An Enhanced Framework for Reliably Managing Private Participation Infrastructure ICT Projects in Developing Countries

Muhammad Ayat¹, Sheheryar Mohsin Qureshi², Chang Wook Kang¹

1. Department of Industrial and Management Engineering,
   Hanyang University ERICA, South Korea

2. Department of Industrial and Manufacturing Engineering,
   NED University of Engineering & Technology, Karachi, Pakistan

Corresponding Author

Chang Wook Kang
Professor, Department of Industrial and Management Engineering, Hanyang University, ERICA Campus,
South Korea
Email: cwkang57@hanyang.ac.kr
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Abstract

Purpose: The purpose of this study is to propose an improved framework for managing Private Participation in Infrastructure ICT (PPI-ICT) projects in the context of developing countries since the requirements to manage them are different in several aspects.

Design/Methodology: The framework has been proposed based on an exhaustive literature review and statistical analysis of the PPI-ICT projects’ dataset using logistic regression, F-test, and student’s t-test. The proposed framework is also applied to the PPI-ICT projects.

Findings: The framework is an extension to NTCP (novelty, technology, complexity and pace) approach by including extrinsic factors such as income of the country, climate risk, religious diversity, political stability, regularity quality, and control of corruption. The proposed framework was used to analyze project characteristics and their external conditions in the context of developing countries. Based on our analyses, we have presented a detailed set of recommendations for project managers, practitioners, and governments to improve the success rate of these projects.

Originality: The major contribution of this study is the framework, which encompasses the NTCP model as well as extrinsic characteristics of PPI-ICT projects. The proposed framework is meant to assist the project managers to comprehend the project characteristics and its external environment to identify an adequate approach for managing projects successfully.

Keywords: Private participation projects, Contingency theory, NTCP model, Project context

1 Introduction

Information and communication technology (ICT) has been increasingly applied in different sectors during the last two decades. Plenty of research has been done to develop guidelines, methodologies, and standards related to the best practices in ICT project management (Karunaratne, Peiris, & Hansson, 2018; Kashiwagi, 2018). However, despite many successful implementations, practitioners face wide range of challenges in carrying out ICT projects. These projects are becoming more difficult to manage due to increasing complexities and uncertainties in budget, user requirements, and rapid changes in technology (Ebad, 2018; Khalil, 2018). ICT projects have serious challenges related to cost overruns, late deliveries, and even cancellation of projects before completion. A project management global survey in 2005 revealed that 31% of information system (IS) projects did not finish on time, and another 31% suffered from cost
overruns (KPMG, 2005). Project Management Institute (PMI) reported that an average of $97 million were lost by organizations for every $1 billion dollar investment because of poor projects performance (PMI, 2017). Standish Group similarly reported that only one third of ICT projects were completed successfully, whereas project failure rates were above 16% over the last two decades (Johnson, 2018). With rapid technology advancement and globalization, the life cycles of products/projects have become shorter with the passage of time (Winter, Kaniiovski, & Dosi, 2000). This has made the issues of overruns and failure more challenging, broader and complex in the ICT sector.

ICT projects that take place with the help of private participation in developing countries are called private participation infrastructure (PPI) projects by the World Bank (World Bank, 2020). The World Bank report of private participation infrastructure (PPI) show that investment in PPI-ICT projects across the world, particularly in developing countries, has increased noticeably (World Bank, 2019). The World Bank maintains a database for PPI projects occurred in developing countries, which indicates that $41.076 billion have been invested in PPI-ICT projects in developing countries from 2000 to 2019, following an increasing trend (World Bank, 2020). The failure of these projects has led to drastic financial consequences to the partner organizations and economies of countries. PPI database also shows that during 2015-2019, projects in various sectors amounting to $7.996 billion have got cancelled in the developing countries (World Bank, 2020).

In PPI projects, the government grants right to the private sector to build and operate certain infrastructure facilities to provide specified services and receive associated revenue for a defined period of time (Noumba & Dinghem, 2005). Due to unique nature of PPI projects such as high level of risk, uncertainty, and sunk cost make the role of governance indicators and institutions of the host country more important for the success of PPI project (Banerjee, Oetzel, & Ranganathan, 2006; Taguchi & Sunouchi, 2019).

