MATERIALS PRICE RISK MITIGATION

IN CONSTRUCTION

PROJECTS

by

MOHAMMAD AMMAR AL-ZARRAD

GARY P. MOYNIHAN, COMMITTEE CHAIR
EDWARD BACK
ROBERT G. BATSON
K. CLARK MIDKIFF

A THESIS

Submitted in partial fulfillment of the requirements for the degree of
Master of Science in the Department of Civil,
Construction, and Environmental Engineering
in the Graduate School of
The University of Alabama

TUSCALOOSA, ALABAMA

2014

ABSTRACT

Construction materials cost estimation is considered one of the most important tasks in the development of project budget. Using material hedging to mitigate the risk of material price volatility is a new concept for construction companies.

This thesis matched material hedging with the fuel hedging application utilized by airlines. The weather hedging process was used as a precedent for material hedging application in the construction industry. This thesis developed a model to provide a step by step guidance to apply material hedging in the construction industry. Further, this thesis matched its model with the model presented by Macdonald (2013) and provided a lower level of detail to support actual implementation of material hedging.

Future work in this area could be the investigation of material hedging cost to decide if the hedging application is feasible. Also, validity and reliability of the model presented by this thesis should be investigated.

DEDICATION

This thesis is dedicated to my father, who is my best friend and my role model. Also, I would like to dedicate this thesis to my beloved wife, who always stood by my side and who has lightened up my spirit with her unconditional love and support.

ACKNOWLEDGMENTS

Many thanks to my advisor, Dr. Gary Moynihan, for his countless hours of reflecting, reading, encouraging, and most of all patience throughout the writing of this thesis. Dr. Moynihan read my numerous revisions and helped make some sense of the confusion. Without his help I could not have done with this research.

Also, I would like to thank Dr. Robert Batson and Dr. Clark Midkiff, who agreed to serve on my thesis committee and a special thanks to Dr. Edward Back, for all his help and guidance that he has given me over the past year.

CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Construction project cost estimation is considered one of the most essential tasks in the budget development of any project. Construction projects are exposed to many forms and degrees of uncertainty and risk, such as materials price fluctuation. Materials price uncertainties are extensive throughout the project life cycle, occurring at project initiation and continuing until termination. As a result, further investigation to evaluate new techniques to reduce the risk of construction material price fluctuations is needed.

1.1 BACKGROUND

The construction sector and construction activities are considered to be one of the major sources of economic expansion and improvement. The construction industry is considered the best sector for motivating employment. The employment opportunities that the construction industry provides are considered a service to the society because it benefits the younger and lower skilled workers, who have fewer alternative job opportunities (United Nation report, 2008). Many cities are heavily dependent on construction industry to provide a significant boost to their economy as a whole. The construction industry stimulates the economic activity as a whole directly by employing hundreds of thousands of workers while indirectly generating hundreds of thousands more jobs throughout the larger economy (United Nation report, 2008).

Output from the construction industry is an essential part of the national output. By accounting for 6% to 10% of the Gross Domestic Product (GDP) of both developed and underdeveloped countries, the construction industry has a significant impact on personal earnings and creation and sustaining of employees (Crosthwaite, 2000).

Companies throughout the economy are dependent on the performance of physical infrastructure such as roads, rails, power stations, air terminals, and telecommunications to remain competitive. The quality of physical infrastructure could be an important consideration for inward investors in their location decisions (Crosthwaite, 2000).

1.2 COST ESTIMATION IN CONSTRUCTION INDUSTRY

Why do project costs seem to always go over the initial estimation? The answer to this question is a result of many factors, mainly a poor cost estimating practices (Reilly, 2005). Project cost estimation is considered one of the most important tasks in the development of project budget. However, due to material price fluctuation, cost estimation is usually uncertain. Traditional cost estimation methods lack accuracy, especially in feasibility or assessment stages (Flanagan and Norman, 1993). The current cost estimating methods can be summarized as follow (Sears et al. 2008):

- “Cost per Function Estimate: This method is based on the estimated costs per unit of use.
- Index Number Estimate: This method is done by multiplying the original construction cost of the current structure by a national price index that has been adjusted to local conditions (i.e., weather, labor expense and materials costs).
- Unit Area Cost Estimate: This method uses an estimated price for each unit of gross floor area. The method is common in residential home construction.

- Unit Volume Cost Estimate: This estimate is based on an approximated costs for each unit of the total volume enclosed.
- Panel Unit Cost Estimate: This analysis is based on unit costs per square unit area of floors, unit length of walls and unit roof area.
- Parameter Cost Estimate: This estimate involves parameter costs, for each of several different building components or systems. These method is based on dimensions or quantities of the work enclosed.
- Partial Takeoff Estimate: This analysis uses quantities of major work items that is taken from uncompleted design documents. These are priced using estimated unit prices for each work item using the RSMeans database."

RSMeans is a division of Reed Business Information. RSMeans provides a cost estimation database that helps contractors calculate the costs of construction prior to beginning construction, and provide accurate estimates for their project costs (Mubarak, 2012). Therefore, RSMeans can improve the contractors' decision making, minimize risk and save time. This cost estimation database is updated annually and is available online, via CD-Rom, or in book form and can be used by professional estimators for up-to-date labor, materials and overhead costs for specific project types and locations. According to Mubarak (2012) "RSMeans is North America's most recognized construction cost data base". The problem with using RSMeans is that it is not always accurate for the market or project types. RSMeans depends on average values. Unless the project numbers are exactly equal to the average data used in the guides, the numbers don't always produce accurate result (Cholakis, 2011).

Engineering News Record (ENR) is another source for cost estimation indices. ENR has two types of indices: construction cost index (used in residential) and building cost index (used in commercial or industrial). Both indexes have a materials and labor component (ENR, 2014). ENR has price reporters in 20 U.S. cities who check local prices. The prices are quoted monthly from the same suppliers each month for all of the materials in the indices. ENR does not use average values since the ENR reporters gather "spot prices" from one source for all of the materials tracked (ENR, 2014). Although ENR may considered to be a better source that RSMeans both do not reflect material price volatility issue.

While some cost estimators continue to use hardcopy documents and electronic spreadsheets, many are beginning to use cost estimation software tools. For example, 4Clicks Project Estimator allows users to create estimates and manage multiple types of projects and contract methods; Single Award Task Order Contracting (SATOC), Multiple Award Task Order Contract (MATOC), and Basic Ordering Agreement (BOA) (Cholakis, 2011). Most cost estimators rely on their past real world experiences as a source of data for cost estimation. However, using old or historical data does not take in consideration materials price fluctuations.

1.3 RISK ASPECT OF CONSTRUCTION ESTIMATION

Construction material suppliers faces serious financial risks due to their high debt to equity ratio structure and the nature of the material import trade (Chen et al. 2010). Construction projects are exposed to many forms and degrees of risk, such as price volatility and shocks. Within a project context, risk will be defined as the probability of an undesired outcome that has the potential to reduce the possibility of meeting the project objectives (Macdonald, 2013).

Managing risks in construction projects has been recognized as a very important management process. Highly volatile raw material prices and ineffective price management can jeopardize a company's success greatly. Current major construction projects involve multiple years of work which increase the risk of material price change with time. The increase of volatility in construction material price leads to financial risk and could potentially result in corporate failures.

The engineering and construction (E&C) industry has tried to address risk through numerous approaches. Most current approaches for material risk assessment are deterministic which means that they treat variables such as price as if they were fixed. However, in reality material price fluctuates up and down (EUFRAM, 2014). Probabilistic approaches quantifies variation by using distributions instead of fixed values in risk assessment. A distribution defines the range of possible cost values, and shows which values within the range are most likely. Taking into consideration the full range of possible cost outcomes can improve decision making about material risks (EUFRAM, 2014).

Simulation optimization is another way to manage risk. Optimization in general is maximizing the desired outcome for a specific level of risk or minimizing risk for a specific outcome (Taha, 2007). Probability distribution describes the outcome of a decision under certain risk. Decision making under risk can be optimized using the expected value criterion in which alternatives are compared to identify the alternative that maximize expected profit or minimize cost (Taha, 2007).

The indemnification and insurance provisions are the primary risk mitigation devices in any construction contract. These provisions obligate the party with less bargaining power to insure the other against certain risks. These contractual provisions could help the two parties allocate materials risk and other risks contractually (Thomas, 2014). However, they cannot address unforeseen circumstances that can affect materials pricing (i.e., the 1973 oil embargo).

The current approaches for material risk assessment do not reflect price volatility issues. The construction industry has been slow to realize the potential benefits of new methods in risk management. Cost escalation of construction projects can be defined as the deviation of final project costs from the initial cost estimates (Dawood, 2001). Materials price fluctuation is one of the main factor that causes cost escalation in construction projects. By identifying and controlling cost escalation drivers construction companies can improve cost estimates (Dawood, 2001).

1.4 MATERIALS PRICE FLUCTUATIONS

Construction materials may encompass 50-60% of the total cost of a project if combined with other services such as equipment (Spillane, 2011). When left unmanaged, materials may have greater significant impact on project cost. Materials price uncertainties are extensive throughout the project lifecycle, occurring at project initiation and continuing until termination. Fluctuations of materials' prices, which are volatile, are a driver of project costs. Volatility is a measure of the amount and rapidity of price changes, regardless of whether it is a financial increase or decrease. This is important not only because price escalations may occur, but because price adjustments also potentially impact resources allocation and project selection decision (Macdonald, 2013).

Contractors are highly affected by the radical increases in the cost of raw materials, especially when they take on projects on fixed price contracts. When material prices increase significantly in the course of a project, both the contractors and the clients are negatively affected. Contractors can find themselves facing major losses and clients face the risks of contractors either going out of business at the middle of the contract, or trying to source low quality materials to overcome pressures. Historically, raw materials' prices typically only moved up (in one direction). A manager was tasked with estimating the rate of the increase and timing his orders to get ahead of the price hikes. Presently, prices for key raw materials fluctuate up and down, and it can be a critical mistake to take delivery just before prices fall. For example, in Figure 1 and according to the U.S. Bureau of Labor statistics (2014), the Producer Price Index (PPI) shows that steel and cement price used to go up (in one direction) until the early 90's. After that, the price of these materials started to fluctuate. Figure 2 gives us a closer look on the Producer Price Index for steel, asphalt, cement and lumber and shows the severity of material price fluctuation between 2006 and 2013 (U.S. Bureau of Labor Statistics, 2014).

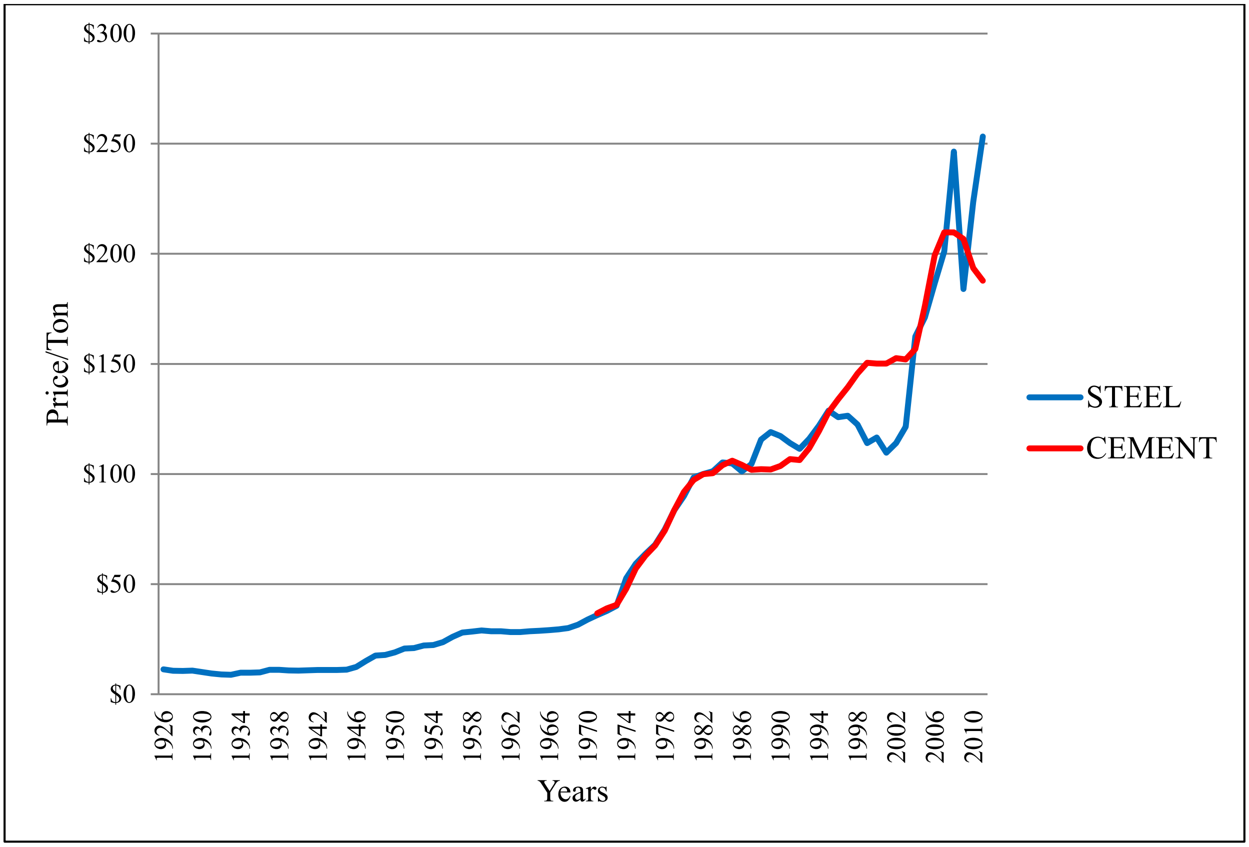

Figure 1: Producer price index of steel and cement (1926-2010)

