagement users have negative or breakeven ROI; whereas 67% of the high engagement users have reported a ROI over 25% (Bernstein Jones, Russo, Laquidara-Carr, Taylor, Ramos, Lorenz, Winn, Fujishima, Fitch, Buckley, & Gilmore, 2012).

According to a report by Jones and Laquidara-Carr (n.d.), more than half the respondents have stated that BIM helps reduce the final cost of the project by 5% and accelerate the schedule by 5%. Moreover, the report shows that over a quarter of respondents report at least 25% of improvement in labor productivity when using BIM. Finally, the report states that almost a third of respondents report that BIM helps reduce onsite labor by 25% due to offsite fabrication. On the other hand, the majority of contractors have reported that the use of a well-developed BIM model contributes to 10% of the lower final construction cost (i.e., Dodge Data & Analytics). According to Jones and Laquidara-Carr (n.d.), 45% of the AEC industry respondents see 5 to 10% reduction of final cost and acceleration project completion due to schedule compression. Additionally, 44% have reported that BIM helps in more than 10% of RFI reduction.

Most importantly, the research asked 40 owners and 100 general contractors to rate the effect of BIM in a very high, *high*, and *medium* scale. 23% of the owners and contractors have rated increased predictability/fewer unplanned changes as *very high*, while 35% of owners and 40% of contractors have rated it as *high*, in addition to 25% of owners and 27% of contractors having rated it as medium. When asked about *reduced rework*, 20% of owners and 21% of contractors have rated *very high*, 33% of owners and 34% of contractors have rated *high*, and 23% of owners and 24 % of contractors have rated *medium*. Finally, regarding *reduced amount of out-of-sequence work due to earlier problems*, 18% of owners and 9% of contractors have rated *very high*, while 30% of owners and 36% of contractors rated *high*, in addition to 30% of owners and 38% of contractors have rated *medium*. In order to achieve such results and utilize BIM, the team must look out for four categories,

1- BIM Planning,

2- Platform Compatibility,

3- BIM-Integrated Project Meetings, and

4- Owner Advocacy

Overall, BIM can be a major tool used for reducing risk and improving efficiency. Reducing errors and cost, in addition to increasing offsite fabrication, labor productivity, and schedule acceleration are factors that can be vital to the final outcome of the project. Accordingly, focusing on these steps can significantly reduce the risk of the project, thus making it insurable and less likely for change orders to occur.

Lean mindset.

When discussing BIM, collaboration, and efficiency, the concept of Lean comes into mind. Lean construction is a relatively new way of approaching a project that has emerged in the 1990s, with the primary aim of improving the quality and efficiency of the project. According to Koskela and Howell (2002), Lean construction is a "way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value". Lean construction shares many common factors, and is arguably derived from *Lean Manufacturing and Lean Production* that has been mainly developed by Toyota. Additionally, theories proposed by *TQM*, *SPC*, and *Six-Sigma* are evident in Lean construction. However, there are three main unique tools that are evident in Lean construction, which include *Target Value Design*, *Last Planner System*, and *Lean Project Delivery System*.

The relationship between stakeholders is deemed the main element associated with the Lean mindset, which can be extremely beneficial to the COIP. “One key difference between traditional and lean project delivery concerns the relationship between phases and the participants in each phase” (Koskela & Howell, 2002). In Lean construction, stakeholders meet during the early phases of the project in order to provide valuable insight from different perspectives. For instance, facility management can provide valuable input to the design team, thus resulting in a better outcome. Similarly, during the design process, construction managers and architects specifically communicate in order to produce better documents and a more efficient schedule.

In terms of time efficiency, Lean construction is able to generate a more efficient schedule due to collaboration, last planner system, and pull schedules. During schedule revision, the presence of everyone in the room can solve many problems and significantly cut down the schedule life. Subcontractors or craftsmen that execute the job specify the amount of time needed for the task, collaboration and pull scheduling add more efficiency to the process. The team will meet in order to develop a schedule. Using pull planning, the team will start from the end (i.e. a completed project) and make their way backwards through the schedule asking themselves what is needed to finish this task. Here, the last planner system comes into play where the trades specify the time needed for each task. Since all stakeholders are in the room, the can be done on the spot and while collaborating and coordinating between trades.

Finally, one of the most important areas of Lean construction is the ability to prefabricate parts of the building, even more, the ability to have off-site fabrication. This, first of all, limits the safety risk as the objects are being fabricated on a controlled environment. Moreover, the use of BIM helped a lot in prefabrication. A whole functional bathroom can be fabricated offsite while the structure is being erected. The bathroom will come in just on time for when it needs to be installed. This saves a lot of time and chance of error. Similarly ducts and ventilation systems can now be manufactured offsite and assembled on site since the BIM model has done clash detection already. Benefits of lean construction in relation to stakeholders can be seen in Table 1. All of this helps in reducing waste and saving time and money. In a study by Umtost et al. (2014), nearly 8000 change orders were reviewed between 2008 and 2014. The percentage of change orders and errors and omissions were 42% and 38% lower respectively than projects that did not use BIM or Lean (i.e., Table 2 & 3).

Table 2

Lean Effects (Umstot et al., 2014)

	Number of Projects	Total CO Rate	Errors & Ommissions CO Rate	Ratio of Errors & Omissions Rate/ Total CO Rate
Without BIM or Lean	20	7.73%	2.99%	0.33
With BIM and Lean	15	4.43%	1.88%	0.36

Table 3

Change Orders in Lean and BIM vs. Without Lean and BIM (Umtsot et al., 2014)

	Number of Projects (n)	Total CO Rate	Errors & Ommissions CO Rate	Ratio of Errors & Omissions Rate/ Total CO Rate
New Construction				
Without BIM or Lean	13	7.54%	3.04%	0.305
With BIM and Lean	13	4.38%	1.90%	0.355
Renovation				
Without BIM or Lean	7	8.00%	2.90%	0.367
With BIM and Lean	2	4.80%	1.79%	0.388

Similarly, significant improvement in schedule is evident, since 20% of projects that used BIM and Lean completed the project on schedule, while 5 % of the projects that did not use BIM or Lean completed the project on time (i.e., Table 4).

Table 4

Schedule Efficiency When Using BIM and Lean (Umstot et al., 2014)

	Number of Projects (n)	Completion Time	Percentage
Without BIM nor Lean	19	1	5
With BIM and Lean	15	3	20

Additional benefits that the study finds are summarized in Table 5.

Table 5

Benefits of Lean (Umstot et al., 2014)

Benefit	SDCCD Metric	SDCCD Experience
Reduces waste associated with change orders	Total and error & omission change orders as % of total construction cost	Total change orders reduced from 7.73 to 4.46% on average; average cost savings of $900,000 per project
Improved schedule performance	% of projects that completed within contractual completion date	Project schedule performance improved using BIM and Lean, but using critical path method scheduling only 20% of projects completed on time; this prompted abndonment of CPM scheduling and requrement to use the Last Planner System
Meeting programatic requirments and enhancing calue with a constrained budget	# of projects that met target value design budget	Used target value design to enhance value and meet the target budget in 83% of the projects included in this study
Enhanced value generation through more sustainable buildings	# of buildings that exceeded LEED Silver certification	Using BIM improced this by a factor of 45% and using target value design improved this by a factor of 100% from projects where none of these tools were used.
Enhanced value generation through lower operational and maintenance costs	Maintenance cost per square foot	Majot factor in helping reduce annual sqaure footage maintenance costs from $3.73 to $1.46 over a 3-year period

Risk management.

Although there is a third party that is specifically ready to cover risks, contingency is still essential when using COIP. Bundschuh (personal communication, March 1, 2016) explains that insurance companies do not believe in insuring a project without the presence of contingency. In other words, no contingency places all the risk on the insurance company, thus creating an inadequate business model. Moreover, since insurance companies take risks in return for money, having all the risk placed on them will require an extremely high premium. Therefore, in such a case, the important factor is to balance between mitigating the risk and having an acceptable premium.

On the other hand, in cases where change orders are issued and claims occur, the insurance company will cover the insured one when contingency is exhausted. Usually, best practice is associated with a set contingency that is dedicated to specific phases and performances of a project. For instance, there should be a dedicated contingency to cover excavation, while another contingency is dedicated for structure. Additionally, stakeholders should not use contingencies dedicated to other acts, unless such acts are complete. For instance, earthwork contingency shall remain untouched until earthwork is done. Then and only then can this contingency, or what’s left from it, be used for other causes.

Therefore, the COIP will require stakeholders to have dedicated contingencies to different phases of the project, although they may be of lower value in comparison to usual contingencies. After finalizing each phase, the contingency is moved to a rewards pool. Instead of carrying leftover contingency from one phase to another, the COIP allows stakeholders to dedicate the money to other factors, since the claims of other phases are covered by insurance and its own contingency.

For instance, assuming a team sets a contingency of $500,000 for excavation and use $200,000 of it. When the excavation is completed, the remaining $300,000 is moved to the next phase and added to its contingency. The COIP allows the team to make use of the $300,000 in other areas, such as expansion of scope or owner-initiated change orders. This is possible since the insurance will cover each phase separately. The insurer will have a cap on each phase in a sense where if a team exhausts the contingency of one phase, the insurance will cover the rest. However, it would make sense if the $300,000 was put in the rewards pool similarly to what happens in IPD contracts. This will also give a bigger incentive for the team to achieve good results.

Funding and Delivery Method

This section will give a general overview on the essential parts that are needed for the fundamentals of this policy to work.

Funding.

When one hears about COIP, one big question arises and that is, *who will pay for it?* This is an important question. As discussed earlier in this chapter, it is essential that the policy covers all stakeholders, which explains all stakeholders paying a share of the premium. This will help reduce the impact that a premium may have. For instance, if the premium is set high and paid by one party, it will affect that party to an extent in which it may be more desirable to eliminate the risk of cost overrun, instead of insuring against it.

If a situation is taken where the project cost is estimated to be $100 million. After reducing the risk in the methods discussed above, the insurance company will be able to insure this project for a premium of 2% for example. However, based on preliminary survey (i.e., survey I in chapter V), no owner will accept to buy this policy if they are responsible for paying for it by himself/herself. Accordingly, $2 million is a large amount of money and the owner may rather take his chances. On the other hand, dividing the policy amongst the stakeholders will reduce the impact of this premium. Moreover, dividing the policy cost will make all stakeholders have “skin in the game”. In other words, stakeholders will have a commitment to deliver high standards.

The following is a hypothetical example that is by no means accurate, nor does it illustrate the calculations that are needed for paying the policy premium.

