Contingency Utilization in Construction Projects: A Psycho-Contractual Approach

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By

Zohaib Khaliq

(NUST2015MSCE&M00000119858**)**

Department of Construction Engineering and Management
National Institute of Transportation (NIT)
School of Civil and Environmental Engineering (SCEE)
National University of Sciences and Technology (NUST),
Islamabad, Pakistan.

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Signature: ____

Name of Supervisor: Dr. Muhammad Jamaluddin Thaheem

Date: ____

Signature (HOD):_________________________________

Date: ____

Signature (Dean/Principal):________________________

Date: ____

This is to certify that the

thesis titled

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Submitted by

Zohaib Khaliq

(NUST2015MSCE&M0700000119858)

has been accepted towards the partial fulfillment

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Dr. Muhammad Jamaluddin Thaheem

Supervisor

Department of Construction Engineering and Management

NIT, National University of Sciences and Technology (NUST), Islamabad

This thesis is dedicated to my parents and siblings for always being an unending source of love and encouragement.

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Abstract

Although construction industry is risk-averse, a major portfolio of risk is accepted and jointly managed between a client and contractor under cost-plus guaranteed maximum price contract through cost contingency (CC). Other than allocation adequacy, a proper management of these funds is not only vital to financial and schedule targets, it also impacts stakeholder relationships. There is a lack of pragmatic guidelines for CC management, resulting in contractual and managerial conundrums. Also, contingency spending rates are not standardized, causing improper CC utilization. Therefore, this study analyzes the current practices and prevailing conundrums of CC management, along with investigating the behavioral implications of a project manager's (PM) mental model over CC spending rate. An extensive survey and case studies are used to achieve these objectives. It is found that respondents contradict over key aspects of CC and organizations manage CC through ad-hoc mechanisms. Also, PMs demonstrate lesser aggressive behavior than their passive tendencies, and their majority withholds contingency amount in the first half of the project. The findings highlight conundrums and offer practical guidelines for CC utilization.

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List of abbreviations

PM	Project Manager
EVM	Earned Value Management
CPI	Cost Performance Indicator
SPI	Schedule Performance Indicator
PRM	Project Risk Management
PMI	Project Management Institute
CR	Contingency Reserve
MR	Management Reserve
SD	System Dynamics
MCS	Monte-Carlo Simulation
VaR	Value at Risk
GGM	Gompertz Growth model
CEAC	Cost Estimate at Completion
$CEAC_R$	Cost Estimate at Completion (Risk)
PC	Planned Contingency
AC	Actual Contingency
DOD	Department of Defense
EAC	Estimate at Completion

PB	Planned Budget
TCC	Total Cost Contingency
EPC	Engineering Procurement Construction
CC	Contractor Contingency
GMP	guaranteed Maximum Price
IPC	Interim Payment /certificate
CSR	Contingency Spending Rate
ERA	Estimating using Risk Analysis
TPA	Traditional Percentage Approach

Chapter 1

INTRODUCTION

1.1 Preamble

The literature stress on the sensible and appropriate allocation of risk among contracting parties but in practice this responsibility is placed on only one party, i.e., the owner (Peckiene et al., 2013). Therefore, unlike owner the contractor has to face a portfolio of risks in a construction project (Kartam and Kartam, 2001; Shumway et al., 2004; Smith and Bohn, 1999). Lack of information (incomplete contract document) and errors in interpreting the available information (ambiguity about the language of contract document) are the main sources of uncertainty (Rauzana et al., 2015). The scope of risk in a project increases with design complexity and subjective estimation. Owners recognize these issues and often demand bid, payment and performance bonds from a contractor to safeguard their interests. The situation worsens in the face of poorly prepared drawings, specifications, and significant scope changes.

Risk analysis along with proper response is essential for minimizing the losses and enhancing the profitability (Akintoye and MacLeod, 1997). Risk response strategies during project execution are contingency funds, subcontracting and third party insurances (Ke et al., 2012; Lyons and Skitmore, 2004). Theoretically, it is cognitive to transfer risk to the party that is in the best shape to act in response, but in practice, a contractor might lose competitive edge by paying a heavy risk premium (Laryea and Hughes, 2010). Further, owner and consultant can avail bond and insurance facilities against their risks; contractor does not have this luxury due to cost escalation since most of the construction risks are owned and handled by the contractor (Li et al., 2004). Ke et al. (2012), (El-Adaway and Kandil, 2009) and (Lyons and Skitmore, 2004) discussed the negative impacts associated with insurance and therefore use of contingency funds, and subcontracting are favored over third party insurances.

Contingency is defined as *"an amount of funds, budget, or time needed above the estimate to reduce the risk of overrun of project objectives to a level acceptable to the organization"* (PMI, 2017). Contingency is used to respond to uncertainties and bring back the project to their original schedule and cost targets (De Marco et al., 2015). Proper estimation, allocation and smart consumption of contingency during project execution are very important for achieving the set goals (Barraza and Bueno, 2007).

During the project execution, contingency utilization related decisions made by the project manager (PM) impact the project performance (Ford, 2002). Subjectivity and dependence on individual skills are the main drivers of contingency management (Burroughs and Juntima, 2004). Murray and Ramsaur (1983) contemplated over the assessment of the spending rate to handle risk to be the most challenging and crucial phase of contingency management. PMs peruse either aggressive or passive strategy for managing contingency (Narbaev and De Marco, 2017). PM with aggressive behavior utilize funds quickly, for resolving emergencies, handling project delays and early facility improvement (Salah and Moselhi, 2015). On the contrary, under passive strategy, the spending rate is slow. PMs delay the application of contingency until its utilization is necessary to achieve critical objectives (Ford, 2002). Under this approach facility improvement funds are released late (Narbaev and De Marco, 2017). PM's aggressive or passive contingency utilization behavior affects the cost, timeliness and value addition to the facility (Ford, 2002). Moreover, in the case of contingency drawdown request, PMs often encountered with decision dilemma regarding how much amount to release. De Marco et al. (2015) highlighted the complexity of decision-making process under difficult project conditions and varying demands of the owner and senior management.

It has been observed that a good number of PMs do not formally manage cost contingency (Andi, 2004; Barraza and Bueno, 2007; Bello and Odusami, 2013; Ortiz-González et al., 2014). Which results in exhaustion of these reserves before the project closure, requiring extra funds to address the later risks (Baccarini, 2004a). Unavailability of additional funds may harm the quality of the project along with overrunning of cost and time objectives. The large size of contingency, its central role in determining project success and its dynamic management make it an important project management concern (Ford, 2002).

The management of contingency cost can be treated akin to the project cost. There are known patterns in the form of s-curve and performance measuring tools such as Earned Value Management (EVM) for construction cost. S-curve is used to show planned cumulative cost and continuous resource utilization at different stages of the project against time (Narbaev and De Marco, 2017), whereas EVM is a standard tool for overseeing the project time and cost performance (Narbaev and De Marco, 2013). The performance baseline is established at an early stage of the project to check for any deviation from project goals (Babar et al., 2016). This measurement helps PMs track the project progress and preempt any major deviations by reallocating the current or utilizing additional resources (Mubarak, 2015). The inputs and performance indices (CPI, SPI) generated using project management tools fail to define a decision support system which guides PMs on how to use contingency in response to cost and schedule indicators (Ford, 2002).

The inadequacy of existing cost management tools fuels the research for the development of specialized theory and simple tools for contingency management. But, currently, available contingency management tools are either complex or based on assumptions (Hammad et al., 2016). The tendency of the construction industry to apply these models is jeopardized by their complexity and presence of assumptions which as contrary to the pragmatism (Barraza and Bueno, 2007). Ortiz-González et al. (2014) found that construction companies seldom use such management methods and some of the PMs are not even aware of them. The application of these models in the construction industry was considered ineffective (Kutsch and Hall, 2005). Barraza and Bueno (2007) stated that the complexity is the main issue due to which some managers do not use these techniques. Without addressing reality, it will be impossible to propose any sound solution for contingency management (Laryea and Hughes, 2010). Partly due to such complex tools and techniques, and partly due to non-systemized and informal decision-making, lack of management practices regarding contingency utilization is evident in the literature (Hammad et al., 2016).

This lack is further exasperated in the form of nonexistent standard guidelines and assessment tools to monitor contingency consumption (De Marco et al., 2015; Hammad et al., 2016). Instead of well-organized and systematic procedures, contingency management is dependent on organization policies and PM's intuition and experience (Barraza and Bueno, 2007; Ford, 2002; Ortiz-González et al., 2014). Since contingency is a prime instrument to manage project risk, its consumption can establish the project outcome (Ke et al., 2012).

Dynamic and challenging nature of construction industry makes it a risky business. There are formal methods and techniques suggested in the literature to curtail the negative impacts associated with risks. However, the industry has a very poor reputation for managing risk, with many major projects failing to meet deadlines and cost targets (Mills, 2001).

1.2 Research objectives

The main objectives of this research are

1. To identify the upcoming conundrums related to contingency management.
2. To assess the behavioral reflection on actual project risk expenditure.
3. To propose appropriate contingency consumption guidelines.

1.3 Research hypothesis

The contingency reserves get consumed before the end of the project. In such scenario, project managers face cash issues in the later part of the project on accounts of contingency.

H_0: The contingency is consumed before the project completion.

H_1: The contingency is not consumed before the project completion.

1.4 Research questions

The main research questions are

1. What are the problems faced by project managers in consuming and managing cost contingency amount?
2. How risk behavior influences the contingency management patterns during various stages of the project?

3 What psycho-contractual guidelines can be suggested to enhance project success by effective management of cost contingency?

1.5 The scope of the study

This study tends to explore the current contingency management models and consumption patterns in the literature with the aim of finding their limitations and providing suitable guidelines for contingency withdrawal.

1.6 Significance of the study

This study will propose certain guidelines for contingency utilization during project execution. Based on these instructions, PM's would be able to monitor their contingency usage against a standard consumption region. Also, the guidelines will help contingency consumers to forecast future contingency needs. Also, the outcome of this study will highlight the level of agreement over basic aspects related to contingency management. Based on the findings stakeholders might be able to address the conundrums related to contingency management and its usage through specific contract provisions

1.7 Limitations

The research will only provide guidelines for Contractor's Contingency (CC) under cost-plus guaranteed Maximum Price (GMP) contract type.

1.8 Thesis Overview

This thesis has been organized into five chapters. Chapter 1 is 'introduction' it includes an introduction to the research, problem statement, scope, significance, and objective of the research. Chapter 2 is 'literature review' it focuses on the previous studies in the field of contingency management and provides essential information and synthesis.

Chapter 3 is ‘Methodology’ of the research. It explains how the research has been carried out to obtain our objectives. *Chapter 4* is ‘*Results and Discussion*’ that covers the analysis of data after being collected and results according to our research objectives. Discusses in detail related to how these objectives are achieved from collected data. It also explains how the collected and analyzed data is interpreted to produce the results which interpret achievement of research objectives. Lastly, *Chapter 5* is ‘*Conclusions and Recommendations*’ where conclusions and recommendations have been drawn and summarized.

Chapter 2

LITERATURE REVIEW

The focus of this chapter is on the past work, which is relevant to this research. It entails a brief discussion on risk, type of risks, project risk management (PRM), risk allocation, contingency, type of contingency, contingency estimation, cost contingency management. The main portion of this section is related to; review of research related to contingency, a summary of models for contingency management, a synthesis of problems related to contingency management, factors affecting contingency release, contingency use strategies and a critical review of contingency management models

2.1 Risk

Project outcome is uncertain. It is in the very nature of the project that circumstances changes as the project moves through planning, execution and completion stages. There may be external or internal events that might harm the achievement of planned goals and targets (Baloi and Price, 2003). The risk is defined as "*a variable in the process of a construction project whose variation results in uncertainty as to the final cost, duration, and quality of the project*." (Akintoye and MacLeod, 1997). Risk can also be explained as "*the chance of something happening that will have an impact on objectives, may have a positive or negative impact*" (Smith and Bohn, 1999). According to PMI (2017) "*Project risk has been defined as an uncertain event or condition that, if it occurs, has a positive (opportunities) or a negative (threats) effect on at least one project objective such as time, cost, scope, or quality*."

2.2 Types of risks

Construction projects naturally contain a variety of uncertainties and risks throughout all phases from conception until completion. These uncertainties can be distinguished as known unknowns (predictable) and unknown unknowns (unpredictable) (Hammad et al., 2016; Lee et al., 2017; Salah and Moselhi, 2015). The main objective of proper risk management is to turn as many unpredictable into predictable by applying creative thinking during risk identification process (Eldosouky et al., 2014). While, On the contrary, some risks are unidentifiable and are hard to predict their occurrence (Lee et al., 2017).

2.3 Project risk management (PRM)

According to Frimpong et al. (2003), a successful project is characterized by its achievement of set objectives and goals regarding its technical aspects, time and budget constraints. It is not so simple in construction projects; the risk is a factor that can negatively influence the project success by diminishing its performance, resulting in cost and time overruns, and quality decline, hence the failure of the project (Ghosh and Jintanapakanont, 2004; Taylan et al., 2014). Some studies have discussed the impact of risk on construction projects regarding success parameters. For example, in Saudi Arabia, 70% of projects suffer time and cost overruns (Assaf and Al-Hejji, 2006). Similarly, Odeyinka and Yusif (1997) found that 7 out of 10 Nigerian construction projects suffer delays and cost overruns due to various uncertainties.

PRM it is a critical part of project management (Lyons and Skitmore, 2004). Proper application of PRM in the construction industry is useful for achieving project targets (Zou et al., 2009). PRM is a proactive approach, and it is a systematic way of dealing with risks (Gray, 2000; Hillson, 2002; Mills, 2001). It is the combination of different activities which are intended to reduce the disturbances occurring during project delivery (Skorupka, 2003). It is an iterative process, which applies from planning until completion to achieve better risk performance. The process of PRM follow the steps that are planning, identification, analysis, responses, monitoring and control of risk on a project. Its main objective is to exploit the positive events and to reduce the consequences of negative events (PMI, 2017). PRM starts from the identification of factors that may influence the project outcomes positively or negatively. The purpose of identifying risks is to expose a list of potential threats to be managed before they become problems (PMI, 2017). If a risk is not identified, it cannot be managed (Bajaj et al., 1997). For efficient management, identification is considered as the most crucial part (Chien et al., 2014). Risk factors identification is not enough; they also need to be measured to assess their importance. The assessment techniques are majorly divided into qualitative, quantitative and semi-quantitative categories (Chien et al., 2014). During the analysis phase, risks are categorized based on their criticality (Al-Bahar and Crandall, 1990).

Risk response planning is the process of evaluating options and choosing appropriate actions to enrich opportunities and shrink threats (PMI, 2017). Response to risk is based on its exposure to project objective (Enshassi and Mayer, 2001). This step specifies the action, which would minimize the probability and impact of identified risks. Ahmed et al. (1999), Akintoye and MacLeod (1997), Enshassi and Mayer (2001) and Potts and Ankrah (2014) explored the available choices to react to a risky situation and suggested four distinct responses, which are, risk avoidance, risk reduction, risk retention and risk transfer.

2.4 Risk allocation

The risk is a major entity in the construction industry and has a significant effect on the final cost of the project (Babar et al., 2016). The risk is allocated when more than one party (owner, contractor, consultant, etc.) is liable for the project progress, making sure that for every recognized risk there is a certain guardian (Abednego and Ogunlana, 2006). This activity influences the behavior of the project participants, which influence both project performance and final cost.

In a construction project, owner selection of contract type is very critical to the project success (Pinto et al., 2009). The owner must opt for a contract type that will maximize the efficiency and encourage the contractor to the desired goals. Contract selection is widely dependent on the clarity of language; completeness of information for the bidders at the tender time and the scope of risk that owner is willing to expose himself. In this context, every contract allocates risk. The power and authority to manage the risk are defined in the contract document. Although all parties are affected by risk allocation, the owner has the ultimate power of division (Peckiene et al., 2013). Most of the contracts neglect equitable risk sharing. Given the opportunity, an owner should favor appropriate risk decision that will reduce risk and improve project performance. However, in practical owner appears to avoid risk by shifting most of the project risk to another contracting party (usually the contractor) through disclaimer (exculpatory) clauses (Gransberg and Ellicott, 1997). As a result, the extra burden of risks is supported by adding a handsome contingency to the bid price (Andi, 2006).

2.5 Contingency

Contingency has a different meaning for different contracting parties. Contractor considers it as a fund for uncertainty and more profit: consultant takes it as a fund for minor design problems whereas owner takes it money to cover change orders (Mohamed et al., 2009). In the practice of project management, cost contingencies have the mandate of covering probable cost increases above target estimates (Barraza and Bueno, 2007; Hammad et al., 2016; Picken and Mak, 2001). According to (PMI, 2017), Contingency is "*the amount of money or time needed above the estimate to reduce the risk of overruns of project objectives to a level acceptable to the organization.*" Günhan and Arditi (2007) termed it as funding for unexpected and undesirable events. Baccarini (2004b) presented it as an antidote to risk. Contingency funds are liable for surprise elements of cost which can't be anticipated at bidding (Ford, 2002). Risner (2010) defined contingency as untapped funds that may generate a high risk for construction projects in case of misuse. Contingency sum is a specific provision of money in an estimate for undefined items that statistical studies of historical data have shown will be required (AACE, 2000).

2.6 Type of contingency

At the time of preparation of estimates of any project, it is not possible to assess all the cost items as there can be any risks that may arise in future during execution of the project. According to Figure 2.1 project's uncertainty resides in two areas; aleatory (Variation and changes) and epistemic (Lack of knowledge) (Frank, 1999). Typically, Quantity Surveyors would add contingency to pre-tender estimates to cater for any unforeseen costs or events that may arise after the date of the estimate (Aibinu et al., 2011). Such risks are of two types known-unknown and unknown-unknown, and

Contingency funds cater for both (Hammad et al., 2016; Lee et al., 2017). Based on the type of uncertainty, contingency sum is classified into two categories; contingency reserve (CR) and management reserve (MR).

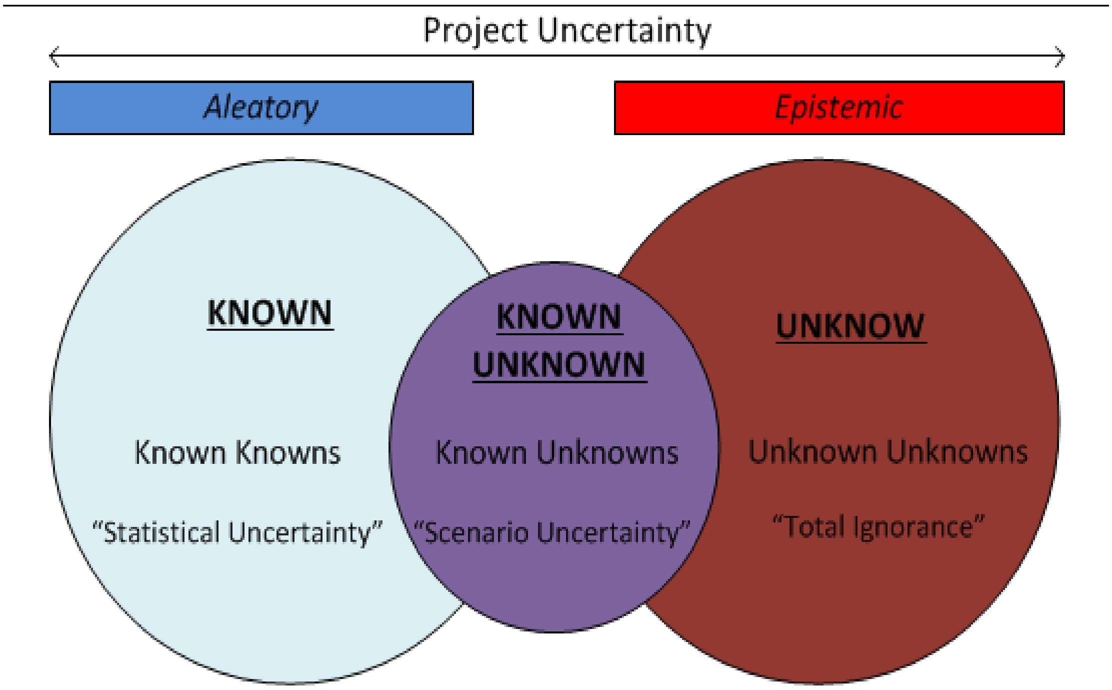


Figure 2.1: Project Uncertainty

2.7 Contingency reserve (CR)

Scope definition of any construction project is hardly good enough to price a tender. Although during quantity take-off, a certain fund is set aside along with the base price, there is ambiguity about activities performance and working circumstances during the construction project (Barraza and Bueno, 2007). The vagueness in the definition of project scope, site condition, and various other factors are classified as Known-unknown risks (Hammad et al., 2015). These risks can be identified, analyzed, planned and estimated (Moselhi and Salah, 2012).CR caters for these known unknowns and can be estimated using various risk management techniques.