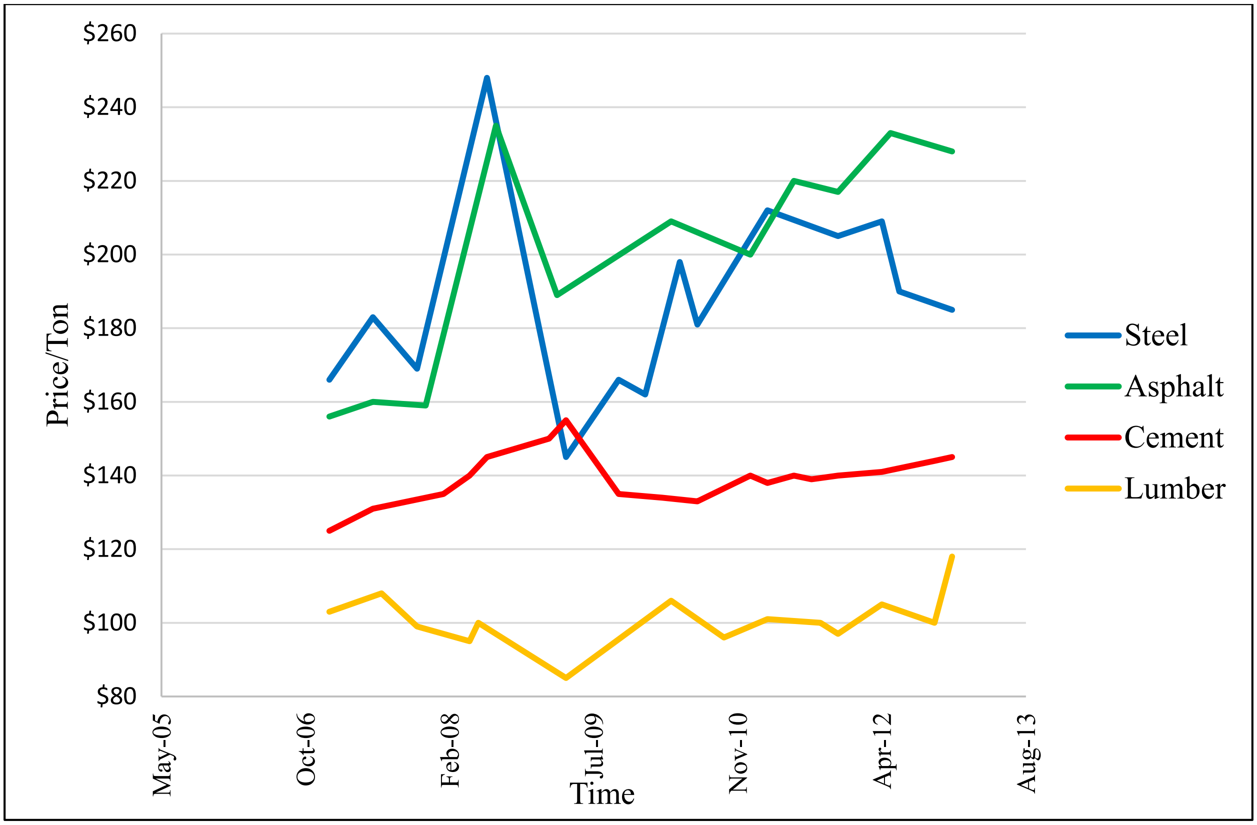

Figure 2: Producer price index of steel, asphalt, cement and lumber (2006-2013)

A current topic of contractor conversation is the ever-shifting price of construction materials. Changing materials prices can cause real challenges for the construction industry when identifying costs (Duyck, 2014). Further investigation to evaluate new techniques to reduce the risk of construction material price fluctuations is needed.

CHAPTER 2

LITERATURE SEARCH

Limited knowledge has been established on using derivatives for material risk hedging, and little is known about applying weather hedging in the construction industry. Substantive research has been found in the field of airline fuel hedging. However, very little research has focused on whether hedging achieves reasonable financial objectives in the construction industry. Macdonald (2013) developed and proposed a model for materials price risk mitigation using financial derivatives for use in the Engineering and Construction (E&C) industry.

2.1 LITERATURE SEARCH METHODOLOGY

A systematic assessment of past literature is a vital part of any academic research (Webster and Watson, 2002). Engineering field of study suffered from an absence of good literature reviews, which has delayed hypothetical development (Shaw, 1995). Hart (1998) defined the literature review as “the use of ideas in the literature to justify the particular approach to the topic, the selection of methods, and demonstration that this research contributes something new”. Nowadays, literature searches are carried out using computers and electronic databases. Computer databases offer access to massive quantities of information, which can be retrieved more easily and quickly than using a manual search (Cronin et al. 2014). There are several electronic databases, many of which deal with specific fields of information. Keyword searches are the most common method of identifying literature (Ely and Scott, 2008). When conducting a literature search an important question in determining whether a publication should be included in the research review is defining the type of source. This research will use the following specific search resources:

1- The University of Alabama online catalog
2- Wiley Online Library
3- Elsevier Science database
4- American Society of Civil Engineering (ASCE) library
5- Construction Industry Institute (CII)
6- U.S. Bureau of Labor Statistics (USBLS)
7- Mercatus Energy Advisors Website.

The literature search was conducted using keywords such as hedging, hedging in airline industry, and hedging in construction industry. This method was very successful especially when searching ASCE library and Wiley Online Library. In summary, seventeen articles were found using the Wiley Online Library, sixteen articles using ASCE, fourteen articles using the Elsevier Science database and one article using each of the CII, USBLS and Mercatus Energy Advisors Website.

Also, visiting The University of Alabama Business library and Engineering library was a very successful method to find hardcopy journal articles. For example, two articles were found in The Journal of Finance about hedging in airline industry. Also, one article was found in each of The Journal of Financial Economics and The Journal of Business Finance & Accounting.

2.2 NATURE OF FINANCIAL HEDGING

A hedge is an investment position projected to offset potential losses that may be incurred by a companion investment. Derivatives in general are contracts whose value is derived from one or more variables called underlying assets (i.e., fuel). Hedging derivatives and their integration (i.e., futures, forwards, swaps, and options) make up the major part of an oil company's operations in the worldwide oil market (Mattus, 2005).

Both forward and future contracts are an arrangement to buy or sell something at a future date at a fix price. Contrasting forward contracts, futures contracts trade on central exchanges, called future markets (Morrell and Swan, 2006).

Another type of derivative is called an option. Options are of two types: calls and puts. Options give the buyer the right, but not the obligation, to buy or sell a certain quantity of the underlying asset, at an agreed price on or before a certain future date (Morrell and Swan, 2006). The last type of derivative is called a swap. Swaps are private arrangements to exchange cash flows in the future according to an agreed formula (Morrell and Swan, 2006).

Companies choose the hedging tool according to their own needs and plans. The formerly mentioned derivatives utilize different time periods. Some consist of a shorter hedging period, and some consist of a longer time period, as suggested by Long (2000) and noted in Figure 3.

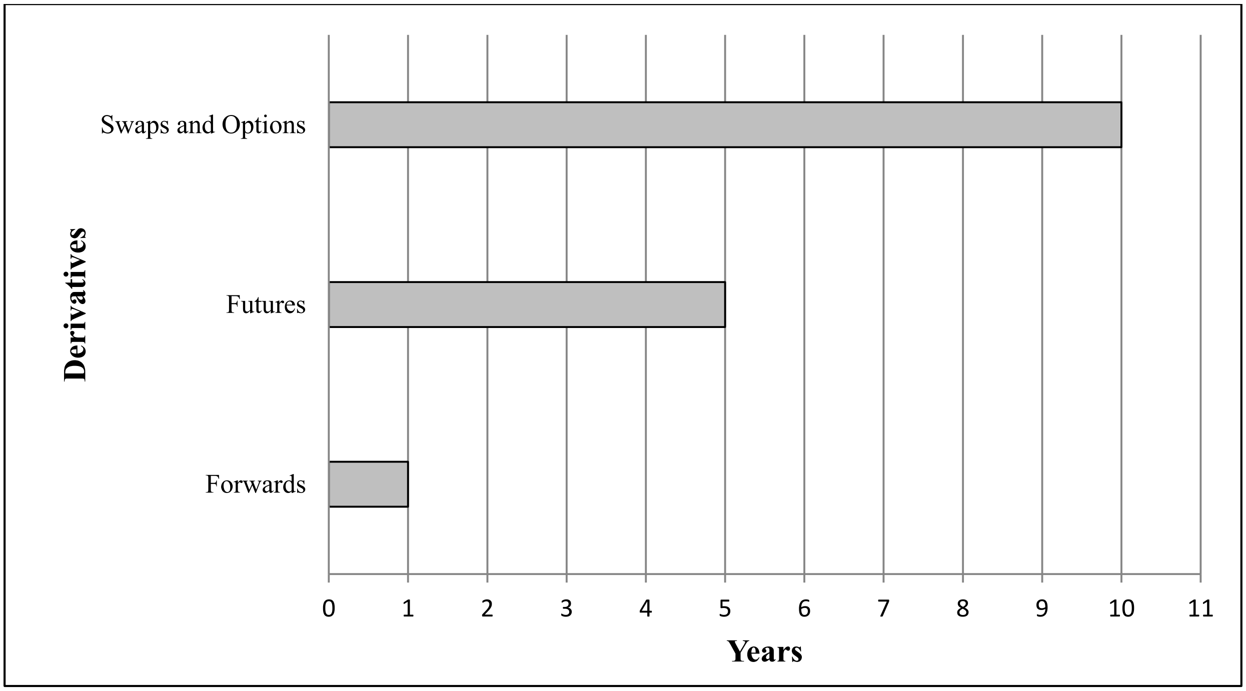

Figure 3: Oil market trading horizons

Figure 3 shows that forward contracts' time period is up to one year which is considered to be a short-term contract. Future contracts' time period is up to 5 years, and it is considered to be a medium-term contract. Finally, swaps and option that are up to 10 years are considered to be long-term contracts. Regardless of the derivative type, there are four main hedging strategies that a company could use (Morrell and Swan, 2006):

1. "No hedge at all;
2. Naive hedging strategy - in this strategy, a future contracts is bought in the beginning of the hedge period and then closed at a specific time T;
3. Optimal hedge ratio - this strategy determines the number of contracts to purchase at the beginning of the hedging period based on the ratio of the covariance and the variance of the future contract price;

4. Dynamic hedge ratio - this is the dynamic version of the previous strategy in which at each trading opportunity, covariance and variance will be updated."

It has been established that although derivative use can be effective in terms of managing financial risks, it may be expensive (Horng and Peihwang, 1999). The reason for the high cost of hedging is the fact that hedging is really experience-oriented, and requires the knowledge of financial specialists (Geczy et al. 1997). Scholars also suggest that risk avoidance via derivatives is not limited to financial-related institutes, but may also be applied to other industries (Bartram et al. 2009). Although, some mention of the use of hedging has appeared in the literature regarding the transportation industry, in general, the most detailed information has been found to pertain to the airline industry.

2.3 HEDGING APPLICATION IN THE AIRLINE INDUSTRY

Fuel hedging has been the practice in the airline industry for a long time. The main reason for hedging fuel is fixing the costs because fuel prices are more unstable than other costs and expenses. Therefore companies hedge the fuel to cover other costs (Jin and Jorion, 2006). Jet-fuel expenses represent a significant cost factor for airline companies stretching from 10%–20% of the firm's total operating expenses (Carter et al. 2006). For example, for every $1 increase in fuel price, U.S. airlines face an additional annual cost of $425 million (Spencer, 2004). Beyond the price behavior of the majority of commodities, prices for jet-fuel are highly unstable. Moreover, the levels of instability themselves are extremely variable (Carter et al. 2006).

Another reason for hedging fuel is the fact that passing fuel costs to passengers is difficult when fuel prices peak quickly. Since air tickets are purchased at varying times in advance of the actual fuel cost increases, the time lag of airfares and input prices effectively reduces the firms' ability to shift the cost increase entirely to passengers when the air travel service is delivered and jet fuel is consumed (Delta Airlines, 2014).

As part of a corporate risk management strategy, hedging generates both benefits and risks to firms (Stulz, 1984). Past studies have examined hedging behavior of U.S. airlines, but the impact of fuel hedging on airlines is empirically an unsettled issue. Sturm (2009) found that hedging is positively correlated with the airlines' firm value. Rampini et al. (2014) found a strong positive correlation between hedging and operating income. However, an earlier study by Rao (1999) suggested that the quarterly pre-tax income of an average U.S. airline company in the late 1980s and 1990s would be less unpredictable with hedging. For example, Southwest Airlines is considered to be a relatively "successful" hedger in the airline industry. However, despite its impressive net gains of $1.3 billion from fuel derivative contracts' settlements in 2008 (while other airlines experienced losses), owing to higher and volatile fuel costs, Southwest paid out $245 million to counterparties in 2009 (Southwest Airlines, 2014). In 2011, the company also experienced nearly a 30 percent decline in both its net income and operating income, primarily due to higher fuel costs (Southwest Airlines, 2014). Among the less successful hedgers in the industry, Delta, in 2009, incurred $1.4 billion fuel hedge losses from contracts purchased in 2008, when fuel prices unexpectedly dropped after a record high (Delta Airlines, 2014).

In summary, by not hedging, airlines expose themselves to the risk of fuel spot price increases, and by hedging, airlines face the risk of falling fuel prices in the near term and incurring financial losses in fuel hedging contracts.

2.4 HEDGING APPLICATION IN THE CONSTRUCTION INDUSTRY

Although it is known that using derivatives as a risk management tool adds value to a firm (Marsden and Prevost, 2005), the weather derivative is the only current application of the concept for construction-related companies.