If one divides the premium in a logical manner that represents the risk and responsibility, one may reach a point where the owner will pay 50% of the premium, the architect and contractor will split the other 50% based on negotiations, thus totaling 100%. Based on this division, the owner will pay $1,000,000, while the contractor and architect will split the remaining $1,000,000, which is significantly less than having one party pay $2 million. Since the owners are generally responsible for communicating their ideas and explaining both, the scope and program, this usually carries the highest risk in the case that the project cost is exceeded, he/he will then share 50% of the risk. On the other hand, the architects and the contractors will share the other half, since they are responsible for creating, checking, and executing the drawings. The same way the architect is responsible for producing a well-developed set of drawings, the contractor is also responsible for providing input during thr design phase, in collaborative delivery methods, for the architect and detecting any mistakes before construction. The split of the remaining 50% can be influenced by many factors, such as history records and the complexity of the project

Moreover, having a rewards pool will benefit the policy on multiple levels. Since the team has a shared contingency that can turn into a reward, it will then make sense charge a deductible, in the cases where a deductible is present, out of this rewards pool to bring higher incentive. In this this way, deductibles will not have a negative impact other than limiting profit. In other cases, however, deductibles make stakeholders pay. Another benefit for this approach is the incentive for the team to collaborate. Since the team wants to benefit from the reward pool as much as possible, construction managers will be more vigilant in providing better predesign services, collaborate to resolve problems, and find mistakes early on in the project, where it normally costs less to resolve. Similarly, architects will be more willing to collaborate and think of alternative perspectives to better produce well-developed drawings.

Best delivery method: *CM-Risk*.

To many, this approach will appear best suitable for *IPD* contracts. However, since *IPD* is arguably a method where most projects achieve the targeted budget or are being placed below it, which generates no use for such a policy. Nevertheless, as S. Jones (personal communication, February 17, 2016) states that *IPD* is not for everyone; it requires sophisticated owners that are willing to be included in most decision-making processes and be part of the team.

In conclusion, this policy can be applied to any delivery method, except *IPD* and *Design-Bid-Build*. *Design-Bid-Build* is the only delivery method that involves no collaboration potential, since the contractors are included at a late point in the process, after the construction documents are completed. Therefore, it is impossible to implement this policy, since a big part of it is based on early collaboration between stakeholders. Accordingly, since this policy only requires collaboration, BIM, and Lean mindset, then it can be deemed applicable in remaining major delivery methods (e.g., *Design-Build* and *CM-Risk)*. However, *Design-Build* has some obstacles (i.e., discussed earlier) of involving the owner and transparency, which makes *CM-Risk* the best suitable delivery method that can be combined with this proposed policy.

What Makes COIP Effective?

Promoting collaboration.

The insurer requires that the team makes use of Lean and BIM; the team has to deliver the project in a collaborative method. Since the fundamentals of BIM and Lean primarily focus on the importance of collaboration, this will leave the team with no choice but to collaborate. In addition to its usefulness in almost any type of delivery method, BIM also makes the collaboration process significantly more effective **(**Goedert & Meadati, 2008). Also, since the profits are shared and each individual is as equally protected against loss, the team has no reason to hold back and not be as transparent as possible. All stakeholders are under one insurance policy that does not examine faults, but rather attempt to find different ways of avoiding errors (Goedert & Meadati, 2008). Therefore, instead of protecting themselves against each other, stakeholders can thoroughly work together to achieve common goals.

History records.

In some instances, professionals mistakenly think that using this policy will relieve stakeholders from risk. However, since a sufficient amount of risk still remains in the process, this will ideally ensures that stakeholders are consistently motivated to perform project objectives in a collaborative manner.

Similar to the mechanisms of other insurance policies, stakeholders that develop a bad history record will experience an increase in their premium on future projects. In contrast, a clean record will ensure a lower insurance premium. Moreover, a high premium will directly affect the premium of the team, which will then lead to a greater total cost. As result of the increased competition that is apparent in the market, owners may not select such stakeholders for the project. Moreover, that particular premium value is a direct reflection of performance history, and owners may not want to take on such a risk (Chinyio & Olomolaiye, 2009).

For instance, assume a contractor has worked on a couple of projects that have previously implemented COIP. 30% of these projects have sent claims to the insurer. On the other hand, 10% of another contractor’s projects have sent claims. With that being said, both contractors are competing for the same new project. However, the first contractor will be required to pay the insurance company with a higher premium, since he/she is considered to be riskier due to previous history records and project experiences. The owner will then assess the qualifications and cost associated with each contractor on the project. Since the first contractor has a higher insurance premium, this will then be higher for the owner. In other words, 50% of the policy price with the first contractor is higher than 50% of the policy price with the second contractor. Moreover, a contractor with a smaller number history of claims is deemed a positive factor in the selection of the first contractor (S. Jones, personal communication, February 17, 2016).

On the same note, this will encourage stakeholders to focus more on the quality of their performance, in order to keep their records clean and achieve low premiums. Since all stakeholders are under one policy, then they all have an equal risk probability of receiving a poor mark on their records. In other words, when one stakeholder’s poor performance results in having claims sent to the insurance, then all stakeholders will directly receive poor marks on their records. Such a case will encourage stakeholders to collaboratively work as a team and review each other’s performance. For instance, once an architect produces poor drawings that lead to a large number of change orders and claims, then the entire team's records may be significantly affected, which may then lead to accusations and litigations in extreme cases. In order to avoid such scenarios and maintain clean records, contractor will feel more motivated to review the drawings and provide more of their input into the design phase (S. Jones, personal communication, February 17, 2016).

Rectification coverage.

One of the primary reasons for occurring change orders is a poor set of construction documents. In many cases, the poor quality is a direct result of time limitation or insufficient time management during the design phase (Love, 2002). However, creating drawings that are of good quality is particularly vital for the success of the project. Therefore, when using COIP and if needed, the insurance company will fund the architect for spending more time on the drawings, in order to deliver the expected level of quality (Love, 2002). Accordingly, this will save a large amount of money for the insurance company, instead of having the team spend their contingency and ask for claims throughout at a later point in the project. Additionally, spending that amount of money is considered to be negligible, as opposed to moving into different phases of the project with drawings that are of poor quality, which can then result in a massive loss due to change orders (Love, 2002).

Proposed Study Concept

Introducing a new concept to the design and construction industry is a challenging process. According to McKeon (2011), the AEC industry is not always open for change.

In other words, if the construction market does not accept change, attempting to introduce a new *theoretical* concept that appears to be logical and effective on paper may still be damaging and ineffective once it is *actually* (i.e., in the real world) implemented in the industry (McKeon, 2011). Therefore, it is still important to understand the construction market's needs before introducing a new concept. However, this proposed study examines the market's acceptance rate towards the theory of COIP, and the possibility of it being implemented as a *real* policy.

Accordingly, the study's research questions are developed to understand the way that the market is going to react to a new insurance policy, which primarily aims to tackle the problem of cost overrun caused by change orders. Moreover, the research is set to determine the part of the market (Architects, Contractors, and Owners) that accepts or rejects the policy, as well as the reasons for choosing either one. The main research questions are as follows:

Question 1.

Does the design and construction market accept the COIP?

Question 2.

Do owners and program managers have a different perspective than architects, engineers, and contractors?

Question 3.

What are the elements that affect the acceptance rate of professionals in the industry?

CHAPTER V

METHODOLOGY

Measures

Interviews.

A total of 3 interviews were conducted during the first part of this research study. Two of them were 1-hour long, face-to-face interviews, while the third one was a 1-hour long, Skype interview. The interview questions primarily focused on factors mentioned in the literature review, which target the problems associated with change orders and the market's acceptance rate towards a proposed, theoretical insurance policy as a solution to such problems. For instance, two examples of the interview questions (i.e., refer to Appendix B-Part II for more interview questions) were as follows:

1- How would you define change orders?

2- Based on your experience, how do you deal with change orders and what are the techniques that you would use to prevent them?

Surveys.

Two surveys were conducted in this study. In order to conduct the surveys, this research study used a data collection website called *Qualtrics* (i.e., www.qualtrics.com). Both surveys were roughly around 3-minutes long. It is important to note that the use of a survey as a primary measure is beneficial for three main reasons: they are used to target a large population, are inexpensive, and limit experimenter-expectancy bias (i.e., limit subjectivity in responses) (Solomon, 2001).

Survey I

Survey I aimed to understand the issue of change orders and the way that the construction industry perceives it. The main purpose of this survey was to understand the way professionals deal with change orders, and whether they perceive change orders as a problem to the industry or not. The survey included an informed consent at the beginning of the survey (i.e., refer to Appendix A), which also generally introduced the research topic. The survey consisted of 11 questions (i.e., refer to Appendix B-Part I for survey questions), a general comments section, and an option for participants to declare having their names included in the research.

Survey II

After receiving feedback from survey I, survey II was conducted in order to improve both, the lack of clarification that was evident in the first survey and a more accurate understanding of the construction market's acceptance of COIP. Accordingly, survey II also included an informed consent at the beginning of the survey (i.e., refer to Appendix A), which was then followed by a page with two options to explain the COIP concept.

*1- Option 1.*The first option was to watch an animated video (i.e., refer to link in Appendix D) that was created by an animation website called Powtoon (www.powtoon.com), in order to better explain the concept of COIP to the participants.

*2- Option 2.*The second option was to read the narrative that is demonstrated in the animation video (i.e., refer to Appendix D).

Survey II consisted of 13 questions and a section to include any additional comments. However, depending on responses of each participant, the dynamic survey changed. For example, if the participant listed himself/herself as an owner, certain questions would not appear to them (i.e., refer to Appendix B-Part I)

Participants

Sampling and targeted participants.

The Atlanta Business Chronicle was one of the sources for acquiring contact information of participants. The Atlanta Business Chronicle lists the top 25 construction firms in Atlanta in each category (e.g., Architects, Builders, etc.). Accordingly, the participant sample included professionals in either one of the 25 presented construction firms. Therefore, the main sampling method used was *convenience sampling*, since 25 more prominent construction industries (i.e., as opposed to less prominent ones) in Atlanta were primarily targeted in this research study. The surveys were then sent out to all the listed architecture firms, engineering firms, interior design firms, contractors, interior commercial contractors, and commercial developers. In addition to the primary list of construction firms in the Atlanta Business Chronicle, the AIA (i.e., American Institute of Architects) magazine was another source used to collect participants' contact information. Architecture firms were listed in the magazine, which also invited professionals to participate in the survey. Social networks, such as LinkedIn (i.e., www.LinkedIn.com) and professional forums (e.g., http://community.cmaanet.org and http://archinect.com/), were tools that were used to attract more participants to partake in the study by posting a link to the survey and a brief explanation of the study. Finally, personal connections and contact from the industry were also invited to participate. The inclusion criteria required participants to be over 18-years of age, in addition to being professionals amongst the AEC industry (i.e., architect, contractor, engineer, owner, and program manager). Moreover, the surveys were completely anonymous, where an anonymous survey link was distributed to potential participants via email, LinkedIn, and forum posts.

In survey I, the link was posted on social media and sent via email to 123 professionals. 89 successful participants were then recorded. In Survey II, the link was also published on social media tools and sent via email to the same participants. The participants were also encouraged to share the links with other professionals related to the area of research to participate in the survey. 221 surveys were started, however, 130 were fully answered. Thus, 130 successful responses were recorded.

Participant description and demographics.

In survey I, out of the 89 participants, 24% (i.e., 21 participants) were architects, 51% (i.e., 45 participants) were contractors, 8% (i.e., 7 participants) were owners, 17% (i.e., 15 participants) were program managers, and 11% (i.e., 10 participants) were categorized as *othe*rs (i.e., including developers, consultants, and insurance brokers). Tables 6 illustrates the background of participants in survey I.

