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Ph.D. Dissertation in Engineering

Modeling local government's
Perception towards implementation of
ICT infrastructure and services through
Public Private Partnership Mechanism:
Case of Nepal

February 2018

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Dedicated to my beloved parents, beautiful wife, and sweet kids

Abstract

Modeling local government's Perception towards implementation of ICT infrastructure and services through Public Private Partnership Mechanism: Case of Nepal

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Public ICT infrastructure and services are the key components of the modern economy, filling the gap between citizen and government. Public ICT infrastructure and services are closely related to efficient government service delivery, explaining why governments across the world are investing huge resources to develop such projects. Understanding the governments' priority to develop such infrastructure and services plays an important role in how the government perceives the power of ICT to enhance government service delivery mechanisms.

Until the date, there have been no study carried out that investigates the government preferences towards the implementation of ICT services and

infrastructure in general, and through the public-private partnership (PPP) mechanism in particular, this dissertation provides valuable insights. It looks at different levels of government agencies and stakeholders for understanding how government agencies are deciding on the implementation of ICT infrastructure and services. This study uses the stated preference method to understand the government preferences to implement ICT infrastructure and services through the PPP mechanism. The PPP mechanism is employed to deliver public infrastructure utilizing private resources rather than the limited government resources. In general, the PPP mechanism is a risk sharing mechanism that transfers risk associated with ICT projects between the partners. However, during the negotiation with the private sector for sharing risks as well as incentives, different voices may arise on by what mechanism how much of the risk should be shared. Thus, understanding the decision makers' individual psychological behavior is instrumental in mapping the overall government preference towards the implementation of ICT projects through the PPP mechanism. This dissertation employs the Mixed Logit model to incorporate the individual taste variations in deciding on the procurement of ICT projects through the PPP mechanism.

The government decision-making unit is composed of a different socio-economic background and interest groups. The decision-making procedure in the government follows a democratic process and is normally grouped into the favored and against the particular agenda. Utilizing the concept of this process, this study analyzes the data on how decision makers from various groups behave from the perspective to share the risk associated with PPP projects. The Latent Class Logit model is used to analyze individuals' homophile behavior on the risk sharing mechanism to alternatives and their attribute levels. The result reveals that there exist two groups of decision makers, both having different views on sharing the risk when implementing ICT projects through PPP.

The local governments have their own priority based on their needs and available resources. Thus to understand their development priority, this study uses the MDCEV to model the local governments' priority under budget constraints. This is important to understand how the budget limitation deters the priority to develop the public ICT infrastructure and services through the PPP mechanism.

Keywords: public-private partnership, ICT infrastructure/service development priority, Decision heterogeneity, Nepal

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Chapter 1 Introduction

1.1. Overview

High speed internet access has played a major role in economic growth during the past decades (Czernich, Falck, Kretschmer, & Woessmann, 2011). The internet infrastructure and content-rich application transferred through the high-speed internet infrastructure are becoming the highest interest of governments across the world, as ICT infrastructure and internet applications are becoming the pillar of the modern economy. Robust ICT infrastructure and services connect all economic segments and bring them into the consolidated economy. Consolidating all economic agents, connecting their activities, and sharing information between those agents increases the innovative activities and contributes to an increased economic growth. According to Ho (2002), a robust ICT infrastructure and ICT application richness reduce the transaction cost to the government and citizens. Moreover, the effective use of Public ICT services, e.g., E-government infrastructure and associated applications, strengthens the relationship between the government and other beneficiaries. Public ICT infrastructure and services help to deliver government services to the citizens more effectively (Ghimire, 2011; Heeks, 2002).

Most developing countries have given priority to meet the common goals set by seventieth United Nations (UN) general assembly as the Sustainable

Development Goals (SDG)¹. The SDG contain focused goals and targets on building global resilience. Within the 17 goals and 169 targets, access to information and technology, e.g. universal access, is described as a key factor for building resilient infrastructure and fostering innovation. However, the development of ICT infrastructure services in the least developed countries, e.g., in Nepal, is heavily aid-dependent (Martin Chautari, 2014) which hinders the meeting of the goals in the countries' context. According to Kromidha (2012), the effectiveness of international assistance in developing such infrastructure and services in the least developed countries has been seen as high, as international assistance is commonly based on benchmarking cases. Nevertheless, it may not be effective in countries that have already laid the foundation for ICT infrastructure. Kromidha (2012) further argues that the least developed countries possess fewer resources for the development of public ICT services where the international agency have sufficient space to play and manipulate the status of e-government to raise the value of their domain of expertise. On the other hand, the aid recipient countries may act as free riders under the weak institution and governance when the assistance is utilized for the development of all sectors, rather than utilizing it for reforming policy and regulations (Bräutigam & Knack, 2004). In such cases, the foreign aid is ineffective to meet the goals set by the SDG.

¹ The 70th sessions of the United Nation General Assembly adopted the sustainable development goals to strengthen the global prosperity by recognizing the forms and dimension of poverty. The full-text of the resolution is available at http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E Accessed on December 10, 2017

Similar to other least developed countries, Nepal's government priority is set on providing for basic needs and the development of basic infrastructural services, rather than on building ICT infrastructure and enhancing government efficiency. In the early years, ICT was considered as luxury goods, but is now becoming increasingly necessary to transform the societal structure by helping to overcome current deficiencies and creating new opportunities. It has been shown that IT and its proper usage can help to prioritize and allocate resources more effectively. However, government budget limits and pressure to address the basic demand for infrastructure such as transportation, energy, and education heavily affect the government's investment in quality ICT infrastructure and the integration of ICT for delivering government services.

Integration of technology in the government allows to transform the traditional approach of service delivery to a technology-driven service delivery mechanism. Many governments across the world have been integrating ICT to enhance government effectiveness, and provide efficient services to citizen, businesses, and within the government. The use of ICT in government service delivery does not only transform the service delivery mechanism, but also reduces the cost of service delivery. Following the global trend and public demand stemming from technological advancement, the government of Nepal has started to integrate ICT in the government through several paradigm-shifting initiatives. Such initiatives include preparing human resources, setting a conducive regulatory framework, along with implementing key ICT projects (Ghimire, 2011). The outcome of initiatives taken by the government has been constrained by the financial, technical as well as

managerial perspective. Public IT systems are resource intensive and require abundant technical as well as financial resources along with an effective management. As pointed by Kromidha (2012), international assistance to overcome such constraints has played an instrumental role in laying down the implementation framework in some aspects. However, such assistance is not sufficient to have a large impact on the economy, unless the government itself becomes capable enough to absorb and utilize it by understanding the contextual situation. Otherwise, the initiatives taken to integrate technology in service delivery are costly and lead to failure, as it has been seen during the early 2000s (Heeks, 2002).

With the advancement of ICT technologies, governments across the globe have been transformed by adopting ICT in government workflow processes. However, the adoption of ICT services to facilitate government services delivery in the developing world has not been as successful as expected but has produced mixed result (Ismail, Heeks, Nicholson, & Aman, 2016). The reason behind the mixed outcome is thought to be the lack of effective interaction between demand and supply. For instance, the transformation of government needs a foundation such as human resources, infrastructure and the overall framework to incorporate all facets of the government process that supports the roadmap for the envisioned strategy (Ho, 2002). In addition, both the supply and demand side need to be well prepared in order to accept the changes in government service delivery (Al-Shafi & Weerakkody, 2010; Altameem, Zairi, & Alshawi, 2006; Ebrahim & Irani, 2005; Guerra, Zizzo, Dutton, & Peltu, 2003). The lack of preparedness results in negative consequences, e.g., marginalized groups may not be able to receive the benefits, and leads to an even wider gap in the

society on one hand, and a waste of public resources on the other hand. In that case, rather going through the traditional procurement approach, major policy tools such as partnership mechanisms would be more fruitful. However, state-of-the-art partnership mechanisms might not be addressed properly because of the object-oriented partnership mechanism bounded by the contractual agreement. Nevertheless, the partnership mechanism can be designed in such a way that it creates value for the society. The value creation mechanism through public-private partnership can be instrumental not only in strengthening the public ICT infrastructure and services but also in empowering the private sector. The empowerment of the private sector for government service delivery can become the bridge between the supply and demand side as it creates positive externalities through various value-added services apart from the objective of partnerships (Lattemann, Stieglitz, Kupke, & Schneider, 2009; Panda, 2016).

The public IT system facilitates providing government services using internet technologies. It is about the transformation of the government into the digital world (Ho, 2002). The extensive use of IT services and incorporating the open government agenda that provides seamless IT services as well as the inclusive participation in the decision-making is the measure of the overall success of a public ICT system. In order to develop further into a smart government, one needs to integrate ICT into the government workflow and implement ICT for facilitating public services delivery. The smart government is defined by the extensive use of ICT in the government process for decision making and enhancing the government efficiency and effectiveness (Eom, Choi, & Sung, 2016; Gil-

Garcia, Zhang, & Puron-Cid, 2016). Smart government includes a robust public ICT infrastructure, services, use of mobile technologies, and artificial intelligence in the government process. Nevertheless, there is no common consensus on what makes a government smart and on the extent of smartness. Some researchers argue that a smart government vision is the extensive utilization of ICT in the government process or extensive digital transformation of the government. However, the stakeholders often forget the basic component of the sustainability of smartness. For instance, the definition of the smart government only deals with the part of society which has already become digitally literate and the model of implementation places a digitally literate demography in the center. This approach may be appropriate where the digital divide is minimal; however, it may not function properly in the case of developing countries where the digital divide is a major concern. The provision of the smart government should be inclusive to all facets of the society such as addressing the poor and marginalized society. Thus, collaborating with the different components of the society such as government, business, academia and the public is necessary for a sustainable development.

To date, several e-government initiatives such as smart driving license, national identity card, inland revenue system and so on have been developed. Some other initiatives have also been created by individual agencies to improve service. However, a consolidated system under the interoperability framework laid by the government has yet to be developed. After the decentralization of federal government power to the local

governments under the provision of the new constitution², local governments can execute publicly valued ICT projects. Nevertheless, a comprehensive cost-benefit analysis of segregated system and the unified system and their comparison would be the best approach while implementing such projects. Hallahan and Peha (2011) argue the need for a consolidated system as it creates positive externalities and speeds up the diffusion of ICT services. However, implementing a unified ICT system can only be feasible if the system is a high priority for all neighboring local governments.

After the promulgation of the new constitution, the federal government of Nepal has provided a small amount of budget to each local government for general administrative expenses related to infrastructure development and expenses for social welfare. Despite the limited budget, local governments have many priority projects and a wide development agenda including reforming social welfare programs and other projects that have both short-term as well as long-term importance. Therefore, under this limited resources, the local government needs to prioritize development projects. In order to address the immense demand for infrastructure, the financial constraint is the major challenge, which necessitates partnering with the private sector for certain infrastructure developments in which the private sector has shown superiority over the public sector in managing the infrastructure. Since public agencies are welfare maximizers they use

² The government of Nepal has promulgated a new constitution through the constitutional assembly on September 20, 2015

public money to create economic opportunities such as creating a conducive environment for innovators by prioritizing the government budget to promote innovative activities (Yang, 2014).

Generally, the government is understood as a single organization and the organization's behavior is completely different from individual behavior as individuals representing the government are bounded by institutional rules and regulations. Under the same jurisdiction and legal environment, the behavior of public institution should be predictable without having to perform organizational behavior analysis. However, when a public agency has its own strategy and targets to address the public concern depending on their resource availability, they might act differently on addressing the public concern. A similar idea has been coined by Yang (2014) to increase the innovative activities of the firm through subsidies.

Similar to the individual, the government is a utility (welfare) maximizer and uses the "government preference" keyword to find the appropriate strategy to increase the innovative activities from the two possible options of "innovation subsidy" and "product subsidy" using the game-theoretic approach. Joyce (1989) studied the government preference function under the consideration that government agencies are social welfare maximizers. The government uses different policy tools to optimize the social welfare. The author took the example of monetary policy to show how the government preference function can be modeled to optimize the social welfare through policy intervention. While developing a specific strategy to deal with the problems under the government constraint such as budget, Beggs and Strong (1982) modeled the government budget allocation to the

education sector under the utility theoretical framework. Thus, prioritizing individual programs based on their importance is the general behavioral approach of government agencies. Horton (2006) also studied government priority and its importance in implementing archival services.

The contextual differences in interpretation lead to decision making such as “procurement structure, multiple values and relationship of the social actors and the consequences, intended and unintended, of the technology used” creates differences in decision making of public agencies, even under the same umbrella policy framework (Moncaster & Simmons, 2015). Understanding these differences necessitates the study of decision heterogeneity in public agency. Evidence-based decisions for executing projects leads to sustainability of the project. As ICT is fast changing, sticking to documented negotiation to reach financial closure may lead to failure and distracts from the path to achieve the envisioned goals. Thus, the active role of government of updating the policy embodying the advancement is instrumental to encourage the private sector’s involvement into more innovative activities. The decision by a public agency should not be viewed from the individual perspective, rather it is institutional and reflects normative pluralism. Surel (2000) talks about the normative framework for policymaking. Market stimulating technology policy (Lall & Teubal, 1998) under the normative framework is a winning approach that identifies the gap between policy conception and outcomes (Moncaster & Simmons, 2015).

An institution is a form of structure with a set of predefined objectives and the rational behavior of individuals representing the institution is perceived

as the behavior of institution (Searle, 2005). Since the respondents are the senior government officials and elected candidates through popular votes and are key personnel of the corresponding organization, their behavior is bounded by the institutional rules and regulations. In the “collective intentionality” idea coined by Searle (2005), the decisions of those respondents are rational and represent the decisions of the organization. Thus, the utility perceived by the individual respondent is the utility of organization. As the government is a social welfare maximizer, the utility-maximizing behavior of individual representing the government has a direct relationship with the government agencies’ utility maximizing behavior. Thus, respondents’ utility is the social welfare as they try to balance the benefit of the private sector and end user. The sole responsibility of the government is to maximize the social welfare through various activities. However, under a limited budget, pressure to improve the public facility and create economic dynamism government leads to the need for strategic partnership. Several strategies and government preferences have been studied to create economic dynamism. Thus, local governments can streamline their budget for short-term as well as long-term importance on priority by collaborating with the private sector to create economic opportunities aimed at addressing societal problems such as unemployment.

Thus, accounting for government preference while implementing policy and development programs is justifiable under the decentralized jurisprudential system where the local governments’ strategy is different from the central government’s strategy as their access to resources are different than that of the central government. Similarly, if the individual

local government's strategy and preferences are significantly different in various aspects such as setting priority (Horton, 2006), dilemma on setting policy and dealing approach (Surel, 2000), allocating resources (Beggs & Strong, 1982), or interpreting policy (Moncaster & Simmons, 2015) then the accounting heterogeneity would provide better implications on how the policymakers are heterogeneous within the umbrella policy.

This dissertation focuses on how the local government or individual public agency perceive the development of public ICT infrastructure through the PPP mechanism. Moreover, it helps to understand the government's willingness to implement ICT projects. The PPP mechanism focuses on risk sharing between the private and public sector, however, the perception towards this risk-sharing approach of decision makers might differ due to the diverse composition of the government. Thus, this dissertation further aims to identify the preference towards attributes of PPP under the heterogeneous, particularly focusing on making the project financially sustainable by agreeing on an approach for the future cash flow.

1.2. Research motivation and objectives

The IT Policy 2000 (Government of Nepal, 2000) is the first policy that has mentioned and outlined the development of the ICT industry. Moreover, it clearly outlined the strategy to nurture the information technology (IT) industry. The policy itself is a breakthrough, which aims to enrich the ICT landscape of the country. It has placed a high priority on the development of ICT infrastructure and services, particularly public ICT infrastructure and services. After the inception of the policy, the Nepalese

ICT industry was expected to grow at a faster pace and pave the road towards a knowledge-driven economy. The policy has stressed close collaboration with the private sector in order to advance the IT industry by creating a conducive investment-friendly environment, opening doors to introduce technology in government services, legalizing internet-based transactions, and creating a competitive environment in the IT industry. It has covered the supply and demand sides and has started the work on the digital agenda for the future. Based on this policy, several programs have been initiated along with the establishment of a separate agency to look after the IT industry. Similarly, the e-government master plan and the overall implementation framework have been laid out to further strengthen and align the IT industry and the national digital agenda.

Following the path governed by the ICT policy, the Government of Nepal has subsequently updated the ICT policy through several policy amendments, directives, acts and development programs. One of these development programs was the nationwide telecenter network. The government had given priority to the development of the nationwide telecenter network in rural as well as urban areas and supported academic institutions for preparing ICT empowered human resources for the future. Nevertheless, the development of the nationwide telecenter network has been heavily constrained because of the lack of government strategic planning, management, corruption, financial resources and of course the lack of proper human resources. One can raise doubts on what would have happened if the telecenter network project had been implemented in collaboration with the private sector.

Several connectivity projects around the world have been implemented and successfully executed through the use of the PPP mechanism³. It can be assumed that the project would have been successful if it were implemented in collaboration with the private sector. The reason behind this is that the private sector possesses better management skills, may offer a number of value-added services on top of the service offered through the telecenter network, might have a better sustainability model and allows to expand the network by leveraging further capital to diffuse the value added services apart from the basic internet service offered through the telecenter network.

At that moment, the policy has spoken about the PPP mechanism for the development of the ICT infrastructure and services. It could be possible that the slackness of the government agency for formulating the broader prospects of the PPP policy to incorporate the private sector for expanding the telecenter network. I cannot argue and present the reason for the failure of the telecenter network, rather I would state that it is because of the underlying government inefficiency to follow the directive given by the policy. This slackness is better explained by Leibenstein's X-inefficiency concept (Leibenstein, 1966, 1977, 1978), which states that underlying inefficient behavior of public agency through unknown sources has an adverse effect on the economy and fails to provide welfare to the

³ However, there is no comparative study available that proves whether connectivity projects conducted through the PPP mechanism are indeed all successful cases

society. Thus, I argue that if the telecenter network was implemented in collaboration with the private sector, it would have been successful.

Time has changed and citizens have become more demanding due to advances in ICT and increased global openness. However, limitations to implementing the ICT projects are somewhat comparable to the situation during the early 2000s. Thus, one of the objectives of this dissertation is to identify whether the government's perception towards the implementation of ICT infrastructure and services in collaboration with the private sector has changed or not. If it has changed, then it aims to analyze the preference structure of government for the ICT projects and attributes for the PPP mechanism. Moreover, by conducting a comprehensive investigation of the underlying heterogeneity among the decision makers, the robust preference structure for the attributes will be identified along with the importance of the attributes in the preference structure.

Second, the study further deepens the analysis towards the type of alternative ICT projects that the government is willing to implement through the PPP mechanism. The PPP mechanism is basically a risk sharing mechanism. In the case of developing countries, particularly in Nepal, the market of ICT services for project sustainability has not been ready compared to the developed world because of the underlying digital gap, economic situation and the complex nature of interdependence with other systems. Consequently, the government may need to bear significant risks for project sustainability. In that case, this study further analyzes government risk-sharing strategies such as providing subsidies during the initial phase of the project to the operation phase. However, understanding

the complex nature and possible composition of the government, I further deepen my study by segmenting the level of heterogeneity in the decision-making unit. The segmentation of the decision making provides more intuitive results to understand how the decisions for implementing projects through PPP are affected and how those segments behave to the attributes of interest.

Last but not the least; the PPP mechanism is generally employed when the government has resource limitations but is highly willing to pool the resources with the private sector for delivering the public project. However, as mentioned earlier, Nepal has a very low digital literacy and the private sector might not be interested to bear all the associated risk of the project to deliver public projects. Thus, as an incentive to the government how government willing to allocate the budget either as capital investment to projects or through subsidy to the project when government agency wants to implement multiple ICT projects within next 5 years. It helps to understand how government resource limits hinder the implementation of ICT projects and to scrutinize the key attributes of the PPP mechanism (risk sharing mechanism) while implementing ICT projects through PPP.

1.3. Contribution to the academic literature

The public-private partnership mechanism is a risk sharing mechanism between a public agency and the private sector. There is wide range of literature available in the PPP domain, both theoretically and empirically. Some literature focused on enriching the PPP debate in broadly dealing with different PPP features such as risk factors (Chung & Hensher, 2015;

Jin & Doloi, 2008; Medda, 2007) in a broad sense; another stream of literature rigorously focused on specific factors such as concession period (Carbonara, Costantino, & Pellegrino, 2014a), incentive sharing (Engel, Fischer, & Galetovic, 2013; Hallahan & Peha, 2011), financial attractiveness of project (Bonnafoos & Jensen, 2005; Hallahan & Peha, 2011).

Initially, the PPP mechanism used to employed for large infrastructure projects such as transportation project, energy project, telecommunication project to fill the gap between the government budget deficit and infrastructure demand. However, the PPP approach has been extended to all fields in which the government is specifically seeking improvements in close collaboration with the private sector. Therefore, governments across the globe have been collaborating with the private sectors other than infrastructure such as various ICT sectors (Given, 2010; Hallahan & Peha, 2011; Sadowski, Nucciarelli, & De Rooij, 2009)

There is very few literature available in the PPP domain that uses the discrete choice methodology such as (Chung & Hensher, 2015). Thus, this study fills the gap in the existing literature by extending the use of the discrete choice model in PPP literature.

The specific target of the study is to model the government's perception towards the implementation of ICT projects through the PPP mechanism, from which we expect to draw the attention of stakeholders in a wider perspective. From the policy implication perspective, it would provide the key insights into how decision maker representing the government

perceive the key attributes of PPP. Assessing the perception of decision makers individually, as well as collectively under the assumption that individual exhibit behavioral homophile, provides key insights into the concerned authority to take the appropriate measure to identify the appropriate private sector for possible collaboration. Moreover, this dissertation takes advantage of single as well as multiple discrete choice methodologies to assess the behavioral aspect of local governments, e.g., to what extent they are ready to make trade-offs on the attributes of interest (of this study) under both budget constraints and pressure to develop public infrastructure and services.

Thus, this study expects to contribute to filling the literature gap by extending the use of discrete choice methodology to model the decision makers' perception towards the development of infrastructure. This research is not case-specific and can be extended further to study other behavioral aspects of decision makers which represent the government agency.

This dissertation is structured as follows: Chapter 2 briefly summarizes the context and states the problems. Chapter 3 summarizes the literature relevant to this study. Chapter 4 summarizes the methodology and discusses how this methodology is suitable for the dissertation's objectives. Chapter 5 presents the descriptive statistics and model estimation along with the interpretation of the estimation result. Following the estimation result, Chapter 6 presents the discussion and implications of the results along with the concluding remarks of the thesis. This chapter also presents the limitation of the results, and provides a direction for future research.

Chapter 2 Research background and problem discussion

In the early days, the government has solely looked for the development of ICT enabled services without incorporating the private sector in a broader perspective. However, with this myopic view towards incorporating the private sector for providing public services, government reform using ICT has massively slowed down. The most likely reason for this sluggish development is the number of constraints and inefficiencies in the government, which could be easily overcome by collaboration with the private sector.

The government's investments in the ICT infrastructure and services is focused on paving the national economy towards a knowledge-driven economy by improving the efficiency and effectiveness in the ICT sector as well as generating indirect impacts on the overall economy. Moreover, the investments in ICT infrastructure and services allow to empower the citizen and serve to enriching the citizen-government relationship to achieve the broader prospect of democratic values. A number of researchers has stressed that development of e-government systems and ICT infrastructure leads to a robust and resilient economy as well as strengthens the democracy through the active participation of citizens in citizen-centered policy making with effective implementation.

ICT infrastructure and quality services that allow interaction between the government and citizens strengthen the relationship between the government and other beneficiaries and are becoming a phenomena around

the world. ICT is increasingly used to deliver government services and allow an effective interaction by improving both the government's efficiency and effectiveness simultaneously. The government of Nepal has envisioned strengthening such relationships in the IT Policy 2000 (Government of Nepal, 2000) by for the first time planning to nurture the domestic IT industry. The Policy has stressed close collaboration with the private sectors to advance the IT industry, creating a conducive investment-friendly environment, opening the door to introducing technology in government services through advancing public ICT infrastructure and services, legalizing internet-based transaction, creating a competitive environment in IT industry, and other measures. It has addressed the IT industry by covering both demand as well as the supply side in a broader view and has paved the digital agenda for the future. Based on this policy, several programs have been initiated along with the establishment of a separate agency to look after the IT industry⁴.

Over the last decade, the government of Nepal has given priority to implementing an e-government system. Several initiatives have started to strengthen the ICT industry, to integrate ICT technologies, and to deliver government services using these ICT technologies. The government of Nepal has given special attention to implementing the e-government

⁴ The High Level Commission for Information and Technology (HLCIT) was established as an autonomous government body to look after the development of the IT Industry, later it was dissolved (because of the power imbalance between line ministry and some other political issues)

system effectively by sketching the e-government implementation plan. The e-government implementation plan focuses on building infrastructure; preparing the required human resources; digitizing government information; developing applications, and ultimately integrating the various e-government systems to provide a one-stop digital government.

