A Prospect for the Implementation of Public-private Partnership in Housing Provision in Ethiopian

Eyob Wondwossen Dejene

A Thesis Submitted to the Department of Civil Engineering

School of Civil Engineering and Architecture

Presented in Partial Fulfilment of the Requirement for the Degree of Master's in Civil Engineering (Specialization in Construction Engineering and Management)

Office of Graduate Studies

Adama Science and Technology University

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DECLARATION

I declare that this thesis/dissertation entitled "**A Prospect for the Implementation of Public-private Partnership in Housing Provision in Ethiopia**" is my work and has not been submitted to any university for similar purposes. Proper citations duly recognize the references used in this thesis.

Eyob Wondwossen Dejene	_____	_____
Name of the student	Signature	Date

RECOMMENDATION OF ADVISOR

I, the advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled "**A Prospect for the Implementation of Public-private Partnership in Housing Provision in Ethiopia**" prepared under my guidance by Eyob Wondwossen Dejene submitted in partial fulfillment of the requirements for the degree of Masters of Science in Construction Engineering and Management. Therefore, I recommend the submission of the revised version of the thesis to the department following the applicable procedures.

Fikreyesus Demeke (Ph.D.)	_____	_____
Advisor/Supervisor	Signature	Date

APPROVAL OF THE ADVISOR

I, the advisor of the thesis entitled "**A Prospect for the Implementation of Public-private Partnership in Housing Provision in Ethiopia**" developed by Eyob Wondwossen, hereby certify that the recommendations and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

Fikreyesus Demeke (Ph.D.)	_____	_____
Advisor/Supervisor	Signature	Date

APPROVAL OF BOARD REVIEWERS

We, the undersigned, members of the Board of Examiners of the thesis by Eyob Wondwossen, have read and evaluated the thesis entitled "**A Prospect for the Implementation of Public-private Partnership in Housing Provision in Ethiopia**" and examined the candidate during the open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Construction Engineering and Management.

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Office of Postgraduate Studies, Dean	Signature	Date

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ABSTRACT

Access to housing is a serious problem in Ethiopia, particularly in Addis Ababa, where the demand is high. Exploring public-private partnerships (PPPs) is crucial to address such issues. This study aims to explore the prospect for the implementation of PPPs in Housing Provision in Ethiopia. To achieve this, a fuzzy rating scale questionnaire was used to identify key drivers and enablers of PPP adoption in housing provision. The collected data underwent fuzzy analysis and factor analysis resulting in the identification of critical factors and their categorization into principal groups. Furthermore, through the use of fuzzy synthetic evaluation, driving and enabling indices at the group level was identified, resulting in the development of evaluation models. Interpretive Structural Modeling (ISM) was also used to examine the interrelationships between factors influencing the choice of a suitable PPP model for a housing project. The study's findings revealed that the driving force behind adopting PPP in the housing provision is very high in Ethiopia, indicating a very high need for PPP-related solutions to the current challenges in housing provision. In this regard, the study identified ten critical factors that drove the adoption of housing PPP, among them, the private sector's ability to raise funds for public projects, save time in delivering projects, better risk transfer and sharing, facilitate creative and innovative approaches, and acceleration infrastructure provision are the five top-ranked drivers. Furthermore, the study identified twenty-seven critical factors that are highly significant in enabling the successful implementation of PPP in housing provision. The top five factors include establishing well-organized and committed PPP units, political stability, in-time land acquisition, right project identification and project technical feasibility, and appropriate risk identification and risk sharing. Moreover, the study has investigated that the choice of the PPP model for housing projects is influenced by various factors. These factors encompass the preferences of stakeholders, the distinctive characteristics of the project, and the prevailing local conditions. These factors are interconnected and mutually influential, signifying the sensitivity of the model selection process. Using these factors, the study developed a framework for selecting the suitable PPP modality for housing projects. These findings provide practical insights and frameworks for policymakers and practitioners to effectively implement PPPs in the housing sector.