Table 6

Occupation of Participants in Survey I

#	Field	Choice Count	
1	Architect	24%	21
2	Contractor	51%	45
3	Owner	8%	7
4	Program Manager	17%	15
5	Other	11%	10
			89

Additionally, in survey I, 49 % (i.e., 44 participants) reported to have more than 15 years of experience in the construction industry. 20% (i.e., 15 participant) have 11 to 15 years of experience, 19% (i.e., 17 participants) have from 5 to 10 years of experience, and 11% (i.e., 10 participants) have less than 5 years of experience. Figure 7 demonstrates the experience level of participants in survey I.

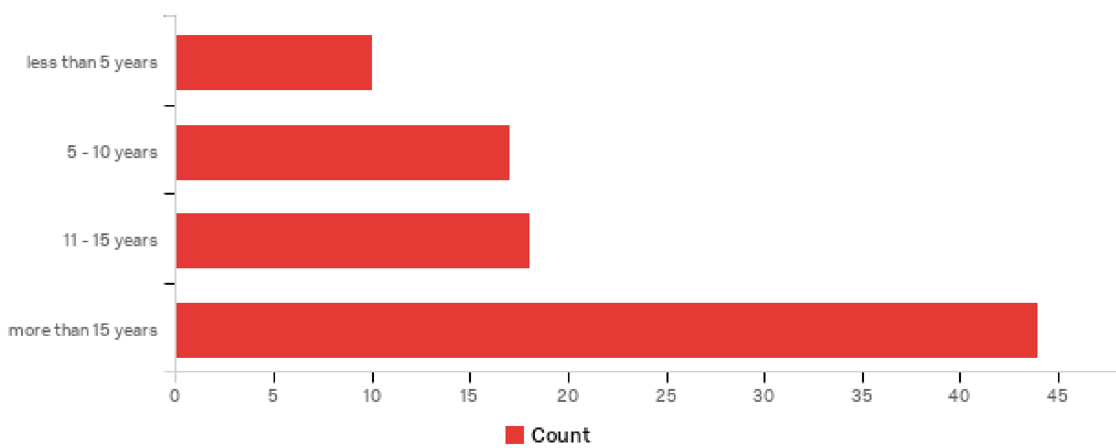


Figure 7. Level of Experience (Survey I).

On the other hand, in survey II, out of the 130 participants, 9.2% (i.e., 12 participants) were architects, 24% (i.e., 31 participants) were contractors, 15% (i.e., 20 participants) were owners, 28% (i.e., 36 participants) were program managers, 26% (i.e., 34 participants) were consultants, 1.5% (i.e., 2 participants) were developers, 1.5% (2 participants) were insurance brokers, and 5% (7 participants) were categorized as *others* (i.e., including Engineers and Subcontractors). It is important to note that some of the participants recorded two or more responses of the roles listed above. Table 7 illustrates the background of participants in the first survey.

Table 7

Occupation of Participants in Survey II

#	Field	Choice Count	
7	Program Manager/ Owner's Representative	28%	36
6	Owner	15%	20
8	Other	5%	7
5	Insurance Broker/ Company	2%	2
4	Developer	2%	2
2	Contractor	24%	31
3	Consultant	26%	34
1	Architect	9%	12
			130

Moreover, in survey II, 75 % (i.e., 98 participants) reported to have more than 15 years of experience in the industry. 9% (i.e., 11 participants) have 11 to 15 years of experience, 12% (i.e., 16 participants) have 5 to 10 years of experience, and 4% (i.e., 5 participants) have less than 5 years of experience. Figure 8 shows the experience level of participants in survey II.

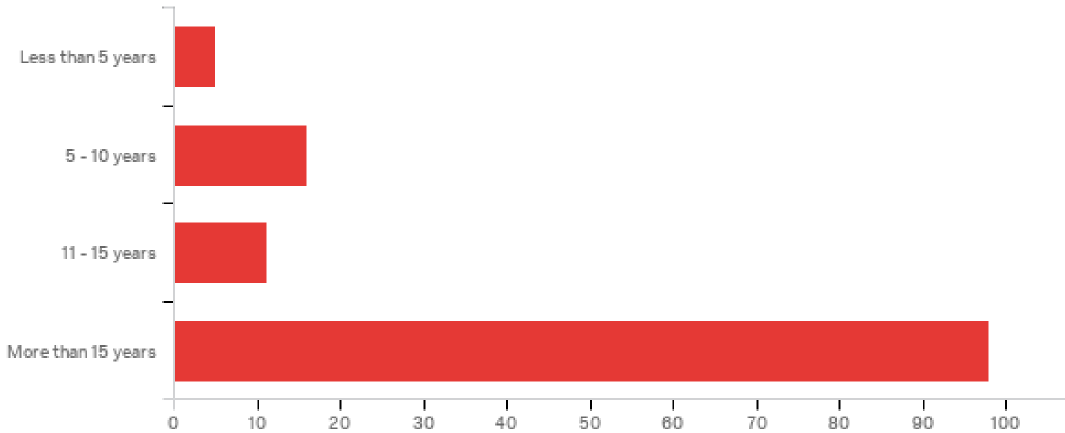


Figure 8. Level of Experience (Survey II).

Additionally, 95% (i.e., 124 participants) worked in North America, while the remaining 5% (i.e., 6 participants) worked in Asia, Africa, Australia, Europe, and South America (i.e., one participant per region).

Study Design

A combination of qualitative and quantitative analysis was used in this research study. Literature review and analysis lead to developing the theoretical insurance policy (i.e., explained in Chapter IV), hence the use of a qualitative review. However, in order to test the market's acceptance rate, a quantitative study of concept testing was conducted. "Concept testing is how people, without prompting, interpret a sketchy idea for a new product or service" (Smith & Albaum, 2006). This helps validate the results, since professionals have direct input and are able provide data through anonymous surveys in a more objective manner.

CHAPTER VI

RESULTS

Survey Results

Results of survey I.

This survey was designed to understand the problems pertaining to change orders from the market's perspective. In the first question about change orders, the participants were asked to rate the relation between change orders and the success of the project, which is translated into the impact that change orders initially carry. The rating system ranged from 0 to 5, where a response of 0 indicates *least impactful* and a response of 5 indicates *most impactful*. The mean response for this question was 4.6 out of 5, which means that the participants believe that change orders may significantly impact the success of the project. Moreover, in the following question and on a scale of 0 to 5, participants were then asked to rate the likelihood of having a cost overrun that is caused by change orders, where a response of 0 indicates *least likely* and a response of 5 indicates *most likely*. Consequently, the mean response was 4.75 out of 5, constituting 95% (i.e., refer to Table 8). In the second question and based on their experience, participants were asked to roughly estimate a percentage increase in the price of a project, as result of change orders. Accordingly, the answers included less than 5%, between 5-10%, between 10-15%, between 15-20%, and more than 20%. Each range was assigned a number on a scale of 1 to 5, where a response of 1 indicates less than 5% and a response of 5 indicates more than 20%. The mean response was 2.17 (i.e. refer to Table 9) and the most common response lies within the 5 to 10% range.

Table 8

Likelihood of Cost Overrun Caused by Change Orders (Survey I)

#	Field	Choice Count	
1	0	2%	2
2	1	3%	3
3	2	5%	4
4	3	28%	25
5	4	30%	26
6	5	32%	28
			88

Table 9

Increase in Price Caused by Change Orders (Survey I)

#	Field	Choice Count	
1	less than 5 % of original price	32.58%	29
2	5 to 10 % of original price	33.71%	30
3	10 to 15% of original price	21.35%	19
4	15 to 20 % of original price	8.99%	8
5	more than 20 % of original price	3.37%	3
			89

Moreover, participants voted *owner-initiated change orders* as the most common causes of change orders, followed by *unforeseen conditions*, and then *design errors*. The causes that received the least responses included construction errors and acts of God (e.g., storms, tornados, and earthquakes) (i.e., refer to Table 10). However, once participants were asked about the cause that had the greatest impact on cost, *unforeseen conditions* was observed to be the costliest one. *Design errors* were voted as the second costliest cause, which was then followed by *owner-initiated change orders* (i.e., refer to Table 11).

Table 10

Causes of Change Orders (Survey I)

#	Field	Choice	Count
1	Owner initiated change orders	46%	41
2	Design errors	17%	15
3	Construction errors	2%	2
4	Acts of God	2%	2
5	Unforeseen conditions	20%	18
6	Other	12%	11
			89

Table 11

Most Expensive Change Order (Survey I)

#	Field	Choice	Count
1	Owner initiated change orders	19%	17
2	Design errors	32%	28
3	Construction errors	5%	4
4	Acts of God	2%	2
5	Unforeseen conditions	38%	33
6	Other	5%	4
			88

Afterwards, the questions geared towards the idea of involving a third party, such as an insurance company that can control the cost of change orders. Results showed that 46% of the participants accepted the idea of sharing the risk by including a third party in return for a premium, whereas 54% rejected the idea. Table 12 shows the mentioned results, with respect to professions. However, once participants were asked whether they would allow insurance companies to review drawings, 71% of them declined, while only 29% accepted. Nevertheless, the participants who accepted also specified that insurance be minimally involved, so as to only be present on milestones reviews (i.e., refer to Table 13).

Table 12

Different Professions' Acceptance to Involve a Third Party (Survey I)

		Would you allow a third party to be included to share the risk for a premium?		
		Yes	No	Total
Are you a(n):	Architect	9	11	20
	Contractor	17	27	44
	Owner	4	3	7
	Program Manager	8	7	15
	Other	7	3	10
	Total	40	47	87

Table 13

Level of Involvement of Insurance by Profession (Survey I)

		To what extent would you allow insurance comp. to be involved?				
		Fully, on a daily to weekly basis	Interfere on a monthly basis	Only be present when the owner is present	Interfere partially, only be present on the milestone meetings of the project	Total
Are you a(n):	Architect	1	1	1	4	7
	Contractor	2	1	6	8	17
	Owner	0	1	0	1	2
	Program Manager	1	1	1	3	6
	Other	2	1	0	3	6
	Total	4	5	7	17	33

Finally, once participants were questioned about their opinion on a good premium for this policy, the mean response was 2.89% of the total price of the project with a standard deviation of 5.01. Table 14 shows all the results of the survey that are broken down based on profession.

