

INTEGRATING SUSTAINABILITY INTO PROJECT RISK MANAGEMENT; AN APPLICATION IN PPP PROJECTS

Beenish Bakhtawar¹, Muhammad Jamaluddin Thaheem², and Husnain Arshad³

¹ Department of Civil Engineering, CECOS University of IT & Emerging Sciences, Phase-VI, Hayatabad, Peshawar, Pakistan

² Department of Construction Engineering and Management, National University of Sciences and Technology (NUST), Sector H-12, Islamabad 44000, Pakistan

³ Department of Civil Engineering, The Hong Kong University of Science and Technology (HKUST), Clear Water Bay, Hong Kong

ABSTRACT

Public private partnership (PPP) has been recognized as a potential model for delivery of sustainable infrastructure. The long-duration and risk-sharing mechanisms of PPP provide a unique opportunity for fostering innovation and driving sustainable development. However, efficiency gains from these features can be materialized only through effective implementation. In PPP projects, sole reliance on the traditional project management procedures and processes limits scope of decision making to the contract duration and the contracting parties. For more informed decision-making, it is useful to align the management of large infrastructure projects with the core values of sustainability assessment focusing both short- and long-term impacts of the project and the changing project environment during its life cycle. In particular, such limitations in approach result in a rigid treatment of risk during the risk assessment focusing only on the iron-triangle project controls; time, cost, quality. The integration of sustainability into the project management framework is a relatively new concept. In particular, little work has been done on its integration with project risk management framework (PRM). The existing PRM needs to be improved for inclusion of sustainability considerations for efficient management of complex infrastructure projects, especially PPPs. Thus, a systematic literature review of articles ranging from year 2000-2018 has been carried out to propose a three areas of integration for sustainability and PPP referred as: policy, process, and product. The process approach has been further elaborated into three levels of sustainability assessment integrated in project management; macro, meso, micro. At the meso level, risk and sustainability integration has been proposed. The study has long ranging implications for furthering the understanding of risk-sustainability cause-effect chains (opportunity-threat interaction) for developing a decision-support system for sustainability inclusive risk assessment. Overall, the study presents a novel framework for a budding research line helping decision makers to better explore the opportunities created through sustainability for large infrastructure projects and realize long-term project success.

INTRODUCTION

Public Private Partnership (PPP) projects are based on long-term contracts for infrastructure delivery or service provision where the private sector bears substantial risk and management responsibility (Grimsey and Lewis 2007). PPP got popularity owing to the low financial capabilities of governments and ever-increasing infrastructure deficits. Private Participation in Infrastructure (PPI) reported a private investment of US\$93.3 billion across 304 projects in 2017 (PPI 2017). Other than its financial readiness, PPP delivery system has a strong potential for sustainable infrastructure delivery (Olusola 2016). The absence of well-planned infrastructure projects can create imbalance in the socio-economic landscape of any country creating financial burdens on local community, loss in livelihood and an overall decrease in the quality of life (Sahoo and Dash 2012). Thus, sustainable development is vital for infrastructure projects primarily through an inclusive planning for environmental and social stressors (Griggs et al., 2013). In large infrastructure projects, incorporation of sustainability considerations not only enables sound economic development, job creation and the purchase of local goods and services, it also enhances quality of life for citizens, increases positive impacts, and protects the vital natural resources and environment while