Keywords: *Public-Private Partnership (PPP); housing provision; driving factors; enabling factors; model selection factors, model selection framework; Interpretive Structural Modeling (ISM); fuzzy*

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronyms	Full Name
BBO	Buy-Build-Operate
BLOT	Build-Lease-Operate-Transfer
BLOT	Build-Lease-Operate-Transfer
BLT	Build-Lease-Transfer
BOO	Build-Own-Operate
BOOT	Build-Own-Operate-Transfer
BOT	Build-Operate-Transfer
BTL	Build-Transfer-Lease
BTO	Build-Transfer-Operate
CVI	Content Validity Index
DB	Design-Build
DBF	Design-Build-Finance
DBFM	Design-Build-Finance-Maintain
DBFO	Design-Build-Finance-Operate
DBFOM	Design-Build-Finance-Operate-Maintain
DBFOMT	Design-Build-Finance-Operate-Maintain-Transfer
DBM	Design-Build-Maintain
DBO	Design-Build-Operate
DBOM	Design-Build-Operate-Maintain
DI	Driving Index
DSCR	Debt-Service Coverage Ratio
EI	Enabling Index

FA	Factor Analysis
FDRE	Federal Democratic Republic of Ethiopia
FHC	Federal Housing Corporation
FMF	Fuzzy Membership Function
FSE	Fuzzy Synthetic Evaluation
FST	Fuzzy Set Theory
I-CVI	Item Level Content Validity Index
IRR	Internal Rate of Return
ISM	Interpretive Structural Modeling
KMO	Kaiser-Meyer-Olkin
MF	Membership Function
MICMAC	Cross-Impact Matrix Multiplication Applied to Classification
O & M:	Operation & Maintenance Contract
OMM	Operation-Maintenance-Management
PC	Principal Component
RLT	Rehabilitate-Lease-Transfer
ROT	Rehabilitate-Own-Transfer
SD	Standard Deviations
SPSS	Statistical Package for Social Science
SSIM	Structural Self-Interaction Matrix
UN	United Nations
PPP	Public-private partnerships
TFN	Triangular Fuzzy Number
IMF	International Monetary Fund

PFI	Private Financing Initiative
MOF	Ministry of Finance
OECD	Organization for Economic Cooperation and Development
PPA	Power Purchase Agreement
PPIAF	Public Private Infrastructure Advisory Facility
PPP DG	Private Partnership Director General
SPSS	Statistical Package for the Social Sciences
SPV	Special Purpose/Project Vehicle
UK	United Kingdom
VFM	Value for Money WB World Bank
ROO	Rehabilitate-Own-Operate
ROT	Rehabilitate-Own-Transfer
RLT	Rehabilitate-Lease-Operate

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

As an infrastructure access to housing is an important tool for ensuring basic living conditions for people, stabilizing society, keeping social harmony, and promoting economic development (Qin et al. 2017). However, the international community recognizes that increasing the provision of housing to the public is one of the major development challenges of the twenty-first century. This challenge is even more severe in developing economies with high populations (Ojebode 2016). UN-HABITAT (2011) also confirmed that access to housing has been a major issue and concern of governments in many developing countries, particularly in sub-Saharan Africa. In this context, Ethiopia faces a similar challenge, as the accessibility of affordable housing presents a significant obstacle, which is even more severe in the capital, Addis Ababa (Tesfaye 2007). The Ethiopian government has taken many approaches to alleviate the problem but, poor land management practices, lack of diversified housing delivery systems; the absence of a robust and affordable housing construction industry; and the absence of a diversified housing financing system are all factors that hinder the process (Bishu 2017).

Public-private partnerships (PPPs) are widely used to finance projects, build infrastructure, and deliver services as they bring together the strength of both the public and private sectors (Chan et al. 2009; Cui et al. 2018). PPP utilizes the efficiencies and innovations of private enterprises and can provide much-needed capital to finance public programs and projects, thereby freeing public funds for core economic and social development programs (Chan et al. 2009). To employ this benefit in alleviating the prevailing housing shortage, governments around the world are turning to PPP as one possible financing option for large-scale investments in the provision of housing (UN-HABITAT 2011a). PPP has been adopted in the housing sector as a part of the enabling approach, this is because delivering housing through PPP offers better value for money compared to the conventional method, facilitates the delivery of affordable housing, encourages the utilization of private sector innovation and management skills, and allows risk sharing (Kavishe et al. 2019a).