Table 14

General Results of Survey I Broken Down by Profession

		Are you a(n): Architect	Contractor	Owner	Program Manager	Other	Total
Years of experience in the industry:	less than 5 years	1	7	0	2	2	10
	5 - 10 years	1	13	1	0	2	17
	11 - 15 years	2	14	1	1	2	18
	more than 15 years	17	11	5	12	4	44
	Total	21	45	7	15	10	89
How much would you rate the relation that change orders have with the success of the project? (0...	0	0	1	0	1	1	3
	1	1	1	0	0	0	2
	2	3	8	2	2	1	14
	3	7	7	1	1	2	17
	4	3	16	3	3	6	26
	5	7	12	1	8	0	27
	Total	21	45	7	15	10	89
How likely is it to have a cost overrun caused by change orders?	0	1	1	0	0	0	2
	1	0	2	0	2	0	3
	2	2	1	1	1	0	4
	3	8	9	2	4	3	25
	4	6	15	2	1	4	26
	5	4	16	2	7	3	28
	Total	21	44	7	15	10	88
Based on your experience, how much increase in price do change orders cause on a project?	less than 5 % of original price	13	7	3	5	1	29
	5 to 10 % of original price	4	18	4	5	4	30
	10 to 15% of original price	2	11	0	5	4	19
	15 to 20 % of original price	1	6	0	0	1	8
	more than 20 % of original price	1	3	0	0	0	3
	Total	21	45	7	15	10	89
What are the most common causes for change orders?	Owner initiated change orders	10	22	2	4	8	41
	Design errors	2	9	0	4	0	15
	Construction errors	0	0	0	0	2	2
	Acts of God	0	2	0	1	0	2
	Unforeseen conditions	4	8	3	4	0	18
	Other	5	4	2	2	0	11
	Total	21	45	7	15	10	89
Which type of change orders mostly affect or damage the cost of the project?	Owner initiated change orders	6	9	2	3	0	17
	Design errors	2	18	1	4	6	28
	Construction errors	0	2	0	0	2	4
	Acts of God	1	0	0	1	0	2
	Unforeseen conditions	8	15	4	7	2	33
	Other	4	0	0	0	0	4
	Total	21	44	7	15	10	88
Would you allow a third party to be included to share the risk for a premium?	Yes	9	17	4	8	7	40
	No	11	27	3	7	3	47
	Total	20	44	7	15	10	87
Would you be willing to allow the third party (insurance company) to review documents, interfere...	Yes	5	12	2	5	6	26
	No	16	33	5	10	4	63
	Total	21	45	7	15	10	89
If yes, to what extent?	Fully, on a daily to weekly basis	1	2	0	1	2	4
	Interfere on a monthly basis	1	1	1	1	1	5
	Only be present when the owner is present	1	6	0	1	0	7
	Interfere partially, only be present on the milestone meetings of the project	4	8	1	3	3	17
	Total	7	17	2	6	6	33

Results of survey II.

After analyzing the responses of the first survey, there appeared to be significant differences in *project managers* and *owners* vs. other professions, which correspondingly lead to testing the following hypothesis: If the concept of Change Order Insurance Policy (i.e., COIP) is initiated, then the acceptance rates of program managers and owners will be higher than *architects* and *contractors*. Accordingly, a survey was developed and sent out to the same number of participants, whereby participants were also asked to share it with other professionals that may possible add valuable input to the survey. As opposed to survey I, the second survey was adjusted to ensure that all aspects are carefully clarified and understandable.

In the first survey, the majority of participants believed that 2.89% of the project value is an appropriate price for this policy, the first question used 4% of the project's price and 2% (i.e., half of 4%), in order to measure the relationship of acceptance rate and the price of the policy. Participants were then questioned about their willingness to purchase COIP if it constitutes 4% of the project's price. The responses were on a scale of 1 to 5, where a response of 1 indicates *very likely* and 5 being *very unlikely*. The mean response was 4.02, which means that it is closest to *unlikely*. Accordingly, the results indicate that the acceptance rate of COIP when premium constitutes 4% of the total project cost is 10% (i.e., refer to Table 15).

Table 15

Acceptance of Participants to Buy COIP at 4%

		Architect	Contractor	Consultant	Developer	Insurance	Owner	Program Manager	Other	Total
If the premium of this policy is no more than 4% of the total cost of the project, how likely are...	Very Likely	0	0	0	0	0	0	0	0	0
	Likely	1	0	2	1	0	1	4	1	9
	Neutral	3	5	8	0	1	3	10	0	29
	Unlikely	5	12	8	0	1	7	9	2	42
	Very Unlikely	3	14	16	1	0	9	13	4	50
	Mean	3.83	4.29	4.12	3.5	3.5	4.2	3.86	4.29	90
	Total	12	31	34	2	2	20	36	7	130

The following questions primarily dealt with the participants' willingness to purchase COIP if it constitutes 2% of the projects. Such questions were designed to measure the relation between acceptance rate and price (i.e., if the price changes from 4% to 2%, then the acceptance rate will change from_____). The response options appeared on a scale of 1 to 5, where a response of 1 indicates *very likely* and a response of 5 indicates *very unlikely*. The mean response was 3.36, which means that it is close to neutral. When the premium constituted 2% of the total cost, results showed that the acceptance rate of COIP is 24% (i.e., refer to Table 16).

Table 16

Acceptance of Participants to Buy COIP at 2%

		Architect	Contractor	Consultant	Developer	Insurance	Owner	Program Manager	Other	Total
If the premium of this policy is no more than 2% of the total cost of the project, how likely are...	Very likely	1	0	1	1	0	1	4	1	9
	Likely	2	5	12	0	1	2	10	1	32
	Neutral	2	7	4	0	1	6	5	1	23
	Unlikely	5	8	8	0	0	8	7	1	35
	Very unlikely	2	11	9	1	0	3	10	3	31
	Mean	3.42	3.81	3.35	3	2.5	3.5	3.25	3.57	76
	Total	12	31	34	2	2	20	36	7	130

Participants who responded to the two questions with values indicating *very unlikely*, *unlikely*, and *neutral*, were then asked a question about their negative response. Accordingly, the most frequent response to such a question was that the price was too high, followed by the notion that stakeholders would not accept it. As a result and based on this survey, price is the primary reason that is keeping stakeholders from buying this policy. Accordingly, Table 17 illustrates these results.

Table 17

Reason for Participants Not Buying COIP

#	Field	Choice Count	
1	Price is too high	33%	39
2	It does not work	19%	23
3	Stakeholders would not accept it	32%	38
4	Change orders are not an issue	4%	5
5	There is a better way to deal with change orders	26%	31
6	other	30%	36
			119

When participants were asked to rate the effectiveness of this policy, with 5 being *not effective at all* and 1 being *extremely effective*, the mean response was observed to be 3.89, which is the closest to *slightly effective*. Table 18 demonstrates these results, with respect to each profession.

Table 18

Level of Effectiveness of COIP

		Architect	Contractor	Consultant	Developer	Insurance	Owner	Program Manager	Other	Total
In your opinion, how effective do you think applying this policy would be?	Extremely effective	0	0	0	1	0	0	0	0	1
	Very effective	3	1	1	0	1	0	1	0	7
	Moderately effective	2	7	9	0	1	5	14	3	38
	Slightly effective	5	7	13	1	0	11	10	1	41
	Not effective at all	1	15	11	0	0	4	10	3	41
	Mean	3.36	4.2	4	2.5	2.5	3.95	3.83	4	86
	Total	11	30	34	2	2	20	35	7	128

Participants were then asked about the extent to which they are willing to accept COIP if the owner asks them to. The response options were on a scale of 1 to 5, where a response of 1 indicates *very likely* and a response of 5 indicates *very unlikely*. The mean response was 2.96. This apparent change continued increasing, once participants were questioned about their willingness to accept this policy if the owner had it as a condition. The mean for acceptance was observed to be 2.32 (i.e., 53% acceptance rate). Table 19 and 20 show this change in acceptance.

Table 19

Acceptance Rate if Owner Asks for COIP

		Architect	Contractor	Consultant	Developer	Insurance	Owner	Program Manager	Other	Total
How likely are you to use this policy if the owner asks you to?	Very likely	1	3	2	1	0	0	2	1	9
	Likely	3	7	10	0	1	0	14	2	36
	Neutral	0	4	9	0	1	0	15	2	28
	Unlikely	4	8	5	0	0	0	0	1	18
	Very unlikely	1	6	5	0	0	0	3	1	16
	Mean	3.11	3.25	3.03	1	2.5	0	2.65	2.86	62
	Total	9	28	31	1	2	0	34	7	107

Table 20

Acceptance Rate if Owner Has COIP as a Condition

		Architect	Contractor	Consultant	Developer	Insurance	Owner	Program Manager	Other	Total
How likely are you to use this policy if the owner has it as a condition?	Very likely	1	8	5	0	1	2	8	2	26
	Likely	6	8	14	2	1	7	17	2	47
	Neutral	3	8	12	0	0	10	9	2	42
	Unlikely	1	3	1	0	0	1	0	0	6
	Very unlikely	0	2	1	0	0	0	0	1	4
	Mean	2.36	2.41	2.36	2	1.5	2.5	2.03	2.43	51
	Total	11	29	33	2	2	20	34	7	125

44% of the participants agreed that the COIP encourages teamwork. Once they were questioned about the beneficial constituents of the policy, they ranked *encouraging teamwork* first, followed by *limiting cost overrun* caused by change orders. Table 21 portrays several constituents of the policy that participants found to be particularly beneficial.

Table 21

Beneficial Elements of COIP

#	Field	Choice Count	
1	Reducing litigation	24%	30
6	Motivating stakeholders to improve the quality of work	30%	38
2	Encouraging team work	44%	55
3	Limiting cost overrun cause by change orders	37%	46
4	There are no beneficial elements	20%	25
5	Other, please specify	16%	20
			126

On the other hand, participants were then questioned about their opinion on the disadvantages associated with this policy. Accordingly, the highest ranked element was the additional cost of this policy, followed by the inclusion of a third party (i.e., insurance), and the possibility of increasing litigation. Table 22 portrays the mentioned results.

Table 22

Disadvantageous Elements of COIP

#	Field	Choice Count	
1	It is an additional cost	76.19%	96
2	It involves a third party in the process (insurance company)	65.08%	82
3	It might increase litigation	44.44%	56
4	There are no disadvantageous elements	1.59%	2
5	Other, please specify	25.40%	32
			126

Moreover, participants were also questioned about their opinion on the type and size of projects that this policy would be best suited for, with respect to the price. The majority of participants (i.e., 40%) stated that COIP is best suited for projects that cost more than $100 Million. Additionally, *governmental projects* were the most common response to the type of projects (i.e., 51%), followed by *infrastructure*. Tables 23 and 24 demonstrate the mentioned results. Finally, Table 25 demonstrates all the results of the second survey, which are broken down by profession.