promoting efficient use of financial resources (Diaz-Sarachaga, Jato-Espino, and Castro-Fresno 2017). Project executors, however, are mostly after profitability because of which projects fail to ensure an overall wellbeing of the community and environment (Hu and Zhu 2015). In such a scenario, the risk of realization of wider socio-environmental wellbeing is shifted on governments (Rouhani 2015). Keeping such issues in perspective, the PPP's appeal for realization of sustainable project delivery is promising (Hueskes 2017) due to its key attributes of long-term contract duration, flexible risk sharing mechanism, competitive procurement, innovative financial arrangement and vast range of modality choices (Pinz, Roudyani, and Thaler 2018a, Agarchand and Laishram 2017). However, PPP projects are complex because of their lengthy duration, large scale environmental footprint, significant impact on a country's economy and engagement of multiple stakeholders groups (Rouhani 2015). This significant interaction with the project boundaries makes it challenging to manage uncertainties over the lengthy project duration. Thus, PPP projects face various risks like changing stakeholder needs and public response, political disturbances, natural disasters, shifting government priorities, socio-economic changes, and fluctuating market forces. This creates a multilayer risk system in these projects (Kumar, Jindal, and Velaga 2018, Mangano and Narbaev 2017, Waziri 2017) exposing inefficiencies of the risk management process, disrupting project performance (Sundararajan and Tseng 2017). Various authors have reported poor risk identification, ambiguous risk assessment, misplaced risk allocation and insufficient mitigation plans as major planning deficiencies causing delays, cost overruns, stakeholder dissatisfaction and ultimately project failure (Ke, Wang, and Chan 2013, Xiong et al. 2015, Shrestha et al. 2018, Srivastava 2017). Thus, there is a significant need to incorporate high-ranging social, environmental, and economic whole life cycle sustainability considerations in the project performance measurement and risk management processes (Solino and de Santos 2010). Such an integration demands reconsideration and improvement of the traditional project management practices, which currently govern these projects for effective implementation.

Traditionally, PPP projects are assessed using iron triangle project controls (time, cost and quality). Although these criteria are predominantly used in construction projects, the increased complexity of PPP projects merits an atypical performance criteria suited to sustainability considerations. Currently, PPP projects follow the traditional project risk management framework given in PMBOK® Guide (Shrestha et al. 2018, Ozcan 2016, Hwang 2013, Xu 2011). However, studies addressing PPP risk management mostly offer a short- or medium-term approach, majorly focusing on measure of threat to the project success as envisioned in terms of iron-triangle project controls. However, studies focused on risk assessment in PPP projects, only an ambiguous description is provided regarding success criteria against which the risks are measured (Shahrara 2017, Osei-Kyei 2017). This ambiguity also translates into the limitation of present project risk management frameworks to cater the sustainability agenda (Silvius 2018). A major constraint in this regard is that presently the project and sustainability performances are assessed separately. Sustainability is a multi-dimensional concept open to subjectivity as per the context of application. This makes its implementation in practical terms challenging. To address this issue, sustainability must be brought under the project management umbrella. In a notable work, Silvius and Schipper (2014b) conceptualized this integration as sustainable project management and defined as *“planning, monitoring and controlling of project delivery and support processes, with consideration of the environmental, economic and social aspects of the life-cycle of the project's resources, processes, deliverables and effects, aimed at realizing benefits for stakeholders, and performed in a transparent, fair and ethical way that includes proactive stakeholder participation”*. It is apparent that the practical application of sustainability involves interrelated project and process levels (Shen et al. 2010). Furthermore, risk identification and management is suggested as a major area of potential sustainability impact in project management. In this regard, relevant studies make the following recommendations (Martens and Carvalho 2017, Aarseth et al. 2017, Kivila, Martinsuo, and Vuorinen 2017, Yu et al. 2018, Tan, Shen, and Yao 2011, Ugwu and Haupt 2007, McConville and Mihelcic 2007, Yilmaz and Flouris 2010, Silvius 2018, Anderson 2006, Weber, Scholz, and Michalik 2010):

- i. Extension of risk identification to include environmental and social risks
- ii. Reorientation of risk management towards sustainability
- iii. Inclusion of sustainability stakeholders in decision-making

The present study essentially builds upon these recommendations to develop a framework for sustainability integration in PPP projects. The framework outlines the missing link of risk-sustainability relationship in the

overall integration of sustainability in the project management framework. In line with the developed framework, risk and sustainability indicators are then identified from relevant literature ranging from year 2000-2017. At the end, possible relationships between PPP risks and sustainability indicators are then explored by developing an impact matrix to reveal unexplored risk effects on project sustainability.

LITERATURE REVIEW

To achieve the set goals, PPP literature published during the period 2000-2018 was systematically reviewed. Articles were extracted from different indexing databases like Web of Science (WoS), Scopus and Google Scholar, and publishers like Taylor and Francis, ASCE and Elsevier, using keywords “public private partnerships”, “P3”, “BOT”, “DBFM”, “TOT”, “BOO” and “PPP”. Details of the review are elaborated in Figure 1.