2.8 Management reserve (MR)

A contingency should be set aside to respond unknown-unknown. These are residual, unidentified and unpredictable risks, which are not discovered during the risk identification process (Lee et al., 2017). Management and planning of unknown-unknown are not possible (Moselhi and Salah, 2012), but they may be tackled by applying general contingency known as MR. MR is added allowance after the normal contingency reserve. This reserve is just known to management and is not part of the contingency allowed on the works.

2.9 Contingency estimation

Contingency estimation has been the focus of study for many researchers (Barraza and Bueno, 2007). Contingency estimation techniques are based on two approaches; probabilistic and deterministic (Moselhi and Salah, 2012). A deterministic approach is based on expert opinion whereas probabilistic technique relays upon statistics (Baccarini, 2004b). Contingency budget can be defined as a percentage of a project's budget, as a fixed monetary value, or developed using various quantitative methodologies (Xie et al., 2011). In practice, traditional percentage approach is preferred over other estimation techniques (Baccarini, 2005b), but Cioffi and Khamooshi (2009) criticized this approach. On the other hand, in the related literature regarding probabilistic estimation recently three other estimation approaches have also gained a good reputation, which are Monte Carlo simulation (MCS), regression analysis and artificial neural networks (ANN) (Baccarini, 2006).

2.10 Contingency management

Contingency estimating and management is critical management functions needed for the successful delivery of construction projects. Considering their importance, academics and industry professionals have proposed a wide range of methods for risk quantification and accordingly for contingency estimation. However, considerably fewer procedures and methods can be found in the literature for contingency drawdown and its management (Barraza and Bueno, 2007). Also, note that the contingency estimating is commonly prepared before project execution; its management is an ongoing process over project duration (Ortiz-González et al., 2014). The budget contingencies are critical to achieving the project objectives, and they can represent a large portion of a project budget (Eldosouky et al., 2014). Therefore, the efficacy of contingency management can robustly influence project success.

Contingency management is proper utilization of contingent resources to handle project risks and uncertainty so that the project may be delivered within planned limits of cost, duration, and quality (Barraza and Bueno, 2007). The gap between planned and actual estimate is largely dependent on the appropriate and timely application and management of contingency (Uzzafer, 2013). Effective contingency management can strongly influence project success. The managerial process of defining, monitoring and controlling the cost contingency during the project execution may influence the final project cost (De Marco et al., 2016; Ford, 2002). Despite the fact, contingency management is often defined in a subjective and non-systematic manner (Ford, 2002; Moselhi and Salah, 2012). Several studies suitably consider the dynamic process of contingency management as an integral and important indicator of final project cost (Babar et al., 2016; De Marco et al., 2016; Narbaev and De Marco, 2017).

2.11 A review of contingency related research:

The gap between planned and actual estimate project cost is largely dependent on the proper application and management of CC (Uzzafer, 2013). Also, several studies have justified this fact with the help of case studies (Babar et al., 2016; De Marco et al., 2016; Narbaev and De Marco, 2017). Due to the contingency importance, a wide range of methods for risk quantification and accordingly contingency estimation has been developed (Baccarini, 2005b). However, a few procedures and methods are reported for contingency management (Barraza and Bueno, 2007). After a detailed literature review, this lack is further ascertained as given in Table 2.1. It can be seen that out of the total literature published between years 2000-2018 on cost contingency related matters, approximately 20% deal with its management.

Table 2.1: A comparison of contingency estimation and contingency management studies

Period	Contingency Estimation Studies	Contingency Management Studies
2000-2003	(Mak and Picken, 2000), (Touran, 2003a), (Touran, 2003b)	(Ford, 2002)
2004-2007	(Burroughs and Juntima, 2004), (Baccarini, 2004a), (Baccarini, 2004b) , (Baccarini, 2005a), (Khalafallah et al., 2005), (Baccarini, 2006), (Günhan and Arditi, 2007)	(Rowe, 2006), (Barraza and Bueno, 2007), ,
2008-2011	(Laryea, 2007), (Panthi et al., 2009), (Tseng et al., 2009), (Lhee et al., 2009), (Schneck et al., 2009), (Molenaar and Wilson, 2009) , (Barraza, 2010), (Thal Jr et al., 2010), (Idrus et al., 2011), (Espinoza, 2011), (Lhee et al., 2011)	(Xie et al., 2011)

2012-2015	(Buertey et al., 2012), (Teye Buertey et al., 2012), (Moselhi and Salah, 2012), (Polat and Neval Bingol, 2013), (Baccarini and Love, 2013), (Ojuri, 2013), (Bakhshi and Touran, 2014), (Buertey, 2014), (Jimoh and Adama, 2014), (Otali and Odesola, 2014), (Lhee et al., 2014), (El-Touny et al., 2014), (Salah and Moselhi, 2015), (Elbarkouky et al., 2015), (Samuel and Snapp, 2015), (Rauzana et al., 2015), (Babaa, 2015)	(Eldosouky et al., 2014), (De Marco et al., 2015), (Salah and Moselhi, 2015)
2016-2018	(Elbarkouky et al., 2016), (Addo, 2016), (Nyagormey, 2016), (Jung et al., 2016), (Lee et al., 2017), (Nawar, 2017)	(Hammad et al., 2016), (De Marco et al., 2016), (Narbaev and De Marco, 2017)

2.12 Contingency management models

After a detailed review of the literature, nine models for contingency management were identified. Table 2.2 shows chronological order of research and provide information about the developer name, intended objective of research, tools, and techniques to achieve these objective, inputs variable and output results.

Table 2.2: A summary of existing contingency management models

Reference	Study Objectives	Inputs	Tools and Techniques	Outcome
Ford (2002)	CC flow management and assessment of management strategy impact	Primary data, project conditions, uncertainty, PM's management style.	System Dynamics	CC performance indices concerning cost (***pe***), schedule (***ps***) and facility improvement ($\boldsymbol{f_i}$)
(Rowe, 2006)	Development of a Contingency	Initial contingency (C_i), Change order distribution($\Delta_{t/f}$),	MS Excel	Retained Contingency (C_R), Estimate at Completion

	Tracking System (CTS)	Current Budget (B), Current Forecast (F), Actual Cost (A)		(EAC), Contingency surplus / Deficit ($C_{S/D}$)
Barraza and Bueno (2007)	Establish parameters for CC monitoring	Budget At Completion (BAC), the degree of risk acceptable (α_c)	Monte-Carol Simulation	Planned Budget (PB), Total Contingency Cost (TCC), and activity cost contingency status.
Xie et al. (2011)	CC updating and forecasting	Prediction period, confidence level c, the observation period	Value at Risk (VaR)	Contingency update at data date along with a forecast for the future milestone.
(Eldosouky et al., 2014)	Estimation and monitoring of Cost Contingency Reserve (CCR).	Performance Measurement Baseline (PMB), CCR, Nonspecific risk provisions (NSRP)	(EVM) and Project Risk Management (PRM) interface	A better mechanism for CCR monitoring and control.
De Marco et al. (2015)	Cost contingency flow and excess contingency release mechanism	Primary data, Top management and owner pressure, PM willingness for facility improvement.	System Dynamics	Systematic allocation and reallocation of contingency funds, a decision-support system for excess contingency.
Salah and Moselhi (2015)	CC estimation, allocation, its management	PM’s management skills, experience, and lesson learned from past projects	Fuzzy set and IF-AND-THEN approach	Planned Contingency (PC), Actually Contingency (AC), project contingency status

Hammad et al. (2016)	Cost contingency allocation, monitoring, and updating	activities planned value (PV_A), the degree of risk acceptable (α_c)	Monte Carlo Simulation	Total cost (TC), Planned value project (PV_P), cost contingency project (CC_P), activity-based cost status
De Marco et al. (2016)	Formulate CEAC adjusted with CC forecast	Project cost baseline and estimated CC	Gompertz Growth Model	Risk-adjusted cost estimate at completion ($CEAC_R$)
Narbaev and De Marco (2017)	Formulate CEAC adjusted with CC forecast	Project cost baseline, Estimated CC	Gompertz Growth Model	Risk-adjusted cost estimate at completion ($CEAC_R$)

2.13 Problems associated with contingency management

Literature was thoroughly reviewed to synthesize the problems with contingency management. Identified problems are also ranked based on their reporting in literature. As shown in Table 2.3, the top three reported issues have a wide reporting span of over 30 years. Also, most of the problems have double-digit reporting duration. It shows the lack of research in the field of contingency management. Table 2.2 also try to locate the source of the problem found in the shape of managerial, contractual and psychological guidelines.

A major section of construction management is related to managerial and contractual guidelines regarding the basic cost of construction. Although a certain portion of literature also covers '*uncertainty*' attached to the basic cost, its major focus is on pre-construction guidelines. PRM and contingency estimation are fairly discussed and have strong managerial backgrounds. Literature identified a wide gap in the shape of limited guidelines regarding allocation, ownership, utilization, reappropriation, reallocation, releasing, updating and monitoring of contingency during the execution phase of construction work. Most of the problems might resolve given a sound Managerial (M) process along with smart Contractual (C) guidelines while keeping the Psychological (P) trait of PM in mind.

Table 2.3 Conundrums related to contingency management and their relevant sources

#	Conundrum	Selected References	Reporting Period (Years)	Frequency	Lack of Guidelines		
					M	C	P
1.	The absence of standard Contingency spending rate (CSR).	(Murray and Ramsaur, 1983), (Salah and Moselhi, 2015), (Hammad et al., 2016), (Narbaev and De Marco, 2017)	35	8	✓	✓	✓
2.	The absence of standard contractual and managerial guidelines.	(Ruskin, 1981),(Ford, 2002), (Barraza and Bueno, 2007), (Salah and Moselhi, 2015)	35	7	✓	✓	×
3.	Lack standard mechanism for periodic updating and forecasting CC.	(Ford, 2002), (Xie et al., 2011), (Eldosouky et al., 2014), (Narbaev and De Marco, 2017)	16	6	✓	✓	×
4.	Lack of consensus over Contingency consumption trends.	(Barraza and Bueno, 2007), (Salah and Moselhi, 2015), (Hammad et al., 2016)	10	5	✓	×	✓

5.	Ambiguity about contingency coverage and its objectives	(Patrascu, 1988), (Baccarini, 2004b), (Mohamed et al., 2009)	21	4	✓	✓	✗
6.	The absence of standard guidelines for contingency release.	(Ford, 2002), (De Marco et al., 2015) (Ayub et al., 2016)	15	3	✓	✓	✓
7.	Opportunity cost due to blockage of contingency funds.	(Xie et al., 2011), (De Marco et al., 2015), (Ayub et al., 2016)	6	3	✓	✓	✓
8.	Contingency ownership	(Diekmann et al., 1988b), (Ford, 2002), (De Marco et al., 2015)	28	3	✗	✓	✗
9.	Excess contingency ownership.	(Eldosouky et al., 2014), (De Marco et al., 2015)	2	2	✓	✓	✗

2.14 Factors affecting contingency release

Risk management is proactive approach; all the feasible response options are analyzed and estimated before the execution phase of the project (Chapman, 1997). Although Construction organization is risk averse, market competition, project characteristics and several other factors need attention before pricing risk (Laryea and Hughes, 2010). Contingency funds are established to respond accepted risks (Lyons and Skitmore, 2004). Although, the estimation process of contingency is a team effort performed in a static environment, these funds consummated under only PM’s supervision in dynamic circumstances (Ford, 2002).

PM’s contingency release decision-making is dependent on certain factors. A comprehensive literature review identified some factors affecting contingency release. Also, subjective (S) and objective (O) nature of these factors are also marked. As shown in Table 2.4, PM’s experience, project cost performance, PM’s management strategy, and project complexity are the main drivers of contingency drawdown. However, it is strange that the significance of schedule performance of the project, future risk perception and percentage of project completion is not entertained in most of the studies related to management of contingency funds. Lack of contingency management studies might be the reason for the lesser appearance of these factors.

Limited literature of contingency management is a major limitation of Table 2.4. Reliability of any model built over this frequency analysis will be questionable, in order to use this information, it will be smart to validate it from the construction industry.

Table 2.4 Factors affecting contingency release

#	Factors	Selected Reference	Frequency	Estimation	
				S	O
1.	PM’s experience	(Ford, 2002), (Barraza and Bueno, 2007), (Xie et al., 2011), (Salah and Moselhi, 2015), (Hammad et al., 2016), (Ayub et al., 2016)	9	×	✓
2.	Project cost performance	(Barraza and Bueno, 2007), (Xie et al., 2011), (Salah and Moselhi, 2015), (Ayub et al., 2016), (Hammad et al., 2016)	8	×	✓
3.	PM’s management strategy.	(Ruskin, 1981),(Moselhi and Salah, 2012), (Moselhi and Salah, 2012), (De Marco et al., 2015), , (Ayub et al., 2016)	7	✓	×

4.	Project Complexity.	(Ford, 2002), (Xie et al., 2011), (De Marco et al., 2015), (Salah and Moselhi, 2015)	5	✓	✓
5.	Project characteristics (Risk and cost structure)	(Ford, 2002), (Moselhi and Salah, 2012), (Salah and Moselhi, 2015)	3	✓	✓
	Project schedule performance	(Ford, 2002), (Ayub et al., 2016)	2	×	✓
6.	Future risk perception.	(Xie et al., 2011), (Ayub et al., 2016)	2	✓	✓
7.	Top management Pressure.	(De Marco et al., 2015), (Ayub et al., 2016)	2	✓	×
8.	Facility improvement	(Ford, 2002), (De Marco et al., 2015)	2	✓	×
9.	Owner Pressure.	(De Marco et al., 2015)	1	✓	×
10.	Percentage completion of the project.	(Ayub et al., 2016)	1	×	✓
11.	The amount of contingency funds in hand.	(Ayub et al., 2016)	1	×	✓
12.	The level of Stakeholder's satisfaction.	(Ayub et al., 2016)	1	✓	×
13.	Project quality performance.	(Ayub et al., 2016)	1	✓	×
14.	Project Safety performance.	(Ayub et al., 2016)	1	✓	×
15.	Emergencies	(Ford, 2002)	1	×	✓
16.	delays	(Ford, 2002)	1	×	✓

2.15 Contingency use strategies

Construction projects are risk-oriented. The outcome of most of the construction projects suggests that there is a major gap between what was set and what is achieved (Flyvbjerg, 2007). Although there is a well-established process for PRM and contingency estimation, PMs perceive contingency funds as inadequate and sometimes ineffective (Baccarini, 2004a; Baccarini, 2004b; Laryea and Hughes, 2010). PMs might doubt the efficacy of these risk-handling practices while on the opposite end researchers might blame inappropriate usage of suggested funds. If the process of PRM is assumed perfect and the estimated contingency enough, then there is a need to investigate the person responsible for contingency utilization. According to Ford (2002) PM is the only man responsible for contingency related decision making.

The main objective of this research is to study the behavioral influences on contingency usage. PM's comfort level, future risk perception, and management expertise have a significant effect on when PM releases contingency and how much. According to Ford (2002), PM's either use contingency aggressively or passively. Whereas, some of the research suggests it might follow project s-curve (Salah and Moselhi, 2015). Indifferent to how PMs use contingency, its exhaustion before project completion is considered a serious threat (Diekmann et al., 1988a). At the same time, an excess contingency at project completion is not necessarily a sign of successful risk management plan (Ford, 2002). Murray and Ramsaur (1983) consider the assessment of the spending rate to manage this risk to be the most complicated and essential aspect of contingency management.

After a detailed review of the literature, varying spending patterns of contingency are observed. As shown in Figures 2.2 and 2.3, different types of contingency spending patterns are; linear, basic, front-end loaded, back-end loaded and custom (De Marco et al., 2016; Hammad et al., 2016; Narbaev and De Marco, 2017; Salah and Moselhi, 2015).

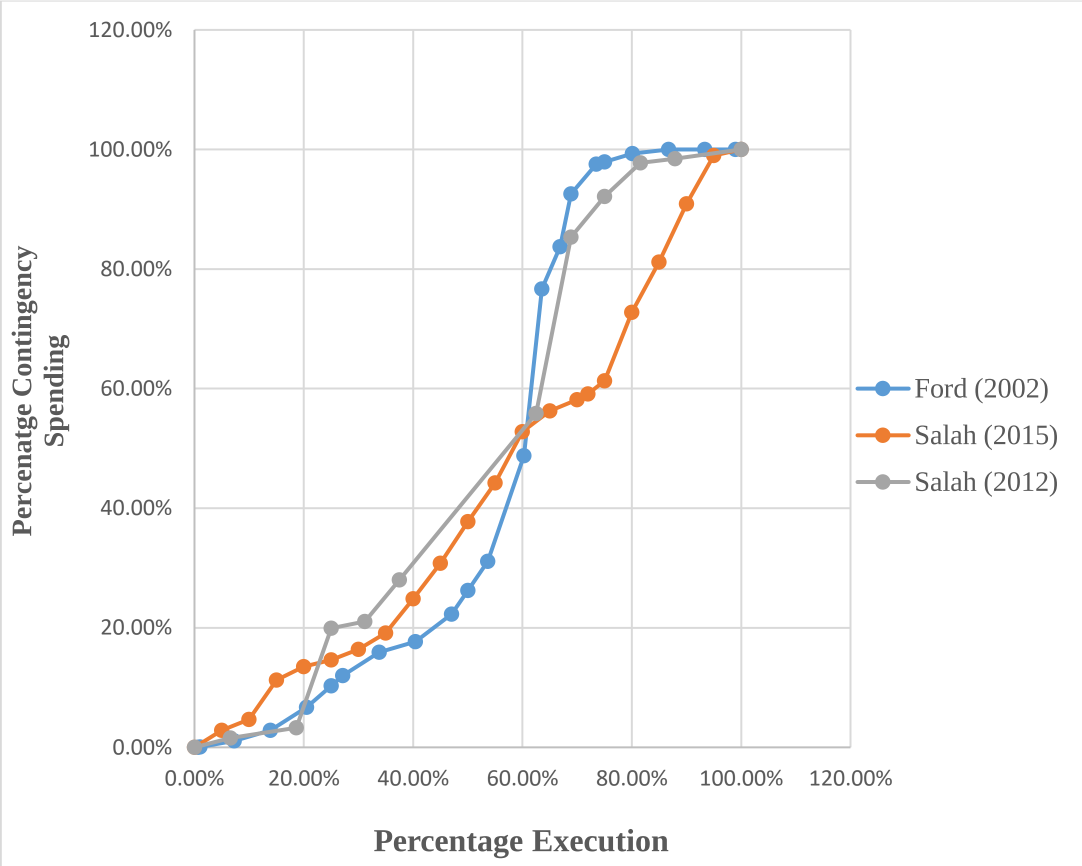


Figure 2.2: Comparison of Ford (2002), Salah (2012) and Salah (201

Hammad et al. (2016) and Barraza and Bueno (2007) in pursuit of defining a mechanism for contingency monitoring and updating, assumed a linear contingency consumption pattern. Whereas, Salah and Moselhi (2015), based on IF-AND-THEN approach, defined the procedure for selection of '*ready-made*' planned contingency (PC) curve. De Marco et al. (2016) and Narbaev and De Marco (2017) tried to represent contingency spending curve using mathematical functions. Finally, Salah and Moselhi (2015) used actual data to draw a baseline contingency pattern. Although Ford (2002) established the behavioral impacts of PM's contingency utilization approach, Salah and Moselhi (2015) proposed contingency depletion curve as free from PM's psychological trait.