PPI-ICT projects taking place in developing countries face higher risk, uncertainty, and unpredictability, which makes the projects difficult to manage (Xiaopeng & Pheng, 2013). Besides, the developing countries have disproportional share of natural resources and wealth (Rapoza, 2011), poor governance, low competencies, and skills of the population (Hanushek, 2017; Stevenson & Starkweather, 2010). Based on distinctive conditions and challenges of the developing countries, a number of studies suggest different project management approaches for developing and developed economies (Bond-Barnard, Fletcher, & Steyn, 2018; Bond-Barnarda & Steyna, 2010). For this purpose, additional to the intrinsic characteristics of ICT projects, the contexts of the developing countries (extrinsic factors) are important to consider for successful implementation of the PPI-ICT projects. This study aims to analyze previous literature and PPI-ICT dataset to present an adequate framework for managing PPI-ICT projects in developing countries.
The proposed framework is an extension to NTCP model to assist managers in distinguishing projects based on their intrinsic and extrinsic characteristics. The framework considers important external factors to explain the role of the host country and its environment in success of PPI projects and recommend appropriate project management approach. The framework is meant to aid project managers in foreseeing project difficulties and sort out the exact project priority based on its characteristics and external situation. Certainly, the proposed framework may also be useful in providing pragmatic suggestions to all stakeholders for ensuring higher success rate. It is important to explain what project success means in this PPI-ICT dataset. The definition of project success in PPI dataset used in this study is in line with Jiménez, et al. (2020). A project will be referred to as a failure when its contracted period is terminated earlier by either project partner (Jiménez, Jiang, Petersen, & Gammelgaard, 2019).

This study is organized as follows. Section 2 discusses the previous literature to provide theoretical background to the proposed framework. The next two sections discuss the proposed framework and methodology. Section 5 comprises the results and discussion, followed by implementation of the proposed framework to PPI-ICT project. The section also presents a set of recommendations for the improvement of the performance of PPI-ICT projects. In the last section, the study is concluded.

2 Literature Review

This section has been divided in three subsections to previous literature in a more organized way.

2.1 Project Management and Contingency Theory

Projects are unique, represent new experiences, address problems and management challenges. They differ from one another in many ways, which can be distinguished by technology, customer, size (Shenhar & Dvir, 2007), contract type (Babatunde, Adeniyi, & Awodele, 2017; Toriola-Coker, Owolabi, Alaka, Bello, & Pathirage, 2021), industries and systems (Amid, Moalagh, & Ravasan, 2012), geography (Ahsan & Gunawan, 2010), organization size (Amoah & Pretorius, 2019), and socio-cultural settings (Maumbe, Owei, & Alexander, 2008). These variabilities in projects follow a certain pattern that can be modelled for dealing with projects of diverse nature (Shenhar & Dvir, 2007) for which various methodologies are found in the literature.

There are two main categories of project management methodologies: plan driven and change driven (Pace, 2019). The traditional and dominant approach for managing projects is plan-driven model as demonstrated by project management bodies of knowledge (PMI, 2004). On the other hand, the contingency theory suggests project specific change driven approaches. It is argued that the traditional project management “one size fits all” approach is suboptimal. Project specific approach should be adopted keeping in view the project characteristics and context. Considering the context of project is important for successful managing projects (Stretton, 2019b). For example, Pramanik, Mondal, & Haldar, (2020) have proposed a framework for selection of information services projects, which cannot be applied for selection of construction...
projects. The risk identification framework in construction projects (Chileshe & Yirenkyi-Fianko, 2012; Nabawy, Ofori, Morcos, & Egbu, 2021), critical success factor in building design projects (Koutsikouri, Austin, & Dainty, 2008), and important factor for cost estimation in construction projects (Dandan, Sweis, Sukkari, & Sweis, 2019) cannot be used in the context of information services projects. Similarly, the success factors of construction projects in developing countries (San Santoso & Gallage, 2019) cannot be used for the projects in developed countries. Therefore, it is crucial for success of each project to identify its type and apply appropriate project management approach (Dvir, Sadeh, & Malach-Pines, 2006).

2.2 NTCP diamond Model

Shenhar and Dvir (2007) proposed a structured project specific framework known as NTCP (Novelty, Technology, Complexity, Pace) diamond framework that managers can use when making decisions about projects selection. They argued that the variabilities in projects have not been addressed in current traditional project management models. Therefore, an appropriate model is imperative to combine the common and different features in a single model to help project managers classify projects and select appropriate approach for managing them. The framework consists of four dimensions – novelty, technology, complexity, and pace.

Novelty explains how new the project is to the user and market. It affects the process of market analysis and project definition (Ehrman & Holzmann, 2012; Shenhar & Dvir, 2007). The projects with highest level of novelty such as innovative projects, pose a number of challenges and difficulties because of lack of enough existing knowledge, higher uncertainty and unexpected changes (Nuseibah, Quester, & Wolff, 2016; Wolff & Zadnepryanets, 2016). There is higher likelihood of aversion from the desired objectives in these types of projects because of the difficulties to define the requirements and to make accurate estimates (Gawlik & Kielbus, 2010). The novelty dimension is further categorized by Shenhar & Dvir, (2007) as derivative, platform, and breakthrough. Each of the sub-category explains the level of novelty. For instance, derivative is the upgradation of existent product; platform refers to the new line or new model; and breakthrough is the development of completely new product to the world market such as space shuttle (Sauser, Reilly, & Shenhar, 2009).