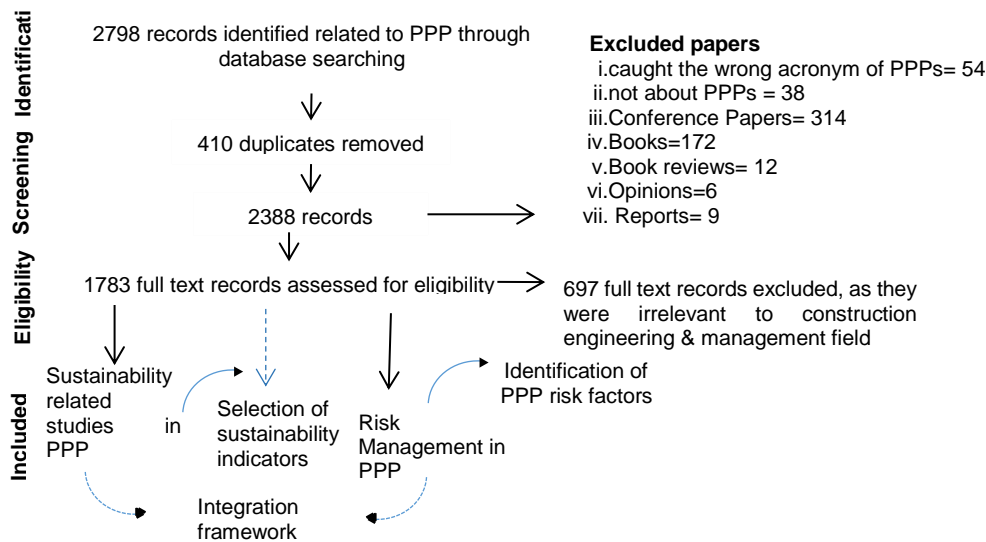


Figure 1 PRISMA diagram for Literature Review

Out of an initial 2,798 literary works, 1,783 journal articles were found relevant to construction engineering & management research in PPP projects. Out of this dataset, articles following the research themes of ‘sustainability’ and ‘risk management’ were selected through content analysis. The studies on sustainability were used to select the sustainability indicators for assessment while the studies on risk management in PPP projects were used to identify and shortlist the relevant risk factors. Crossover research of these two themes is negligible in perspective of PPP projects. Therefore, notable generic sources were used to develop the conceptual framework of the study. Data sources on ‘sustainability in project management’, ‘sustainable project risk management’, ‘sustainability and risk management’, ‘sustainability risks’, etc. in context of construction projects were extracted from similar sources in this regard. The three-part systematic literature review is further elaborated in this section.

SUSTAINABILITY INTEGRATION IN PPP PROJECTS

Various authors have acknowledged PPP model for its potential to foster sustainable development. Content analysis of sustainability related research in PPP projects, in perspective of construction management, reveals three potential areas for integration of sustainability related criteria in decision-making: policy, process and product.

At the policy level, sustainability related outcomes for infrastructure delivery can be integrated with PPP strategy. In this case, sustainability acts as an ideological cover for effective PPP implementation (Pinz, Roudyani, and Thaler 2018b). In this regard, governments need to deploy legislative, regulatory and procedural instruments for realizing sustainable development goals (SDGs). For sustainable infrastructure