2.4.1 WEATHER HEDGING APPLICATION

The purpose of weather derivatives is to allow companies to insure themselves against fluctuations in the weather. The first weather derivative trade was done by Enron Corporation in 1997. According to the Weather Risk Management Association (WRMA), the value of weather derivatives trades in the year of 2011 totaled $11.8 billion, about 20% up from the previous year (WRMA, 2011). In recent years, the weather derivative concept has been introduced to construction companies (Holmes, 2004). Weather derivatives help construction companies avoid the losses due to a period of rain or other bad weather when construction workers cannot work outside. Construction companies may use free or paid weather prediction services to monitor the weather, but the accuracy of these services can be minimal and do little to reduce the financial impact of the weather (Holmes, 2004). By using a weather derivative, construction companies can manage and mitigate the financial risk of extreme rain during construction (Riker, 2014). There are many ways to trade weather derivative. Primary market trades are usually Over-The-Counter (OTC), meaning that they are traded directly between the construction companies and banks (Jewson et al. 2010).

There are several elements that define a weather derivative as suggested by Climetrix (2010). The first element is the reference weather station which is used as the reference location for the weather hedge. Second, is the weather index which defines the degree of weather which rules when and how payouts on the contract will happen. Third, is the term over which the underlying index is calculated. The next element is weather derivative structure such as puts, calls, and swaps. The final element is the premium which is an amount of money that is paid by the buyer of a weather option. The premium is usually between 10% and 20% of the amount of the contract (Climetrix, 2010).

2.4.2 CONSTRUCTION MATERIAL HEDGING

Limited knowledge has been established about using derivatives for material price risk hedging. Macdonald published a paper in 2013 on using hedging as a tool to mitigate material price risk. In her paper, Macdonald provided an overview of the construction industry need, and introduced the problem of materials price risk mitigation in construction projects. Then Macdonald discussed traditional risk mitigation strategy in the E&C industry such as allocation of additional financial resources or contingencies. She demonstrated that existing financial solutions are not adequate and does not take into consideration material price volatility.

Next Macdonald developed a model for materials price risk mitigation using financial derivatives for use in the construction industry. Macdonald argued that in order to avoid the negative reputation of financial hedge, the construction companies should use hedging as a strategy to protect against costs escalation but not to make profits. Macdonald's model (2013) consists of various stages to mitigate materials price risks as shown in Figure 4. These stages are the guidance phase; the identification phase; the assessment phase; the determination phase; the settlement phase; and the evaluation phase. This model is further discussed in section 5.3 of this thesis.

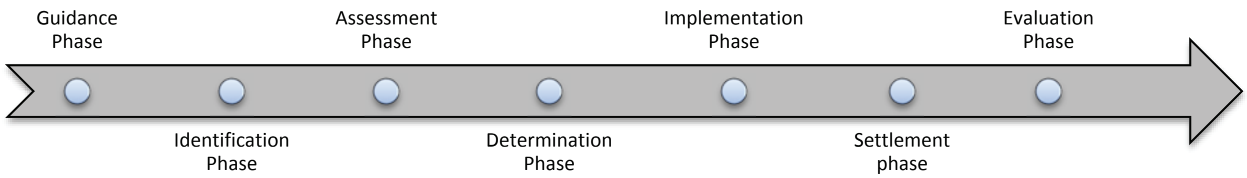

Figure 4: Macdonald's model (2013)

Macdonald simulated her model on selected real-world projects to show the positive impact of derivative usage on those projects. Construction projects are unique and have different durations. Macdonald used simulation to determine if hedging is useful regardless of commodity or project duration. The result of Macdonald research showed that hedging mitigated the risk of escalating costs regardless of the project type, duration and materials used.

Macdonald's model is general and did not take into consideration the cost of hedging. Also, Macdonald did not mention any guidelines or best practices for actual implementation of hedging in the construction industry. The "best practice" refers to a way that has constantly shown results superior to those achieved with other means, and that is used as a benchmark (Stevenson, 1996). Identifying best practices in the area of airline fuel hedging, then applying it in the construction industry, will provide a set of detailed guidelines for implementation, and thus save time and eliminate trial and error process improvements.

CHAPTER 3

METHODOLOGY

This research matched construction material hedging with the fuel hedging application and utilized the weather hedging process as a precedent for the construction industry. This thesis developed a step-by-step guideline to apply material hedging and matched it with Macdonald's (2013) model.

3.1 SCOPE AND LIMITATION OF THE RESEARCH

This research conducted a detailed investigation of how the airlines have conducted hedging for fuel costs. This research identified best practices in the area of airline fuel hedging, and discussed how these best practices can be applied to the construction industry. Also, this research collected knowledge on the application of weather hedging in the construction industry and used this knowledge to create a step-by-step guideline to applying material hedging successfully. This research also provided some suggestion to link and incorporate the materials hedging steps within Macdonald's (2013) model on a conceptual level.

Originally, the research scope was envisioned to include investigating the cost of hedging, but due to the time limitation, the investigation of cost was left for future research efforts. No validation of the approach has been done because it is considered beyond the scope of this research. The research utilized a conceptual approach and the actual implementation of the hedging best practice to construction industry was left for further research.

3.2 METHOD OF PROCEDURE

To identify best practices in the area of airline fuel hedging, this paper considered two criteria. The first regards quantitative criteria. In this criteria, the paper looked for the hedging practice that consistently show the pursued results. This means that the practice has been used for a long time, and each time the practice has been used it gave the same result. Between many of the articles that this research considered, eight primary research articles identified the same hedging practices as the best practice in airlines industry.

The second criteria regards the qualitative aspect. In this criteria, the paper looked for the practice that have a direct or immediate effect on the results. This means that the practice has a direct relationship with the result. For example, if a company uses only swaps as a hedging technique, and the hedging was successful, then the swaps technique has a direct relationship with the result.

This research found a study that investigated the fuel hedging performance of 27 firms in the U.S. airline industry during 1994-2001. The study found a positive relation between using specific hedging tools and value increases in investment (Carter et al. 2002). Although only one study met the qualitative criteria, this study is reliable enough since it covered the U.S. airline industry hedging techniques for a period of seven years. The hedging practice should meet both criteria to consider it as a best practice. Figure 3 shows the process to identify best practices using the quantitative and qualitative criteria.

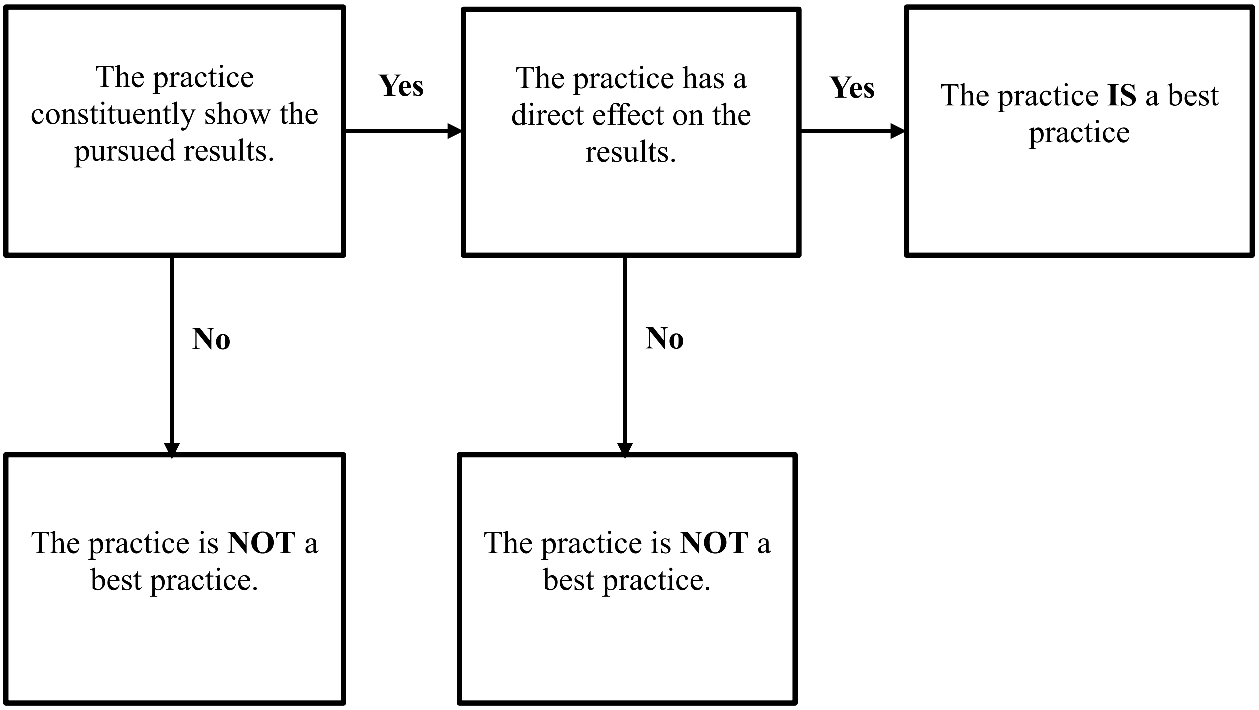

Figure 5: Criteria to identify best practices

The first step of this research was conducting a literature review to reveal what is already known in the body of knowledge about hedging practice in the airline industry and the construction industry. The literature search was conducted using keywords such as hedging, hedging in airline industry, and hedging in construction industry.

The second step of this research was collecting and identifying the best hedging techniques in the airlines industry. The methodology to identify best practices utilized the quantitative and qualitative criteria as shown in Figure 3. Eight primary research articles has been identified to meet the quantitative aspect, and one research article has been identified to meet the qualitative aspect. Contacting some of the major airline companies was another option to collect information about hedging. For example the researcher contacted the public relations director at Southwest Airlines

(Ms. Linda Rutherford) to ask some question about their hedging policy. However, no information was collected since the Ms. Rutherford stated that this is confidential information and they cannot release it.

The third step was investigating the application of weather hedging techniques in the construction industry. This provides a precedent for derivative use in the construction industry. Although there are number of web articles about weather hedging in construction engineering, only one primary research article has been found about the detailed application of weather hedging in the construction industry. The knowledge collected from this article was a key for this research because there is limited knowledge about the application of hedging in construction companies.

The fourth step was investigating the possibility of applying the knowledge collected from Step Two and Step Three to create a guidance to help construction companies apply material hedging successfully.

The fifth step was to integrate the material hedging steps developed in this thesis with the Macdonald's (2013) model. Macdonald (2013) provided a general ideas about material hedging application and this research added detailed steps procedure for this application.

The final step was drawing conclusion and providing recommendation for future research direction. Figure 4 below shows the methodology necessary for accomplishing the objectives of this research.

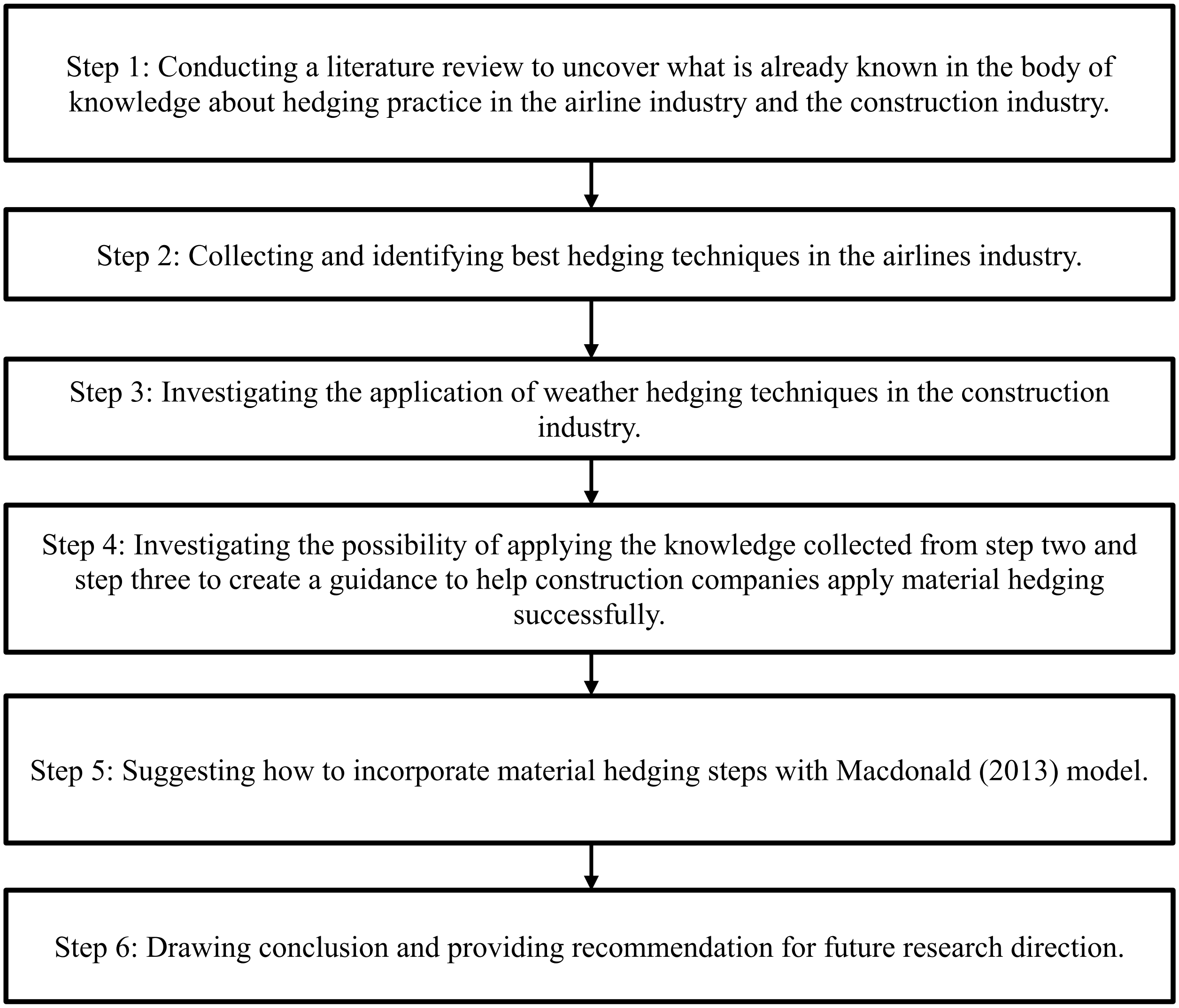

Figure 6: Summary of research methodology

3.3 NATURE AND FORM OF RESULT EXPECTED

The planned result of this reaserch was a step-by-step guidance to help construction companies apply material hedging successfully. A flow chart to explain this procedure was also provided. Suggetions to incorporate the material hedging procedure within Macdonald (2013) model was dicussed. The research identified future work that could be done in the area of construction materials price hedging.