The technology dimension refers to the level of technology involved in a project. It affects the freezing time of design, involves technical activities, and required technical skills. Technology dimension is considered one of the major sources of uncertainty in projects (Shenhar & Dvir, 2007). Hi-tech projects are highly susceptible to resource risks (Verma, Parikh, & Dixit, 2020). The involvement of new and rapidly changing technologies are challenging the enterprising and project management professionals to successfully carry out the projects (Hubbard & Rogers, 2019). The technology dimension has been further sub-categorized as low-tech, medium-tech, high-tech, and super high-tech levels.
(Ahn, Zwikael, & Bednarek, 2010; Shenhar & Dvir, 2007). Each level indicates the complexity and newness of technology. Low-tech projects are based on established technologies such as technology used in construction projects. In medium-tech projects, existing technologies are used, however, several new features are also incorporated such as manufacturing of appliances, automobile, and heavy equipment in stable industries. High-tech projects employ technologies which exist at the stage of project initiation, but it is completely new to the organization such as software development projects. Super high-tech projects are based on completely new or emerging technologies such as the space and defense projects (Das & Khanapuri, 2019).

The dimension of complexity represents system scope, which affects project organization and project management (Shenhar & Dvir, 2007). Complexity develops higher risk of project failure and seriously affect project progress, quality, budget, and schedule (Ghatak & Garg, 2019), which should be considered in during project risk management (Rodrigues-da-Silva & Crispim, 2014). The complexity dimension is further sub-categorized as assembly, system and array projects. Assembly projects involve single unit using simple tools of planning and control such as designing a single service system. System projects involve many elements and subsystems. They jointly work to meet specific operational needs such as automobile manufacturing, computers manufacturing, or construction of building. Array projects involve dispersed systems collectively working for a common objective such as mass transit infrastructure, communication networks, power distribution network, and space shuttle (Sauser et al., 2009).

Pace is the fourth dimension of the NTCP, which refers to the timeframe of projects. It affects the autonomy of project team, bureaucracy, and involvement of top management. The dimension is further sub-categorized as regular, fast/competitive, time-critical, and blitz projects (Shenhar & Dvir, 2007). In regular projects, time is not critical to immediate organizational success such as space shuttle projects. Fast/Competitive projects are important to complete on time to achieve competitive advantages such as construction of airport and new product development. These are common projects carried out by profit-driven organizations. For time critical projects, meeting project timeline is critical to project success – any type of delay leads to project failure. These projects are centered on a specific window or event. The most urgent and critical projects are blitz projects. These are crises projects, such as response to natural disasters, that have to be completed as soon as possible (Sauser et al., 2009).

The aforementioned NTCP framework cover the intrinsic characteristics of the projects related to novelty, level of technology, scope, and timeframe of the projects. Additional to these factors, the size of the projects is another important characteristic of the projects, which needs to be considered. Several disadvantages are associated with larger projects (Lupton, Jiménez, Bayraktar, & Tsagdis, 2019) such as managerial complexity (Nooteboom, Van Haverbeke, Duysters, Gilsing, & Van den Oord, 2007), less
flexible structure and bureaucratic issues (Laforet, 2008), and greater organizational inertia (Zhou & Li, 2010).

Another important factor is the type of PPI projects namely brownfield, and greenfield. Studies showed the importance of considering these types of PPI projects (Ruiz Díaz, 2020). The brownfield or redevelopment projects are difficult and expensive as compared to greenfield projects as they require additional resources for environmental remediation (Siironen, 2019) and their non-feasibility for the general structural configurations (Nuthanapati, Adel, & Al Awadhi, 2019). Furthermore, the liability of foreignness is the additional costs that foreign firms have to pay mainly due to their unfamiliarity to political, economic, and cultural environments in the host country (Millar & Ju Choi, 2008; Wang & Wang, 2020). The presence of local sponsor in the project is one of the possible ways to reduce the liabilities of the foreignness (Jiménez, Bayraktar, Puche-Regaliza, & Herrero, 2020).

2.4.2.3 Extrinsic factors

The uniqueness of the projects correspondingly leads to various types of critical problems, which cannot be solved using standardized approaches. Therefore, customized methodologies are required for managing different types of projects (Pace, 2019). PPI-ICT projects in the context of developing countries presents a number of challenges (project and country specific), which can neither be fully addressed by using the traditional “one size fits all” approach nor by NTCP framework. NTCP model focuses on project characteristics, but cannot explain fully the extrinsic factors.