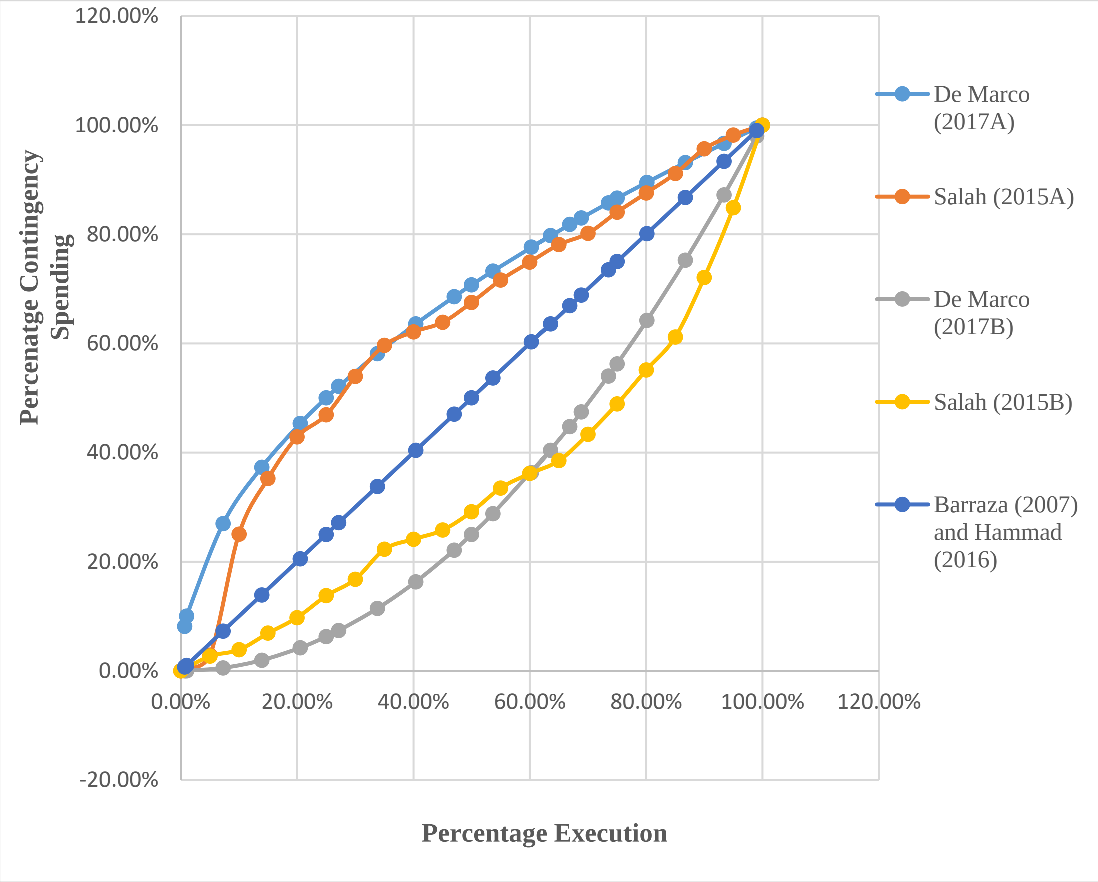


Figure 2.3: Comparison of De Marco (2017) with Salah (2015)

It is interesting to study how managers use contingency and to relate this back to established contingency estimation processes. Undertaking this investigation may require detailed study of contingency estimation and its utilization environment. As shown in Table 2.3 contingency spending pattern is one of the basic issues with contingency management. Researchers tried to update and forecast contingency based on less pragmatic patterns (De Marco et al., 2016; Hammad et al., 2016; Narbaev and De Marco, 2017). Practical patterns can be established by considering PM's psychology.

2.16 A critical review of contingency management models:

Contingency funds management is very important to achieve project targets. Although construction industry has successfully defined standard procedures for risk and its management, the process of contingency management is nonsystematic and based on subjective judgment and PM's expertise (Ortiz-González et al., 2014). In the presence of standardized, the issue of project targets overrun is still faced by the construction industry. There is a need for critical analysis of current contingency management techniques discussed in the literature.

Ford (2002) tried to define a flow management model for cost contingency, based on the information collected through detailed interviews of PMs. SD, as an analysis tool, introduced a series of 30 formulae for the allocation and reallocation of funds within four escrow accounts. Although this model generalized the decision-making process by formally addressing currently available management practices, the dependence on PM's skills and their preferred management style (aggressive or passive) makes it highly subjective. This model requires inputs for 30 formulae for generating the results. According to Barraza and Bueno (2007), complex and time-consuming models will not be pragmatic and user-friendly. Therefore, they used MCS for contingency allocation and defined a simple method for cost contingency monitoring. The proposed method monitors the project activity based performance by comparing the activity target cost with actual cost. Activities performances are classified based on status A (cost underrun), B (cost overrun, contingency underrun), C (cost overrun, contingency overrun). This method allows contingency performance to be monitored at both the activity and project levels. Although it is a simple method compared to Ford (2002) and ensures easy monitoring without the capability of control, it cannot be easily implemented in complex projects. Another limitation is its assumption of the same probability of overrun or underrun for every activity (Hammad et al., 2016).

The sophistication and reliability of simulation models are built into their selection of variables. In this context, Ford (2002) considered PM's management strategy the only significant variable. Barraza and Bueno (2007) neglected a significant variable of 'bid competitiveness.' According to Smith and Bohn (1999), analytical models tend to miss the competitive nature of bidding in their design for formulating contingency. As an improvement, De Marco et al. (2015) suggested the varying project conditions and pressure of owner and top management should also be considered as input variables.

Unlike detailed procedures for cost and time extensions in the face of variation orders, the subject of contingency updating is rarely addressed in the literature (Barraza and Bueno, 2007). Contingency is estimated before project execution, and a handsome amount of funds (maybe in millions) are prescribed in the bid to achieve project goals (Xie et al., 2011). Contingency blockage in the escrow account will result in opportunity costs (Ayub et al., 2016; De Marco et al., 2015). To alleviate such cost, Xie et al. (2011) applied value at risk (VaR) to forecast and update contingency funds at milestones. Though their proposed method is favorable on highway projects due to limited repeating activities, for complex projects, its validity will be hard to get. VaR for a market stock is easy to calculate as historical data is conveniently available, but contingency management practices are not properly documented and shared (Ford, 2002). Therefore, VaR for construction projects will be difficult to obtain. On the other hand, VaR is a statistical tool, which does not consider the source of loss and merely forecasts the expected loss at a certain confidence level.

Contingency depletion is dependent on PM's contingency management strategy, experience, and project characteristics and organizational policies (Moselhi and Salah, 2012). Different types of contingency depletion patterns are observed in literature; linear depletion, basic depletion(s-curve) (Tichacek, 2004), custom depletion(Salah and Moselhi, 2015), front-end loading depletion and back-end loading depletion (Narbaev and De Marco, 2017). Salah and Moselhi (2015) tried to evaluate contingency performance by comparing Planned Contingency (PC) against Actually Contingency (AC). PC is a hypothetical pattern, which is selected from above patterns based on factors affecting contingency depletion by applying IF-AND-THEN approach. The selection procedure of PC is very subjective, and the significance and validity of factors helping PC selection are not available.

Project success is heavily dependent on the estimated costs including contingency (Uzzafer, 2013). Based on the limitation of Barraza and Bueno (2007) of treating each activity with same chances of overrun, Hammad et al. (2016) introduced a cost contingency allocation criterion based on activity's contribution to overall project variance. The criterion takes into consideration cost and uncertainty attached to activity and whether or not the activity is on the critical path. They assumed the contingency depletion as linear which needs practical substantiation through representative case studies.

De Marco et al. (2016) and Narbaev and De Marco (2017) forecasted CEAC adjusted with risk contingency. De Marco et al. (2016) tried to forecast the future contingency requirements based on the major assumption that contingency depletion will follow a nonlinear pattern, represented as an s-curve. Whereas, Narbaev and De Marco (2017) forecasted CEAC based on the assumed pattern of aggressive and passive contingency utilization, inspired by Ford (2002).

As per Laryea and Hughes (2010), without experiential support to explain what happens in practice, the industry will not move forward to develop new approaches. To effect any improvement in analytical and decision support models, the ability of practitioners and experts to precisely capture reality plays a significant role. Most of the studies discussed are based on analytical and formal models, which hardly consider the reality of how construction companies deal with contingency (Ortiz-González et al., 2014). Barraza (2010) stated that the complexity is the main issue due to which some managers do not use these methods. According to Ortiz-González et al. (2014), construction companies seldom use contingency management methods, and some of the managers are not even aware of them. Only Ford (2002) was able to study what goes on in the industry and concluded that PMs do not follow any formal contingency management and there is a serious lack of contingency management techniques and procedures. The practice of contingency management is not recorded and shared, and decision maker hides contingency to avoid its use by any other party.

Thus, it can be deduced that the current contingency management models have failed to provide simple, pragmatic and organized procedures. The literature seems to reflect only the selective practices of contingency management. Contingency consumption pattern and guidelines is a major gap in studies. In practice, the lack of well-organized, systematic and pragmatic models pushes the construction industry to manage contingency based on their organizational policies, PM intuition and expertise (Barraza and Bueno, 2007; Ford, 2002). Therefore, the focus of this research is to inspect the current and upcoming problems with contingency management in construction industry. Based on the collected information and behavioral drivers, a set of practical guidelines and contingency consumption patterns will be formulated which may act as a standard for contingency consumption to support PMs in decision-critical scenarios.

Chapter 3

METHODOLOGY

3.1 Introduction:

This study was executed in five phases to achieve the research targets; In the first phase, an initial study was conducted to set the fundamental objectives. During the second phase, a detailed literature review was performed concerning the established objectives. The third phase covered the development and dissemination of survey instrument. Data collection, analysis and a detailed discussion of the results was done during the fourth phase. Finally, in the last phase, research findings were tested in a case study.

3.2 Initial study

A broad set of contemporary literature was studied to find the research gap. Science Direct, ASCE, and Google Scholar were used to locate the relevant papers. Keywords such as, 'cost contingency,' 'contingency management,' 'cost estimate at completion (CEAC),' 'earned value management (EVM)' and 'risk response strategies' were mainly searched. After a critical review of a set of almost 40 papers, several questions were highlighted: what are the basic problems faced by project managers during the management of cost contingency? What are the existing psycho-contractual guidelines for cost contingency management? Which psycho-contractual guidelines can be suggested to enhance the project success by effective management of cost contingency? How the risk behavior influences the contingency utilization at various stages of a project? Is estimated cost contingency enough to meet the needs of construction projects? In reference to this rationale, a set of well-defined objectives were established to improve the body of knowledge.

3.3 Synthesis and review of the literature

The detailed literature review was performed in two sections. During the first section, PMBOK and FIDIC were thoroughly reviewed to find the existing managerial and psycho-contractual instructions for CC management, respectively. In the second section, literature was explored to locate the relevant articles. An inverted pyramid approach was used to filter the relevant literature as shown in Figure 3.1. Under the umbrella of selected approach, a four-stage screening of available literature was performed. In the first stage, research journals were searched with keyword 'contingency,' 'cost contingency management,' 'cost contingency estimation,' 'risk response strategies,' 'contingency release' and 'contingency utilization.' As a result, over 150 papers were downloaded. During the second stage, the irrelevant literature was prudently screened based on their research goals. At this stage, a comparison of cost contingency concerning its management and estimation was concluded as shown in Table 2.1. During the third stage, research articles related to the estimation of cost contingency were removed, leaving behind approximately 22 articles. A detailed review of these articles was carried out with the core perspective of finding the conundrums related to cost contingency management. Also, the identified conundrums were ranked based on their appearance in the literature as shown in Table 2.3. In the last stage, only those papers were shortlisted which purely presented models and techniques for the management of cost contingency. Table 2.2 shows the chronological order of the existing models along with their intended objectives. A critical review of these papers was also performed at this stage. Also, contemporary cost contingency spending patterns were identified, as shown in Figures 2.2 and 2.3.

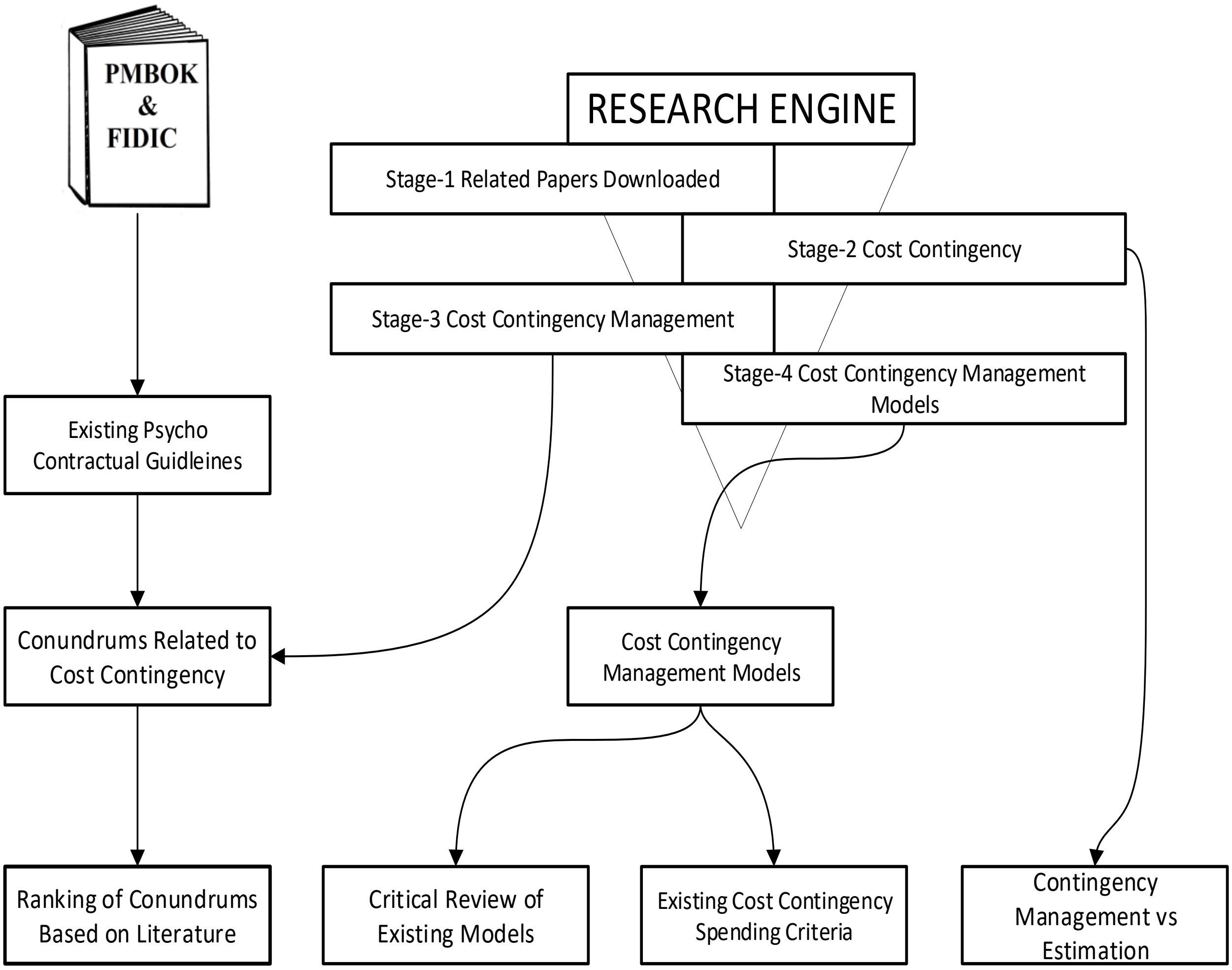


Figure 3.1: Literature review flowchart

3.4 Data collection

This phase is designed to understand the perspective of management experts. A global questionnaire survey was conducted. The questionnaire was divided into three sections, and the sections were further divided into sub-sections. The first section is related to the demographic information of the respondents, where respondents were asked to select their field of work, job title, work experience and the list of countries they worked.

The second stage of the questionnaire gathered the organizational approach and the expert's opinion concerning various contractual and managerial concerns. In this stage, the respondents were inquired about the fundamentals of cost contingency. Further, the opinion of management experts was acquired regarding the physical location and movement of CC funds. Then the industrial approach towards monitoring and forecasting of CC funds was investigated. Finally, the prevailing criteria for CC fund consumption were examined, and the adequacy of cost contingency funds was ascertained.

During the third stage, consumption behavior of PMs was assessed through a selected project scenario and guidelines were formulated. In this stage, respondents were asked about most likely CC consumption pattern. The psychological status of all the respondents was analyzed based on their responses. Finally, CC consumption region was proposed along with managerial guidelines.

The developed questionnaire was then floated to collect responses from field experts. It is sufficiently established in the literature that cost contingency related decisions are mostly influenced by the top management of the construction organization (De Marco et al., 2015; Ford, 2002). To collect reliable data, experienced individuals were focused,. In this process, construction professionals from all around the world were searched based on their designations. The questionnaire was developed in QuestionPro® and was disseminated online through LinkedIn™ and Facebook®. Respondents had the option of submitting the survey after completion of the second stage or proceed further to the last stage.

Chapter 4

Results and Discussions

Out of over 1000 total experts reached, 658 opened the questionnaire, 456 started it, 154 responded till the second section of the survey and 102 till the third section. It took 16 minutes on average to complete all stages. Thus, it took over 35 man-hours in data collection through a survey.

4.1 Demographic information of survey respondents

The breakdown of 154 experts who responded till the second section of the survey is such that there were 70 contractors, 53 consultants and 31 clients or their representatives. It is important to note that in contingency related matters, the consultant-client nexus has a different set of objectives and concerns compared to those of a contractor. Therefore, the results reflect the bifurcation in the surveyed sample based on their role and objectives. In doing so, client and consultant are lumped together and termed as the sponsor. Thus, data were collected from a total of 70 contractors and 84 sponsors.

It is important to note that due to the option of multiple selections, the total number of responses for each question is greater than the total number of respondents. This phenomenon is common to almost all the questions. Further, to meet the objectives of this study, only the experienced practitioners, mainly belonging to construction and project management backgrounds, were approached as shown in Figure 4.1.

