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**Analyzing the differential impact of variables on the success of solicited and
unsolicited private participation in infrastructure projects using machine learning
techniques**

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* Sadly, Jonathan Lawrence, passed away in July 2024. This work is a testament to his dedication and expertise

Analyzing the differential impact of variables on the success of solicited and unsolicited private participation in infrastructure projects using machine learning techniques

Abstract

The study aims to examine the impact of key variables on the success of solicited and unsolicited private participation in infrastructure (PPI) projects using machine learning techniques. The data has information on 8,674 PPI projects primarily derived from the World Bank database. In the study, a machine learning framework has been used to highlight the variables important for solicited and unsolicited projects. The framework addresses the data-related challenges using imputation, oversampling, and standardization techniques. Further, it uses Random forest, Artificial neural network, and Logistics regression for classification and a group of diverse metrics for assessing the performances of these classifiers. The results show that around half of the variables similarly impact both solicited and unsolicited projects. However, some other important variables, particularly institutional factors, have different levels of impact on both types of projects, which have been previously ignored. This may explain the reason for higher failure rates of unsolicited projects. The study highlights this differential impact of variables for solicited and unsolicited projects, challenging the previously assumed uniformity of impact and providing specific inputs to investors, policymakers, and practitioners.

Keywords: PPI projects, Solicited proposal, Unsolicited proposal, Critical success factors, Project contexts

1 Introduction

PPI project is a commonly used style of public-private partnership in which the private sector participates on a contractual basis (Taguchi and Sunouchi, 2019a). Governments grant rights to private parties for the building and operation of an infrastructure facility for a certain time. In return, private parties receive a defined share in revenues (Noumba and Dinghem, 2005). PPI projects are complex due to the involvement of several stakeholders with conflicting interests such as governments, sponsors, and financial institutions (Marques and Berg, 2011). In developing countries, the public sector requires additional financial resources

and technical capabilities to fulfill the growing need for infrastructure development. For this purpose, governments seek partnerships with the private sector to execute large infrastructure projects. Therefore, the concept of PPI projects has become increasingly prominent in developing countries in recent years due to its various advantages for both sectors (Jiménez et al., 2018). For instance, PPI projects attract investments, share risk between the private and public sectors, reduce the financial burden on governments and taxpayers, and bring efficiency and expertise into public initiatives, which in turn provide commercial benefits to the private sector.

The data on PPI projects maintained by the World Bank show a total investment of around \$2100 billion over the past three decades with an increasing trend in investment and the number of PPI projects in developing countries (World Bank, 2022). The data also show that the failed PPI projects in developing countries during this period account for over five percent of total investment. Additionally, time and cost overruns are other critical challenges within these projects in developing countries that significantly affect their performance. Therefore, it is crucial to understand the nature of the PPI projects in developing countries to improve their performances and minimize the waste of funds due to failed projects.

PPI projects in developing countries are initiated either through solicited or unsolicited proposals (World Bank, 2020). The PPI projects following solicited proposals (hereafter solicited projects) are different from the projects following unsolicited proposals (hereafter unsolicited projects) in many ways (Takano-Valdivia, 2021). The solicited projects are developed and initiated by the public sector, whereas unsolicited projects are developed and initiated by the private sector (Yun et al., 2015). The processes of project development, procurement, and partner selection significantly differ between solicited and unsolicited projects (AECOM, 2007) and have different levels of involvement and responsibilities in the public and private sectors (Turley, 2015). Hence, given the distinct characteristics of the solicited and unsolicited projects, we propose that the level of impact of the variables considered significant in previous literature for the PPI project may vary between these two types. The identification of the impacts of the variables on the success of PPI projects without distinguishing projects based on their type of proposal can be misleading in certain cases.

The review of the previous literature on PPI projects using the Scopus database, shows around 70 articles and conference proceedings have been published over the years between 1998 to 2023. These studies have investigated various aspects of PPI projects including their interaction with factors such as macroeconomic conditions of the country, climate risk, religious and language diversity, type of projects, cross-country comparison of the success factors, and role of governance (Chou and Pramudawardhani, 2015, Ruiz Díaz, 2020, Jiménez et al., 2019). Some studies discussed the challenges (Zulu et al., 2023), risks (Tamošaitienė et al., 2020), the transition from unsolicited to solicited proposals (Martek et al., 2017), and the impact of unsolicited proposals on the performance of PPI projects (Ayat et al., 2022c). However, it is important to mention that only two studies have compared the solicited and unsolicited projects. The first study investigated the risk allocation for the two types of projects by analyzing three solicited and three unsolicited projects in Colombia. The second study compared the critical organizational factors, collecting data through questionnaires from the 141 practitioners involved in the Built-Transfer-Operate (BTO) projects in South Korea (Yun et al., 2015). These studies do not fully represent the contexts of PPI projects in developing countries due to their limited datasets and scopes.

To fill this research gap, the current study aims to provide empirical evidence from an extensive and diverse dataset, having information related to 8674 projects from 137 developing countries. This study investigates the impact of certain variables, previously identified as significant for the performance of PPI projects, on the success of solicited and unsolicited projects separately. It will provide specific guidance to the practitioners regarding managing solicited and unsolicited projects within developing countries. Furthermore, we believe that this study will change the direction of research on PPI projects, opening up new avenues for the researchers to investigate further the behaviors of various other factors separately for solicited and unsolicited projects.

The rest of the paper is organized as follows. Section 2 provides a review of the previous literature related to the characteristics of solicited and unsolicited PPI projects. This is followed by Section 3, which presents the research methodology used in this study. Section 4 outlines the results and Section 5 provides

discussion including implications and limitations of the study and suggestions for future research directions. Section 6 concludes the study with a brief and concise summary of the findings.

2 Literature review

The PPI is a unique public-private partnership style, which serves both advanced and emerging economies in different ways (Taguchi and Sunouchi, 2019a). It is a source of infrastructure investment in the public sector, in which the private party bears a significant risk and management responsibility (PPIAF, 2014). Although PPI projects have been adopted globally, there has been an increasing trend in emerging economies in recent years. Therefore, a global perspective of the PPI projects with a focus on developing countries has been discussed in detail in the following subsections.

2.1 PPI Projects: A Global Perspective

PPI projects involve partnerships with the public sector through certain types of contracts. The public and private sectors differ in their strategic freedom and objectives. Private sectors achieve their results mainly through system dimensions, whereas public sectors strive to achieve results through people-based dimensions (Eskildsen et al., 2004). The differences in objectives between the two sectors complicate the PPI projects, which result from the public-private partnership. The conflict of interest and politically motivated interference in PPI projects makes them further complicated (Sun et al., 2016). At the same time, the private sector needs to partner with the government for long-term benefits from infrastructure projects in developing countries (Lei et al., 2017). Practitioners and researchers have a consensus on mutually agreeable objectives, inter-organizational trust, a well-defined methodology for problem-solving, and continuous efforts for improvement; these are the important features of a successful partnership, which leads to improved productivity and lower costs (Naoum, 2003). Besides partnership issues, PPI projects are typically large and require many physical assets and complex systems. Larger PPI projects are more likely to fail (Lupton et al., 2019) because of associated disadvantages such as managerial complexity (Nooteboom et al., 2007), less flexible structure, and bureaucratic issues (Laforet, 2008), and greater organizational inertia (Zhou and Li, 2010).

PPI project is not a contemporary innovation; it originated from the New Public Management in the United Kingdom. Both advanced and emerging economies adopt the concept for their infrastructure development. Advanced countries adopt the PPI concept to enhance the efficiency of the public sector, where emerging economies use it to arrange financial resources to address the growing infrastructure demand. Therefore, the challenges to PPI projects in advanced and emerging economies should be different due to variances in macroeconomic conditions, governance and institutional quality, political instability, regularity quality, and control of corruption. Further, differences in local institutional capacity, technical expertise for larger infrastructure projects, public resistance, and conflict resolution approaches related to land acquisition also differentiate PPI projects in advanced and emerging economies.

