THE SECONDARY RISK CONUNDRUM IN CONSTRUCTION PROJECTS – AN ASSESSMENT OF THE BEHAVIORAL BIASES

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ABSTRACT

Effective project risk management is achieved through identification, assessment, and redressal of risk. However, even a well-developed risk response action has the potential to trigger risky events – also called secondary risks – which would not occur if this action were not taken. This points to the susceptibility of the decision-making process to cognitive biases. This study investigates which of these biases exposes the risk response actions to generation of secondary risk. For this purpose, several behavioral factors and cognitive biases are synthesized from the literature and the top selected factors are investigated through semi-structured interviews of senior construction management professionals. It is found that they are not mindful of their decisions giving rise to the secondary risk and the most influencing factor causing this is availability. Therefore, debiasing strategies are provided to fine-tune decision-making. This study emphasizes holistic, informed, farsighted and unbiased decision-making to improve the project risk management.

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Chapter 1

INTRODUCTION

1.1 OVERVIEW

Emergence of risk is possible at any point in the project which may affect the triple constraints of project success (time, cost and quality) if dealt ineffectively in project management process (Zhang & Fan, 2014). Project risk management includes risk management planning, risk identification, risk analysis, risk response development, response implementation, monitoring and control. There is no dispute over the importance of effective risk management for the success of a project (Hillson, 1999). The unsuccessful risk assessment is one of the causes of poor performance of construction projects affecting both planning and execution stages resulting into ineffective and flawed outcomes (Farooq, Thaheem, & Arshad, 2018). Therefore, to promise the successful achievement of project objectives, identification and evaluation of probable risks along with the determination and implementation of suitable risk response actions is of immense importance.

1.2 RISK RESPONSE ACTIONS

Risk response refers to identification, evaluation, selection and implementation of actions (strategies) to minimize the probability of risk occurrence or to reduce the negative effects of those risks (Zhang & Fan, 2014). Determining suitable set of Risk Response Actions (RRAs) plays a vital part in project risk management (PRM) and is imperative for project success (Zuo & Zhang, 2018). According to Hillson (1999), an ineffective response development will never let risk management deliver its promised

advantages as identified and assessed risks will keep posing a threat to the project. Considerable attention should be given to risk response as it is a significant component and to choose an optimal strategy, an advanced method must be used (I. Naji & Hussein Ali, 2018).

1.3 SECONDARY RISK

Risk being an uncertain event may have favorable or adverse effects on project goals once it occurs. Such risk is referred as primary risk. It occurs at time, that a risk managing attempt avoided one risk but aggravated another that was tougher to detect (Hubbard, 2009) or in other words, more risks are introduced than removed as a result of implementation of an RRA in a project (Hillson, 1999). Such risks are called secondary risks. According to Project Management Body of Knowledge (PMI, 2017), the materialization of secondary risk can be considered as a direct result of employing a response that addresses primary risk.

Zuo et al (2018) gave an example of buckling of an offshore pipeline. A suitable response to which would be guiding a Pipeline Intervention Gadget (PIG) to do the cleaning through the pipeline. A potential secondary risk in this situation may be realized if the gadget is stuck in the middle of the pipeline. If this risk response was not taken, the secondary risk would not have

occurred. Secondary risks should be assessed for pertinent action. A certain risk response action may be eliminated as an option, if the secondary risk exceeds the risk tolerance level of the project owing to its severity.

Majority of existing RRA selection methods mainly focuses on mitigating the primary risks without considering secondary risks that might occur during the application of a

selected RRA (Zuo & Zhang, 2018). An appropriate RRA can never be selected unless all the barriers that come in way of its effective selection are identified and caught by their roots. No matter how many models and tools are suggested and proposed for the improvement of risk response system to avoid materializing secondary risk, they will not be entirely effective unless their causes are understood completely. A simple way is to think of selection of best risk response as a game of chess in which one must think of as many moves ahead as possible. It is akin to considering reactions to a reaction and consequences that could arise from dealing with a risk.

1.4 PROBLEM STATEMENT

In practice, insufficient consideration is given to risk response comparative to risk identification and risk analysis, and it lacks a broadly recognized model or tool for choosing proper response strategies. Thus, it does not have a basic process for project managers to follow (Fan, Lin, & Sheu, 2008). Advancement of risk response is probably the most vulnerable part of risk process (Zuo & Zhang, 2018). It is probably because several separate disciplines are involved in the risk process: during identification, the major stakeholders are construction technicians and experts, but they are replaced with risk experts during analysis and must be reintroduced during the response development. This changing over of primary stakeholders is a tiring process and construction organizations end up using risk experts for the entire process.

Furthermore, tools and procedures followed by construction companies for an effective and successful management of project risk need improvement to achieve

project goals. Regardless of the error most ineffective methods add to the assessment, they are applied with absolute confidence. Resulting in flawed judgments that would not else have been made (Hubbard, 2009). Decision-making in uncertain situations is also influenced by risk attitude (Elwell, 2009). Perception of risk, to a certain degree, is based on the personal attitude of the decision-maker (Lefley, 2018). Majority of the procedures of risk assessment essentially depend on at minimum some subjective contributions by human, but to the surprise, they make constant sort of blunders in decision about uncertainty and risk (Hubbard, 2009). Unfortunately, professionals' intuitions do not all arise from true expertise. We are often confident even when we are wrong (O'Brien, 2012). Research and experience both suggest that the attitude of individuals and organizations has a momentous impact on whether risk management delivers what it promises. Further complexity is created due to human element in risk process (Elwell, 2009). The reason of ineffectuality of selected response cannot be judged without identifying these barriers that render the decision-making poor at response development stage. To obtain the expected benefits from risk management tools, improved risk knowledge management process is needed (Cagliano, Grimaldi, & Rafele, 2015). The competences and constraints of the human, need to be well-thought-out so that any issues that overload the limited cognitive capacity can be resolved to facilitate decision-making (Williams & Noyes, 2007). Hence to avoid secondary risks from materializing, it is extremely important to figure the root cause of their generation and taking corrective actions to reduce the probability of their occurrence, from the very start. This makes it imperative to recognize the main barriers that result in ineffective response development, eventually causing secondary risks. The efforts and money spent by the project management team for improved risk

management will not reduce the risk exposure of the project unless a sophisticated process is adopted that caters for the ideal response actions considering secondary risks. Therefore, identification of the causes of secondary risk is required for an optimal risk response selection to enhance project success chances.

1.5 RESEARCH OBJECTIVES

- To identify the barriers related to human behavior in effective risk response development.
- To assess the top influencing behavioral factors in developing risk response actions.
- To propose strategies to control behavioral factors that ultimately influence secondary risk occurrence.

1.6 SIGNIFICANCE OF STUDY

This study might help construction industry understanding and catering for the causes of secondary risk happening hence improving the chances of project success.

1.7 RELEVANCE TO NATIONAL NEEDS

The construction industry of Pakistan is growing so is the project risk exposure and the need for the determination of the risk position after implementation of a response. Due to unawareness of the importance of effective risk responses, projects are vulnerable to delays, cost over-runs and poor quality. To improve project performance and assure timely delivery it is vital to opt for suitable RRAs to reduce primary and secondary risks which will be hard without completely comprehending the true causes of the secondary risks. Eluding secondary risk causes would allow the construction companies to maximize profits and minimize expenses by selecting effective

responses for primary risk. Risk management process of construction projects might benefit from this study by getting to select effective risk response actions, knowing the causes of secondary risk and avoiding them.

Chapter 2

LITERATURE REVIEW

2.1 DECISION-MAKING IN CONSTRUCTION INDUSTRY

About all the phases of a construction process, from planning the project through its execution to the phase of using a built structure one must make decisions in construction industry (Szafranko, 2017). Decision-making is the essence of management, considered as a product of mental processes guiding to opt a course of actions amongst various substitutes (Albar & Jetter, 2009). Significant part of decision-making process for all construction companies is risk management (Mills, 2001). Mostly literature discusses about the poor decision-making and assessment, resulting in deficient risk response development… but what manifests such decisions is neglected (Gupta & Thakkar, 2018). Methods for optimal risk response selections have been proposed in literature (Zhang & Fan, 2014), but factors inducing poor response development ultimately materializing secondary risks are not much explored. Hence there is a need of recognizing causes of secondary risks for better selection of a risk response action and improved chances of project success.

2.2 THEORIES OF DECISION-MAKING

Several decision-making theories have been proposed to capture the essence of motivation, inputs, mechanics, scrutiny, and follow-up of rational human behavior when determining a future course of action under risk and uncertainty. Few selected theories are briefly described in Table 1.