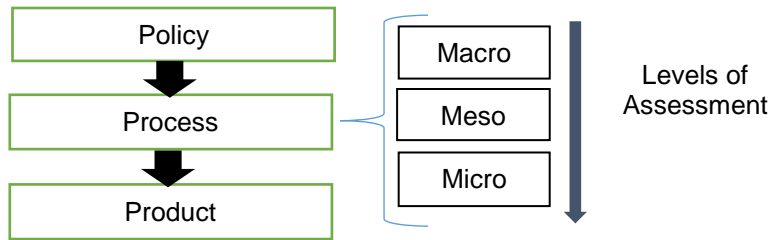


Figure 2 Sustainability Integration in PPP

delivery, the policy level instruments are the necessary initial conditions to create a favorable environment for a functional PPP arrangement (Pinz, Roudyani, and Thaler 2018a). Although this arrangement is reported to improve the sustainability performance of projects, the implementation framework of PPP projects rarely endorses a sustainability agenda. Hueskes (2017) asserts that governments play a pivotal role in orienting PPP infrastructure development towards sustainability through enforcing good project governance. Therefore, governments need to show commitment to adoption of sustainable options, while capitalizing on private sector capabilities to amend this situation (Agarchand and Laishram 2017). Regulating PPP projects on sustainability objectives enables the delivery of sustainable PPP projects which is the product level integration. Some studies have addressed this approach to explore the adoption of PPP model for delivery of social infrastructure (Javed, Lam, and Chan 2013, Abdul-Aziz 2011) and environment-friendly projects (Foley et al. 2011). However, to assess and improve the sustainability performance of PPP projects, greening the processes is required. Researchers have regarded the adoption of whole life cycle approach critical to the sustainability performance and efficiency of PPP projects. For project evaluation, consideration of life cycle critical success factors (Liu et al. 2015), inclusion of life cycle cost during financial evaluation (Wang 2014), use of advanced technologies for PPP life cycle performance evaluation (Love 2015), life cycle risk management and stakeholder engagement are some of the areas of incorporation currently being explored. The decision-making process in PPP projects mainly includes consideration for project viability, feasibility, risk, procurement, contract, and stakeholder and project management. Ensuring social and environmental protection beyond the minimum acceptable limits, while maintaining financial and economic performance of the project for all these considerations over the project life cycle, is necessary to maintain life cycle sustainability performance of projects. At the process level, few studies explicitly address the issue of sustainability in PPP projects (Patil and Laishram 2016, Patil 2016a, Atmo 2014, Koppenjan 2015). These studies focus on decision-making for improving sustainability performance of various PPP life cycle phases. Multiple studies have focused on development of sustainable procurement practices for PPP project delivery where incentivizing sustainable outcomes through inclusion of sustainability related bidding criteria is widely stressed. However, inducing flexibility in concession contracts is a challenge in this regard. The use of relational and alliance contracting strategies is considered for effective stakeholder management and efficiency gains in concession contracts (Kumaraswamy 2005). The viability of a PPP project is mainly assessed through assessing value for money (VfM). Patil (2016b) highlights that VfM analysis lacks the incorporation of social and environmental externalities despite being a primary metric for sustainability in PPP projects. According to Atmo (2014), attaining VfM in PPP projects requires an intricate balance of project cost, risk and performance. Therefore, it is required to explicitly address sustainability related objectives during project planning. However, frameworks for development of sustainability assessment are still underway for specialized projects. Overall, sustainable project management for PPP delivery is an emerging concept with undeveloped epistemology. In this regard, PM-sustainability crossover researchers are trying to develop management tools, techniques and methodologies aligned with the triple-bottom-line sustainability agenda (Silvius 2017). Martens and Carvalho (2016) proposed a central position for sustainability in project management frameworks to ensure sustainable project performance. Therefore, the current project management framework demands reflection and modification (Aarseth et al. 2017). After detailed review, the study delineates a heuristic framework yielding three possible levels of assessment: macro, meso, and micro, as elaborated in Figure 3.