Several previous studies have investigated different factors impacting the success of PPI projects such as procurement and renegotiation (Guasch, 2017), logistic infrastructures (Parola and Lam, 2018), the fiscal risk from early termination of PPI projects (Herrera Dappe et al., 2022), national culture (Kaminsky, 2018), rule of law (Arimoro, 2017), hazard analysis (Lee et al., 2018), privatization and governance (Jiang et al., 2015), policy risk (Jiménez et al., 2018), project risk (Hwang et al., 2013, Keers and van Fenema, 2018), and business friendliness, political effectiveness and no governmental interventions (Xiao and Lam, 2020). Ruiz Diaz (2020) has investigated the impacts of governance indicators, macroeconomic variables (inflation rate, GDP per capita, interest rate), types of PPI projects, and project size and shows the significant impacts of macro-economic stability, regularity quality on the performance of PPI projects in developing countries. More specifically, macroeconomic shocks (measured by depreciation in the exchange rate) increase the chances of PPI project cancellation from less than five percent to more than eight percent (Harris and Pratap, 2009). Furthermore, the degree of government involvement (Lee et al., 2018), fiscal strength (Mansaray, 2018), political stability (Hammami et al., 2006), and the presence of a local sponsor (Jiménez et al., 2019), and strong financial condition of the country (Ayat et al., 2022b) reduce the risk of failure of PPI projects. Studies also found that higher levels of climate risk in the host country (Lupton et al., 2019), within-country religious diversity (Jiménez et al., 2019), and project size (Mieritz, 2012, Johnson, 2018) reduce the likelihood of the success of PPI projects in developing countries.

Researchers have also analyzed the PPI projects in various sectors such as renewable electricity (Kaminsky, 2022), airports and seaports (Farrell and Vanelander, 2015), transportation (Kaminsky, 2018), and the water sector (Marin and Izaguirre, 2006). Further, the role of institutional factors in risk allocation in energy projects (Kouton et al., 2023), their impacts on the success of greenfield and brownfield PPI projects (Taguchi and Sunouchi, 2019b), and comparative analysis of the determinants for greenfield and brownfield projects (eun Chi, 2019) have been investigated. Recently, several researchers have investigated the proposal aspects of PPI, particularly the unsolicited proposals. Various topics have been explored related to the projects following unsolicited proposals, such as project selection (Osei-Kyei et al., 2020), risk allocation (Castelblanco and Guevara, 2020), critical success factors (Mallisetti et al., 2021), comparison of capital investment in solicited and unsolicited projects (Pabodha Abeysekara, 2021), comparison of unsolicited proposal frameworks (Marques, 2018), motivations of governments for unsolicited proposal (Osei-Kyei et al., 2018), assessment of advantages and disadvantages of an unsolicited proposal (Zapatrina, 2019) and the impact of project characteristics and external factors on the performance of the PPI projects following an unsolicited proposal (Ayat et al., 2022c).

2.2 Features of solicited and unsolicited projects

A project proposal outlines a plan for a project including objectives, desired outcomes, methods, procedures, and timelines (TECHNO-PM, 2022). It helps in the systematic and structural evaluation of potential contractors during the selection process. However, project proposals can vary significantly based on the legal and other relevant requirements of organizations, sectors, and countries. In the context of PPI projects in developing countries, two distinct types of project proposals are used for initiating projects, namely solicited and unsolicited proposals. The characteristics of both types of projects are summarized in the following subsections.

An unsolicited proposal is started by a private entity seeking business opportunities. It is neither requested nor is it a part of the government's infrastructure development plan (Verma, 2010, Yun et al., 2015). It usually offers cutting-edge technology or innovative ideas for infrastructure development and problem-

solutions (Hodges and Dellacha, 2007). An unsolicited proposal is a preliminary feasibility study report related to the project background, initial feasibility, management, and financial details (Cameron, 2017). In contrast, a solicited proposal is developed by the public sector by a government's infrastructure development plan (Yun et al., 2015). The government identifies the required infrastructure and then invites expressions of interest (EOI), requests for proposals (RFP), or simply a public tender. In response to the government's invitation, the private parties submit technical and financial bids in an open competitive tendering process (Turley, 2015).

Unsolicited projects are difficult and face more obstacles as compared to solicited projects (Abdel Aziz and Nabavi, 2014), and have a low value of money and social benefits (World Bank, 2017) as compared to solicited projects. Despite the efforts of various countries to eliminate corruption and enhance competition in unsolicited proposals, it gives unavoidable advantages to their original proponents over the competitors (Marques, 2018) remaining less transparent and less competitive than solicited proposals (Kim et al., 2011, Zawawi et al., 2016). There are also some legal concerns associated with unsolicited proposals regarding intellectual property rights (Soreide, 2006). Furthermore, unsolicited proposals are generally prepared incompletely and have weak proposal contents, including poor technical information, an inaccurate cost base, and misidentification of risks associated with the proposed project (PPIAF, 2014), and generally receive approval without robust evaluation. On the other hand, solicited projects go through detailed and rigorous feasibility studies related to the project design, economics, social aspects, and environmental factors before the project is approved (Pabodha Abeysekara, 2021).

The procedures for project selection and implementation of these types of projects vary in different countries (Osei-Kyei et al., 2020). Therefore, several countries such as Peru, the Philippines, Taiwan, India, Indonesia, Chile, South Korea, South Africa, China, the USA, and Australia have developed frameworks to process unsolicited proposals properly (Zawawi et al., 2016, Takano, 2017, Marques, 2018). We summarize the characteristics of solicited and unsolicited proposals used in different parts of the world (Pabodha Abeysekara, 2021, Marques, 2018, Turley, 2015, Zawawi et al., 2016, Castelblanco and Guevara, 2020, Castelblanco et al., 2020) as in Table 1.

Despite the challenges and risks, unsolicited proposals are a reality in most countries and have significantly increased in recent years mainly due to the ease of securing external funding, a lack of technical and financial capacity of the public sector to recognize and prioritize projects, avoidance of lengthy competitive bidding processes, and fast project completion (Mallisetti et al., 2021).

Table 1: Summary of the features of solicited and unsolicited projects

	Unsolicited Project	Solicited Project
Initial proposers	Private sector	Public sector
Nature	The private sector reaches out with unsolicited proposals (USP) to the public sector to develop infrastructure that is not included in the government priority list. The USP is usually written for new or innovative ideas.	The public sector identifies its priorities considering financial values and social benefits and invites proposals from the private sector.
Selection	The private sector assesses the value of money to apply for a project	The public sector performs the economic, social, and financial feasibility studies for the evaluation of the project.
Requirements for Submission	<p>The following are the general requirements for submissions of USP to screen the proposals that are not valuable or practical:</p> <ul style="list-style-type: none"> • Feasibility studies • Financial models and cost-benefit analyses • Business plans and associated risks <p>Note: Usually, the private sector performs the feasibility study and establishes implementation plans. However, in some cases, such as in South Korea, a separate public body known as a public and private investment management center carries out preliminary feasibility studies after getting a USP.</p>	The public sector performs the feasibility study and establishes implementation plans.
Mechanisms/ procedures	<p>The following are the most common mechanisms used for managing USP:</p> <ul style="list-style-type: none"> • Direct negotiation • Bonus system • Swiss challenge • Regular procurement • Best and final offer 	<p>Generally, an open and competitive tender is placed for managing solicited proposals. The private sector submits technical and financial bids in response to the following, or similar to the following documents:</p> <ul style="list-style-type: none"> • Request for Expression of Interest (EOI) or • Request for proposal (RFP) • Simple public tender

2.3 Research Gap

The projects following solicited and unsolicited proposals exhibit distinct characteristics based on their proposer, nature, selection, and procedure, as discussed above. Consequently, we assume that the impact of various variables, particularly institutional variables in the context of developing countries, may differ between them. Despite the extensive literature on various aspects of PPI projects, a critical gap remains in examining the impacts of these variables, particularly in differentiating between solicited and unsolicited proposals. To fill this gap, we need to investigate the level of impact of these variables on the performance of solicited and unsolicited projects separately using a detailed methodology and a rich dataset.