No.	Name	Year	Theorist	Fundamental Premise
1	Probability theory	1654	Blaise Pascal and Pierre de Fermat	It is a theory of evaluating and making statements regarding the likelihood of occurrence of uncertain events. It provides the means to reasonably model, analyze and explain problems where the prediction of future events lacks confidence.
2	Expected utility theory	1738	Daniel Bernoulli	It asserts that the decision-maker picks amongst risky or uncertain scenarios by evaluating their expected utility values; i.e., the weighted sums attained by adding the utility values of outcomes multiplied by their respective probabilities.
3	Game theory	1944-1950	Emile Borel, John Von Neumann, and John Nash	It provides a set of ideas meant for decision-making in states of competition and conflict under definite rules. It engages games of strategy (such as chess) but not of chance (such as rolling a dice). A strategic game denotes a condition where two or more contributors are confronted with choices of action, by which each may benefit or lose,

No.	Name	Year	Theorist	Fundamental Premise
				reliant on what others select to do or not to do. Therefore, the result of a game is established mutually by the strategies selected by all contributors. These are also conditions of uncertainty as no contributor is aware of what the other participant is going to choose.
4	Prospect theory	1979-1992	Daniel Kahneman and Amos Tversky	It explains the way individuals select among probabilistic substitutes that include risk, where the likelihood of outcomes is uncertain. It posits that people make judgments built on the possible value of losses and gains rather than the outcome and that people assess these losses and gains by means of some heuristics.
5	Quantum cognition theory	1990s	Diederik Aerts, Jan Broekaert, Sonja Smets, Liane Gabora, Harald Atmanspach	It is a rising field that uses mathematical logic of quantum theory to model cognitive events, like information managing by the individual's brain, language, decision-making, memory, concepts and conceptual reasoning, human judgment, and opinion. Quantum cognition is grounded on the quantum-like model that information processing by complex systems such as the brain, considering contextual

No.	Name	Year	Theorist	Fundamental Premise
			er, Robert Bordley and Andrei Khrennikov	dependence of information and probabilistic perceptive, can be mathematically defined in the framework of quantum info and quantum probability theory.

Table 1: Decision-making theories

An exuberant correspondence between Pascal and Fermat began in 1654, regarding the problems and queries with games of chance, arrangement of objects and chance of winning a fair game. Concept of probability, expected value and conditional probability was introduced as an outcome of this communication and is viewed as the advent of traditional probability theory (Debnath & Basu, 2015). Despite the beauty of the theory, validity of its description was beset by inconsistent data (Hammerstein & Stevens, 2016). Theory of expected utility presented a new concept of expected utility. Ascertaining that decision maker choose among risky or uncertain situations by evaluating their expected utilities rather than their expected values. It prevailed for some years as normative and descriptive model of decision-making under ambiguity. But was critically questioned later. A significant body of evidence showed that decision makers steadily breach its basic dogmas. Major violations in choices between risky prospects of expected utility were then explained by prospect theory (Tversky & Kahneman, 1992). Alike most other economic models, major concern with game theory was in its supposition that individuals are rational, self-serving and utility-maximizing actors. Game theory couldn't substantiate the fact that people might not always fall into a Nash equilibrium, depending on the societal situation and individual's attributes (Chowdhury, 1944). Two approaches have been perceived to emerge to surface in years

of research i.e. ‘heuristic’ and ‘rational. Herbert Simon’s idea of bounded rationality strongly ingrains the heuristic approach. Suggesting that individuals are prone to use simple heuristics which does not always seem rational when judging and making decisions (Bruza, Wang, & Busemeyer, 2015). Quantum theory based, models of cognition and decision-making have been a topic of interest lately. Quantum theory offers an alternate probabilistic framework for modelling decision-making collated with traditional probability theory, and has been effectively used to cater behavior related inconsistent or irrational from a conventional point of view (Yearsley & Busemeyer, 2016).

2.3 BEHAVIORAL FACTORS

Behavioral factors are known to influence the decision-making process and consequently increase the chances of secondary risk formation. A detailed literature review was performed to identify these factors and score them through content analysis where relative importance based on the cumulative frequency of appearance in the literature was quantified, as shown in Table 2. Owing to a large collection of these factors, a screening was performed and factors with the cumulative frequency of 0.5 or less were considered for further study (Ahmad, Jamaluddin, & Maqsoom, 2018; Ullah, Ayub, Qayyum, & Thaheem, 2016). This helped in selecting the top seven factors. But it is important to note that the most frequently appearing factor, cognitive heuristics and bias, is a combined term and contains several cognitive errors and biases. Therefore, the next six factors have been used for data collection and analysis.

No.	Factor	Frequency	Cumulative frequency	References
1	Cognitive heuristics and bias	11	0.122	Woods, Johannesen Richard I Cook, & Sartor, 1994; Stingl & Geraldi, 2017; Williams & Noyes, 2007; Makridakis & Taleb, 2009; Ajzen, 1996; Hubbard, 2009; Kahneman, 2011; Tversky & Kahneman, 1974; Beresford & Sloper, 2008; Kahneman & Tversky, 1973; Cindy Dietrich, 2018
2	Availability/accessibility bias/readily available internal information	7	0.2	Stingl & Geraldi, 2017; Ajzen, 1996; Kahneman, 2011; Tversky & Kahneman, 1974; Kahneman & Tversky, 1973; Cindy Dietrich, 2018; Albar & Jetter, 2009
3	Representativeness	6	0.266	Ajzen, 1996; Hubbard, 2009; Kahneman, 2011; Tversky & Kahneman, 1974; Le & Wartschinski, 2018; Kahneman & Klein, 2009
4	Emotion	6	0.333	Kahneman, 2011; Elwell, 2009; Beresford & Sloper, 2008; Toda, 1980; Ambady & Gray, 2002; Loewenstein, Hsee, Weber, & Welch, 2001
5	Optimism bias	5	0.388	Stingl & Geraldi, 2017; Makridakis & Taleb, 2009; Ajzen, 1996; Kahneman, 2011; Beresford & Sloper, 2008
6	Anchoring	5	0.444	Stingl & Geraldi, 2017; Kahneman, 2011; Tversky & Kahneman, 1974; Cindy Dietrich, 2018; Kahneman & Klein, 2009
7	Framing effect	5	0.5	Williams & Noyes, 2007; Hubbard, 2009; Kahneman,

No.	Factor	Frequency	Cumulative frequency	References
				2011; N.N., D.G., & M.W., 2016; Beresford & Sloper, 2008
8	Intuition/gut feel	4	0.544	Kahneman, 2011; Buchanan, 2006; Albar & Jetter, 2009 Kahneman & Klein, 2009
9	Hindsight bias	3	0.577	Woods et al., 1994; Kahneman, 2011; Cindy Dietrich, 2018
10	Law of small numbers	3	0.611	Hubbard, 2009; Kahneman, 2011; Tversky & Kahneman, 1974
11	Insensitivity to prior probabilities/ base rate fallacy	3	0.644	Hubbard, 2009; Tversky & Kahneman, 1974; Welsh & Navarro, 2012
12	Risk attitude	3	0.677	Elwell, 2009; Beresford & Sloper, 2008; Lefley, 2018
13	Risk perception	2	0.7	Williams & Noyes, 2007; Lefley, 2018
14	Disregarding variance in small samples	2	0.722	Hubbard, 2009; Kahneman, 2011
15	Overconfidence	2	0.744	Hubbard, 2009; Kahneman, 2011
16	Retrievability bias	2	0.766	Tversky & Kahneman, 1974; Kahneman & Tversky, 1973
17	Illusory correlation	2	0.788	Tversky & Kahneman, 1974; Kahneman & Tversky, 1973
18	Episodic future thinking/ Farsightedness	2	0.811	Benoit, Gilbert, & Burgess, 2011; Schacter, Benoit, De Brigard, & Szpunar, 2015
19	Conjunction fallacy	1	0.822	Hubbard, 2009
20	Self-serving bias	1	0.833	Ajzen, 1996
21	Cognitive ease	1	0.844	Kahneman, 2011

No.	Factor	Frequency	Cumulative frequency	References
22	Halo effect	1	0.855	Kahneman, 2011
23	WYSIATI	1	0.866	Kahneman, 2011
24	Insensitivity to sample size	1	0.877	Tversky & Kahneman, 1974
25	Insensitivity to predictability	1	0.888	Tversky & Kahneman, 1974
26	Illusion of validity	1	0.9	Tversky & Kahneman, 1974
27	Misconception of regression	1	0.911	Tversky & Kahneman, 1974
28	Bias due to the effectiveness of a search set	1	0.922	Tversky & Kahneman, 1974
29	Imaginability bias	1	0.933	Tversky & Kahneman, 1974
30	Insufficient adjustment	1	0.944	Tversky & Kahneman, 1974
31	Dogmatism	1	0.955	Lefley, 2018
32	Over-dependence on prior knowledge	1	0.966	Cindy Dietrich, 2018
33	Episodic counterfactual thinking	1	0.977	Schacter et al., 2015
34	Episodic memory	1	0.988	Schacter et al., 2015
35	Substitution bias	1	1	Kahneman & Klein, 2009

Table 2: Behavioral influences in decision-making

Decision-making is a resource-intensive process, demanding significant time and dedication of several individuals and groups particularly in the workplace, and it is even more so for the people involved in risk management (Doyle & Dolan, 2015). However, the human element tends to exaggerate the complexity of risk procedure, with numerous obvious as well as hidden influences (Elwell, 2009). Behavioral

decision-making tries to comprehend the true influences on an individual's choice-making (Mullaly, 2014). In exercise, project managers often recollect past alike projects or risk occasions when facing the difficulty of selecting risk response approaches for the recent project. They tend to employ earlier experience from their memory in the form of experiences acquired, case studies and quality procedures to choose the right approach from a group of several promising approaches (Zhang & Fan, 2014).