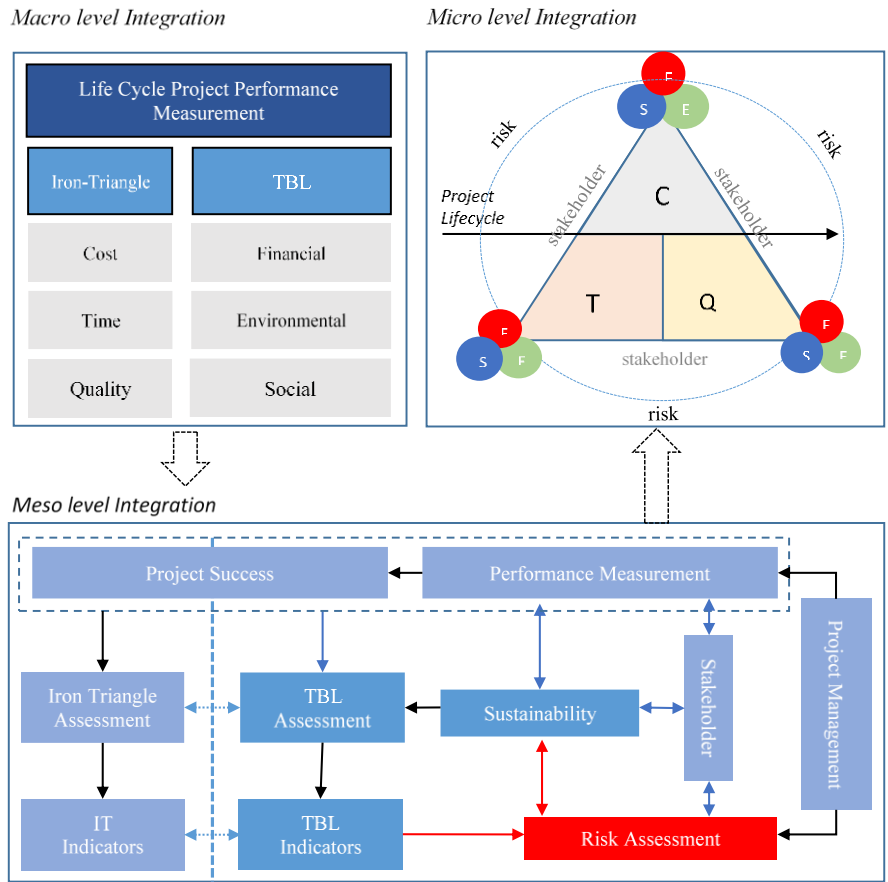


Figure 3 Levels of Sustainability Assessment under Project Management Umbrella

These levels are categorized based on the level of clarity and measurability of indicator hierarchies used for sustainability assessment. On a macro level, triple-bottom-line oriented sustainability criteria are included at policy or organizational level as benchmarking tools for qualitative assessment. In this regard, Pinz, Roudyani, and Thaler (2018b) conclude that inclusion of macro-level considerations of triple-bottom line sustainability objectives is the basic step of implementing sustainable PPP projects. In this regard, the 17 UN SDGs are a general benchmark for sustainability implementation. Various studies consider the concept of sustainability in implicit terms with a broad consideration of sustainability outcomes for strategic decision-making (Patil and Laishram 2016, Patil 2016a, Atmo 2014, Koppenjan 2015). On a further interpretative (meso) level, the three areas can be broken down into indicator groups and sub-groups, which form a mix of qualitative and quantitative sustainability indicators. Based on the indicator descriptions, these generic sustainability indicator groups are employed for performance assessment. The studies with this point of view move one-step ahead from interpreting sustainability for practical assessment, quantitatively. In this regard, Patil (2016b) devised generic indicator groups against sustainability principles for enabling sustainable outcomes. Akbiyikli, Eaton, and Dikmen (2012) and Shen et al. (2016) evaluated the sustainability performance of PPP projects based on triple-bottom-line driven sustainability impacts. Kivila, Martinsuo, and Vuorinen (2017) highlight various limitations of iron-triangle project controls (time, cost & quality) in effectively assessing long-term project performance. Furthermore, Liu (2017) recommends the extension of project performance measurement in PPP towards a stakeholder-inclusive life cycle framework. At the most intricate (micro) level, the information obtained by the upper levels of analysis can be efficiently utilized for further quantitative analysis. This involves the use of inventory level indicators specific to the scope and application area of the study. Although such inventory level indicators are being used in the studies conducting sustainability assessment, there is no study reported which overtly quantifies these indicators into project controls of time, cost and quality.