The NTCP framework encompasses project intrinsic characteristics that have been identified to be crucial for the selection of appropriate project management approaches and can enable the identification of project risks. It is a generic framework, which can be applied to wide range of diverse projects (Shishodia, Dixit, & Verma, 2018) but it does not consider the contexts of the projects. Projects do not happen in vacuum but exist in VUCA-environments (volatile, uncertain, complex, and ambiguous) (Pace, 2019). Therefore, it is important to consider several contextual issues while managing projects irrespective of the project type (Stretton, 2019a). For effective project management, number of studies have integrated different frameworks with the NTCP diamond model. For instance, a series of studies was conducted that emphasized on different external contexts including economic actors, socio-cultural actors, and role of external stakeholders (Stretton, 2019b, 2019c). Similarly, Shishodia et al., (2018) developed an integrated framewok to analyze the prominent risk categories associated with the four dimensions of the NTCP model using risk categories proposed by Kendrick (2015).

Several researchers have used data from World Bank maintained PPI projects database in their studies to investigate different aspects of the PPI projects. They found different factors, which have significant impact on the success of PPI projects. For instances, the impact of climate risk (Lupton et al., 2019),
political risk (Jiang, Martek, Hosseini, & Chen, 2019), corruption (Jiménez et al., 2020), regularity quality (Ruiz Díaz, 2020) and within-country religious diversity (Jiménez et al., 2019). Other studies also indicated that extrinsic factors, such as macroeconomic indicators and economic growth (Mubila, Lufumpa, & Kayizzi-Mugerwa, 2000), stability in exchange rate and policies (Opawole & Jagboro, 2017), socio-political and economic environment (Owusu-Manu et al., 2017), and security condition, political stability, lack of skilled manpower (Chang, Hwang, Deng, & Zhao, 2018) have impact on the project performance. Since PPI projects are carried out in several countries and each country has different external conditions, it is important to have a framework that encompasses extrinsic factors along with the NTCP model (intrinsic characteristics) for improved project performance. Therefore, we extended the NTCP model to adequately manage PPI-ICT projects in developing countries by adding another dimension covering the extrinsic factors of the host country.

3 Research Methodology

This study proposes a new framework (an extension to NTCP diamond model), which also explains extrinsic factors affecting success of PPI projects as given in Figure 1. The framework is based on the findings of previous literature and analysis of the PPI-ICT dataset using results of logistic regression and statistical tests. In the first phase, theoretical background of all dimensions of the proposed framework have been discussed to provide a clear understanding of the new framework. In second phase, logistic regression and statistical tests have been carried out to check the significance of the extrinsic factors in the success of the PPI-ICT projects. In third phase, the framework was applied to the PPI-ICT projects occurred in developing countries for further in-depth analysis of the PPI-ICT projects. The following subsections discuss the components of the framework in more detail.
The primary data for this study have been acquired from PPI project database of the World Bank (World Bank, 2020). The PPI database consists of various types of projects including energy, ICT, and transportation. Since this study focuses on ICT projects, therefore, only the data of ICT projects were extracted. The dataset consists of 539 ICT projects carried out in 107 developing countries (low, lower middle, and upper middle income countries) under the context of private participation in infrastructure projects. It is also important to explain here the low, lower middle, and upper middle income countries. We used World Bank classification of countries as low, lower middle, and upper middle income countries based on their Gross National Income (GNI) per capita. Those countries whose GNI per capita is less than US$ 1026 are referred to as low-income, those whose GNI per capita is in the range of US$ 1026 to US$ 3995, and US$ 3996 to US$ 12375 are categorized as lower middle, and upper middle income countries, respectively (Worl Bank, 2020). The list of the developing countries where PPI-ICT projects occurred is given in appendix A. From the database, information about projects including private partner characteristics, project size, project type, project duration, and current status of projects is extracted. The summary of the extracted data is given in appendix B.

Figure 1 Components of the proposed framework
In addition, the data for governance indicators are taken from Worldwide Governance Indicators (WGI) (Kaufmann, Kraay, & Mastruzzi, 2010). Furthermore, data for language diversity and religious diversity were obtained from the website of Professor Douglas Dow (http://dow.net.au/?page_id=35), climate risk from the German watch data source (https://germanwatch.org/en/cri), and business freedom were collected from the website of the Heritage Foundation (https://www.heritage.org).

### 3.2 Logistic regression

Logistic regression is useful for binary class problems (Chen, Sun, & Han, 2019). In this study, the dependent variable is project success, which is binary class variable. Thus, the logistic regression was applied to estimate the relationship between project success and the given predictors. The logistic regression is used to identify the probability of the dependent variable (Y=1):

\[
\ln \left( \frac{P(Y=1)}{1-P(Y=1)} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_k X_k
\]

In this model, P is the probability that dependent variable (Y=1) and X_1……… X_k are the predictors, where \( \beta_0 \) is the constant and \( \beta_1 \ldots \ldots \beta_k \) are the regression coefficients.