Cognitive scientists have strived long to completely apprehend the ways people make judgments and decisions in situations of conflict and uncertainty (Bruza et al., 2015). Different cognitive and emotional limitations in an individual's psychology of choice-making are exposed by studies that hamper human logic and cause systematic errors (Albar & Jetter, 2009). There are many factors related to one's behavior that influence the quality of decisions during response development. Most decisions are grounded on tenets concerning the likelihood of uncertain events. These decisions are all built on data of partial rationality, which are processed in accordance with heuristic rules (Tversky & Kahneman, 1974). Primarily, Simon nurtured the idea of heuristics by proposing a behavioral model of rational choice that reasons for *'limited'* rationality, where decisions are rendered by the course of dynamic adjustment on both extrinsic (environmental) and intrinsic (human characteristics) factors (Furnham & Boo, 2011). However, the reliance on these rules leads to systematic errors (Tversky & Kahneman, 1974).

Following a logic for problem-solving, that is quite different from consequential logic, heuristics are simple ground rules which cause irrational decision behavior. Therefore, they are viewed as an inferior method for decision-making since long

(Albar & Jetter, 2009). Individuals rely on heuristics for ease and speed in decision-making (Cindy, 2010). A related concept is bias – a propensity to think and act in a way that inhibits rationality and neutrality. According to Hubbard (2009), these heuristics and biases influence both what is managed to recall and how this recalling is interpreted. A better comprehension of these heuristics and biases can improve judgments and decisions under uncertainty (Morvan & Jenkins, 2017).

The taxonomy of Arkes (1991) is useful for understanding biases. It classifies biases by their psychological origin: association-based (AB) errors, which are a consequence of involuntary mental associations; psychophysically-based (PB) errors, which result from inaccurate mappings amongst physical stimuli and mental reactions; and strategy-based (SB) errors, which befall when decision-makers employ a suboptimal cognitive strategy (Montibeller & von Winterfeldt, 2015). Larrick (2004) linked the three types of biases to two cognitive systems—System 1 (intuition) and System 2 (reasoning). The procedures of System 1 are automated, effort free and quick whereas the procedures of System 2 are monitored, effortful and slow (Kahneman, 2011). It is argued in the literature that AB and PB errors are associated to System 1 procedures, whereas SB errors are associated to System 2 procedures (Lee, 2019).

The six behavioral factors selected through content analysis are categorized into these errors as shown in Figure 1 and explained subsequently.

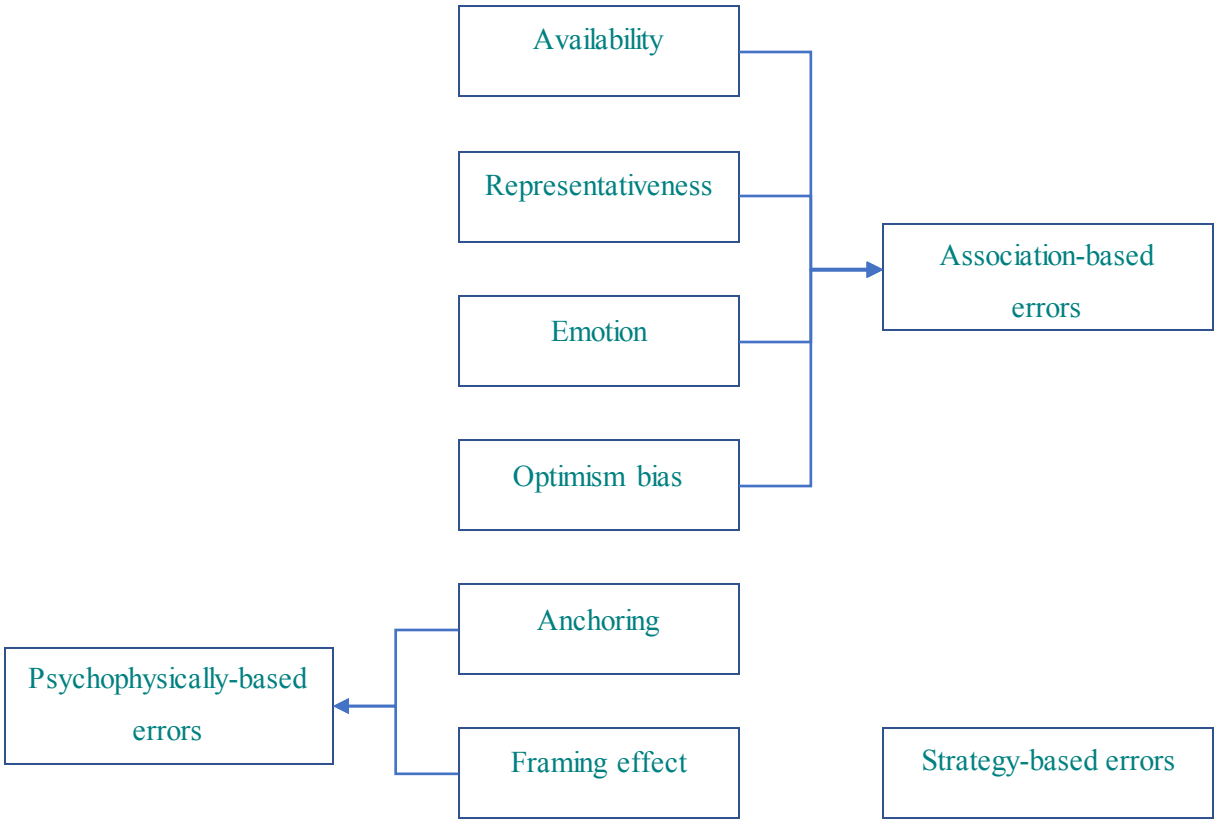

Figure 1: Behavioral factors and errors

2.4 ASSOCIATION-BASED ERRORS

AB errors involve associations within semantic memory that are irrelevant or even counterproductive to a judgment or decision. One such heuristic is representativeness which is one of the most important behavioral factors (Cindy Dietrich, 2018). It is the extent to which an event is identical in essential attributes to its source population and reflects the prominent features of the course by which it is created. When people depend on representativeness to reach a decision, they are expected to judge erroneously since more representativeness of something does not essentially make it more likely. But then, individuals imply the availability heuristic when they guess frequency or likelihood by the ease with which occurrences could be recollected. Thus, one can evaluate the numerosity of a class, the probability of an occurrence or the chronicity of co-occurrences by assessing the comfort with which the related

mental process of retrieval or affiliation can be carried out (Tversky & Kahneman, 1973).

Alternatively, the overestimation of favorable outcomes and the underestimation of negative outcomes are described as optimism bias. This is an umbrella term for several cognitive biases (Stingl & Geraldi, 2017). When predicting the outcomes of risky projects, managers fall prey to the planning fallacy quite easily. Influenced by it, they make decisions based on a deceptive optimism rather than on a logical assessment of gains, losses, and odds. They overrate benefits and underrate expenses, causing strategic misrepresentation. They turn to the scenarios of success while overseeing the probability of errors and inaccuracies. It results in such initiatives that are improbable to accomplish in time or within budget or to provide the anticipated returns or even to be completed. In this regard, people repeatedly (but not always) take on risky projects because they are exaggeratedly optimistic about the chances they face (Kahneman, 2011). While investigating this phenomenon in infrastructure projects, Flyvbjerg (2009) probed the reasons for investment decisions in the worst infrastructure projects. Further, the risk attitude of an individual affects decision-making in uncertain situations – it may cause stimulus spending or miser saving. The emotional state of an individual is one of the substantial contributors to risk attitude (Doyle & Dolan, 2015). Emotions might cause a misestimation of the probability of occurrence (Montibeller & von Winterfeldt, 2015). In the same way, subjective confidence is mostly established by the internal uniformity of the information on which a decision is based, rather by the quality of information (Kahneman & Klein, 2009).

2.5 PSYCHOPHYSICALLY-BASED ERRORS

PB errors ensue when individuals map physical stimuli onto psychological responses nonlinearly. One such error is anchoring. Slovic (1967) first originated the idea of anchoring in decision-making. However, the anchoring effect mentioned in the current study was first introduced by Tversky and Kahneman (1974) in their pioneering work on decision under uncertainty (Wilson, Houston, Etling, & Brekke, 1996). In their opinion, anchoring is an uneven effect on decision-makers to make judgments that are partial to an initially proposed value (Furnham & Boo, 2011). It means that they rely too heavily on an initial bit of information to make consequent judgments.

Another PB error is the framing effect. Richard Feynman stated that two mathematically equivalent statements can be unequal in the way that they manifest themselves to the human mind differently. Likewise, research shows that an individual's understanding of risk is influenced by the way it is framed (N.N. et al., 2016).