3 Research methodology

A comprehensive research methodology is applied in this study consisting of a thorough literature review to identify the variables recognized as significant in previous studies for the PPI project and a diverse dataset collected from multiple databases. The following subsections discuss the methodology in detail.

3.1 Key variables:

The framework for the selection of variables for this study draws from previous literature, identifying those variables deemed significant for the success of PPI projects in developing countries. For this purpose, we reviewed around 70 articles and conference proceedings that have been published over the years between 1998 to 2023 related to the PPI projects. This process was performed by two researchers independently. The findings of both researchers were validated by a third researcher to ensure the reliability of the extracted data. Following a detailed and rigorous review of the previous literature, a total of eighteen independent variables were gathered for this study, which were identified in previous studies as significant for the success of PPI projects in developing countries. A detailed list of the variables is given in Appendix A.

The identified variables were grouped into three categories including governance indicators (06 variables), socio-political and economic indicators (09 variables), and project characteristics (03 variables). Furthermore, the study includes one binary class-dependent variable to identify whether the project is successful or not. In line with the approach used by Jiménez et al., (2019), if a project in the PPI database

is marked as either active or concluded, it is assigned “1” which denotes project success. Conversely, if the project is categorized as distressed or canceled, it is assigned “0” indicating the project's failure. The detailed structure of the variables is shown in Figure 1.

3.2 Data collection

The dataset used in this study was collected from various reliable sources including the World Bank, German Watch, and The Heritage Foundation. The major dataset was collected from the World Bank-maintained PPI projects database (World Bank, 2020), having a diverse set of information regarding PPI projects including total investment, sub-types of PPI (brownfield and greenfield projects), presence of local sponsors, and project status. The dataset includes around 8,674 PPI projects that occurred in 121 developing countries between 1996 and 2021. Data for other independent variables were collected from various other reliable sources including German Watch data source (<https://germanwatch.org/en/cri>), data maintained by Douglas Dow of the Melbourne Business School (http://dow.net.au/?page_id=35), The Heritage Foundation (<https://www.heritage.org>), and WGI database of the World Bank (<https://data.worldbank.org/>).

Furthermore, this study conducts analysis using three distinct datasets. The first dataset consists of 8,674 PPI projects having both solicited and unsolicited projects (hereafter, we will call it the PPI projects dataset). It was further subdivided into two smaller subsets based on the project proposal types: one containing 3,787 solicited projects (hereafter, we will call it the Solicited projects dataset) and the other containing 4,887 unsolicited projects (hereafter, we will call it the Unsolicited projects dataset). The analysis based on these three distinct datasets will provide a good understanding of the impact of the identified variables on PPI projects, as well as when examined independently for solicited and unsolicited projects.

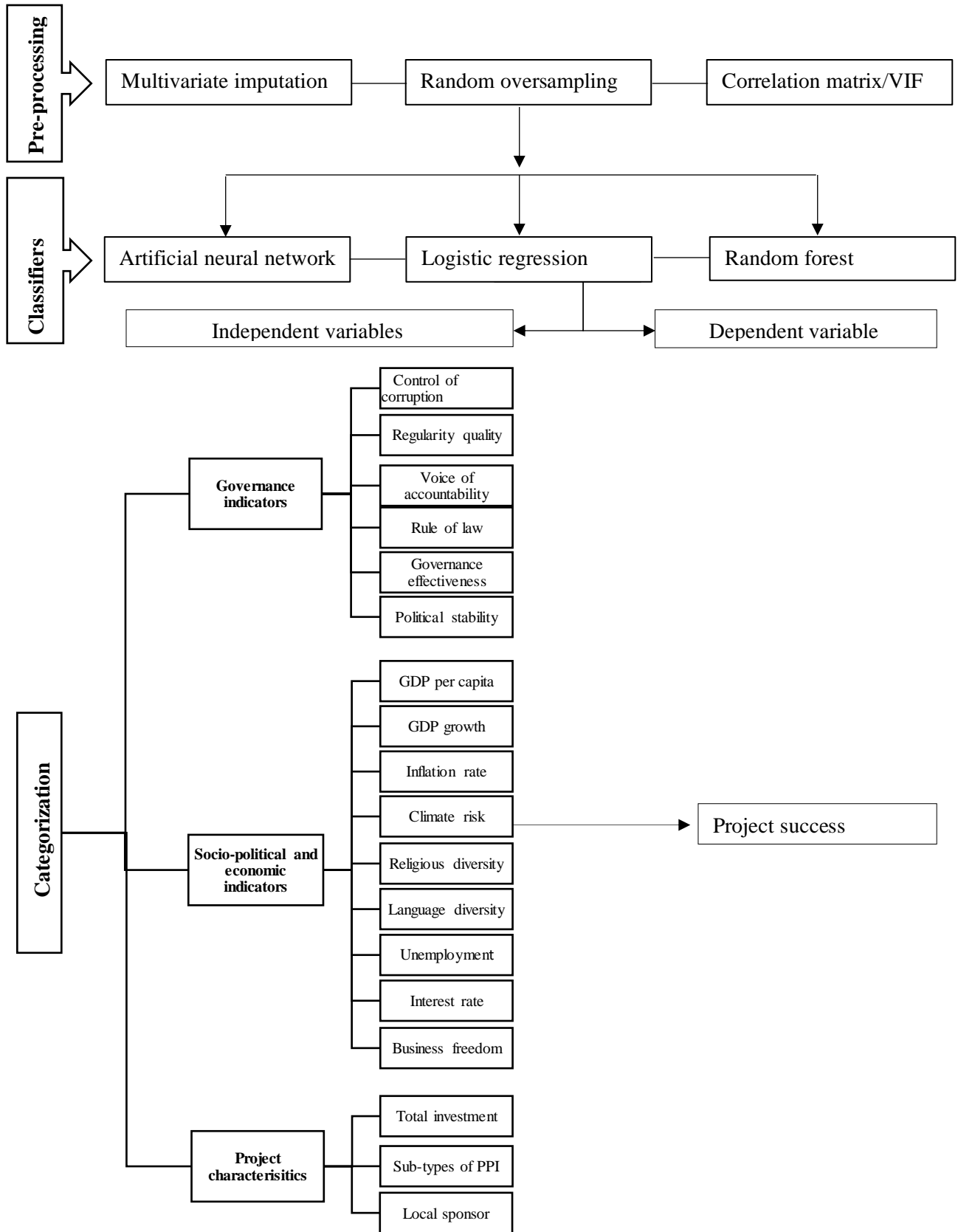


Figure 1: The Framework's structure

3.3 *Model preparation*

Several variables that significantly impact the response variable are collected from the previous literature using a pre-defined framework ensuring the relevancy of the variables. However, there are chances of including correlated and redundant variables in the datasets. Additionally, the dataset can also consist of issues such as missing values and imbalanced binary classes. These issues may have an impact on the performance of the proposed model. Therefore, the following steps are taken to make the dataset suitable for machine learning techniques.

3.3.1 Correlation matrix and variance inflation factor (VIF)

Multi-collinearity undermines the statistical significance of independent variables. Therefore, it is important to check and resolve the multi-collinearity issue if there is any among the independent variables. Therefore, we use a correlation matrix and variance inflation factor (VIF) to avoid multi-collinearity issues in the dataset.

3.3.2 Suitability of the dataset

For the Machine learning classification framework, the dependent variable must be categorical. In this study, the dependent variable is Project success (Yes/No), which is a binary categorical variable. Further, the classification techniques need a large sample size. A general guideline is at least 10 cases for each independent variable in the model. The sample size used in this study is around 8,674 PPI projects, which is above the minimum required threshold of 180 cases.