The modern ICT industry of Nepal started with the promulgation of the IT Policy 2000. This IT Policy laid the foundations for the ICT industry and paved the way for building a knowledge-based society. This IT policy envisioned a digital strategy for the government and aimed to give extra mileage to restructuring both the government and industry. Several policy initiatives such as a provision to include the private sector in building ICT infrastructure and services; developing e-commerce applications; a mandatory provision to include IT in education; and the establishment of a separate autonomous regulatory agency were undertaken. Moreover, through this IT policy, the government established an IT park to nurture the development of the ICT industry and foster startups in the IT sector. Following this plans, required and associated policies, regulations, and directives have been formulated to strengthen the IT industry.

In 2006, the government of Nepal prepared the e-Government Master Plan along with the e-government interoperability framework under the technical and financial assistance of the Korea IT Industry Promotion Agency (KIPA) and the Asian Development Bank (ADB). The e-Government Master Plan i) established a vision and implementation strategy of e-governance, ii) suggested major e-government projects for paving the foundation and directing the roadmap for digital government

and iii) suggested a restructuring of government agencies, preparing the legal framework (Pariyar, 2007). The e-Government Master Plan (afterwards: eGMP) has been broadly incorporated to establish the framework for the authority under the provision of a lead agency; to formulate the regulations that enhance the different facets of the electronic use of services (such as consumer protection, commercial certainty, efficiency of access, public and commercial infrastructure); develop applications (through public and private investment, market development, facilitate developing applications); enhance the HR capability (ICT development skills, increase effectiveness of the regulatory and strategic skills, increase the community e-literacy); as well as to improve infrastructure and access (develop interconnected network infrastructure and develop convergent and accessible technologies).

Since the enactment of the IT policy 2000, the government of Nepal has placed priority on implementing e-government projects to automate the government services using information technology. However, the pace of implementation and the maturity of the services are being questioned. A number of public agencies are showing their online presence and providing their services through websites⁵. Nevertheless, due to a lack of coherence between online and offline services, relying on the online side is not preferred to date. There might be several reasons behind the lack of trustworthiness and reliability of the online services compared to the

⁵ Mostly providing only a limited amount of information

traditional system. In a study by Ghimire (2011), it is stressed that the regulatory provisions are one of the important factors that have hindered the implementation of an e-government system despite the related regulatory framework having already been outlined.

Similarly, the e-Government Master Plan, as well as the overall implementation framework have been sketched out along with subsequent updates on policy documents to strengthen the IT industry and align the national digital agenda.

After the liberalization of the IT industry, particularly the telecommunication sector, several ICT indicators have improved along with the active private participation in telecom services. However, the national agenda for the ICT infrastructure, one-stop integrated government, and digital economy are still yet to be realized in a solid form and are challenged by a number of factors such as inadequate manpower and financial resources for the strategic development of the sector. The possible reasons is that e-government services may not properly address the contextual reality such as infrastructural, institutional, legal or human resources readiness (Heeks, 2002). That is why the e-Government Index is not consistently improving. This gives enough space for government and stakeholders to revisit the implementation plan and the effectiveness of subsequent ICT policies in the development of the IT industry. The E-government indices for 2003-2016 are shown in Table 1.

In the case of Nepal, the government envisioned the implementation of ICT infrastructure and services using its own government resources.

However, the progress of e-government and the development of key components of the e-government are heavily delayed, which can be seen from the e-government development index⁶ developed by the United Nations Public Administration Network (UNPAN). The United Nations E-Government Knowledge Database employed different methodologies for calculating the e-government development index and its sub-components. According to the countries overall ranking, the e-government maturity of Nepal is not consistently improving. The telecommunication infrastructure component shown in Table 1 is improving over the indexed time, which shows the impact of telecommunication market liberalization where the government transferred the significant risk associated with the telecom infrastructure development and market to the private sector. For the development and implementation of e-government services, the government has formulated key policies and established separate institutions through the ICT policy 2000 and its subsequent policy updates, however, the impact has not been reflected in practice. The delay in the implementation of public IT infrastructure and services may be because of budget constraints⁷ (Gelders, Bouckaert, & van Ruler, 2007; Yi, 2015), inadequate human resource, and insufficient technical capability of the

⁶ The e-government development index of Nepal is accessible at <https://publicadministration.un.org/egovkb/Data-Center>

⁷ (government may not effectively allocate their budget to the ICT infrastructure and service development cutting budget from other priority sector such as basic infrastructure facility),

government, system design and slackness of government policy (Al Nagi & Hamdan, 2009; Ebrahim & Irani, 2005).

Table 1E-Government indexes (source UNPACS¹)

Indices/year	2003	2004	2005	2008	2010	2012	2014	2016
Online service	.319	.336	.400	.288	.168	.288	.158	.399
Telecommunication infrastructure	.006	.006	.006	.012	.023	.06	.168	.167
Human capital	.480	.500	.500	.518	.582	.452	.377	.471
E-government development	.268	.281	.302	.273	.0257	.266	.234	.346
E-participation	.138	.066	.079	.023	.057	.026	.294	.509
Overall rank	130	132	126	150	153	164	165	135

Despite its poor infrastructure and low quality of living (living standards), Nepal has immense potential for being a prosperous nation and graduating from a least developed country to a fast developing country (or emerging economy). The government has declared its development strategy and economic plan in order to graduate from the least developed country status to a developing country by 2022. However, the accomplishment in terms of the indicators required to successfully reach the level of a developing country in the competitive era driven by the digital economy seem doubtful.

In order to boost the mainstream economy, ICT enabled human resources as well as integration of ICT in the economy and government service delivery plays a critical role. Several initiatives such as open data initiatives are another stream to empower the digital economy and ensure public participation. Open data can boost government initiatives through

the active participation of citizens and concerned stakeholders if the untapped potential is unleashed appropriately utilizing global technological practices as well as regional political and economic agendas (that could address the possibility synergies with the economic growth of neighboring countries). This could only happen if the government is able to open its data, protecting the basic norms of open data as well as appropriate incentive plan to utilize government data in order to create more opportunities and integrate private business data into government data to increase business value and to attain economic growth. However, for such activities the quality of infrastructure and richness of ICT services are pre-requisites to add values to open data; otherwise, it providing the data would be a waste of resources.

A census and household survey by the Central Bureau of Statistics (2014) shows that the people are more concerned with the technology, rather fulfilling their necessary needs. This awareness is the positive market pull needed for a successful diffusion of ICT services because of the active participation of the private sector in the telecommunication sector. In order for it to materialize, it needs a rigorous transformation of product and services together with a transformation of the organizational structure and behavior (Klievink, Bharosa, & Tan, 2016; Veenstra, Klievink, & Janssen, 2011). However, the speed of capturing the consumers' perception towards technology is lacking and addressing the demand has been less effective from sole government efforts. From the open innovation theory, which allows different perspectives to include input from active groups beyond the boundaries and the norms of certain products or services, emphasizing output-oriented functions and technological collaboration is an alternative

approach to increase government accountability (Jho & Song, 2015) to the public. More clearly, open innovation in public ICT infrastructure and services leaves space to innovate on government, which can be treated as an active feedback system to transform the organization and the way to deliver its services efficiently. This approach entails the incorporation of an open innovation strategy in order to foster innovation in the government and to enhance efficiency by creating an information platform partnering with private entities. This is suitable to overcome the constraints perceived by the government agencies and focus on improving their internal affairs and monitoring the system (Klievink et al., 2016). Thus, in order to address the government constraints, such as budget, and providing space for third parties to support the government strategy, a public-private partnership to deliver e-government services is instrumental.

After the market liberalization, particularly, in the telecommunication industry⁸, responsibility and associated market risk to expand the telecommunication services have been transferred to the private sector. Consequently, the market penetration of telecommunication services has remarkably grown faster than without private sector participation⁹. After the telecommunication market liberalization, the government of Nepal has enacted the IT policy in 2000, which opens ICT to the private sector and

⁸ The telecom industry was liberalized through the Telecommunication Act 1997

⁹ Mobile telephone service penetration in 2003 (before the first private telecom operator was introduced to the market) was 0.334, in 2008 (with six active operators) 16, and in 2016 111.696 per 100 inhabitants.

places a higher priority on incorporating private participation for the development of the public IT infrastructure and services through several policy updates and amendments. However, due to high digital illiteracy and low economic activities in the rural areas, the private participation in the network infrastructure and ICT services has been limited because of the unattractive expected return on investment. In order to address this market failure, a provision to incorporate the private sector in the expansion of quality access infrastructure, as well in a wide range of ICT applications that simultaneously strengthen the diffusion of IT services by utilizing private sector resources, is necessary. The strategic utilization of private sector resources for infrastructure and service development would tackle the problems associated with different risks such as market risk. Thus, this study explores the government preferences on infrastructure and the attributes for the public-private mechanism by which government optimally shares risk with the private sector.

Over the last decades, a number of studies has focused on the success factors of public ICT systems, taking institutional, financial, and managerial as well as an end-user perspectives into account.

Knowing the benefits of ICT in government service delivery and its impact on the economy, the government of Nepal has enacted the well-known ICT policy in 2000, stressing the partnerships with the private sector for all possible infrastructure sectors and services. It has paved the foundation for the modern ICT industry of Nepal by outlining the priority sectors for the development of ICT infrastructure and services, and preparing human resources for future to stand in the global ICT market. Nevertheless, the

private sector has been actively involved only in the telecommunication sector, despite several unsolicited projects interests submitted to the government by the private sector. Several studies have been conducted to identify the possible causes for the failure to reach PPP agreements when either of the parties has shown interest. The causes for failure are absence of a proper risk sharing mechanism, the financial condition of either party, market risk, the risk of investment, the risk of financial return and so on.

Thus, knowing the government's strategy for the development of the ICT infrastructure and services, preferences for the risk sharing mechanism with the private sector for the development of those ICT projects would play an instrumental role for prospective PPP projects in Nepal.

The decentralization has become more prominent and has been ensured after the promulgation of the new constitution of Nepal in 2015. The local government can make its development strategy and decision execution of such policy and strategy depending on their needs and available resources. However, in order to build an integrated e-governance system, a common framework for collaboration between the various government agencies is required for an efficient resource allocation. Allocating the resources properly and building integrated ICT infrastructure and services across the country in a complex and decentralized system is difficult when policy intervention is normative.

Since the liberalization of the ICT industry, the government has formulated a series of policies to strengthen the ICT industry, empower the private sector and also envisioned to adopt ICT into the government workflow.

Several initiatives such as institutional reformation, for instance, the establishment of the regulatory agency and other autonomous institutions, the establishment of IT parks and initiatives for the expansion of networks under government supervision have been undertaken. In addition, several policy initiatives such as a provision to collaborate with the private sector for the development of the network infrastructure and development of ICT applications have been formulated. Nevertheless, the output of such initiatives has not been as fruitful as expected.

The government itself is a complex system comprising different levels of administration (such as federal, state and local), dealing with different aspect of society with different dimensions of government as well as governance. It is the government's responsibility to provide the infrastructure, security, and public services to facilitate public life and lay down the path for a prosperous future. Thus, the government requires strategic and systematic long-term planning for moving forward the national economy while dealing with various problems. These strategies are undoubtedly based on dealing with the short-term as well long-term economic development vision of the country. In order to provide online services by integrating other government agencies is challenging (Zhou, 2008a, 2008b). To remove the possible hurdles, the government has prepared the e-government implementation master plan, envisioning the seamless integration of government agencies and their services as much as possible. In the e-government master plan, some of the e-government projects have been identified as the key components for the successful implementation of e-government projects. These key projects are the national ID Card (NID) system, taxation system, vital registration system,

government integrated data center, and inter-government connectivity. These are considered as the boosting components of the e-Government initiatives and if their implementation is falling behind, it will most likely slow down the implementation of other projects as well.

Of course, the technology adoption capability and the leadership in the line ministry is the prime factor. However, with the current situation of digital awareness in citizens and the current technological advancement, the government should think ahead further than the current state of e-Government in Nepal. In developing countries, governments have been successful in including the private sector in infrastructure development. However, the government needs to distinguish the sector and services to enable private sector participation in e-government services. Thus, this study will also try to identify the government preference structure for incorporating the private sector in the implementation of public ICT projects.

Thus, in order to explore the opportunities of ICT, the government has two options; i) invest public money into all kinds of public ICT infrastructures and services, ii) outsource and iii) incorporate the private sector when developing such infrastructure and services to mutually benefit each other by sharing the associated risks. Until now, the government used the first option and this policy has not performed as well as envisioned. The second option is somehow related to the first one, because most of the major ICT projects were developed with the assistance of bilateral and/or multilateral

agencies¹⁰ and if the government decided to go for the outsourcing option, government most likely needs to also depend on donor agencies. However, in the third option, the government uses the private sector's capital, management skills, and technical capability to address the lack of infrastructure and/or services and overcome its budget limitation and management inefficiencies.

The following benefits can be achieved if the government collaborates with the private sector for the development of public ICT infrastructure (Das Aundhe & Narasimhan, 2016; Eom & Fountain, 2013; Fife & Hosman, 2007; Kaliannan, Awang, & Raman, 2010; Klievink, 2015; Maskin & Tirole, 2008; Nucciarelli, Sadowski, & Achard, 2010; The Institute for Public-Private Partnerships)

- a. The public sector can leverage the private sector's capital for the development of public ICT projects outside of public funding sources.
- b. Enhancement of service delivery efficiency and effectiveness
- c. Use of innovative approaches and appropriate business models for project sustainability
- d. The government can focus on its core business such as monitoring the service quality, market regulation, policy
- e. The private sector has better technology than the public sector

¹⁰ National ID card – ADB; e-Government Master Plan -ADB, KIPA, Smart Driving license -ADB, Building Permit system (few cities) -UNDP, DFID and so on

- f. Possibility of cost-sharing and risk transfer in public projects, with a possible return on investment
- g. Accessing the invaluable expertise of the private sector in the areas of user satisfaction, productivity gains and efficiency
- h. Possibility of technology transfer
- i. Enhancing government accountability and performance
- j. Promoting entrepreneurship and empowering private sector

2.1. ICT industry and Government Intervention in Nepal

The era of modern ICT industry has begun after the market liberalization of the telecommunication industry through the Telecommunication Act 1997. Before the telecom market liberalization, there was limited access to telecommunication services. For instance, in order to get a fixed line subscription, a prospective user had to wait in a queue for a long time and the service would be connected only after the approval of a gazetted officer or recognized political figure. Moreover, the fixed telephone network was limited to major cities and district headquarters. Because of these issues (problems/limitations/ network externality) the tariff rate was high and out of access to the general/marginalized citizen. Similarly, the internet was launched in Nepal commercially for the first time in 1995 based on dial-up technology (which is dependent on fixed telephony lines). The internet services were offered only in major cities such as Kathmandu, Lalitpur, and Pokhara, and the access of internet services was even more difficult

than that of the telephone services. Thus, before 1997 can be considered as the dark era when it comes to communication technology in Nepal.

After the liberalization of the telecommunication industry in 1997, the state-owned telecom company introduced the first GSM mobile service. However, a similar approval system along with long waiting times to get mobile service and high tariff rates were common until the first private telecom operator entered the market. However, after the active participation of the private sector, the mobile subscription rate, as well as the number of mobile subscription, has increased exponentially, as can be seen in Figure 1. From this, we can come to the conclusion that, after the involvement of the private sector in the telecommunication service, the underlying inefficiency of the market (market failure) was properly addressed through the policy to introduce the private sector in the telecommunication service industry and breaking the state monopoly. The argument presenting this case is that the state-owned company (government) failed to expand the network and provide adequate services because of its inefficiency. Frieden (2005) argues that the success of ICT service deployment and diffusion to the market has a strong and positive relationship with the public policies and how the government intervenes in the market through these policies. Thus, I argue that the public ICT services are managed better if the government intervenes through an effective policy as well as its practical implementation.

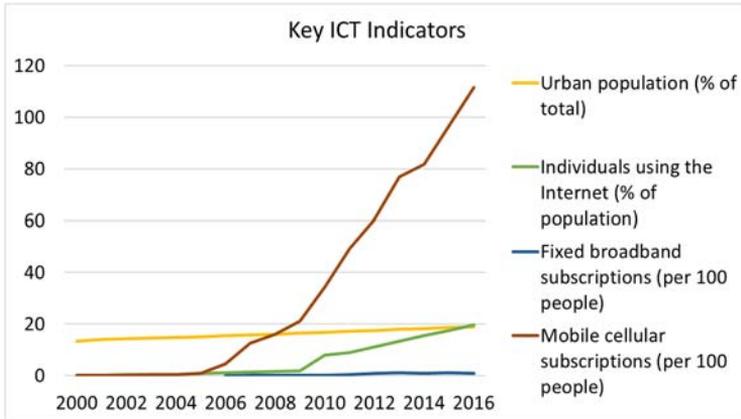


Figure 1 ICT indicators of the country

2.2. Public private partnership in Nepal

The history of PPP in Nepal began after the government decided to allow private participation in electricity generation through the Hydropower Act and Electricity Act in 1992. Several independent power producers have been actively involved in electricity generation in the hydropower sector. Later on, the BOT policy in the transportation sector was enacted in 1999. However, no PPP projects were awarded in the transportation sector. In the telecommunication sector, the PPP mechanism was used to introduce the first private operator after the liberalization of telecommunication through the Telecommunication Act 1997. The development of public infrastructure through the PPP mechanism was accomplished through the Public Infrastructure Build, Operation And Transfer Policy 2000 and the Private Financing In Build And Operation Of Infrastructure Act 2006, however, a comprehensive policy has only been enacted in 2015

(Government of Nepal, 2015b). The PPP policy 2015 has spoken broadly about each aspect of the infrastructure and services through the PPP mechanism. The IT policy 2000 had envisioned the possible collaboration with the private sector for the development of ICT infrastructure and e-government services; however, fifteen years later, the ICT Policy 2015 endorsed PPP in ICT infrastructure development, which shows major delays in formulating and implementing policies.

The main goals of the ICT 2015 are i) 75% digital literacy, 100% internet penetration, 90% broadband access for the population, a 7.5% GDP share of the ICT industry by 2020; ii) 80% government services will be e-government services; iii) Special funding provision for innovation and incubating ICT startups with the guiding principle of active incorporation of the private sector for the development of ICT infrastructure and services. Moreover, the Broadband Policy 2014 targets to connect all government offices across the country via an optical fiber network by 2020 (Government of Nepal, 2015a).

After the promulgation of the new constitution, the central government has transferred the decision power to the local governments through a power decentralization provision by which the local governments are able to execute PPP projects based on their development priorities and strategy.

In the next five years, the government of Nepal needs to invest a huge amount of money for the development of ICT infrastructure and services to achieve the goals targeted by the policies. In order to accomplish these

goals, the private partnership mechanism for developing critical infrastructure and services is crucial.

Recently, many governments have been attracted to the PPP mechanism in ICT sectors, such as PPP for deploying broadband network infrastructure and other ICT services like e-government. The need for incorporating the private sector for the deployment of broadband infrastructure might have been driven by the comparative outcome of the telecom sector with and without private sector involvement. After the liberalization of the telecommunication industry, the telecom service penetration in the developing countries has skyrocketed along with an increasing impact of ICT on the economy. The private participation in the ICT infrastructure has provided positive externality by inducing more private participation and capital along with innovations in the ICT sector. The active participation of the private sector for the ICT infrastructure development has several positive impacts such as strengthening the human capital. The private sector is directly concerned with the maximization of its profit in the short/long run with a various array of product/process innovations.

In a liberalized market, when the government collaborates with the private sector under non-binding conditions, the value creation along with the spillover is inevitable, because of the competitive market. In this case, the end user gets quality services at low cost more effectively and efficiently than if it was provided by the public sector. Most of the innovative activities are the result of market competition, high cost and the willingness to address the market demand from the supply side. Whereas needed, economic status and perception to take risks are the major drivers

of the innovative activities on the demand side (Jakob Edler, 2016). J. Edler and Georghiou (2007) argue that demand is the primary source of innovation. They considered that demand is the stimulant for innovation and there are higher chances that the end user may start micro-enterprises which grow to become larger enterprises.

Government across the globe have their own priority for the development of infrastructure based on their requirements to boost the economy. The rapid economic growth and intrinsic as well as extrinsic pressure to build and manage public infrastructure has been heavily constrained because of the governments' fiscal deficit, managerial inefficiency, and lack of technical expertise (Hammami, Ruhashyankiko, & Yehoue, 2006; Yehoue, 2013). Therefore, the government is attracted to incorporating the private sector for building and managing public infrastructure and services through the PPP mechanism.

The notion of involvement in the PPP mechanism by the government is to maximize the available resources and pool private sector capabilities by having social welfare as the central point. However, the decision on whether to employ the PPP mechanism or use a traditional procurement approach for public infrastructure is based on the utility maximization theory. The theory of consumer demand (Lancaster, 1966) and utility theory (Cochran, 1974) are well suited to identify the dilemma on using PPP or traditional procurement options (Stephenson Jr, 1991). Hence, this study aims to address the proper identification of alternative projects that are best suited for development through the PPP mechanism. From the utility theoretical perspective, the dilemma between whether to procure

through a traditional approach or an innovative approach can be addressed by comparing the perceived level of utility between these two available options to the public agency (Martimort & Pouyet, 2008). Moreover, while procuring through the PPP mechanism, the key features of the PPP mechanism such as the amount of subsidy to the private consortium, selection of company, offering financial incentives to the consortium and concession period play a vital role for the particular project alternative.

The PPP mechanism is employed for the value of money approach, effectively transferring risk from the public agency to the private entity by leveraging public resources for the private effective use of private capital. Since the 1980's, PPP has been used in the transportation, water and sanitation, energy and telecommunication sectors; nevertheless, the application horizon has been extended to cover services such as ICT infrastructure and services (the e-Government system) under various partnership schemes. E-Government services are resource intensive in the sense that they require huge financial and technical resources, in both of which the private sector has shown its superiority over the public sector. In addition, the use of the PPP mechanism serves not only the value for money and using the resources of the private sector, but also allows for an effective creation of value by employing the available resources (Panda, 2016). The infrastructure quality and the integration of technology in the other economic sector is lacking, and the use of technology such as ICT can increase the economic dynamism through the value creation mechanism. Thus, the underlying allocative efficiency will be distributed across the beneficiaries effectively. However, the contractual agreement should be flexible/complete enough to utilize the resources to materialize

the agreement for the value for money as well as should be conducive to value creation. The conducive environment for value creation can be considered as the market environment, with appropriate risk sharing mechanism between the partners so that the private sector can focus its resources on performance-enhancing activities and the public sector focuses on market regulation as well as monitoring and facilitating the private sector.

2.3. Risk associated with the public private partnership mechanism

2.3.1. Market

In PPP literature, most researchers are concerned about modeling the involved risks (see for instance (Chung & Hensher, 2015)). Out of the many risk categories, market risk has a key influence on the success of PPP projects as it is directly related to the project sustainability and to ensuring the return on the investments made by the private sector. Little literature is available on modeling the market risk in the ICT domain through the PPP perspective. Though ICT by itself might not be too different from other product or services, the existing digital divide determines the market potential unlike other PPP products or services such as toll road traffic. Moreover, some literature argues that the diffusion of ICT products or services also depends on other factors such as trust or information privacy

(Dutton & Shepherd, 2006; Guerra et al., 2003; Luo, Li, Zhang, & Shim, 2010).

In Nepal, which is characterized by a major digital divide, rural economy, and a weak telecom infrastructure, the market potential of new ICT products or services might not be sufficient to ensure a return on investment to the private sector. In such cases, a government subsidy for the development of infrastructure and services is inevitable. However, in such a case the opportunistic behavior of either party may deteriorate the social welfare, which needs a proper risk management strategy that is assessing the socio-economic status of the market (Medda, 2007).

2.3.2. Rent-seeking behavior

In the PPP mechanism, rent-seeking behavior arises when either of the parties behaves opportunistically (Koppenjan & Enserink, 2009). In the current context, the market risk sharing mechanism can be accomplished in three ways: i) transferring market risk completely to the private sector i.e. end users pay the service fee, ii) retaining market risk by the government, i.e., the government pays revenue to the project company without having users pay the service fee, and iii) the private company and government share the market risk in a certain proportion. In the PPP mechanism, the government provides certain incentives to the private sector; however, the private sector should not be privileged for providing the public services. In the context where the public agencies budget limitations severely affect the development of public infrastructure and

services, the public sector may provide higher incentives through different mechanisms such as subsidy provisions or through providing a minimum revenue guarantee mechanism to meet the minimum revenue required for sustaining the project. In such a situation, the private sector may play opportunistically and draw a higher profit without undertaking the rigorous innovative activities that would be necessary when operating in a competitive market. Similarly, a public agency might entirely depend on the private sector risking their investment. In either situation, the social welfare cannot be maximized and market failure would be inevitable.