2.6 STRATEGY-BASED ERRORS

SB errors occur when humans use a suboptimal approach rather than an ideal one. Using a suboptimal strategy could be helpful because it is quick and simple to perform. Although the suboptimal strategy may be adaptive, it can be costly and result in more errors. For example 'insensitivity to the prior probability of outcomes', also called base rate neglect, which defines individuals' propensity to underweight previous knowledge in support of new information (Welsh & Navarro, 2012). Similarly, if conjunction (joint occurrence) of two events is more probable than the essential event, particularly if the probability judgment is based on a reference case

that is like the conjunction. In other words, when it is assumed that specific conditions are more probable than a single general one, then judgments are thought to be biased due to conjunction fallacy (Hubbard, 2009).

These errors and behavioral factors influence the RRA decision-making in such a way that the risk mitigation strategies become partly effective and act as a source for secondary risks.

Chapter 3

RESEARCH METHODOLOGY

To investigate the chances of secondary risk occurrence due to behavioral errors while developing RRAs in construction projects, this study is completed in four stages. In the first phase, decision influencing behavioral factors were identified through a detailed literature review. Content analysis was performed for the identification of top factors and the less important ones were screened out, as previously explained. Further, a representative sample size for data collection was established in the second phase. Afterward, a data collection instrument comprising of genuine risk and decision scenarios in the context of construction projects was developed in the third phase. Applying this tool, data was gathered in the fourth phase and thorough analysis was done on it. A detailed explanation of all these steps shown in Figure 2 is provided in the subsequent sections.

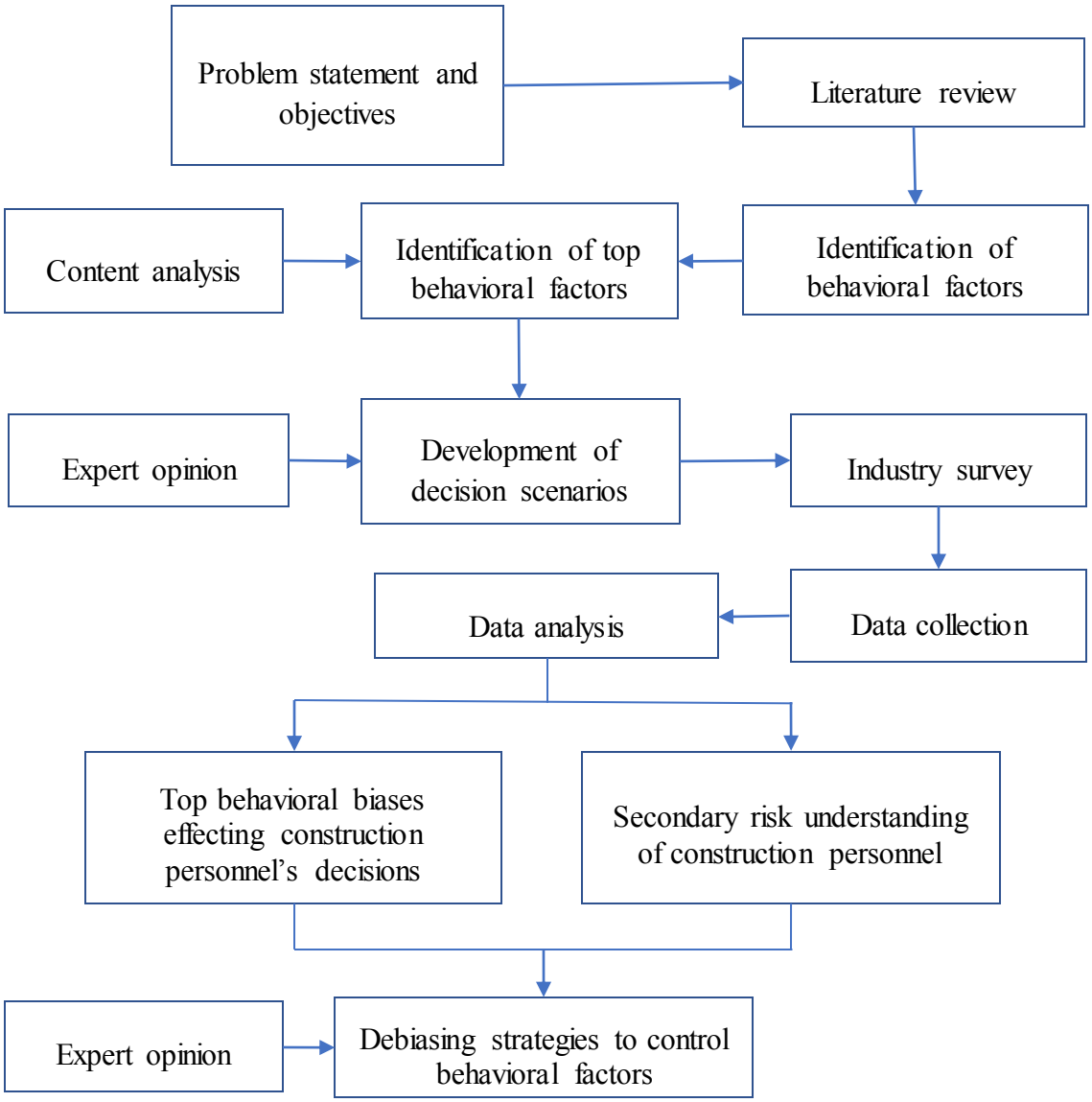

Figure 2:Research methodology

3.1 SAMPLE SIZE DETERMINATION

Due to the distinct type of investigation in this study, professionals were chosen based on non-probability convenience sampling technique. It is essential to notice that the ease presented by this technique was not essentially in the form of physical or logistic comfort of access but the level of specific expertise and experience of the chosen experts. The objective was to engage senior decision-makers who are involved in planning, designing, and execution of large-scale construction and infrastructure

projects. However, to reduce any selection bias geographically distributed experts were selected instead of choosing the entire sample from a single region, organization or project. As a result, the selected professionals presented a portfolio of vast experience and belonged to different construction and infrastructure organizations representing clients, consultants, contractors, suppliers and project management units. Despite robust representativeness, a quantitative rationale must be established for statistical justification of the sample – after all a study questioning the representativeness bias must take all the necessary measures to ensure it is not entrapped by such heuristic errors.

In this regard, Baker et al (2007) recommended the sample size between 12 and 60, with 30 as mean. A similar recent study utilized a sample size of 57 individuals (Farooq et al., 2018) built on Cochran (2007) which applies a static confidence level, marginal error and sample mean. The basic formula to decide the sample size is given in Equation 1, where *n* is the sample size, *m* the margin of error, *p* the sample mean and *t* the factor associated with the confidence level.

$$\boldsymbol{n = t^2 p(1-p) \Big/ m^2} \quad \text{Equation 1}$$

Using it, a minimum sample size of 57 was determined, with a margin of error ± 13%, confidence level 95% and the sample mean 50%. Against this target, interviews were conducted from 65 experts which is also in the upper range of Baker et al (2007) giving statistical and hypothetical authenticity and explanation of sample size.

3.2 EXPERIMENTAL DESIGN

The third phase involved the design and development of the data collection instrument. In doing so, two types of scenarios were developed. The first type investigated the individual judgment of secondary risk causation while the second type investigated the effect of six top behavioral factors in clouding the decision-making in a typical construction project context. To ensure technical and procedural robustness, 9 experts were interviewed for the development of the instrument to provide realistic and relevant scenarios for the semi-structured interviews. These experts possessed technical and academic proficiency in behavioral and social sciences, civil and infrastructure engineering, and project risk management. They provided several real-world examples of complex managerial and administrative decision-making in construction and infrastructure projects. Following the best practices of behavioral research and based on the expert opinion, meaningful yet uncomplicated details were incorporated in the scenarios.

Additionally, the scenario statements were strengthened by easily understandable and relatable discrete choice options since they help respondents answer quicker and better (Kahneman and Tversky, 1979). The choice options were synthesized from literature and expert opinion to create logically and physically suitable scenarios. Each question is appropriately designed to ensure the most impartial opinion gathering focusing on the behavioral preferences of respondents. In doing so, each scenario of the first type presented decision options containing secondary risk emergence likelihood. The transparency of risk emergence varied from very clear to highly concealed; meaning that in some scenarios it was easy to detect the secondary risk emergence while in other scenarios, a respondent would have to think deeply and

farsightedly to detect the emergence of secondary risk. The purpose of these scenarios was to check if decision-makers really suffer from any cognitive biases which hinder their insight of secondary risks and if they can figure out the susceptibility of their decisions in giving rise to secondary risks. A total of 5 such scenarios were developed to judge secondary risk understanding. A sample is given as an example below.