Table 23

Most Suitable Project Size for COIP

#	Field	Choice Count	
1	Under $1 million	10%	11
2	$1 - $5 million	12%	13
3	$6 - $20 million	10%	11
4	$21 - $50 million	13%	14
5	$51 - $100 million	14%	15
6	More than $100	40%	42
			106

Table 24

Most Suitable Project Type for COIP

#	Field	Choice	Count
1	Residential projects	11%	13
2	Community projects (ex. Auditoriums, clubs, community centers, libraries, museums)	20%	24
3	Sports facilities projects	20%	24
4	Educational projects	17%	21
5	Governmental projects	42%	51
6	Automotive projects	5%	6
7	Infrastructure projects	34%	41
8	Entertainment projects	9%	11
9	Military projects	15%	18
10	Industrial projects	19%	23
11	Medical projects	17%	20
12	Office buildings	15%	18
13	Other	18%	22
14	None of the above	20%	24
			121

Table 25

Results of Survey II

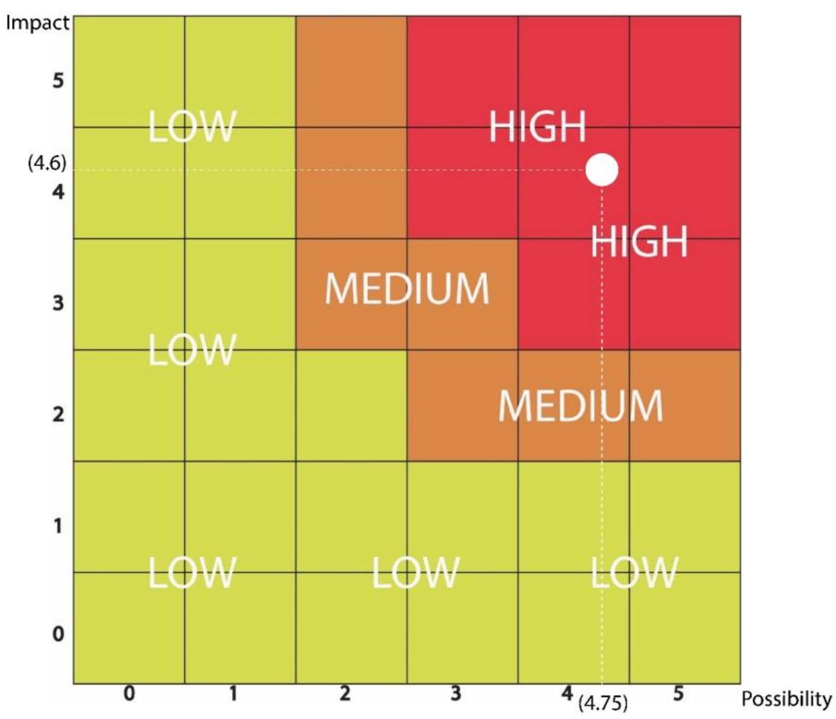
Question	Response	Architect	Contractor	Consultant	Developer	Insurance	Owner	Program Manager	Other	Total
If the premium of this policy is no more than 4% of the total cost of the project, how likely are...	Very Likely	0	0	0	0	0	0	0	0	0
	Likely	1	0	2	1	0	1	4	1	9
	Neutral	3	5	8	0	1	3	10	0	29
	Unlikely	5	12	8	0	1	7	9	2	42
	Very Unlikely	3	14	16	1	0	9	13	4	50
	Mean	3.83	4.29	4.12	3.5	3.5	4.2	3.86	4.29	90
	Total	12	31	34	2	2	20	36	7	130
If the premium of this policy is no more than 2% of the total cost of the project, how likely are...	Very likely	1	0	1	1	0	1	4	1	9
	Likely	2	5	12	0	1	2	10	1	32
	Neutral	2	7	4	0	1	6	5	1	23
	Unlikely	5	8	8	0	0	8	7	1	35
	Very unlikely	2	11	9	1	0	3	10	3	31
	Mean	3.42	3.81	3.35	3	2.5	3.5	3.25	3.57	76
	Total	12	31	34	2	2	20	36	7	130
The main cause that is stopping me from buying this policy is: (Please check all that apply)	Price is too high	4	11	11	1	0	6	13	1	39
	It does not work	0	5	6	0	1	5	5	3	23
	Stakeholders would not accept it	2	8	13	0	1	3	11	1	38
	Change orders are not an issue	0	2	0	0	0	1	1	1	5
	There is a better way to deal with change orders	0	6	11	0	1	6	8	1	31
	Mean	3.4	4.77	5.34	1	5	5.32	4.77	5.17	107
	Total	10	30	32	1	2	19	31	6	119
In your opinion, how effective do you think applying this policy would be?	Extremely effective	0	0	0	1	0	0	0	0	1
	Very effective	3	1	1	0	1	0	1	0	7
	Moderately effective	2	7	9	0	1	5	14	3	38
	Slightly effective	5	7	13	1	0	11	10	1	41
	Not effective at all	1	15	11	0	0	4	10	3	41
	Mean	3.36	4.2	4	2.5	2.5	3.95	3.83	4	86
	Total	11	30	34	2	2	20	35	7	128
How likely are you to use this policy if the owner asks you to?	Very likely	1	3	2	1	0	0	2	1	9
	Likely	3	7	10	0	1	0	14	2	36
	Neutral	0	4	9	0	1	0	15	2	28
	Unlikely	4	8	5	0	0	0	0	1	18
	Very unlikely	1	6	5	0	0	0	3	1	16
	Mean	3.11	3.25	3.03	1	2.5	0	2.65	2.86	62
	Total	9	28	31	1	2	0	34	7	107
How likely are you to use this policy if the owner has it as a condition?	Very likely	1	8	5	0	1	2	8	2	26
	Likely	6	8	14	2	1	7	17	2	47
	Neutral	3	8	12	0	0	10	9	2	42
	Unlikely	1	3	1	0	0	1	0	0	6
	Very unlikely	0	2	1	0	0	0	0	1	4
	Mean	2.36	2.41	2.36	2	1.5	2.5	2.03	2.43	51
	Total	11	29	33	2	2	20	34	7	125
In your opinion, what are the beneficial elements in this policy? (Please select all that apply)	Reducing litigation	4	4	8	0	2	2	10	2	30
	Encouraging team work	7	9	11	0	2	12	15	3	55
	Limiting cost overrun cause by change orders	5	8	11	2	1	8	15	2	46
	There are no beneficial elements	2	7	9	0	0	2	5	1	25
	Other, please specify	0	7	5	0	1	3	3	2	20
	Motivating stakeholders to improve the quality of work	5	7	11	0	0	7	10	1	38
	Mean	6.45	5.21	5.76	3	7	5.75	5.14	4.86	121
	Total	11	29	33	2	2	20	35	7	126
In your opinion, what are the disadvantageous elements in this policy? (Please select all that ap...	It is an additional cost	8	21	24	2	1	16	33	4	96
	involves a third party in the process (insurance compan	7	15	23	1	0	12	27	4	82
	It might increase litigation	2	16	16	0	0	11	14	4	56
	There are no disadvantageous elements	1	0	0	0	1	0	0	0	2
	Mean	3.82	4.62	5.09	2	5	4.9	4.97	4.14	105
	Total	11	29	33	2	2	20	35	7	126

Analysis

Based on the results of the first survey, and the use of the Risk matrix (i.e., refer to in Chapter III of this research study), an analysis was conducted on the level of risk that change orders carry. In questions 3 and 4, participants rated change orders with a 4.6/5 impact and 4.75/5 possibility that change orders are occurring. This puts change orders at a high-risk area on the Risk matrix (i.e., refer to Table 26). The white line illustrates *where* change orders lie, with respect to possibility and impact. Therefore, the possibility of diminishing the risk by transferring it to a third party is one option to deal with such a risk.

Table 26

Change Order Risk Matrix



Moreover, the results showed that the sample was split into 46% of the participants who accepted the concept of insuring change orders and 54% who rejected the concept. In addition, as shown in Table 27, owners and program managers exhibited higher acceptance of the policy, in comparison to architects and contractors. Therefore, a more specific survey was developed to test the market's response towards insuring change orders, and whether the different professions have different perspectives towards this policy.

Table 27

Acceptance of Change Orders by Profession (Survey 1)

		Architect	Contractor	Owner	Program Manager	Other	Total
Would you allow a third party to be included to share the risk for a premium?	Yes	9	17	4	8	7	40
	No	11	27	3	7	3	47
	% Yes	45	39	57	53	70	46
	Total	20	44	7	15	10	87

After analyzing the results of the second survey, we can notice (i.e., refer to Table 28) that Program managers and owners have higher acceptance rates than architects, contractors and consultants in every single situation asked. Therefore, in this sample, if the concept of COIP is initiated, then acceptance rates of program managers and owners will be higher than architects' and contractors'. However, even though program managers and owners are more likely to accept the COIP, the majority still does not accept it. In the next section, the significance of these results is tested.

Table 28

Acceptance Rate of Owners & Program Managers vs. Architects, Contractors, & Consultants

		Arch. Cont. Cons.	PM / Owner	Developer	Insurance	Other	TOTAL
If the premium of this policy is no more than 4% of the total cost of the project, how likely are...	Very Likely	0	0	0	0	0	
	Likely	33	5	1	0	1	
	Neutral	16	13	0	1	0	
	Unlikely	25	16	0	1	2	
	Very Unlikely	33	22	1	0	4	
	Acceptance Rate	17.20%	20.37%	30.00%	30.00%	14.20%	18.64%
	Mean	4.14	3.98	3.5	3.5	4.29	4.07
	Total	77	56	2	2	7	144
If the premium of this policy is no more than 2% of the total cost of the project, how likely are...	Very likely	2	5	1	0	1	
	Likely	19	12	0	1	1	
	Neutral	13	11	0	1	1	
	Unlikely	21	15	0	0	1	
	Very unlikely	22	13	1	0	3	
	Acceptance Rate	29.20%	33.21%	40.00%	50.00%	28.60%	31.17%
	Mean	3.54	3.34	3	2.5	3.57	3.44
	Total	77	56	2	2	7	144
How likely are you to use this policy if the owner asks you to?	Very likely	6	2	1	0	1	
	Likely	20	14	0	1	2	
	Neutral	13	15	0	1	2	
	Unlikely	17	0	0	0	1	
	Very unlikely	12	3	0	0	1	
	Likeliness Rate	37.40%	47.00%	80.00%	50.00%	42.80%	41.26%
	Mean	3.13	2.65	1	2.5	2.86	2.94
	Total	68	34	1	2	7	112
How likely are you to use this policy if the owner has it as a condition?	Very likely	14	10	0	1	2	
	Likely	18	24	2	1	2	
	Neutral	13	19	0	0	2	
	Unlikely	5	1	0	0	0	
	Very unlikely	3	0	0	0	1	
	Likeliness Rate	52.60%	55.92%	60.00%	70.00%	51.40%	54.20%
	Mean	2.37	2.20	2	1.5	2.43	2.29
	Total	73	54	2	2	7	138

Moreover, when observing the results in the second survey, a significant change in the participants' responses to the question asking about the extent to which they are willing to buy COIP for 2%, in comparison to such willingness if the owner asks them to. The mean response of acceptance changed from 3.36 (i.e., 24% acceptance rate) to 2.96 (i.e., 38% acceptance rate). Even more so, the acceptance rate increased to 2.32 (i.e., 53%

acceptance rate) if the owner had it as a condition. Therefore, it can be concluded that the owner plays a significant role in the acceptance rate of the policy.

Statistical analysis.

In this section, three main questions are raised:

1. Does *profession* have a significant relationship with *willingness to buy* the policy, if its premium constitutes *no more than 2%* of the project's cost? In statistical terms, let $\boldsymbol{X_2}$ be the variable denoting the willingness to buy the policy, only if the premium constitutes no more than 2% of the project's cost. The null hypothesis is tested as follows: Profession and $\boldsymbol{X_2}$ are independent, versus the alternative hypothesis: Profession and $\boldsymbol{X_2}$ are dependent on each other.

2. Does *experience* have a significant relationship with *willingness to buy* the policy, if its premium constitutes *no more than 2%* of the project's cost?

3. Does the *willingness to accept at 4%* have a significant relationship with *willingness to buy* the policy, if its premium constitutes no more than 2% of the project's cost?
   The null hypothesis is tested as follows: $\boldsymbol{X_4}$ and $\boldsymbol{X_2}$ are independent, versus the alternative hypothesis: $\boldsymbol{X_4}$ and $\boldsymbol{X_2}$ are dependent on each other.

In order to respond to the above-mentioned questions, contingency tables were used between the two variables, where the Pearson's chi-squared test is observed to evaluate each hypothesis.