In order for a project to become financially sustainable, the private company needs to involve innovative activities to attract end users¹¹. However, the revenue generation mechanism is determined during the project negotiation period and is based on the socio-economic circumstances as well as the nature of the project. Nevertheless, because of the opportunistic behavior of both parties, they show future rent-seeking behavior. In the same way, this is true for the project funding strategy. This rent-seeking phenomenon is pervasive in all collaboration activities. Takano (2017) studied rent-seeking opportunistic behavior in unsolicited proposals and found that it originates from the asymmetric, non-transparent and discretionary process in decision-making. Some literature argues that the rent-seeking behavior is due to the weak institutional arrangements and clarity in the contract, which create the quasi-rents

¹¹ Offer low cost services, quality products, reliable products, better customer care, better design of product so that customer feels no hassle to use the service (ease of use)

through lobbying, lawsuits, and other activities to establish a mechanism to draw benefits through various mechanism such as licensing, providing subsidies or privileging the absolute power to operate in the market (creating a monopoly)(Keefer & Knack, 2007). Figure 2 and Figure 3 show how rent-seeking behavior changes when the funding strategy and market sharing strategy changes. Moreover, in market sharing, public funding strategy, or subsidy strategy, a proper economic evaluation accounting for the social cost is important. When rent-seeking behavior arises, these accounting processes are often not transparent, leading to a loss of welfare and market failure.

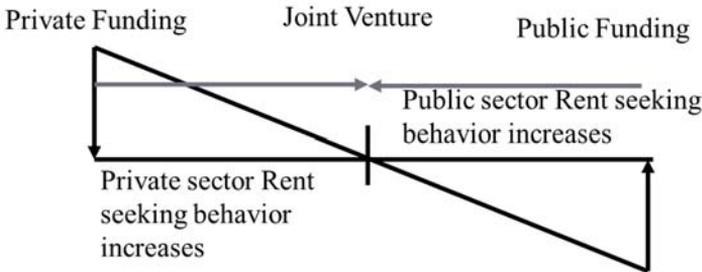


Figure 2 Rent-Seeking behavior in Funding mechanism

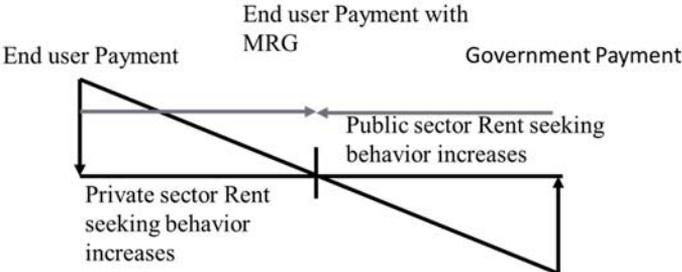


Figure 3 Rent-Seeking behavior in market sharing

Chapter 3 Theoretical synopsis and literature review

The economics behind the improvement of public services delivery can be explained through the public economic perspective (Engel et al., 2013; Iossa and Martimort, 2015). The public economy explains economic efficiency and the distribution of welfare. However, because of the lack of government effectiveness and governing policies, the risk of market failure in developing countries is higher. Thus, after the 1980s, governments have changed their policies to reduce the active involvement of the public sector in providing public infrastructure and services towards collaborating with the private sector. This change in policy had a great impact on economic growth, as it empowers the private sector in public infrastructure and subsequently increases the effectiveness by reducing the inefficiency of the public agencies (OECD, 2008). This policy drift (Béland et al., 2016) has contributed to maximizing social welfare and thus creating a Pareto-efficient state by pulling the available resources from both the public and private sector. In the traditional procurement approach, this point is hard to attain because of the cost of innovation and a lack of competition in the traditional procurement system. From the micro-economic theory, the welfare will be maximized only when the marginal cost is equal to the market price, which is also the Pareto-efficient state of distributing the resources. Because of the lack of competition and accounting for the appropriate value of money and the inefficient behavior of the public agencies, the demand for public infrastructure and services has often not been appropriately addressed, or the cost of addressing the demand is

extremely high. This entails welfare loss because of the inefficiency of the public agency, as the public agency fails to use and manage the resources appropriately.

In contrast, the private sector, who has better technology, financing capability, and management skills than public agencies, can address the prospective demand and strengthen themselves to better provide services of the underlying associated risks. This, in turn, provides public infrastructure services and increases welfare better than traditionally procured services (Zhang & Chen, 2013). Private participation creates a competitive environment for providing services by breaking the monopoly market in public services and increases the allocative efficiency (Engel et al., 2013). However, private participation needs a remarkable amount of resources, a conducive environment, and a supporting policy to maintain the infrastructure. Moreover, it requires market reformation and the restructuring of the organization such as privatization or corporatization in order to create new ventures or partnerships with a specific purpose. By doing so, it increases the effectiveness by reducing public inefficiency through the PPP mechanism (Hammami et al., 2006). Sustainability can be achieved through market liberalization where the market controls the sources of underlying industry inefficiency as the private sector derives incentives from the liberalized market, which obviously changes productivity.

Public-private partnership (PPP) has been broadly pronounced in other infrastructure services such as transportation, energy, water supply, and waste management. Realization of the PPP model in the ICT sector is one

of the most prominent areas where the government can benefit (Fife & Hosman, 2007) with the lowest possible resources. As mentioned, the outcome of initiatives taken by the government has been challenged by financial, technical and managerial constraints. The e-government system is resource intensive and requires an abundance of technical and financial resources together with effective management. These resources and associated risks can be shared through the PPP mechanism with the private sector. This not only lowers the failure rate of the implementation of e-government, but also increases the opportunities that come along with it, such as job opportunities, technical efficiencies, increased government accountability and the promotion of inclusive civic participation in government. Partnership under the intuition of government agencies' concern and profit maximization motif of the private sector can be bounded by increasing social welfare rather being either aspect of the partnering entity. The private sector can leverage a greater impact through technology dissemination, increasing the impact on the society even under limited government resources. However, the partnership needs special attention and negotiation to provide adequate incentives rather than simply giving privileges to the private sector (World Bank, 2005).

The Public-Private Partnership (PPP) mechanism for infrastructure development has been widely practiced since the 1980's to fill the gap between infrastructure demand and supply. The aim of the PPP mechanism is to utilize private capital and management strength for the purpose of large infrastructure, such as telecommunication, energy, and transport infrastructure (Hammami et al., 2006). The trend of incorporating the private sector for the public infrastructure has not only been limited to

these sectors, but also extended further, for instance to provide quality education, healthcare, and in many other sectors where the government is looking for effectiveness, efficiency, and innovation. In addition, the partnerships not only provide infrastructure and services to address the current market demand, but also to address societal problems and create future opportunities through research and development.

Until to date, the PPP mechanism has been viewed/perceived as the interaction between the government and the private sector. As the government suffers from a number of challenges, such as the budget deficit, inefficiency, and ineffectiveness on service delivery it has difficulties to address the demand for infrastructure and/or services (Hammami et al., 2006). Supply side innovation may occur to address the demand through market intervention. Direct government interventions such as regulation, subsidies (Le & Jaffe, 2016; Yang, 2014), taxation policies (Xu & Xu, 2013) and indirect interventions such as import-export tariffs (Gouvea & Vora, 2016) significantly affect the innovation system.

The interaction between the parties has been well discussed in the broader landscape through different approaches such as appropriate risk sharing mechanisms, value for money approach, and through underlying various theoretical background such as institutional economics and political economics which has provided ideas about the success factors of the PPP mechanism (Osei-Kyei & Chan, 2015). A wide range of literature focused on identifying the success factors of the PPP mechanisms, considering a broader scope of the PPP landscape, the individual sectors and individual case studies (Hammami et al., 2006; Kaliannan et al., 2010; Mota &

Moreira, 2015; Sharma, 2007; Yehoue, 2013). In spite of the richness of the PPP literature, researcher are less attracted to PPP research in the ICT domain other than telecommunication, even though a number of ICT applications have been implemented through the PPP mechanism.

From the resource view perspective, PPP projects have a number of advantages over the projects without PPP agreement. For instance, the public sector can utilize the private sector's technical, managerial and financial capabilities and the private sector can become the de facto service provider sharing the risk with the public sector. The private sector, which already participated in PPP arrangements, has better knowledge to deal with the risks associated with the PPP arrangements in a new environment. The experienced private sector, as well as the public sector, utilize their tangible and intangible assets to improve risk allocation and the management process that is necessary to ensure the success of large infrastructure projects. Often, PPP in the telecommunication sector has been introduced after the market liberalization and by firms which already know about the rivals' strength in the market, which is key to shape their strategy to deal with the market. In order to capture the competitive advantage, an experienced firm can deploy its available resources to deal with the rivals, which leads to positive welfare creation in the market (Jin & Doloï, 2008).

The collaboration can be made in two different structures, such as building and operating the facility separately, or in a combination of both with a selected private partner based on the needs and the competencies of the partners. In this context, Iossa and Martimort (2015) theorized the PPP

arrangements from the microeconomic perspective and concluded that the bundling of the builder and operator outperforms unbundled cases. In bundling, the operator can effectively internalize positive externality and maximizes profit. However, in an unbundled scenario, the builder does not have an incentive to make uncontracted investments for quality enhancement of the infrastructure, and the operator may need to invest further to internalize the positive externality.

The responsibility of either party needs to be effectively characterized by identifying the private sector's capability, so that they can effectively bear their contractual responsibility for the success of the PPP project. Most of the private sector focuses on the profit based on the contractual agreement. In general, most contractual agreements are incomplete (Hart, 2003) and fail to allocate the risk sharing mechanism effectively among the collaborating partners, which also affects the resource utilization. In this case, the available resources may not be used properly for value creation and a firm might not outperform its competitor, which increases its market risk. Thus, defining the boundaries of the scope of the partnership, the contractual agreement should clearly extend the possibilities for value creation through innovative activities that enhance the performance so that any associated cost can be covered by their discounted future rents.

3.1. Studies on ICT infrastructure and service development

Several studies on the implementation of public ICT projects have focused on the critical success factors (Al-Shafi & Weerakkody, 2010; Altameem et al., 2006; Khadaroo, Wong, & Abdullah, 2013). In some aspect, these studies tried to link infrastructure gaps and financial issues, however, they did not provide a rigorous explanation of how these infrastructure gaps and financial issues could be solved while implementing public ICT services.

Weerakkody, El-Haddadeh, Sabol, Ghoneim, and Dzupka (2012) studied a strategy that was adopted by developed countries to implement public ICT services, especially the cases of the UK and Slovakia. According to the study, the UK government employed their public ICT services development strategy by utilizing the private sector resources. The UK is one the leading countries to leverage the private sector's capital for the development of public infrastructure. In addition, for the development of public ICT services, the UK government arranged a special unit that observes whether the progress in the implementation of public ICT projects followed the cohesive development strategy. The authors concluded that the UK government is following the strategic path envisioned by the policy to exploit the ICT as followed by the private sector. Whereas the Slovak government streamlined their resources not linking with the private sector to disseminate into the market. The authors highlighted that the major difference between the Slovak and UK government is that the Slovak government focused on modernizing local

the government and the UK government focused on re-engineering back office processes and change management.

The use of public money for the development of public projects and utilizing the private sector is justified only when it creates value for the society. However, it depends on how closely the end user interacts with the system and the interaction of end-users with the implemented government ICT system occurs at the local level (Sandoval-Almazan & Gil-Garcia, 2012). When the implementing agency is not competent for the end user management, the extent of interaction of end-user lowers the exploitation of ICT services, which creates negative externalities for the successful diffusion of ICT services. How to increase the level of interaction of the system with the end user is a key issue. Undoubtedly, the answer for increasing the interaction level is civic participation to the system. As the number of participants in the system increases, the interaction with the system increases.

Klievink et al. (2016) have considered the idea of creating a portfolio in partnership with the private sector to address the pitfall where reachability and effectiveness of the government's effort are limited. The collaboration between government agencies or between the government and the private sector can address gaps when setting aside their primary interest. The optimal public value can be ensured by abiding to the highest level of social norms, policy directives, laws and regulations (Klievink et al., 2016; World Bank, 2005, 2016). Such collaboration may happen at service as well as at the infrastructure level to provide different services to

stakeholders. However, the collective effort is interlinked with the strengths of a number of factors (or success factors).

Ghimire (2011) studied how regulatory provisions affect the public trust towards the success of e-government in Nepal. The study focused on how strong regulation attracts the public towards the e-government services. The e-government system is a complex system, and a number of public agencies participated in the system by offering their services through the internet and associated technologies. The implementing agency should abide by the provisions laid out by the national e-government and interoperability framework. However, while implementing e-government services, the host agency may interpret the regulation in their own comfortable way, making it difficult to coordinate with other agencies. In such a case, the system may lose the public trust leading to a failure of the system.

3.2. Studies on ICT infrastructure and service development through the PPP mechanism

Many studies have been carried out on PPP, especially in the construction and public infrastructure sectors. However, only a very limited number of literature is available on PPP in the ICT sector, even though a number of cases have been implemented around the globe.

Das Aundhe and Narasimhan (2016) explained how and why intangible factors determine the success of public ICT projects through the PPP

mechanism, critically focusing on the complex government structure while adopting innovative public services.

Kaliannan et al. (2010) studied the possibility of PPP in the public ICT sector, analyzing the case of Malaysian projects implemented through the PPP mechanism. This study also presented successful ICT projects through the PPP mechanism practiced in some Indian states.

Hang (2009) studied the implementation of ICT projects through the PPP mechanism. He used the analytical hierarchical method to uncover the problems in implementing public ICT projects through the PPP mechanism and found that government support, procedure, and legal framework are important factors along with the planning and the feasibility of the project.

Previous studies on public ICT projects have indicated a number of critical success factors for both implementation and adoption of technologies (Altameem et al., 2006) from both the supply and demand perspective. Likewise, many issues have been studied in PPP in a different domain. However, there are no studies available on implementing ICT services in collaboration with the private sectors as well as other government agencies. As PPP is risk sharing between the government agencies and the private sector for the successful projects, and public ICT projects, particularly e-government itself, is another domain where the success rate is low (Heeks, 2005), this in turn lowers the success rate of the PPP mechanism. The common challenges are a lack of political commitment, legal framework, proper action plan, effective communication, well-defined management process, market risk (M. Falch & Henten, 2010; Fredebeul-Krein &

Knoben, 2010; Given, 2010; Raman & Björkman, 2009; The Institute for Public-Private Partnerships, 2009) and challenges in allocating risk (Abednego & Ogunlana, 2006; Carbonara et al., 2014a; Carbonara, Costantino, & Pellegrino, 2014b; Hwang, Zhao, & Gay, 2013; Khan, Surat, Tareen, & Saeed, 2016).

In the last two decades, governments around the world have been involved in partnerships, privatization, venturing, and outsourcing for certain services or the construction of public infrastructure. The optimal utilization of resources should be governed by the value creation through the mutual benefits that optimize social welfare (Panda, 2016). Thus, PPP is mainly considered as sharing the risk with the private sector and as a tool to stimulate investments in the IT infrastructure in the long run (Falch & Henten, 2010; Fredebeul-Krein & Knoben, 2010; Given, 2010). However, strategic planning between the partners (Braun, 2004) and balanced negotiation power are the key factors that ensure the success of PPP. Researchers have been focusing on identifying the critical success factors for PPP, which are best summarized by Osei-Kyei and Chan (2015) who performed a key-word search on published papers in major journals.

In the PPP model, the private sectors look to different incentive mechanisms to guarantee their minimum revenue from the projects. The financial accountability of contracting parties (Hodges & Grubnic, 2010) for the PPP plays a vital role to deal with unforeseen circumstances that could lead to the failure of the partnership in the long run. To avoid such circumstances, it is necessary to include provision for tariff adjustment based on the macroeconomic situation (Beckmann, 2013) and to ensure the

minimum revenue guarantee mechanism for the private sector to strengthen the partnership in ICT.

Zhang, Xu, and Xiao (2014) summarized the influencing factors on the diffusion of public ICT services by reviewing the literature. These factors pose critical issues for a successful implementation and can be minimized with the collaboration between the municipal (Ferro & Sorrentino, 2010), private sector (Sharma, 2007) by best utilizing the available resources. By using the collaboration with inter-governmental agencies or with the private sectors, the acceptance of the public ICT services is higher than with individual efforts due to the utilization of multiple channels to persuade the potential adopters from their position/reputation in the society. The private sector is efficient in building infrastructure, building capacity that is needed to support it, and in strengthening the services linking with businesses, which ultimately increases opportunities. The private sector can easily link government services to the targeted customers more effectively and efficiently than the government is able to (Kaliannan et al., 2010).

In order to tackle the non-transparency issue in public procurement processes, (Ojha & Pandey, 2014) presented a case study from the Karnataka State of India which employed the PPP mechanism.

Klievink and Janssen (2009) have analyzed how and where private sector participation strengthens the public ICT services.

Cordella and Bonina (2012) argued that public sector reform needs to look at different perspectives to incorporate the private sector in a richer context

of the development of ICT adoption in the government workflow. The private sector's experiences, along with its richer technological capability, sound management and organization procedure, can help public agencies to deliver public services in collaboration with the private sector. They coined the term New Public Management (NPM) as an alternative to the e-government system and government reform utilizing the strength of ICT technologies.

Gil-García and Pardo (2005) have outlined the factors that are crucial for the implementation of public ICT services. They summarized the previous literature focusing on critical success factors for ICT initiatives, an area in which developing countries, in particularly Nepal, are lacking behind. Because of not following the strategic path shown by policy, several initiatives have become either ineffective or wasted resources. This can be attributed to the slackness in following the development strategy and inefficiency in the government. The challenges for achieving success are categorized in five categories as a) Information and data challenges, b) Information technology, c) Organizational and management, d) Legal and regulatory, e) Institutional and environmental. By incorporating the private sector for government reform, particularly in NPM (Cordella & Bonina, 2012) the public sector strengthens the reform process by focusing on market regulation and creating a conducive environment for shifting the technological, financial, management risk to the private sector.

Kromidha (2012) has focused on how international aid contributes to the development of public services, particularly focusing on developing countries. He found that international aid is positive for the least

developing countries. The international aid mainly constitutes technical, managerial and policy support, along with financial contributions to the development of ICT infrastructure and services. However, the research shows that it is insignificant to developed countries and is less likely to progress, as the countries have passed the early stage of public ICT service development in line with the main government development strategy.

Broadband connectivity and government services are undoubtedly considered as public goods and governments across the globe have been involved to provide these goods to the public under the public utility framework (Sadowski et al., 2009). The United Nations Sustainable Development Goal (SDG) has stressed universal connectivity as one of the major development goals. Under the SDG framework, governments have been involving in expanding network connectivity across the demography through various procurement approaches such as the PPP mechanism. For the development of the municipal network and also to address the market failure, a number of municipalities in developed countries (Sadowski et al., 2009) and developing countries have been employing the PPP mechanism. The author analyzed how the government subsidy played an instrumental role in project sustainability. The paper has also shown that government subsidies played a key role in boosting the penetration of broadband subscriptions and reducing the cost for the end users.

Hallahan and Peha (2011) argue that a consolidated ICT infrastructure is better than a fragmented network. Fragmented systems are more prone to market risk, security vulnerability and cost inefficiencies than nationwide consolidated and integrated networks.

3.3. Studies on public private partnership through discrete choice

Chung and Hensher (2015) studied the risk perception of stakeholder involvement in the PPP mechanism for investing in toll roads. This study used the discrete choice methodology to model the risk perception affecting the investment in toll roads. The authors took stated preference data from the practitioners for modeling the risk perception experienced in previous PPP projects and the ex-ante risk perception for the toll road investment. They further analyzed how this risk effects modeling the project risk profile.

Janssen, Borgers, and Timmermans (2014) studied the adaptive behavior for the choice of retail location for the development of retail outlets. They strongly assumed that the preference structure for executing retail facilities through the PPP mechanism is reflected based on the environment and professional background of the decision maker. By using the different contextual scenario, they found that the decision preference is significantly different showing the effect of the behavioral role in the decision-making process. This is a key finding for employing the discrete choice experiment to understand the underlying heterogeneity of the decision makers.

Chapter 4 Empirical models

4.1. Utility theory

The public organization always looks to provide better social welfare by optimizing the use of available resources. Most researchers and policymakers agree that an increase of social capital is accomplished by creating opportunities across the demography. However, in developing countries, increasing such opportunities has been constrained by a number of factors such as infrastructure availability and proper utilization of resources. Under the resource-constrained condition, governments across the world have been actively utilizing the private sector for leveraging its capital, management skills, and technology for delivering public infrastructure as well as managing such infrastructure. However, in either perspective of the procurement approach employed for the development of public infrastructure as well as managing such infrastructure, public money is used. It is a major concern for the public agency to decide whether to procure through the PPP mechanism or through the traditional procurement approach. Several studies have been done (Martimort & Pouyet, 2008) to shed the light on the dilemma between traditional procurement and an innovative procurement approach.

It is the public agency's job to identify the perceived level of utility for the development of public infrastructure, and manage particularly ICT infrastructure and services procured via traditional procurement and PPP options. The primary assumption of this study is that the government of Nepal has a high degree of budget limitation for the development of ICT

infrastructure and services, and that they would look to the PPP mechanism for developing such projects. Under this assumption, the primary question is in which contextual situations (in terms of PPP key attributes) a public agency would maximize their perceived level of utility from developing ICT projects through the PPP mechanism.

The demand for infrastructure can be modeled based on different underlying assumptions. The modeling technique differs in a number of theoretical assumptions. Here, in this research work, it is assumed that the government addresses the demand for ICT infrastructure based on strategic economic planning. In the case of developing countries, financial resources are one of the most prominent constraints that hinder the development of infrastructure, even though such development is a high priority for the government. ICT infrastructure development and implementation of ICT services are not high on the priority list of developing country due to the necessity to develop other basic infrastructure such as transportation first. A robust ICT infrastructure and its proper utilization (exploitation) vitalize the economy by creating a substantial foundation for the knowledge-based economy. Nevertheless, several issues such as demand for transport, energy, health infrastructure, which are life-line infrastructure and services need to be addressed before allocating budget to ICT infrastructure and services. On the other hand, the market in developing countries, particularly in Nepal, is often not ready to absorb the investments made by the government. Public money should utilize the notion that it creates allocative efficiency across the demography, so that public spending reaches the Pareto-efficient state. However, this study assumes that the government seeks private participation in the ICT infrastructure or

service/application development to increase the effectiveness of the services within a short period of time. It also helps to disseminate new technology effectively, supporting the sustainability of the projects. The use of the private sector for delivering public infrastructure and services empowers the private sector and creates a conducive environment for spillover effect in the market. It also helps filling the gap between budget deficit and lack of infrastructure, so that the government can utilize the budget in sectors and areas where private participation is not anticipated. Nevertheless, appropriate incentive mechanisms should be employed to attract investments and participation from the private sector.

In order to deal with this problem, modeling the perceived level of utility of incorporating the private sector in particular ICT projects is a task for which the Random Utility Model (RUM) theoretical approach seems best suited. The Random Utility Model, proposed by Mcfadden (1974), is widely used for analyzing the utility perceived by decision makers when the decision maker makes a decision of selecting the best option among available candidate alternatives. Through the use of the utility theoretical model, a public agency's (the decision maker) utility structure for the particular project alternative that would be implemented through the PPP mechanism can be easily evaluated by considering the levels of the attribute in the utility structure. Modeling such utility can be expressed in mathematical form as

$$U_{nj} = V_{nj} + \varepsilon_{nj} \quad (4.1)$$

where U_{nj} is the perceived level of utility by the n decision maker for selecting the alternative j from the available J alternatives. V_{nj} is the representative part of utility which is observed by the researcher. However, ε_{nj} is the stochastic part of utility and cannot be observed by the researcher. In order to account for such stochastic part of utility in the model, it is assumed that ε_{nj} follows the probabilistic distribution. The use of probabilistic distribution depends on the modeling framework (Train, 2009).

While making the decision to select the best alternative from the available alternative set, the decision maker compares his/her utility perceived from each alternative and selects the alternative that provides the highest level of utility.

Thus, the probability of selecting the i^{th} alternative from the available alternative set is given by the following expression (Train, 2009):

$$\begin{aligned}
 P_{ni} &= Prob(V_{ni} + \varepsilon_{ni} > V_{nj} + \varepsilon_{nj} \forall j \neq i) \\
 &= Prob(\varepsilon_{nj} < \varepsilon_{ni} + V_{ni} - V_{nj} \forall j \neq i)
 \end{aligned}
 \tag{4.2}$$

4.2. Discrete models

In the discrete choice situation, the decision maker chooses one alternative and the available alternatives are perfectly substitutable with each other.

While making the decision, the decision maker tries to optimize his/her utility by selecting one of the several available alternatives (Train, 2009).