3.3.3 *Data Exploration*

Before applying the classification algorithms, the data are pre-processed to make it suitable for the algorithms by considering the following steps.

3.3.3.1 Data Normalization:

The variables with different ranges and scales can lead to bias toward the variables with higher values, which can affect the performance of the proposed model (Bashir et al., 2021). The given dataset has sixteen numerical variables with different units and sizes. To avoid the potential bias toward the variables having

larger values and improve the performance of the model, we have used the scaling techniques in the given dataset.

3.3.3.2 Imputation

The dataset analysis shows that it contains more than 5% missing values. The removal of these values can affect the data's reliability and quality, leading to bias and a loss of valuable information. Therefore, to address the issue of missing values, we will look for an appropriate imputation method. For this purpose, the missing values mechanisms including missing at random (MAR), missing not at random (MNAR), and missing completely at random (MCAR) will be tested. Based on the outcomes of the missing value mechanism test, an appropriate imputation method will be applied.

3.3.3.3 Oversampling

The dataset analysis shows that the dependent variable i.e., project success/failure has imbalanced binary classes. Therefore, it is important to fix the imbalanced classes issue and to make the algorithms classify the minority class (project fail) with accuracy. The framework also uses an oversampling technique.

3.3.4 *Splitting of dataset*

After pre-processing the dataset, we divided the dataset into two subsets, 70% training dataset and 30% testing dataset. In the first step, the model applies to the training dataset to train it. In the next step, it applies to the testing dataset for assessing the performance of the classifiers in predicting the project success.

3.4 *Machine learning framework*

The sample used in this study consists of real datasets with missing values, and unbalanced class. To resolve these issues and to make the data useful for the analysis, a machine learning framework has been used in this study. This framework consists of data exploration to make the data suitable for the machine learning algorithms, and the application of machine learning algorithms for assessing the impact of the independent variables (n=18) on the success of solicited and unsolicited projects. Gondia et. al. (2020) and Ayat et al., (2022) have used similar frameworks using a group of machine learning techniques for the prediction of construction project delay risk and PPI project success respectively. The following subsections discuss the

framework in detail.

3.4.1 Classification algorithms

The framework consists of the following three classification algorithms (machine learning algorithms) that have been selected in this study based on their abilities to deal with different data structures such as linear, complex, and nonlinear structures.

3.4.1.1 Artificial Neural Network (ANN)

ANN is a strong classification algorithm, which uses three types of learning methods namely supervised, unsupervised, and reinforcement learning (Kumar and Thakur, 2012). ANN is considered a strong and multitask algorithm that mimics real neurons. It works better in detecting nonlinear effects and complex interactions (Nikzad et al., 2012, Mehra et al., 2018). It does not require explicit distributional assumptions and process relationships (Ghobadian et al., 2009). Therefore, it is considered useful for a variety of tasks and a commonly used machine learning algorithm.

3.4.1.2 Random forest

Random forest is another promising machine-learning algorithm that consists of several independent trees (Zhao et al., 2018). It combines multiple randomized decision trees using a bootstrap sample, in which each tree predicts the dataset (Pavlov, 2019). It is a user-friendly algorithm, the users just need to identify the number of trees and predictors that can be easily optimized (Biau and Scornet, 2016). It works better in complex relations between predictors and response variables (Kuhle et al., 2018).

3.4.1.3 Logistic Regression

This study used logistic regression to identify and compare the impacts of the various identified variables on solicited projects, and unsolicited projects. Logistic regression estimates the probability of the event that is most likely to happen (Chi-Hsien and Nagasawa, 2019) and is preferably applied to a dataset in which predictors are low dimensional and linearly related to response variables (Maroco et al., 2011, Couronné et al., 2018, Ranganathan et al., 2017). The dataset used in this study is low dimensional and has a binary

class-dependent variable. Therefore, logistic regression was also applied in this study to check the impacts of the identified independent variables on the success of solicited projects, and unsolicited projects.

3.4.2 Evaluation criteria

Several performance evaluation matrices including accuracy, sensitivity, precision, specificity, F₁ Score, and Geometric means have been applied to evaluate the efficiency of the classifiers. Since accuracy, sensitivity, and precision have emphasized on positive class (project success in this case). On the other hand, specificity has a high focus on negative class (project failure in this case). The F₁ Score combines precision and sensitivity, whereas geometric means provide a more comprehensive assessment by considering specificity and sensitivity.

4 Results

The dataset consists of eighteen independent variables: two categorical variables and sixteen numerical variables. The categorical variables are binary class variables namely, the presence of local sponsors and greenfield projects (Type of PPI project). The numerical variables are various in size and have been presented in different units. Therefore, a scaling technique is performed to standardize the numerical variables before applying the classification algorithms. The descriptive statistics of the dataset as given in Table 2 show that average total investment, which is an indicator of project size, is lower for unsolicited projects (Mean \$239 Million) as compared to solicited projects (Mean \$272 Million). The observation suggests that unsolicited projects in the given dataset are smaller in size than solicited projects. Further, the data reveals that greenfield projects (brand new projects from scratch) attract more unsolicited proposals than brownfield projects (extension or renovation of the existing projects). Apart from these two variables, which show significant distinctions between solicited and unsolicited projects, the remaining variables have similar characteristics across both project types.

Table 2: Descriptive statistics

Variables	Total				Unsolicited				Solicited			
	Min	Max	Mean	Standard deviation	Min	Max	Mean	Standard deviation	Min	Max	Mean	Standard deviation
Type of PPI* (Greenfield)												
Local sponsors*												
Total investment (Millions USD)	0.3	35587	229.1	668.90	0.3	6882	239.0	452.40	0.4	35586	272.15	849.14
Control of corruption	.00	80.41	42.25	14.24	.00	80.41	40.88	15.264	1.44	79.62	44.108	12.452
Regularity quality	0.52	82.69	48.40	13.84	0.52	81.73	47.73	14.392	3.85	82.69	49.306	12.970
Voice of accountability	0.48	86.21	40.20	22.17	0.48	84.58	40.15	21.560	3.94	86.21	40.249	22.952
Rule of law	0.48	83.97	42.02	12.74	0.48	83.97	40.33	14.046	3.32	78.37	44.407	10.362
Government effectiveness	0.96	85.85	51.61	13.29	1.53	85.85	49.76	13.615	0.96	84.81	54.149	12.380
Political stability	.00	94.69	29.54	14.97	.00	94.69	29.75	15.859	0.47	91.47	29.300	13.663
GDP per capita	138.9	15421	4580	3548.52	138.9	14613	3401	3029	341	15421	6183	3571.83
GDP growth (%)	-33.1	18.29	5.05	3.63	-33	18.29	5.356	4.059	-9.38	15.18	4.642	2.916
Inflation	-10.0	513.9	6.79	10.70	-10.0	513.9	7.854	13.628	-2.08	50.99	5.595	4.101
Climate risk	.00	36602	10098	14013.3	.00	36601	9234	13607	.00	36601	11268	14462
Religious diversity	.00	0.99	0.31	0.20	.00	.99	.318	0.206	.00	0.99	0.318	0.195
Language diversity	.00	1.00	0.43	.323	.00	1.00	.434	0.321	.00	0.97	0.424	0.326
Unemployment	0.13	35.27	7.002	4.506	.14	35.27	7.17	4.772	.13	28.47	6.767	4.101
Interest rate	-35.3	77.62	14.34	20.234	-35.3	77.62	13.93	19.338	-12.8	77.62	14.867	21.319
Business Freedom	20	86.70	68.51	10.785	20	86.70	68.32	11.18	20	86.70	68.767	10.212

*Categorical variables

The data has imbalanced binary classes dependent variables, which poses a serious challenge to classification algorithms. Most of the classification algorithms are designed to assume an equal number of instances of both classes (positive and negative classes) and get biased toward the majority class. Therefore, this study uses Random Oversampling Examples (ROSE) to fix the issues of imbalanced classes by enhancing the number of minority classes. ROSE focuses on the minority class and creates synthetic examples in a way that significantly reduces the risk of overfitting. This technique is also applied to similar datasets in previous literature (Ayat et al., 2022a, Lunardon et al., 2013).