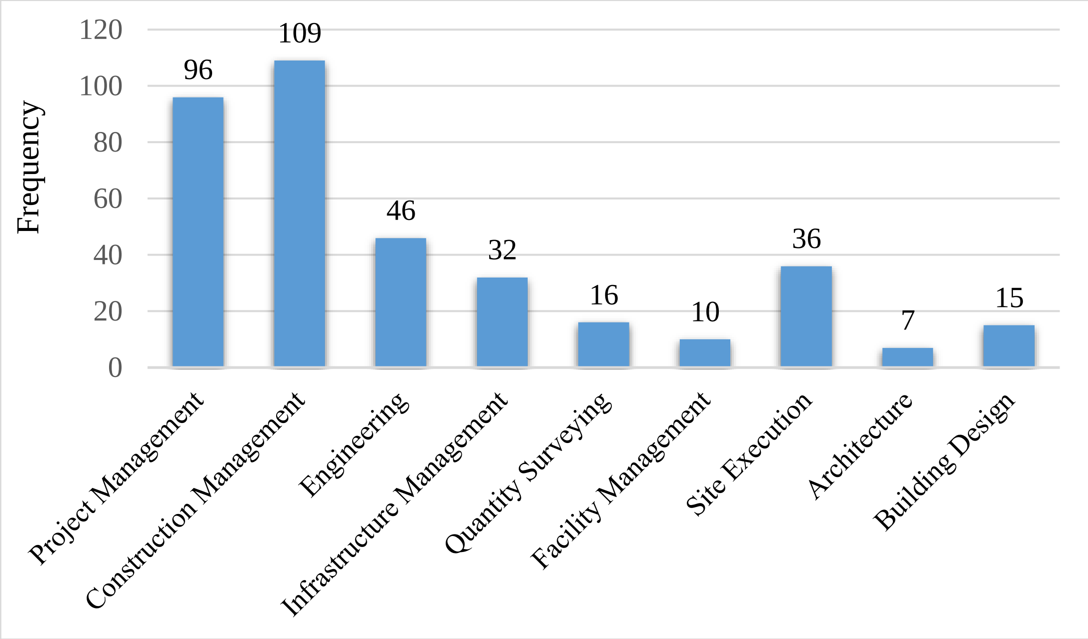


Figure 4.1: Field of work

Figure 4.2 reinforces the findings shown in Figure 4.1 that most individuals belonging to management backgrounds occupied relevant positions in their organizations. As per Ford (2002), Opinion of such experienced and important experts enhances the level of confidence in the survey results.

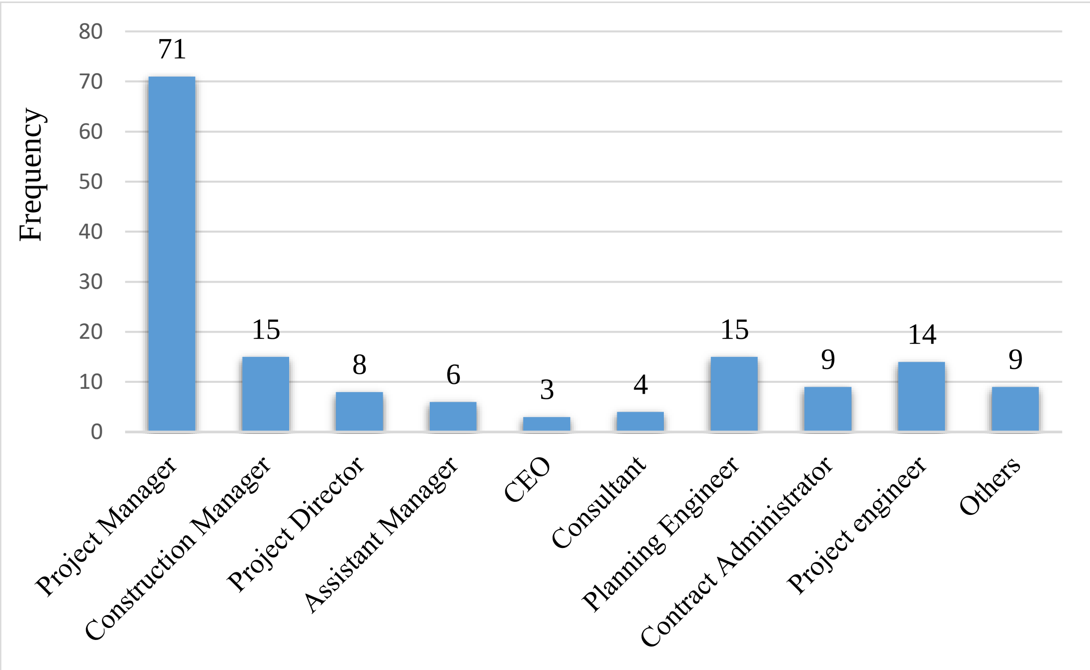


Figure 4.2: The organizational position of participants

More than 85% of the individuals possessed working expertise of 5 years or above. Also, more than 75% of the responding individuals were above 30 years old. The respondents had working experience in 48 countries. Figure 4.3 shows top 17 countries where respondents gained their experience.

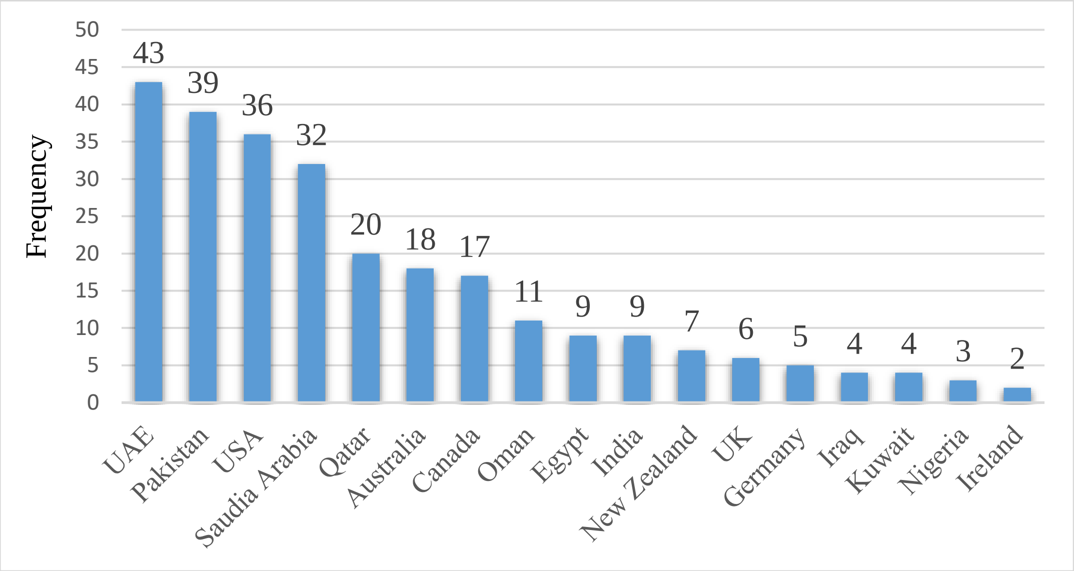


Figure 4.3: Countries of working experience

4.2 Fundamental CC conundrums

About the CC funds coverage, construction experts were presented with a variety of options, which were extracted from the literature. As shown in Figure 4.4, more than 80% of the participants opted for known-unknown risks to be handled by CC funds, which is further ascertained in PMI (2017) and Lee et al. (2017). Interestingly, 49 respondents selected the estimation errors to be covered by the CC funds which was contrary to the finding of Baccarini (2005b).

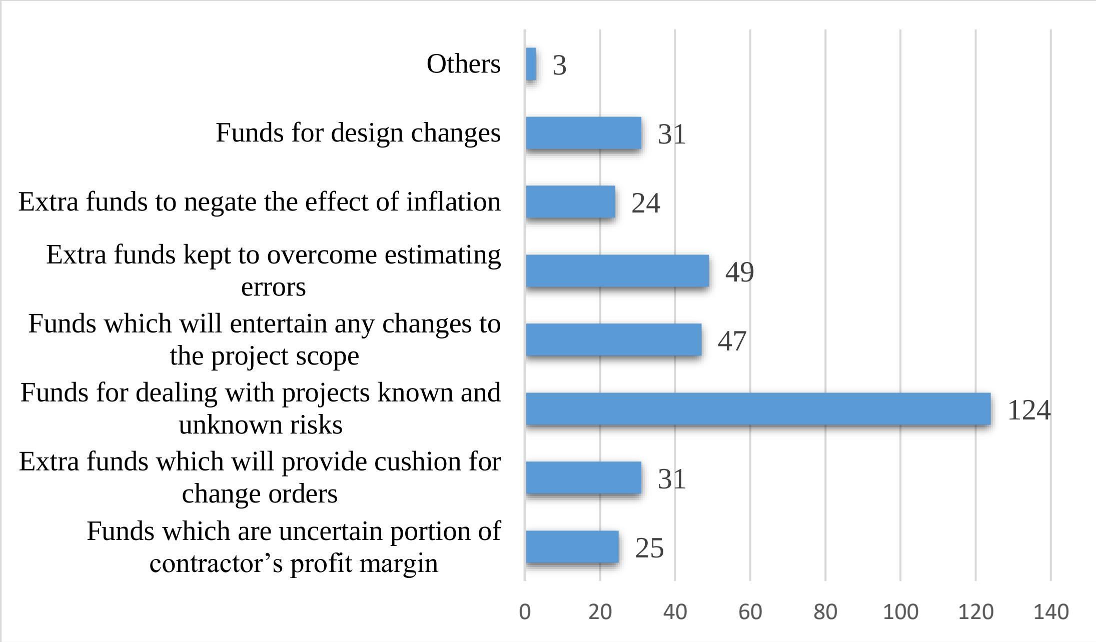


Figure 4.4: CC objectives

According to Figure 4.5, mainly consultants supported the use of CC funds for scope changes and change orders, Touran (2003b) considered change order and its impact on project objectives as a significant variable for CC estimation. Just like change orders, a majority of consultants selected design changes. It is important to note that consultants are mainly responsible for design related risks (Perez et al., 2017) and such an opinion points to either a conflicting behavior on the part of consultants or lack of clear understanding for the usage boundaries of CC funds. Further, contractors will not be comfortable in sharing CC funds to cover the risk of other parties (Sastoque et al., 2016). So, it can be observed that there is a considerable difference of opinion between consultants and contractors over the coverage of CC funds, which was also pointed by Mohamed et al. (2009). In the absence of a contractual guideline for the ownership and responsibility of CC funds, this situation may trigger dispute and hamper the project execution (Zaghloul and Hartman, 2003). Therefore, there is a need to establish standard guidelines, which not only highlight the items to be covered by CC funds but also the extent of their coverage.

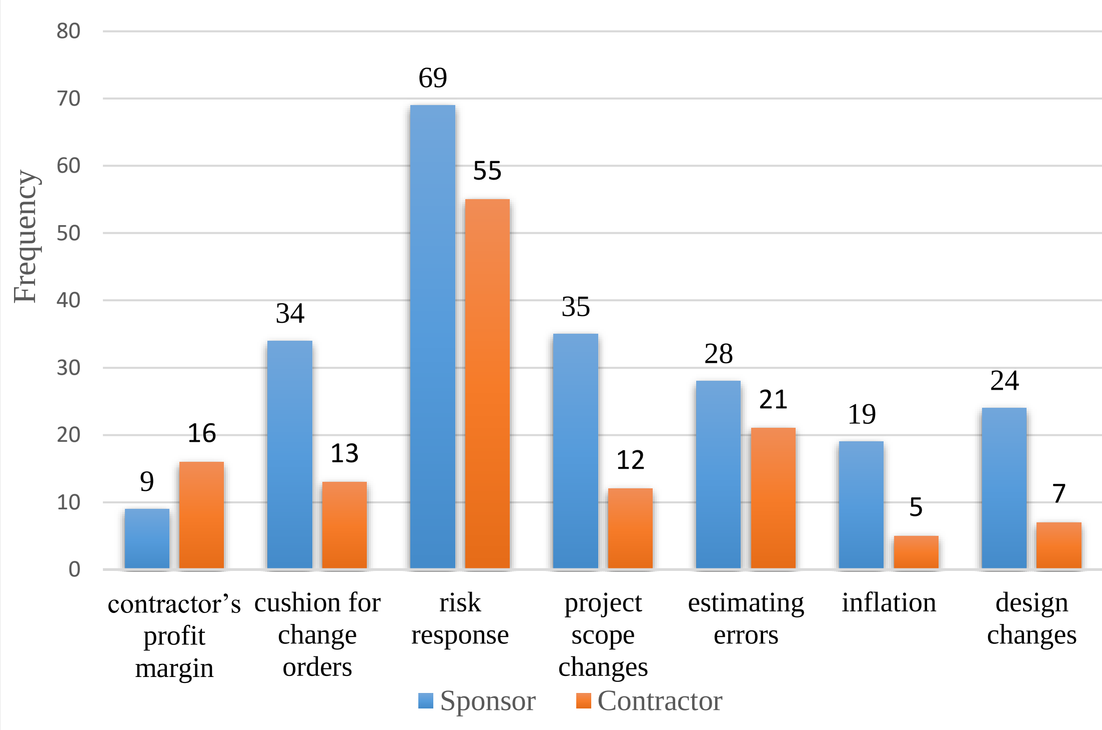


Figure 4.5: CC Coverage in purview Organization

Further, respondents were asked to select the key objectives of cost contingency concerning their organizational approach. According to the Figure 4.6, on budget and timely completion are respectively the main CC objectives. Also, quality of executed work and stakeholder's satisfaction were the go-to options for the achievement of cost and time objectives. Interestingly, the CC objectives justify the observations of Ford (2002). There are some minor differences between the objective of CC and the key performance indicators (KPIs) of a project ranked by Ayub et al. (2016) and PMI (2017).

Figure 4.6: CC objectives

Figure 4.7 establishes a comparison of contractor's and consultant's perspective regarding the objectives of CC funds. Contractors are more animated to complete the project within the agreed boundaries; consultants appreciate the spending of CC on stakeholder's satisfaction. Both the parties have equal representation regarding the safety and quality of projects.

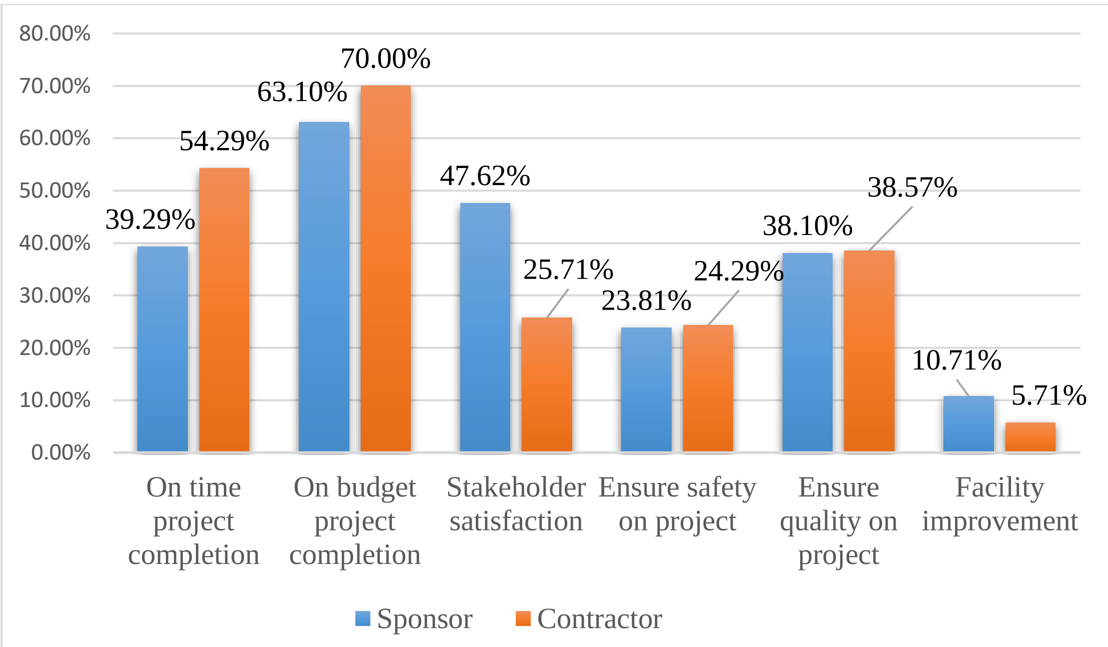


Figure 4.7: Comparison of CC objectives

At the start of literature review, Table 2.2 shows a comparison of research related to estimation and management of cost contingency. According to the results of that comparison, 82% of the researchers focused the estimation of cost contingency. To assess the applicability of existing models respondents were asked about their organizational approach for cost contingency estimation.

According to Figure 4.8, almost 60% respondents selected the Traditional Percentage Approach (TPA) which supports the findings of Mak and Picken (2000), who argued that the general trend to estimate CC is based on lump sum amount without considering any critical or non-critical line items. Interestingly, the findings of the current study suggest a decrease in usage of TPA from 77% as per Baccarini (2005b) to 58%. This decrease can be justified by more adoption of ERA (35%) by the construction industry. According to Mak and Picken (2000), the simplicity of ERA is close to the TPA, and public sectors of various developed countries have made it necessary for participating in the bidding process.

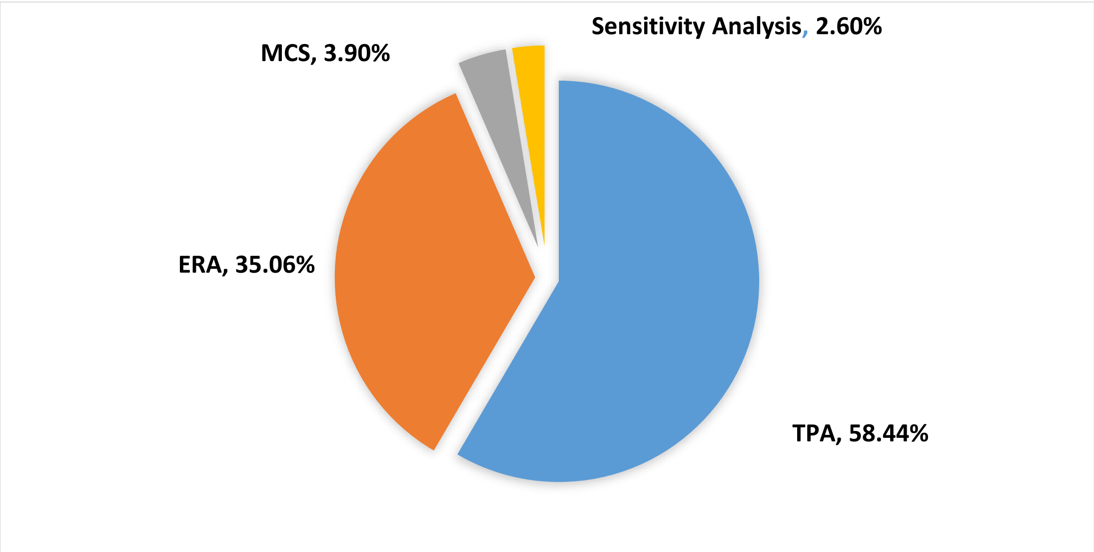


Figure 4.8: Cost contingency estimation approach

Further, only a few participants selected MCS (3.9%) and sensitivity analysis (2.6%) for CC estimation. Similarly, Brook (2016) studied some methods for risk estimation and criticized the lack of their application in real life projects. On the other hand, Smith and Bohn (1999) interviewed managers, which concluded that they do not have any knowledge of the published mathematical models for estimating CC. According to Baloi and Price (2003), these models depict the mathematical capabilities of publishers, rather than offering a rational and simple approach to CC estimation.

4.3 Funds related conundrums

According to Xie et al. (2011) and De Marco et al. (2015) cost contingency funds are the source of opportunity cost. To provide a solution to this problem participants were asked about the time in the project when these funds are available. As shown in Figure 4.9, the majority of participants reported the interim payment certificate (IPC) based recovery of CC funds. Since IPCs recover the cost that is already spent, the loss in value due to opportunity cost does not seem to be a real problem as per the findings of this study. This conclusion is further reinforced by the majority of respondents not reporting to receive the full CC funds just after the award of the contract. A quarter of the respondents reported that the matter varies from project to project, pointing towards a contextual decision-making trend.