### 3.3 Statistical Test

We applied F-test and Student’s t-test using PPI-ICT project dataset to test whether the project success in different income groups of the countries is different or not.

#### 3.3.1 F-test to Compare Variances

In this study, F-test is used to check whether the population variances (\( \sigma_i^2 \)) of the three groups (low income, lower middle income, and upper middle income) are equal or not. R language has been used for performing F-test in this study. Following hypotheses are formed:

Null Hypothesis (H_0): \( \sigma_i^2 = \sigma_j^2 \)

Alternative Hypothesis (H_1): \( \sigma_i^2 \neq \sigma_j^2 \)

\( \alpha = 0.05 \)

Rejection region: Test statistics (F) = \( \frac{s_1^2}{s_2^2} > F_{\alpha/2,v_1,v_2} \)

where \( s_1^2 \) and \( s_2^2 \) are the variances computed from the samples.

#### 3.3.2 Student’s t-test

Student’s t-test tells how significant are the differences between two groups. The larger the t-score, the more the difference between groups and vice versa. In this study, t-test is used to see whether or not the differences between income groups are significant. If from the F-test it is confirmed that the variance of the population is not equal, then Welch approximation is used, and following hypotheses are formed:
\[ H_0 : \mu_i = \mu_j \]
\[ H_1 : \mu_i \neq \mu_j \]
\[ \alpha = 0.05 \]

\[ t' = \frac{(\bar{x}_1 - \bar{x}_2)}{s_p \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \]

\[ v = \frac{\left( \frac{s_1^2}{n_1} + \frac{s_2^2}{n_2} \right)^2}{\frac{s_1^2}{n_1} \left( \frac{n_1}{n_1 - 1} \right) + \frac{s_2^2}{n_2} \left( \frac{n_2}{n_2 - 1} \right)} \]

In the above equation \( \mu_i \) is the population mean, whereas \( s_1^2 \) and \( s_2^2 \) are the variances computed from the samples, \( n \) is sample size, and “v” is the degree of freedom.

4 Results and Discussion

Data analysis shows that around 80% of the PPI-ICT projects have at least one foreign private partner and only 20% of the projects have been carried out completely by the cooperation of domestic private partners. The dataset also shows that around 90% of the ICT projects have budget more than US$ 3 million. Further, analysis indicates that these projects primarily focus on providing fast and reliable internet and digitalizing the government and public sector institutions. The PPI-ICT projects recorded by PPI database are worth $119.796 billion carried out in 107 low and middle income countries during 1990 to 2019.
Table 1: Extrinsic factors and their coefficient values

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of PPI</td>
<td>-0.632***</td>
<td>.043</td>
</tr>
<tr>
<td>Local sponsors</td>
<td>.351***</td>
<td>.056</td>
</tr>
<tr>
<td>Total investment</td>
<td>-.031**</td>
<td>.042</td>
</tr>
<tr>
<td>Control of corruption</td>
<td>.0123**</td>
<td>.053</td>
</tr>
<tr>
<td>Regularity quality</td>
<td>.047**</td>
<td>.055</td>
</tr>
<tr>
<td>Rule of law</td>
<td>.082</td>
<td>.024</td>
</tr>
<tr>
<td>Government effectiveness</td>
<td>.027</td>
<td>.042</td>
</tr>
<tr>
<td>Political stability</td>
<td>.0134***</td>
<td>.042</td>
</tr>
<tr>
<td>GDP growth (%)</td>
<td>-.033</td>
<td>.32</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>.042</td>
<td>.068</td>
</tr>
<tr>
<td>Climate risk</td>
<td>-.231***</td>
<td>.064</td>
</tr>
<tr>
<td>Religious diversity</td>
<td>-.210***</td>
<td>.042</td>
</tr>
<tr>
<td>Language diversity</td>
<td>.072</td>
<td>.060</td>
</tr>
<tr>
<td>Interest rate</td>
<td>-.432</td>
<td>.334</td>
</tr>
<tr>
<td>Business freedom</td>
<td>.032</td>
<td>.053</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.032***</td>
<td>.450</td>
</tr>
</tbody>
</table>

- *** means significant at 0.01
- ** means significant at 0.05
- * means significant at 0.1