The potential of PPP in addressing public infrastructure need is also evident in developing countries as it provides private funding, offers better risk allocation, utilizes private sector skills

and experience, offer value for money, certainty of project time and cost, and improves the quality of service (Debela 2022c; Kavishe and Chileshe 2018; Robert et al. 2014c; Yuan et al. 2010, 2012). Therefore, governments around the globe are turning towards PPP arrangements to address massive public infrastructure needs. In this regard, the government of Ethiopia has also understood the need for mobilizing resources from different sources to meet the growing demand for public infrastructure (Debela 2022a). Accordingly, the government has initiated the implementation of affordable housing in PPP modalities with the involvement of the Ministry of Finance (PPP Directorate General), Federal Housing Corporation, and the Addis Ababa City Administration (FDRE PPP Directorate General 2021).

Even if the implementation of PPP is a valuable approach, it does not provide a guaranteed solution to the housing problem. Challenges including insufficient PPP expertise, inadequate contracting and tendering documentation, inadequate legal framework, misinformation regarding the financial capabilities of private partners, poor risk allocation, and inexperienced private partners hinders the effectiveness of PPP in many countries (Jacobson 2013; Kavishe et al. 2018; Muhammad et al. 2018). Therefore, identifying the key drivers and enablers of PPP implementation for housing provision is crucial. Because identifying the key drivers can reveal potential PPP solutions to address current delivery challenges (Cherkos and Jha 2021a; Kavishe and Chileshe 2018). Simultaneously, identifying the enabling factors can help ensures that essential conditions are met before implementation, predict project outcomes, and focusing on them during implementation greatly enhances the chance of success (Debela 2022b; Ng et al. 2012; Sanni 2016).

Furthermore, different types PPP models exist DBF, DBFM, DBFOM, and so on, which differs basically in asset type, risk transfer, and how the private party compensated for its role in the partnership (MOHUA 2017; World Bank 2017, 2020). These models are evolved to adapt to the changing project characteristics and stakeholder preferences (Cherkos et al. 2020b). Every project has unique characteristics (Ahadzie et al. 2008) and each government has a distinct objective behind the adoption of the system (Kavishe et al. 2019b; Numminen 2022), emphasizing the importance of selecting a fitting PPP model that aligns with project traits, stakeholder preferences, and prevailing conditions for successful implementation.

There also exist differing interests and goals of the private and public sectors. Private sectors prioritize technical feasibility and multiple benefits for successful infrastructure project implementation, focusing on partnership benefits and profits. Conversely, the public

emphasizes timely project execution and social benefits (Olusola Babatunde et al. 2012). Despite varying and sometimes conflicting stakeholder interests, decision-makers must select a viable PPP model that effectively addresses public accountability, commercial interests, and social considerations for government, investors, and the community (Xie and Thomas Ng 2013).

This initiated the need to standardize PPP implementation process. A step in this direction involves creating PPP model selection factors. These factors aid decision-makers in choosing the right model considering project traits, local conditions, and stakeholder risk preferences (Cherkos et al. 2020b). Developing such criteria empowers decision-makers to evaluate PPP options, identifying the most suitable model for minimized conflicts and increased project success (Xie and Thomas Ng 2013). In the context of housing PPP's unique nature and complexity, standardizing the process is vital (World Bank 2020; MOHUA 2017) .

Moreover, standardizing PPP agreements enhances project financing potential by providing clarity and transparency to stakeholders. This approach enables private investors to understand public sector expectations, promoting trust and confidence, and resolving concerns over political will (Mahalingam 2010). However, developing project-specific contracts through PPPs leads to higher costs and reduced competition (Van Den Hurk and Verhoest 2016). Conversely, standardizing contracts proves cost-effective and efficient, benefiting less-experienced governments with adaptable mechanisms, streamlining procurement for similar projects. Critics point out rigidity issues but suggest diverse PPP models tailored to project specifics (Yong 2010). But, the practice of employing standardized contracts is not as prevalent in long-term and high-risk PPP procurement (World Bank 2019).