CHAPTER 4

HEDGING BEST PRACTICES IN THE AIRLINE INDUSTRY

Call options, collar options and swaps are the primary derivatives that are used by airlines and they have a positive relation with airline companies' value increase. Board of directors, hedging committee, and, the CFO are the three main parties that make hedging decision in the airlines industry. The airlines industry depends on banks and fuel contractors to supply them with hedging advice and information. This would seem to be an apparent conflict of interest, since those firms are likely to also be the airlines' hedging counterparties.

4.1 BEST HEDGING TECHNIQUES IN THE AIRLINE INDUSTRY

Within the literature research conducted, only eight articles provided the level of detail to indicate best practices. The first article is published by Mercatus Energy Advisors. In 2012, Mercatus conducted a survey of executives at 24 global airlines. Participants in the Mercatus survey stated that they are currently and/or have previously utilized various hedging instruments and structures. However, the majority of these airlines are utilizing fixed price swaps, call options, and collar options, which tend to be the favored hedging instruments of the industry. According to Mercatus (2014), only 3% of the companies use futures while 39% use swaps. Also, 29% of the companies use call option and 26% use collar option while 3% use forwards. Figure 5 shows the hedging instrument utilizes by twenty-four commercial airlines as suggested by Mercatus (2014).

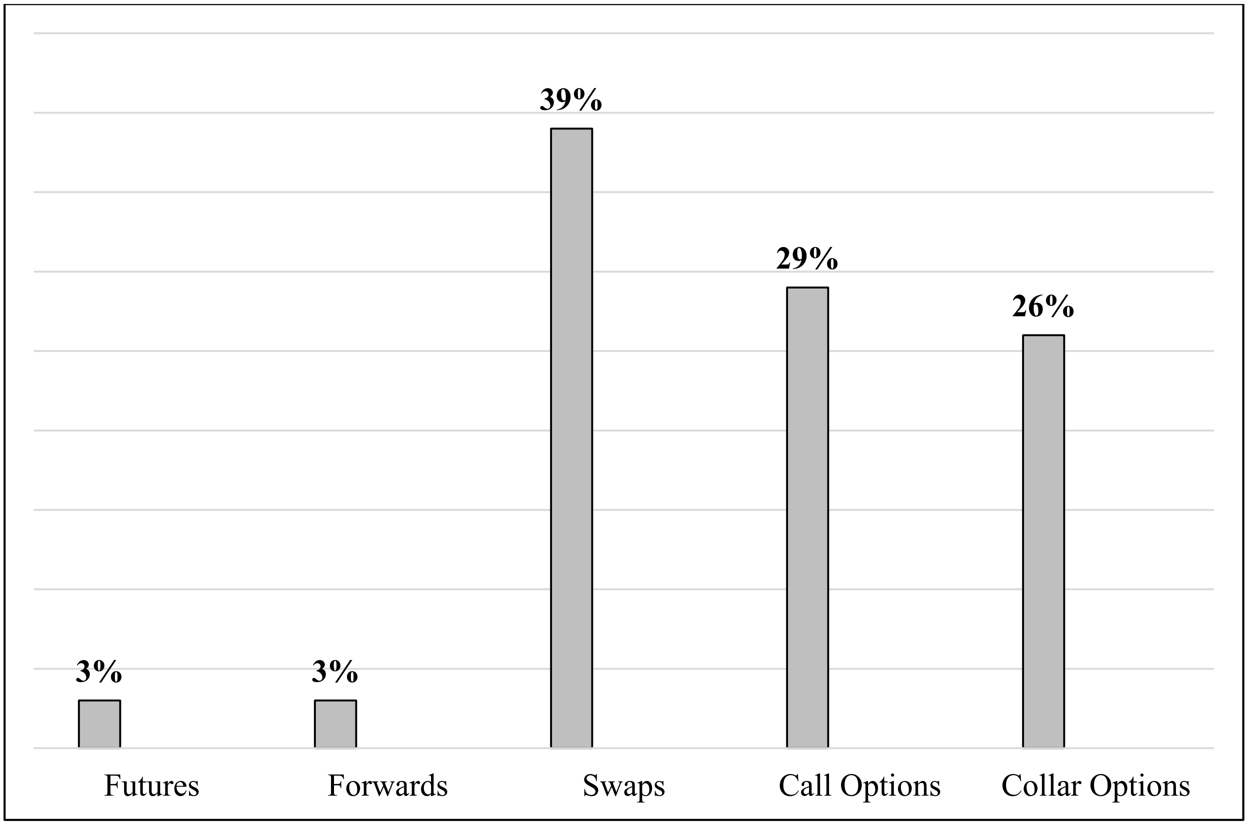

Figure 7: Hedging instruments utilized by airlines industry

Carter, Rogers, and Simkins (2006) conducted a similar study on the airline industry and they arrived at the same result as Mercatus (2014). Carter, Rogers, and Simkins (2006) stated that the call option is used primarily by airlines, since it protect them from any fuel price increase. Options is more flexible than futures, giving the holders the ability to protect themselves against undesired price movements, while at the same time giving them the chance to participate in favorable movements. As suggested by Carter, Rogers, and Simkins (2006), the example in Figure 6 shows the use of call option to protect $1.20 per gallon of fuel.

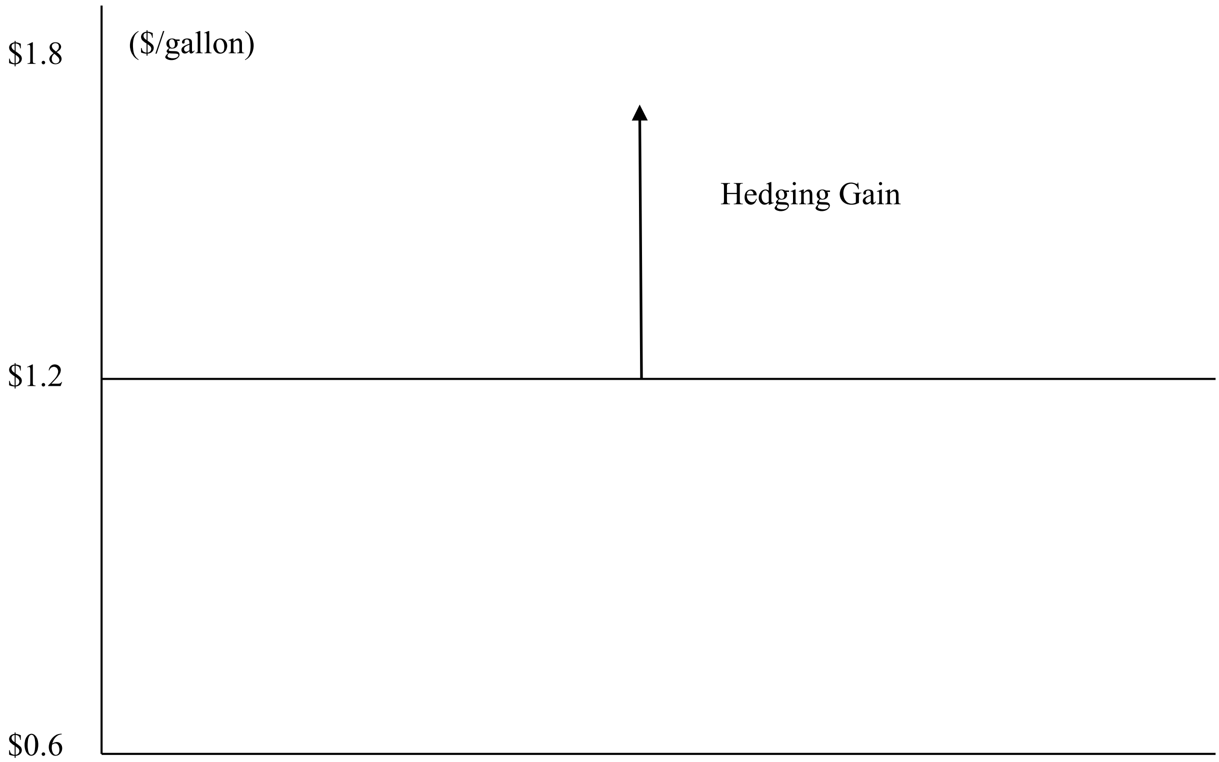

Figure 8: Protecting $1.20 per gallon of fuel using call option

However, more recently to hedge their exposure to fuel prices, airlines have moved to use blends of a call and a put option called a collar (Carter et al. 2006). The call option protects the holder from price rising higher than its strike price (the price at which the contract can be exercised). The holder of this call option also writes a put option to limit any possible gain if price decreases below its strike price (Carter et al. 2006). The total cost of taking the two options is the difference between the call option premium paid and the put option premium received. This is popular with airlines because it fixes the price for fuel between two identified values. As suggested by Carter, Rogers, and Simkins (2006), the example in figure 7 shows the use of collar option to protect $1.20 per gallon of fuel.

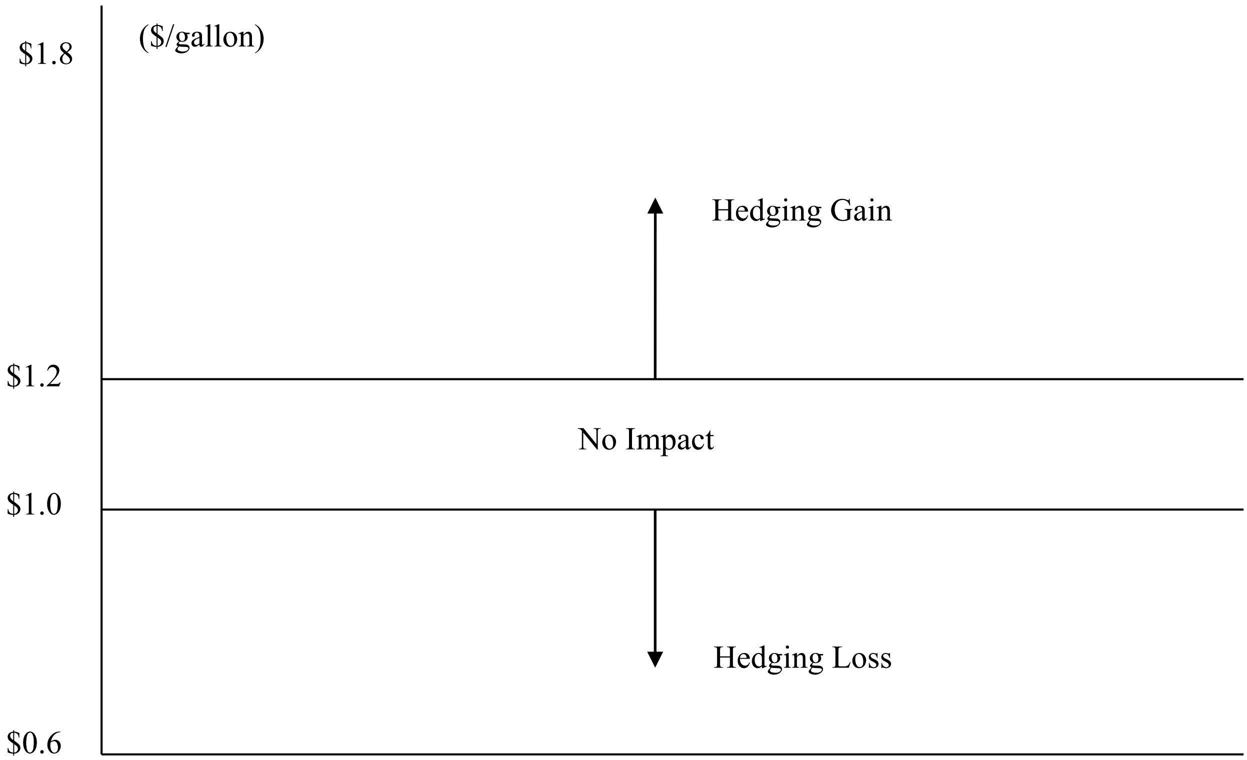

Figure 9: Protecting $1.20 per gallon of fuel using collar option

Carter, Rogers, and Simkins (2006) stated that swap is often considered the "most favorite" hedging strategy for airlines. The airline would buy a swap for a period of one year at a fixed strike price for a stated amount of jet fuel per month. The average price for that month is then compared with the strike price. If the average price larger than the strike price, the counter-party which is a bank would pay the difference times the amount of fuel to the airline (Carter et al. 2006). However, if the average price were lower than the strike price, then the airline would pay the difference. As suggested by Carter, Rogers, and Simkins (2006), the example in Figure 8 shows the use of a swap to protect $1.20 per gallon of fuel.