Sustainability integration in project risk management

The current study adopts a meso level approach for bridging the risk-sustainability gap. It further devises a methodological framework for conducting a sustainability oriented risk assessment through identification of risks and sustainability indicators from existing literature elaborated in the next section. Despite a plethora of sustainability related frameworks, one major missing link is the unexplored relation between risk and sustainability, as proposed in the conceptual framework. Being two of the most widely interpreted concepts, there are inherent epistemological and executional incompatibilities making it difficult to form a convergent construct for integrated assessment. To make the case for developing a sustainability oriented risk assessment, a certain level of pragmatism must be adopted drawing on practical interpretations of both risk and sustainability for project success. Sexton and Linder (2014) present four possible rationalizations of the risk-sustainability integration, one of which is the development of a single analytical assessment procedure. When adopting a risk-based scheme, capitalizing on the performance dimension of sustainability offers a logical integration of sustainability into the project risk management framework. This caters to the need of a strong integrated planning tool for realizing inclusive project success. In this way, familiar risk assessment tools can be effectively utilized for solving the sustainability problem.

PPP infrastructure projects are based on long-term contracts. To manage a concession of over 20 years, risk analysis and allocation from a life cycle perspective is crucial for attaining VfM in these projects. Initiating the risk management process in the feasibility stage and managing well through the operation and maintenance is important to reach a balance between varying stakeholder interests and changing project dynamics. This allows the decision-makers to reach optimal risk allocation solutions in consideration with conflicting stakeholder attitudes towards unmanageable project risks (Zou, Wang, and Fang 2008) At the risk identification level, social and environmental risks are mainly addressed only in a commercial aspect and long-term risks are mostly transferred to the external stakeholders, mainly to general public (Taylor and Harman 2016), rendering the project unsustainable. A series of studies propose a focused risk assessment as a solution for sustainability challenges. However, this alone cannot help decision-makers to holistically assess sustainability within the risk construct. On the flipside, treating sustainability as a project performance metric and a goal for project risk management enables expansion of the quantitative risk assessment process and capturing the effect of uncertainty on sustainability objectives. For this purpose, the triple-bottom-line of sustainability includes three areas of assessment, which can be further broken down into indicator groups and sub-groups forming a mix of qualitative and quantitative indicators (Shen et al. 2016, Akbiyikli 2012). Based on them, a focused risk assessment can be performed by assessing the vulnerability of sustainability indicators towards the risk nucleus of PPP projects. This is a scarcely explored yet useful approach to uncover the sustainability consequences of project risks. Shahriar, Sadiq, and Tesfamariam (2012) analyzed risk using graphical risk assessment techniques to profile consequences on triple-bottom-line sustainability areas.

SELECTION OF TRIPLE-BOTTOM-LINE INDICATORS

Following the review of PPP studies incorporating sustainability, it is observed that different triple-bottom-line based sustainability hierarchies are reported with focus on economic, environmental or social areas of protection from project impacts. However, the levels of assessment can be divided into impact categories, sub-categories and inventory indicators. On a holistic level, triple-bottom-line oriented sustainability criteria can be divided into three impact categories; economy, environment and society where there are sustainability indicators guiding decision-makers to prioritize the areas of impact. To select the indicators for PPP projects, present hierarchies are focused towards the procurement (Kumaraswamy 2005), planning (Dahl 2005) or design (Koppenjan 2015). For introducing sustainability in general and overall perspectives, the traditional triple-bottom-line seems to incorporate all aspects in its hierarchy of impact categories, and tends to encompass more holistic version of issues and aspects (Hacking and Guthrie 2008). The use of generic set of indicator groups is more helpful for decision-making as in case of PPP, the indicators should be enforceable at policy level as well. Within these generic indicator groups, inventory level indicators can be specified varying from project to project. For environmental area of sustainability, (Goedkoop et al. 2009) has proposed human health damage, ecosystem damage and resource damage as general environmental indicators, which further contain a detail variety of impacts (Menoufi et al. 2012). For social sustainability,

UNEP/SETAC guidelines and methodological sheets have been used for selection of impact categories (Benoît-Norris et al. 2011). These impact categories are stakeholder based. For this study, five impact categories are selected as shown in Table 1. For financial sustainability, literature establishes the initial capital and life cycle costs as two main indicators (Shen 2010). These are directly related to the functions of Net Present Value (NPV) and Internal Rate of Return (IRR), which are used for economic evaluation of PPP projects (Fitch et al. 2018, Xu et al. 2012). Therefore, this study used the initial cost and life cycle cost as the indicators of financial area of sustainability.