Globally, some governments improved PPP procurement management by devising standardized components for contract design. Countries like India streamlined the PPP bidding process through standardized documents for diverse PPP models (World Bank 2017). Yet, developing countries like sub-Saharan Africa struggle due to PPP inexperience and lack of standardized contracts, hindering project success (Cherkos et al. 2020b). Hence, for nations like Ethiopia it is important to establish or adopt relevant standardized PPP models, as it bridges the experience gaps and facilitate the successful implementation of the system. Moreover, housing projects exhibit distinctions in PPP application when compared to projects in other sectors. These variations are evident in the in terms of social objectives and associated risks, long-term consequences, government participation, funding mechanisms, and regulatory

structures. Consequently, numerous PPP models must undergo adjustments to align with the unique requirements of the housing projects (MOHUA 2017).

Despite the government's efforts to introduce PPP in the housing sector and the evident potential of the system in minimizing the housing shortage faced by the country, no research has been conducted to study the prospects of PPP implementation in the Ethiopian housing provision. Therefore, the purpose of this study is to explore the reasons for adopting PPP in housing provision, with the goal of facilitating its successful implementation in the Ethiopian housing sector. This research also aims to identify the factors that influence the selection of PPP model for housing project. Furthermore, the research aimed to develop a framework that assist the decision-making process in selecting suitable standardized PPP model for housing projects. Accordingly, the research findings will provide valuable insights for PPP and housing policymakers, aiding in the effective implementation of such partnerships in housing provision. Furthermore, this study will contribute to the advancement of knowledge in this field and encourage further research on the successful use of PPPs in Ethiopia's housing sector and beyond.

1.2 Statement of the problem

Insufficient housing finance, a shortage of skilled manpower, and rapid urbanization pose challenges in providing adequate and quality housing in developing countries. These challenges, in turn, contribute to reduced economic development and lower living standards (Cheng et al. 2016; Kolo et al. 2014; Makinde 2014). In developing countries like Ethiopia, access to housing is a substantial problem, particularly worsen in capital Addis Ababa due to rapid urbanization, leading to an extremely high demand for housing (Ojebode 2016; Tesfaye 2007). Challenges such as a lack of diversified housing delivery systems and financing system further hinder the progress in alleviating this problem (Bishu 2017). Consequently, to address such issue and improve living conditions, exploring public-private partnerships (PPPs) becomes crucial (Robert et al. 2014a). In this regard, the Ethiopian government has proactively initiated the implementation of PPPs in the housing sector to address the significant housing shortage prevalent in the country (FDRE Ministry of Finance 2021).

PPP bridges the gap caused by insufficient government funding for infrastructure. It provides benefits such as access to private capital, specialized skills, and innovative approaches for the execution of public projects (Babatunde et al. 2012b). These provide a long-term solution for

enhancing social infrastructure and maximizing the value of public assets (Li and Akintoye 2003), by serving as a key tools that enable governments and the private sector to collaborate for mutual benefit by agreeing to share risks, costs, and benefits (Muhammad and Johar 2019).

In doing so, the prior step to implementing PPP in delivering public projects is to identify the driving factors that trigger the government to engage in this arrangement, because these driving factors could be understood as potential PPP solutions to the current challenges in housing provision (Cherkos and Jha 2021a). Previous studies have revealed that the distinctive attributes of PPP in each country affect its attractiveness, as evidenced by variations in the factors driving PPP adoption across different nations (Chan et al. 2009; Chou and Pramudawardhani 2015a; Debela 2022c; Liu and Wilkinson 2011a; Numminen 2022; Robert et al. 2014c). Moreover, the motivations for adopting PPP can differ from one sector to another (Yuan et al. 2010, 2012). In this regard, Ethiopia has a distinctive political, economic and social system for private sector investment in the infrastructure sector (Debela 2022c). However, there has been no research conducted to explore the driving factors behind PPP adoption in the Ethiopian housing sector. Therefore, it is crucial to examine these driving factors within the Ethiopian context particularly to the housing sector.