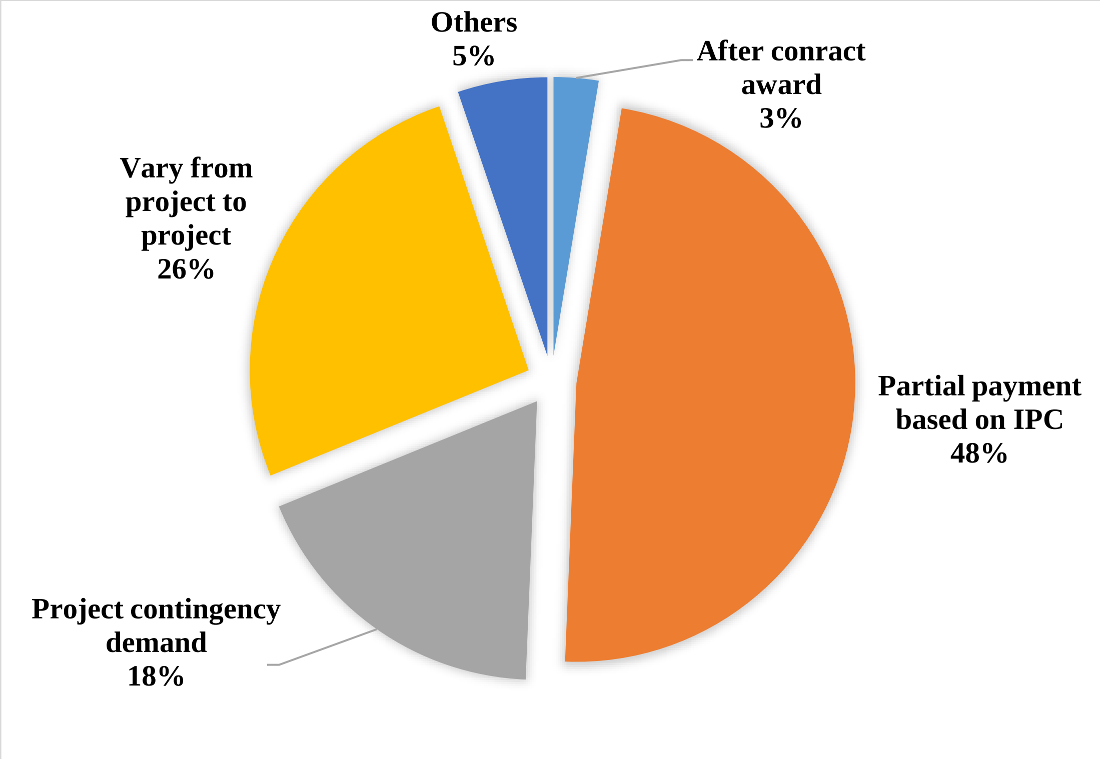


Figure 4.9: CC funds Availability

Participants were asked about the physical location of CC funds under the specified contract type of Cost-plus GMP. According to the results shown in Figure 4.10, only 12% respondents selected escrow account system contrary to the assumption of De Marco et al. (2015). Though the trend of noncompliance with previous research is alarming, the findings point towards a tendency of construction professionals to deal with matters on the case to case basis, this offers greater flexibility in decision-making but introduces subjectivity and robs the practices of necessary standardization. Although debate on the pros and cons of standardization is outside the scope of this paper, interested readers may refer to Polesie et al. (2009) and Polesie (2013).

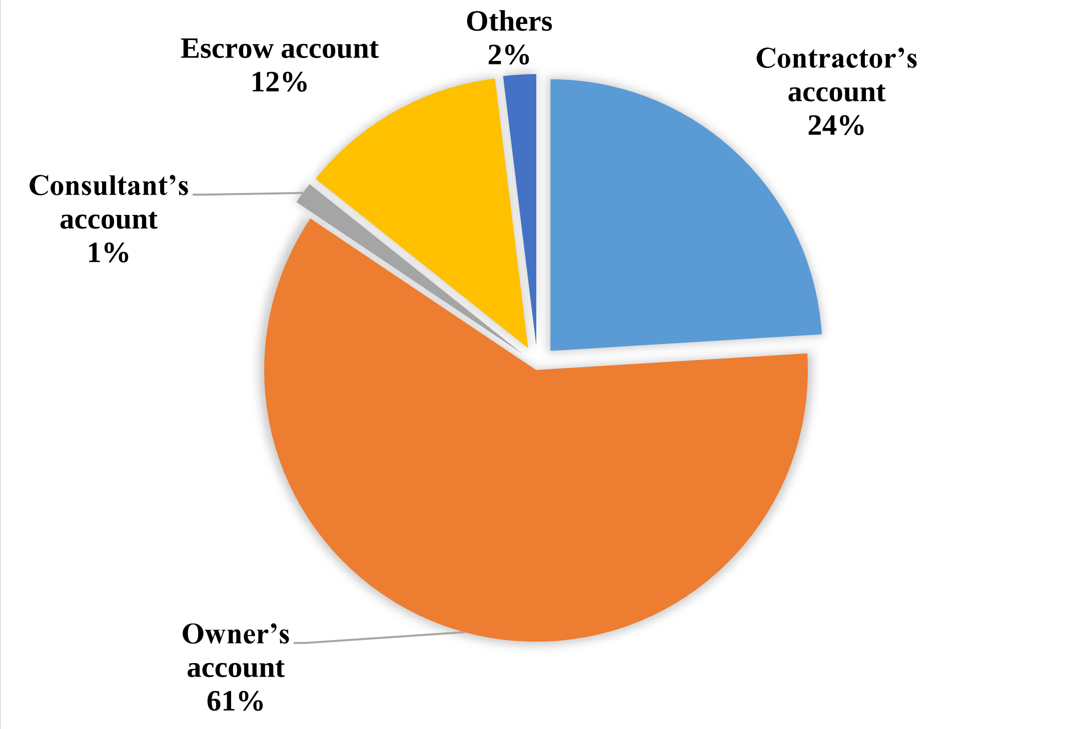


Figure 4.10: Cost Contingency Funds Physical Location

Further, according to 61% of the participants, CC funds are available in owner's account. Although under the specified conditions, continuous availability of these funds to PM is essential for project success (Ford, 2002), the actual practices are different to this recommendation, pointing towards ad hoc and informal working patterns in the construction industry (Barraza and Bueno, 2007; Ortiz-González et al., 2014).

To further observe the level of ad hocism, the current practices regarding the ownership of cost contingency were investigated. Lack of clear consensus was observed as shown in Figure 4.11. Majority of the experts (41%) suggested the client for the ownership of excess CC, which is contrary to Ford (2002) and De Marco et al. (2015), as they suggested that the developer has the ultimate ownership of excess contingency. Their recommendation is in the best interest of the project as the executing party receives a little more than their due share of incentive. Such an approach improves the client-contractor relationships but puts a burden on a consultant to ensure all functional, as well as enriching works, are sufficiently done. However, the downside to this approach is an undue advantage to contractors who focus only on correcting rather than improving. Such contractors will tend to save CC funds and not spend on facility improvement; this raises the need for a standardized and contractually bound consumption guideline which will eliminate the subjectivity of decision-making and bind the parties with their obligations.

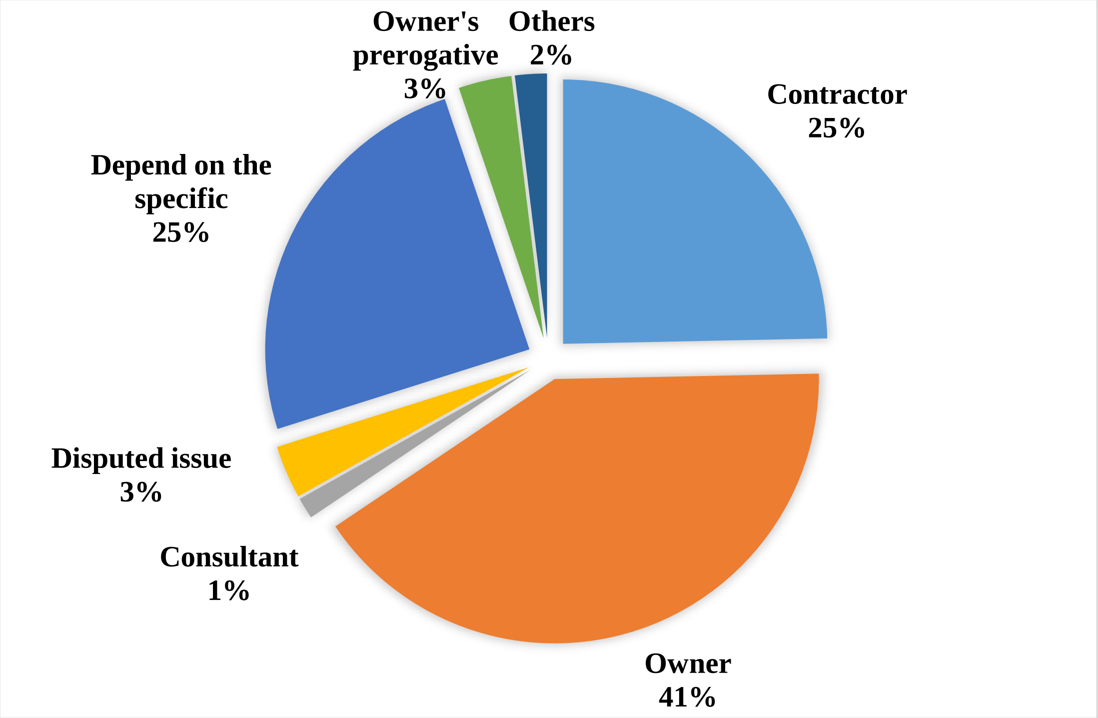


Figure 4.11: Excess Cost Contingency Ownership

The lack of consensus can be further seen in Figure 4.12 where the majority of the contractors does not consider the client to be the rightful owner of excess CC. Similarly, 90% of the total consultants did not approve the contractor's ownership over the excess contingency; this again points to an unharmonious mindset of industry representatives and justifies the need for standard procedures.

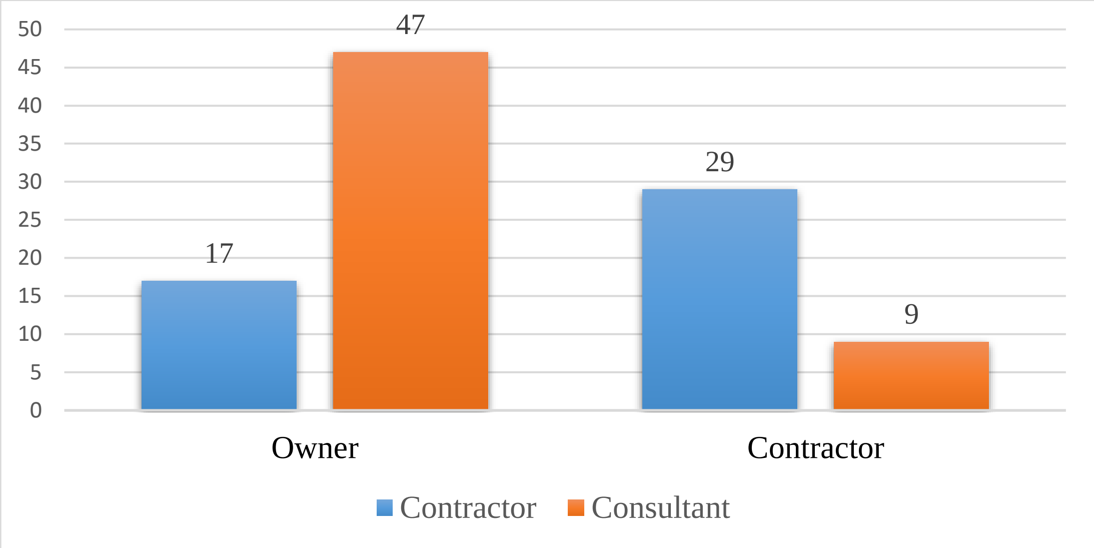


Figure 4.12: Comparison of owner and contractor

4.4 CC funds usage

Respondents were engaged to observe the contemporary practices regarding the time and amount of CC funds usage as a risk response. According to Figure 4.13, more than 85% of participants opted for self-improvised and organization based guidelines which are contrary to the findings of Baccarini (2005b) where it was found that organizations do not have formal cc consumption guidelines. Though it seems advisable that such practices and guidelines be documented and formally shared for the overall education and awareness of the construction sector, the sensitive nature of CC funds does not allow such transparency (Ford, 2002). Further, only 7% of the respondents use published guidelines which shows the lack of research regarding the usage of CC funds, reinforcing the need for a formal set of psycho-contractual guidelines. In the absence of any standard published guideline for CC utilization, only a minority of the respondents selected ‘gut feelings’ based CC usage, contrary to the thinking of Barraza and Bueno (2007) who deduced that judgment and ‘feeling’ are the base for decisions regarding contingency management. It can be argued that the construction sector has matured regarding policies and guidelines over the last decade. Current sophistication can be linked to major intrinsic motivators such as internal competition (FIEC, 2014; FIEC, 2015) and accountability Mak and Picken (2000), and extrinsic motivators such as declining contribution to GDP (FIEC, 2016; FIEC, 2017).

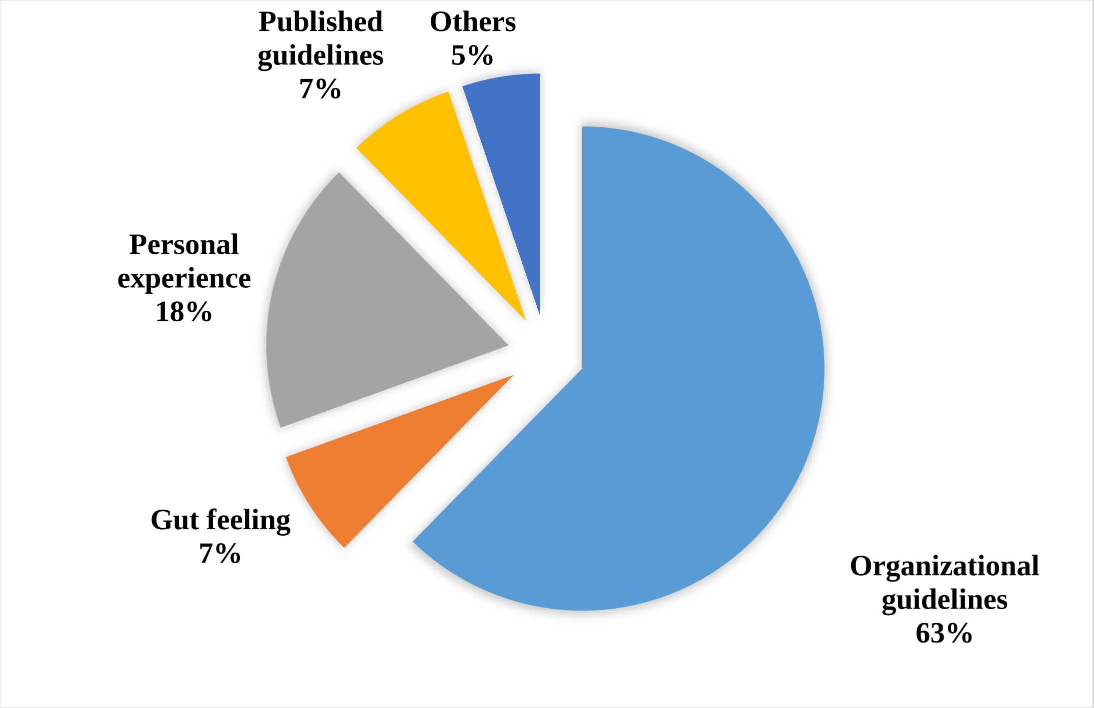


Figure 4.13: CC utilization criteria

4.5 CC funds adequacy

Respondents were asked to suggest a percentage of planned and actual CC spending concerning the total project cost in order to check the number of projects exceeding or falling short of the budgeted CC and margin of this deviation, It is important to note that this solicitation was made under the assumption of cost-plus GMP contract type. According to the Table 4.1, average planned CC funds are 8.78% of total project cost, whereas actual consumption is 9.36%. Also, 41% respondents were found to need extra contingency during project currency, whereas 26% had excess contingency and 33% respondents consumed their entire planned contingency by the project completion.

Table 4.1: Cost contingency adequacy

Status	Percentage	Average Planned CC	Average Actual CC	Deviation
Extra CC required	41%	7.46	11.17	3.71%
CC available in excess	26%	10.65	7.04	3.61%
All CC consumed	33%	8.94	8.94	0
Average	100%	8.78	9.36	0.58

The level of CC funds adequacy was further investigated as shown in Figure 4.14, where participants were asked to pick the percentage of the projects that are likely to drain CC funds earlier than project completion. According to the results, more than 50% of the participants believe in the possibility that at least one in every four projects exhausts all of its contingent resources before completion which is in line with Diekmann et al. (1988a).

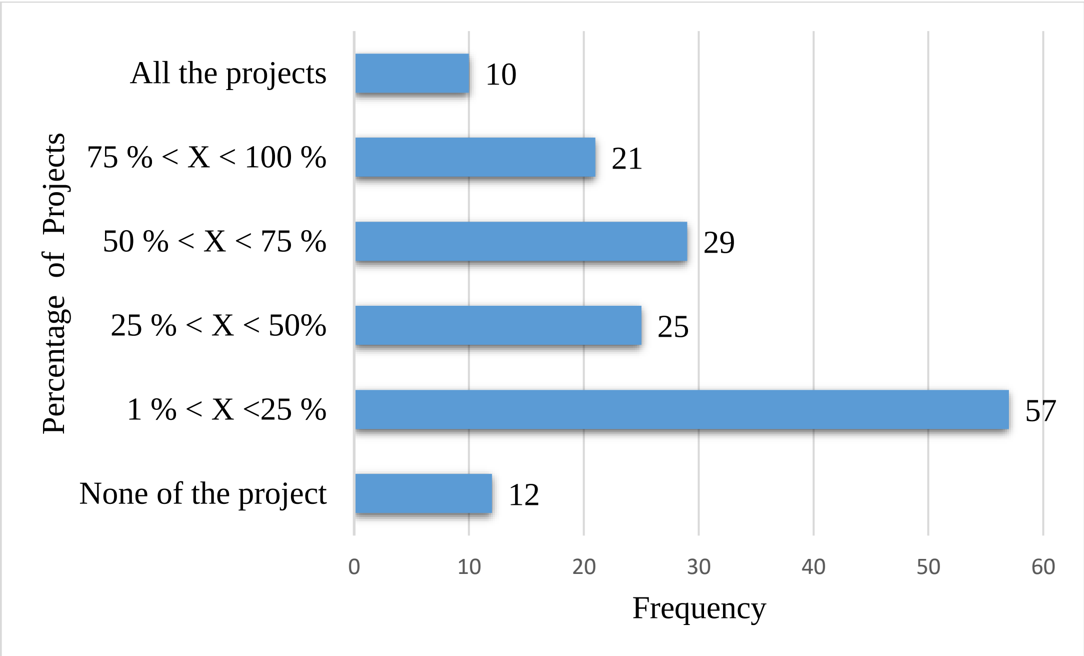


Figure 4.14: CC funds Exhaustion

Later on, the respondents were asked about the funding required to manage the risks arising after the exhaustion of budgeted CC funds. According to a majority of the respondents, extra CC funds will be demanded from the client as shown in Figure 4.15. This observation suggests that client-contractor relationship will be critical due to earlier exhaustion of CC, which was previously stressed by Aibinu and Jagboro (2002). According to 60 participants, they will use profit as compensation for CC, but it will damage the repute of CC funds manager, who is mostly the PM. According to one of the Ford (2002) interviewees, unspent contingency guarantees the job. Some of the participants opted to do nothing in response or compromise on quality to generate funds; such thinking will leave a negative impact on project health and is not recommended in the best interest of the project.