The analysis of the data also shows that there are more than 5% missing values, which were required to be addressed using the appropriate imputation method. Based on the output of the missing values test that the missing mechanism is MAR, we applied a multiple imputation method known as multivariate imputation using chained equation (MICE). It leads to unbiased results when the data are MAR. As discussed above, there are three types of missing value mechanisms missing at random (MAR), missing not at random (MNAR), and missing completely at random (MCAR). If the data are MCAR, it would be justifiable to exclude the missing values using complete case analysis (Dziura et al., 2013). Multiple imputation methods are preferred to resolve the issue of missing values if the mechanism is MAR. MNAR can also be handled with a more complex multiple imputation (Jakobsen et al., 2017).

For checking the threat of multicollinearity among the independent variables, both the correlation matrix and variance inflation factor (VIF) are used in this study. The results, as given in Table 3, show that the correlation values among all the variables fall in the normal range, remaining below the threshold of 0.7. This suggests the absence of multi-collinearity among these variables. Additionally, the values of VIFs are also well below the limit of ten as recommended in the literature (Neter et al., 1996, Kennedy, 2008), further confirming the absence of multicollinearity as a threat in this study. Subsequently, all the given variables can be treated as independent variables (regressors) in the model.

Table 3: Correlation matrix

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	VIF
Political stability	1.00																		1.60
Climate risk	-.03	1.00																	1.25
Total investment	.008	.075	1.00																1.04
Type of PPI (Greenfield)	.011	.055	-.02	1.00															1.31
Rule of law	-.11	.141	-.025	.011	1.00														1.30
Inflation	.080	.129	.009	.013	.018	1.00													4.72
Local sponsors	-.10	.100	-.005	-.05	.018	.008	1.00												4.28
Unemployment	.150	.067	.021	-.13	.052	-.05	-.08	.00											4.71
GDP per capita	.023	.008	-.114	.046	-.12	.098	.058	.02	.00										2.28
Religious diversity	-.46	-.05	.016	-.02	-.07	-.01	.065	.14	.087	.00									1.18
GDP growth (%)	.126	-.25	-.021	-.08	.002	.139	-.03	.179	.206	-.13	1.00								4.73
Interest rate	.049	-.10	-.012	-.02	.175	.049	.007	.043	.198	-.08	.245	1.00							2.59
Regularity quality	.019	.121	-.008	-.02	.019	.040	-.02	-.07	-.019	.210	-.15	-.19	1.00						3.88
Business Freedom	.323	-.30	-.031	-.02	-.19	-.05	.094	.019	.037	-.24	.020	.119	.096	1.00					1.46
Language diversity	.331	-.05	-.051	.066	-.27	.078	-.05	.060	.480	-.20	.008	.312	.207	.022	1.00				3.44
Voice of accountability	.085	.356	.012	-.036	-.436	-.018	.145	-.076	.079	.133	.090	-.19	-.04	.124	-.15	1.00			3.80
Control of corruption	-.21	-.04	.005	.062	-.43	-.02	.022	-.226	.005	.177	-.18	-.25	-.09	.010	.090	.065	1.00		2.02
Government effectiveness	-.06	-.31	.022	-.02	-.29	.017	.033	.045	-.142	-.04	.114	.012	-.49	-.226	-.12	.036	-.24	1.00	2.25

To optimize the threshold values, the receiver operating characteristic (ROC) curve is plotted, showing the relationship between the true positive rate and the false positive rate at various cut-off points as given in Figure 2. The curve shows that the 0.5 threshold is on the upper left corner of ROC (100% sensitivity, 100% specificity). However, we checked the results for keeping threshold values at 0.4, 0.5, and 0.6. The findings suggest that keeping the threshold at 0.5 gives the best results in the model. Furthermore, the 10-fold cross-validation method has been used, where the dataset is randomly divided into

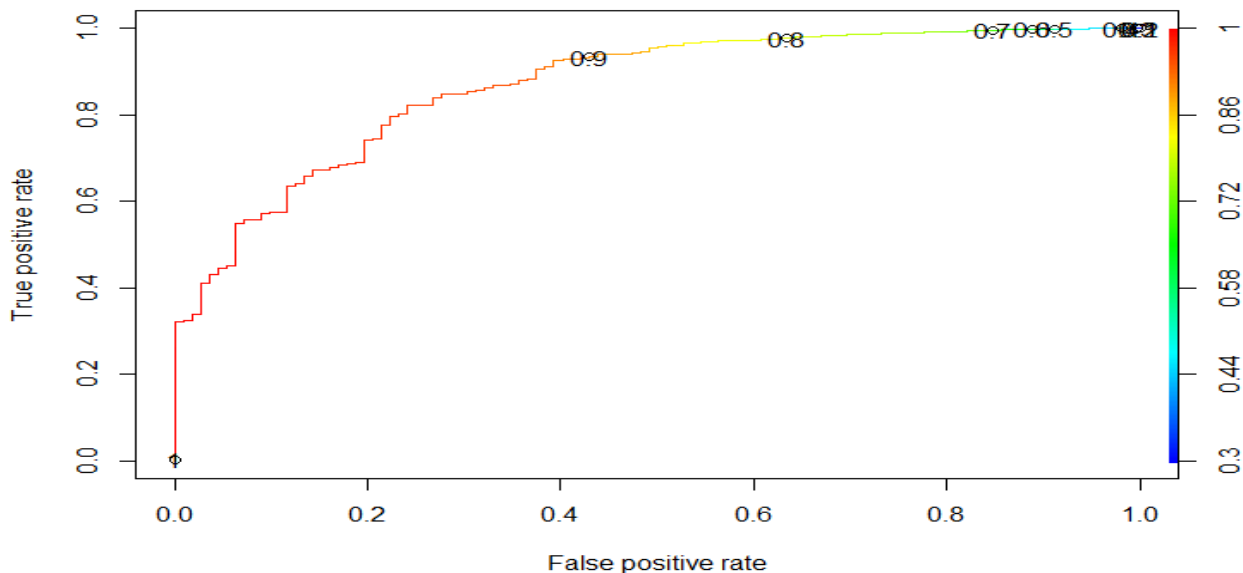


Figure 2: Receiver operating characteristic curve

10 different and distinct folds. The model is first trained by 9 folds and then test its performance by using the 10th fold.

After evaluating the three classification techniques namely random forest and artificial neural network (ANN) using a diverse group of criteria metrics including accuracy, precision, specificity, sensitivity, F₁-score, and geometric means, the logistic regression is a better fit for this dataset as shown in Table 4. The results of the random forest and ANN have been biased toward positive classes at large. Therefore, the logistic regression is preferred to apply in this data for investigating the impact of the selected eighteen independent variables on the success of solicited and unsolicited variables. The better performance

logistics regression for this data may indicate a strong linear relationship of independent variables/features with the dependent variable/response. The Logistic regression performs better when there is a strong linear relationship between independent and dependent variables (Westreich et al., 2010, Muchlinski et al., 2016) as compared to random forest and ANN (Kuhle et al., 2018). It is also important to acknowledge that there is not a one-size-fits-all prediction method for all types of datasets. The selection of the suitable method depends on the structure of the dataset and the nature of the problem.

Table 4: Comparison of the performances of the three machine-learning algorithms

	Logistic Regression	Artificial Neural Network	Random Forest
Accuracy	0.998	0.989	0.989
Precision	0.975	0.976	0.950
True positive rate / Sensitivity	0.980	0.982	0.997
Specificity	0.973	0.67	0.55
F₁-score	0.980	0.973	0.964
Geometric means	95.01	71.12	69.19

4.1 Analysis of the machine learning algorithm results

As mentioned in the above section, logistics regression was chosen over other classifications in this study to investigate the impacts of the identified variables on the success of PPI projects using three datasets; solicited projects dataset, unsolicited projects dataset, and combined dataset consisting of both solicited and unsolicited projects (PPI project dataset). The results of the logistic regression for all three datasets have been presented in Table 5.