4.2.1. The mixed logit model

In the standard logit model, the utility of the decision makers is estimated based on the homogenous behavior among the decision makers over the choice profiles and the attributes of the choice parameters (Train, 2009). This obviates the biased results because of the strong assumption of the constant error distribution (considered as white noise) on an unobserved component of the utility among the decision makers and attributes of the choice sets. The assumption of non-linearity of the parameters and the variables capture the observed and unobserved heterogeneity among and within the decision maker. This gap has been realized by (Train, 1998) to avoid such biases caused by the assumption of the homogeneous behavior of the decision makers by assuming variation in taste among them. The mixed logit models can overcome the limitations of the standard logit models by allowing for random taste variation, unrestricted substitution patterns, and correlation among the unobserved factors in the model (Train, 1998, 2009). They are also highly flexible to approximate the random utility model (Train, 2009). This flexible assumption to incorporate the observed and unobserved heterogeneity is heavily constrained in the case of the standard logit models, which assume that the error components are identically distributed among the decision makers. However, the mixed logit model assumes that they are distributed among the decision maker

following a certain probability distribution (e.g. normal, log-normal or triangular) (Train, 2009).

Consider that the government agency faces J choice alternatives to implement ICT projects through the PPP mechanism and the utility received by the n government agency from the alternative project j is given by

$$U_{nj} = \beta'_n x_{nj} + \varepsilon_{nj} \quad (4.3)$$

where x_{nj} are the attributes related to the choice alternatives and the decision maker. β'_n is the vector of coefficient corresponding to the attributes of the alternatives and the decision maker. ε_{nj} are the unobserved factors. In the mixed logit specification, these parameters are assumed to be varying over the decision maker and follow a certain probabilistic distribution, which characterizes the taste and the behavior of the decision maker (McFadden & Train, 2000; Train, 2009). While facing the choice alternatives, the decision maker selects a particular choice alternative among the available choice alternatives knowing his/her own β and ε , however, these parameters are unknown to the decision maker. In the standard logit models, the researcher observes these parameters with the assumption that the unobserved component follows the *iid* extreme value. Thus, the researcher assumes the appropriate probability distribution that vary across the decision makers and the properties of the choice alternatives based on the characteristics of the attributes. For

instance, as decision makers often do not like the higher price of a product, researchers might assume that the coefficient for the price attribute is negative for all decision makers and the long-normal distribution can be used¹² (Train, 2009).

The probability of choosing the i alternative over all possible β (Train, 2009) is given by

$$P_{ni} = \int \left(\frac{e^{\beta'_n x_{ni}}}{\sum_j e^{\beta'_n x_{nj}}} \right) f(\beta) d\beta \quad (4.4)$$

4.2.2. Latent class logit models

In the previous section, I briefly presented the model to understand the presence of heterogeneity among the decision makers by incorporating the taste variations across the individuals. It is quite important for understanding the individual's preferences rather than assuming the individuals who might have behaviorally different perspectives on viewing the attribute and its level and the alternative altogether. This behavioral differences can be caused by the difference in the level of formal education, experiences in the government, prior experiences in PPP projects, size of the population of the local government, responsibility in the government (for instance, directly elected through a popular vote or a bureaucratic

¹² Triangular distribution may also be used (Train, 2009, P. 138).

officer appointed by the government through a certain procedure). It is very important to understand and divide the groups of decision maker into a number of segments to allow for a clear understanding of the composition of the government for the decision-making process while executing PPP projects. The data employed for this analysis is only a representative one, , however, it can be instrumental to understand the overall implications of the results. This segmentation of the group of decision makers and their preferences is referred to as latent groups.

Both the Mixed Logit model and the Latent class models are derived from the standard multinomial logit model, allowing the coefficients to vary between the respondents. The difference between the two models can be generally regarded as the coefficients varying across the individual or across the groups. In the Mixed Logit model, the functional form of mixing distribution varies across the individual, which allows the researcher to capture the unobserved heterogeneity among the decision makers (Hole, 2008). However, the latent class model assumes a discrete mixing distribution where the unobserved heterogeneity is not distributed across the individual, but rather across the groups whose behavior is considered to be homogeneous.

Traditional random parameter models require that an assumption is made for the functional form of the mixing distribution to capture the unobserved heterogeneity. The latent class models (also referred to as the finite mixing models) potentially overcome this limitation by identifying homogeneous subgroups of data where the distributional assumptions are not made. However, a conventional latent class model does not account for the

possibility of variation within the identified latent classes (homogeneous parameter effects are assumed within each class to simplify the model estimation). Researchers assume that the mixed logit model and the latent class models give similar results, however, the latent class model fails to account for the possible heterogeneity across groups by assuming that individual belonging to the latent group have a homogeneous behavior. The within-class fixed parameter assumption may not be valid since the number of the identified latent groups is small, which raises the possibility of not accounting for the residual heterogeneity within the group (Behnood & Mannering, 2016).

In latent class, unlike to the mixed logit model, heterogeneity is accounted in discrete form while modeling and is composed of number of classes (Greene & Hensher, 2003; Train, 2009). In other words, the individuals behavior on particular decision instance is divided into number of latent classes where individual belongs to a latent class, c , which is not revealed to the researcher. Moreover, the estimate consists of fixed number of classes with class specific parameter to the individual and set of probabilities. Individual i 's choice among J alternative at choice situation t given that individual i is in class c is the one with maximum utility, where the utility functions (Greene & Hensher, 2003) are

$$U_{jit|c} = \beta'_c x_{jit} + \varepsilon_{jit} \quad (4.5)$$

Where U_{jit} is utility of alternative j to the individual i in choice situation t . x_{jit} is the set of attributes, and ε_{jit} is the unobserved heterogeneity for

individual i and alternative j in choice situation t . Since the Latent class model is derived from the standard multinomial logit model, the choice probabilities within the class (Greene & Hensher, 2003) is given by,

$$Prob[y_{it} = j | class = c] = \frac{e^{\beta'_c x_{jit}}}{\sum_{j=1}^J e^{\beta'_c x_{jit}}} \quad (4.6)$$

The most notable part is, class specifying parameter is not present in the final class probabilities

$$Prob[class = c] = Q_{ic} = \frac{e^{\theta'_c z_i}}{\sum_{c=1}^C e^{\theta'_c z_i}}, \theta_c = 0 \quad (4.7)$$

Where z_i is an observable set of individuals with context invariant (Greene & Hensher, 2003; Train, 2009).

For a particular class, the probability of an individual being in a particular latent class is expressed as

$$P_{i|c} = \prod_{t=1}^T P_{it|c} \quad (4.8)$$

The probability of individual's specific choice is the expected value (over classes) of the class-specific probabilities. Thus,

$$\begin{aligned}
Prob(y_{it} = j) &= E_c \left[\frac{e^{\beta'_c x_{jit}}}{\sum_{j=1}^J e^{\beta'_c x_{jit}}} \right] \\
&= \sum_{c=1}^C Prob(class = c) \left[\frac{e^{\beta'_c x_{jit}}}{\sum_{j=1}^J e^{\beta'_c x_{jit}}} \right] \tag{4.9}
\end{aligned}$$

The log likelihood function to be maximized can be expressed as

$$lnL = \sum_{c=2}^C \ln \left[\frac{e^{\beta'_c x_{jit}}}{\sum_{j=1}^J e^{\beta'_c x_{jit}}} \times \prod_{t=2}^T P_{nt|c} \right] \tag{4.10}$$

There is a large array of literature which compares these two models while applying these models to different domains of empirical studies. They found that there is no unified performance showing one works better than the other, concluding that these models are entirely data dependent (Greene & Hensher, 2003). However, some literature argues that the selection of a model entirely depends on the researcher's contextual situation. For instance, if the researcher is interested in uncovering the effect of individual heterogeneity for identifying the decision maker's preference, the Mixed Logit model is preferred. Whereas if a researcher understands that the individual's behavior ultimately converges into homophile latent groups and identifying the heterogeneity of latent group is considered important, the Latent Class model is preferred.

4.3. Multiple discrete-continuous choice model

The discrete choice models are useful when the decision maker is supposed to be involved in single activity out of several available activities. In the case of the discrete choices, the decision maker tries to maximize the utility for a particular choice out of the available alternatives. This kind of choice situation can be useful for dealing with the various discrete choice methodologies if the choice alternatives are perfectly substitutable with each other. The analysis of single choice situations can be modeled using the single discrete choice methodologies. However, multiple discrete choice situations may be modeled through the Random Utility Model by making a combination of choices and treating them as a single choice (Bhat, 2008). In such a case, the new multiple choice alternative is the combination of all available single choice alternatives, which increases the complexity in computation and the associated alternative specific features would be lost during the process of computation. For instance, if the number of the available alternatives is four, the total alternatives allowing multiple discreteness would be 15 (selecting only one alternative at a time $C(4,1) = 4$; selecting two alternatives at a time $C(4,2) = 6$; selecting 3 alternatives at a time $C(4,3) = 4$ and selecting all alternative at a time $C(4,4) = 1$). If the number of alternative increases, the number of choice situations allowing multiple selections would also increase. Similarly, while making the combination of single alternatives to deal with the multiple discreteness, retaining the alternative specific features would be a serious endeavour. In such a case, the single discrete choice methodologies fail to capture all associated properties, leading to serious modeling issues.

The notion of multiple discreteness is to allow maximisation of utility by trading off the use of alternatives. On the other hand, the notion of selection of multiple discreteness is the unavailability of the perfect alternative for the esteemed purposes and all available alternatives are not perfect substitutes for each other. This makes the decision maker go for multiple choices and maximise the utility by making a trade-off of the utilities among the alternatives. Nevertheless, the estimation of utility tradeoff between alternatives while involving multiple discreteness situations is not possible, even allowing for a bundle of single alternatives.

The issues in modeling the multiple discrete choice scenarios incorporating the utility tradeoff between the alternatives are better addressed by the multiple discrete-continuous extreme value (MDCEV) model developed by (Bhat, 2005, 2008). The model assumes that the decision maker engages in multiple activities and maximises the utility under resource constraints. The maximisation of available resources is important to model real world activities by selecting a single or multiple choices at a time.

The multivariate probit and logit models may also be used to deal with the multiple discrete choices, nevertheless, these models are not based on the utility maximization while consuming multiple goods at a time and trading the utility between the alternatives under the budget constraints (Bhat, 2008). The major problem of these models is lack of ability to deal with the diminishing marginal returns between the alternatives (Bhat, 2005, 2008).

The MDCEV model is important for an accurate estimation of public-private interplay modeling because the local government agencies are likely to make the decision on public-private partnership for the public services and a continuous choice of budget flows for the advancement of the public services in partnership with the private sector or non-profit making agencies to jointly maximize the utility. For instance, the government may be involved in the development of the broadband network in partnership with a private company as it is one of the key infrastructures for the digital economy. At the same time, the partnership mechanism and provisions that ensure the implementation and successful operation of the broadband network may require a remarkable amount of resources from the public agencies. However, both parties set the business strategy for the optimal gain on the project conclude negotiation when each partner perceives that their C/B ratio is higher. In other words, the possible benefit from the project is higher than the cost to the public agencies and the profit to the private sector is higher than could be achieved by investing the same amount elsewhere. In that case, both parties may agree to collaborate to meet their objectives.

It is clearly important to know about the local government's willingness to initiate ICT projects that have a greater impact on the society. The smallest unit of independent administration is called municipality (or rural municipality) and the upper-level administration called state administration may have common interests and strategies for the development of ICT services and infrastructure. However, when the full authority has been transferred to the smallest local unit, service duplication can happen, which ultimately leads to investment duplication. Thus, in

order to streamline the investment and utilize the optimal resources to meet the common goal. partnering with a single and reliable private partner reduces the transaction cost more than independent and decentralized projects (Hallahan & Peha, 2011). Implementing a small project may cost more than implementing projects with similar objectives and a greater scope.

The current status of the of the aggregate demography of the dwellers depends on the probability to make the decision by the government. However, the weight may be less than that of the decision making authority. When a country has a higher democratic accountability, the government may clearly understand the voice of the people, which reflects the policy, and the steps that transform the policy into actions.

In single discrete choice settings, only one option out of the available alternatives, which are perfectly substitutable with each other, is chosen. However, the implementation of e-government projects often leads to multiple projects at a time, depending on the government's development strategy, requirements and the capability for simultaneously implementing the projects. In such cases, MDCEV is one of the candidate empirical models to analyze the multiple discreteness problems. The private participation in the public services reduces the burdens to the government in a number of aspects such as financial risk, market risk, and other associated risk. Apart from these risks, there is also a huge number of benefits such as the utilization of private capital, technological expertise, and managerial skills to deliver the government services, which increase the government's credibility and enhance the effectiveness of the public

services. Nevertheless, at a certain point, the government may stop partnering with the private sector for a particular project category or it may seek further possibilities in that project category. This shows that there exists a diminishing marginal return that is the satiation in having a partnership with the private company. This is the fundamental driving force that the government may have multiple partnerships with private companies by diversifying the number of the services and the sectors. In such cases, the standard discrete choice models are not equipped to handle such type of diminishing marginal returns from having multiple projects with private companies.

The MDCEV model is a powerful tool to analyze consumer behavior when a decision maker encounters a multiple discreteness choice situation (Bhat, 2005, 2008). In the single discrete choice models, the consumer preference of a particular choice alternative from a set of an available choice set is analyzed and the consumer makes a trade-off between the attributes of the alternatives. However, in multiple discrete choice cases, all available alternatives are not perfectly substitutable with each other Bhat (2005, 2008), so the consumer trades off the attributes and the consumption of the alternatives simultaneously. The MDCEV model is popular in the transportation field and has been widely applied research on household vehicle ownership and its mileage (Bhat & Sen, 2006)

Considering the functional form of the translated constant elasticity substitution function for the utility function (Bhat, 2008), and considering if the government agency chooses J project alternatives among the K available project alternatives and allocates an amount of e_j for alternative

j , the government agency's i 's utility for allocating the budget can be expressed as

$$U_i(e_1, \dots, e_j, 0, \dots, 0) = \sum_{j=1}^K \psi(x_j)(e_j + \gamma)^{\alpha_j} \quad (4.11)$$

In the above equation, $\psi(x_j)$ represents the baseline utility received from choosing the j th alternative. In this model, the government agencies are assumed to allocate the e_j amount for the j th alternative by optimizing their utility under the budget constraints. The parameter represents a translation parameter, which determines the existence of a corner solution or interior solution. If $\gamma = 0$, then there exist an interior solution which means the government agency expenses to all available alternatives with a certain amount by optimizing the overall utility under the budget constraints. However, if $\gamma \neq 0$, then there exists a corner solution which means the agency does not allocate budget to at least one alternative ((Bhat, 2005, 2008). The next parameter α_j represents the degree of diminishing marginal utility, also called the satiation parameter. Both γ and α parameters have the same meaning in the utility function which can lead to identification problems during the estimation process (Bhat, 2008). Thus, the easy way to resolve the identification problem is to fix either of the parameter to a constant.

The baseline utility $\psi(x_j)$, which takes the random utility form and is always positive (Bhat, 2005, 2008), is expressed as

$$\psi(x_j, \varepsilon_j) = \psi(x_j)e^{\varepsilon_j} = \exp(\beta'x_j + \varepsilon_j) \quad (4.12)$$

x_j is a set of attributes characterizing the alternative and the decision makers whereas ε_j captures the unobserved component of the utility that affects the baseline utility for alternative.

Therefore, equation (4.11), designed to calculate utility, can be alternatively (Bhat, 2005, 2008) expressed as

$$U = \sum_{j=1}^K [\exp(\beta' x_j + \varepsilon_j)] (e_j + \gamma)^{\alpha_j} \quad (4.13)$$

The budget constraint restricts the use of few alternatives that the government agency selects and is incorporated into the model by

$$\sum_{j=1}^K e_j = E \quad (4.14)$$

The utility function is given in equation (4.13) and with the Constraint (4.14) can be solved using the Lagrangian multiplier and the Kuhn-Tucker condition (Bhat, 2005, 2008),

The optimal expenditure for a particular alternative can be calculated by forming a Lagrangian multiplier and applying a Kuhn-Tucker condition for the optimization objective function under constraints (Bhat, 2008)

$$\mathcal{L} = \sum_k \frac{\gamma_k}{\alpha_k} [\exp(\beta' z_k + \varepsilon_k)] \left\{ \left(\frac{e_k}{\gamma_k p_k} + 1 \right)^{\alpha_k} - 1 \right\} - \lambda \left[\sum_{k=1}^K e_k - E \right] \quad (4.15)$$

Where λ is the Lagrangian multiplier associated with the expenditure constraint. The optimal expenditure allocations are given by

$$\left[\frac{\exp(\beta' z_k + \varepsilon_k)}{p_k} \right] \left(\frac{e_k^*}{\gamma_k p_k} + 1 \right)^{\alpha_k - 1} - \lambda = 0, \text{ if } e_k^* > 0, k = 1, 2, \dots, K$$

$$\left[\frac{\exp(\beta' z_k + \varepsilon_k)}{p_k} \right] \left(\frac{e_k^*}{\gamma_k p_k} + 1 \right)^{\alpha_k - 1} - \lambda < 0 \text{ if } e_k^* = 0, k = 1, 2, \dots, K \quad (4.16)$$

The optimal demand satisfies the above condition and the budget constraints $\sum_{k=1}^K e_k^* = E$. Solving the above equation for the first good and λ leads to (Bhat, 2005, 2008)

$$\lambda = \frac{\exp(\beta' z_1 + \varepsilon_1)}{p_1} \left(\frac{e_1^*}{\gamma_1 p_1} + 1 \right)^{\alpha_1 - 1} \quad (4.17)$$

By substituting the value in Equation (4.16) and taking the logarithm

$$V_k + \varepsilon_k = V_1 + \varepsilon_1 \text{ if } e_k^* > 0 \quad (k = 2, 3, \dots, K)$$

$$V_k + \varepsilon_k < V_1 + \varepsilon_1 \text{ if } e_k^* = 0 \quad (k = 2, 3, \dots, K) \text{ where}$$

$$V_k = \beta' z_k + (\alpha_k - 1) \ln \left(\frac{e_k^*}{\gamma_k p_k} + 1 \right) - \ln p_k \quad (k = 1, 2, 3, \dots, K) \quad (4.18)$$

The probability that the individual allocates the budget to (Bhat, 2005, 2008) is given by

$$P(e_1^*, e_2^*, \dots, e_M^*, 0, \dots, 0) = |J| \int_{\varepsilon_1 = -\infty}^{\varepsilon_1 = +\infty} \left\{ \left(\prod_{i=2}^M \frac{1}{\sigma} \lambda \left[\frac{V_1 - V_i + \varepsilon_1}{\sigma} \right] \right) \right\} \times \\ \left\{ \prod_{s=M+1}^K \Lambda \left[\frac{V_1 - V_s + \varepsilon_1}{\sigma} \right] \right\} \frac{1}{\sigma} \lambda \left(\frac{\varepsilon_1}{\sigma} \right) d\varepsilon_1 \quad (4.19)$$

$$|J| = \left(\prod_{i=1}^M c_i \right) \left(\sum_{i=1}^M \frac{1}{c_i} \right) \text{ where } c_i = \frac{1-\alpha_i}{e^* + \gamma_i p_i}$$

The probability that the individual allocates the budget to (Bhat, 2005, 2008) is given by

$$P(e_1^*, e_2^*, \dots, e_M^*, 0, \dots, 0) = \frac{1}{\sigma^{M-1}} \left(\prod_{i=1}^M c_i \right) \left(\sum_{i=1}^M \frac{1}{c_i} \right) \left[\frac{\prod_{i=1}^M e^{\frac{V_i}{\sigma}}}{\left(\sum_{k=1}^K e^{\frac{V_k}{\sigma}} \right)^M} \right] (M-1)! \quad (4.20)$$

$$V_k = \beta' z_k + (\alpha_k - 1) \ln \left(\frac{e^*}{p_k} + 1 \right) - \ln p_k \quad (k = 1, 2, 3, \dots, K) \quad (4.21a)$$

when an α –profile is used and

$$V_k = \beta' z_k - (\alpha_k - 1) \ln \left(\frac{e^*}{\gamma_k p_k} + 1 \right) - \ln p_k \quad (k = 1, 2, 3, \dots, K) \quad (4.21b)$$

when a γ –profile is used

The MDCEV model neglects the potential interdependence among the alternative, assuming that the stochastic components in the error terms are independently distributed (Pinjari, 2011). This is unlikely in the case of the simultaneous development of the ICT infrastructure. Since ICT infrastructure is interdependent with each other, the maturity of any of the ICT infrastructure or services demands other ICT infrastructure or services. Thus, in order to incorporate the interdependence of the ICT infrastructure

and the government agencies' strategy to implement a robust ICT system, the random taste variation among the alternatives Mixed MDCEV model fits better by incorporating the taste variations among the alternatives.

In order to incorporate the random taste variation among the alternative and the attributes of the alternative, it is assumed that the error component ε_k is further divided into the two component, say ζ_k and η_k . The first component ζ_k can be assumed to be independently identically distributed following a Gumbel distribution across the alternatives with the scale parameter of σ . The second component η_k is correlated across the alternative with a heteroscedastic scale and follows the multivariate normal distribution $\eta \sim N(0, \Omega)$.

The unconditional probability for an optimal budget for the first M of the k goods (Bhat, 2008) are given by

$$P(e_1^*, e_2^*, \dots, e_M^*, 0, 0, \dots, 0) = \int_{\eta} \frac{1}{\sigma^{M-1}} \left[\prod_{i=1}^M c_i \right] \left[\sum_{i=1}^M \frac{1}{c_i} \right] \left[\frac{\left(\prod_{i=1}^M e^{\frac{V_i + \eta_i}{\sigma}} \right)}{\left(\sum_{i=1}^M e^{\frac{V_k + \eta_k}{\sigma}} \right)^M} \right] (M-1)! dF(\eta) \quad (4.22)$$

where F is the multivariate cumulative normal distribution (Bhat, 2005, 2008; Bhat & Sen, 2006)

The Lagrangian function for optimal expenditure allocation is given as

$$\mathcal{L} = \sum_k \frac{\gamma_k}{\alpha_k} [\exp(\beta' z_k + \varepsilon_k)] \left\{ \left(\frac{e_k}{\gamma_k p_k} + 1 \right)^{\alpha_k} - 1 \right\} - \lambda \left[\sum_{k=1}^K e_k = E \right] \quad (4.23)$$

where λ is the Lagrangian multiplier associated with the expenditure constraints (that is, it can be viewed as the marginal utility of the total expenditure or income). The KR first order conditions for the optimal expenditure allocations (the e_k^* values) to (Bhat, 2008) are given by

$$\left[\frac{\text{Exp}(\beta' z_k + \varepsilon_k)}{p_k} \right] \left(\frac{e_k^*}{\gamma_k p_k} + 1 \right)^{\alpha_k - 1} - \lambda = 0, \text{ if } e_k^* > 0, k = 1, 2, \dots, K \quad (4.24)$$

$$\left[\frac{\text{exp}(\beta' z_k + \varepsilon_k)}{p_k} \right] \left(\frac{e_k^*}{\gamma_k p_k} + 1 \right)^{\alpha_k - 1} - \lambda < 0, \text{ if } e_k^* = 0, k = 1, 2, \dots, K$$

The optimal demand satisfies the condition in equation (4.24) and the budget constraints $\sum_{k=1}^K e_k^* = E$. It is noted that only $K - 1$ values of optimal budget e_k^* need to be estimated, since the amount of budget for one project is automatically determined from the amount of budget expended from other projects.

The gamma parameter is reparametrized as $\gamma' = \exp(\gamma)$ and entered into the model to force to attain the corner solution in the model. After reparametrizing the gamma to a simple exponential function, it resulted in the statistically significant value in the estimation.

The private participation in the public services reduces the burden to the government in a number of aspects such as financial risk, market risk, and other associated risks. In addition to these risks, there is also a huge number of benefits such as the utilization of private capital, technological expertise,

and managerial skills to deliver government services. This increases the government's credibility and enhances the effectiveness of the public services. Nevertheless, at a certain point, the government might stop partnering with the private sector for a particular project category or it may seek further possibility on that project category. Which means there exist diminishing marginal returns that is the satiation in having a partnership with the private company. This is the fundamental driving force for the government to have multiple partnerships with private companies by diversifying the services and the sectors. In such cases, the standard discrete choice models are not equipped to handle such type of diminishing marginal returns from having multiple projects with the private companies.

I have briefly summarized the empirical methodology used in this study. Figure 4 presents the summary of the overall methodological framework for this study.

