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Improving the risk quantification under behavioural tendencies: A tale of construction projects

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Abstract

Complex construction projects are risky owing to several features and factors. Their management involves risk assessment which is subjected to various behavioural tendencies and the existing body of knowledge lacks appropriate methods to quantify these effects. The prevalent standard model of Expected Utility Theory does not differentiate between threat and opportunity, resulting into an identical estimation for both facets of risk. This limitation was addressed by Prospect Theory which better captures risk preferences. However, construction industry still relies upon conventional methods of risk assessment. The current study introduces a weighting function to better quantify the cognitive errors in construction risk assessment by adjusting the over- and under-estimation. In doing so, detailed scenario-based, semi-structured interviews are conducted engaging senior professionals. It is found that, typically, opportunities are underestimated by 7.5% and threats are overestimated by 8%. Integrating these findings into risk response strategies results into a realistic and effective resource allocation.

Keywords: Risk assessment; Risk quantification; Construction projects; Risk behaviour; Cognitive bias

1. Introduction and background

Construction is a fast-growing industry with significant contribution to the economic growth of a country. With rapid advancement, an increased number of uncertainties are bound to occur (Thevendran and Mawdesley, 2004). Project uncertainties may hinder the successful completion by mainly effecting the triple bottom line of project success that is time, budget, and quality (Ali et al., 2007). One of the reasons of poor performance in construction projects is the inadequate risk assessment which affects both in planning as well as execution stages resulting into ineffective and flawed outcomes. Therefore, an appropriate and effective risk assessment approach must be adopted in order to cater for faulty performance. Effective risk management cannot be ensured without an appropriate and balanced assessment for decision makers. It is an established fact that what cannot be rationally measured cannot be wisely managed (Broadbent, 2007). Thus, a realistic and systematic quantification of risk would go a long way in ensuring project success (PMI, 2013).

Due to presence of uncertainty in almost every human action (Smith and Bohn, 1999), risk is inevitable and requires proper management. It is necessary to understand and identify a risk as early as possible, so that a relevant strategy can be implemented to minimize any likely negative aspect it may have (Wang et al., 2004). Project Management Body of Knowledge (PMBoK) defines risk as a chance event which may positively or negatively influence the project objectives, should it occur (PMI, 2013). Such an influence of risk on project objectives drives the decision makers to effectively manage it which is not possible without its better quantification. Initially, Daniel Bernoulli proposed a risk quantification model in 1739, which was based on utility

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of weighted averages of all the outcomes in an uncertain scenario (Stearns, 2000). It remained a de facto standard of risk quantification for almost two centuries. However, the concept was invalidated by Neumann and Morgenstern (1944) who proposed that the utility of a lottery is the probability-weighted average of the utilities of all outcomes instead of single utility of combined outcomes. This followed a new model to quantify risk, known as Expected Utility Theory (EUT). According to EUT, risk event can be estimated by multiplying its probability (P) of occurrence and its impact (I) (Vose, 2008) as mathematically given in Eq. (1) and theoretically known as PI-model.

$$\text{Risk } (R) = \text{Probability } (P) \times \text{Impact of the outcome } (I) \quad (1)$$

Later on, a number of weaknesses of this model were reported (Williams, 1996; Taroun, 2014). For instance, applying this model implies an indifference between situations with potentially large consequences with small probabilities, and more frequently occurring events having relatively small outcomes, because the output will remain same in both the cases. Instead, an effective risk management would require different approaches in these situations. Similarly, Bouchouicha and Vieider (2017) conducted experiments over students and their findings point that risk preferences may change over outcomes, as risk attitudes significantly vary, according to the characteristics of the decision problem. People tend to seek risk for small outcomes and avoid it as stakes increases. Further, EUT model considers risk neutral behaviour only. Indeed, people in general are not risk-neutral. This numerical combination of impact and likelihood assumes equal significance for both the components of threat and opportunity. But in reality, decision makers have different preferences for one or the other depending upon their risk attitude (Kahneman and Tversky, 1979; Slovic, 2000). Therefore, decision-making based on EUT is not only inadequate but also misleading (Haimes, 1993; Williams, 1996; Haimes, 2004; Andi, 2006; Stingl and Geraldi, 2017).