> *"Your project properly follows safety regulations. As part of it, you have provided personal protective equipment (PPE) to site staff and labor. Based on experience, you are worried that labor might mishandle and damage the PPE. To avoid this situation, your effective response strategy will be to:*
>
> *a. Impose fines on labor who damage the PPE.*
>
> *b. Collect the PPE at the end of the working day and re-issue it the next day.*
>
> *c. Purchase better quality PPE to sustain wear and tear.*
>
> *d. Other"*

Furthermore, keeping the same spirit of simplicity and logic, each scenario of the second type centered on a single behavioral factor to avoid effect modification and information distortion due to the confounding effect (Atzmüller & Steiner, 2010). Additionally, to strengthen contextualization, local places and currency unit (PKR) were used. By design, participants were required to pick between two options; one biased toward a specific factor and the other unbiased which helped reach a decisive conclusion. A total of 12 scenarios for behavioral factors were developed such that each factor can be tested through two scenarios. The main rationale for restricting the quantity of scenarios was time limitation for each interview. Thus, the experiment served the objective of determining the behavior of construction management experts to various RRAs during the decision-making process. One scenario is given as an example below.

"You are working as a Site Manager on a road project worth PKR 45 million (US$ 286,000) in Peshawar, Pakistan. Excavation of the site has started. You read an article in a newspaper discussing that trench cave-ins are a major killer in construction. At least 50 fatalities occur per year due to cave-ins in Pakistan. Procuring trench boxes to avoid this risk will add PKR 500,000 (US$ 3,180) per box to the project budget. Your analysis suggests that you need at least 4 boxes. Your line of action will be:

a. You will continue with excavation and will regularly inspect excavation before and after work shifts.

b. Considering the above-mentioned statistics, you will procure the trench boxes to ensure the safety of the workers."

3.3 DATA COLLECTION

Data were collected in the fourth phase through in-person semi-structured interviews of experienced construction professionals occupying managerial and decision-making positions. The selection criteria for these professionals were 1) a minimum graduate degree and b) a minimum of 10 years of technical and managerial experience. The selection of these experts followed non-probability convenience sampling, as already mentioned. Every participant was briefed about the nature and scope of research to receive realistic responses. The scenarios were randomly presented to each respondent to minimize the chance of detecting any pattern and structure of the experiment. All the data were collected in a single round of interviews and no feedback was considered to introduce any changes in the designed survey. All interviews were conducted separately to avoid any influence due to group dynamics. As a result, the cohort representing the prime stakeholders of the construction industry provided a comprehensive insight into decision-making styles, common pitfalls, and opportunities for improvement. Furthermore, after analyzing the top behavioral factors, remedial strategies synthesized from the literature were run through the selected experts to propose potential improvements in decision-making.

Chapter 4

RESULTS AND ANALYSIS

Following the structured methodology, 65 high-grade construction experts from main cities of Pakistan, with an average experience of over 19 years, contributed in this survey. As more than half of the respondents aged over 43 years with over 19 years' experience, as shown in Table 3, the data can be thought consistent and of great quality.

Gender	**Male**		**Female**	
	61		4	
Average Age (in years)	**31 to 40**	**41 to 50**		**Above 50**
	32	23		10
Average Experience (in years)	**10 to 15**	**16 to 20**		**Above 20**
	27	15		23
Type of Organization	**General Contractor**	**Consultant**	**Client**	**PM Unit**
	34	19	6	6

Table 3: Demographics of participants

In terms of gender distribution, 94% of participants were male. While this is representative of typical gender distribution in the construction industry (Fiolet, Haas, & Hipel, 2016; Vijayaragunathan, S., and Rasanthi 2019), it stimulates the future research by asking if women will exhibit different behavior under the same

circumstances. Regardless of the women-are-wonderful effect, the question of decisions by-producing secondary risks merits investigation under the known risk aversion tendency of women (Powell & Ansic, 1997; Charness & Gneezy, 2012).

Returning to the demographics of the current study, the participants occupied management positions at different levels with titles such as General Manager (GM), Project Manager (PM), Resident Engineer (RE), Project Director (PD), Risk Manager (RM) and Planning Engineer as shown in Figure 3.

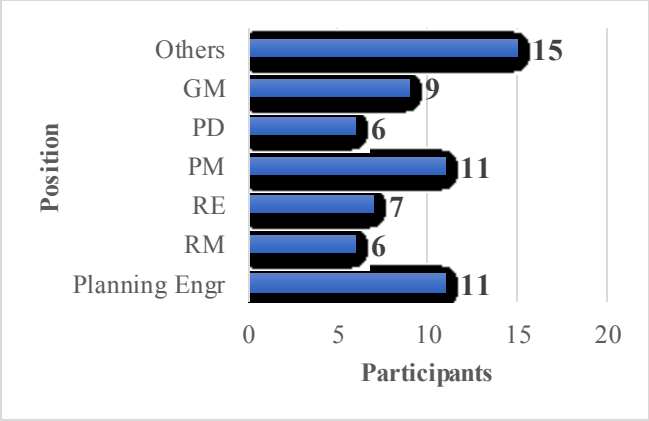

Figure 3:Distribution of the participants' position.

The participation of high-profile participants confirms a complete view of project decisions and offers generalizable data for almost the complete lifecycle of construction projects. Further, the organizational background of the participants has been so chosen that all the main stakeholders are adequately represented. So, general contractors (34), consultants (19) and clients (6) form 90% of the sample as given in Table 3. By and large, this sample best represents the construction professionals under the resource constraints and contrasting with the related prior studies (Fiolet et al., 2016), it is sufficient to reveal some interesting and conceivably vital results discussed in more detail in the subsequent sections.

4.1 SECONDARY RISK CAUSATION

In the next phase of analysis, interviewees' perceptiveness and generation of secondary risk were investigated. Overall, it is found that in over 60% cases (193 out of 325 responses), the respondents were unable to perceive the secondary risk involved in an RRA, as shown in Figure 4. Interestingly, almost half the times (159 out of 325 responses), the respondents were neglecting fairly visible and easily perceptible secondary risks. However, almost one-third (104 out of 325 responses) of the decisions were insightful enough to perceive secondary risk.

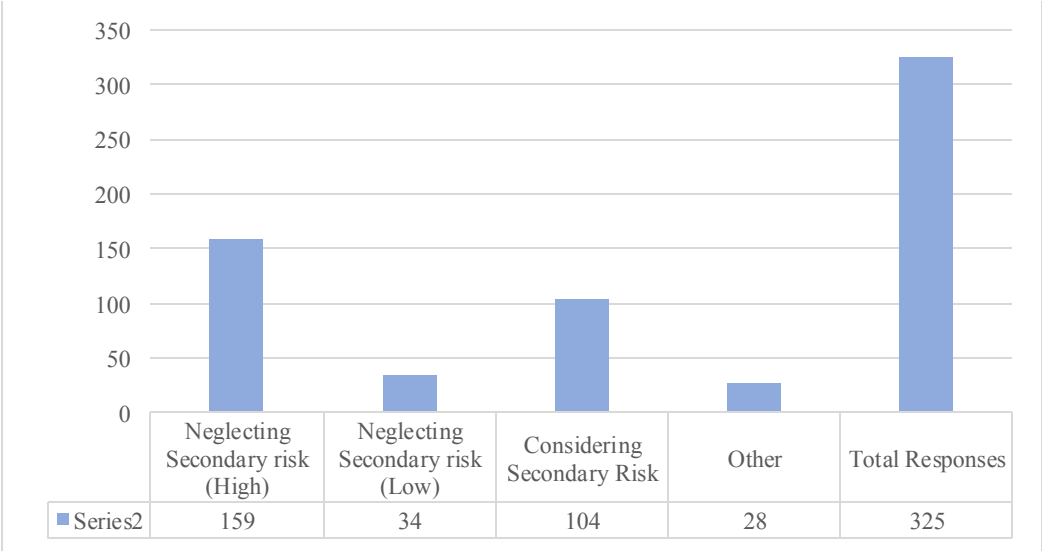

Figure 4: Participant's perceptiveness of secondary risk

It is remarkable to notice that even in scenarios where the secondary risk was apparent, experts frequently failed to select a suitable response to avoid it. For example, secondary risk in scenario 1 was relatively perceptible but only 22 respondents out of 65 (33.8%) selected the secondary risk-free option. Similarly, scenario 2 was so designed that secondary risk was harder to detect and therefore remained concealed from 86% of respondents. Considering the greater percentage of the participants not being able to select a secondary risk-free RRA, it can be construed

that construction professionals mostly fail to foresee the consequences of a particular response by causing secondary risks that eventually jeopardize project success.

The second section of the questionnaire investigated the behavioral biases the construction professionals fall prey to while making decisions. Interestingly, the respondents were being influenced by all the behavioral factors in their decisions with varying percentages. Precisely, 76% of the decisions were affected by the availability bias, followed by optimism (68.5%), representativeness (65%), framing (64%), anchoring (58.5%) and emotion (55%) biases, as shown in Figure 5.