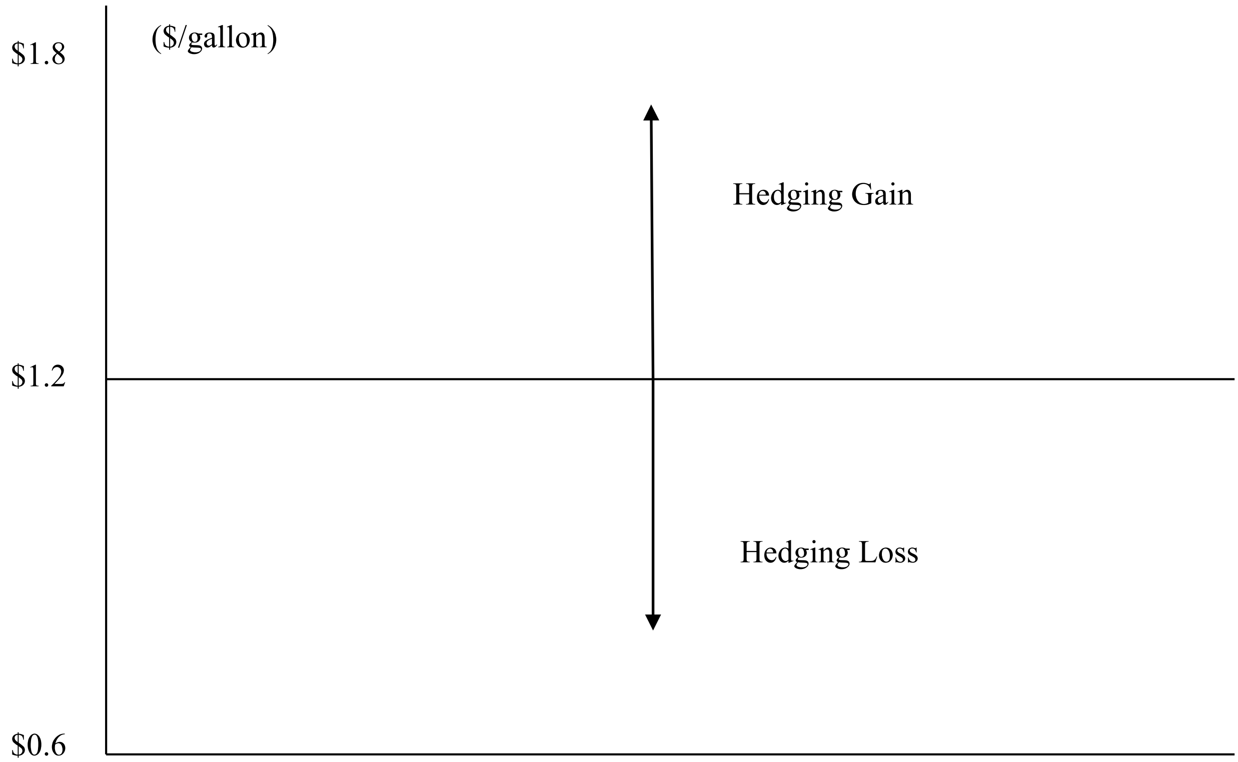

Figure 10: Protecting $1.20 per gallon of fuel using swaps

A third study is done by Gerner and Ronn (2013). They backed up the results of both Mercatus (2014) and Carter, Rogers, and Simkins (2006). Gerner and Ronn (2013) stated that most airline companies use call options to provide insurance against sudden upward price shocks. Also, buying a jet fuel swap allows airlines to hedge their exposure to jet fuel prices fluctuation. If the price of fuel goes up, the gain on the fuel swap offsets the increase in fuel cost (Gerner and Ronn, 2013). On the other hand, if the price of fuel declines, the loss on the fuel swap offsets the decrease in fuel cost. Either way, once the swap is executed, the airline has locked in their fuel cost (Gerner and Ronn, 2013).

According to Scott Topping, Director of Corporate Finance for Southwest Airlines, "The majority of airlines depend on plain vanilla instruments to hedge their fuel costs, including swaps, call options and collars" (Carter et al. 2004). This is consistent with the argument of the first three articles above. An article that is published by Cobbs and Wolf (2014) stated that "the most frequently used hedging contracts by airlines: swap contracts (including plain vanilla, differential, and basis swaps), call options (including caps), collars (including zero-cost and premium collars)". Further, Lim and Hong (2014) stated that futures are used by some airlines, but most airlines today use primarily swaps and call options to hedge their jet fuel price risk. Westbrooks (2005) supported this argument and he stated that most airlines use hedges to some extent to limit their fuel risk. This has been done mostly by utilizing swaps, call options, and collar options.

Carter, Rogers, and Simkins conducted an earlier study in (2002) investigating the fuel hedging performance of 27 firms in the U.S. airline industry during 1994-2001. They found a positive relation between using call options and swaps as hedging tools and value increases in capital investment (Carter et al. 2002).

The above eight articles identified call options, collar options, and swaps as the best practice for fuel hedging application in the airlines industry. One of these articles found a positive relation between using these hedging tools and capital value increases. It is safe to conclude that call options, collar options, and swaps meet this research quantitative and qualitative criteria for best practice since they are the primary derivatives that are used by airlines and they have a positive relation with airlines companies value increase.

4.2 RESPONSIBILTY OF HEDGING DECISION

The responsibility for making hedging decision varies based on many factors such as the company size and the company involvement in hedging. Twenty-two percent of the participants in the Mercatus (2014) survey stated that the board of directors is responsible for making the hedging decisions. Thirty-nine percent of these companies have a special hedging committee.

Eleven percent of the companies made the CEO or the president responsible about making the hedging decisions while 22% of the companies make CFO or VP of finance responsible for those decisions. Six percent of the companies did not reveal who is responsible for making the hedging decision. Figure 9 shows responsibility for hedging decision according to this study as suggested by Mercatus (2014).

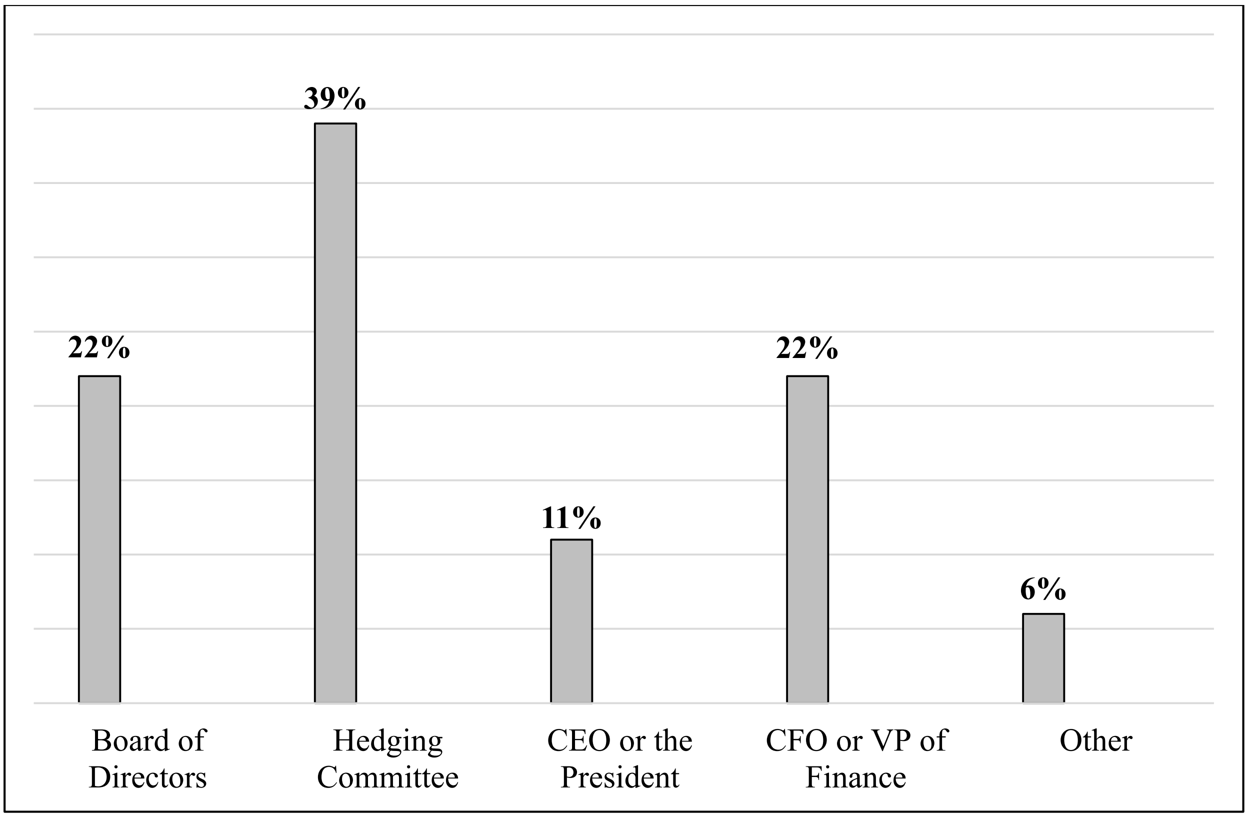

Figure 11: Responsibility for hedging decision

To make the right hedging decision the majority of the airlines companies rely on financial institutions and fuel suppliers, most likely their counter-parties, to provide them with hedging advice, data and information (Mercatus, 2014). Sixty-eight percent of the companies that participated in the study rely on financial institutions for hedging advice. These financial institution include banks and brokerage firm which have hedging expert personnel. Sixteen percent of the companies rely on information from the fuel supplier. Eleven percent of the companies hire consultant to help taking the hedging decision. Only 5% of the companies rely on their internal resources to gather data and information for their hedging decision. Figure 10 shows the primary source of hedging advice, data and information for twenty-four commercial airlines as suggested by Mercatus (2014).

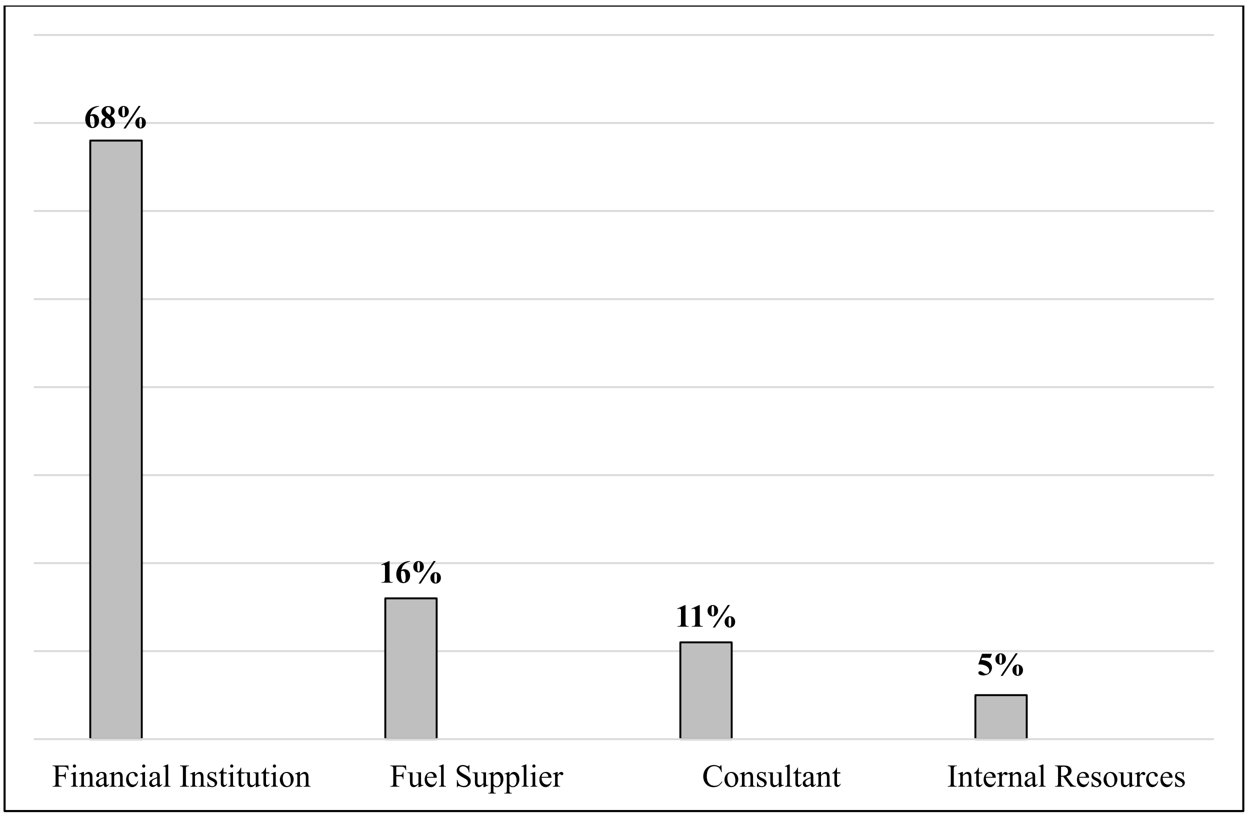

Figure 12: Primary source of hedging advice, data and information

Jet fuel is not traded on any exchange market and usually it is traded Over-The-Counter (OTC). OTC trades involve counter-party risk for both sides, and thus small airlines would find it hard to find banks that are willing to take the risk of selling fuel derivatives to them (Morrell and

Swan, 2006). OTC derivatives are traded directly between the airlines and banks and most airlines choose to trade with more than one bank to reduce the counter-party risk (Gerner and Ronn, 2013).

The first step to trade in OTC securities is to open a hedging account with a bank. The bank will contact the fuel supplier to know the selling price of the security. If the airline company accept the price quoted, the bank will transfer the necessary funds to the fuel supplier account (Gerner and Ronn, 2013).

CHAPTER 5

CONSTRUCTION MATERIALS HEDGING

Construction materials hedging gives construction companies the ability to submit a very competitive bid on a specific project. Companies are also able to manage debt effectively, improve liquidity, and invest for growth. In an industry in which there is plenty to worry about, hedging takes materials price risks off the table for the construction companies. This chapter provides construction companies with a step-by-step guidance to apply material price hedging successfully.