The results of the logistic regression confirm that climate risk, control of corruption, political stability, regularity quality, and religious diversity have significant impacts on the success of PPI projects as shown in Table 1. Climate risks such as extreme weather conditions lead to disruption of supply chain, suspension of operations (Oetzel & Oh, 2014), and decrease in assets (Mithani, 2017). PPI projects are physical asset intensive, therefore, these projects are more vulnerable to climate risk (Flyvbjerg, 2009). Likely, corruption causes higher risk and uncertainty that negatively impact the performance of the projects (Jiménez, Russo, Kraak, & Jiang, 2017). In case of the PPI projects, which are usually led by foreign investors, the consequences of the corruption are more drastic due to their lack of familiarity to local context, relational and transactional costs (Henisz & Delios, 2001). Moreover, political stability brought consistency to county policies (Jimenez & Bayraktar, 2020), boost foreign direct investment and business activities, (Li & Liu, 2005), which has positive impact on the project success. On the other hand, the uncertainty of political events, such as regime changes, coups, revolution, and political violence, leads to instability in the market and changes in policies, which negatively impacts projects (Chang et al., 2018). Similarly, regularity quality reduces administrative, and bureaucratic barriers, and offset the effects of shocks, which increases the likelihood of project success (Ruiz Díaz, 2020). Furthermore, PPI projects involves both private sector and
public sector. Therefore, these projects are prone to higher religious diversity. The religious diversity creates informational challenges for investors in terms of communication with diverse stakeholders from different religious sects having conflicting beliefs, norms, and preferences (Jiménez et al., 2019). Therefore, we included these variables as important extrinsic factors to be considered before execution of PPI-ICT projects. Furthermore, the analysis of the data shows that income group of the host country also has strong impact on the performance of PPI-ICT projects, which is further confirmed through statistical analysis.

Student t-test was applied to see whether the difference of project success rate in each income group is significant or not. F-test was carried out before performing Student t-test to see the population variances of three income groups are equal or not. F-test shows that the population variances are not equal. Therefore, Welch two sample t-test was used to check the differences are significant or not. As can be seen from Table 2 that project success in low income countries is significantly different from lower middle income and upper middle-income countries. The results of the tests confirm the significance of income group on the PPI-ICT projects occurred in developing countries. This also justifies the inclusion of income group of the country as an extrinsic variable to the proposed framework.

### Table 2: F-test and t-test values to see the differences between the groups

<table>
<thead>
<tr>
<th>Value of test statistics</th>
<th>Lower middle-income countries</th>
<th>Upper middle-income countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>F test (compare variances)</td>
<td>F-value 0.3571 p-value 0.0483</td>
<td>0 &lt;2.2e-16</td>
</tr>
<tr>
<td>Welch two sample t-test</td>
<td>t-value 2.0984 p-value 0.0431</td>
<td>4.1492 0.00013</td>
</tr>
</tbody>
</table>

The variation in project success rate in different income countries is perhaps due to a number of reasons. Studies show that political instability, bad security situation, and poor competencies of population are negatively related to the income of a country (Hanushek, 2017; Li & Liu, 2005). Moreover, the lack of skilled manpower is another core reason for lower economic growth and poor project performance in developing countries. World Bank data show that more than 30% of the working population in low income countries does not have basic skills needed for quality jobs. Numerous studies indicate the importance of individual skills for project performance and success (Pant & Baroudi, 2008; Stevenson & Starkweather, 2010). The relationship between individual skills and competencies and economic growth of a country is an important variable that explains different project success rates for different income groups.

This shows the importance of considering income group of the host country in project evaluation along with other extrinsic variable including climate risk, control of corruption, political stability, regularity
quality, and religious diversity. The inclusion of diverse extrinsic factors such as governance indicators, climate risk, religious diversity, and economic conditions will give important information to the practitioners for understanding the external risk associated to PPI projects in developing countries.

5 Implementation of the Proposed Framework

In the following section, we explain the aspects of PPI-ICT projects using the proposed framework as given in Figure 2. The figure 2 has been developed based on previous literature and analysis of the dataset of PPI-ICT projects. The straight lines in the figure indicate that majority of the PPI-ICT projects fall in that specific sub-category such as System, Hi-tech, Platform, and Time-critical. The dotted lines show that some of the projects also fit in sub-categories such as Array, and Fast-competitive. It is also important to mention that this is a general categorization of the PPI-ICT projects. There can be some exceptional cases, which can deviate from the identified sub-categories. However, we believe that majority of the PPI-ICT projects will fit in this categorization. The section discusses the implementation of the proposed framework using

Figure 2: Implementation of the Proposed framework to PPI_ICT projects
PPI-ICT dataset. Based on the findings of the case study, a set of specific recommendations related to each dimension have been presented for improving success rate of ICT private participation projects.