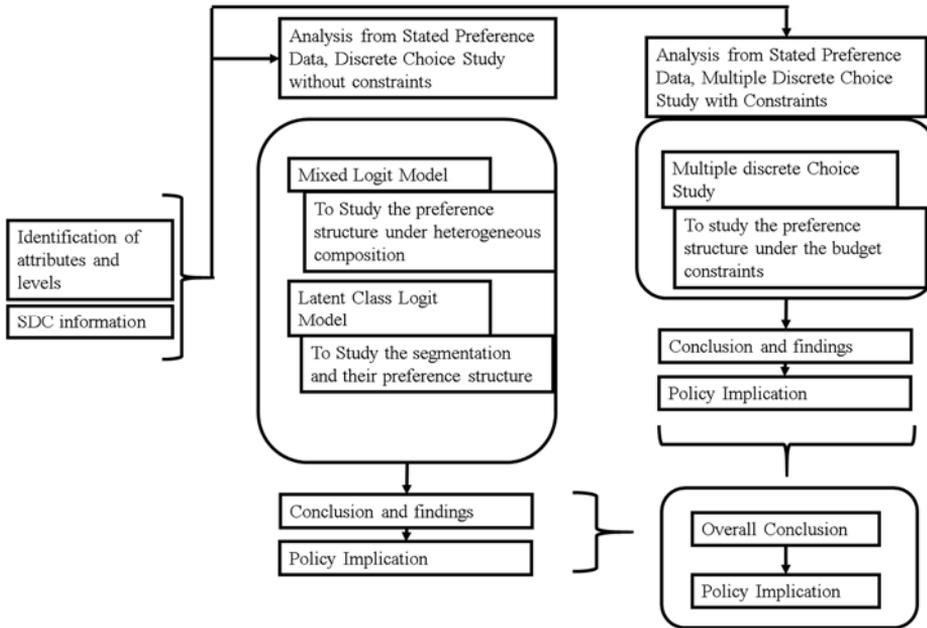


Figure 4 Overall Methodological framework of the study

Chapter 5 Experimental design and estimation results

This study uses discrete choice to model the decision makers' perceived utility using the stated preference data. The major part of the discrete choice analysis using the stated preference data involves the experimental design using the relevant attributes and their levels. I have used the orthogonal experiment and grouped those orthogonally designed choice profiles to create the choice set.

5.1. Survey design and data collection

5.1.1. Conjoint experiment design

Conjoint analysis is a widely applied tool in market research for measuring the consumers' behavior towards a product, brand, and its features (Ben-Akiva, McFadden, & Train, 2015; Green & Srinivasan, 1990; Louviere, Flynn, & Carson, 2010). It is widely applied in marketing research to judge the utility level of a product or service separately or in a combination with the attributes attached to the product or service (Johnson et al., 2013; Vermeulen, Goos, & Vandebroek, 2011). In the conjoint analysis, the researcher is focused on getting answer on the "importance of features", "share of product brand", "price sensitivity of the product and the features included in the product" to assist the design of new products and services according to the market's demand. This allows to identify consumer preferences over the product or services attributes of the product, which helps to translate consumer preferences into price sensitivity by estimating

the willingness-to-pay (WTP) (Chen & Thurmaier, 2008; Hensher, Shore, & Train, 2014). “The result of the experiment has been used to calculate a measure of welfare or more specifically willingness to pay for a product and programs and their marginal willingness to pay for the attributes that make up such product and programs” (Lancsar & Savage, 2004, pp 901). The conjoint analysis is done using a number of underpinning theoretical backgrounds to understand and explain consumer behavior (Louviere et al., 2010). This method is widely adopted for the analysis of marketed and non-marketed (such as environment¹³ (Adamowicz, Boxall, Williams, & Louviere, 1998)) (Andreopoulos, Damigos, Comiti, & Fischer, 2015; Johnson et al., 2013) research based on the utility theory.

To get those answers, real-life product scenario, however, hypothetical choice sets were presented to the respondents (Ben-Akiva et al., 2015). There are several ways to conduct the conjoint analysis. Among the several conjoint methods; the choice based discrete choice experiment is one of the most promising approaches that can provide deeper and broader information on the revealed data. In the stated preference experiments, the researcher can include all aspects¹⁴ of the decision maker in the study

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¹⁴ Probably during the analysis/ estimation process, the weightage factor can be used to account for the decision makers’ weightage for implementing the project. A higher weightage may be given to a key person whose decision plays a vital role. Lower decision weightage can be given to other respondents who are directly involved in the decision making process but have less decisive power than the key person. Any decision of the

sample so that the intrinsic as well as extrinsic phenomena during the project implementation can be properly addressed in the estimation result by applying the various behavioral models.

The choice scenario is presented in such a way that each choice profile includes important features considering all other features that are not included in the choice profile are the same as the presented choice scenario. When designing the choice profiles, the most important attributes are included with their appropriate level. The choice profiles generated through the choice experiment are then grouped in a way that ensures the optimality criterion for the optimal design (Vermeulen et al., 2011). In such a case, the decision maker chooses the choice profile that provides the highest level of utility among the presented alternatives. The basic idea about selecting the choice profile is that the decision maker makes a tradeoff between the various attributes. For instance, if the decision maker likes only a certain color then he/she may compromise other attributes to obtain a particular product that has the preferred color. Similarly, if two or more than two products have the same color that is preferred by the decision maker, then he/she may take other attributes into account when making a tradeoff between the comparable attributes of the product.

government is on behalf of the citizens and the government elucidated decision may be subjected to the public criticism.

In this study, I have used the choice-based full profile conjoint analysis¹⁵. The choice profiles are generated using factorial design. When including all the factorial designs, the resulting number of choice profiles would be very large and getting responses from the large set of choice profiles is extremely difficult. In order to reduce the number of choice profiles while at the same time retaining all properties of the choice profiles, I have used the orthogonal design approach. The orthogonal design is an approach that includes all possible combination of the choice profiles where the estimation of the part-worth utility from the profiles retains the main effect as if all profiles were included during the analysis. However, it is true that as the number of the choice profiles increases, the estimation result also improves. Nevertheless, it is very difficult to obtain responses when the number of the choice profiles increases and also the quality of the responses deteriorates if the number of choice profiles increases.

In a Full Profile conjoint analysis, all possible combinations of the alternatives are presented to the decision maker, and the decision maker selects the appropriate choice profiles that give the highest level of utility among the available alternatives. Decision makers need to compare all

¹⁵ In the full profile conjoint analysis, the choice profiles are presented with a full set of attributes to the respondents who are asked to select the most preferred choice alternatives (in this study respondents are asked to rank the choice profiles from most preferred to least preferred). Moreover, the respondents are asked to put 1 if the choice profile is most preferred and 5 if it is least preferred in that particular choice set (one choice set contains five project profiles).

choice profiles and their associated attributes against each other to find the optimal level of perceived utility from the available choice alternatives. Thus, to avoid this difficulty, a series of choice set are presented to the decision maker, assuming that the choice sets are not related to each other. This repeated choice scenario is one of the best ways to aggregate the choice preference of the respondent.

In this study, I have used the choice based conjoint analysis to collect the intended information from the respondents. There is a very limited number of ICT infrastructures and services implemented through the PPP mechanism to analyze the government preferences to implement through the PPP mechanism. Previously, the local government did not have the right to decide on any project in either the form of the traditional procurement approach or through the PPP mechanism. Rather, the central government decided to assess the need for projects and the preferred procurement method. However, after the promulgation of the new constitution and the enactment of several laws, the local government has the exclusive right to decide on projects and assessing their need. Thus, this study aims to identify the local governments' preferences to implementing ICT projects through the PPP mechanism, which necessitates the use of the stated preference survey. Therefore, the stated preference survey is used for the collection of the data. The survey questionnaire consists of three parts. The first part is a conjoint survey, the second part consists of general questions regarding ICT projects and the perception towards ICT projects if implemented through the PPP mechanism. The third part is related to the demography of the respondents. For the conjoint survey, I have used the set of attributes that defines the

characteristics of PPP projects. Five key projects were selected based on the assumptions explained in the previous section, which were also considered as the attributes of the projects. However, when grouping the choice profiles, I assumed that each choice set must contain different projects so that the respondents identify their implementation strategy depending on their requirements.

5.1.2. Attributes and levels

Identifying the relevant attributes in the choice experiment for the discrete choice analysis is the most important part, and is the first step of the study. After a rigorous literature survey, I have identified the attributes and their appropriate levels. The attributes for this study are selected in such a way to identify the significance and have no meaning closely related with each other, which is crucial to reduce the individuals' false interpretation of utility among the provided alternative in a choice scenario (Hensher, Rose, & Greene, 2005; Louviere et al., 2010).

This is the first study to conduct a choice experiment for modeling the demand of PPP projects. The literature available on PPP hardly explains the relevancy of certain PPP attributes (features), rather it focused on designing the concession period (Carbonara et al., 2014a; Zhang, 2011), analyzing the perceived level of risk during PPP arrangements (Chung & Hensher, 2015), influence of participation of domestic as well as international partners, number of private partners (Hammami et al., 2006), partnership type, market sharing strategy between public and project company (Carbonara et al., 2014b; Mota & Moreira, 2015), or subsidy.

The role of the private partner is very important for the success of PPP projects (Hammami et al., 2006; Margetts, 2006). While selecting the private partners, the government may have different approaches such as consideration of competition, innovation, cost (Margetts, 2006), or domestic preferences (Hang, 2009). Thus, in order to identify those different preferences, I have used two types of private companies to identify whether the Nepalese government has a domestic preferential treatment while selecting the project partners for ICT projects through the PPP mechanism.

In any project, the internal rate of return plays an important role in deciding whether the project is profitable or not. However, IRR is used basically to compare the most profitable project among a number of project alternatives. The rate of return provision for public services is widely used in projects associated with features such as network services, public goods, having externalities and natural monopolies (Grimsey & Lewis, 2002). While implementing ICT projects through the PPP, the economic valuation is considered beforehand to effectively address the value of money for both partnering parties (Coulson, 2008). The most commonly used valuation method is the internal rate of return (IRR) of the project, which is an alternative way of using the net present value (NPV) of the project (Bonnafoos & Jensen, 2005). The IRR is more suitable because of its ability to account for the value for money when discounting factors are included and has more flexibility to account for capital, inflation, taxes and associated financial risk. However, Milis and Mercken (2004) argue that it is not the proper method that can account for tangible as well as intangible economic benefits when investments are made in a complex system such

as ICT and when the selections are made under the mutually exclusive condition. Since this study intends to identify the government's priority to implement ICT infrastructure and/or services, the economic valuation method using IRR approach is not mutually exclusive per se. Because the government may be interested to implement multiple projects through the PPP mechanism, the decision for executing any project might not affect the decision for implementing other ICT projects through the PPP mechanism. The notion to use IRR in this study is that it is simple to approximate the financial performance either contracting party and it is deemed suitable for multi-year investment projects such as ICT (as ICT is a short life-cycle technology, it requires multi-year investments). Another reason behind selecting the IRR approach for accounting the economic valuation is that ICT technology and ICT-based applications possess greater hidden challenges (such as security threats or technology updates which are unknown to most of the technology adopters) than another economic valuation methods such as NPV (Jerman-Blažič, 2008). Thus, this study uses the traditional approach to incorporate/attract the private sector for the development of public ICT projects accounting for the prospective financial performance and reward criteria which are instrumental decision criteria for the ex-ante project evaluation (Hynek, Janeček, Lefley, Půžová, & Němeček, 2014).

The use of IRR has assumed that it covers the private sectors expectation of market interest rates, risk premiums accounting for the uncertainties of cost, revenue and the profit margins (Bonnafous & Jensen, 2005). Similarly, from the public sector's point of view, the IRR of the project is equivalent to the NPV accounting with the sustainability of the project.

Thus, if the IRR is not sufficient to cover the return of investment, the government may need to bear the additional financial burden and support the project through different incentive mechanisms such as minimum revenue guarantees or subsidies to the private sector to ensure the return on the equity even though government has a significant equity share with the private consortium (Grimsey & Lewis, 2002).

Generally, the public sector provides the legitimacy to operate the infrastructure, however, PPP projects are not always profitable without getting support from the government. In such cases, the public sector may use the revenue guarantee mechanism to attract the private sector even though the forecasted revenue is not sufficient to guarantee a return on the investment (Grimsey & Lewis, 2002). In order to implement successful projects, the involved parties should consider whether the revenue streams can cover the operating cost and service debt finance as well as provide returns to risk capital. Thus, I have used three cases of revenue generation mechanisms, which are widely practiced in PPP projects. With the wide provision of ICT policy as well as PPP policy, the government (especially local governments) can utilize the private sector to reduce the debt burden by sharing the financial risk and incentives with the private sector (Grimsey & Lewis, 2002).

PPP projects are viable and reliable if they have a long-term revenue stream (Grimsey & Lewis, 2002). In such a case, the public sector's risk sharing mechanism is important. However, special attention should be taken while considering risk sharing mechanisms as they might open the door for opportunistic behavior of either party. Grimsey and Lewis (2002)

argue that providing financing or financial guaranties has a higher risk than transferring or retaining the risk by the public sector.

ICT projects can be accomplished in three operation modalities when private sector participates in the public ICT projects. A study by Lattemann et al. (2009) elaborated on the different funding models practiced in PPP as “Operator Model”, “Concession Model”, and “Cooperation Model”. The guiding principle for these collaboration models is directly linked to the risk sharing mechanism (Hodge & Greve, 2007). Employing the PPP mechanism aims at using private sector resources such as finance and managerial and technical capability to enhance public infrastructure with the goal to reduce the government budgetary pressures on infrastructure development. Incorporating the private sector in public services provides the value for money through appropriate incentive sharing mechanisms (Hodge & Greve, 2007). The collaboration model, particularly the project financing model, has been widely studied as the nexus between project failures (Morten Falch & Henten, 2008; Iossa & Martimort, 2015; Nucciarelli et al., 2010; Sadowski et al., 2009). Thus, different collaboration model such as joint ventures, private funding, and public funding of the PPP mechanism are being debated. However, this study does not deal with any particular collaboration approach for the success of the PPP mechanism. Rather it presents alternative approaches to the government for the possible PPP mechanism to be used in ICT projects.

In the PPP mechanism, the operation period or concession period is one of the most important attributes. The operation period is often linked with the return on investment. For PPP projects such as in the transport sector or

energy sector, the operation period is longer than for the ICT sector. The private sector primarily focuses on the return of investment and on drawing a greater profit and thus prefers longer operation periods. However, a shorter operation period is preferred by the public sector, because longer operation periods are associated with a greater risk to the public sector (Shen, Bao, Wu, & Lu, 2007). In many ICT sector projects, particularly, in telecommunication projects, a short period is granted and after the successful completion of the granted period, both parties may extend the operation period. The extension or renewal of operation period is often accomplished by renewing a license or granting a license through new provisions considering technology updates and service requirements.

Thus, after a rigorous literature survey factors widely discussed as key for the success of PPP are taken to serve as the key attributes for this study.

Table 2 Attributes and its levels

Attribute	Attribute Level	Remarks
Candidate Project	Broadband, utility electronic building permit system, digitization	Elearning, management, Digitization (Base) 1: Broadband 0: otherwise (other follows similarly)
Origin of Private Company	Domestic Company International Company	0: Domestic Company 1: International company

Revenue Generation Mechanism	End user Payment	1: end user payment
	End user Payment with MRG	0: end user payment with MRG
	Government Pay	Government Payment (Base)
Partnership mechanism (Financial Risk sharing)	Joint Venture	1: Joint Venture
	Public Funding	0: Public Funding
	Private Funding	Private Funding (Base)
Internal Rate of Return	5%, 8%, 11%, 15%	IRR in %
Operation year	7 years, 10 years, 15 years	Operation years

After identifying the attributes and their level, I have generated the orthogonal choice profiles. The sample orthogonal choice profiles generated are shown in Table 3.

Table 3 Sample Choice profiles generated from Orthogonal Design

Card ID	projects	Origin of Partner company	Revenue generation mechanism	Partnership Type	IRR	Operation Year
1	Broadband	International	Enduser	JointVenture	11%	10 Year
2	Broadband	Domestic	Government Pay	JointVenture	15%	7 Year
3	e-learning	International	Enduser	PublicFunding	5%	7 Year
4	Broadband	International	EnduserMRG	PublicFunding	11%	7 Year

5	Umgt	Domestic	Enduser	PrivateFunding	5%	10 Year
6	Digitization	International	Government Pay	JointVenture	11%	15 Year
7	Broadband	Domestic	EnduserMRG	JointVenture	5%	15 Year
8	eBPS	Domestic	Government Pay	PublicFunding	15%	7 Year
9	eBPS	International	Enduser	JointVenture	8%	10 Year
10	eBPS	Domestic	Government Pay	PublicFunding	5%	10 Year

The sample choice set presented to the respondents is given in Figure 5.

	Broadband Internet (C1)	E-learning (C2)	Utility Management and payment (C3)	e-BPS (C4)	Digitization and publishing (C5)
Partner company	Domestic	International	Domestic	Domestic	Domestic
Revenue Generation	Enduser	Enduser	Government Pay	Enduser with MRG	Enduser with MRG
Partnership Type	Private Funding	Public Funding	Public Funding	Joint Venture	Public Funding
Internal Rate of Return	11%	5%	11%	15%	11%
Operation Year	7 Year	10 Year	7 Year	10 Year	10 Year
Your Preference (1)					
Max budget can be allocated (2)					

*kindly rank the project in (1) and put the budget you want to allocate in (2) if your government really want to implement the project.

Figure 5 Sample Choice Set used for conjoint survey

5.1.3. Data collection

I performed a purposive sampling of respondents. The respondents were identified from the basic assumption of a probable candidate who plays an instrumental role in making the decision to execute a project. The basic

assumption was that the respondents should be government officers or elected personnel (mayors, vice mayors and ward¹⁶ presidents). The survey responses were collected between September and early November of 2017 from a trained enumerator. The trained enumerator made individual face-to-face meetings with the respondents and took enough time to properly explain the questionnaire before noting the responses. Before conducting the final survey, a pilot survey was conducted through email. In the pilot survey, 24 valid responses were received from more than 200 survey requests. Since the pilot survey questionnaire was sent to personally known members of the government, in addition to the survey responses, comments regarding the survey questionnaire were received. Most of the comments from the respondents during the pilot survey were related to difficulties in filling out the response without an enumerator. The responses received from the pilot survey were analyzed and the survey questionnaire underwent a few revision including attribute modification/redefinition and regenerating the conjoint profiles.

In the final survey, a trained enumerator explained the purpose of the survey and explained how to fill the survey responses based on a hypothetical ICT project as an example relevant to the government agency of the respondents. In the conjoint survey, two types of questions were asked in a choice set. The first question was to rank the alternative projects based on the attractiveness considering whether the respondent's

¹⁶ A ward is the smallest unit under the local government. In a local government (municipality/rural municipality) the ward president is the third highest position after mayor and vice mayor elected through the popular votes for the municipality council.

organization can implement any of the project alternatives and with the example choice set. Respondents were then asked to rank the perceived attractiveness of the project. The second type of response was more difficult than the previous one. For the second type of response, respondents were asked to select the project as if his/her organization really wanted to implement the project in the next five years. They were further asked to name the tentative amount of budget that they can spend (either in the form of a subsidy, import tax exemption, lump-sum funding, providing government facilities such as land and converting it into a monetary value at current market prices) on the project. While making the second response, respondents were asked to identify the tentative budget if they wanted to implement multiple projects in the next five years through the PPP mechanism.

In the next part of the questionnaire, respondents were asked to assume that they have 20 alternative projects (five projects in one choice card and four choice cards). Further, they were asked to pick five preferred alternatives to construct a new choice set if they wanted to implement those projects in the next five years. The final response to this newly constructed choice set by the respondents is ranking them from most preferred to least preferred and identifying the tentative budget amount for those selected projects.

In the first case of a conjoint response, the assumption was that the organization will implement the project in the next five year through the PPP mechanism if the respondent put the budget on any choice alternative in a choice set. In a conjoint response, I found that most of the respondents

have assigned a budget to at least one project and very few respondents assigned a budget to all projects in a choice set.

Since the construction of the new choice set by the respondents was very tedious and time-consuming, almost half of the respondents did not complete the choice set. Those who made the choice set by themselves either named only a few projects (less than five) or did not add the budget.

The second part of the questionnaire was related to institutional information such as the respondents' affiliation and their perception about what makes PPP projects successful, particularly focusing on ICT projects. The third part of the questionnaire focused on information related to the respondent.

5.2. Descriptive statistics

In order to understand the overall picture of the research outcome, it is essential to know about the sources of data. This study employs the stated preference response because of the nature of the study to understand the public agencies' preference towards the implementation of ICT infrastructure and services through the PPP mechanism. However, the ex-post analysis is also possible for analyzing the preference structure of the government agency for the study. Nevertheless, because of the unavailability of historical cases, this study uses the stated preference data.

For collecting the responses, the characteristics of the respondent play a crucial role. After a rigorous review of the existing literature, a focus group discussion, and case analysis, I have identified the target response group

as the government officials and elected people who are key for assessing the need for ICT infrastructure and service projects and making the decision on the appropriate procurement method to accomplish such infrastructure and services.

Table 4 presents the basic outline of the sample and how the responses were collected for this study. Before conducting the final survey, more than 200 survey questionnaires were distributed through email to government officials and elected personnel. However, only 24 responses were received, even after several reminders via email. In the final survey, an individual interview was conducted with the respondents by a trained survey enumerator. The survey responses and the comments received during the first phase of the survey were properly addressed in the final survey. The purposive and selective sample was taken based on the criteria that respondent should be government officers (at least section officers or equivalent) and/or elected personnel (based on the recently held local elections). I have tried my best to balance responses from rural municipalities, municipalities, and metropolitan-level cities as well as government officers and elected personal. However, I have purposefully only included mayors, vice mayors and ward presidents from the elected response sample because of the possible biases from including responses of people who do not hold significant decision powers.

In the data analysis for this study, I have only used the responses received from the final survey. In the final survey, 80 percent of the respondent have at least one-year prior work experience in government. This is very important as it ensures that respondents are at least aware of the limitations

for the implementation of ICT projects in general, and ICT projects through the PPP mechanism in particular.

Table 4 Study Sample Information

Target sample	Government employee and elected personnel (Mayor, Vice Mayor, and Ward President)
Data Collection Period	September –November 2017
Sample Size	88
Method used to collect data	Individual training by trained enumerator before response; Individual meeting with respondents
Prior experience in Government	0* to 45 year

The characteristics of the respondents’ demography are presented in Table 5. 50% of the respondent themselves assumed that the current market size for any ICT services subscription (if offered by the government) is in between 2000 to 5000 and 32.9% of the respondents assumed that the immediate service market would be larger than 10000. Understanding the self-disclosing market size is very important for the PPP contract negotiations. Several researchers agree that both the private sector and the public agencies forecast the market prior to any project negotiations. Though the numbers are similar, they depict a vivid picture from the perspective market size and the additional resources to cover the target

population. Table 5 **Error! Reference source not found.** summarizes the relation between the self-disclosed current market size and the urban population through cross-tabulation. The table shows that 27% of the respondents believe that 2000 to 5000 people may subscribe the ICT services where the urbanization rate is only 20 to 40%. It shows that the respondents are very optimistic (probably overly so) about the market size for prospective service subscriptions, which might lead to unsustainable projects. The overestimation of the market size by the public agency is known from other PPP cases, regardless of how seriously the prospective market had been assessed. Several researchers identified this wrong estimation of the market as a major reason for subsequent project failure.

Table 5 Synopsis of respondents and study sample characteristics

Characteristics of respondent (Sample Size 88)			
Current market size		Urban Population	
less than 2000	2(2.3%)	less than 20%	19(23.7%)
2000 to 5000	44(50%)	20% to 40%	35(43.7%)
5000 to 10000	13(14.7%)	40% to 60%	17(21.3%)
above 10000	29(32.9%)	60% above	9(11.3%)
Formal Education level of respondent		Type of Government	
		Central	
Middle School	6	Government	48
High School	23	Local Government	35
		Provincial	
Undergraduate Level	36	government	5
Graduate Level	23		

Willingness to collaborate other agency		Prior PPP experience of respondents	
Willing to collaborate	27	Experience in PPP	24
Conditional	59	No Experience	64
Respondent background		Experience in Government	
Elected personnel	28	Less than 1 year	18
Bureaucracy (Regular)	60	1 to 5 year	26
		6 to 10 year	30
		More than 10 year	14

However, the government estimation of the market size might not be the actual market size for the prospective ICT services. It is true that there will not be any competitive services offered as alternative to the prospective services. Nevertheless, because of various reasons, end users might not immediately shift to using the electronic services.

Table 6 Cross Tabulation of self-disclosed market size and urban population

		Urban population				Total
		less than 20%	20% to 40%	40% to 60%	60% above	
Current market size	less than 2000	0(0%)	1(1%)	1(1%)	0(0%)	2
	2000 to 5000	16(18%)	24(27%)	3(3%)	1(1%)	44
	5000 to 10000	0(0%)	6(7%)	7(8%)	0(0%)	13

	above					
	10000	11(13%)	4(5%)	6(7%)	8(9%)	29
Total		27	35	17	9	88

Table 6 shows the cross-tabulation of respondent characteristics with respect to the respondents' prior experience in the government. The survey sample contains forty-one percent of respondents who already have at least 5 years of experience in the government as current bureaucrats. Whereas twenty percent of the respondent who are elected personnel do not have prior experience in the government. However, 11% of the respondents have at least one year experience in the government. The background of the elected officials might be political, having no prior government experience, or they might have previously worked for the government but resigned from their previous post to run in the election.