5.1 DEVELOPMENT OF RECOMMENDED HEDGING PROCESS

The development of the construction material hedging process is based on the analysis of weather hedging process in the construction industry, combined with the fuel hedging process in the airline industry.

5.1.1 WEATHER HEDGING IN THE CONSTRUCTION INDUSTRY

The first step is to identify the type of weather (i.e., rain, wind, or temperature) that affects the project. Once related weather variables have been recognized, weather volatility can be related to the delays by obtaining old weather data from the nearest National Weather Service location (Holmes, 2014). Based on this data the contractor can estimate the number of days that need to be added to a project duration to cover the weather impact. This helps the contractor estimate the penalties for delays because of weather. This also enables construction companies to analyze the possible financial impact of weather on a project schedule and to quantify the benefits of hedging to mitigate that impact (Holmes, 2014). To establish a reference line for the identified weather risk, construction companies should identify the following points as suggested by Holmes (2014):

1. The point where project delays become intolerable (the strike value);
2. The gradual cost increase for each increment of precipitation (the tick value);
3. The maximum penalties for delays because of weather (the maximum payment).

The weather station locations used in the analysis are used for the hedge locations. The period of coverage is equal to the project period. The weather type was defined in the analysis, as were the strike value (the value at which the contract starts to pay out), tick value (the payout amount for one increment change beyond the strike value.), and maximum payment levels (Holmes, 2014). Next, construction companies should decide what type of weather risk contract best fits their need (i.e., swap, option, etc.). One common form of weather derivative is a call option. An example of a call option for a construction industry may be as follow:

Coverage Period: From April 1 to October 31

Weather Type: Sum of Daily Rain

Strike Value: 20 inches

Tick Value: $50,000 per tenth-inch

Maximum Payment: $3,500,000

In this example, the option seller would pay the construction company $50,000 per tenth-inch in excess of 20 inches of rain, up to a maximum payment of $3,500,000. If there were 24 inches, the construction company would receive $2,000,000 from the option seller (Holmes, 2014). Figure 11 shows the weather hedging process steps.

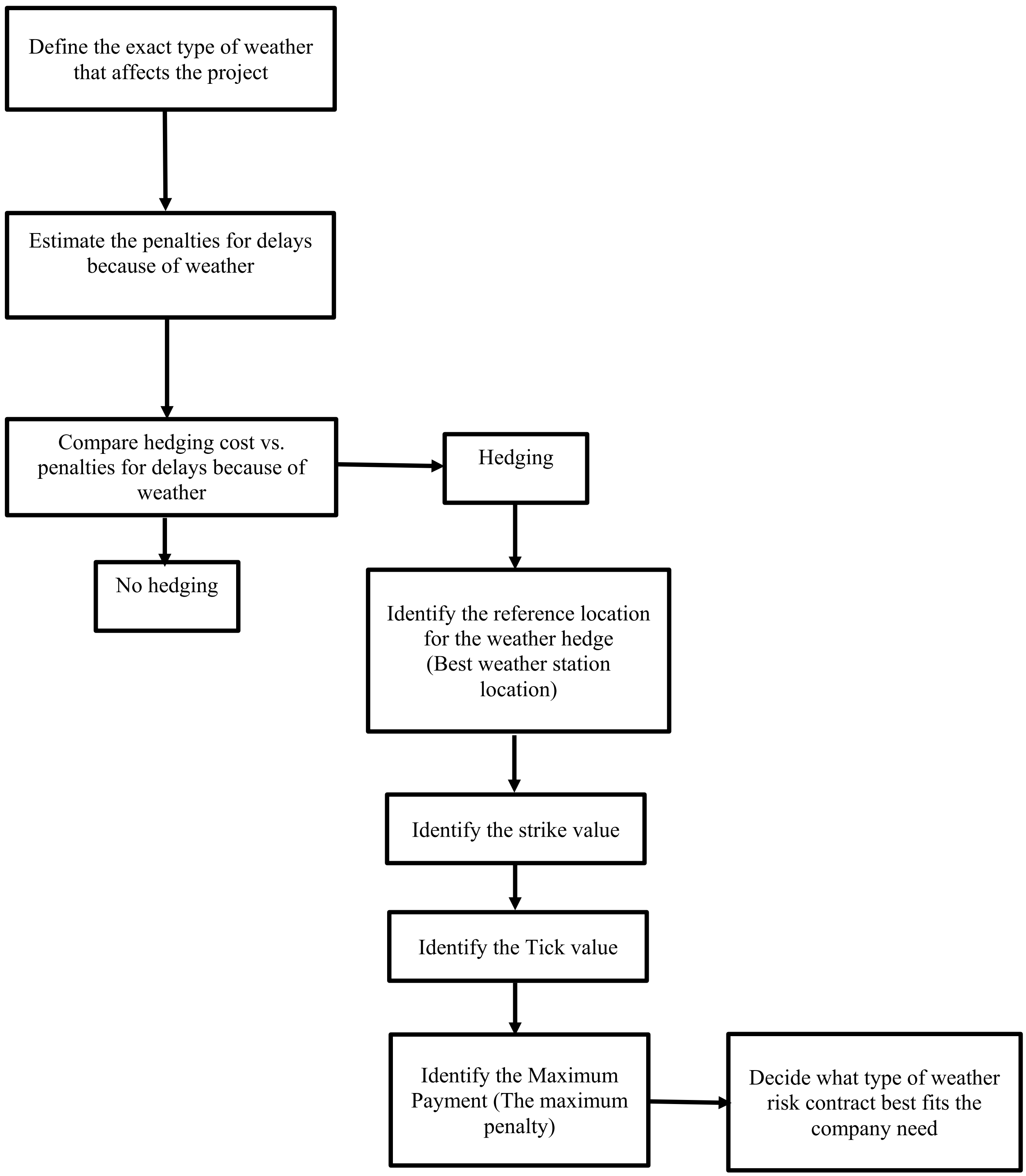

Figure 13: The weather hedging process steps

5.1.2 FUEL HEDGING IN THE AIRLINE INDUSTRY

First, the airline industry identifies all energy-related risks including market, credit and regulatory risks. These risks can be investigated using quantitative or qualitative analysis. An energy risk management policy can then be established to formalize the goals, objectives and risk tolerance, and to determine who executes the hedging policy. A hedging committee, board of directors, and CFO are the preferred three choices for airline industry hedging responsibility (Mercatus, 2014). The responsible party should determine three main values:

1. The strike value, or the value of the jet-fuel at which the contract starts to pay out.
2. The tick value, or the payout amount for $ increment change in a gallon of jet fuel price beyond the strike value.
3. The maximum financial payout of the contract that need to be purchase.

Once the previous steps are in place, the execution of hedging and trading strategies can begin. Airline companies ask financial institutions and fuel suppliers to provide them with hedging advice, data, and information. Then, the airline company purchases hedging contracts that fit their need. The preferred types of contract are options and swaps. These contracts are traded Over-The-Counter (OTC). OTC derivatives are traded directly between the airlines and banks, and as such have counter-party risk that must be taking into consideration (Gerner and Ronn, 2013). Hedges should be constantly examined to determine if they fit within the company's goals and management policy. The positions should be enhanced when possible. As the company's risk exposure changes, there should be an efficient process for reporting and determining if the hedging policies need to be modified or if the existing policy and strategies are correct. A call option protects the airline company from fuel price increase. An example of a call option for an airline may look like the following:

Coverage Period: From Jan 1 to June 30

Fuel Type: Jet Fuel

Strike: $5 per gallon

Tick: $1000,000 per 10 cent increase per gallon

Maximum Payment: $5,000,000

In this example, the option seller would pay the airline company $1000,000 per 10 cent in excess of $5 per gallon of jet fuel, up to a maximum payment of $5,000,000. Figure 12 shows the airline hedging process steps.

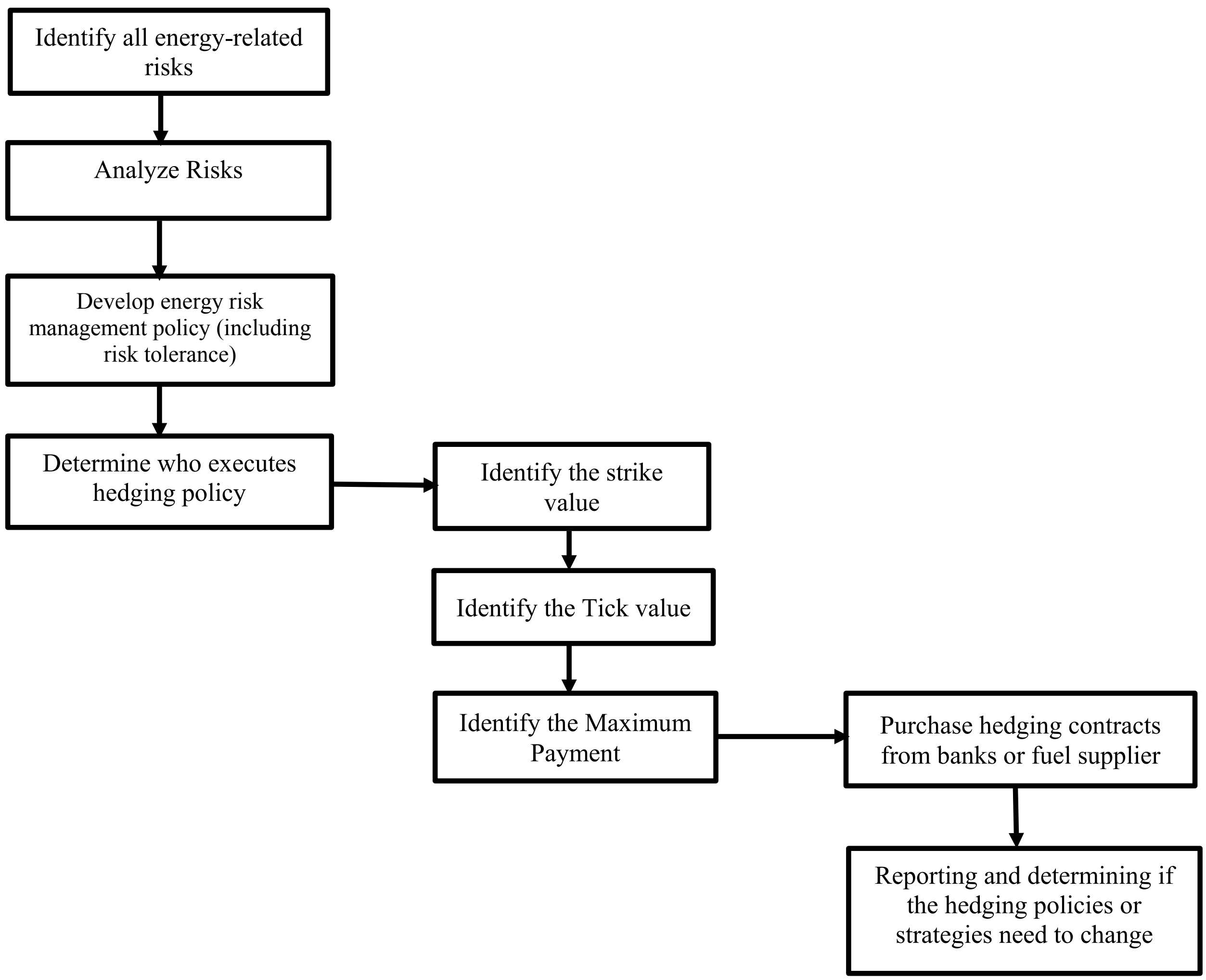

Figure 14: The airline hedging process

5.2 CONSTRUCTION MATERIALS HEDGING PROCESS

This section provides construction companies with a step-by-step guidance to apply material price hedging successfully. These steps are based on the knowledge collected from weather hedging application in the construction industry and the fuel hedging application in the airline industry. These steps are: identify and analyze risks; determine tolerance for risk; develop hedging management policy; develop hedging execution strategies; implementation, monitoring, analyzing and reporting risk; and, finally repeat the process.

5.2.1 IDENTIFY AND ANALYZE RISKS

Both the fuel hedging and the weather hedging process start with identifying all risks related to hedging. The construction company can apply this step during the bid process. Before bidding, the construction company estimates the cost of material needed using a cost index. That leads to an understanding of the impact of the material price fluctuation on the company profit by projecting cash flow requirements in the event that material prices significantly exceed norms. During this step, the exact type of materials that affects the company should be identified and looked at in monetary terms (i.e., price fluctuation of one ton of steel).

5.2.2 DETERMINE TOLERANCE FOR RISK

Both the fuel hedging and the weather hedging process mentioned determining tolerance as an important step in hedging process. Once relevant material variables have been identified, analysis of the price volatility of this material should be done to decide at what point price volatility become unacceptable for the company. Consideration of any schedule penalties (late delivery of the project), as identified in the project contract, will be incorporated into this step.

5.2.3 DEVELOP HEDGING MANAGEMENT POLICY

Hedging management policy should be developed to clearly describe the decision-making process and define who (individuals and/or committees) executes the hedging and related activities. The fuel hedging process mentioned clearly the importance of determine who is responsible for hedging decisions. Based on the knowledge collected from airline fuel hedging, creating a dedicated hedging committee is the best choice for making the hedging decisions for the construction industry.

5.2.4 DEVELOP HEDGING EXECUTION STARTEGIES

Execution strategies are the process for implementing the hedging strategies, and complying with hedging management policy. For example, the execution strategies determine which hedging and trading instruments should be used to meet the targeted hedge objectives. Based on the fuel hedging application in the airline industry, the best trading instruments are swaps and options (i.e., call, put, or collar options).

Also, based on the weather hedging and fuel hedging applications, it is important to address the following four points during the process of choosing the hedging instrument that fits the company needs.