The results show that the impacts of some of the identified variables are similar in all three datasets. For instance, greenfield projects (p-value < 0.01), and political stability (p-value < 0.05) have positive and significant impacts, whereas GDP per capita, and religious diversity have negative and significant impacts (p-value < 0.01) on the success of PPI projects in all three datasets. Furthermore, government effectiveness, GDP growth, unemployment, voice of accountability, inflation, language diversity, and unemployment have statistically insignificant effects on the success of PPI projects in all three datasets.

Table 5: Factors affecting success in solicited and unsolicited PPI projects

Independent variables	Total			Unsolicited Proposal			Solicited Proposal		
	B	SE	Significant	B	SE	Significant	B	SE	Significant
Type of PPI (Greenfield)	.225	.082	.006***	.123	.065	.059**	.937	.347	.007***
Local sponsors	.333	.179	.063	.451	.143	.002***	.272	.639	.670
Total investment	-.129	.048	.007***	-.056	.058	.340	-.223	.095	.019**
Control of corruption	.264	.150	.079**	.200	.131	.127***	.790	.620	.203
Regularity quality	.120	.149	.423	.454	.114	.000***	.511	.545	.348
Voice of accountability	.394	.159	.013	.150	.121	.214	.448	.619	.019
Rule of law	.269	.159	.090*	.316	.134	.019**	.720	.557	.196
Government effectiveness	-.147	.164	.370	.012	.135	.930	-.993	.601	.098
Political stability	.173	.096	.071**	.127	.073	.084**	.750	.323	.020**
GDP per capita	-1.135	.196	.000***	-.364	.104	.000***	-2.163	.793	.006***
GDP Growth (%)	-.082	.104	.429	-.050	.076	.509	.112	.330	.735
Inflation	-.057	.112	.607	.026	.063	.673	.117	.256	.648
Climate risk	-.266	.163	.100**	-.489	.124	.000***	.243	1.149	.832
Religious diversity	-.193	.099	.053***	-.214	.080	.007***	-.616	.349	.078***
Language diversity	-.060	.134	.651	-.109	.099	.269	-.999	.543	.066
Unemployment	-.161	.098	.098	-.162	.073	.026	-.406	.437	.352
Interest rate	-.014	.125	.912	-.248	.088	.005***	-1.447	.760	.057**
Business Freedom	.027	.128	.836	.039	.090	.666	1.138	.540	.035**
Constant	-3.936	.461	.000***	-4.82	.289	.000***	-10.06	1.382	.000***
	<ul style="list-style-type: none"> • *** indicates significance at 0.01 • ** indicates significance at 0.05 • * indicates significance at 0.1 								

The results also show that the level of significance of several variables for solicited projects and unsolicited projects is different. For example, the presence of local sponsors and regularity quality have a positive and significant impact ($p\text{-value}<0.01$) on unsolicited projects, whereas their impacts are insignificant on solicited projects. Furthermore, the impact of control of corruption ($p\text{-value}<0.05$) and the rule of law ($p\text{-value}<0.1$) are positive and significant for unsolicited projects, whereas insignificant for solicited projects. Similarly, climate risk is negative and significant for unsolicited projects ($p\text{-value}<0.01$), while insignificant for solicited projects. The results further show that total investment is negative and significant ($p\text{-value}<0.01$), and business freedom is positive and significant ($p\text{-value}<0.05$), for solicited projects, whereas, insignificant for unsolicited projects.

The results further show that the impact of some variables on the PPI projects (consisting of solicited and unsolicited projects) is different from their impacts on solicited and unsolicited projects. In the list of independent variables, there are eight variables including local sponsors, total investment, control of corruption, regularity quality, rule of law, climate risk, interest rate, and business freedom that have different levels of impacts on the PPI projects than either solicited or unsolicited projects.

As shown above, the regression analysis examines the impact of various independent variables on the project success across three models including total, unsolicited proposal, and solicited proposal. Below is a summary of the significant findings for each model.

The results show that a few variables such as political stability, GDP per capita, and religious diversity are consistently significant in all three models. Another set of variables including control of corruption, rule of law, and climate risk are significant for Total and Unsolicited projects.

Local Sponsors, regularity quality, and unemployment are significant for unsolicited projects but not for total and solicited projects. Similarly, total investment and voice of accountability are significant for solicited projects but insignificant for unsolicited projects. Interest rate is significant in both the unsolicited and solicited proposal models, while business freedom is only significant for solicited Proposals.

These results highlight the differing impacts of various factors on the project success across the different models, with some variables consistently influencing the outcome while others show significance

only in specific contexts. This indicates significant variation in the level of impact of several variables on the three types of datasets. This also suggests the importance of the division of the projects based on their proposal types to investigate the true level of impact of the given factors on the PPI project's success.

5 Discussion

This study investigates how a set of identified variables impacts the success of PPI projects occurring in developing countries and their relationship with the project proposal (solicited and unsolicited). In this section, we will discuss in detail the results obtained from our study as presented in the previous section, and the key findings that emerged from our analysis. Furthermore, we will also put forward the significance of this study in the broader context of PPI projects, its implications, and future research avenues.

5.1 PPI projects

PPI projects in developing countries use either solicited or unsolicited proposals, each involving a distinct set of aspects and considerations. Particularly, these proposals follow different identification and selection processes for a project. However, there are also several similar aspects, needs, and requirements common to both solicited and unsolicited projects. Therefore, several variables have the same and consistent impact on both types of projects. For instance, political stability and greenfield projects have positive and significant impacts, and religious diversity and GDP per capita have negative and significant impacts on PPI, solicited, and unsolicited projects. These findings are aligned with the results of prior studies on PPI projects occurring in developing countries (Jiménez et al., 2020, Ruiz Díaz, 2020, Jiménez et al., 2019, Lupton et al., 2019, Jiménez et al., 2017).

Political stability in the host country provides a friendly environment for PPI projects (Hammami et al., 2006). On the other hand, the uncertainty related to political events such as regime change, coups, revolutions, and political violence induces instability in the market and policies, which have a negative impact on projects (Chang et al., 2018). These kinds of uncertainties and risks, which are referred to as political risks, are usually outside the scope of project activities, and they make projects more uncertain,

unpredictable, and difficult to manage (Xiaopeng and Pheng, 2013). The absence of political risks in a politically stable country could contribute to the success of PPI projects regardless of their proposal type.

According to the results of this study, PPI projects are more likely to succeed when greenfield projects are involved. The study considers two types of projects: brownfield and greenfield projects. The brownfield, or redevelopment projects, are considered more expensive than greenfield or new projects on the same spot. Greenfield projects follow general industrial practices related to the structural and foundation configurations whereas, due to certain constraints and challenges in brownfield projects, they may not be feasible for similar supporting structural configurations (Nuthanapati et al., 2019). Furthermore, greenfield projects do not need environmental remediation, and the land is ready for project development right away (Siironen, 2019). It requires more time for project completion to remediate the project site and additional administrative project approval (e.g., licenses) in the case of brownfield projects, all of which have an impact on project cost and time. Additionally, environmental risks include the cost of remediation, and third-party liability is associated with redevelopment projects (Espinoza and Luccioni, 2002). Moreover, the analysis of the greenfield and brownfield projects obtained from the World Bank-maintained PPI database also shows a higher success rate for greenfield projects (97.86%) than for brownfield projects (95.11%) (World Bank, 2020). The higher uncertainty and difficulty of carrying out brownfield projects as compared to greenfield projects may be the primary reasons for the significant positive impact of greenfield projects on success across all three datasets.