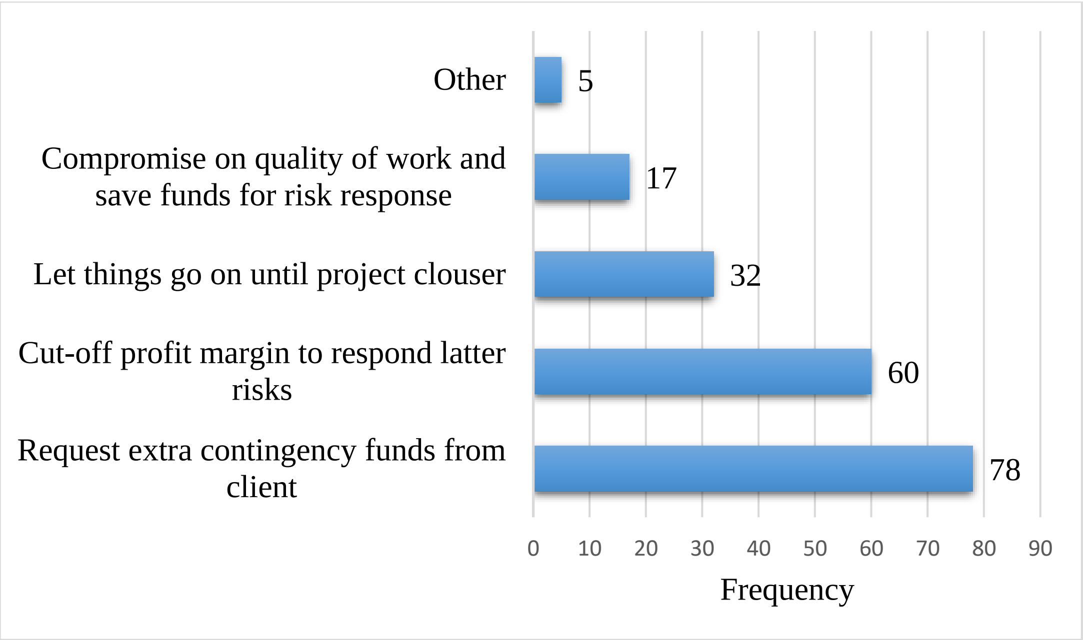


Figure 4.15: Funding for later risk

4.6 Monitoring and forecast

To monitor and forecast the direct cost in construction projects, PMs are facilitated by the availability of standard procedures such as EVM which represents the cumulative cost in the form of an S-curve. In the absence of any reasonable body of knowledge concerning the planning, tracking, and forecasting of CC, respondents, were inquired if they adequately and systematically plan the spending of CC before project execution. As expected, more than 70% of respondents negated it. Therefore, in the absence of any reliable baseline for cost contingency, its optimum utilization during project currency cannot be ensured which will hamper the forecasting of future spending. In this context, De Marco et al. (2016) tried to forecast the consumption of CC funds based on an S-curve which was later improved by Narbaev and De Marco (2017) through incorporating passive and aggressive behaviors.

In the next stage of the survey, when asked about the monitoring of cost contingency funds, interestingly, more than 80% of participants replied positively. But they did not report any formal monitoring systems being implemented. In this context, the literature has established some parameters for monitoring of CC funds by presuming a linear depletion pattern (Barraza and Bueno, 2007; Hammad et al., 2016). Clearly, in the absence of any standard CC usage patterns, management techniques for monitoring and forecasting the future CC demand will be a sham because what cannot be rationally measured cannot be wisely managed (Broadbent, 2007).

4.7 CC consumption trends

Experts were posed a specific scenario to formulate a standard baseline for CC. They were asked to assume the role of PM for the execution of a 2-million-dollar project with a deadline of 2 years under cost-plus GMP contract. In addition to GMP, the client will provide $ 100,000 CC which will be available at project start in an escrow account. According to specific provisions of the contract, excess contingency will be owned by the client and liquidity damage will be $ 5,000/day.

Participants were given four types of CC consumption behaviors to assess the general CC usage trend. As per Salah and Moselhi (2015) these behaviors were normal, aggressive, passive and basic (Salah and Moselhi, 2015). Experts were asked to report CC consumption patterns under the specified conditions as per their experience. According to the results shown in Table 4.2, a majority of respondents (90%) reported a non-linear CC consumption, which does not follow the normal behavior. It is contrary to the opinion of Barraza and Bueno (2007), and Hammad et al. (2016) who postulated that majority of PMs linearly consume the CC funds without subscribing to non-normal behaviors such as aggressive or passive. Only 37% participants expressed to spend these funds aggressively or passively, which supports the suggestions and assumptions of Ford (2002), and Narbaev and De Marco (2017) respectively. A majority (52%) of respondents thinks they follow a basic CC consumption in the form of an S-curve, which validates the assumption of De Marco et al. (2016). Thus, it is seen that different practitioners tend to consume CC funds differently based on their threat perception and urgency requirements.

Furthermore, these experts were asked to smartly utilize $ 100,000 CC as there are no extra funds available. In addition, they were instructed to completely consume these funds to achieve the set targets. The spending behavior of 102 experts was analyzed, and individual comparison of the planned and actual CC consumption was established to identify the participants who retained their spending criteria. The findings show that

70% respondents consumed funds differently than their perceived behavior. A comparison of respondents' behavioral patterns based on their general threat perception and actual CC utilization is established in Table 4.2.

Table 4.2: A comparison of CC consumption

Behavioral Patterns	General Threat Perception	Actual Utilization	Behavioral Shift	Overall Behavioral Shift
Normal (Linear)	12%	33%	21%	**70%**
Aggressive (FEL)	11%	16%	5%	
Passive (BEL)	25%	42%	17%	
Basic (S-curve)	52%	9%	-43%	

The results point to a major shift in the managerial approach to CC utilization, as a majority (42%) of experts consume CC funds passively in comparison to their perceived pattern of basic (52%). According to Ford (2002), the cautious usage shows that project managers are concerned about the time and cost targets. Interestingly, the aggressive usage of CC was not entertained by participants at both perception and actual utilization stages, which in light of Ford (2002) depicts a PM's lack of commitment regarding value addition to the facility. Also, a sizable portion (33%) of participants were indifferent to any behavioral tendencies and consumed CC linearly. Although a majority (52%) of participants opted S-curve based CC consumption, in actual only, 9% opined to consume in this fashion, which contradicts with the assumption of De Marco et al. (2016).

4.8 Contingency spending rate (CSR)

According to Ford (2002), the top three utilization criteria for CC funds are resolving emergencies, reducing project delays and improving the facility. The findings of this research expand upon the facility improvement function of CC funds and reveal that the participants focus on the quality of executed work and stakeholder satisfaction after resolution of emergencies and reduction in delays. However, to achieve the first two objectives, the factor of facility improvement is neglected during the first half of the project, resulting in passive CC utilization (Ford, 2002). On the contrary, some PMs tend to overreact to the arising issues along with the requirement for value addition to the facility during the early stages of the project, thus applying extra CC funds (Salah and Moselhi, 2015). Although there is an established sense regarding the aggressive and passive consumption of CC (Ford, 2002), the magnitude of such behavior is not measured in the literature.

According to Murray and Ramsaur (1983), the assessment of spending rate is the most complicated and essential aspect of contingency management process. Despite its importance, this aspect remained unaddressed, and only recently Narbaev and De Marco (2017) considered $\sqrt{\Omega}$ and Ω^2 to represent the aggressive and passive rate of CC usage. Given the importance of CC consumption baseline to monitor, control and forecast CC and CEAC (Babar et al., 2016; Hammad et al., 2016), spending pattern of 102 respondents was further analyzed to formulate standard CC consumption rate and guidelines for all the established behaviors. Mean values of BEL, FEL, and basic CC usage groups were calculated as shown in Table 4.3.

Table 4.3: Mean CC usage

Project duration	Established behavioral patterns of CC consumption			Project duration	Established behavioral patterns of CC consumption		
	Passive	Basic	Aggressive		Passive	Basic	Aggressive
5%	2.16	1.11	4.625	**60%**	43.51	59.56	72.94
10%	4.86	3.44	11.25	**70%**	55.30	74.44	80.94
15%	7.93	5.55	17.19	**80%**	68.46	87.22	86.19
20%	11.70	7.77	25.06	**85%**	77.91	91.67	90.44
30%	16.86	16.56	35.44	**90%**	86.02	94.56	93.38
40%	24.63	27.44	49.06	**95%**	93.46	97.33	96.94
50%	34.72	41.56	61.75	**100%**	100	100	100

CC exhaustion before project completion is considered a serious threat to cost and time objectives (Diekmann et al., 1988a). At the same time, an excess contingency with poor value addition to the facility cannot be considered a sign of good management practices (Ford, 2002). Based on the findings of Table 4.3, balanced approaches to passive and aggressive CC spending are given in Figures 4.16 and 4.17 respectively.

According to Table 4.3, experts with passive utilization tendencies used only 55% of the total contingent resources at 70% of project execution. It is in line with Ford (2002); PMs with passive behavioral tendencies are more reluctant to spend CC at the end of the project to meet the deadlines. Furthermore, the findings of this study are compared with previously established CC usage criteria set by Narbaev and De Marco (2017) shown in Figure 4.16. It points that the actual passive tendencies of the participants are relatively lesser than the established pattern by Narbaev and De Marco (2017). Also, Equation 1 shows the spending pattern for passive CC utilization with an R^2 value of 99%.

$$y = 0.0069x2 + 0.3001x + 1.4865 \qquad Equation\ 4.1$$

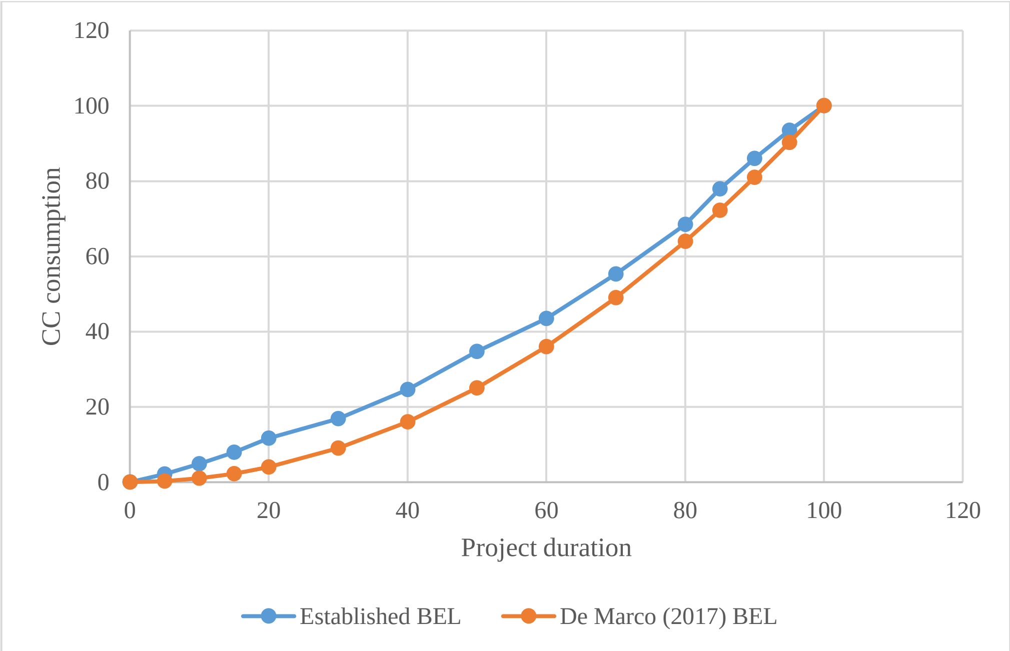


Figure 4.16: A comparison established CSR with Narbaev and De Marco (2017)

Project duration was divided into 5 phases to study the difference between both studies. A comparison of CC spending rates for each phase was established in Table 4.4. During the middle phase, the spending rate for both studies is almost equal. The major difference in spending rate can be observed during the first (0-20%) and the last (81%-100%) phases. During the first phase, participants are willing to spend .38 extra CC for every 1% progress in work than Narbaev and De Marco (2017). Whereas due to the cautious usage of CC at first and second phases, Narbaev and De Marco (2017) has .15 and .22 extra CC for every 1% project progress than the established rate of this research.

Table 4.4: Phase wise comparison of CC consumption rate

Project phase	CC spending per 1% project progress			
	Passive behavior		Aggressive behavior	
	Research findings	Narbaev and De Marco (2017)	Research Findings	Narbaev and De Marco (2017)
0-20%	0.58	0.2	1.25	2.24
21%-40%	0.65	0.6	1.2	0.93
41%-60%	0.94	1	1.19	0.71
61%-80%	1.25	1.4	0.66	0.60
81%-100%	1.58	1.8	0.69	0.53

Furthermore, the level of aggressiveness was calculated based on the mean values shown in Table 4.3. During the first two phases of project execution, participants showed a partially aggressive behavior as only 49% of contingent resources were utilized at 40% project completion. Whereas in comparison to passive CC utilization, the spending rate for aggressive participants was more than double for first two phases and a half for the last two phases. Further, the findings of this research were compared with Narbaev and De Marco (2017) as shown in Figure 4.17. A major difference can be seen till the 60% project completion.

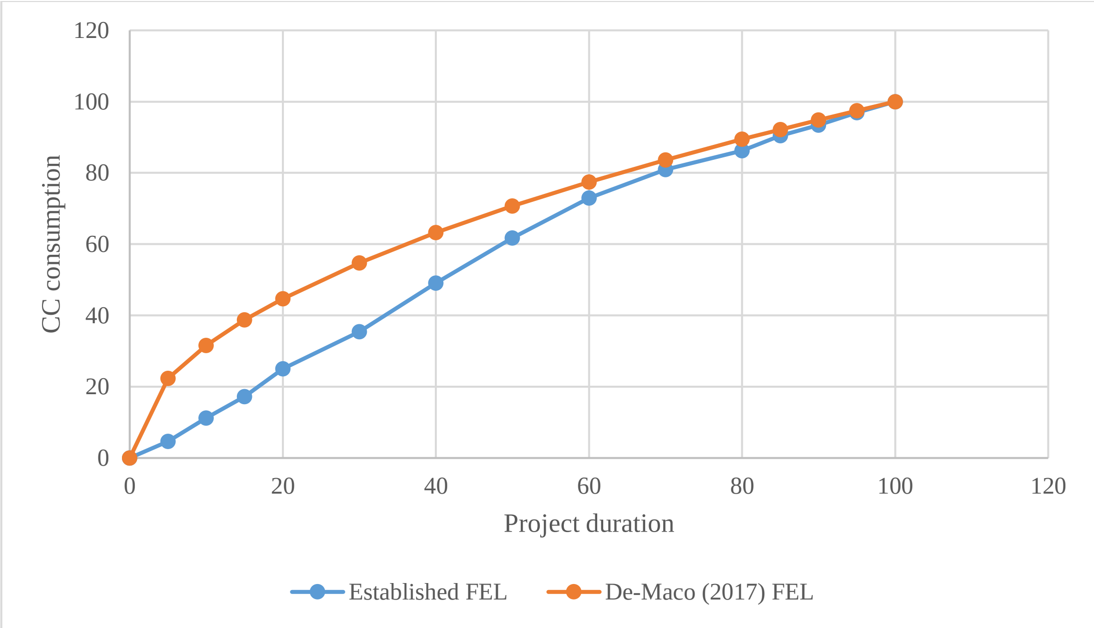


Figure 4.17: A comparison established CSR with Narbaev and De Marco (2017)

Comparison of phase wise spending rates of this research with Narbaev and De Marco (2017) can be seen in Table 4.4. During the first phase, the rate of CC usage set by Narbaev and De Marco (2017) was 80% more than the participants' rate, which shows that experts, in reality, are significantly lesser aggressive users of CC. In the second phase, there is a significant drop of 1.31 per 1% project progress from the first phase of the project. Interestingly the last two phases are close to the recommended spending rate of the experts. Also, Equation 2 shows the aggressive CC spending.

$$y = -0.0053x2 + 1.5676x - 4.312 \qquad \textit{Equation } 4.2$$

4.9 Research validation

`To validate the findings of this study, a CC usage region is established based on the minimum and maximum CC usage limits shown in Figure 4.18. Due to the sensitivity of data, most of the PMs were unwilling to share a detailed CC usage information. Later on, they were asked to give the percentage CC usage at various project stages. Three PMs agreed to share CC usage profile.

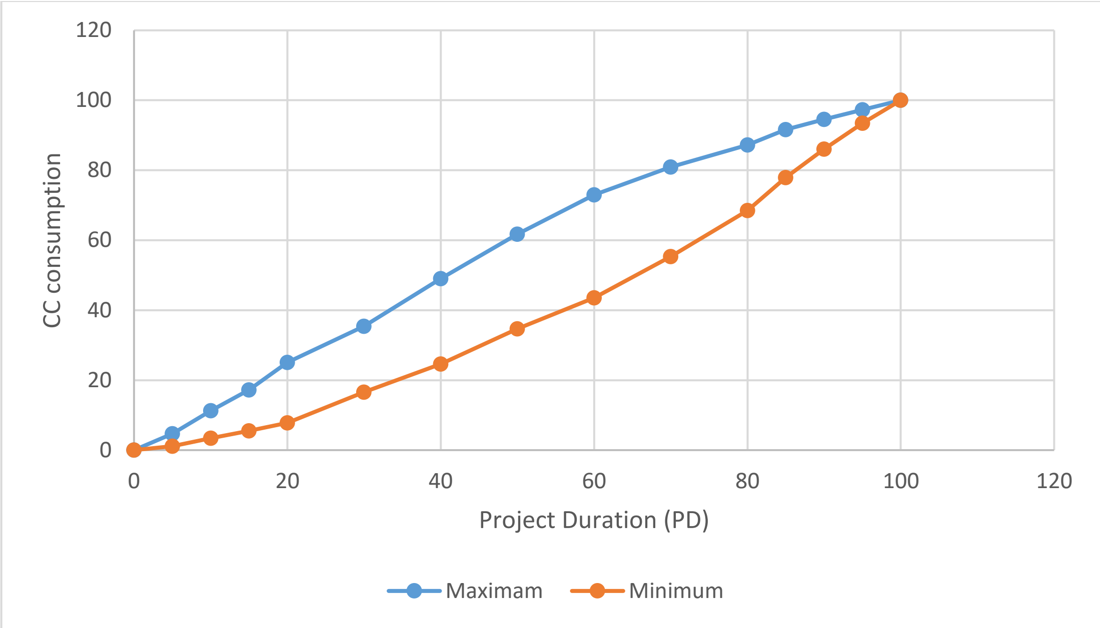


Figure 4.18: Established CC region

4.9.1 Case study 1

The spending of CC for this case study was plotted against the established region for CC as shown in Figure 4.19. Interestingly the CC usage did not exactly match any of the established behaviors but remained within the set boundaries during certain phases. Such as, during the first phase (0% - 18.5%), only 3.3% of the TCC was utilized which is even half of the minimum established limit of 7.7%. Although at 62.5% PD, 56% of TCC was consumed but at 69% PD, almost 85% of TCC was utilized which shows either the occurrence of a black swan event or the PM's intent to reduce project delays. Interestingly, during the last phase (81.57% - 100%), there were only 2.25% CC funds available, which points to poor management.