In the sample, the number of respondents from provincial governments is very low. The government of Nepal is in the process of implementing the newly promulgated constitution and the implementation of the constitution will be completed only after federal and provincial elections. After this, several institutions will be set up. However, very few government agencies were realized as provincial agencies. Thus, this sample contains a low number of respondents who are from the provincial governments.

Most government officials stated that they have prior familiarity with the e-government system. However, 11 percent of the respondents were completely unaware of the e-government services.

Table 7 Cross Tabulation with respect to respondent experience in government

		0-1 year	1-5 years	5-10 years	Above 10 years
Current			20(22.73	27(30.68	10(11.36
Responsibility in Government	Bureaucrat	3(3.41%)	%)	%)	%)
	Elected	18(20.45	3(3.41%)	3(3.41%)	4(4.55%)
Type of Government	Central Government	1(1.14%)	18(20.45	21(23.86	8(9.09%)
t from where respondent represent	Local Government	19(21.59	3(3.41%)	7(7.95%)	6(6.82%)
	Provincial government	1(1.14%)	2(2.27%)	2(2.27%)	0(0%)
Prior Familiarity with e-Govt	Yes	16(18.18	21(23.86	27(30.68	14(15.91
	No	5(5.68%)	2(2.27%)	3(3.41%)	0(0%)
Formal Education of Respondents	Middle School	2(2.27%)	0(0%)	3(3.41%)	1(1.14%)
	High School	14(15.91	4(4.55%)	1(1.14%)	4(4.55%)
	Undergraduate Level	%)	12(13.64	17(19.32	3(3.41%)
	Graduate Level	4(4.55%)	%)	9(10.23%	%)
		1(1.14%)	7(7.95%))	6(6.82%)

The respondents had different opinion on successfully concluding PPP projects. Thus it is even more important to map their understanding about what ensures PPP project success.

Table 8 Respondent Opinion profile for success of ICT projects through PPP mechanism

	1	2	3	4	5	mean	Std Err
Public Risk Capability	1	1	2	4	80	4.83	0.067
Private Risk Capability	1	2	4	13	68	4.648	0.082
Contract Adjustment	2	2	8	21	55	4.42	0.098
Govt Monitoring	0	4	4	19	61	4.557	0.084
Private Experience	1	1	10	38	38	4.261	0.085
Project Scope Not Limited	1	3	28	25	31	3.932	0.102
Consistent Govt Policy	2	4	29	20	33	3.886	0.111
Active Public Sector	4	2	16	28	38	4.068	0.113
Open standard Technology	1	11	22	21	33	3.841	0.118
supportive-Government	3	8	16	25	36	3.943	0.12
Multiple projects to Private							
Sector	15	10	22	20	21	3.25	0.148
Allow Similar Private	1	15	25	22	25	3.625	0.118
Higher level Intervention	0	8	12	21	47	4.216	0.107

5.3. Empirical models and estimation results

In Chapter 4, I have briefly discussed the modeling framework for this study. This section presents the estimation results, discussion, and implications of the results. This section is further divided into three subsections. Section 5.3.1 presents the government's perception towards incorporating the private sector to address the demand for ICT infrastructure and services. In this section, I assume that the decision makers are behaviorally different and their individual behavior affects the overall decision making in the government.

In Section 5.3.2, I assume that the decision makers in a government agency are from the interest group and that their behavior affects the decision-making process. The government is a complex system where different groups of people, such as expert groups, political personnel either elected through popular vote or politically appointed, and regular bureaucratic personnel, directly and indirectly participate in the policy-making and decision-making processes. Therefore, treating such heterogeneity across the individual decision-making procedures is unrealistic because while making the decision for executing a particular policy or making a procurement decision, all responsible personnel has to agree on certain points. Thus, for the further analysis, I treat these groups as being composed of n number segment, with their behavior for a particular agenda being similar. Thus, treating this heterogeneous composition as a group when modeling allows to draw better implications.

The last Section, 5.3.3, discusses how the government is prioritizing the development of ICT projects through the PPP mechanism under budget constraints. This section provides a rigorous explanation on the government budget deficit for the development of ICT projects through the PPP mechanism.

5.3.1. Study on the presence of heterogeneity in public agencies for implementing ICT projects through the PPP mechanism

As outlined earlier, this section assumes that all decision makers behave differently to the attributes and their levels. Under the random utility methodological framework, I have modeled the government utility function to implement the candidate ICT projects through the PPP mechanism.

$$U_{njit} = \beta_{IntlCpy}X_{IntlCpy} + \beta_{EndPay}X_{EndPay} + \beta_{EndPayMRG}X_{EndPayMRG} + \beta_{JointVen}X_{JointVen} + \beta_{PubFun}X_{PubFun} + \beta_{IRR}X_{IRR} + \beta_{OpYear}X_{OpYear} + \varepsilon_{njit} \quad (5.1)$$

In the above equation, $X_{IntlCpy}$ is a dummy variable to represent the presence of international company(s) in the PPP consortium. X_{EndPay} and $X_{EndPayMRG}$ are the dummy variables representing revenue generation mechanism during the operation of the project whereas government pay is considered as the reference variable to incorporate the revenue generation

mechanism in the model. $X_{JointVen}$ and X_{PubFun} are also dummy variables representing the collaboration method for the management as well as project financing, with private funding as the reference variable. The next variable X_{IRR} shows the financial attractiveness of the project. The last variable X_{OpYear} represents the operation years to be granted to the project company. The β_x are the associated estimators.

As mentioned earlier, the decision makers may have a different opinion based on their individual characteristics reflecting the difference in behavior. Thus, in order to understand the behavioral effect on decision making, it is important to incorporate the taste variation among the decision makers (Kim, Lee, & Koh, 2005; Lee, Kim, Lee, & Park, 2006; McFadden & Train, 2000; Revelt & Train, 2000; Train, 2009; Train & Sonnier, 2005). Thus, I have incorporated taste variation assuming that their behavior on a particular attribute follows a certain probabilistic distribution.

For the data, I have utilized the choice data received from the survey. The survey data consists of a ranking of all alternatives provided in the choice set. Nevertheless, for this analysis, I have utilized the first preferred choice alternative as the chosen alternative.

The explanation for assuming such a distribution is that there exists a wide range of perceptions towards the characteristics of PPP projects among the decision makers. For instance, the decision maker may think that an international project company is appropriate because it brings with it foreign investment, technology, and skills to the domestic industry, which

empowers the domestic industry as well as contributes to the national economy. However, there might be perception that domestic industry should be empowered by providing the opportunity, as there would be lower transaction costs when working with a domestic company. Thus, assuming a normal distribution for this attribute is a plausible assumption.

For the revenue generation mechanism, the assumption of the normal distribution can be explained from the perspective of the dilemma between transferring market risk to the private company and not transferring. In the first case, a strong preference for transferring market risk to the private company makes sense because it helps to avoid possible rent-seeking behavior from the private sector. Since 2000, the mobile subscription rate has skyrocketed even though it was new technology/service to the market. The internet penetration in the urban areas is also high, which is positive for a conducive market environment for the prospective ICT infrastructure and service market. However, there might be another type of decision maker which is skeptic on transferring market risk to the private sector in order to diffuse the ICT infrastructure and services faster into the market because of the existing digital divide regardless of the number of population living in the urban area and the low-income status of the end users. Several researchers agree that the diffusion of ICT services is affected by the income status of the end users and the existing digital divide. Thus, a normal distribution for the revenue generation mechanism is assumed. Similarly, for the partnership type, the normal distribution is assumed.

For the financial attractiveness of the project, IRR, normal distribution is assumed. Similarly, the normal distribution is assumed for the operation period to be granted to the project company. With the assumption that when the project has a longer operation period, particularly as ICT projects involve fastest advancing technology, the project company draws remarkably higher gains, thus lowering the social welfare. However, under the flexible contract negotiation approach or when a project is performing better, granting a longer project operation period can be justifiable. Zhang (2011) used the simulation approach to identify the distribution of the concession period and found that assuming a normal distribution performs better than assuming other distribution functions.

The estimation of the model presented earlier is performed using the Gauss 6.0 program. The estimation uses the Bayesian procedure with Gibbs sampling following the studies of (Kim et al., 2005; Lee et al., 2006; Shin, Woo, Huh, Lee, & Jeong, 2014; Train, 2009). While setting data for the estimation, for the revenue generation method, I have used the government payment option as the reference option. The private funding option is set as the reference. Whereas the partner company is the dummy variable and international company(ies) is set as 1 and the domestic company is 0.

Table 9 Estimation using Mixed Logit Model

Variable	Mean	Variance	RI
Intl Company	1.77(0.23)***	0.468(0.138)***	21.05%
End user Pay	-1.575(0.228)***	0.45(0.135)***	20.04%

End user Pay (MRG)	-2.04(0.172)***	0.346(0.088)***	15.21%
Joint Venture	-3.694(0.214)***	0.448(0.128)***	18.08%
Public Funding	-2.12(0.196)***	0.387(0.106)***	17.42%
IRR	0.151(0.043)***	0.102(0.016)***	4.48%
Operation Year	-0.129(0.045)***	0.105(0.017)***	3.74%

Note: *** represents the Significant level at 1% level respectively; standard error is presented in parenthesis.

Table 9 presents the estimation results using the mixed logit model. In the estimation results, utility management project is significant and positively contributes to the utility structure in reference to the digitization project. Other candidate projects are statistically insignificant, showing that the decision makers are indifference to implementing these projects through the PPP mechanism.

The estimation results show that the decision makers perceive positive utility ($\beta_{IntlCpy} = 1.77$) to selecting an international company as the partner private company. The estimation shows that the public agency perceives a positive utility towards the origin of the partner company if it is not a domestic one. This result is very insightful and shows how Nepalese government agencies are open to foreign companies as they provide foreign capital and also knowledge to empower the domestic industry. The respondents pay high attention to the attribute signifying the origin of the partner company. However, because of the presence of heterogeneity among the decision makers, some group of decision maker

favors domestic companies. This result is incongruent with the provision of the government to have at least a 20% share for a domestic company in any foreign direct investment, which implies that the public agencies are following the policy to include domestic companies. The presence of heterogeneity on company origin is insightful from the transaction cost point of view, because a domestic company knows better about the market situation, has a better understanding to deal with the government agencies as well as risk management than a foreign company. It can be interpreted as the government agencies trusting domestic companies more than international project partners. Since the ICT infrastructure and services are directly related to the handling of public information, the public agency perceives a high risk for collaborating with international partners. This may also stem from experiences gained in previous projects such as the smart driving license¹⁷.

For the revenue generation mechanism, the public agency does not want to transfer the market risk to the project company ($\beta_{EndPay} = -1.575, \beta_{EndPayMRG} = -2.04$) with reference to the government pay as a

¹⁷ The government of Nepal implemented the smart driving license project through the traditional procurement approach. There were three shortlisted international companies among the domestic as well as international bidders. The project was awarded to one of the shortlisted international companies. However, the government faced many difficulties during the project implementation as well as operation period. Another notable point for this project is that the company was found to have mirrored the data server located within the government integrated data server to their own company data server.

revenue generation method to be employed for the project company. It shows that the public agencies are aware of the low digital literacy as well as the market readiness for offering new IT services. However, due to the presence of heterogeneity, the decision makers are not argued to retain the market risk to the government rather transferring to the project company. For the partnership type, decision maker perceive negative in their utility structure to retain the associated risk by the government ($\beta_{JointVen} = 3.694, \beta_{PubFun} = -2.12$). It is interesting that there is heterogeneity among the decision makers for partnership type for both levels. It is because the government has a weak financial status to initiate ICT projects, which is a strong point for incorporating the private sector in the development of ICT infrastructure and services. From the above two attributes, interesting implications can be drawn from the perspective of risk sharing. While implementing ICT projects through the PPP mechanism, the estimation results show that the public agencies try to balance the initial project funding and the recurrent cashflow to the project company. It solves the issue of the budget deficit to initiate the project by the government and addresses the issue of perceived market risk by the private sector.

The attribute IRR ($\beta_{IRR} = 0.151$) has a positive contribution to the utility, which signifies that the government is willing to partner with the private sector for the development of ICT projects that are financially attractive. Nevertheless, due to the presence of heterogeneity among the decision makers, there are some who believe that the government should not use PPP if the project is financially unattractive. The financial attractiveness

of the project is the key parameter that both parties are specially concerned about and if the project fails to generate the required amount of revenue, the government needs to take over the project, which leads to a loss of welfare and detracts the private sector from future PPP projects.

In the case of granting the operation period to the project company ($\beta_{OpYear} - 0.129$), public agencies perceive negative utility for granting longer operation periods. It is an obvious result, but quite insightful with the notion to balance the social welfare and assuming that the project company draws larger profits from the longer operation period of a particular project. This assumption is plausible in the sense that ICT is one of the fastest advancing technology fields and by granting a longer period the project company obtains a higher profit from using outdated technology.

While making decisions, individuals treat each attribute with different levels of importance. The relative importance of attributes provides a better understanding about how respondent are making decisions. I have calculated the relative importance of the attributes using the formula given by Shin et al. (2014). The partworth estimate of attribute k is calculated by multiplying the coefficient value of attribute k to the difference of the maximum and minimum level obtained from the 10000 draws from the distribution of the estimated coefficients.

$$Relative\ importance(RI) = \left[\frac{(PartWorth_k)}{\sum_k PartWorth_k} \right] \times 100 \quad (5.2)$$

The estimates of relative importance are presented in column 4 of Table 9. It shows that the decision makers put higher importance on the origin of the partnering company and transferring market risk to the private sector. Similar importance has been given to initial project investment followed by the particular project. From this estimates, it can be said that public agencies are highly sensitive towards risk management when working with private companies through the PPP mechanism.

Table 10 shows the transformed coefficients of the estimated parameter. The result was obtained after 10000 draws with Gibbs sampling. The first 100,000 draws were discarded to get model stability to overcome the issues of sample size. Unlike the classical approach that maximizes the likelihood function, the Bayesian approach treats the beta parameter as the random variable and follows the joint probabilistic density function (Kim et al., 2005; Koo, Kim, Hong, Choi, & Lee, 2012; Lee et al., 2006; Train, 2009). While implementing the Metropolis-Hasting algorithm, I have used 0.1 as the starting value of the proportionality factor for jumps in the MH algorithm in order to force stability by restricting the selection of draws that have a large correlation between adjacent draws (Gilks, Best, & Tan, 1995). In the transformation procedure, 10,000 draws were used to draw the further implication taken from the normal distribution with a mean equal to the estimated value of b and the variance equal to w (Kim et al., 2005; Lee et al., 2006; Train, 2009). In order to check the stability of the model, I have followed the idea presented by Hensher and Jones (2007). I have observed the log-likelihood on each draw of the 100000 discarded samples and the value was virtually unchanged after 40000 draws (see the appendix for a plot of the model stability).

Table 10 transformed random coefficients estimates

Variable	Mean	Variance
Intl Company	1.7656	0.464
End user Pay	-1.5731	0.4568
End user Pay (MRG)	-2.041	0.3472
Joint Venture	-3.6963	0.4377
Public Funding	-2.1155	0.3911
IRR	0.1569	0.1019
Operation Year	-0.133	0.105

The posterior estimation provides a better understanding about how the individual behaves while making decisions. In the estimation, the individual's behavior regarding "International Company", "End User Payment", "End User Payment with Minimum Revenue Guarantee", "Joint Venture", and "Public Funding" has a large variance and the individual beta parameters are widely spaced from the mean. This shows that the decision makers have different perception towards these variables. However, in the case of "IRR" and "Operation Year" the individual beta parameters are close to the mean value, even though there exists perception heterogeneity (see the appendix for a plot of the individual beta parameters).

Table 11 presents the shares of population for each coefficient. According to the share of population for the attributes and their level, less than 1% of the respondents do not want an international company working on the

project whereas 99.5 % strictly prefer to include international companies in the private consortium. They want to promote domestic companies by leveraging the knowledge and technology from international companies. This result is similar to international practice in countries such as the US, Japan, or the Netherlands which are incorporating international partner in the e-government as reported by Margetts (2006). It is, however, opposite to Vietnam's case of domestic preferential treatment (Hang, 2009). Domestic IT companies are often not specialized in e-government systems or competent enough to handle large-scale public projects. Nevertheless, advanced countries such as the Netherlands, Japan, or Canada hold a large share of their government ICT projects (Margetts, 2006). The Japanese government depends wholly on domestic companies for government ICT projects; the Netherlands have a large share for government ICT services, Canada is mixed (Margetts, 2006). According to (Margetts, 2006) the US government prefers small companies and only 20% is done by the top five companies for the government ICT business in order to create a competitive market. However, in the case of the UK it is around 80%. Therefore, the selection of domestic companies and the size of the company depends entirely on the government's policy that reflects a country's overall industrial, procurement, and innovation policy.

In the case of the market risk sharing mechanism, 99% of the respondents do not prefer to transfer it to the private company, because of the low level of digital literacy and income per capita (or willingness to pay for the services) (Manandhar, 2012). For the revenue generation mechanism, there is a strong argument for not letting end user pay the service fee, thus rather retaining the market risk by the government. For the equity share,

decision makers strictly prefer to have private capital, which means decision maker are quite aware of the difficulty to have a significant equity share in the project. This means that the government agencies are aware of balancing the market risk between the private and public sector, which is a positive direction for the successful implementation of ICT projects through the PPP mechanism, especially when purchasing parity and digital literacy are low.

From the share of population obtained from the ex-post estimation, it is interesting to note that 30.73% of the respondents do not want to provide financially attractive projects and 69.327% want to execute financially attractive ICT projects through the PPP mechanism, showing the presence of a large heterogeneity in the opinion regarding the financial attractiveness.

Table 11 Shares of population for coefficients

Variable	Below zero	At zero	Above zero
Intl Company	0.49%	0	99.51%
End user Pay	99.00%	0	1.00%
End user Pay (MRG)	99.97%	0	0.03%
Joint Venture	100.00%	0	0.00%
Public Funding	99.96%	0	0.04%
IRR	30.73%	0	69.27%
Operation Year	65.92%	0	34.08%

As a summary of this section, to improve the government public ICT infrastructure and service delivery mechanisms, PPP plays an instrumental role in filling the gap of infrastructure and the service deficit as the government faces limitation to provide such infrastructure. The results show that the decision makers do not have similar preferences towards the risk sharing mechanism.

5.3.2. Study on the decision segmentation in public agencies for implementing ICT projects through the PPP mechanism

The government decision-making unit is composed of a complex system. In most cases, the government decision is made through a rigorous assessment of the underlying socio-economic situation and several experts are involved in the assessment. Nevertheless, politicians and government officials are the key figures that make a decision taking the experts' opinion as suggestions. I assume that the respondents, who are most likely to participate in the decision making for executing ICT projects through the PPP mechanism do not have similar opinions regarding the execution of ICT projects in general, and executing them through the PPP mechanism in particular. As the need for developing ICT infrastructure and services has increased as the country's economy advanced, the government needs to make specific decisions regarding the execution of ICT projects through various procurement approaches. In such a situation, the stakeholder has only two options for implementing the public ICT projects. Thus, considering all individuals' behavioral characteristics to study the decision

pattern is not plausible. Thus, this study assumes that the decision makers are divided into certain homophile groups, whose opinion about executing the ICT project is similar. In order to model such homophile groups, it is assumed that there are Q unobservable classes (groups) and individual belonging to that particular classes have similar opinions regarding the execution of ICT projects through the PPP mechanism. Moreover, they have a common preference structure for implementing ICT projects through the PPP mechanism.

To analyze the government preference towards adopting ICT projects, the following utility equation is used:

$$\begin{aligned}
 U_{nj|q} = & \beta_{nBroad|q}X_{Broad} + \beta_{neLearn|q}X_{eLearn} + \beta_{numgt|q}X_{umgt} + \\
 & \beta_{nebps|q}X_{ebps} + \beta_{nEndPay|q}X_{EndPay} + \beta_{nEndPayMRG|q}X_{EndPayMRG} + \\
 & \beta_{nJointVen|q}X_{JointVen} + \beta_{nPubFun|q}X_{PubFun} + \beta_{nIRR|q}X_{IRR} + \\
 & \beta_{nOpYear|q}X_{OpYear} + \varepsilon_{nj|q}
 \end{aligned} \tag{5.3}$$

In order to decide on the number of latent classes that exhibit an optimal goodness of fit of the model, I have used the Bayesian information criteria (BIC) and consistent Akaike information criteria (CAIC) (Pacífico & Yoo, 2012). The use of information criteria in selecting the optimal number of classes is a common approach as these information criteria are widely used in identifying the number of latent classes. The CAIC has shown that the observation can be divided into either two classes or eight classes, whereas the BIC criteria shows that there exist either three classes or eight latent classes. Both CAIC and BIC criteria are used for identifying the goodness of fit of the model. Using the information criteria estimates, the goodness

of fit of the model can be optimal with 2 or 3 latent classes. Thus, in order to avoid this problem and make the possible segmentation of decision makers who favors or rejects the agenda simple to understand, I decided to use two latent classes. Both information criteria employed here exhibit a different number of classes, nevertheless, two classes are used in order to avoid the complexity of modeling and making substantive explanations when using three classes. Another technical issue when using a larger class size is the increased standard errors (Hole, 2008). Table 12 shows the information criteria¹⁸.

Table 12 Information criteria with number of latent class

Number of Latent Classes	LLF	Number of parameters	CAIC	BIC
2	-534.915	16	1157.468	1141.468
3	-512.552	25	1162.038	1137.038
4	-505.152	34	1196.533	1162.533
5	-514.238	43	1264	1221

The estimation using the latent class model is presented in Table 13. The estimation result reveals two heterogeneous groups of decision-makers

¹⁸ The information criteria, AIC, CAIC and BIC measure the extent of model fit for the given dataset. They are calculated using the formulas $AIC = -2 \cdot \ln L + 2 \cdot K$, $CAIC = -2 \cdot \ln L + K \cdot \ln(N+1)$ and $BIC = -2 \cdot \ln L + K \cdot \ln N$.

who have different opinions about the implementation of ICT infrastructure and services through the PPP mechanism under the given choice scenario. Both classes of decision makers are indifferent towards the origin of the partnering company for the development of ICT projects. The mixed logit model presented in Table 9 shows heterogeneity among the decision makers using the classical approach, however, their behavioral structure does not belong to a particular group of decision makers.

Table 13 Estimation result using Latent Class Logit Model

Variables	Class 1		Class 2	
	Coefficients	Std. Err.	Coefficients	Std. Err.
Intl Company	0.448	0.545	-0.431	0.411
End user Pay	-1.297*	0.673	1.088**	0.536
End user Pay (MRG)	-0.739**	0.289	0.660**	0.334
Joint Venture	-1.790**	0.809	0.592	0.536
Public Funding	-0.406	0.373	0.195	0.385
IRR	-4.000	5.348	5.601	5.532
Operation Year	-0.175	0.132	0.199**	0.087
Broadband	-1.409***	0.323	0.311	0.386
eLearning	-0.915***	0.271	-0.656	0.447
Utility management	-1.561***	0.520	1.083***	0.401
Building permit system	-3.824***	1.173	-0.345	0.414

Regarding the revenue generation approach, the first group perceives negative utility ($\beta_{IntlCpy|1} = -1.297$) towards the revenue generation that transfers the whole risk to the private company. It shows that because of the underlying digital divide and economic status of the end users, the end users may not be able to pay the service fee required to reach the minimum revenue that ensures the return of investment on time. However, it is interesting to note that the first group perceives agreeing on a revenue generation mechanism ($\beta_{EndPayMRG|1} = -.739$) in the shape of end user payment with a minimum revenue generation guarantee highly negative. The mobile penetration rate of Nepal is 130.24 and the total internet/data subscription is 61.99 percent (Nepal Telecommunication Authority, 2017). In such a situation, it is legitimate to consider that new ICT services may diffuse faster and produce targeted revenue for the project company. It can be reasoned that the first group is highly concerned about possible rent seeking behavior of the private sector (and/or the government) during the operation of the project. The second class of decision makers has a different opinion than the first class ($\beta_{IntlCpy|2} = 1.088$), as they believe that the market is ready to accept new technology and services and it is possible to raise the minimum revenue required for ensuring a return on investment to the project company. Similarly, for sharing the market risk, they oppose the first group of decision maker ($\beta_{EndPayMRG|1} = 0.660$) showing that the government should bear some risk regarding the market conditions if the project company failed to generate sufficient revenue from the end users.

For the partnership type, the first class of decision makers does favor joint ventures ($\beta_{JointVen1} = -1.790$), but they are indifferent towards public funding. It can be explained from the rent seeking perspective as they are aware of these behavior in joint ventures. The rent seeking behavior is common when there is a high chance of market failure (Martin & Scott, 2000) because of the immaturity of the market for new ICT services. As explained by Koppenjan and Enserink (2009), the asymmetry benefits between the private and public officials for the joint project may lead to an increased rent seeking phenomenon. This opportunistic behavior may lead to project failure with significant loss of welfare. However, the second class of decision makers is indifferent towards joint ventures. Thus, based on their latent behavior, they are showing rent offering and avoiding the possible rent seeking phenomena for incorporating the private sector to develop the public ICT projects. The first latent group has shown their behavior as avoiding future rent seeking phenomena whereas the second group is positive or indifferent to it. Thus, I name these two groups “rent-seeking avoider” and “rent-offer”.