The religious diversity in the host country has emerged as a significant negative factor for project success in all three datasets. A possible reason would be the complexity associated with religious belief systems and their impact on human behavior. A religion or belief system plays critical roles in human behavior, practices (Norris and Inglehart, 2011), and frames of reference (Kumar and Nti, 2004). Within a country religious diversity makes it difficult for organizations to understand the behaviors of project stakeholders, local markets (Jiménez et al., 2019), and individuals' motives and willingness to interact and cooperate with others (Dow et al., 2016). The complications associated with religious diversity within the host country negatively affect the performance of PPI projects (Jiménez et al., 2019).

GDP per capita has a surprisingly significant and negative impact on the success of PPI projects in all three datasets in this study, which is also in line with multiple previous studies (Jiménez et al., 2020, Jimenez and Bayraktar, 2020, Jiménez et al., 2019). The possible reason for the negative impact of GDP per capita may be the coincidence of the unprecedented increase in GDP per capita across the world from 1990 to 2018 (Maddison Project Database, 2020), and the value of total investment in PPI projects (9.2 times the increase) during the same period in developing countries (World Bank, 2020). However, the impact of GDP per capita needs a deeper investigation in future studies.

Moreover, the results show that the impact of a few variables including GDP growth, voice of accountability, inflation, language diversity, and unemployment is insignificant for PPI, solicited, and unsolicited projects. This indicates that these factors may not be of much importance to be considered while performing PPI projects whether following solicited or unsolicited proposals. These results are also consistent with several previous studies (Jiménez et al., 2019, Jiménez et al., 2017, Lupton et al., 2019, Ruiz Díaz, 2020). The possible reasons for the insignificance of unemployment, and language diversity for their minimal impact on the role of institutions. Furthermore, the insignificant impact of financial factors such as inflation, and GDP growth can exist because of the existence of several types of financial guarantees for private parties performing PPI projects such as exchange rate guaranteed, interest rate increase guaranteed, and construction cost guaranteed (World Bank, 2020).

5.2 Solicited projects vs. unsolicited projects

As discussed in the above sections in much detail the projects following solicited and unsolicited proposals are different at many levels including their procedure for identification, selection, and development. Therefore, the performance of both types of projects is not the same and is influenced by various factors in different ways. The results show that several variables, particularly institutional variables, have different levels of impact on solicited and unsolicited projects. For instance, the control of corruption, regularity quality, and rule of law, have a significant impact on the success of unsolicited projects, whereas insignificant for solicited projects.

Unsolicited projects face numerous challenges and setbacks in their successful execution as compared to solicited projects (Abdel Aziz and Nabavi, 2014) due to various factors such as the lack of fairness, absence of international standards, and potential abuse of power (Hodges, 2003, Hodges and Dellacha, 2007), and ambiguity in the selection process (PPIAF, 2014). Moreover, the procurement process often lacks of transparency and competition in unsolicited projects (Nwangwu, 2019). These may highlight the vulnerability of these projects to institutional factors such as control of corruption, regularity quality, rule of law, and political stability, which have a significant impact on the success of PPI projects (Jiménez et al., 2017, Taguchi and Sunouchi, 2019a). Further, the private sector conducts preliminary studies in case of unsolicited proposals, which are usually followed by various forms of public proposals in different countries after the initial assessment. Despite the existence of a sort of public proposals, the unsolicited project proponents have advantages over the competitors (Marques, 2018). Furthermore, the rapid preparation of unsolicited proposals without active public sector involvement avoids due procedures in their selection and implementation (Turley, 2015). The lower transparency in the unsolicited projects process and high levels of risk make these projects vulnerable to possible accusations of misconduct by various stakeholders (Hodges and Dellacha, 2007). The less transparency, lack of standard framework, and poor competition in the unsolicited projects process may be possible reasons for the higher vulnerability of unsolicited projects to institutional factors as mentioned above.

The results also show that the presence of local sponsors and climate risk has a significant impact on the success of unsolicited projects, whereas their impacts are insignificant for solicited projects. When foreign investors participate in overseas businesses, they suffer due to the liability of foreignness (Maruyama and Wu, 2015). The liability of foreignness refers to the extra expenses that foreign firms pay due to their lack of familiarity with the political, economic, and cultural settings in the host country. (Wan et al., 2020, Millar and Ju Choi, 2008). The engagement of a local firm in the project is one possible manner to reduce the impact of the liability of foreignness (Jimenez and Bayraktar, 2020). The difference in the level of the impact of the presence of local sponsors in solicited and unsolicited projects may be explained due to the lack of a standardized framework for managing unsolicited projects in the majority of developing

countries (Yun et al., 2015). The knowledge of local norms, culture, bureaucratic styles, and participation of the local community may have a greater influence on unsolicited projects as compared to solicited projects, which are generally carried out through a standardized and well-structured framework (Turley, 2015).

Climate disasters are unpredictable events that have adverse impacts on local economic sectors including business operations (Mithani, 2017). For the protection of the facilities, and to reduce the disruption of operations due to climate disasters, additional resources are needed for insurance and the implementation of contingency and recovery plans (Huang et al., 2018). Therefore, climate risk increases transaction costs, uncertainty, and risks of project failure (Huang et al., 2018, Lupton et al., 2019). The solicited projects are included in the government priority list, which are well planned and allocate enough budget to account for the likelihood and severity of climate and other types of natural disasters. However, unsolicited proposals are made quickly without the involvement of the public sector (Turley, 2015), incomplete technical information (PPIAF, 2014), and are approved without robust evaluation (Pabodha Abeysekara, 2021). Thus, unsolicited projects may be carried out without a detailed plan for addressing natural disasters including climate risks. This may explain the reason for the significance of the climate risk on unsolicited projects.

The results also show that business freedom has a significant impact on the success of solicited projects, whereas it is insignificant for unsolicited projects. Business freedom indicates the efficiency of the business regulations in a country. A high score for business freedom shows the freest environment for business (Economic Freedom Index, 2021). Unsolicited projects are identified and developed by private parties, while the public sector has limited involvement in them in many aspects including making feasibility reports and establishment of implementation plans. On the other hand, solicited projects are identified by the public sector and carried out under public financial management or procurement-specific laws. The difference in the level of involvement of public and private sectors in solicited and unsolicited projects may be the possible reason for the significant impact of business freedom on the solicited projects. As a final note, the impact of several variables on solicited and unsolicited variables are significantly

different due to their distinct nature and characteristics. This is a significant contribution of this study to the literature on PPI projects, which also guides policymakers, investors, and practitioners.

5.3 Implications of the study

The study provides several important implications for researchers as well as valuable insights to policymakers, investors, and project practitioners about managing solicited and unsolicited projects in developing countries.

5.3.1 Theoretical implications:

- The study adds a new perspective to the literature on project management. Previous literature suggested that the identified factors are significant for the success of both solicited and unsolicited projects equally. However, this study found that the impact of various factors is different for solicited and unsolicited projects. This suggests that the context-specific nature of these variables should be accounted for in the theoretical models of PPI project success. For example, political stability, GDP per capita, and religious diversity are consistently significant across all models, indicating their universal importance. However, variables like local sponsors, regularity quality, and business freedom show significance only in specific contexts, suggesting that their influence is conditional on the type of proposal.
- This study serves as a steppingstone towards a more comprehensive and deeper understanding and better prediction of PPI project outcomes. The results show the importance of differentiating between solicited and unsolicited proposals for PPI project success. This can lead to a better project outcomes prediction model based on the type of project proposal. For instance, variables such as control of corruption, rule of law, etc., significantly impact unsolicited proposals but not solicited proposals, emphasizing the need for customized strategies in managing PPI projects.
- In short, this will stimulate new discussion among the researchers and experts in project management to investigate the impact of certain variables on solicited and unsolicited projects separately.