1. At what point do material price volatility become intolerable (the strike value or the value of the construction materials at which the contract starts to pay out);
2. What is the incremental cost to your company for each $ increase per ton/lb of the material (this is the tick value);
3. What is the worst possible case (the maximum financial payout of the contract);

4. What is the duration of the hedging instrument that fits the company need (short-term, mid-term or long-term)?

A call option could provide protection against an increase of material price beyond norms. An example of a call option might look like this:

Period = the life of the project (could be a phase of the project only)

Index = average price of 1 ton of steel

Strike = $800 per ton of steel

Tick size = $100 /Ton

Limit = $500,000 (for 5,000 ton of steel)

Premium = $50,000

When the steel price hits $800 per ton, the hedging contract begin to pay off $100 per ton up to a maximum value of $500,000. The strike value, tick value, and maximum payment can all be changed to meet the company's preferred risk coverage. Companies should take into consideration that the price of a material risk hedging contract to protect against financial loss depends on the likelihood of a contract payout. If the probability of certain material price volatility is low, so will the cost of the contract.

5.2.5 IMPLEMENTATION

The airline fuel hedging application shows that the primary market trades for derivatives is Over-The-Counter (OTC). OTC securities are unlisted so there is no central exchange for the market. The first step a construction company must make before they can trade in OTC securities is to open a hedging account with a broker. After the company places the market order with the broker, the broker must now contact the material supplier.

The material supplier then will quote the broker the ask price that the material supplier is willing to sell the security at. If the construction company accept the price quoted, the broker will transfer the necessary funds to the material supplier’s account and is then credited with the respective securities.

5.2.6 MONITORING, ANALYZING AND REPORTING RISK

Reporting and deciding if the hedging policies or strategies need to change is one of the process steps to apply fuel hedging. Similarly, materials risks should be continuously monitored, measured and reported. As the company's risk exposure changes, there should be a methodical process for reporting and determining if the existing policy and strategies are correct. Also, Hedges should be modified when market conditions change, as noted in the next section.

5.2.7 FEEDBACK LOOP

Revision to the entire process of material hedging is necessary, because the material price could be affected easily by a variety of factors (i.e., regulatory change, world political and economical stability). Changes in material price may then have a subsequent effect on the initial steps of the process. Further, these derivatives may be initiated for varying short-term, mid-term and long-term durations throughout the project. Figure 13 shows these steps and the relationship between them.

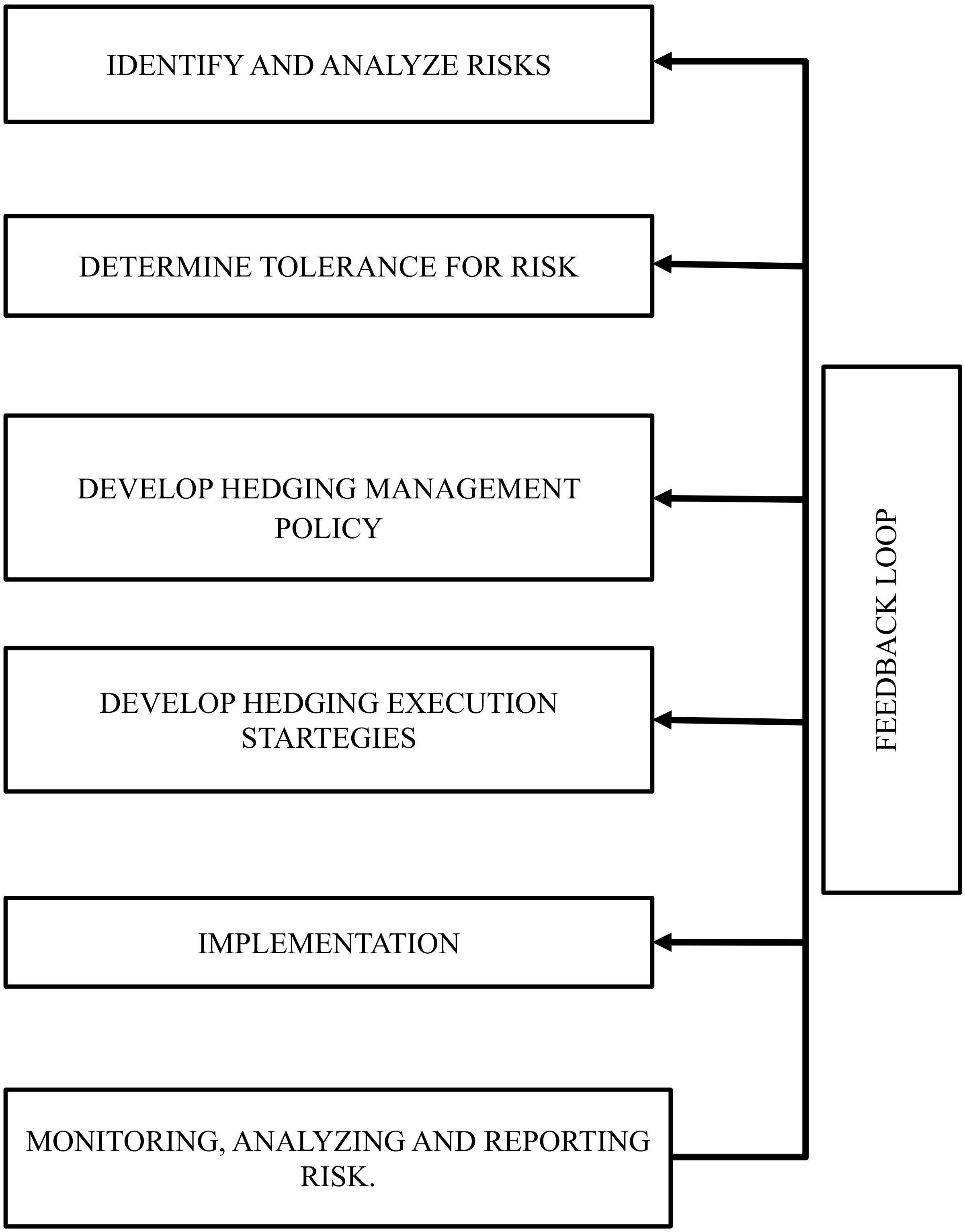

Figure 15: The seven step model for construction material hedging application

5.3 INTEGRATION WITH MACDONALD'S (2013) MODEL

Macdonald's model (2013) consists of various stages to mitigate materials price risks. The first stage is the guidance phase. In this phase the construction company identifies its hedging philosophy (avoiding loss or making profit) and delegates authority to personnel to act according to corporate philosophy. The second stage is the identification phase. In this phase, the construction company identifies project terms and project life cycle to determine which phase of the project bears the materials risk. The third phase, the assessment phase, determines the amount of the materials needed, the delivery location, and the quality of the materials.

The fourth stage is the determination phase. In this phase the construction company determines when and how much to hedge. Additionally, they needs to decide whether to hedge all at once or scaled in over time. The implementation phase is the fifth stage. In this phase the construction company places orders through a clearing house and monitor their hedge position. The sixth stage is the settlement phase. In this phase the construction company decides if they want to close the hedge, move out early of the hedge, or maintain the hedging position till the end of the hedging period. The final stage of Macdonald's (2013) model is the evaluation phase. Here, the construction company evaluates their hedging process to determine if the hedge was successful or if they need to change their hedging policy.

The model developed in this thesis is within the context of Macdonald's model. However, it provides lower level of details to support actual implementation. Most of Macdonald's model phases can be integrated with the material hedging model developed in this thesis with one exception which is the settlement phase since it is beyond the scope of this thesis. Figure 14 compares Macdonald's model and this thesis model side-by-side, and uses arrows to show the relationship between the stages of the two models.

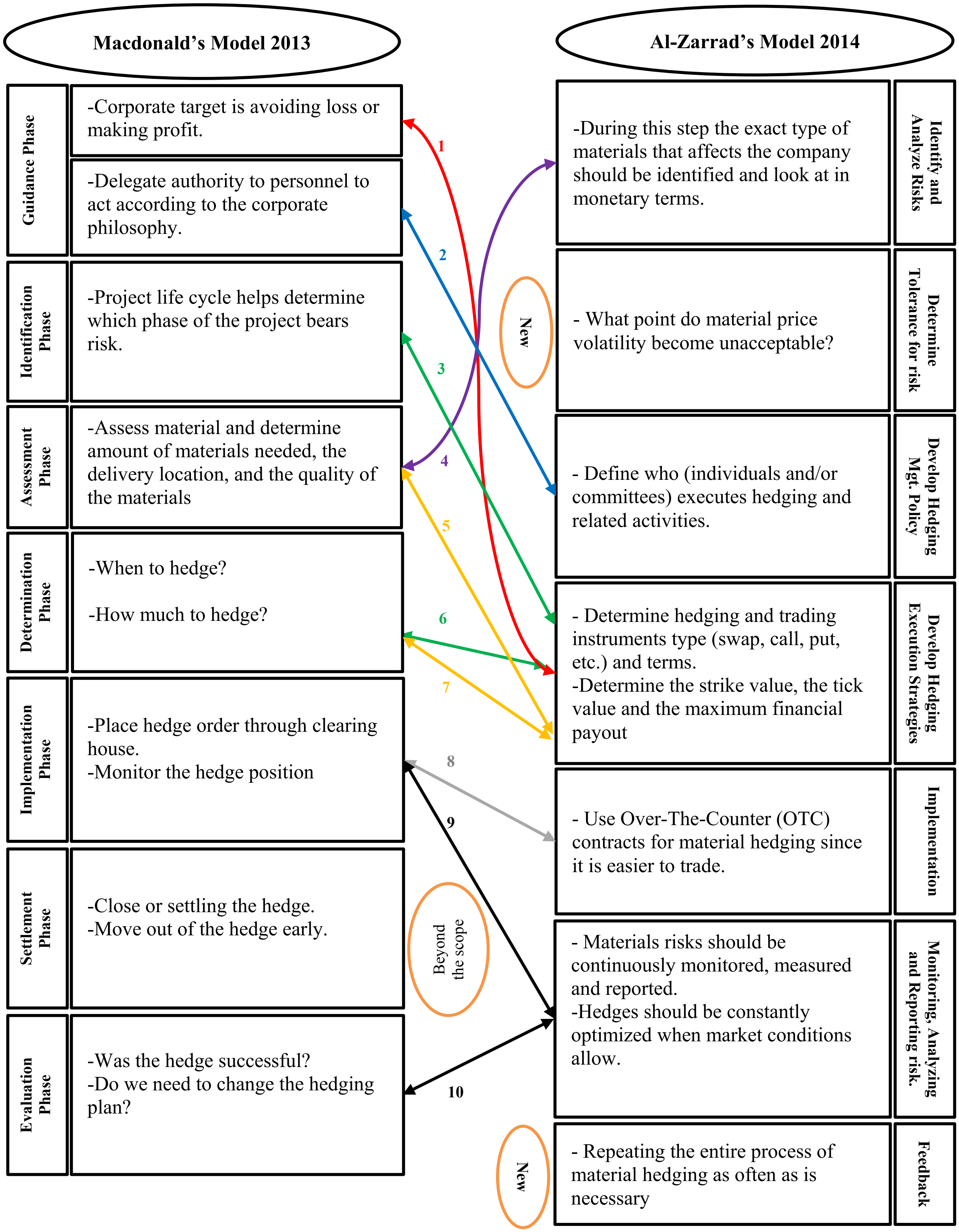

Figure 16: Macdonald's model (2013) vs. Al-Zarrad's model (2014)

Arrow number one (in red) shows that both models stated that construction companies should identify the type of hedging instrument (put option, call option, or swaps) that fits their hedging plan. Macdonald’s model mentioned this indirectly by indicating avoiding loss or making profit as a corporate target. To avoid loss, construction companies should use call option because it protects them from material price increases. A put option can help construction companies making profit. The thesis model mentioned directly that construction companies should determine the hedging instrument type as part of the company hedging execution strategy development.

Arrow number two (in blue) indicates that both models stated that construction companies should identify the party that is responsible about making the hedging decision. Macdonald’s model mentioned that authority should be delegated to personnel to apply the company hedging philosophy. The thesis model noted that the construction companies should define who executes hedging and related activities as part of hedging management policy development.

Arrow number three (in green) shows that Macdonald’s model mentioned the timing of hedging contracts in the identification phase. In this phase, Macdonald stated that construction companies should determine which phase of the project bears the material risk. This implies that the hedging instrument duration could be only for one phase of the project (short term) or for the duration of the project (long term). Also, arrow number six (in green) shows that Macdonald’s model mentioned directly the hedging contract timing again in the determination phase. The thesis model discussed that hedging contracts terms should be identified as part of the company hedging execution strategy development. Arrow four (in purple) indicates that both models noted that construction companies should assess their material requirements. The exact type of materials that affects the company should be identified at this point. Arrow five (in yellow) shows that Macdonald’s model mentioned determining the total amount of materials needed as part of the assessment phase. Also, this thesis model mentioned determining the maximum financial payout of the hedging contract as part of the company hedging execution strategy development. Both are related since the construction company need to know the total amount of materials needed in order to be able to calculate the maximum financial payout of the hedging contract. Arrow number seven (in yellow) also indicates that Macdonald's model asked construction companies to determine how much to hedge as part of the determination phase. To know how much to hedge, construction companies should identify the maximum financial payout of the hedge contract which is mentioned in the hedging execution strategies development stage of the model formulated in this thesis.

Arrow number eight (in gray) shows that both models discussed the implementation phase of construction material hedging. Macdonald's model mentioned that the implementation phase starts by placing the hedge order through a clearing house. While, the thesis model stated that construction companies should use Over-The-Counter (OTC) contracts for material hedging because it is cheaper and easier to trade. Arrow number nine (in black) shows that Macdonald's model mentioned monitoring the hedge position as part of the implementation phase. The thesis model notes that materials risks should be continuously monitored, and that the model presented a completion phase called monitoring, analyzing, and reporting. Also, arrow number ten (in black) shows that Macdonald's model stated that hedge policy should be evaluated to determine if the hedge plan needs to be changed. The thesis model discussed that hedges should be analyzed and modified when market conditions warrant.