5.1 Novelty

Novelty in projects is related to innovation, uniqueness, and uncertainty in requirements (Shenhar & Dvir, 2007). The innovative projects have high novelty level and ambiguity in requirements (Deák, 2009). The realization of an innovative idea could be a new phenomenon and may need a different approach than conventional project management approaches. ICT sector is the key enabler of technological diffusion and innovation (García-Muñiz & Vicente, 2014) and, therefore, faces rapid technological and innovative challenges (Grillitsch, Tödtling, & Höglinger, 2015). Furthermore, the dataset of ICT-PPI projects in developing countries mainly consists of projects to provide fast and reliable internet and digitalize the public affairs and industries. The dataset includes projects of putting high-capacity submarine cables to connect multiple cities and even countries. Landing of submarine cables in different locations in developing countries is relatively a new and infrequent operation in developing countries. A report by The International Telecommunication Union (a UN specialized agency for ICT) on ICT statistics shows that submarine network carries over 99% of the world’s intercontinental electronic communications traffic. The international bandwidth almost doubles in every two years on a global average for last decade (World Telecommunication/ICT Indicators Database 2020, July 2020). The changing nature of ICT projects, such as continuous improvement in international bandwidth and its extension to new regions, has made it more difficult. ICT projects are more challenging mainly due to the higher rate of change of technologies, tools and methodologies (Sherry, Carcary, McLaughlin, & O’Brien, 2012).

Based on the above discussed characteristics of ICT projects, they fit into higher levels of novelty dimension such as platform and breakthrough position. Platform and breakthrough levels represent the innovative stages of the novelty dimensions. The high innovative projects have strategic impact on customers and are important for competitive advantages in market. As discussed above, high innovation leads to ambiguity and uncertainty in projects. In breakthrough projects, overruns are likely to happen. It requires project team having extensive experience to explore the unknown aspects of new features or completely new projects (Shenhar & Dvir, 2007).

5.2 Technology

The level of technology affects project lifecycle. Projects involve higher level of technologies require more flexible style, extensive review, and additional design cycles (Collyer & Warren, 2009). In these types of projects, many changes are expected till advance phase of the project lifecycle. As level of technology increases, the uncertainty in project scope increases. Analysis shows that ICT projects involve hi-tech level technology. The ICT projects are primarily based on new and rapidly changing technologies. These projects are new to the society and the implementation organizations operating in developing countries. Therefore,
ICT projects can be classified as hi-tech on technology dimension of the NTCP model. In high-tech projects, which allow more time for project design cycle, more changes are expected after project initiation. Therefore, project scope management can be a challenge in ICT projects because of hi-tech technology involvement.

5.3 Complexity

Complexity is related to scope system that affects organizational structure. As project complexity increases, there is an increase in ambiguity of information that may influence a project and create an environment that goes beyond the capabilities of the project team (Sauser et al., 2009). Therefore, complex projects require advanced tools and sophisticated soft skills such as managerial and leadership skills (Ehrman & Holzmann, 2012). ICT projects generally are “hybrids” that consist of many independent subprojects (Dekkers & Forselius, 2007). In traditional project management, project managers estimate the requirements and resources. Then, they set scope, plan and control project as a single set of activities. In hybrid ICT projects, each sub-type requires different project management methodologies. Project managers can apply various tools and procedures and work as hard as possible to increase the likelihood of project success, but this is not sufficient. Each sub-component of an ICT project needs to be dealt independently, which makes ICT projects more complex and difficult to manage.

Analysis indicates that around 80% of these projects have at least one foreigner private partner, and 90% projects have budget more than US$ 3 million. Almost all projects involve installation of connections and laying cable in land and sea to connect villages, cities and even countries. This indicates the complexity of PPI-ICT projects, carried out in developing countries, regarding diversity in stakeholders, huge budgets, and difficult activities such as laying cables in sea. These projects may expose to certain risk related to compatibility, communication, flow of information, and developing policies. Therefore, these projects can fit in system or array level of complexity dimension of the framework. Complex environment does not have one step solution. It requires holistic leadership (Rietsema & Watkins, 2012) and skillful human resources for organizational survival to carry out complex tasks (Raghavendran & Rajagopalan, 2011).

5.4 Pace

Pace or project timeframe dimension explains the urgency of the projects. It affects the autonomy of project managers and top management. For timely completion of projects, strong coordination among project stakeholders, clear monitoring points, and involvement of stakeholders are required (Walsham, Robey, & Sahay, 2007). ICT projects are key drivers for addressing the issues of social inclusion, transparency, public accountability, and governance (Puri, Sahay, & Lewis, 2009). Prompt implementation of ICT projects is important for government to improve the quality of governance and cash in the political, social, and economic benefits. Similarly, it is also critical for private sector counterparts to launch the project as early as possible to achieve organizational competitive advantages and business objectives. PPI-ICT projects in developing countries aim to provide fast and reliable internet and digitalize the government and
public projects. The market demand for these projects could be very high. Therefore, these projects fit into
the position of fast/competitive projects or time critical projects of the pace dimension.