5.3.2 *Practical implications:*

- The study highlights the role of institutional factors and their significance in the success of unsolicited projects. This suggests the sponsors should carefully consider and analyze the governance indicators before proposing and investing in unsolicited projects. This also emphasizes the importance of creating a conducive environment for PPI projects in developing countries by enhancing the performance of public institutions.
- Another important finding of the study is about the positive role of local sponsors in the performance of unsolicited projects. It highlights the potential benefits of local engagement, the significance of local knowledge and understanding of the project contexts and addresses the issue of liability of foreignness by involving local stakeholders in the project planning and execution.
- The overall findings of the study suggest different levels of impacts of various variables on solicited and unsolicited projects. This shows the importance of recognizing the uniqueness and difference in the impacts of certain variables on the two types of project proposals. Therefore, practitioners should customize project management strategies and risk assessment techniques to deal with solicited and unsolicited projects in distinctive manners.
- Identification of an appropriate set of critical success factors will improve the performance of both solicited and unsolicited projects. Consequently, it will reduce the project failure rate, and attract further investments to the developing countries which will drive positive changes and prosperity to the local communities.

5.4 *Limitations of the Study*

The study offers several important contributions; however, some limitations should be considered when interpreting the results of this study.

- The study is based on secondary data collected from various reliable and reputable sources using rigorous data processing protocols. The study does not include any direct input from the

practitioners and other stakeholders. However, the results of the study are exclusively derived from the quantitative data analysis and should be regarded as such.

- This study considered the PPI projects for the analysis, which occurred in developing countries. We assume that the performance of PPI projects in advanced and developing countries can be varied due to differences in socioeconomic and several other factors. Therefore, the findings of this study should only be interpreted and explained in the context of developing countries.
- Furthermore, the dataset consists of projects in different sectors including energy, information, communication and technology, and waste management. The study assumes that the level of the impact of the identified variables on solicited and unsolicited projects won't be significantly changed due to the sectors. It should be noted that the study does not provide any specific input regarding the project sector.
- The variables used in the dataset such as the macroeconomic situation can change with time and their impacts can be varied. However, the significance level of these variables would remain the same unless there are some highly significant changes in the values because it considers extensive data from three decades.

5.5 *Future research*

The study also opens several new avenues for the researchers to investigate various other aspects of PPI projects within the context of solicited and unsolicited proposals:

- The study is solely based on secondary data. In the future, to gain a more thorough understanding of the variation in the impact of certain variables due to proposal types, a mixed method can be used including both quantitative methods as well as qualitative approaches. Qualitative approaches such as interviews or surveys with the project stakeholders and researchers may provide diverse perspectives and a deeper understanding of the PPI projects.
- This study is based on the dataset of PPI projects that occurred in developing countries. In the future, researchers may investigate the impact of various factors on the PPI projects that took place in

developed countries and then compare these results with those obtained in the context of developing countries. Such comparative analysis could lead to a deeper understanding of the nature of PPI projects.

- The study doesn't differentiate projects based on their sector such as Energy, ICT, construction projects, etc. The impact of the type of proposal on the project success can be varied for projects of different sectors. Therefore, researchers in the future may explore the relationship between the project sectors and the type of proposal of PPI projects.
- There are several types of project award methods such as competitive bidding, competitive negotiation, direct negotiation, and a licensing scheme. This study is focused on solicited and unsolicited proposals without considering the aforementioned project award methods. These methods use different procedures and may have different impacts on the project's performance. Therefore, researchers in their future studies may compare the impact of the project award methods to understand their roles in the performance of PPI projects.

6 Conclusion

This study provides valuable insights into the PPI projects that occurred in 121 developing countries following solicited and unsolicited proposals. The data have been collected from the World Bank-maintained PPI database and various other databases including the Worldwide Governance Indicator (WGI) database, German Watch, The Heritage Foundation, and Douglas Dow's research page at Melbourne Business School. The dataset was preprocessed and divided based on their proposal types to investigate the specific impact of the identified variables on solicited and unsolicited projects.

The findings of the study show that certain variables, such as religious diversity, sub-types of PPI projects (greenfield projects), and political stability are equally important for both solicited and unsolicited projects. This may explain the shared and common aspects, needs, and requirements of both solicited and unsolicited projects. However, the results also indicate that the institutional role is significant in unsolicited projects while it is insignificant for solicited projects. Also, the impact of understanding the local norms

and working styles to reduce the liability of foreignness (presence of local sponsors) is only important for unsolicited projects. This suggests the higher vulnerability of unsolicited projects to institutional factors and the presence of local sponsors. The high level of impact can be attributed to the absence of a standard framework, lack of transparency, and poor competition in the processes of unsolicited projects in many developing countries. This suggests that the performance of unsolicited projects, which is typically poor as compared to solicited projects, can be improved if the host countries have stronger values for institutional indicators and local sponsors have been involved in project planning and execution. Furthermore, the study highlights that due to various types of financial guarantees from governments in PPI projects, the impacts of financial factors such as GDP growth, and inflation are not significant across the PPI projects. In short, this study provides empirical evidence in support of the different levels of impact of several variables on solicited and unsolicited projects. This indicates the importance of the division of the PPI projects based on proposal types (solicited and unsolicited projects) and designing customized project management approaches for both types of projects.

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- PPI projects database (<https://ppi.worldbank.org/en/ppi>)
- World Bank database (<https://data.worldbank.org/>),
- German Watch (<https://germanwatch.org/en/cri>),
- Melbourne Business School, Douglas Dow's research web page (http://dow.net.au/?page_id=35),
- The Heritage Foundation (<https://www.heritage.org>)

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Appendix A

Variable definitions:

1. **Control of Corruption:** Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. The value of this variable is between 0 and 100.
2. **Regulatory Quality:** Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. The value of this variable is between 0 and 100.
3. **Voice and Accountability:** Reflects perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. The value of this variable is between 0 and 100.
4. **Rule of Law:** Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. The value of this variable is between 0 and 100.
5. **Government Effectiveness:** Reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. The value of this variable is between 0 and 100.
6. **Political Stability and Absence of Violence/Terrorism:** Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism. The value of this variable is between 0 and 100.
7. **GDP per Capita:** GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus

any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars.

8. **GDP Growth (%)**: Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.
9. **Inflation rate**: Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally used.
10. **Climate Risk**: *This variable shows the total losses from climate events, in millions USD adjusted to purchasing power parity. The data related climate risk collected from German watch.*
11. **Religious diversity**: *In religious diversity, the indices are constructed such that a value of 1 represents the situation where no two individuals within the country share the same attribute under investigation adhere to the same religion. Conversely, a value of 0 represents the situation where every individual within the country shares the same attribute (e.g. adheres to the same religion).*
12. **Language diversity**: *In linguistic diversity, the indices are constructed such that a value of 1 represents the situation where no two individuals within the country share the same attribute under investigation (e.g. speak the same language). Conversely, a value of 0 represents the situation where every individual within the country shares the same attribute (e.g. speaks the same language)*
13. **Unemployment**: Unemployment refers to the share of the labor force that is without work but available for and seeking employment.
14. **Interest rate**: Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator. The terms and conditions attached to lending rates differ by country, however, limiting their comparability.

15. **Business Freedom:** *Business freedom is an overall indicator of the efficiency of government regulation of business. The quantitative score is derived from an array of measurements of the difficulty of starting, operating, and closing a business. The business freedom score for each country is a number between 0 and 100, with 100 equaling the freest business environment.*
16. **Types of PPI:** A binary variable assigned a value of 1 if the project is a greenfield and or 0 otherwise. *Greenfield projects:* A private entity or a public-private joint venture builds and operates a new facility for the period specified in the project contract. The private entity takes on much of the financial and operational risk and recoups its investments through the life of the project.
17. **Local sponsors:** The variable is “1” if there is any local sponsor invest in the project, otherwise “0” .
18. **Total Investment:** *It is the sum of investment in physical assets and payments to the government. Investments are recorded in millions of US dollars.*