Results

When professions were compared to the acceptance rate of COIP premium at 2% in a contingency table (i.e., refer to Table 29), it can be observed that p = .34, which is greater than the significance level of .05. Thus, at 5% significance level and based on this survey, it can be concluded that there is no significant relationship between professions and $\boldsymbol{X_2}$. Therefore, they are independent of each other.

Table 29

Contingency Table of Profession vs. X_2

		I am a(n):								
		Architect	Contractor	Consultant	Developer	Insurance Broker/ Company	Owner	Program Manager/ Owner's Representative	Other	Total
If the premium of this policy is no more than 2% of the total cost of the project, how likely are...	Very likely	1	0	1	1	0	1	4	1	9
	Likely	2	5	12	0	1	2	10	1	32
	Neutral	2	7	4	0	1	6	5	1	23
	Unlikely	5	8	8	0	0	8	7	1	35
	Very unlikely	2	11	9	1	0	3	10	3	31
	Total	12	31	34	2	2	20	36	7	130

		I am a(n):
If the premium of this policy is no more than 2% of the total cost of the project, how likely are...	Chi Square	30.46*
	Degrees of Freedom	28
	p-value	0.34

Table 30

Contingency Table of Experience vs. X_2

		Years of experience in the design and construction industry.				
		Less than 5 years	5 - 10 years	11 - 15 years	More than 15 years	Total
If the premium of this policy is no more than 2% of the total cost of the project, how likely are...	Very likely	0	1	1	7	9
	Likely	2	5	2	23	32
	Neutral	2	4	3	14	23
	Unlikely	0	2	1	32	35
	Very unlikely	1	4	4	22	31
	Total	5	16	11	98	130

		Years of experience in the design and construction industry.
If the premium of this policy is no more than 2% of the total cost of the project, how likely are...	Chi Square	10.46*
	Degrees of Freedom	12
	p-value	0.58

As shown in Table 30, when the COIP premium was at 2% (i.e., X_2), the level of experience and the acceptance level of participants were compared, leading to a $p = .58$. This means that the observed p-value is greater than the significance level of .05. Thus, at 5% significance level and based on this survey, it can be concluded that there is no significant relationship between experience level and $\boldsymbol{X_2}$. Therefore, they are independent of each other.

Table 31

Contingency Table of X_4 vs. X_2

		If the premium of this policy is no more than 2% of the total cost of the project, how likely are...					
		Very likely	Likely	Neutral	Unlikely	Very unlikely	Total
If the premium of this policy is no more than 4% of the total cost of the project, how likely are...	Very Likely	0	0	0	0	0	0
	Likely	7	2	0	0	0	9
	Neutral	2	19	7	1	0	29
	Unlikely	0	11	13	18	0	42
	Very Unlikely	0	0	3	16	31	50
	Total	9	32	23	35	31	130

		If the premium of this policy is no more than 2% of the total cost of the project, how likely are...
If the premium of this policy is no more than 4% of the total cost of the project, how likely are...	Chi Square	176.42*
	Degrees of Freedom	16
	p-value	0.00

Finally, Table 31 illustrates the contingency table of acceptance of participants at 4% ($\boldsymbol{i.e.}, \boldsymbol{X_4}$) versus acceptance at 2% ($\boldsymbol{i.e.}, \boldsymbol{X_2}$). It is observed that the *p* < .005, which is less than the significance level of .05. Thus, at 5% significance level and based on this survey, it can be concluded that there is a significant relationship between $\boldsymbol{X_4}$ **and** $\boldsymbol{X_2}$.

CHAPTER VII

DISCUSSION AND LIMITATIONS

This research study primarily tests for the construction market's acceptance rate for using COIP. In the two surveys that have been used for the study, results show that the majority of participants do not accept the idea of using such a policy. However, in this sample, program managers and owners portray higher acceptance rates than do architects and contractors. Nevertheless, since the confidence interval is less than 95%, results cannot be generalized to U.S. markets. On the other hand, the study portrays possible reasons for rejecting the policy and the elements needed for it to be implemented effectively.

On another note, the number of participants that took part in the survey is considered to be one of the limitations pertaining to this research study. Based on this sample, the results showed that there is no relationship between professions and acceptance rates, in addition to the inability to accurately develop a predictive model that tests whether results can be generalized to the U.S market. In such a case, if the study used a bigger sample, the results may have been different.

Furthermore, one of the most evident factors of implementing this policy is the owner's acceptance. As shown in the results of the second survey, once professionals were asked "would you accept the COIP if the owner asks you to?", the acceptance rates amongst a majority of them increased. Based on the comments in the survey, a large number of owners will ideally use this policy if their return on investment is high. For example, some owners responded with "I am an owner and am looking for a good deal", “I'm just trying to guess what scenario would be a big payoff for me (e.g., huge rainstorms during excavation or hitting an underground storage tank)”. Accordingly, since owners aim to make profit, thus making price an important factor for them.

On a similar note, participant results also show that price is the primary factor for not wanting to purchase COIP. Therefore, in order to possibly achieve the best price, it is important to consider some main aspects.

First, professionals generally viewed the total price of the policy (i.e., at 2%) as being quite high. In this research study, the 2% price was initially reached based on the results of the first survey; on average, participants lay on 4%. Consequently, participants that took part in the second survey were asked their opinions on paying 4% of the project’s price for insurance, after the concept had been explained more thoroughly. Moreover, the 2% option was initially added to test for the relation between acceptance and price. According to the statistical analysis, such a relation was evident. Nevertheless, participants still found the price at 2% to be relatively high. Therefore, in order to possibly reach the optimal price, more research studies must be conducted. With that being said, the insurance company must adopt a method that can quantify the benefits of both, BIM and Lean, into money value that can then be measured and deducted from the project price, in order to understand the extent to which these two tools can generate savings. This will ideally help insurance companies develop a well-studied premium. However, in the case that this premium is equal to or greater than 2% after implementing this formula, then the industry will not accept it. Moreover, the industry and technology are unable to reduce the risk to the extent of achieving an acceptable low premium that deem beneficial to both, insurance companies and stakeholders. Therefore, the inability to generate a formula that could accurately predict a well-suited premium is another limitation of this proposed study.

Similarly, a second price-related problem was achieving a formula to fairly divide the cost of COIP between stakeholders. Usually, architects have a fee that differs than that of contractors and may consequently not be able to handle equal costs pertaining to the proposed policy. Accordingly, this is another limitation of the study, since the acceptance rate can significantly be affected by two of the following factors: the cost of COIP for stakeholders, knowing who is responsible for paying what.

One primary limitation of this research study is the inability to empirically test for the efficacy of the policy (i.e., if it actually works or not). In other words, there is no possible way to empirically measure the efficacy of such a policy, unless it is being used/implemented in a built project. Therefore, the advantages will remain theoretical until one can present the COIP in the construction field. Additionally, another limitation of this study is the inability to predict the acceptance, with respect to the price. Consequently, the data collected is not continuous and sufficient enough, to perform this measurement.

CHAPTER VIII

CONCLUSION AND FUTURE STUDY

Many new ideas emerge based on this research study. For instance, participants have molded the theory, in a way that fits their needs. In other words, an owner perceives the theory as being useful in a way that is different than that of an architect, contractor, or program manager, and vice-versa.

According to the overall results of the proposed study, one can reason that the owners appear intrigued by the idea of rating stakeholders. For instance, one of the interviewed owners stated the following: “I like that premiums are lower for good CM/architect combinations. You would be creating sort of a rating system and that could be very effective. I'm just trying to guess what scenario would be a big payoff for me (huge rains during excavation, hitting an underground storage tank, etc...). Coordination errors would likely be negligence and so would try to choose the team with a low premium” (J. Anderson, personal communication, August 26, 2016). However, he does not believe in the necessity of insuring the cost of change orders, since this is not as much of a challenging issue that they suffer from. J. Anderson also specifies that an essential element for them is the ability to thoroughly view history records by the COIP company and measure the performance of stakeholders (personal communication, August 26, 2016).

Often, contractors have safety records that indicate any previous accidents that have occurred throughout previous jobs, in addition to assessing whether contractors are in good standing. However, no such evaluation portrays a contractor’s overall performance in particularly essential aspects, such as achieving the budget or schedule. Additionally, there is no one existing assessment for architects and their performance. As a result, skeptical future researchers may develop a rating system that assesses the performance of both, architects and contractors, which can be deemed beneficial for the owner during the selection process. In such a case, the owner is then able to rely more on objective factors by means of a quantifiable and reliable scale (i.e., measurement of previous performances and standing of stakeholders), as opposed to solely relying on subjective factors (i.e., reputation and word of mouth).

This policy generally aims to include stakeholders in a contract, in order to ensure that they will perform to the best of their abilities. Moreover, this can be motivating in terms of reaching an outcome, where they cannot pay more than estimated at the beginning of the project, but instead may end up gaining and profiting more. Also, owners can account for this proposed rating system when selecting the team members for a project. Nevertheless, this can only happen once the policy is widely adopted by markets, in addition to having owners push stakeholders further into using it.

Although this may not be the most ideal way to deal with change orders, it can still be deemed an effective approach throughout construction industries. In other words, since industries have not yet figured out the ways of eliminating change orders, the COIP can be a temporary solution until an agreed-upon, permanent solution is underway.

APPENDIX A

INFORMED CONSENT

Informed Consent-Survey

Project Title: Limiting Cost Overrun Caused by Change Orders Through Change Order Insurance Policy (COIP)

Investigators: Ennis Parker, AIA, RIBA and Louay Ghaziri
Protocol and Consent Title: Thesis Survey (4/26/16 v1)
Protocol Number: H16205

Thank you for taking the time to participate in this survey.

This survey is for an educational research study conducted by Louay Ghaziri, a student enrolled in the Master of Science in Building Construction and Facility Management at the Georgia Institute of Technology, under the supervision of his advisor, Professor of Ennis Parker.

This research aims to develop a new mechanism for limiting the cost overruns caused by change orders, by including a third-party (insurance company) to share the risk. In the proposed mechanism, the project's participants, or stakeholders, would buy a premium from an insurance company, which insures against the risk of price overrun caused by change orders (excluding owner initiated change orders).

The aim of this survey is to gather information from professionals in the industry about the acceptability of such an idea. Moreover, it will gather information about change orders and their risks from an industry professional's perspective. The data will be analyzed using Qualtrics software and will be included in the research documentation. We expect to get answers from 100 participants.

Please note that the answers are completely confidential and anonymous. There are no known risks to study participants. You should be over 18 to be eligible to participate in this study. If you press “Next” and complete the following survey, it means that you have read the information contained in the above letter and would like to volunteer in this 5-minute survey as part of the research study with no compensation in return. This will be considered as your consent to use your data for the purpose if the study listed above. Please note that participation is completely voluntary and you may discontinue this survey at any time without any consequences.

If you have any questions about this survey or research in general, please email Louay Ghaziri at louay.ghaziri@gatech.edu or call (404)740-4040.

If you have any questions about your rights as a research participant, you may contact Ms. Melanie Clark, Georgia Institute of Technology, Office of Research Integrity Assurance, at (404) 894-6942.