Finally, Macdonald's model presented a settlement phase which is beyond the scope of this thesis and could be a good material for further research. Also, this thesis presented two steps that have not been mentioned by Macdonald's model. These steps are risk tolerance determination and the feedback loop.

CHAPTER 6

CONCLUSIONS AND FURTHER RESEARCH

This thesis developed a step-by-step guidance to apply material hedging. This thesis is considered to be the first attempt to match construction material hedging with airline fuel hedging application and utilizing the weather hedging process as a precedent for the construction industry. Further, the model developed by this thesis overlaps with Macdonald's (2013) model, and provides a lower level of details to support actual implementation of material hedging.

6.1 CONCLUSIONS

Construction materials cost estimation is considered one of the most important tasks in the development of project budget. However, due to material price fluctuation, cost estimation is usually uncertain. Using material hedging to mitigate the risk of material price volatility is a new concept for construction companies.

This thesis provides a detailed investigation of how the airlines have conducted hedging for fuel costs. This research identified best practices in the area of airline fuel hedging, and discussed how these best practices can be applied to the construction industry.

To identify best practices in the area of airline fuel hedging, the thesis looked for the hedging practice that consistently show the pursued results. The thesis looked for the practices that have a direct or immediate effect on the results. The identification of fuel hedging best practices provided a general framework for material hedging application. However, this thesis went further to investigate the application of weather hedging in the construction industry to use it as a precedence for conducting the material hedging application. This was key because it provided an insight of the best way to integrate the fuel hedging practice in the construction industry. This thesis used the analysis of weather hedging process in the construction industry, combined with the fuel hedging process in the airline industry to develop a model for the construction material hedging application. The model consisted of seven steps as shown in Figure 13.

The model developed in this thesis agrees with Macdonald's (2013) model. However, it provides more details to support actual implementation of material hedging. Most of the phases of Macdonald's model have been integrated successfully with the material hedging model developed in this thesis, with one exception. Also, the model developed in this thesis presented two new steps that have not been mentioned by Macdonald's model.

6.2 FURTHER REASERCH

Future work in this area could be the investigation of material hedging cost to decide if the hedging application is feasible. This is very important and could be added to the tolerance phase of this thesis model to help the company decide if material hedging is economical for them.

Further research could be done to investigate the best way to settle the hedging contract. This could be done by simulating different scenarios of hedging situation. Different scenarios could generate different settlement options such as moving out from the hedge early or keep the hedge contract until its due date.

Also, the validity of the model presented by this thesis should be investigated. According to Stewart (1997), "validity is the extent to which a test measures what it is supposed to measure". A study of verification and validation of models by Stewart (1997) stated that "a model is only validated with respect to its purpose". There are many type of validity as suggested by Cronbach (1990). The first type is face validity which is defined as "the degree to which a test appears to measure what it claim to measure". It refers to the transparency or significance of a test as they appear to test participants. The face validity could be done by asking a sample of construction companies to rate the validity of the model as it appear to them.

Another type of validity is predictive validity. According to Cronbach (1990), "predictive validity means expecting a future performance based on the scores obtained currently by the measure, correlate the scores obtained with the performance. The later performance is called the criterion and the current score is the prediction". Concurrent validity is the degree to which the result on a test are related to the result of another test that is already established. Construct validity is the degree to which a test measures a planned theoretical concept. Finally, content validity, sometimes called logical validity, is the evaluation of how much a measure represents every single element of a construct. One or more of these validity tests could be used to evaluate the model presented by this thesis. Another way to investigate the validity of the model is actual implementation. This could be done by taking completed projects, with their original estimates for materials cost and their actual materials cost, then consider if a particular hedge had been applied what would have been the outcome for the contractor.

Further research could also investigate the reliability of the model presented by this thesis. According to Gay (1987), "reliability is the degree to which a test consistently measures whatever it measures". Testing reliability can be done by using test-retest approach to indicate result variation that happens from one testing session to another testing session due to errors of measurement.

6.3 KEY BENEFITS

Construction projects are exposed to many forms and degrees of uncertainty and risk, such as price materials volatility and shocks. Materials price uncertainties are pervasive throughout the project lifecycle, occurring at project initiation and continuing through execution. This thesis addressed the problem of material price volatility by presenting a step-by-step guidance to applying material hedging to mitigate the risk of material price fluctuation.

This thesis considered to be the first attempt to map construction material hedging with both the weather hedging application and the fuel hedging application. This thesis provides a frame work to apply construction material hedging by using the weather hedging and the fuel hedging as precedence to its finding.

Also, mapping Macdonald's (2013) model with the model presented by this thesis give more details about the application of material hedging in the construction industry. Macdonald's (2013) model provides a general recommendation for materials hedging while the model presented by this thesis provides a lower level of details to support actual implementation.

REFERENCES

Bartram, S., Brown, G., and Fehle, F., “International Evidence on Financial Derivatives Usage”, Financial Management, Vol. 38, No. 1, p. 185-206, 2009.

Cholakis, P., “A Comparison of Construction Cost Estimating Tools”, http://4-clicks.com/dl/w/bp.20110926.ComparisonCostEstimatingTools.pdf, April 10, 2014.

Climetrix, http://www.climetrix.com/, Mar 11, 2014.

Cronbach, L., Essentials of Psychological Testing, New York: Harper & Row, 1990.

Crosthwaite, D., “The Global Construction Market: a Cross Sectional Analysis”. Construction Management and Economics, Vol. 18, No. 2, p. 619-627, 2000.

Carter, D., Rogers, D., and Simkins, B., “Hedging and Value in the U.S. Airline Industry”, Journal of Applied Corporate Finance, Vol. 18, No. 4, p. 21-33, 2006.

Carter, D., Rogers, D., and Simkins, B., “Does Fuel Hedging Make Economic Sense? The Case of the U.S. Airline Industry”, The Journal of Finance, Vol. 58, No. 5, p. 320-372, 2002.

Carter, D., Rogers, D., and Simkins, B., “Fuel Hedging in the Airline Industry: The Case of Southwest Airlines”, The Case Research Journal, Vol. 24, No. 2, p. 11-44, 2004.

Cobbs, R., and Wolf, A., “Jet Fuel Hedging Strategies: Options Available for Airlines and a Survey of Industry Practices”, http://www.kellogg.northwestern.edu/research/fimrc/papers/jet_fuel.pdf, June 02, 2014.

Chen, J., Yang, L., Su, M., and Lin, J., “A Rule Extraction Based Approach in Predicting Derivative Use for Financial Risk Hedging by Construction Companies”, Expert Systems with Applications, Vol. 37, No. 8, p. 6510-6514, 2010.

Cronin, P., Ryan, F., and Coughlan, M., “Undertaking a literature review: a step-by-step approach”, http://www.ncbi.nlm.nih.gov/pubmed/18399395, April 02, 2014.

Dawood, N., Yasuhara, T., Usuda, Y., Matsuda, C., and Sawada, A., “Analysis of Cost Escalation and Risk Assessment of infrastructure projects: an application in Japanese Civil Engineering Projects”, 17th Annual ARCOM Conference, Salford, UK, p. 835-844, September 5-7, 2001.

Delta Airlines, http://www.delta.com/, March 16, 2014.

Duyck, D., “Control Fluctuating Material Prices with Price Escalation/De-escalation Clauses”, http://www.schwabe.com/pdf/12cnu_1006.pdf, Apr 02, 2014.

Ely, C. and Scott, I., “Essential Study Skills for Nursing”, British Journal of Nursing, Vol. 17, No. 1, p. 38-43, 2008.

Engineering News Record, http://enr.construction.com/economics/, June 9, 2014.

EUFRAM, http://www.eufram.com/probablistic.cfm, June 9, 2014.

Flanagan, R., and Norman, G., Risk Management and Construction, London: Blackwell Science Ltd., 1993.

Geczy, C., Bernadette, A., and Catherine, S., “Why Firms Use Currency Derivatives,” The Journal of Finance, Vol. 52, No. 4, p. 1323-1354, 1997.

Gay, L., 1987. Eductional Research: Competencies for Analysis and Application, Columbus: Merrill Pub. Co., 1987.

Gerner, M., and Ronn, E., “Fine-Tuning a Corporate Hedging Portfolio: The Case of an Airline”, Journal of Applied Corporate Finance, Vol. 25, No. 4, P. 74-86, 2013.

Hart, C., Doing a Literature Review: Releasing the Social Science Research Imagination, London, UK: Sage Publications, 1998.

Horng, Y., and Peihwang, W., “An Empirical Study of Derivatives Use in the REIT Industry,” Real Estate Economics, Vol. 27, No. 6, p. 61-586, 1999.

Holmes, R., "Weather Risk Management Solutions for the Concrete Construction Industry”, http://www.highbeam.com/doc/1G1-123707777.html, May 7, 2014.

Jewson, S., and Brix, A., Weather Derivatives and the Weather Derivatives Market, Cambridge University Press, 2010.

Jin, Y. and Jorion, P., “Firm Value and Hedging: Evidence from U.S. Oil and Gas Producers”, Journal of Finance, Vol. 62, No. 2, p. 2-41, 2006.

Long, D., Oil Trading Manual, Cambridge: Woodhead Publishing Ltd., 2000.

Lim, S., and Hong, Y., "Fuel Hedging and Airline Operating Costs", Journal of Air Transport Management, Vol. 36, No. 3, p. 33-40, 2014.

Mubarak, S., How to Estimate with RSMeans Data: Basic Skills for Building Construction, New Jersey: John Wiley & Sons Inc., 2012.

Macdonald, R., "Price Risk Mitigation on Construction Projects", Doctoral Dissertation, University of Alabama, Tuscaloosa, Alabama, 2013.

Marsden, A., and Prevost, A., "Derivatives Use, Corporate Governance, and Legislative Change: An Empirical Analysis of New Zealand Listed Companies", Journal of Business Finance & Accounting, Vol. 32 No. 1, p. 255-295, 2005.

Mattus, I., "Application of Derivative Instruments in Hedging of Crude Oil Price Risks", Master Thesis, Estonian Business School, 2005.

Morrell, P. and Swan, W., "Airline Jet Fuel Hedging: Theory and Practice", Transport Reviews, Vol. 26, No. 6, P.713-730, 2006.

Mercatus, "The State of Airline Fuel Hedging & Risk Management", http://www.mercatusenergy.com/state-of-airline-fuel-hedging/, Feb 05, 2014.

Rao, V., "Fuel price risk management using futures", Journal of Air Transport Management, Vol. 5, No. 7, p. 39-44, 1999.

Rampini, A., Sufi, A., and Viswanathan, S., "Dynamic Risk Management", Journal of Financial Economics, Vol, 5, No. 9, p. 4-42, August 2013.

Reilly, J., "Cost Estimation and Risk Management for Underground Projects", Proceeding of International Tunneling Association Conference, Istanbul, Turkey, p. 1-9, May 15-16, 2005.

Riker, D., "New Tools Hedge Weather-Related Financial Risk", http://www.constructionbusinessowner.com/topics/insurance/construction-insurance/new-tools-hedge-weather-related-financial-risk, Apr 12, 2014.

Sears, S. K., Sears, G. A., and Clough, R. H., Construction Project Management: A Practical Guide To Field Construction Management, Hoboken: John Wiley & Sons Inc., 2008.

Shaw, J., "A Schema Approach to the Formal Literature Review in Engineering Theses System" Education Sciences, Vol. 23, No. 3, p. 325-335, 1995.

Southwest Airlines, "Southwest Airlines One Report", http://www.southwestonereport.com/2012/pdfs/2012SouthwestAirlinesOneReport.pdf, May 27, 2014.

Spencer, K., "Fuel Consumption Optimization using Neural Networks and Genetic Algorithms", Master Thesis, Instituto Superior Técnico, Lisbon, Portugal, 2011.

Spillane, J., Oyedele, L., and Meding, J., "Challenges of UK Contractors Regarding Material Management and Logistics in Confined Site Construction", International Journal of Construction Supply Chain Management, Vol. 1, No. 1, p. 25-42, 2011.

Stevenson, W., Productions/Operations Management, Toronto: Irwin Publishing Company, 1996.

Stewart, R., "Simulation Model Verification and Validation: Increasing The Users Confidence", Proceeding of the Winter Simulation Conference, Birmingham, UK, p. 53-59, 1997.

Stulz, R., "Optimal Hedging Policies", Journal of Financial and Quantitative Analysis, Vol. 19, No. 3, p. 127-140, 1984.

Sturm, R., "Can Selective Hedging Add Value To Airlines? The Case Of Crude Oil Futures", International Review Of Applied Financial Issues And Economics, Vol. 1, No. 1, p. 130-146, 2009.

Taha, H., Operations Research: An Introduction, Upper Saddle River: Pearson Education, 2007.

Thomas, W., "Construction Contract Clause Digest", http://www.harmonie.org/user_documents/Construction%20Digest%20edited%206-26-12.pdf, June 9, 2014.

U.S. Bureau of Labor, "Producer Price Indexes.", www.bls.gov/ppi, Feb 25, 2014.

United Nation, "The Challenge of Assessing The Creative Economy: Towards Informed Policy-Making", http://unctad.org/en/Docs/ditc20082cer_en.pdf. May 26, 2014.

Weather Risk Management Association, http://www.wrma.org/, Feb 25, 2014.

Webster, J., and Watson, R. T., "Analyzing the past to prepare for the future: Writing a literature re-view", MIS Quarterly, Vol. 26, No. 2, p.13-23, 2002.

Westbrooks, L., "Airline Fuel Hedging: An Overview of Hedging Solutions Available to Airlines", The Journal of Aviation/Aerospace Education & Research, Vol. 14, No. 5, p. 19-25, 2005.