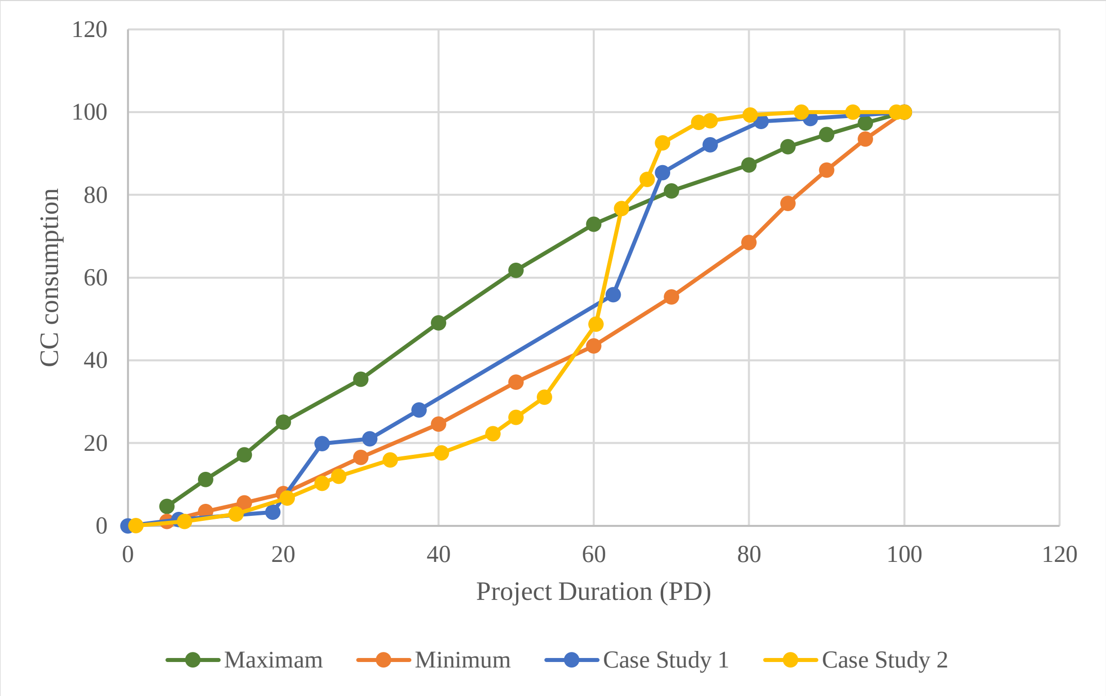


Figure 4.19: Case study 1 and 2

Contingency Spending Rate (CSR) was calculated at five phases of case study 1 to study the consumption behavior. During the first phase, the CSR was extremely low which in light of Ford (2002) shows the lack of intention regarding the facility improvement. During the second and third phases of the project, PM applied CC in aggressive and partially aggressive manners respectively. Due to extremely aggressive usage during the fourth phase, only 2.25% of TCC was available for the last phase of the project, and that is why the CSR is extremely low (.12), as given in Table 4.5.

Table 4.5: CSR of case studies

Passive CSR	Aggressive CSR	Project phase	Case Study 1			Case Study 2		
			Physical Progress (%)	**CSR**	**Behavior**	**Physical Progress (%)**	**CSR**	**Behavior**
0.39	1.25	First	0-18.5	0.18	Extremely passive	0-20.53	0.33	Passive
0.84	1.2	Second	18.6-37.5	1.31	Aggressive	20.54-40.4	0.55	Extra passive
0.94	1.19	Third	37.6-62.5	1.11	Partially aggressive	40.41-60.26	1.56	Partially aggressive
1.25	0.71	Fourth	62.6-81.56	2.2	Extremely aggressive	60.27-80.13	2.54	Extremely aggressive
1.58	0.64	Fifth	81.57-100	0.12	Extremely passive	80.14-100	0.04	Extremely passive

4.9.2 Case study 2

The CC spending in the second case study was plotted against CC region, as shown in Figure 4.19. Only 16% of TCC was utilized till 33% of the PD, which is less than the stated guideline of 20% for passive CC consumption. This deficiency was recovered from 33% to 60% PD. Interestingly, from 60% to 63% PD, abrupt usage of CC was experienced, where a quarter of TCC was consumed, which is in resonance with the pattern of case study 1. As a result, at 80% PD in case study 2, almost all of the available CC fund was consumed. Availability of CC during the last phase is critical to achieving project targets (Salah and Moselhi, 2015) but most the projects tend to exhaust CC before project completion (Diekmann et al., 1988b), as can be seen in case of studies 1 and 2.

The usage of CC for the second case study was investigated using a phase-wise CSR given in Table 4.5. During the first and second phases of the project, the CSR is below than its stated lower limit. This show that PM is neglecting the facility improvement along with arising problems and project delays. During the third phase, CSR increased by a margin of 1 than the second phase, which shows the willingness for dealing with project cost control and delay related matters. Interestingly, the CSR for the fourth phase shows an extremely aggressive CC usage; this may be the effect of untreated risks and project delays during the first and second phases. Due to such passive behavior in the beginning and aggressive behavior towards the end, no CC funds are available for the last phase of the project.

These case studies help understand the consumption patterns and the possible issues that may arise due to behavioral tendencies of consumption. It is imperative to note that due to limited availability of data, the validity of analysis remains inadequate. The performance indices (CPI, SPI) generated by using project management tools ensure a high quality, objective data. Such inputs could have enhanced the validity and generalizability of these case studies, and act as a decision support system to guide PMs on how to use contingency in response to cost and schedule indicator

Chapter 5

Conclusions and Recommendations

CC has a significant impact on stakeholder's relationship and project success. Despite its importance, the subject of CC management is not properly addressed in the literature. General practices regarding contractual and managerial aspects of CC were collected and studied. The lack of consensus between contractors and sponsors regarding CC coverage, objectives and excess CC ownership is highlighted, which might harm the contractor-sponsor relationship. Practitioners are recommended to clarify the highlighted ambiguities through specific contractual provision.

According to research findings, publications related to contingency management is the only 1/5th of the total studies related to contingency. Also, ad hoc based CC management was also reported which points to a lack of standard guidelines for CC management. There is a need to establish more pragmatic contractual and managerial frameworks for CC management. Also, the existing proprietary CC management practices need to be analyzed to help formulate the standard set of contractual and managerial guidelines so that inexperienced organizations can benefit from the practices of well-established firms.

Further, the CSR for aggressive and passive behaviors is calculated which helps in better monitoring and control of CC funds. It was observed that the experts are less aggressive compared to their passive tendencies. The findings also infer that majority of PMs tend to withhold contingency amount in the first half of execution.

This research established CC usage region, which will help PMs assess their CC consumption concerning the suggested limits. The region is based on the recommendations of 102 experts. Construction organizations can analyze their previous completed projects to enhance the reliability of established CC region,

It is reported that that prevalent processes of monitoring and forecasting are based on assumed CC patterns. But this study found that more than half of the construction industry is still applying TPA for CC estimation which does not support the development of a baseline for CC. On the contrary, because of probabilistic nature of risk, any formulated baseline might not be efficient for monitoring and forecasting. This research established consumption trends and usage region of CC by analyzing the CSR. Now, Construction industry and academia can formulate reliable monitoring and forecasting parameters based on the standard consumption trends instead of assumptions.

This research is limited in its scope on the contractor's contingency and projects delivered through cost-plus GMP method. Future research may expand upon these and cater to the contingency of other prime stakeholders and for projects delivered throughout methods. Also, the future research can delve into the financial complications of more advanced project delivery methods such as public-private-partnership.

References

AACE. (2000). International's Risk Management Dictionary. Association for the Advancement of Cost Engineering, 42(4), 28-31.

Abednego, M. P., & Ogunlana, S. O. (2006). Good project governance for proper risk allocation in public–private partnerships in Indonesia. *International Journal of Project Management, 24*(7), 622-634.

Addo, J. (2016). Determination Of Contingency Sum For Building Projects In Ghana. *African Journal of Applied Research (AJAR), 1*(1).

Ahmed, S. M., Ahmad, R., Saram, D., & Darshi, D. (1999). Risk management trends in the Hong Kong construction industry: a comparison of contractors and owners perceptions. *Engineering construction and Architectural management, 6*(3), 225-234.

Aibinu, A., Dassanayake, D., & Thien, V. (2011). *Use of artificial intelligence to predict the accuracy of pre-tender building cost estimate.* Paper presented at the Management and Innovation for a Sustainable Built Environment MISBE 2011, Amsterdam, The Netherlands, June 20-23, 2011.

Aibinu, A., & Jagboro, G. (2002). The effects of construction delays on project delivery in Nigerian construction industry. *International Journal of Project Management, 20*(8), 593-599.

Akintoye, A. S., & MacLeod, M. J. (1997). Risk analysis and management in construction. *International Journal of Project Management, 15*(1), 31-38.

Al-Bahar, J. F., & Crandall, K. C. (1990). Systematic risk management approach for construction projects. *Journal of construction Engineering and Management, 116*(3), 533-546.

Andi. (2006). The importance and allocation of risks in Indonesian construction projects. *Construction Management and Economics, 24*(1), 69-80.

Andi, A. (2004). Appropriate allocation of contingency using risk analysis methodology. *Civil Engineering Dimension, 6*(1), pp. 40-48.

Assaf, S. A., & Al-Hejji, S. (2006). Causes of delay in large construction projects. *International Journal of Project Management, 24*(4), 349-357.

Ayub, B., Thaheem, M. J., & ud Din, Z. (2016). Dynamic Management of Cost Contingency: Impact of KPIs and Risk Perception. *Procedia Engineering, 145*, 82-87.

Babaa, D. Y. (2015). *Determination of cost contingency in the procurement of feeder roads in Ghana.*

Babar, S., Thaheem, M. J., & Ayub, B. (2016). Estimated cost at completion: Integrating risk into earned value management. *Journal of construction Engineering and Management*, 04016104.

Baccarini, D. (2004a). *Accuracy in estimating project cost construction contingency—A statistical analysis.* Paper presented at the Proceedings of the Construction and Building Research Conference of RICS.

Baccarini, D. (2004b). *Estimating project cost contingency-a model and exploration of research questions.* Paper presented at the ARCOM 20th Annual Conference, September, Heriot-Watt University, Edinburgh: Association of Researchers in Construction Management.

Baccarini, D. (2005a). *Estimating project cost contingency-Beyond the 10% syndrome.* Paper presented at the Australian Institute of Project Management National Conference.

Baccarini, D. (2005b). *Understanding project cost contingency: A survey.* Paper presented at the QUT Research Week 2005: conference proceedings, 4-5 July 2005, Brisbane, Australia.

Baccarini, D. (2006). *The maturing concept of estimating project cost contingency-A review.* Paper presented at the Proceedings of the Australasian University Building Educators Association Annual Conference.

Baccarini, D., & Love, P. E. (2013). Statistical characteristics of cost contingency in water infrastructure projects. *Journal of construction Engineering and Management, 140*(3), 04013063.

Bajaj, D., Oluwoye, J., & Lenard, D. (1997). An analysis of contractors' approaches to risk identification in New South Wales, Australia. *Construction Management & Economics, 15*(4), 363-369.

Bakhshi, P., & Touran, A. (2014). An overview of budget contingency calculation methods in construction industry. *Procedia Engineering, 85*, 52-60.

Baloi, D., & Price, A. D. (2003). Modelling global risk factors affecting construction cost performance. *International Journal of Project Management, 21*(4), 261-269.

Barraza, G. A. (2010). Probabilistic estimation and allocation of project time contingency. *Journal of construction Engineering and Management, 137*(4), 259-265.

Barraza, G. A., & Bueno, R. A. (2007). Cost contingency management. *Journal of Management in Engineering, 23*(3), 140-146.

Bello, W. A., & Odusami, K. T. (2013). *Weak management of the predictability of contingency allowance in construction projects in Nigeria.* Paper presented at the Proceeding of the 29th Annual ARCOM Conference.

Broadbent, J. (2007). If you can't measure it, how can you manage it? Management and governance in higher educational institutions. *Public Money and Management, 27*(3), 193-198.

Brook, M. (2016). *Estimating and tendering for construction work*: Taylor & Francis.

Buertey, J. I. T. (2014). Project cost risk and uncertainties: towards a conceptual cost contingency estimation model. *International Journal of Construction Engineering and Management, 3*(5), 144-155.

Buertey, J. I. T., Abeere-Inga, E., & Kumi, T. A. (2012). Estimating cost contingency for construction projects: The challenge of systemic and project specific risk. *Journal of Construction Project Management and Innovation, 2*(1), 166-189.

Burroughs, S. E., & Juntima, G. (2004). Exploring techniques for contingency setting. *AACE International Transactions*, ES31.

Chapman, C. (1997). Project risk analysis and management—PRAM the generic process. *International Journal of Project Management, 15*(5), 273-281.

Chien, K.-F., Wu, Z.-H., & Huang, S.-C. (2014). Identifying and assessing critical risk factors for BIM projects: Empirical study. *Automation in Construction, 45*, 1-15.

Cioffi, D. F., & Khamooshi, H. (2009). A practical method of determining project risk contingency budgets. *Journal of the Operational Research Society, 60*(4), 565-571.

De Marco, A., Rafele, C., & Thaheem, M. J. (2015). Dynamic management of risk contingency in complex design-build projects. *Journal of construction Engineering and Management, 142*(2), 04015080.

De Marco, A., Rosso, M., & Narbaev, T. (2016). Nonlinear cost estimates at completion adjusted with risk contingency. *The Journal of Modern Project Management, 4*(2).

Diekmann, J. E., Sewester, E. E., & Taher, K. (1988a). *Risk management in capital projects*: Construction Industry Institute Austin, TX.

Diekmann, J. E., Taher, K., & Sewester, E. E. (1988b). *Risk management in capital projects*: Construction Industry Institute.

El-Adaway, I. H., & Kandil, A. A. (2009). Contractors' claims insurance: A risk retention approach. *Journal of construction Engineering and Management, 135*(9), 819-825.

El-Touny, A. S., Ibrahim, A. H., & Amer, M. I. (2014). Estimating cost contingency for highway construction projects using analytic hierarchy process. *International Journal of Computer Science Issues (IJCSI), 11*(6), 73.

Elbarkouky, M. M., Fayek, A. R., Siraj, N. B., & Sadeghi, N. (2016). Fuzzy arithmetic risk analysis approach to determine construction project contingency. *Journal of construction Engineering and Management, 142*(12), 04016070.

Elbarkouky, M. M., Siraj, N. B., & Fayek, A. R. (2015). *Fuzzy Contingency Determinator© a fuzzy arithmetic-based risk analysis tool for construction projects.* Paper presented at the Fuzzy Information Processing Society (NAFIPS) held jointly with 2015 5th World Conference on Soft Computing (WConSC), 2015 Annual Conference of the North American.

Eldosouky, I. A., Ibrahim, A. H., & Mohammed, H. E.-D. (2014). Management of construction cost contingency covering upside and downside risks. *Alexandria Engineering Journal, 53*(4), 863-881.

Enshassi, A., & Mayer, P. (2001). Managing risks in construction projects, 18th Internationales Deutsches Projekt Management Forum. *Ludwig burg, Germany*.

Espinoza, R. D. (2011). Contingency estimating using option pricing theory: closing the gap between theory and practice. *Construction Management and Economics, 29*(9), 913-927.

FIEC. (2014). European construction industry federation annual reoprt. Retrieved from http://www.fiec.eu/en/library-619/annual-report-english.aspx

FIEC. (2015). European construction industry federation annual reoprt. Retrieved from http://www.fiec.eu/en/library-619/annual-report-english.aspx

FIEC. (2016). European construction industry federation annual reoprt. Retrieved from http://www.fiec.eu/en/library-619/annual-report-english.aspx

FIEC. (2017). European construction industry federation annual reoprt. Retrieved from http://www.fiec.eu/en/library-619/annual-report-english.aspx

Flyvbjerg, B. (2007). Policy and planning for large-infrastructure projects: problems, causes, cures. *Environment and Planning B: Planning and Design, 34*(4), 578-597.

Ford, D. N. (2002). Achieving multiple project objectives through contingency management. *Journal of construction Engineering and Management, 128*(1), 30-39.

Frank, M. (1999). Treatment of uncertainties in space nuclear risk assessment with examples from Cassini mission applications. *Reliability Engineering & System Safety, 66*(3), 203-221.

Frimpong, Y., Oluwoye, J., & Crawford, L. (2003). Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study. *International Journal of Project Management, 21*(5), 321-326.

Ghosh, S., & Jintanapakanont, J. (2004). Identifying and assessing the critical risk factors in an underground rail project in Thailand: a factor analysis approach. *International Journal of Project Management, 22*(8), 633-643.

Gransberg, D. D., & Ellicott, M. A. (1997). Best-value contracting criteria. *Best-value contracting criteria, 39*(6).

Gray, C. F. (2000). Project management: The management process.

Günhan, S., & Arditi, D. (2007). Budgeting owner's construction contingency. *Journal of construction Engineering and Management, 133*(7), 492-497.

Hammad, M. W., Abbasi, A., & Ryan, M. J. (2015). *A new method of cost contingency management.* Paper presented at the Industrial Engineering and Engineering Management (IEEM), 2015 IEEE International Conference on.

Hammad, M. W., Abbasi, A., & Ryan, M. J. (2016). Allocation and Management of Cost Contingency in Projects. *Journal of Management in Engineering, 32*(6), 04016014.

Hillson, D. (2002). Extending the risk process to manage opportunities. *International Journal of Project Management, 20*(3), 235-240.

Idrus, A., Nuruddin, M. F., & Rohman, M. A. (2011). Development of project cost contingency estimation model using risk analysis and fuzzy expert system. *Expert Systems with Applications, 38*(3), 1501-1508.

Jimoh, R. A., & Adama, S. M. (2014). Assessment of contingency sum in relation to the total cost of renovation work in public schools in Abuja, Nigeria. *Int J Manag Stud Res*, *2*(10), 55-63.

Jung, J. H., Kim, D. Y., & Lee, H. K. (2016). The computer-based contingency estimation through analysis cost overrun risk of public construction project. *KSCE Journal of Civil Engineering*, *20*(4), 1119-1130.

Kartam, N. A., & Kartam, S. A. (2001). Risk and its management in the Kuwaiti construction industry: a contractors' perspective. *International Journal of Project Management, 19*(6), 325-335.

Ke, Y., Wang, S., & Chan, A. P. (2012). Risk management practice in China's Public-Private Partnership projects. *Journal of Civil Engineering and Management, 18*(5), 675-684.

Khalafallah, A., Taha, M., & El-Said, M. (2005). *Estimating residential projects cost contingencies using a belief network.* Paper presented at the Proceedings of Project Management: Vision for Better Future Conference.

Kutsch, E., & Hall, M. (2005). Intervening conditions on the management of project risk: dealing with uncertainty in information technology projects. *International Journal of Project Management*, *23*(8), 591-599.

Laryea, S. (2007). The price of risk in construction projects: contingency approximation model (CAM).

Laryea, S., & Hughes, W. (2010). Risk and price in the bidding process of contractors. *Journal of construction Engineering and Management*, *137*(4), 248-258.

Lee, K.-P., Lee, H.-S., Park, M., Kim, D. Y., & Jung, M. (2017). Management-Reserve Estimation for International Construction Projects Based on Risk-Informed k-NN. *Journal of Management in Engineering, 33*(4), 04017002.

Lhee, S. C., Flood, I., & Issa, R. R. (2014). Development of a two-step neural network-based model to predict construction cost contingency. *Journal of Information Technology in Construction (ITcon), 19*(24), 399-411.

Lhee, S. C., Issa, R. R., & Flood, I. (2009). Predicting Owner's Contingency for Transportation Construction Projects Using Intelligent Computing Techniques *Computing in Civil Engineering (2009)* (pp. 442-451).

Lhee, S. C., Issa, R. R., & Flood, I. (2011). Prediction of financial contingency for asphalt resurfacing projects using artificial neural networks. *Journal of construction Engineering and Management, 138*(1), 22-30.

Li, B., Akintoye, A., Edwards, P., & Hardcastle, C. (2004). *Risk treatment preferences for PPP/PFI construction projects in the UK.* Paper presented at the ARCOM Conference.

Lyons, T., & Skitmore, M. (2004). Project risk management in the Queensland engineering construction industry: a survey. *International Journal of Project Management, 22*(1), 51-61.

Mak, S., & Picken, D. (2000). Using risk analysis to determine construction project contingencies. *Journal of construction Engineering and Management, 126*(2), 130-136.

Mills, A. (2001). A systematic approach to risk management for construction. *Structural survey, 19*(5), 245-252.

Mohamed, D., Srour, F., Tabra, W., & Zayed, T. (2009). *A prediction model for construction project time contingency.* Paper presented at the Construction Research Congress 2009: Building a Sustainable Future.