Thank you,

Professor Ennis Parker, AIA, RIBA and Louay Ghaziri

Informed Consent-Interview

Project Title: Limiting Cost Overrun Caused by Change Orders Through Change Order Insurance Policy (COIP)

Investigators: Ennis Parker, AIA, RIBA and Louay Ghaziri
Protocol and Consent Title: Thesis Survey (4/26/16 v1)
Protocol Number: H16205

Thank you for taking the time to participate in this survey.

This interview is for an educational research study conducted by Louay Ghaziri, a student enrolled in the MSc program in Building Construction and Facilities Management at the Georgia Institute of Technology, under the supervision of his advisor, Professor Ennis Parker.

This research aims to develop a new mechanism in limiting the cost overrun caused by change orders, by including a third-party (insurance company) to share the risk. In the proposed mechanism, the project's participants, or stakeholders, will buy a premium form of an insurance company which ensures against the risk of price overrun caused by change orders (excluding owner initiated change orders), to avoid their damages.

The aim of this interview is to gather information from professionals in the industry about their acceptability of such an idea. Moreover, it will gather information about change orders and their risks from an industry professional's perspective. I expect to conduct a maximum of 50 interviews during this research.

Please note that the conversation is completely confidential. This conversation will be recorded and stored on Louay Ghaziri’s laptop in a folder that is encrypted by password. Only the researchers conducting this study have access to these files. There is no known risks to study participants. You should be over 18 to be eligible to participate in this study. If you sign below, it means that you have read the information contained in the above letter and would like to volunteer in this 30 to 60 minutes interview as part of the research study with no compensation in return. This will be considered as your consent to use your data for the purpose if the study listed above. Please note that participation is completely voluntary and you may discontinue this interview at any time without any consequences.

If you have any questions about your rights as a research participant, you may contact Ms. Melanie Clark, Georgia Institute of Technology, Office of Research Integrity Assurance, at (404) 894-6942.

Thank you,

Professor Ennis Parker, AIA, RIBA and Louay Ghaziri

Name of Participant: ____________________________

Participant's Signature: _______________________

Georgia Tech School of Building Construction
College of Design

APPENDIX B

PART I- SURVEY QUESTIONS

Survey I

Q1 Are you a (n):

- ❑ Architect (1)
- ❑ Contractor (2)
- ❑ Owner (3)
- ❑ Program Manager (4)
- ❑ Other (5) ____________________

Q2 Years of experience in the industry:

- ❍ less than 5 years (1)
- ❍ 5 - 10 years (2)
- ❍ 11 - 15 years (3)
- ❍ more than 15 years (4)

Q3 How much would you rate the relation that change orders have with the success of the project? (0 being not related and 5 being extremely related)

- ❍ 0 (1)
- ❍ 1 (2)
- ❍ 2 (3)
- ❍ 3 (4)
- ❍ 4 (5)
- ❍ 5 (6)

Q4 How likely is it to have a cost overrun caused by change orders?

- ❍ 0 (1)
- ❍ 1 (2)
- ❍ 2 (3)
- ❍ 3 (4)
- ❍ 4 (5)
- ❍ 5 (6)

Q5 Based on your experience, how much increase in price do change orders cause on a project?

- less than 5 % of original price (1)
- 5 to 10 % of original price (2)
- 10 to 15% of original price (3)
- 15 to 20 % of original price (4)
- more than 20 % of original price (5)

Q6 What are the most common causes for change orders?

- Owner initiated change orders (1)
- Design errors (2)
- Construction errors (3)
- Acts of God (4)
- Unforeseen conditions (5)
- Other (6) ____________________

Q7 Which type of change orders mostly affect or damage the cost of the project?

- Owner initiated change orders (1)
- Design errors (2)
- Construction errors (3)
- Acts of God (4)
- Unforeseen conditions (5)
- Other (6) ____________________

Q8 Would you allow a third party to be included to share the risk for a premium?

- Yes (1)
- No (2)

Q9 What percent of the construction cost would you find fair to be paid as the premium for insuring against the cost of change orders?

Q10 Would you be willing to allow the third party (insurance company) to review documents, interfere with decisions and supervision of the project?

- Yes (1)
- No (2)

Q11 If yes, to what extent?

- Fully, on a daily to weekly basis (1)
- Interfere on a monthly basis (2)
- Only be present when the owner is present (3)
- Interfere partially, only be present on the milestone meetings of the project (4)

Q12 Would you like your name/ Firm's name to be listed in the research?
- ❍ Yes (1)
- ❍ No (2)

Q13 If yes, please write your name and the firm's name as you would like them to appear:

Q14 Additional comments

Survey II

Please be aware you cannot go back to previous pages once you press next. If you need access to the animation video please follow the link at the bottom of each page.

Q1 I am a(n):
- ❑ Architect (1)
- ❑ Contractor (2)
- ❑ Consultant (3)
- ❑ Developer (4)
- ❑ Insurance Broker/ Company (5)
- ❑ Owner (6)
- ❑ Program Manager/ Owner's Representative (7)
- ❑ Other (8) ____________________

Q2 Years of experience in the design and construction industry.
- ❍ Less than 5 years (1)
- ❍ 5 - 10 years (2)
- ❍ 11 - 15 years (3)
- ❍ More than 15 years (4)

Q3 Currently working in:
- ❑ Africa (1)
- ❑ Asia (2)
- ❑ Australia (3)
- ❑ Europe (4)
- ❑ North America (5)
- ❑ South America (6)

For the purpose of this survey, assume that the owner will pay 50% of the insurance premium and the architect and contractor will split the remaining 50% based on negotiation.

Q4 If the premium of this policy is no more than 4% of the total cost of the project, how likely are you to buy or suggest using this policy?

- ❍ Very Likely (1)
- ❍ Likely (2)
- ❍ Neutral (3)
- ❍ Unlikely (4)
- ❍ Very Unlikely (5)

Q5 If the premium of this policy is no more than 2% of the total cost of the project, how likely are you to buy or suggest using this policy?

- ❍ Very likely (1)
- ❍ Likely (2)
- ❍ Neutral (3)
- ❍ Unlikely (4)
- ❍ Very unlikely (5)

Answer If If the premium of this policy is no more than 2% of the total cost of the project, how likely are... Unlikely Is Selected Or If the premium of this policy is no more than 2% of the total cost of the project, how likely are... Very unlikely Is Selected Or If the premium of this policy is no more than 4% of the total cost of the project, how likely are... Unlikely Is Selected Or If the premium of this policy is no more than 4% of the total cost of the project, how likely are... Very Likely Is Selected Or If the premium of this policy is no more than 4% of the total cost of the project, how likely are... I wouldn't mind it if suggested Is Selected Or If the premium of this policy is no more than 2% of the total cost of the project, how likely are... I wouldn't mind it if suggested Is Selected

Q6 The main cause that is stopping me from buying this policy is: (Please check all that apply)

- ❑ Price is too high (1)
- ❑ It does not work (2)
- ❑ Stakeholders would not accept it (3)
- ❑ Change orders are not an issue (4)
- ❑ There is a better way to deal with change orders (5)
- ❑ other (6) ____________________

Q7 In your opinion, how effective do you think applying this policy would be?

- ❍ Extremely effective (1)
- ❍ Very effective (2)
- ❍ Moderately effective (3)
- ❍ Slightly effective (4)
- ❍ Not effective at all (5)

Answer If I am a(n): Owner Is Not Selected

Q8 How likely are you to use this policy if the owner asks you to?
- ❍ Very likely (1)
- ❍ Likely (2)
- ❍ Neutral (3)
- ❍ Unlikely (4)
- ❍ Very unlikely (5)

Answer If How likely are you to use this policy if the owner asks you to? Very likely Is Not Selected Or How likely are you to use this policy if the owner asks you to? Likely Is Not Selected And I am a(n): Owner Is Not Selected

Q9 How likely are you to use this policy if the owner has it as a condition?
- ❍ Very likely (1)
- ❍ Likely (2)
- ❍ Neutral (3)
- ❍ Unlikely (4)
- ❍ Very unlikely (5)

Q10 In your opinion, what are the beneficial elements in this policy? (Please select all that apply)
- ❑ Reducing litigation (1)
- ❑ Motivating stakeholders to improve the quality of work (6)
- ❑ Encouraging team work (2)
- ❑ Limiting cost overrun cause by change orders (3)
- ❑ There are no beneficial elements (4)
- ❑ Other, please specify (5) ____________________

Q11 In your opinion, what are the disadvantageous elements in this policy? (Please select all that apply)
- ❑ It is an additional cost (1)
- ❑ It involves a third party in the process (insurance company) (2)
- ❑ It might increase litigation (3)
- ❑ There are no disadvantageous elements (4)
- ❑ Other, please specify (5) ____________________

Q12 This policy would be best suitable for project that cost:
- ❍ Under $1 million (1)
- ❍ $1 - $5 million (2)
- ❍ $6 - $20 million (3)
- ❍ $21 - $50 million (4)
- ❍ $51 - $100 million (5)
- ❍ More than $100 (6)

Q13 This policy would be best suitable for: (please check all that apply)

- ❑ Residential projects (1)
- ❑ Community projects (ex. Auditoriums, clubs, community centers, libraries, museums) (2)
- ❑ Sports facilities projects (3)
- ❑ Educational projects (4)
- ❑ Governmental projects (5)
- ❑ Automotive projects (6)
- ❑ Infrastructure projects (7)
- ❑ Entertainment projects (8)
- ❑ Military projects (9)
- ❑ Industrial projects (10)
- ❑ Medical projects (11)
- ❑ Office buildings (12)
- ❑ Other (13) ____________________
- ❑ None of the above (14)

Q14 Additional comments

Q15 Would you like to participate in a follow-up interview?

- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To End of Survey

Q16 Please fill at least one preferred method of contact.

- Name (1)
- Email (2)
- Phone (3)
- Address (i.e. prospective interview location) (4)
- Preferred date (5)

APPENDIX C

PART II- INTERVIEW QUESTIONS

I. How would you define change orders?

II. What are the causes of change orders?

III. What are the effects of change orders?

IV. Based on your experience, how do you deal with change orders and what are the techniques that you would use to prevent them?

V. Are you aware of any type of insurance that tackles the cost overrun caused by change orders?

VI. Would you accept such a policy?

VII. To what extent to do you think that such an approach can be beneficial or damaging, and why?

VIII. Do you have any final thoughts, opinions, or suggestions about the topic?

APPENDIX D

VIDEO LINKS AND NARRATIVE

The link to the explanation video is: https://www.youtube.com/watch?v=kHlkXPuPp9s

The narrative in this video is below:

Owner: We are losing a lot of money because of change orders

Insurance: I have an idea, let us insure change orders

Insurance: We can come up with a policy that covers all of you against cost overrun caused by change orders! But there has to be some conditions:

- First of all, this policy will not cover owner initiated change orders.
- You have to deliver the project using CM at risk so that you all meet early in the project.
- You have to use Lean mindset while delivering this project.
- You have to utilize BIM in order to minimize risk of coordination and drawing errors.
- If the architect is late on developing the drawings or there is a mistake that is found early in them, we will pay for extra time just so that she can develop a suitable set of drawings.

Owner: so how does this work?