Table 1 Triple-bottom-line sustainability indicators

Sustainability Area	Indicators
Financial Sustainability (FS)	Initial cost (I1)
	Life cycle cost (I2)
Social Sustainability (SS)	Socio economic repercussions (I3)
	Health & Safety (I4)
	Cultural heritage (I5)
	Governance (I6)
	Human rights (I7)
Environmental Sustainability (ES)	Resource damage (I8)
	Ecosystem damage (I9)
	Human health (I10)

RISKS IN PPP PROJECTS

The complex nature of PPP system makes it subjective to interpret and measure risk (Heravi 2012). Due to the increased level of complexity in PPP projects, numerous studies have focused on identifying, allocating and mitigating risk (Li and Zou 2011, Xu, Chan, and Yeung 2010) making risk management one of the most specialized themes of PPP research encompassing multiple facets. From literature, it can be inferred that risk assessment in PPP projects are either context-oriented (Zou, Wang, and Fang 2008) or methodology-oriented (Medda 2007). Overall, there is a limited research related to PPP risk management focused on analyzing risk for developing sustainable PPP projects. However, the need and importance of such an assessment has been highlighted in recent studies. For example, (Diaz-Sarachaga, Jato-Espino, and Castro-Fresno 2017) regarded sustainable risk management (SRM) plan as one of the important criteria for assessing managerial requirements for sustainable assessment of road infrastructure projects. In some studies, instead of orienting the risk identification from a sustainability angle, sustainability has been built into the traditional project risk management framework interpreting or associating it with project success (Silvius and Schipper 2014a). For this, risk assessment was identified as sustainability assessment counterpart for the identification of threats and opportunities (Martens and Carvalho 2016). Following this research gap, research articles published between years 2000-2017 are analyzed in the current study to identify and synthesize various risk factors in PPP infrastructure projects. Based on the recommendations given in Introduction section, a sustainable risk identification process is followed which includes environmental and social risks, follows a life cycle perspective, and incorporates risks surrounding project environment for a holistic assessment. Thus, 143 risks were identified, and further grouped and ranked based on their frequency and qualitative score. Using literature score (LS) and relative importance index (RII), 20 risk factors (RF) were shortlisted for further analysis, as shown in Figure 3. In the hierarchy each risk factor is shown based on their RF (LS, RII, Rank).