Additionally, loss aversion, which is the behavioural tendency to actively avoid uncertain situations, weakens the validity of EUT (Tversky and Kahneman, 1991) and is directly connected with risk aversion. This theory may seem logical but it fails to capture the risk avoiding behaviour of humans as it gives results only for risk-neutral situation in which it is implied that no criterion for risk is used (Haimes, 1993). Hence, EUT is heavily criticized for its precision on account of risk aversion in choices and judgements (Rabin and Thaler, 2001). As per Prospect Theory (PT), people are risk averse in case of potential gains and risk prone when they come across losses (Kahneman and Tversky, 1979). On the contrary, some studies suggest that loss aversion is not always present in decision-making. This effect is cancelled when exchanging goods with goods (Novemsky and Kahneman, 2005). Sometimes loss aversion is reversed when dealing with small outcomes. In such cases, pattern of gains and losses is reversed: losses appear smaller than gains. This can be explained in case of hedonic principle where people like to minimize pain and maximize pleasure, as well as by the assumption that comparatively smaller losses are more easily discounted than larger losses (Harinck et al., 2007).

In the face of such intense criticism, EUT was experimentally invalidated by Kahneman and Tversky (1979). To add further, PT also considers some other behavioural tendencies such as effects of isolation, reflection and certainty in addition to loss aversion. It explains decision-making by considering risk aversion phenomenon (Sun, 2009). It differs from EUT due to addition of probability weighting function $\pi(p)$ and a value function $v(x)$ to capture risk aversion tendency in decision-making. Presently, PT is considered as the basis of behavioural economics (Camerer et al., 2011).

Although PT has some limitations and has thus been criticized for contextual constraints, group decisions and methodological deficiencies, it can still produce better outcomes as compared to conventional PI-model. According to PT, losses loom twofold larger than gains (Tversky and Kahneman, 1992). In other words, it can be inferred that people overestimate the probability and impact of a threat while underestimate in case of opportunity due to their cognitive bias. On the contrary, *optimism bias*, a self-serving bias and deep-rooted in decision-making, is also reported in literature which refers to a positive belief about future than warranted by actual experience (Flyvbjerg, 2008). This phenomenon, also termed as *pervasive optimistic bias*, the most significant of all the cognitive biases, generates an illusion of control (Kahneman, 2011). But it is important to note that the optimism bias is inconsistent with the independence of decision weights found in PT because the human tendency to overestimate a threat and underestimate an opportunity is a matter of action and not belief (Bracha and Brown, 2012). Also, the two are inherently separate issues since decisions made under risk are governed by prudence and those made under uncertainty by the optimism bias, and have been distinctly characterized in the literature (Fox and Poldrack, 2009). The optimism bias in this situation may affect selection decisions, such as project and procurement methods, and influences the decisions under uncertainty. But once a project has been selected, the decision-making is governed by risk for which human tendency to prudence is observed. This important deduction may be incorporated in the existing PI-model to reduce such systematic errors. The argument is also strengthened by PMI (2013), which establishes the objectives of project risk management for increasing the likelihood and impact of positive events, and decreasing those of negative events. Despite its psychological appeal and tendency to accurately capture human behaviour, PT has not been fully incorporated in the conventional risk quantification mainly due to its analytical and behavioural complexities.

Unfortunately, construction industry has a poor reputation in risk analysis when compared with other industries such as finance or insurance (Laryea, 2008). Complex and large construction projects contain larger factors of uncertainty, as compared to small and similar in nature construction endeavours such as housing projects. In such complex projects, the natural instinct and opportunity or threat based risk behaviours of decision makers may critically introduce the cognitive errors in risk assessment process (Kutsch and Hall, 2010). Such a risk assessment can significantly influence the project success.

Based on the above discussed research gap, the main goal of this study is to assess and reduce the cognitive errors in risk