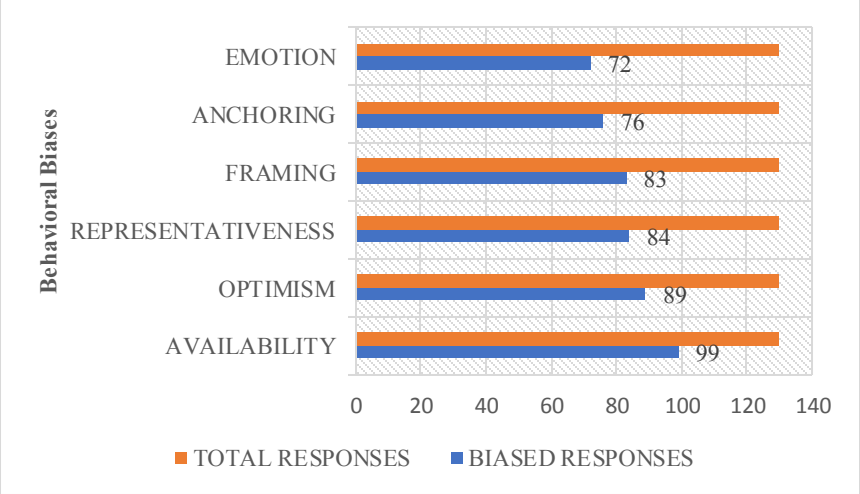

Figure 5: Participant's investigation of behavioral biases

Most respondents were affected by the information and chose not to look beyond the smokescreen formed by it. Though such a lack of critical probing is generally not expected from the construction industry, the scale of single events heavily sways the perception of occurrence. For example, literature has adequately explored the behavioral inconsistencies and proposed remedial cognitive and policy measures to decision-making for significant events such as climate change (Weber, E. U. 2010), floods (Whitmarsh, L. 2008) and nuclear accidents (Keller, Visschers, & Siegrist, 2012), but the same is not so rampant in the construction industry and the only area

that has attracted some research attention is safety (Hallowell, M., 2010; Tixier et al., 2014). Thus, the less significant singular risk events that the construction industry is typically characterized by seem to pacify the advocacy for deeper insight into the risk behavior of construction professionals, resulting in a lack of theory and tools for improved decision-making.

Further, several instances of planning fallacy are sufficient evidence of the lack of informed and perceptive decision-making in the construction industry due to overly optimistic plans (Son, Rojas, Ph, & Asce, 2010; Du, Zhao, & Zhang, 2019). Similarly, the first test scenario for optimism factor received 55 biased responses and 10 rational responses, revealing a conclusive insight into the cognitive pattern of the respondents which tends to reinforce the illusion of control over project events despite irrefutable evidence against it. Similarly, the respondents were biased in their decision-making against representative characteristics. In both the scenarios testing this bias in the form of procurement and hiring decisions, symbolic features were appealing for the respondents. Though the first scenario resulted in somewhat hung decision, 33 votes for the biased option against 32 for unbiased, the second scenario cleared any doubts by 51 votes for the biased option and 14 for unbiased option. The same trend was observed in all other behavioral factors and the least biased factor (emotion) also received a mixed response: 15 votes for the biased option and 50 for unbiased in the first scenario; and 57 votes for the biased option and 8 for unbiased in the second scenario. Overall, not even a single factor received less than 50% biased options revealing the cognitive imprecision which needs effective reduction, control, and management of bias (debiasing) to rationalize the decision-making and enhance chances of project success. It also validates the selection of behavioral factors

reinforcing the need to debias the decision-making against the selected cognitive smokescreens.

4.2 DEBIASING

Though there may be far more talk of biases among managers, talk alone will not eliminate them. Concrete steps are required to manage them (Kahneman, Lovallo, & Sibony, 2011). In this regard, several strategies have been proposed to effectively shift the decision-makers from System 1 to System 2 thinking since it may eliminate, or at least reduce cognitive biases (Bazerman, 2008). For this purpose, analytical models are known to effectively correct SB type errors (Arkes, 1991). But correcting the AB (availability, optimism, representativeness, and emotion) and PB (framing and anchoring) type errors is difficult (Montibeller & von Winterfeldt, 2015). A critical issue in debiasing is the human factor; people resist debiasing for several reasons (Arkes, 2003; B. Kleinmuntz, 1990). They do not like being informed that they have been 'doing it wrong' for all these years. They do not want to surrender power over a decision process. Due to the constraints of time, scope and resources, this study resorted to using the existing debiasing strategies and no new strategies were developed. For this purpose, extensive literature was explored to synthesize a list of 12 debiasing strategies given in Table 4.

Interestingly, training is found to be the most inclusive debiasing technique as it addresses all the top behavioral factors, followed by accountability, consider the opposite, collaborative decision-making and nudge. On the contrary, very specialized debiasing techniques like change the reference point (to address anchoring), reframe losses (to address framing effect) and feedback (to address optimism) are found to focus on particular cognitive barriers. In terms of behavioral factors, the distribution is

almost smooth with a few more stress in the literature on the anchoring with 8 debiasing strategies addressing it out of a total of 12, followed by availability and representativeness being addressed by 7 strategies each.

The most effective debiasing strategies can be selected through the content analysis presented in Table 4, but to validate and contextualize the findings three experts each having over 20 years of experience in project management, general management and risk management were approached for an interview. These experts also participated in the previous round of data collection. This was done to ensure that they already understand the nature of the query. Each expert was briefed about the strategies to solicit their opinion regarding the most convenient and effective ones under the contextual attributes. After the comprehensive discussion, it was deduced that all three experts with few exceptions opted for strategies that follow the Larrick (2004) classification of motivational, cognitive and technological strategies. Every strategy that is selected is briefly discussed in the following section of the chapter.

Strategy	Description	Availability	Representativeness	Emotion	Optimism	Anchoring	Framing	Total	Selected References
Incentives	Stimuli that motivate one's behavior	×	✓	×	✓	✓	×	3	Larrick, 2004; Wüst & Beck, 2018; Morewedge et al., 2015
Accountability	Individuals must justify their decisions	✓	✓	✓	×	✓	✓	5	Larrick, 2004; Lerner & Tetlock, 1999; Thomas & Millar, 2012
Consider the opposite	Explore alternatives to one's preference	✓	✓	✓	✓	✓	×	5	Montibeller & von Winterfeldt, 2015; Croskerry, Singhal, & Mamede, 2013; Arkes, 1991; Larrick, 2004; R. Paul Battaglio, Belardinelli, Belle, & Cantarelli, 2019; Bammer, 2017
Training	Equipping people with the skills needed to arrive at correct	✓	✓	✓	✓	✓	✓	6	Arkes, 1991; Larrick, 2004; R. Paul Battaglio, Belardinelli, Belle, &

Strategy	Description	Availability	Representativeness	Emotion	Optimism	Anchoring	Framing	Total	Selected References
	decisions								Cantarelli, 2019; Fast and Frugal Heuristics: The Tools of Bounded Rationality -Gerd Gigerenzer: Derek J. Koehler, 2004; Morewedge et al., 2015
Collaborative decision-making	Combining the input from multiple experts and making the best choice by diversifying the expertise and skills	✓	✓	✓	✓	✓	×	5	Montibeller & von Winterfeldt, 2015; Bammer, 2017; Kahneman, Lovallo, & Sibony, 2011; R. Paul Battaglio, Belardinelli, Belle, & Cantarelli, 2019
Cross-check judgments	Verify by using the alternative method	✓	✓	✓	×	✓	×	4	Montibeller & von Winterfeldt, 2015; Bammer, 2017; Kahneman, Lovallo, & Sibony, 2011

Strategy	Description	Availability	Representativeness	Emotion	Optimism	Anchoring	Framing	Total	Selected References
Nudge	Indirect suggestions to influence the behavior and decision-making of groups or individuals	✓	✓	×	✓	✓	✓	5	R. Paul Battaglio, Belardinelli, Belle, & Cantarelli, 2019; Morewedge et al., 2015
Change the reference point	The psychological reference point is influenced by recent changes in one's current asset	×	×	×	×	✓	×	1	Arkes, 1991; Kahneman and Tversky, 1979
Reframe losses as gains (or gains as losses)	Expressing a situation in a different way	×	×	×	×	×	✓	1	Arkes, 1991
Metacognition	A thoughtful disengagement from the intuitive judgments and engagement in analytical processes	✓	×	×	×	×	✓	2	Croskerry, Singhal, & Mamede, 2013; Thomas & Millar, 2012

Strategy	Description	Availability	Representativeness	Emotion	Optimism	Anchoring	Framing	Total	Selected References
	to verify initial impressions								
Feedback	Reports of one's choices that can be used as a basis for improvement	×	×	×	✓	×	×	1	Arkes, 1991
Evidence rating	Level (strength) of evidence	×	×	×	×	×	✓	1	Emby & Finley, 1997
Total		7	7	5	6	8	6		

Table 4: Synthesis of debiasing strategies

4.3 MOTIVATIONAL STRATEGIES

Motivational strategies postulate that cognitive biases can be reduced by motivating individuals to perform well. They entail the use of either incentives or social accountability. Provided that the incentive is substantial, logic asserts that individuals will pay more attention, launching System 2 thinking and rectifying their cognitive errors (Battaglio, Belardinelli, Bellé, & Cantarelli, 2019).