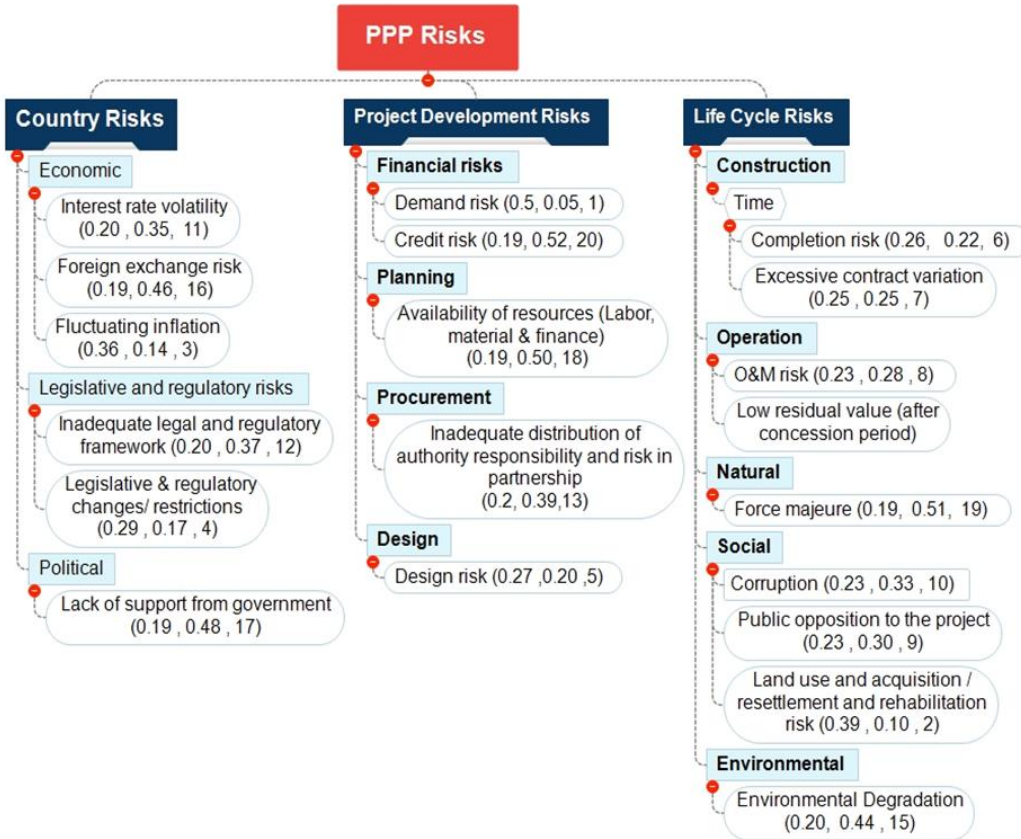


Figure 4 Shortlisted PPP Risks

IMPACT MATRIX

Based on structured interviews, a qualitative assessment of risk-sustainability relationships was carried out involving two phases. In the first phase, respondents were briefed about the study purpose, risk descriptions and sustainability indicator. They were then asked to rate the 200 possible relationships on a Likert Scale from 1-5. In case, there was no significant relationship between a certain risk and indicator, the cell was to be left blank. In the second phase, the interviewees were asked to review their ratings for the relationships where there was lack of consensus. Any relationship rated above 2 was considered significant. Based on this rating, 68 significant relationships were identified as shown in the Table 1. PPP infrastructure projects are complex, making it difficult to translate or trace the impact of a certain risk to relevant sustainability indicators. The impact matrix method therefore, helps to navigate the decision-makers towards an uncomplicated strategy for shortlisting risks for further assessment. Financial sustainability indicator, life cycle cost, shares a significant relationship with all the shortlisted risk factors as per the respondents' ratings. This implies that all significant risks have a direct or indirectly effect the life cycle financial performance of the project. Social sustainability indicator, socio-economic repercussions, closely follows this with 15 significant risk factors effecting the socio-economic impacts of a PPP project. On the contrary, Cultural heritage, resource damage and ecosystem damage show only one significant risk relationship. However, it should be noted that the number of risk-indicator relationships provides an overall insight into the consideration of relationships in the later stage of the analysis. For example, resettlement and rehabilitation risk is the only risk significantly impacting cultural heritage but it has a significant relationship with 5 out of 10 sustainability indicators. Thus, a detailed analysis of these relationships is required to get a deeper insight into the complex risk system for sustainability.

Table 2 Significant risk-sustainability relationships (Impact Matrix)

RF \ SI	IC	LCC(I2)	SER(I3)	H&S(I4)	CH(I5)	GOV(I6)	HR(I7)	RD(I8)	ED(I9)	HH(I10)
Interest rate volatility (R1)	4	3								
Foreign exchange risk (R2)	3	4								
Fluctuating inflation (R3)	4	4	4							
Demand risk (R4)		4	3							
Credit risk (R5)		3	3							
Land use & acquisition/resettlement & rehabilitation risk (R6)	3	3	4		4					3
Legislative & regulatory restrictions (R7)		3	4							3
Inadequate legal and regulatory framework (R8)		4	3			4				3
Design flaws (R9)		4		3						3
Completion risk (R10)		4	4							3
Excessive contract variation (R11)		4								
O&M risk (R12)		4	3	3		3				3
Low residual value (after concession period) (R13)		3								
Force Majeure (R14)		3	3							
Public opposition to the project (R15)	3	3	3	3		3	3			
Corruption (R16)	4	4	4			3	5			
Inadequate distribution of authority responsibility and risk in partnership (R17)	3	3	4			3	4			
Environmental degradation (R18)		4	3	3				3	3	5
Lack of support from government (R19)	4	4	4			3				
Availability of resources (Labor, material & finance) (R20)	3	4	3			3				
Frequency	9	20	15	4	1	7	3	1	1	7

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