Despite the global interest of governments in PPP and its high potential of success in addressing massive infrastructure needs, its implementation in various countries is still experiencing obstacles that hinder its effectiveness in achieving its goals (Damoah et al. 2020; Kavishe and Chileshe 2019). The challenges and barriers in the implementation of PPP are also highly apparent in housing sector, which causes the system to fail in achieving it goals (Batra 2021; Jacobson 2013; Kavishe et al. 2018; Kavishe and An 2016; Muhammad et al. 2018; Trangkanont and Charoenngam 2014). To overcome the challenges from the beginning and to achieve the objectives it is important for countries to investigate the enabling factors that could facilitate the successful implementation of the system (Cheung et al. 2012b; Debela 2022b; Ng et al. 2012).

Additionally, considering the availability of diverse PPP models that can accommodate project characteristics and stakeholder preferences (Cherkos et al. 2020), choosing an appropriate PPP model to fit the project circumstances is essential to successfully implement the system (Zhang et al. 2016). This stimulates the requirements of a systematic selection approach for aiding decision-making (Chan et al. 2001). In this regard, developing PPP model selection criteria that accommodates project characteristics, stakeholder's preference, and prevailing local condition

that influence stakeholders capacity and preference in risk taking (Cherkos et al. 2020) enables decision-makers to evaluate and compare different PPP alternatives and identify a suitable model that could satisfy stakeholders preference and minimize the conflict thereby ultimately increasing the chance of success of a PPP project (Xie and Thomas Ng 2013). Additionally, as it can be seen from Cherkos et al. (2020) there exist interconnection between model selection factors and developing logical interconnections between the factors helps decision-makers select a specific model according to the characteristics of the project and the stakeholders' response to the project.

Furthermore, countries that are new (inexperienced) to PPP needs to standardize or adopt already standardized PPP models that meets their objective, this bridges the experience gap and facilitate the successful implementation of the system (Cherkos et al. 2020). Because standardized contracts can help governments with weak capacity and experience in PPPs to streamline PPP procurement by providing adaptation mechanisms within the scope of the contract (Mahalingam 2010; Yong 2010). In addition, developing framework that assist decision makers in selection the appropriate PPP model using PPP modality selection factors can further standardize the process, maximize the project value by reducing the rebidding and failure possibility of projects due to a lack of interest from private sector entities and lenders, and provide more flexibility to decision makers to select a suitable model satisfying the interests of all the stakeholders (Cherkos et al. 2020).

However, there is a lack of studies in the context of housing PPPs that focus on identifying factors for selecting PPP models and development of model selection frameworks. Housing PPPs exhibit distinct characteristics compared to other sector PPPs (MOHUA 2017; World Bank 2020). These unique characteristics create challenges or even make it impossible to apply findings from previous studies related to selection factors and frameworks that focus on other sectors, as the determinants of success are likely to be unique to projects with specific characteristics (Ahadzie et al. 2008). This indicates the necessity of identifying the factors that influence the selection of PPP models and developing a model selection framework customized to the specific context of housing in Ethiopia.

In this regard, the study explored the driving factors triggering the adoption of PPP for housing provision in Ethiopia. It uncovered the underlying reasons for choosing this system as a potential solution to the current housing delivery challenge. Additionally, the research explored the factors that enabled the successful implementation of the system, aiming to minimize

possibility of failure and contribute to resolving housing issues. Furthermore, the study identified PPP model selection factors to aid decision-makers in choosing the appropriate PPP model for housing projects. After selecting standardized PPP models that aligns with the Ethiopia's objectives behind PPP adoption in housing provision, the research also developed a framework to aid decision-making process in selecting the most appropriate PPP model among the standardized options. This helps to standardize the process, bridge experience gaps, and ensure effective implementation of PPP in housing provision in Ethiopia.

1.3 Objective of the study

1.3.1 General objective

The general objective of the research is to explore the prospect for the implementation of Public-Private Partnerships in Housing Provision in Ethiopia.