5.5 Extrinsic factors

The values of the identified extrinsic factors such as climate risk, control of corruption, political
stability, regularity quality, religious diversity, and income group vary for different countries with
time. However, different reliable databases mentioned in the methodology section maintains these
values for each country bi-annually or annually. Therefore, the practitioners can easily obtain these
values for each country to analyze the external situations of their projects. The values of the factors
can help the practitioners to assess the potential risk associated with these projects. The inclusion
of diverse factors such as governance indicators, climate risk, religious conditions, and economic
conditions give enough information to the practitioners about the external potential risk. For
instance, projects occurred in Uganda, China, India, and Malaysia might have different level of
potential risks because of their different extrinsic conditions., it is important to consider these
extrinsic factors to assess the associated risk before execution of a PPI project.

5.6 Contributions of the Study

The study has the following main contributions:

- The study proposes a comprehensive framework to review the projects using a methodical way. It
  will assist the project managers to consider the uniqueness of each IPPI-ICT project in developing
countries. The managers/organizations will be in a better position to select appropriate tools and
techniques to execute PPI projects conveniently.

- The proposed framework is focusing on the PPI-ICT projects in developing countries considering
  both intrinsic and extrinsic factors affecting projects. This will the project managers to understand
  the country context as well as the project characteristics of PPI-ICT projects.

- Furthermore, PPI-ICT projects have been analyzed using the proposed framework (NTCP model
  and extrinsic factors). Based on analyses, the study puts forward several recommendations for
  addressing issues related to each dimension of the framework. It will help project managers to
design PPI-ICT project specific management approaches.

5.7 Recommendations

Based on our analysis, following recommendations are given for managing PPI-ICT projects in
developing countries successfully.

- ICT private participation projects are placed in hi-tech projects category of technology dimension.
  Higher technology level has an increased number of design and development activities. Therefore,
it is recommended to have a technically sound and skilled project team who is able to forecast problems. Moreover, project managers also need to practice more flexible project management styles and adaptive tools in hi-tech projects and must have the capability to understand the macroeconomic situation of the country

- The dataset shows that PPI-ICT projects carried out in developing countries are large and complex, which are classified as system or array in complexity dimension. Large and complex projects cause confusion in the estimation of cost, time and other resources. Therefore, for managing complex projects, tight control on technical and schedule issues, detailed planning, and professional documentation are highly recommended. In addition, strong team coordination, partial integration, clear monitoring and approval points, and representatives of all key groups during project integration may help in managing complex projects.

- The abundance of unskilled and incompetent workforce in low income countries is another issue that needs to be handled at the start of the project through proper scrutiny and trainings. Particular focus must be given to the trainings and project team formation. Trainings must focus on job professionalism, dealing with stakeholders, emotional maturity, punctuality, importance of objectivity, sticking to plans, and change management.

- The data show that around 80% of the projects have at least one foreign private partner in carrying out PPI-ICT projects in developing countries. It is possible that the private partner may be unaware of cultural characteristics and sensitivities of the community, and problems may arise after application of certain technology. Therefore, it is suggested to involve community leaders, bureaucracy, and other government officials to carry out such projects without any hindrance from the community.

6 Conclusion

The study proposes a framework based on the previous literature and analysis of PPI-ICT projects’ dataset. The framework has extended the NTCP diamond model by adding an additional dimension, which explains the impact of extrinsic factors on PPI-ICT project success. The dimension considers income of a country, climate risk, control of corruption, political stability, regularity quality, and religious diversity of the host country as important factors for project evaluation. The proposed framework is meant to assist projects managers considering the uniqueness of each PPI-ICT projects in developing countries. It will also aid them in developing project specific approaches and solving project issues in the early stages.

Furthermore, the PPI-ICT projects have been analyzed in this study using the proposed framework considering NTCP model and extrinsic characteristics of projects. The framework implementation is helpful for the practitioners to understand project characteristics as well as the extrinsic factors such as income of a country, climate risk, control of corruption, political stability, regularity quality, and religious diversity of
the host country. Furthermore, a comprehensive set of recommendations for each dimension of the framework have been presented for improving the performance of PPI-ICT projects in developing countries. Although the study has made some important contributions, there are few limitations. However, the study also opens new avenue for future research.

- The data used in this study consist of projects carried out in low-income and middle-income countries. However, Private participation projects also happen in developed countries. Future research may include PPI projects carried out in developed economies (upper-income countries).
- The analysis in this study is based on literature review and PPI-ICT dataset collected form World Bank database. The database only includes the projects reported in major news media, government websites and reports, sponsor information, annual reports, etc. It does not include projects involving local and small operators, because they are not usually reported in the mentioned sources. Future research could improve the method of data collection to address the challenges facing the PPI database, which may lead to more comprehensive analysis.
- There can be other projects different than those analyzed in this study. They may need different frameworks and different factors to consider. Therefore, someone in future should use data from other sources to explore further aspects of the PPI-ICT projects.

References


Ehrman, E., & Holzmann, V. (2012). Diamonds are forever: project type profiling (PtP) based on the ideal company project.


Pace, M. (2019). Can complex adaptive systems help the wicked problem that is project management, 1, 2.