4.3.1 Incentive

Economists support incentives to motivate people to make smarter choices (Wüst & Beck, 2018). The assumption is that individuals will put more effort into 'reflection and calculation' if the stakes are high (Debiasing; Richard P. Larrick, 2004). Changing incentives can substantially improve decision-making. However, they are neither the only solution nor a solution for every bias (Morewedge et al., 2015). Correspondingly, there is little empirical evidence to consistent improvement in mean decision performance through incentives. For that to happen, decision-makers must possess effective strategies that they either fail to apply or apply halfheartedly in the lack of incentives (Camerer & Hogarth, 1999). Decision-makers must possess the necessary cognitive capital to which they can apply additional effort. However, incentives are known to improve performance in settings such as clerical and memorization tasks, where people possess the cognitive capital required to perform well but lack the intrinsic motivation. Arkes (1991) argued that the automatic nature of AB and PB errors should make them largely unresponsive to incentives. It is true for most biases of these types, like hindsight, optimism, and framing. Surprisingly, incentives have reduced the influence of anchors in some instances (Nicholas Epley, 2004). Thus, incentives can increase the effort of decision-makers in correcting AB

biases – if they recognize when they occur (Stapel, Martin, & Schwarz, 1998). Although incentives cannot improve cognitive capital in the course of a brief experiment, they can motivate people to acquire the decision skills they need over a longer period of time (Debiasing; Richard P. Larrick, 2004).

4.3.2 Accountability

A second motivational approach to debiasing is holding people accountable for their decisions by conveying that they will later have to explain their choices to others. The principal mechanism by which accountability improves decision-making is pre-emptive self-criticism. In preparation for justifying their decisions, the decision-makers anticipate flaws in their own arguments, thereby improving their decision processes and outcomes. It turns out that self-critical attention to one's judgment process –induced by accountability – not only reduces SB errors (which result from insufficient effort), it also reduces certain AB errors (which result from associations within semantic memory, also called source-confusion errors). For example, increased complexity of thought among accountable participants reduced the influence of (a) previously primed emotions and (b) covertly primed trait constructs by increasing the influence of others relevant (Lerner & Tetlock, 1999).

Nevertheless, the social nature of accountability has some potential problems. For instance, accountable decision-makers tend to give people what they want. If they know their audience's preference for a specific decision outcome, decision-makers distort their decision process to justify that outcome. Consequently, justifying a decision to an audience with *unknown* preferences leads to pre-emptive self-criticism, but justifying a decision to an audience with *known* preferences leads to biased rationale-construction (Debiasing; Richard P. Larrick, 2004). Alternatively, Thomas

and Millar (2012) maintain that the framing effect is reduced when decision-makers are explicitly directed to provide a rationale for their choices before making the decision.

4.4 COGNITIVE STRATEGIES

The cognitive category includes considering the opposite and training strategies, as described below.

4.4.1 Consider the opposite

Research on the power of shifting people toward System 2 thinking has shown that simply encouraging people to 'consider the opposite' of whatever decision they are about to make reduces errors in judgment (Bazerman, 2008; Morewedge et al., 2015). It entails nothing more than asking oneself, "What are some reasons that my initial judgment might be wrong?" It works because it directs attention to contrary evidence that would not otherwise be considered (Debiasing; Richard P. Larrick, 2004). Arkes (1991) states that to address an AB judgment error, neither the incentives nor requests to perform well will necessarily cause subjects to shift to a new judgment behavior. Instead, it will be more helpful to instruct the subjects in the use of behavior that will add or alter associations.

In comparison, simply listing reasons does not typically improve decisions because decision-makers tend to generate supportive reasons. Also, for some tasks, reason generation can disrupt decision-making accuracy if there is a poor match between the reasons that are easily articulated and the actual factors that determine an outcome (Wilson & Schooler, 1991). Similarly, asking someone to list too many contrary reasons can backfire – the difficulty of generating the alternatives can convince decision-makers that their initial judgment must have been right after all (Debiasing;

Richard P. Larrick, 2004). Nevertheless, studies approve that encouraging individuals to consider the opposite have proven effective in decreasing AB errors like availability, optimism and confirmation, and PB errors like anchoring (Arkes, 1991; Battaglio et al., 2019; Croskerry, Singhal, & Mamede, 2013; Montibeller & von Winterfeldt, 2015).

4.4.2 Training

Montibeller and von Winterfeldt (2015) showed the effectiveness of training in reducing biases. But it takes the specific professional and technical training for the debiasing to be successful. Indeed, training involves equipping people with the tools needed to arrive at correct answers. To be trained professionally is a meta-strategy that will amend some judgment errors (Arkes, 1991). Unconscious bias training can be delivered to help people evaluate information, provide clear reasons for decisions, and know when to seek advice or guidance in order to manage their cognitive biases. Academic interviewees noted the importance of providing standardized training and guidance for decision-makers (Cox, Strang, Sondergaard, & Monsalve, 2017). Training can be effective when precision requires experts to recognize patterns and select an appropriate response. Effective debiasing training typically encourages considering information that is likely to be underweighted in intuitive judgment or teaches people statistical reasoning and normative rules of which they may be unaware. In large doses, debiasing training can be effective. Lectures on statistical reasoning, and training in probabilistic sciences, such as psychology, appears to increase the use of statistics and logic when reasoning about everyday problems to which they apply (Morewedge et al., 2015).

4.5 TECHNICAL STRATEGIES

Lastly, technical strategies entail supporting individuals through external tools such as decision models, decision-making software or collaborative decision-making (Battaglio et al., 2019). The experts proposed collaborative decision-making to curb cognitive biases, as discussed below.

4.5.1 Collaborative decision-making

Using groups to collaborate for improving decisions ultimately depends on the diversity of experiences and training of group members, and then following a process that preserves the diversity of perspectives. If run effectively, groups generate their own 'consider-the-opposite' process through 'the 10th Man Rule'. It is interesting that the most popular group decision-making method – brainstorming – comes up wanting on preserving diversity. The fundamental requirement of collaborative decision-making is that the individuals must independently formulate their own hypotheses, judgments, and estimates before working in a group. Once into the group process, shared ideas can spark new dynamics and insights. However, the most insidious problem in groups is that people are unknowingly influenced by the public judgments of others – the groupthink. Especially under conditions of uncertainty, people are susceptible to anchoring on the judgments of others in forming their own judgments (Debiasing; Richard P. Larrick, 2004). Despite this problem, there are many reasons that groups might be beneficial. First, groups serve as an error-checking system during the interaction. Second, synergies can emerge when people with complementary expertise interact. The third and arguably most important reason that groups improve decision-making is statistical; groups increase the effective sample size of experience used to make a decision. Thus, groups hold more diverse perspectives than an individual for the tasks that require novel solutions – such as

creativity or hypothesis generation (Cox et al., 2017; Montibeller & von Winterfeldt, 2015).

Although groups may be prone to bias, using debate correctly to breakdown weak arguments and assumptions is a powerful tool, not available to individuals in the same sense. Thereafter, groups can discuss the portfolio of pros and cons given a more nuanced picture than if someone had set a strong frame advocating a particular solution. Also, groups might be more open to adopting a plan using a mix of positive aspects from the different strategies, rather than just selecting a winner (Sibony & Lovallo, 2006; Andersson & Johansson, 2013).

Chapter 5

CONCLUSION

5.1 CONCLUSION

This study identifies the significant behavior influencing factors in the development of risk response actions that can notably affect the decision-making, resulting in secondary risk causation. Following a semi-structured interview-based data collection, senior management professionals from the construction industry were engaged to reveal that decision-makers are oblivious to the secondary risk potential of their decisions. The most significant bias was found to be that of availability which explains the ingrained propensity of construction professionals to wrongly judge the formation of a risk by the ease with which they can retrieve the related knowledge. Through expert opinion, several debiasing techniques are suggested to logically deal with these behavioral factors. This study highlights the need and importance for the project managers and executives to be aware of cognitive errors that can unexpectedly and significantly affect the quality of their decisions regardless of the use of advanced models for optimum RRA selection. This study expands the body of knowledge on decision-making, and risk and project management by underlining the importance of a 360° view of risk response actions and points toward the strategies to broaden and deepen the planning and decision-making processes in construction projects. Using these findings, project managers can check their decisions and improve overall performance.

Nevertheless, this study is limited by its sample size which future studies my improve by comparing these results with a much larger sample from various countries. Another expansion of this research could be through the development of new debiasing strategies for specific factors over the course of time so that long-term effects could be investigated by

reassessing the performance of decision-makers after fixed intervals. Hopefully, the findings of this study could pave the way for more impactful work.