Insurance: I will take a look at the project scope and examine the risk of changes occurring. Then I will develop a premium, which all of you will split; and since you reduced the risk by following the procedures I listed, the premium will be low. Of course you still have to put contingency in your budget so that I do not carry all the risk. You will set a certain amount of contingency for each phase of the project. When a change order occurs and the contingency is exhausted, I will cover the cost of the change order. This way you will have a cap on the cost of each phase.

Imagine this scenario: you have a contingency of $ 100,000 for earthwork. If a change order costs $ 110,000 we will pay the $ 10,000. However, if earthwork is done and you only used $ 40,000 then the remaining $ 60,000 can go into the profit pool that will be split by the team at the end of the project. This can happen since I am insuring every phase on its own so no need to carry contingency from one phase to another.

Owner, Architect and Contractor: oh great now I am relieved from my risk!

Insurance: No, no, you still have a lot of risk. If we see that the change order is due to a mistake that could've been avoided, we will take a deductible. However, this deductible is discounted from the team's profit pool. There are also your history records that might be affected.

Just like any insurance policy, if you develop a bad record, your premium will be higher, but if you have a clean record, your insurance premium will be lower. If you have a high premium, it will affect the premium of the team which means your cost is higher; and since we are in a competitive market, owners might not select you for the project. Moreover, that premium value will reflect your performance history, so owners might not want to take the risk. Since you are sharing the deductible, you either all win or you all lose, so it's smart to work like a team and collaborate rather than blame each other.

APPENDIX E

RECRUITING LANGUAGE

Email

Good after noon ______ ,
I hope you are doing well.

My name is Louay Ghaziri and I am a master's student in the School of Building Construction at Georgia Institute of Technology.

I am currently working on a thesis research topic tackling change orders and the cost overrun caused by them with Mr. Ennis Parker as my advisor.

I was hoping you could help me by filling this 3-minute survey:

https://gatech.qualtrics.com/SE/?SID=SV_51JG6stqdJHTpml

Please feel free to share the link with other professionals who you think might be interested in participating in this research as it would help the results a lot.

You can fill this survey on a phone, tablet or computer, as it is 100% adaptable.

This is a completely anonymous survey, I will not be able to tell who filled their survey unless you state otherwise at the end.

Thank you for your help.

Thank you
Regards.

Louay Ghaziri CMIT, LEED Green Assoc.

Profile President of Student Construction Association (SCA)
Student MSc BCFM Program Management;
Bach. Architecture
Mobile: 404-740-4040
Mobile: (+961)03-952999
Email: louay.ghaziri@gatech.edu

Skype: louay.ghaziri
Address: Atlanta, GA

LinkedIn

For professionals in the construction industry (Contractors, Architects, Engineers, Program Managers, Owners, etc…):

I am working on a thesis research topic tackling cost overrun caused by change orders with Mr. Ennis Parker as my advisor.

Please take 3 minutes to fill in this survey:

https://lnkd.in/d9kQXXr

Please feel free to share the link with other professionals who you think might be interested in participating in this research as it would help the results a lot.

This is a completely anonymous survey.

Thank you for your help.

REFERENCES

Akintoye, A.S., & MacLeaod, M.J. (1997). Risk analysis and management in construction. *International Journal of Project Management, 15*, 31-38. doi: 10.1016/S0263- 7863(96)00035-X

Al-Momani, A.H. (2000). Construction delay: A quantitative analysis. I*nternational Journal of Project Management, 18*, 51-59. doi: 10.1016/S0263-7863(98)00060-X

American Institute of Architects. (2007). *Aia a201: General conditions of the contract for construction*. Retrieved from: http://www.hba.org/wp-content/uploads/2014/11/B-2-AIA-Doc-A201-2007.pdf

Assaf, S.A., & Al-Hejji, S. (2006). Causes of delay in large construction projects. *International Journal of Project Management*, *24*, 349-357. doi: 10.1016/j.ijproman.2005.11.010

Autodesk. (2016). *What is bim?* Retrieved from Autodesk Inc.(2016, October 1). Retrieved from http://www.autodesk.com/solutions/bim/overview

Beesley, C. (2012, January 11). General business liability insurance-how it works and what coverage is right for you [Web log comment]. Retrieved from https://www.sba.gov/blogs/general-business-liability-insurance-how-it-works-and-what- coverage-right-you

Bernstein, H.M., Jones, S.A., Russo, M.A., Laquidara-Carr, D., Taylor, W., Ramos, J., Lorenz, A., Winn, J., Fujishima, H., Fitch, E., Buckley, B., & Gilmore, D. (2012). *The business value of bim in north america: Multi-year trend analysis and user ratings (2007-2012).* Retrieved from http://bimforum.org/wp-content/uploads/2012/12/MHC-Business-Value- of-BIM-in-North-America-2007-2012-SMR.pdf

Braley, S. (2015). *Leadership in design and construction* [PowerPoint slides].

Callahan. M.T. (2005). *Change order claims*. New York, NY: Aspen Publishers

Chinyio, E., & Olomolaiye, P. (2009). *Construction stakeholder management*. Bristol, UK. Blackwell Publishing Ltd

Demkin, J.A. (2001). *The architect's handbook of professional practice*. New York, NY: John Wiley & Sons, Inc.

e-Builder (2016, March 6). Changing the world one building at a time [video file]. Retrieved from https://www.e-builder.net/videos/better-world

Egbu, C.O. (2004). Managing knowledge and intellectual capital for improved organizational innovations in the construction industry: An examination of critical success factors. *Engineering, Construction and Architectural Management, 11*, 301-315. doi: 10.1108/09699980410558494

Goedert, J., & Meadati, P. (2008). Integrating construction documentation into building information modeling. *Journal of Construction Engineering and Management, 134*, 509-516. doi: 10.1061/(ASCE)0733-9364

Hardin, B., & McCool, D. (2015). *Bim and construction management: Proven tools, methods, and workflows*. Indianapolis, Indiana: John Wiley & Sons, Inc.

Hegazy, T., & Ersahin, T. (2001). Simplified spreadsheet solutions: Subcontractor information system. *Journal of Construction Engineering and Management, 127*, 461-568. doi: 10.1061/(ASCE)0733-9364

Hinze, J. (2000). *Construction contracts*. New York, NY: McGraw-Hill

Hölttä, K.M.M, &Otto, K.N. (2005). Incorporating design effort complexity measures in product architectural design and assessment. *Design Studies, 26*, 463-485. doi: 10.106/j.destud.2004.10.001

Ibbs, C., Wong, C., & Kwak, Y. (2001). Project change management system. *Journal of Management in Engineering, 17*, 159-165. doi: 10.1061/(ASCE)0742-597X

Jones, S. A., & Laquidara-Carr, D. (n.d.). *Smartmarket brief: Bim advancements*. Retrieved from http://images.marketing.construction.com/Web/McGrawHillConstruction/{fba205cd-d9d3-41fb-8e27-d490b9c5be4e}_SMBrief-BIM-Advancements-01.pdf

Jones, S. A., & Laquidara-Carr, D. (n.d.). *Smartmarket brief: Measuring the impact of bim on complex buildings*. Retrieved from http://images.marketing.construction.com/Web/McGrawHillConstruction/{fba205cd-d9d3-41fb-8e27-d490b9c5be4e}_SMBrief-BIM-Advancements-01.pdf

Koskela, L.J., & Howell, G. (2002). The underlying theory of project management is obsolete. *Proceedings of the PMI Research Conference,* 293-302. Retrieved from http://usir.salford.ac.uk/9400/1/2002_The_underlying_theory_of_project_management_is_obsolete.pdf

Lee, H., Huh, W.T., Sun, Y.A., & Dance, C.R. (2015). Auctions in the post-change-order period. *Naval Research Logistics, 62*, 248-268. doi: 10.1002/nav.21626

Lee, S., & Kim, K. (2015). Collar option model for managing the cost overrun caused by change orders. *Sustainability, 7*, 10649-10663. doi: 10.3390/su70810649

Levin, P. (1998). *Construction contract claims, changes & dispute revolution*. Reston, VA: American Society of Civil Engineers.

Liu, J., Li, B., Lin, B., & Nguyen, V. (2007). Key issues and challenges of risk management and insurance in china’s construction industry: An empirical industry. *Industrial Management & Data Systems*, *107,* 382-396. doi: 10.1108/02635570710734280

Love, P.E.D. (2002). Auditing the indirect consequences of rework in construction: A case based approach. *Managerial Auditing Journal*, *17*, 138-146. doi: 10.1108/02686900210419921

Love, P.E.D., & Irani, Z. (2003). A project management quality cost information system for the construction industry. *Information & Management, 40*, 649-661. doi: 10.1016/S0378-7206(02)00094-0

Malecki, D.S. (2009, April 4). Builder's risk insurance: Specialized coverage for construction projects. Retrieved from http://adjustersinternational.com/publications/adjusting-today/builders-risk-insurance/0/

Mohamed, S., Tilley, P.A., & Tucker, S.N. (1999). Quantifying the time and cost associated with the request for information (rfi) process in construction. *International Journal of Construction and Information Technology, 7*, 1471-4175. Retrieved from https://eprints.usq.edu.au/24373/

Munhall, D.L., & Daly, L.A. (2011, February 14). *Standard of care: Confronting the errors-and-omissions taboo up front.* Retrieved from http://www.aia.org/aiaucmp/groups/aia/documents/pdf/aiab089199.pdf

Naoum, S. (1994). Critical analysis of time and cost of management and traditional contracts. *Journal of Construction Engineering and Management, 120*, 687-705. doi: 10.1061/(ASCE)0733-9364

Odeyinka, H.A. (2000). An evaluation of the use of insurance in managing construction risks. *Construction Management and Economics, 18*, 519-524. doi: 10.1080/014461900407329

Ranasinghe, M. (1998). Risk management in the insurance industry: insights for the engineering construction industry. *Construction Management & Economics, 16*, 31-39. 10.1080/014461998372565

Riley, D.R., Diller, B.E., & Kerr, D. (2005). Effects of delivery systems on change order size and frequency in mechanical construction. *Journal of Construction Engineering and Management, 131*, 953-962. doi: 10.1061/(ASCE)0733-9364

Serag, E., Oloufa, A., Malone, L., & Radwan, E. (2010). Model for quantifying the impact of change orders on project cost for u.s. roadwork construction. *Journal of Construction Engineering and Management, 136*, 1015-1027. doi: 10.1061/(ASCE)CO.1943- 7862.0000206

Solomon, D.J. (2001). Conducting web-based surveys. *Practical Assessment, Research & Evaluation, 7*, 1-4. Retrieved from http://pareonline.net/getvn.asp?v=7&n=19

Statistics and facts about construction in the u.s. (2016, February, 7). Retrieved from http://www.statista.com/topics/974/construction/

Sunil, K., Pathirage, C., & Underwood, J. (2015). The importance of integrating cost management with building information modeling (bim). *International Postgraduate Research Conference*, 1-12. Retrieved from http://usir.salford.ac.uk/35630/3/IPGRC_2015_Camera_Ready_75.pdf

Taylor, R.J. (2012, April 17). *Professional liability insurance for construction projects*. Retrieved from https://www.irmi.com/articles/expert-commentary/professional-liability-insurance-for-construction-projects

McKeon, J. (2011, September 26). *Program management 2.0: New thomsen/sanders revisits a "milestone".* Retrieved from http://cmaanet.org/PM20-Release