Table 14 shows the estimation result of the membership function. All three variables included in the membership function are statistically significant. This demonstrates that “rent-avoider” and “rent-seeker” are based on their nature of government responsibility, prior experience with PPP projects and rate of urbanization.

Table 14 Estimation result for membership function

	Average Class probability	Covariates	Coefficients	Std. Err
Class 1	.578	Constant	9.112**	3.645
		Urbanization	-5.173***	1.669
		Government Responsibility	3.927**	1.655
		Prior PPP		
		Experience	-2.501*	1.396
Class 2	.422	Reference		

Note: ***, **, * represents Significance at 1%, 5%, 10% level respectively.

Policy Simulation: Rent avoider and Rent offerer’s perspective

In this section, I present a different hypothetical scenario based on the estimation results from the latent class estimation. Individual-specific choice parameter estimates and the individual class probability parameters were utilized to draw policy implications. The policy simulation is taking the “Digitization” project as the reference project. Moreover, I have taken the best performing choice profile as the base scenario, and three different alternative scenarios are considered. In order to reduce the triviality of simulation, I have assumed three alternative scenarios.

In the above estimation results presented in Table 14, the overall sampled population exhibited two types of rent-seeking behavior. Based on the rent-

seeking behavior, I have simulated the cases for each scenario and their acceptance rate is given below.

Table 15 Policy scenario

	Base	Scenario 1	Scenario 2	Scenario 3
Partner company	International company	International Company	International Company	Domestic Company
Revenue Generation method	End user pay	End user Pay	End User MRG	End user MRG
Partnership Type	Private Funding	Public Funding	Private Funding	Joint Venture
IRR	10%	20 %	15	25%
Operation year	15 years	15	15	15 years

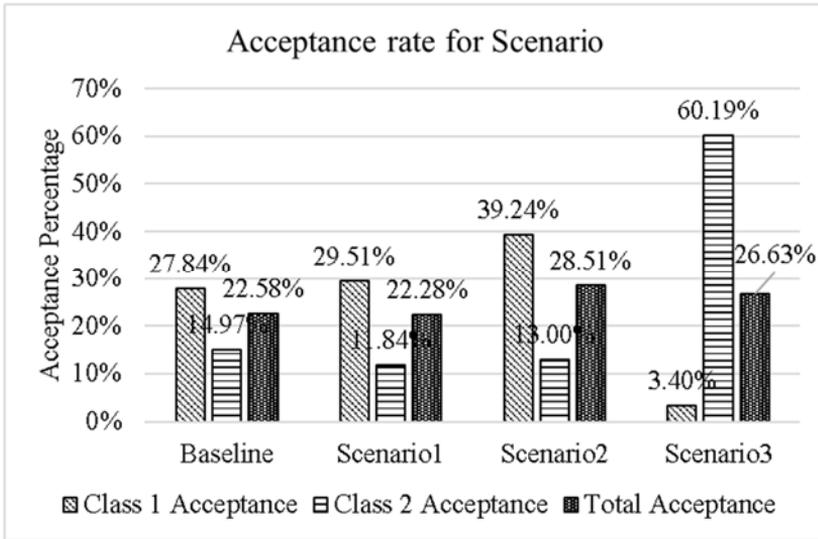


Figure 6 Policy simulation for each Scenario and Class

From the scenario analysis for the different alternative cases, it can be seen that the rent avoiders have clear preferences towards balancing the market risk and investment risk. They show that they are clearly aware of how to make the tradeoff between the possible rent-seeking opportunities that either party may exhibit in future. However, the rent offerers think that there should be a mutual sharing of risk in each phase of the project. For instance, during the operation period or in the initial phase of investment. According to Hart (2003), most contracts are incomplete, and because of this incompleteness, the contracting parties may behave opportunistically, often leading to the failure of PPP projects. Thus, the rent offerers open the door to opportunists by enacting equal risk-sharing provisions in each phase of the project. The rent offerers follow the rules and regulations strictly, however, fail to maximize the welfare which may lead to the

project's failure (Marques, 2017; Migué, Bélanger, & Niskanen, 1974). Thus, because of this rent-seeking behavior, the public agencies' efficiency decreases. However, the rent avoiders have a clear idea about sharing the associated risk in the Nepalese context of weak market potential for ICT services and a government budget-deficit.

Understanding the heterogeneity of the government decision makers is very important to lay out the preferences. I have identified the presence of heterogeneity and segmented that heterogeneity into possible latent groups. From the Mixed Logit estimation result, I have concluded that strong heterogeneity is present except for public funding (the mean of end user payment and end user with MRG are not statistically significant even though the associated variance is insignificant). This implies that decision makers have a common understanding that the government is running under the condition of a budget deficit. In such a case, the government needs further policy instruments that provide better incentives to the private sector to leverage private capital for the development of public ICT projects.

Moreover, by using the Latent Class model, I found that there are two clear latent groups behaving differently while making the decision to incorporate the private sector for the development of ICT projects. Their behavior is closely related to possible rent offering and avoiding. Such future rent offering phenomena while designing the PPP projects with the private sector are crucial for project sustainability. The results suggest that flaws in the PPP negotiation could be introduced that open the door to rent seekers. In order to reach a common agreement with the decision makers,

the central government needs to provide rigorous training on PPP and the incentive sharing mechanism so that the local government can map their resources and share both risks and incentives appropriately to ensure the success of the project.

5.3.3. Study on the government's priority for infrastructure projects under budget constraints

In this section, I assume that there is a budget constraint in the government, which decides to use the PPP procurement approach for the development of public ICT infrastructure and services, rather than the traditional procurement method. In the survey questionnaire, I have asked to allocate the budget (as an initial lump-sum subsidy or initial contribution to the project) as if the government agency really wants to implement the project through the PPP mechanism in the next 5 years. The sample choice set used while collecting the responses is given in Figure 5Figure 5.

The estimation result of a mixed variant of the MDCEV model using Bayesian procedure is presented in Table 16. The Bayesian procedure estimation has numerous benefits over the maximum likelihood approach. It converges faster, takes a shorter time, can be suitable for a smaller sample size than the maximum likelihood procedure, and it provides a more accurate approximation for the posterior distribution of the parameters (Koo et al., 2012; Lim & Kim, 2015; Train, 2009).

Table 16 Estimation result using Mixed MDCEV Model

		mean	Transformed Mean	Variance	Transformed Variance	
Baseline	e-Learning	0.105 (0.313)	0.1063	1.071 (0.172)	0.1277	
	UMGT	-1.697 (0.219)***	-	1.047 (0.164)	0.1493	
	eBPS	0.021 (0.346)	0.0236	1.062 (0.164)	0.1524	
	Digitization	0.787 (0.246)***	0.784	1.065 (0.176)	0.1363	
e-Learning	Intl Company	-0.292 (0.227)	-0.2907	1.049 (0.17)	0.2297	
	End user Pay	1.785 (0.341)***	1.7875	1.061 (0.172)	0.1959	
	End user Pay (MRG)	0.132(0.204)	0.133	1.026 (0.155)	0.2055	
	Joint Venture	0.18(0.192)	0.1843	1.03 (0.173)	0.209	
	Public Funding	0.319 (0.271)	0.3139	1.059 (0.154)	0.2202	
	IRR	0.623 (0.152)***	0.6235	1.068 (0.17)	0.1962	
	Operation Year	-1.0 (0.256)***	-1.003	1.063 (0.168)	0.2032	
	Utility					
	Management	Intl Company	0.823 (0.18)***	0.8193	1.065 (0.167)	0.2015
		End user Pay	-0.16 (0.147)	-0.1586	1.052 (0.167)	0.2645

	End user				
	Pay (MRG)	-0.792 (0.17)***	-0.7923	1.055 (0.164)	0.2264
	Joint				
	Venture	-0.316 (0.247)	-0.3139	1.061 (0.174)	0.172
	Public				
	Funding	0.324 (0.162)**	0.3266	1.09 (0.168)	0.1837
	IRR	0.003 (0.193)	0.0033	1.057 (0.177)	0.259
	Operation				
	Year	-0.876 (0.19)***	-0.881	1.075 (0.17)	0.2016
<hr/>					
Building					
Permit	Intl				
System	Company	0.147 (0.306)	0.1471	1.098 (0.176)	0.1996
	End user				
	Pay	0.553 (0.3)*	0.5577	1.077 (0.175)	0.1851
	End user				
	Pay (MRG)	-0.681 (0.202)***	-0.6817	1.064 (0.169)	0.2062
	Joint				
	Venture	0.304 (0.179)*	0.302	1.053 (0.16)	0.2538
	Public				
	Funding	1.06 (0.167)***	1.0597	1.078 (0.182)	0.1547
	IRR	0.368 (0.216)*	0.366	1.123 (0.173)	0.1791
	Operation				
	Year	0.607 (0.209)***	0.6071	1.042 (0.168)	0.1387
<hr/>					
Digitization	Intl				
	Company	-0.705 (0.331)**	-0.7095	1.025 (0.16)	0.1352
	End user				
	Pay	0.546 (0.268)**	0.546	1.061 (0.163)	0.138
	End user				
	Pay (MRG)	0.521 (0.152)***	0.5185	1.052 (0.176)	0.1231

Joint				
Venture	-0.086 (0.14)	-0.0856	1.67(0.29)	0.3903
Public				
Funding	-0.417 (0.151)**	-0.4174	1.399 (0.233)	0.4703
IRR	-0.803 (0.145)***	-0.8031	1.38 (0.222)	0.4537
Operation				
Year	-0.082 (0.166)	-0.0808	2.112 (0.387)	0.2182

*Note: eBPS: Electronic Building Permit System, UMG: utility management system; standard error is presented in parenthesis; ***, **, * represents Significance at 1%, 5%, 10% level respectively.

The parameters are assumed to be distributed normally across the decision makers and the estimation results are presented in Table 16. The results reveal the following important information:

The baseline parameter for alternative “eLearning system and “electronic building permit system” are not statistically significant. However, “utility management” and “digitization”, where the “broadband” infrastructure considered as the baseline alternative. Digitization is one of the key initiatives that have to be completed in order to move forward with digital government. In most developing countries, the extent of information richness for providing the electronic services is lacking, which has led to the failure of e-government services in the developing countries (Heeks, 2002).

This is the first study to compare the government interest for the implementation of ICT infrastructure and/or services through the PPP

mechanism. Nevertheless, government across the globe, as well as multilateral development agencies such as the World Bank and the Asian Development Bank have a primary interest to provide connectivity infrastructure. Various studies have been carried out to shed light on the significant relationship between economic growth and broadband penetration. However, the variances for the baseline parameters are all significant and have high values, which signifies the presence of high heterogeneity among the respondents. Since the sample respondents were distributed across urban and rural areas, the government's priority setting differs depending upon immediate needs or strategic utilization of private sector resources towards public infrastructure or services. In addition, I have also accounted for the taste variances by using the probability distribution across the sample. The presence of heterogeneity in the estimation result provides the important implication for the policy makers not to generalize one's perspective to all government agencies when implementing ICT infrastructure and/or services through the PPP mechanism.

The choice attribute level for the origin of partner company, "international company", is not statistically significant. It shows that the decision makers are indifferent towards the origin of the partner company and decision makers prefer the features of the e-learning, such as ease of use, interactivity, and flexible design (Sife, Lwoga, & Sanga, 2007). In the case of the utility management system, international companies are more preferred than domestic ones as they possess technology that enhances service quality. In technologically advanced countries, the use of the internet of things to enhance the utility management is widely applied. By

using the internet of things, automated meter reading technology and automated billing systems are the major breakthroughs in the field of utility management systems. However, these technology are yet to be introduced into Nepal. With the introduction of such technology, the errors of manual billing could be reduced and the detection of problems (such as electricity theft, water leakage and so on) and rapidly taking corrective measures will make the services more effective. In the case of the building permit system, decision makers are indifferent towards the origin of the partner company.

The paper-based archival documents contain government information and the digitization project may need to access that crucial information. The awareness of possible leakage of government information or trust in the international company while providing access probably led to a negative contribution to the utility structure of the decision maker¹⁹. Nevertheless, the government agency perceives a positive utility while implementing the electronic building permit system through an international company. In all cases, there is a high degree of variance, which shows that there are no common voices in the sample.

¹⁹ A similar instance was reported while implementing the smart driving license. However, the project was implemented through the traditional procurement method. The project was awarded to Madras Security Printers, an Indian company. There were a number of newspaper op-eds and public criticism has been reported as the possible leakage of public information.

For the revenue generation mechanism for e-learning projects, the government agencies are not willing to transfer the financial risk (operational financial risk) to the private sector. In other words, government agencies are highly aware of the market risk. Since the level of digital literacy in the country is low compared to other south Asian countries, and in order to access the digital learning materials, end users might need to purchase additional devices or might need to pay for other access methods²⁰. This can hinder the diffusion of e-learning content across the country. There are numerous international cases in which ICT projects were categorized as failure because of the high market risks. In the case of Nepal, as is shown in Figure 1 and Table 1, the maturity of the ICT infrastructure and/or e-government services and the preparedness of the human resources required for attaining a minimum market threshold is very low compared to regional emerging economies such as India or Sri-Lanka. It is quite interesting to note that the government agencies are ready to transfer the market risk to the private sector. However, there are two different implications that can be drawn from this result: i) the government agency does not want to create a monopoly market for providing e-learning services, but is in favor of market competition and creating an open innovation platform²¹, ii) the government agency wants to utilize the private sectors managerial and technical capability for the successful

²⁰ E-learning content can be accessed through personal computers and smart devices connected to the internet and/or through public internet cafés.

²¹ A monopoly market is less innovative compared to a competitive (at least duopoly) market

diffusion of the e-learning services²². However, in other ICT applications, transferring market risk to the private sector is positive. In either case, there is a presence of heterogeneity, meaning that further investigation is needed on the contextual aspects under which the market risk can and should be transferred to the private company.

The partnership type can be defined in different approaches such as partnership organization models, collaboration model, funding approach, or risk sharing strategy (Hodge & Greve, 2007; Nucciarelli et al., 2010). This approach has the important implication in the case where the market is not ready. In this study, I have only put the attributes into three basic levels of partnership type, without going through the details of partnerships generally practiced or common PPP mechanisms. In the partnership approach, government agencies perceive it negatively when the government is directly involved in initiating the project such as in joint ventures or full public funding approaches, where the private funding approach is taken as the base. For the initial investment and overall management of the system, the government highly perceives that the private sector should be involved. Which signifies that i) the government is highly aware of the existing inefficiency, ineffectiveness, or in general X-inefficiency in the government agencies, ii) because of the budget deficit, the government is looking for an initial investment in the project, iii) government agencies

²² End user cost may be a key factor for the diffusion of e-learning or creating a digital learning environment.

do not want to be directly involved in the project, rather they see their role in monitoring the quality of the system.

IRR and the operation year are the key components in the PPP mechanism and are directly related to the financial attractiveness of the project. The government agencies perceive positive utility, even providing a higher IRR to the e-learning and building permit system, indifferent to the utility management system projects but negative to the digitization project. It is quite interesting to note that the government agency's perceive the utility structure negatively while providing a higher IRR to the digitization project. This is because digitizing the archival documents does not have lead to any long-term business model. Rather it is a short-term project and government agencies are probably in need of technology and assistance from the private sector.

The last attribute for the choice scenario, "operation year", the government does not want to provide a longer operation year to the project. Rather they want to update the operation license based on the outcome of the project.

The priority to implement ICT infrastructure and services through the PPP mechanism is given by the alpha parameter where a higher value signifies that decision makers have a higher priority and a lower value signifies a lower priority (Bhat, 2005, 2008). The level of satiation to the ICT projects depicts a vivid picture to understand the government's priority to implement ICT projects through the PPP mechanism. The level of satiation perceived by the government agencies is presented in Table 17, which also shows the marginal diminishing utility when ICT projects are implemented

through the PPP mechanism. The estimation for the satiation parameter shows that government agencies are highly in need of “electronic building permit system”, “utility management system”, “broadband infrastructure”, “e-Learning system” and “Digitization” in the order of priority. All the satiation parameter are statistically significant, which justifies the use of the MDCEV model (Ahn, Jeong, & Kim, 2008). From the results, the magnitude of satiation parameter shows that the government has a high priority for the application projects rather than for the key components of the knowledge society such as infrastructure and human resources.

Table 17 Satiation parameter for ICT projects

Projects	Mean of δ	Mean of α	Variance of δ	Variance of α
Broadband	-2.906(0.314)***	0.056	1.103(0.2)***	0.001
eLearning	-3.229(0.464)***	0.04	1.043(0.197)***	0.0002
Utility management	-1.922(0.331)***	0.134	1.039(0.198)***	0.003
Building permit system	-1.794(0.517)***	0.1483	1.027(0.178)***	0.002
Digitization	-3.549(0.367)***	0.029	1.055(0.192)***	0.0001
Gamma value	2.406(0.028)***	11.29	0.048(0.01)***	2.993

Note: ***, **, * represents Significance at 1%, 5%, 10% level respectively.

In summary, we have seen the government’s priority to execute projects through the PPP mechanism under budget constraints. The results show

that government agencies have a high priority to implement the building permit system and utility management system. This result is very insightful from the perspective of following the path of a benchmarking country such as Korea. According to Chung (2015), the Korean government was involved heavily in building proper human resources by providing subsidies for computers, building ICT infrastructure and supporting informatization. After that, the Korean government was actively involved in developing applications to connect citizens and the government by utilizing the outcome of earlier policy instruments. However, in the case of Nepal (as this reflects the government strategy and implementation priority), it is quite doubtful that the country follows the case of a successful country which has a strong public ICT infrastructure and highly developed services. From the indicators shown in Figure 1 and Table 1 it cannot be with certainty said that Nepal is leapfrogging, but the results shows that public agencies are highly prioritizing applications rather than key components such as building the human resource base, network infrastructure and informatization of archival documents to improve the public service delivery.

The data sample contains the stated preference from the choice experiment for the purpose of knowing whether the government authorities are going to implement ICT projects in next five years or not. Unlike other studies (

see Bhat and Sen, 2006²³), the decision makers do not have the same requirements. For instance, the department of education may go for a digitization project and e-learning projects, so to some extent they might be interested in supporting broadband networks. However, they might not be interested in supporting broadband networks. However, they might not be interested in a utility management type system and electronic building permit system. This variability and difference of requirements in the sample might not appropriately capture the issues through the MDCEV model (Fang, 2008). Nevertheless, with the lack of a modeling framework that appropriately triggers the implementation of multiple ICT projects under limited budgeting situation, the MDCEV model works better if one does not account for the endogeneity issue on modeling the problem under multiple discreteness frameworks.

In order to account for such endogeneity issues, one needs to incorporate the instrumental variable through different modeling frameworks such as the Heckman Model (Fang, 2008). However, it does not account for the multiplicity to incorporate the private sector for the development of ICT infrastructure under a constrained situation (Lu, Hess, Daly, & Rohr, 2017).

²³ In their study, they considered that a vehicle is a common requirement for a household. However, they might hold multiple vehicles because one vehicle type might not fulfill their demand, meaning they are not perfectly substitutable

Chapter 6 Conclusion and Policy Implications

6.1. Conclusion

The strategic development of ICT infrastructure and services paves the way to the knowledge-driven economy. Government policy and strategic planning to realize the government policy is the only way to integrate ICT into the government service delivery and enhance the efficiency of public service delivery. It does not only improve the government accountability towards the public, but also enhances the government effectiveness, valuing the tax paid by the public. There is no doubt that the starting point for the implementation of public ICT infrastructure and services is the enactment of policy. However, after the formulation of relevant policy and a strategic plan a decade ago, the ICT infrastructure and service maturity of Nepal is still low compared to other south Asian countries. However, there is the clear correlation between the countries level of infrastructure maturity and extent of ICT services, in particular e-government services.

However, in order to integrate ICT into the economy, government reform is necessary to distribute the welfare across the economy via transforming the government into a digital government. It is widely known that developing countries suffer from budget deficits, however, incorporating the private sector in the development of ICT infrastructure and service fills the gap of infrastructure deficiencies and budget constraints (Bakker, 2002). Thus, understanding the decision makers' perception towards

incorporating the private sector for the development of ICT infrastructure and services, as well as their priority for executing ICT projects incorporating the private sector is essential for the stakeholders. Thus, this study provides a comprehensive analysis of the government's priority to implement ICT infrastructure and services under the faced budget constraints.

Through the use of mixing distribution, this study finds a decision heterogeneity in the public agency for implementing ICT projects through the PPP mechanism. Further, through the use of a Latent Class Logit model, I have found that decision makers' behavior is divided into two latent classes, which aids the further implication in addition to the result obtained from the Mixed Logit model. It is important to understand the possible decision opinion group in the government for executing ICT projects through the PPP mechanism that provides fruitful insight on how the central government should enact policy to dictate behavioral flaws or indecisive condition on making contracts with private companies for public projects. Obviously, the indecisive condition arises when the decision maker cannot clearly identify the perceived level of utility borne to the society to attain the optimal welfare distribution state (Migué et al., 1974).

As developing countries often lack fundamental management skills to tackle the financial as well management challenges of large and complex technological projects, it becomes necessary to incorporate the private sector to accomplish those tasks (Ojha & Pandey, 2014) and distribute the benefits brought by the digital technology to the citizens. While

incorporating the private sector for the development of the project, assessing various risk factors and managing them plays an instrumental role. Jin and Doloi (2008) argue that building organizational capability would help to allocate the risk measures across the contracting parties. Under the weak institutional environment, the interest group may play the dominant role while allocating the risk during the PPP negotiations (Spindler, 1990). In such a situation, the inferior rent-seeking behavior may become dominant. Thus, enhancing institutional capability and strengthening the governance system allows to tackle such behavior in the long run.

Further, by using the mixed variant of the MDCEV model, I investigated how the government is willing to implement the projects as well as their preference structure for individual projects. Moreover, I have found the level of marginal diminishing utility of adopting new projects through PPP mechanism. Mostly, the PPP mechanism is employed when the government is running a budget deficit and perceives that the private sector could manage the public projects better than the public agency. Thus, this study provides insights into how the government is prioritizing their strategy and resources to implement ICT projects through the PPP mechanism.

This study contributes to closing the literature gap on the government's preferences for implementing ICT projects in general, and through the PPP mechanism in particular. It provides a theoretical as well as empirical foundation. Moreover, the major contribution of this dissertation is that it identifies the government's priority for implementing the projects. Thus,

the study provides the public agencies' perspective on their implementation priority of public ICT infrastructure and services through the PPP mechanism. The success of public ICT projects is possible only when there is active participation of all stakeholders (particularly citizen) (Altameem et al., 2006) and their acceptance in all aspect such as providing incentives to the private sector (because of the use of public money), acceptance of service offered and willingness to pay for the services by the end users. Moreover, the private sector's perception towards participating in such infrastructure and service projects also provides extra mileage to ensure the successful execution of PPP projects to understand whether the government perception towards the project attributes and alternatives is attractive enough for the private sector. To draw a clear picture of successful negotiations (execution of ICT projects through PPP) and operation, a tri-patriate model connecting the citizens' perspective, government perspective, and the private sectors' perspective is important.

It is very difficult to balance the market risks (including operation and maintenance risk) and financial risks (initial funding) during the project negotiation. In such cases, the provision of flexible contraction negotiation would create a higher social welfare and increase the projects' sustainability. This study's limitation is that it did not consider a comprehensive analysis by testing operating expenditure (OPEX) and capital expenditure (CAPEX) sensitivities. Thus, further research is advised to perform a sensitivity analysis through the discrete choice approach to answer the question on how decision makers perceive OPEX and CAPEX during the project negotiation phase.

6.2. Key findings and implications

This section summarizes the important findings and suggests policy implications based on the findings of the study. The decision makers positively prefer foreign companies and give a higher priority when making a choice. It is obvious that the domestic ICT industry of the country is still in an infant stage in terms of technology, management skills and financial capability, which makes it difficult to engage in large-scale projects. Working with international companies brings foreign knowledge to domestic companies and creates spillover effects which ultimately empower the domestic companies (Carayannis & von Zedtwitz, 2005). However, it is quite important to create a conducive environment for the interaction of domestic and foreign companies. In the traditional procurement approach, the knowledge spillover is limited as the foreign company delivers the project without having a close collaboration with domestic companies. The current FDI policy having the provision of a minimum 20% equity share for the domestic company is not sufficient as foreign entities only share equity with a particular company, rather than engaging in a broader range of partnership activities, e.g., a knowledge sharing platform, as suggested by Panda (2016) and Klievink et al. (2016) to create value through the partnership. This would also help to reduce the transaction cost between the partnering companies.