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APPENDICES

Appendix I: Questionnaire

Section 1: Personal Details

1. Your Name: _____ **2.** Gender: **a.** Male **b.** Female

3. Your age (in years): _____ **4.** Position: _____

5. Your organization is:

a. Academia **b.** Main/General Contractor **c.** Subcontractor **d.** Supplier

e. Design Consultant **f.** Supervisory Consultant **g.** Financial Consultant **h.** PM Unit

i. Client **j.** Operator

6. PEC Category of your organization (for contractors only):

a. C-A **b.** C-B **c.** C-1 **d.** C-2 **e.** C-3 **f.** C-4 **g.** C-5

7. Your working experience (in years)

a. 0-5 **b.** 6-10 **c.** 11-15 **d.** 16-20 **e.** Above 20

8. E-mail Address: _____

Section 2:

1. Your project properly follows safety regulations. As part of it, you have given personal protective equipment (PPE) to site staff and labor. Based on experience, you are worried that labor might mishandle and damage the PPE. To avoid this situation, your effective response strategy will be to:

a. Impose fines on labor who damage the PPE.

b. Collect the PPE at the end of working day and re-issue it on the next day.

c. Purchase better quality PPE to sustain wear and tear.

d. Other

2. You are acting as a Procurement Manager for your construction company. For a project of

multi-story commercial building located in Karachi, you have to purchase cladding material for façade. The material supplier you are considering is the one of the few suppliers who provide the cladding material suggested by the project architect. Preliminary works for cladding installation is ongoing and will be complete within 10 days. The distance between the site and supplier showroom puts you in a doubt if just-in-time procurement, which you usually use, is a good idea for material delivery in this case. Your effective response strategy will be to:

a. Order the material right away and receive the delivery within next 4-5 days.

b. Consider a nearby located supplier with whom you have never worked before.

c. Advise the client to change the cladding material and opt for an easily and extensively available material.

d. Other

3. Your company is acting as a general contractor for a high-rise building project located in Dubai. You are the Project Manager. The client has concerns about possible issues in the project if proper coordination between the design consultant and your team is not ensured. They cite a past experience where HVAC works suffered since the coordinator was a mechanical engineer and usually remained involved in design issues rather than performing coordination job. To proactively manage this situation and ensure better coordination your response will be to:

a. Appoint a new team member having qualification and expertise in civil works from Pakistan

and send him to Dubai. His primary job will be to improve coordination.

b. Not hire a new member but train and frequently advise the team members to ensure better coordination.

c. Other

4. You are the Safety Manager on a commercial building project. During the construction of utility vaults, you are worried about the chances of fire breakout. To avoid any dangerous situation your response will be to:

a. Install CO_2 fire extinguishers.

b. Install fire hydrant

c. Provide sand buckets

d. Other

5. You are the Procurement Manager and need to procure sand from a supplier for a lump sum project your company has undertaken. Due to the possible fluctuation in the material prices, you are concerned that the cost of sand will escalate and will eventually increase project cost. Your response to cater this situation will be to:

a. Procure total quantity of the material required for the project and store it.

b. Convince the client to allow price adjustment and procure the sand as and when needed.

c. Other

1. Being the Project Manager of a high-rise building project being constructed in Islamabad, you require a site engineer for the project. You along the client representative conduct interviews for this position. Two candidates, Engr. Abul Bari and Engr. Moeen Nawaz, appear for the post having same years of experience and qualification. You find Engr. Moeen Nawaz more appropriate for the job considering the type of projects he has previously been part of. However, the client representative suggests you to hire Engr. Abdul Bari as he has previously worked with Engr. Bari and found his skills reliable for this job. Your line of action will be:

a. Considering client's representative experience, you will appoint Engr. Abdul Bari for the job.

b. Regardless of the opinion held by the client representative about Engr. Abdul Bari, you

will still hire Engr. Moeen Nawaz based on his related work experience.

2. You are offered a job as site engineer on a project in a hilly area where chances for land sliding are 5%. The very next day you are informed that five people died due to land sliding on that project location.

a. You will take the job anyway

b. You will look for a safer opportunity

3. As a contractor you are constructing a commercial building in Lahore worth 30 million and the construction is in finishing phase. Over lunch one of your friends informs you about his recent project in Karachi where cracks have appeared just after completing the finishing works. He is seeking your help. You inquire about the cement-sand ratio he has used. He informs that 1:6 cement-sand ratio has been used. You provide him some guidelines keeping in view your technical knowledge and experience. Back on site, you inquire about the cement-sand ratio being used in your project and find out that it is 1:6. And if you try to improve it to 1:4, an additional amount of 8 lacks will be required. Your line of action will be:

a. You will use 1:6 considering the difference in weather conditions and workmanship of both

cities.

b. You will change the cement-sand ratio by increasing the cost of the project.

4. While serving as a Project Manager of a high-rise building project, you realize the need for an experienced and senior design engineer in your team to add value to the project. You have an eligible candidate for this position, Engr. Muhammad Yousuf. Your design team consists of young engineers, Engr. Ali Abbas and Engr. Waleed Khalid, who possess good skills of design software while the senior designer you are thinking to appoint lacks software skills but has vast knowledge and experience in structural engineering. This addition of new member

might create a little friction among team members. While training the new member will add cost to the project as well as additional time will be required. Your line of action will be:

a. You will induct Engr. Muhammad Yousuf and invest both time and cost to train him before bringing him into the team.

b. You will appoint him without training, thinking the team will get along eventually.

5. Your company has sent you to a new project in Karachi in the capacity of Project Manager. It's your first ever experience of working in that city. Your boss tells you to trust Envicrete people as your company has worked with them in the past. On the first day of job, your Materials Engineer informs you that the pavers that your company is purchasing from Envicrete have lately been failing strength tests. Your line of action will be:

a. To discuss the situation with your boss and try to reason with him that the quality of Envicrete product has declined.

b. To visit the Envicrete facility and try to reason with them that their quality must be improved or else you might procure from other companies.

c. To continue working as per routine and observe quality tests myself.

6. You are working as a Site Manager on a road project worth 45 million in Peshawar. Excavation of the site has started. You read an article in a newspaper discussing that trench cave-ins are a major killer in construction. At least 50 fatalities occur per year due to cave-ins in Pakistan. Procuring trench boxes to avoid this risk will add Rs 5 lacks per box to the project budget. Your analysis suggests that you need at least 4 boxes. Your line of action will be:

a. You will continue with excavation and will regularly inspect excavation before and after work

shifts.

b. Considering the above-mentioned statistics, you will procure the trench boxes to ensure

safety of the workers.

7. You are working as a Project Manager and you are conducting hiring for the post of junior engineer. You have shortlisted two candidates, Engr. Zulfiqar Ali and Engr. Ehtesham Bukhari, both having same qualifications and skills. Moreover, Engr. Zulfiqar is a graduate of a well reputed university and Engr. Ehtesham has additional experience of internships during his studies. Who will you select?

a. Engr. Ehtesham as he has internship experience of 3-months with same nature of job.

b. Engr. Zulfiqar as his university is among the top institutes of the country, and his abilities are evident from his academic records.

8. Your sub-engineer, Mr. Ali Ahmad, comes to you to ask for a leave of 4 days due to domestic reasons. Being the Project Manager, you know that allowing him might generate the risk of delay for 2 days in the project activity that he is working on. Ali is a punctual and hardworking person. Meanwhile you get a discourteous call from your boss who holds you responsible for the budget overrun of a recently completed project due to delay in its completion. Your line of action will be:

a. You will approve the leave of Ali as you think 2-days delay might not affect the project completion.

b. You will not approve the leave as you don't want to be held responsible for any other unsuccessful completion of a project.

9. You are in the process of procuring a sub-contractor for HVAC services among two well-recognized organizations for your project of PC hotel Mirpur Azad Kashmir where your firm is working as a general contractor. Both sub-contractors have your required quality of product and technical staff. Company A has a large variety of efficient equipment with latest technology while Company B was established two years before company A. Which one will you select?

a. Company A based on the variety of technology they have.

b. Company B, considering them more stable as they were established before company A.

10. You are a fresh graduate who joins a well reputed company as a junior engineer. You are responsible for development of architectural drawing and their submission to senior engineer for correction and approval. On your orientation day, you have been made clear that all the drawings must be kept confidential. After working in this organization for over a year, your colleague working on a different project asks you to share your drawings for guidance. Your line of action will be:

a. You will share your work as you have been working with this person for a year.

b. You will not share the drawings but will verbally guide him.

11. As procurement head of private sector organization, you are choosing among two suppliers of tiles for finishing works of a building project undertaken by your organization. Supplier A has reportedly provided 90% of the times best quality of tiles. You have been procuring finishing material from Supplier B for over a decade, but they have failed to meet your quality requirements once or twice. Your line of action will be:

a. You will select Supplier A as they seem more promising and you had an unpleasant experience with B.

b. You will select Supplier B based on your previous relations.

12. As head of business development, you are deciding whether to bid for an infrastructure development project in a newly launched housing scheme in Islamabad. The project is expected to gain your company an approximate profit of 85 million. The housing developer is asking you to mobilize your resources and bear the initial costs of about 20 million. Your calculations suggest that it is a good deal and you have made your mind to accept the offer. The next day you hear in the news that Supreme Court has taken a notice of land acquisition issues of another housing developer working in Islamabad and the entire project is put on

halt. Your line of action will be:

a. You mobilize your resources considering that your client is a legitimate party.

b. You excuse the client and opt out of the deal.