Molenaar, K. R., & Wilson, C. R. (2009). *A risk-based approach to contingency estimation in highway project development.* Paper presented at the Construction Research Congress 2009: Building a Sustainable Future.

Moselhi, O., & Salah, A. (2012). Fuzzy Set-based Contingency Estimating and Management. *Gerontechnology, 11*(2), 188.

Mubarak, S. A. (2015). *Construction project scheduling and control*: John Wiley & Sons.

Murray, J. W., & Ramsaur, W. F. (1983). *Project Reserves: A Key to Managing Cost Risks*.

Narbaev, T., & De Marco, A. (2013). Combination of growth model and earned schedule to forecast project cost at completion. *Journal of construction Engineering and Management, 140*(1), 04013038.

Narbaev, T., & De Marco, A. (2017). Earned Value and Cost Contingency Management: A Framework Model for Risk Adjusted Cost Forecasting. *The Journal of Modern Project Management, 4*(3).

Nawar, S. E.-D. (2017). Owner time and cost contingency estimation for building construction projects in Egypt.

Nyagormey, J. J. (2016). *Determination of contingency sum for works procurement during tendering stage in Ghana.*

Odeyinka, H. A., & Yusif, A. (1997). The causes and effects of construction delays on completion cost of housing projects in Nigeria. *Journal of Financial Management of Property and Construction, 2*, 31-44.

Ojuri, O. B. (2013). *The 10% Standard or Lump sum-A Statistical Analysis of Estimating Construction Contingency accuracy.* Paper presented at the WEST AFRICA BUILT ENVIRONMENT RESEARCH (WABER) CONFERENCE.

Ortiz-González, J. I., Pellicer, E., & Howell, G. (2014). CONTINGENCY MANAGEMENT IN CONSTRUCTION PROJECTS: A SURVEY OF SPANISH CONTRACTORS.

Otali, M., & Odesola, I. (2014). Effectiveness evaluation of contingency sum as a risk management tool for construction projects in Niger Delta, Nigeria. *Ethiopian Journal of Environmental Studies and Management, 7*(6), 588-598.

Panthi, K., Ahmed, S. M., & Ogunlana, S. O. (2009). Contingency estimation for construction projects through risk analysis. *International journal of construction education and research, 5*(2), 79-94.

Patrascu, A. (1988). *Construction cost engineering handbook*: CRC Press.

Peckiene, A., Komarovska, A., & Ustinovicius, L. (2013). Overview of risk allocation between construction parties. *Procedia Engineering, 57*, 889-894.

Perez, D., Gray, J., & Skitmore, M. (2017). Perceptions of risk allocation methods and equitable risk distribution: a study of medium to large Southeast Queensland commercial construction projects. *International Journal of Construction Management*, *17*(2), 132-141.

Picken, D. H., & Mak, S. (2001). Risk analysis in cost planning and its effect on efficiency in capital cost budgeting. *Logistics information management, 14*(5/6), 318-329.

Pinto, J. K., Slevin, D. P., & English, B. (2009). Trust in projects: An empirical assessment of owner/contractor relationships. *International Journal of Project Management, 27*(6), 638-648.

PMI. (2017). PMI, P.M. I. 2017. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), Project Management Institute, Incorporated.

Polat, G., & Neval Bingol, B. (2013). A comparison of fuzzy logic and multiple regression analysis models in determining contingency in international construction projects. *Construction Innovation, 13*(4), 445-462.

Polesie, P. (2013). The view of freedom and standardisation among managers in Swedish construction contractor projects. *International Journal of Project Management, 31*(2), 299-306.

Polesie, P., Frödell, M., & Josephson, P.-E. (2009). *Implementing Standardisation in Medium-Sized Construction Firms: Facilitating Site Managers' Feeling of Freedom through a Bottom-up Approach.* Paper presented at the Proceedings for the 17th Annual Conference of the International Group for Lean Construction.

Potts, K., & Ankrah, N. (2014). *Construction cost management: learning from case studies*: Routledge.

Rauzana, A., Bakar, A. H. A., & Yusof, M. N. (2015). The Impact of Uncertainty Variableson Contingency Cost. *Australian Journal of Basic and Applied Sciences, 9*(7), 279-283.

Risner, R. (2010). Auditing construction contingency. *Association of healthcare internal auditors*(March), 37-38.

Rowe, J. F. (2006). A construction cost contingency tracking system (CTS). *Cost engineering, 48*(2), 31-37.

Ruskin, A. M. (1981). *Monitoring and Contingency Allowances: Complimentary Aspects of Project Control*.

Salah, A., & Moselhi, O. (2015). Contingency modelling for construction projects using fuzzy-set theory. *Engineering, Construction and Architectural Management, 22*(2), 214-241.

Samuel, E. I., & Snapp, O. J. (2015). Theorizing a Forward Difference Orthogonal Function Method of Computing Contingency Cost in Construction Projects. *International Journal of Construction Engineering and Management, 4*(5), 210-217.

Sastoque, L. M., Arboleda, C. A., & Ponz, J. L. (2016). A proposal for risk allocation in social infrastructure projects applying PPP in Colombia. *Procedia Engineering, 145*, 1354-1361.

Schneck, D., Laver, R., & O'Connor, M. (2009). Cost Contingencies, Development Basis, and Project Application. *Transportation Research Record: Journal of the Transportation Research Board*(2111), 109-124.

Shumway, R., Richard, A., & Ritti, J. (2004). New trends and bad results in construction contracts, part II. *Leadership and Management in Engineering, 4*(3), 99-104.

Skorupka, D. (2003). Risk management in building projects. *AACE International Transactions*, RI191.

Smith, G. R., & Bohn, C. M. (1999). Small to medium contractor contingency and assumption of risk. *Journal of construction Engineering and Management, 125*(2), 101-108.

Taylan, O., Bafail, A. O., Abdulaal, R. M., & Kabli, M. R. (2014). Construction projects selection and risk assessment by fuzzy AHP and fuzzy TOPSIS methodologies. *Applied Soft Computing, 17*, 105-116.

Teye Buertey, J. I., Abeere-Inga, E., & Adjei Kumi, T. (2012). Project cost contingency estimation in Ghana: an integrated approach.

Thal Jr, A. E., Cook, J. J., & White III, E. D. (2010). Estimation of cost contingency for air force construction projects. *Journal of construction Engineering and Management, 136*(11), 1181-1188.

Tichacek, R. L. (2004). Contingency Misuse and Other Risk Management Pitfalls. *AACE International Transactions*, RI41.

Touran, A. (2003a). Calculation of contingency in construction projects. *IEEE Transactions on Engineering Management, 50*(2), 135-140.

Touran, A. (2003b). Probabilistic model for cost contingency. *Journal of construction Engineering and Management, 129*(3), 280-284.

Tseng, C. L., Zhao, T., & Fu, C. C. (2009). Contingency estimation using a real options approach. *Construction Management and Economics, 27*(11), 1073-1087.

Uzzafer, M. (2013). A contingency estimation model for software projects. *International Journal of Project Management, 31*(7), 981-993.

Xie, H., AbouRizk, S., & Zou, J. (2011). Quantitative method for updating cost contingency throughout project execution. *Journal of construction Engineering and Management, 138*(6), 759-766.

Zaghloul, R., & Hartman, F. (2003). Construction contracts: the cost of mistrust. *International Journal of Project Management*, *21*(6), 419-424.

Zou, P. X., Chen, Y., & Chan, T.-Y. (2009). Understanding and improving your risk management capability: Assessment model for construction organizations. *Journal of construction Engineering and Management, 136*(8), 854-863.

Annexure – I

Contingency Utilization in Construction Projects: A psycho-contractual framework

Respected Sir/Madam,

This survey is being carried out as part of MS research titled "Contingency utilization in construction projects: A psycho-contractual framework." The research is aimed at finding the upcoming problems with contingency management. Based on the findings, this study will propose certain guidelines for contingency utilization. This survey will help in assessing industrial practices regarding contingency management. Your contribution towards this research is highly appreciated.

Please be assured that the data will only be used for study purpose and no personal information will be disclosed at any forum. Please click next to continue and complete the survey and remember to click submit at the end. In the case of any inquiry, please feel free to contact.

Regards,
Zohaib Khaliq
Graduate student
Dept. of Construction Engineering & Management
School of Civil & Environmental Engineering
National University of Sciences & Technology (NUST)
Islamabad, Pakistan
Email: **zkhaliq.cem7@nit.nust.edu.pk**

*Required

Section-1

Personal Information

1. Please indicates your highest academic qualification.
   - B.Tech
   - B.Sc/B.Eng
   - M.Sc/M.Eng/M.Tech/P.Dip
   - Ph.D./D.Eng
   - Other:

2. Please indicate your years of professional experience

- From 1 to 5
- From 6 to 10
- From 11 to 15
- From 16 to 20
- From 21 and above

3. Please indicate your field of work (Please select all that may apply).
- Architecture
- Building design
- Infrastructure management
- Construction management
- Quantity surveying
- Engineering
- Facility management
- Site execution
- Project management
- Financial consultancy
- Other: ____________

4. Please indicate your job title.

- Project director
- Project manager
- Construction manager
- Contract administrator
- Assistant manager
- Site manager
- Project engineer
- Architect/Designer
- Consultant
- University teacher/professor
- Other: ____________

5. Type of organization.
- Client
- Consultant
- Contractor
- Other

6. Please select relevant age group (X) years.
- 21 < X < 25
- 25 < X < 30
- 30 < X < 35

- $35 < X < 40$
- $40 < X < 50$
- $X > 50$

7. Countries in which you have working experience

Section-2

Limitation of the survey:

The survey is limited to the projects performed under cost-plus Guaranteed Maximum Price (GMP). Kindly keep this in mind while giving your feedback.

1. Does your organization carry out systematic project risk management before the submission of the bid? *
   - Yes
   - No
   - Other_____________
2. How do you define 'Cost contingency' concerning your organizational terminology?(Please select all that apply) *
   - Funds which are an uncertain portion of contractor's profit margin
   - Extra funds which will provide a cushion for change orders
   - Funds for dealing with projects known and unknown risks
   - Funds which will entertain any changes to the project scope
   - Extra funds kept to overcome estimating errors
   - Extra funds to negate the effect of inflation
   - Funds for design changes
   - Other_____________
3. What are the intended objectives of Cost contingency? (Please select all that apply) *
   - On time project completion
   - On budget project completion
   - Stakeholder satisfaction
   - Ensure safety on the project
   - Ensure quality of executed work
   - Facility improvement
   - Other_____________

4. What kind of approach does your organization use to estimate the amount of contingency funds? *

- Traditional percentage approach (x% of total project cost)
- Estimating using risk analysis (ERA)
- Monte-Carlo simulation (MCS)
- Sensitivity analysis
- Other_____________

5. In your experience, under cost-plus GMP contracts, planned cost contingency funds are how much (in percentage) of total project cost for EPC projects.

6. In your experience, under cost-plus GMP contracts, actual cost contingency funds are how much (in percentage) of total project cost for EPC projects.

7. When the cost contingency funds are received by the contractor. *

- Full payment after the award of the contract.
- Partial payment based on Interim Payment Certificates (IPC) generated by the contractor and approved by the consultant
- Partial payment at milestones.
- Partial payment based on contingency demand of project.
- Vary project to project due to lack of standard managerial and contractual guidelines
- Other_____________

8. From the start till the execution of the project; Cost contingency funds are physically available in *

- Contractor's account
- Owner's account
- Consultant's account
- An escrow account (client and contractor's joint account)
- Other_____________

9. Which party owns excess contingency at the project completion*

- Contractor
- Owner
- Consultant
- The disputed issue as there are no standard contractual guidelines
- Depend on the specific provision defined in the contract between client and contractor
- Owner's prerogative
- Other_____________

10. Do you or your organization plan the spending of cost contingency during project execution? *

- Yes
- No

- Other______________

11. Do you or your organization monitor the spending of cost contingency during project execution?

- Yes
- No
- Other ___________

12. In your experience the percentage of EPC projects (X) under cost-plus GMP contract, that consumes all of their estimated/planned cost contingency funds before project completion. *

- None of the project
- 1 % < X <25 %
- 25 % < X < 50%
- 50 % < X < 75 %
- 75 % < X < 100 %
- All the projects

13. How does your organization respond latter risks after exhaustion of planned/estimated cost contingency? (Please select all that apply) *

- Request extra contingency funds from client
- Cut-off profit margin to respond latter risks
- Let things go on until project completion
- Compromise on quality of work and save funds for risk response
- Other ___________

14. How do you decide the timing and amount of contingency to be released; as a risk response? *

- Organizations have its own sets of guidelines, which help in decision making
- Based on gut feeling, as there are no published guidelines.
- Based on personal experience
- Based on published guidelines
- Other ___________

Section-3

Contingency Depletion:

Literature was thoroughly reviewed, and following contingency depletion patterns of cost, contingency was identified.

1. Front-loaded curve (FEL)

FEL shows a PM's aggressive usage of contingency. Aggressive spending means more contingency will be depleted in the early phase of project and less in the finishing phase

2. Back-loaded curves (BEL)

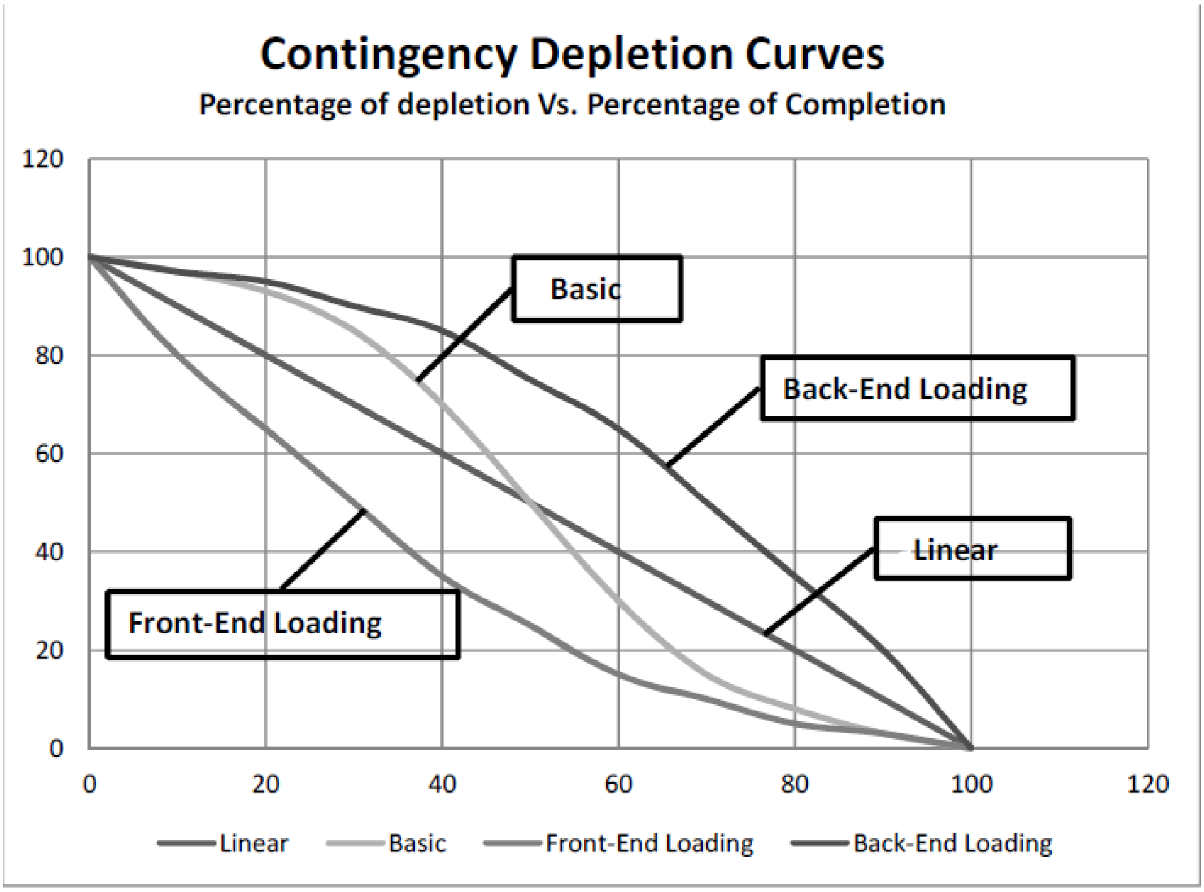
BEL shows a PM's passive spending of contingency. Passive spending means less spending of a contingency during early phase and more spending in the finishing phase

3. Basic (S-curve)

Basic spending indicates a PM's will consume contingency as per cost baseline of the project, which normally is S-curve. In basic S-curve, the spending of contingency will be less in early and finishing phase, but spending rate is more during the middle phase of the construction project

4. Linear

It shows uniform contingency utilization throughout the project life. Contingency will spend linearly concerning the percentage of the construction project completed, i.e. at 60 % of project completion 60 % of contingency funds will be consumed.



Scenario

Suppose your CEO has appointed you as Project Manager (PM) for the execution of an Engineering Procurement and Construction (EPC) project. The contractual relationship between your organization and the Client is based on Cost-Plus Granted Maximum Price (GMP). According to your CEO; financial experts of the organization came up with $ 2 Million GMP. The project must be executed within two years. Otherwise firm has to face plenty of $ 5000/day in the shape of liquidity damages. To ensure that project will be completed with targets $ 100,000 in contingency are kept in an escrow account, which will only cover the execution phase of the project. According to one of the specific contract provisions, excess contingency will be owned by the client at project completion. CEO of your organization stressed that every last penny of 100,000 dollar contingency must be consumed to avoid any delay, cost overrun, to ensure; the quality of work, the safety of workers and satisfaction of the client.

Must read the above information before answering the following questions.

1. CEO has asked to apply your experience to suggest the most likely spending of contingency under the established scenario. *

    - Linear
    - Basic
    - Front-End Loading (FEL)
    - Back-End Loading (BEL)

To avoid opportunity cost due to blockage of contingency in an escrow account. CEO has also asked you to apply your experience to give a tentative cumulative utilization of 100,000 at different phases of project execution.

2. Total cost contingency funds that you plan to use from the start of the project until the 5 % Project completion. (Select figure in between 1,000 and 100,000)

3. Total cost contingency funds that you plan to use from the start of the project until the 10 % Project completion (Select figure in between 1,000 and 100,000)

4. Total cost contingency funds that you plan to use from the start of the project until the 15 % Project completion (Select figure in between 1,000 and 100,000)

5. Total cost contingency funds that you plan to use from the start of the project until the 20 % Project completion (Select figure in between 1,000 and 100,000)

6. Total cost contingency funds that you plan to use from the start of the project until the 30 % Project completion (Select figure in between 1,000 and 100,000)

7. Total cost contingency funds that you plan to use from the start of the project until the 40 % Project completion (Select figure in between 1,000 and 100,000)

8. Total cost contingency funds that you plan to use from the start of the project until the 50 % Project completion (Select figure in between 1,000 and 100,000)

9. Total cost contingency funds that you plan to use from the start of the project until the 60 % Project completion (Select figure in between 1,000 and 100,000)

10. Total cost contingency funds that you plan to use from the start of the project until the 70 % Project completion

11. Total cost contingency funds that you plan to use from the start of the project until the 80 % Project completion (Select figure in between 1,000 and 100,000)

12. Total cost contingency funds that you plan to use from the start of the project until the 85 % Project completion (Select figure in between 1,000 and 100,000)

13. Total cost contingency funds that you plan to use from the start of the project until the 90 % Project completion (Select figure in between 1,000 and 100,000)

14. Total cost contingency funds that you plan to use from the start of the project until the 95 % Project completion (Select figure in between 1,000 and 100,000)

15. Total cost contingency funds that you plan to use from the start of the project until the 100 % Project completion (Select figure in between 1,000 and 100,000)