The PPP mechanism is mostly about sharing the risk between the public agency and the private sector. Moreover, the essence of PPP is to overcome government inefficiency, ineffectiveness and budget constraints as well as infrastructure deficiencies by leveraging the private capital and the private

sector's expertise. However, it is advised that while assessing the risk allocation strategy, no privilege should be given to the private sector (World Bank, 2005) in allowing to draw a higher benefit from the project. The results reveal that government agencies are very sensitive towards sharing the financial risk with the private sector in ICT projects through PPP. Despite the immense market potential for the investor in public ICT services, the willingness to pay for ICT services such as the internet (Manandhar, 2012) is still low. In such a situation, it is very difficult to attract the private sector without guaranteeing minimum revenues from the project. Assessing the estimation results from the Mixed Logit estimation, decision makers are ready to retain a market risk to the government, however, they prefer private investment for the development of the project. It should be noted, however, that rent-seeking behavior can occur when sharing the revenues and the project's financing risk. Since both parties are the utility maximizers, they might exhibit opportunistic behavior from the development to the operation of the project, ultimately risking the successful outcome of the project.

Assessing the results of the latent class estimation and policy simulation, I found that there is wide variation in understanding the risk allocation for possible PPP projects. This variation probably arises from the lack of understanding the risk sharing mechanism in the contextual situation. This shows the need for an agency that deals with the PPP projects in the country to streamline a coherent policy for balancing the risk factors between the parties in a contextual situation. The presence of rent-seeking behavior could harm the economy as it deters social welfare. Spindler (1990) discusses the rent-seeking phenomenon observed during the period

when privatization had evolved in the 1980s, and argues that it would have severe consequences if “interest groups” manipulate decision makers to draw economic rents. Jin and Doloï (2008) argue that enhancing organizational risk management capabilities would minimize the possible rent seeking behavioral perception. Rent-seekers may argue that providing higher rent-seeking opportunities would increase private investment (Keefer & Knack, 2007) in the development of public infrastructure, however, it would be counterintuitive to reasoning like that, even in the short run.

Apart from the revenue risks and project financing risks, making decisions based on the financial attractiveness of the project to the private sector also influences the overall risk of the project (Ng & Xie, 2008). Since the return on investment is a prerequisite for any potential investors, the pressure from special interest groups can also influence the decision makers whose behavior is to create rent-seeking opportunities. Thus, building a strong agency that has the authority to regulate and monitor the PPP market with an appropriate policy would be a suitable solution to identify projects in consultation with the local governments to assessing their needs.

In PPP projects, granting a longer operation period to the project company negatively affects social welfare as it diverts a part of the consumer welfare to producer welfare as private sector extracts more benefits (Carbonara et al., 2014a; Shen et al., 2007; Zhang, 2011) from outdated technology as contracted during the period of contract negotiation. However, it is also possible to make provision to update the technology or system periodically in tune with advancements of technology. Nevertheless, in such a situation

the project/service cost may rise significantly. The reason would be that either party is unaware of technological advancements.

The ICT infrastructure of the country is weak regardless of the correlation of the country's economic growth and other underlying supportive covariates. If the local government is willing to implement ICT infrastructure and e-government services through the PPP mechanism, there should be less heterogeneity in order to support the overall development of the ICT industry. In this regard, the general hypothesis on preferences towards the project selection follows the coherence between the market conditions and the development strategy. For instance, in internet connectivity, broadband infrastructure is one of the pre-requisites not only for the diffusion of ICT services and their benefits, but also for breaking down the digital dividend across various demographics. Afterwards, the digitization and publishing of the government information provides a wide array of information to the end users who knows about the government activities. Nevertheless, the results of the presence of heterogeneity in the sample suggests that they are not consistent with the project preferences. This might be because of the local governments' intention to utilize existing infrastructure and their intention to avoid a duplication of the infrastructure. Nevertheless, it does not provide a consistent answer in the case of the preference towards the digitization and publishing of government information.

Assessing the estimation results from the MDCEV model, the government priority has not reflected the level of maturity of public ICT services. This raises questions on the effectiveness of the government policies and the

strategy perceived by the responsible personnel in the local government. Moreover, as argued by Kromidha (2012), the effectiveness of following benchmarking cases and the outcome of support from the international community is questionable, meaning that Nepal has not yet built sufficient absorption capability to successfully follow benchmarking cases.

In the current context, the government of Nepal has enacted PPP policy addressing the gap of vacantness in the policy. However, the question on what would happen if the provincial governments reject the PPP policy enacted by the federal government and would prepare significantly differing policies to those enacted by the central government to attract the private sector in their jurisdiction, remains unanswered. Thus, the federal government should take the initiative to interact with the provincial governments to enact a coherent policy by having a similar perception towards the risk factors and dealing the private sector through the same policy. By doing so, private participation among the provinces would be balanced along with the simultaneous development of public ICT infrastructure and services across the country.

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Appendix A

Survey Questionnaire

Survey on Implementation of ICT infrastructure and services by government agencies.

This survey questionnaire is to identify the willingness to adopt the ICT infrastructure and ICT services (e-government services) by the government agencies through the public-private partnership mechanism. We have categorized the e-government projects into three basic categories. The first category involves the digitization and publishing the information, which is the basic step for the e-government. The second phase is about providing the connectivity to the service recipient, and the third phase is the application phase. In the questionnaire, at least one projects are from each category is taken as the representative projects and altogether five projects were selected as an alternatives project. You are requested to rank the attractiveness of the project (1 for the most preferred project, 2 for less preferred than 1 and so on) and put the tentative budget if you want to implement through PPP mechanism. The second part of the questionnaire consist of general questions.

No individual responses will be disclosed rather will be processed using statistical application and only implications will be drawn from the responses. Moreover, the information will be kept strictly confidential and the result will be used only for academic research purpose, not for any commercial or other purposes.

Should you have any comments, suggestions or questions about this survey, kindly contact us via email at bikramac@snu.ac.kr

Kindly read the attributes used and their levels of the alternative ICT project.

Attributes and Levels

Attributes	Attribute Level	Definitions
ICT project type in which government interested to involve in PPP	Broadband Project	Broadband Internet project is a representative project for the infrastructure type project. When adopting broadband projects government agency, citizen and business may able to get high-speed internet access at affordable cost (also provide free access to public places)
	Digitization and publishing	Digitization includes digitizing all archival documents and putting in the standardized database system which can be published through web portal or can be accessed through third-party API
	E-learning Utility Management and payment e-BPS	Only three projects are selected out of many possible application projects. These are the services which transform traditional government services to the online services and/or social services. This type of projects includes e-commerce features required for the transaction.
Year of collaboration	7 years, 10 years, 15 years	Explicit operational duration, it may be extended depending on the performance and/or requirement of the projects

Partnership type/ Capital Mobilization	A) Joint ventures B) Public funding private O&M C) Private funding and private O&M	1) Joint ventures, both private and public sectors collaborate for the ICT projects with equal/some shares of financial as well as O&M Risk 2) Public sector is responsible for all kinds of funding and private sector is responsible for O&M 3) Private sector is responsible for project financing and O&M
Revenues Generation method	A) End-user (with revenue guarantee) B) End-user (without revenue guarantee) C) Payable by Government	A/B) The project generate revenue from the end user with/without revenue guarantee from the government C) The government will pay the projects in lump sum amount as a revenue of the project.
Private Partner	1) Experienced Domestic IT Company 2) Experienced International IT Company	The type of private partner is defined as the origin of the company or major share of the partnership
Average minimum IRR if partnered with private sector	5%,8%,11%,15%	It is the financial attractiveness of the project

Section A. In this section, five representative projects are given. Each project differs with the project attributes. in this section, there are four different situations and respondents are requested to provide the responses such as rank the attractiveness of the project and the put the tentative budget if they want to implement the project. Each set should be treated independently. Each set consists of five alternative projects and their scenario are presented in the table considering all project characteristics are same which are not explicitly mentioned below. For the budget, government need may need to invest (spend) during the project period to support private company and the total investment of the project may be higher than that of the government budget allocation.

Question 1. Please rank the given set of project alternatives first and if you are really going to implement the project through the PPP mechanism kindly put the tentative amount of budget in which your organization (Government) can investment for that project. [for detail about the project ranking and budget allocation please refer to example]

* Example: Out of following 5 project alternatives, one really wants to implement project X3 (Utility management) is the first preference according to the need and 2million USD can be allocated and the project X5 (Digitization and publishing) is the second priority in which 5 million is allocated.

	Broadband Internet (X1)	E-learning (X2)	Utility Management and payment (X3)	e-BPS (X4)	Digitization and publishing (X5)
Partner company	International Companies	Domestic Companies	International Companies	Domestic Companies	International Companies
Revenue Generation	End User Payment	End User Payment	End User Payment (MRG)	End User Payment	End User Payment
Partnership Type	Joint Ventures	Public Funding Private O&M	Joint Ventures	Private Funding Private O&M	Public Funding Private O&M
Internal Rate of Return	15%	15%	5%	8%	11%
Operation Year	7 Years	7 Years	15 years	7 Years	10 Years
Your Preference (1)	5	3	1	4	2
Max budget can be allocated (2)	x	x	2 million	x	5 million

Please rank the following project alternatives and put the tentative amount if you really want to implement through PPP mechanism.

Set A

	Broadband Internet (A1)	E-learning (A2)	Utility Management and payment (A3)	e-BPS (A4)	Digitization and publishing (A5)
Partner company	International	Domestic	Domestic	International	International
Revenue Generation	Enduser	Government Pay	Enduser	Enduser with MRG	Government Pay
Partnership Type	Joint Venture	Joint Venture	Private Funding	Public Funding	Joint Venture
Internal Rate of Return	11%	11%	5%	8%	11%
Operation Year	10 Year	10 Year	10 Year	15 Year	15 Year
Your Preference (1)					
Max budget can be allocated (2)					

*please (1) rank the project and (2) put the investment amount if your government really want to implement the project.

Set B

	Broadband Internet (B1)	E-learning (B2)	Utility Management and payment (B3)	e-BPS (B4)	Digitization and publishing (B5)
Partner company	International	International	International	International	Domestic
Revenue Generation	Enduser with MRG	Enduser with MRG	Enduser with MRG	Enduser	Enduser
Partnership Type	Private Funding	Public Funding	Joint Venture	Joint Venture	Private Funding
Internal Rate of Return	5%	8%	15%	8%	5%
Operation Year	15 Year	7 Year	7 Year	10 Year	7 Year
Your Preference (1)					
Max budget can be allocated (2)					

*please (1) rank the project and (2) put the investment amount if your government really want to implement the project.

Set C

	Broadband Internet (C1)	E-learning (C2)	Utility Management and payment (C3)	e-BPS (C4)	Digitization and publishing (C5)
Partner company	Domestic	International	Domestic	Domestic	Domestic
Revenue Generation	Enduser	Government Pay	Government Pay	Enduser with MRG	Enduser with MRG
Partnership Type	Private Funding	Public Funding	Public Funding	Joint Venture	Public Funding
Internal Rate of Return	11%	8%	11%	15%	11%
Operation Year	7 Year	15 Year	7 Year	10 Year	10 Year
Your Preference (1)					
Max budget can be allocated (2)					

*please (1) rank the project and (2) put the investment amount if your government really want to implement the project.

Set D

	Broadband Internet (D1)	E-learning (D2)	Utility Management and payment (D3)	e-BPS (D4)	Digitization and publishing (D5)
Partner company	Domestic	Domestic	Domestic	International	Domestic
Revenue Generation	Government Pay	Enduser with MRG	Enduser with MRG	Enduser	Government Pay
Partnership Type	Public Funding	Private Funding	Public Funding	Joint Venture	Public Funding
Internal Rate of Return	15%	15%	8%	11%	8%
Operation Year	15 Year	10 Year	10 Year	15 Year	15 Year
Your Preference (1)					
Max budget can be allocated (2)					

*please (1) rank the project and (2) put the investment amount if your government really want to implement the project.

Question 2. Consider all 20 options given above as available project options alternatives, please select any five projects and rank in order of your preference and also put the budget to each project in the following table.

Example: if your 1st preference is option 1 (i.e. Broadband) then select any 4 alternative broadband project which you perceive the best one, here out of 4 broadband projects B1 is the best and ranked as 1st, and the budget is 5million USD. If your 2nd preference is eBPS project and select 4 alternative eBPS projects and here C4 is the best alternatives and budget can be allocated to C4 project is 9million USD

	1st Preference	2nd preference	3rd preference	4th preference	5th preference
Project in order	B1	C4	B2	A5	D3
Estimated budget	5million USD	9million USD	2million USD	1.3 million USD	0.7 million USD

Please put the preference and tentative budget to the following table.

	1st Preference	2nd preference	3rd preference	4th preference	5th preference
Project in order(1)					
Estimated budget (2)					

*please (1) select any 5 projects which you are really interested to implement through PPP and also put in rank with your preference and (2) put the investment amount for the project that your government can allocate budget.

Section B

1. What is the tentative number of potential users for the ICT services if your government/department offer any IT services?
 - a) Less than 2,000 subscribers
 - b) 2,000 to 5000 subscribers
 - c) 5,000 to 10,000 subscribers
 - d) More than 10,000 subscribers
2. Do your organization have any experience in collaborating with Private Company?
 - a) Yes b) No
3. To what extent do you agree the following argument are responsible for the optimal output of the PPP project in ICT? If you agree please mark 5 and disagree mark 1.

	Disagree	1	2	3	4	5	Agree
A Public sector should have high-risk management capacity	Disagree						Agree
B Private sector should have high-risk management capacity	Disagree						Agree
C Provision to provide contract adjustment according to context	Disagree						Agree
D Government should monitor the Projects regularly	Disagree						Agree
E Experience private company is necessary	Disagree						Agree
F Project scope should not be limited in the current context	Disagree						Agree
G Consistent government policy is important	Disagree						Agree
H Active involvement of public sector is important	Disagree						Agree
I Use of open standard (open source) technology is important	Disagree						Agree
J Supportive community is important	Disagree						Agree
K Multiple involvements of consortium in ICT projects	Disagree						Agree
L Higher level intervention to the project disturb the optimal output	Disagree						Agree

4. What is the percentage of urbanization in your effective government territory? (if you are from the separate department, what is the tentative number of the subscriber who lives in the urban area?)
 - a) Less than 20%
 - b) 20% to 40%
 - c) 40 to 60%
 - d) 100%
5. In order to minimize the public investment, do you want to collaborate with the neighboring local government or other organizations?
 - a) Yes
 - b) Depends on projects and private sector's intention and other government agencies

Section C

1. Please encircle if one of the following that suits about your academic Qualification:
 - a. High school
 - b. Bachelor level
 - c. Master level
 - d. PhD
 - e. Some trainings
2. What is your experience in government organization(s) (_____ in Years)
3. What is your responsibility in Government:
 - a. If you are elected personnel: a) Mayor, b) Vice Mayor c) Member
 - b. If you are regular staff please mention your position: (_____)
4. Are you familiar with e-Government (ICT) project and services
 - a. Yes
 - b. No
5. What is your type of government organizations
 - a) Local government (Rural/Municipality)
 - c) State Government
 - d) Federal Government
 - e) Separate Department (in case your organization has national scope)

Thank you very much your time and cooperation

Thank you for your kind cooperation
Bikram Acharya
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HP: - [REDACTED]

Appendix B

Checking Model Stability

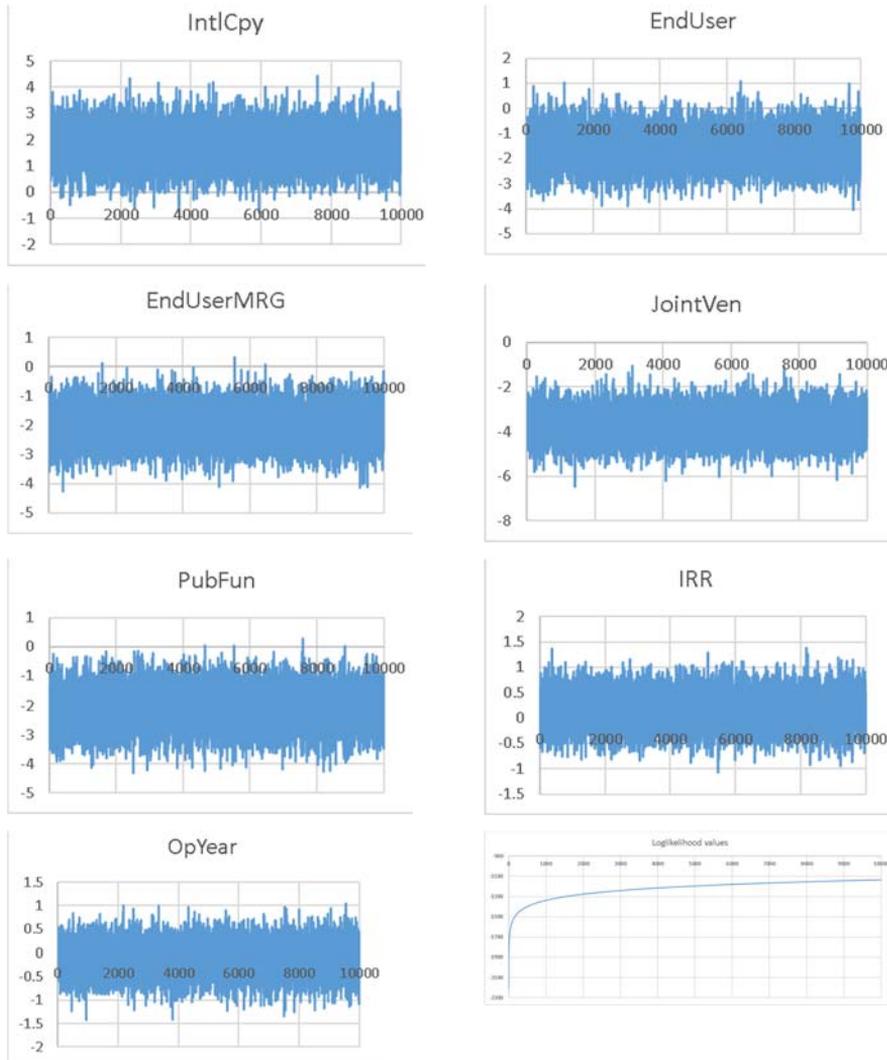


Figure 7 Plot of beta parameter against the number of draws

Appendix C

Plot of beta parameter

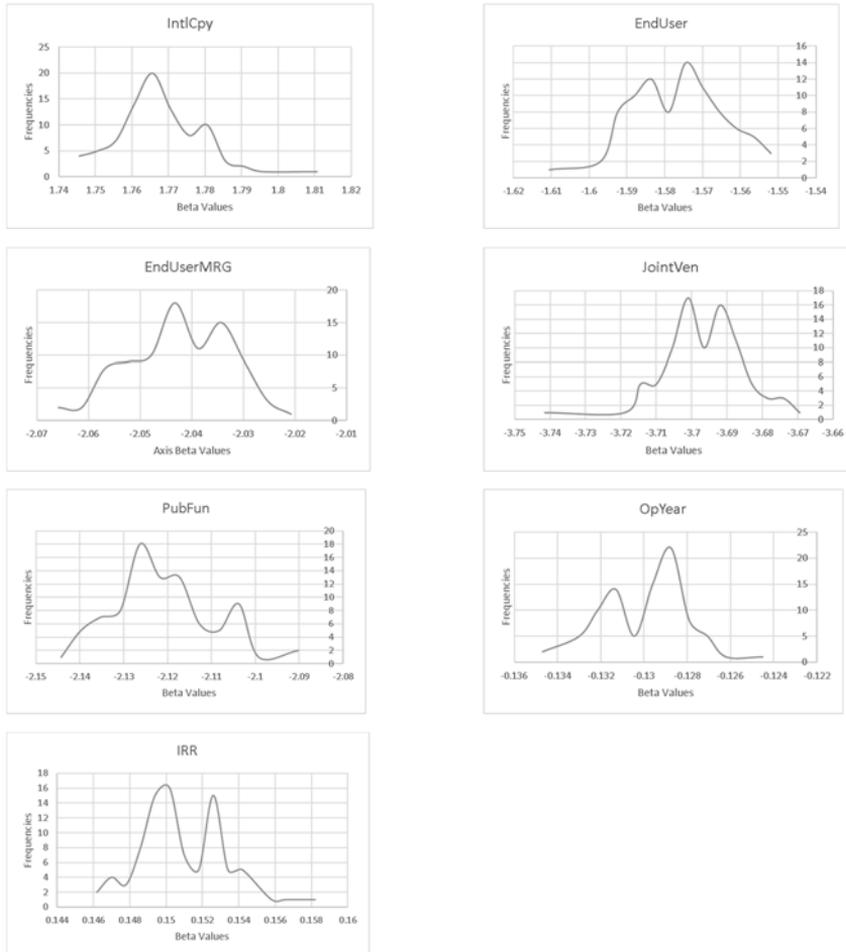


Figure 8 Plot of individual beta parameter

초록

공공 ICT 인프라와 서비스는 현대 경제의 핵심 구성 요소로서 정부 서비스와 시민의 연결의 효율을 높이는데 결정적인 역할을 수행한다. 현재 전세계의 정부들은 거대한 자원을 투자하여 자신들의 우선순위에 따른 공공 ICT 인프라와 서비스 개발에 집중하고 있다. 정부가 다양한 시민들의 니즈를 효율적으로 충족할 수 있는 공공 ICT 인프라와 서비스를 개발하기 위해서는 어떤 ICT 인프라가 정부 서비스 제공의 효율을 증가시킬 수 있는지 파악하는 것이 중요하다.

현재까지 일반적인 투자와 민간합작투자사업(PPP, Public-Private Partnership) 메커니즘을 통한 공공 ICT 서비스 및 인프라 설치에 대한 정부의 인식을 분석하는 연구는 수행되지 않았다. 본 연구에서는 네팔의 다양한 정부 기관 및 이해 관계자들이 공공 ICT 인프라 및 서비스 설치에 대한 인식을 분석하고, 이를 선진국들의 전략과 비교하여 향후 공공 ICT 인프라 및 서비스 구현을 위해 도입해야 할 정책적 함의를 제공한다. 본 연구에서는 PPP 메커니즘을 통해 ICT 인프라와 서비스를 구현하려는 정부의 인식을 분석하기 위해

진술선호(Stated Preference) 분석을 사용한다. 일반적으로 PPP 메커니즘은 제한된 정부 자원 하에서 민간 자원을 활용하여 공공 기반 시설을 개발하기 위해 활용된다. 대부분의 PPP 사업은 성공적인 운영을 위해 프로젝트와 관련된 재정적 위험을 프로젝트 개념화의 초기 단계부터 파트너 간으로 이전하는 위험 공유 메커니즘이다. 하지만, 재정적 위험과 인센티브를 공유하는 과정에서 민간 부문과 정부의 의견이 충돌할 수 있다. 그렇기 때문에, 이러한 공유 과정에서 민간 부문과 정부가 겪는 심리적 요소를 정확히 이해하는 것은 정부의 PPP 메커니즘을 통해 ICT 프로젝트를 진행하는데 대한 인식을 분석하는데 중요한 역할을 한다. 따라서, 본 연구에서는 Mixed Logit 모델을 사용하여 PPP 메커니즘을 통해 ICT 프로젝트를 수행하는데 있어 다양한 정부 기관들의 이질적인 선호를 분석하였다. 정부의 의사 결정 기구는 다양한 사회적, 경제적 배경과 이해 집단으로 구성되었다. 정부의 의사 결정 절차는 민주적 절차에 따라 이루어지며 일반적으로 특정 의제에 대해 서로 다른 의견을 가진 집단으로 분류된다. 본 연구는 정부 잠재계층모델(Latent Class Model)을 활용하여 정부의 의사결정자들이 PPP 프로젝트와 관련된

위험을 공유하는데 어떤 인식을 가지는지를 분석하였다. 또한 이들의 인식 결과를 기반으로 의사 결정자들을 특정 의제에 찬성, 또는 반대하는 그룹으로 구분하였다. 분석 결과 PPP 를 통해 ICT 프로젝트를 수행하기위한 위험을 공유하는데 있어 서로 다른 견해를 가진 두 그룹의 의사 결정권자가 있음을 알 수 있었다.

지방 정부는 필요와 가용 자원에 따라 정책의 우선순위를 정하며, 본 연구에서는 이러한 과정을 구현하기 위해 다중이산연속선택모형(MDCEV)을 활용하여 예산 제약하에 지방 정부의 공공 ICT 인프라와 서비스 개발 우선 순위를 도출하였다. 다중이산연속선택모형(MDCEV)의 연구결과는 예산상의 제약으로 인해 PPP 메커니즘을 통한 공공 ICT 인프라와 서비스 개발의 우선 순위가 어떻게 영향을 받는지 나타냈다.

키워드: 공공-민간 협업, ICT 인프라/서비스, 개발 우선 순위, 의사 결정, 이질성, 네팔