1.3.2 Specific objectives

- To identify the key drivers for the adoption of public-private-partnership in the provision of housing in Ethiopian.
- To identify the critical factors that enables the successful implementation of public-private-partnership in the provision of housing in Ethiopian.
- To identify the factors that influences the selection of public-private-partnership model for housing projects and investigate the influence of one factor on the other using Interpretive Structural Modelling (ISM).
- To develop a framework that assists the decision-making process in selecting an appropriate public-private partnership models for housing projects.

1.4 Research Questions

In order to address the aforementioned objectives, the study sets forth the following questions that must be answered by the end of the research.

- What are the driving factors that triggered the adoption of public-private partnerships in the provision housing in Ethiopia?
- What are the critical factors that can enable the successful implementation of public-private partnerships in the provision of housing in Ethiopian?
- What are the criteria for selecting the appropriate public-private partnership modality for housing projects?

- How to support the decision-making process in selecting a suitable public-private partnership model for housing project?

1.5 Significance of the study

Public sectors worldwide are increasingly prioritizing public-private partnerships as a means to finance projects, develop infrastructure, and deliver services. In the case of the government of Ethiopia, this research aimed to investigate the driving factors that have led the adoption public-private partnerships for housing provision. This examination will help the government clarify the primary reason behind adopting this system. Furthermore, it will enable the private sector involved in these partnerships to understand the government's objectives, fostering a common understanding and collaborative effort to maximize potential benefits from the system. Additionally, this exploration will assist the government in identifying PPP-related solutions to address existing challenges in the housing provision. It will also ensure that any actions taken within the framework of the system remain aligned with the established objectives.

Additionally, due to the nature of public-private partnership contact, several factors contribute to the complexity of this system, including the long-term nature of PPP contracts, the involvement of multiple stakeholders, sensitivity of the system to political instability and macroeconomic risks, and the country's relative inexperience with the system. This research aimed to explore the key factors or conditions that enable the successful implementation of public-private partnerships (PPPs) in providing housing in Ethiopia. By identifying these enabling factors, the research contributes to minimize the potential for failure by ensuring that essential conditions are met before implementation. This approach maximizes the likelihood of success and, ultimately, helps reduce the severe shortage of housing facilities in the country. Additionally, this research can facilitate the assessment of the adequacy of the country’s resource and condition to successfully execute the project with the selected model.

Moreover, this research identified factors that influence the selection of public-private partnership (PPP) models. These factors will enable the selection of the most suitable PPP modality that fits the project characteristics, stakeholder preferences, stakeholder capacity, and the prevailing local condition. This can maximize the potential success of the project. Additionally, by utilizing these selection factors, the research developed a framework to guide the decision-making process in choosing the appropriate PPP model for a proposed housing

project. This framework serves to support and standardize the decision-making process and provide a structured approach for decision-makers.

In conclusion, the outcome of the research will provide public-private partnership and housing policy makers with practical inputs and framework to support the implementation of public-private partnership in housing sector. Furthermore, the study will expand knowledge in this area and will encourage researchers to conduct further studies and highlight the effective implementation of the system in housing sector of Ethiopia and other countries.

1.6 Scope of the study

PPP is a broad concept used by governments to develop infrastructure and provide services in various sectors and most empirical studies on PPP implementation have centered on many themes (i.e. risks, relationships, critical success factors, PPP challenges, PPP driving and attractive factors, financing/value for money, and etc.). However, this research studies the prospect for the implementation of PPP in the provision of housing in Ethiopia. In this regard, this research focuses on identifying the drivers that trigger the government of Ethiopia to adopt PPP to provide houses to the public. Furthermore, this research explores into the key factors that enables to the effective implementation of the public-private partnership in the provision of housing in Ethiopia. It also focuses on the identification of identifying the factors that influence the selection a suitable PPP model for housing projects.

In the development of a decision support framework for selecting PPP modes in housing projects, this research focuses exclusively on standardized PPP models developed by the World Bank, inspired by successful initiatives in India. These specific models are chosen due to their suitability in aligning with the objectives of adopting PPP in housing provision, particularly in emerging markets where PPP is gaining prominence. Despite the availability of various PPP models tailored to project characteristics and stakeholder preferences, this research centers on the World Bank-developed models to better address the objectives of PPP implementation in the housing sector of developing nations where PPP market is emerging.

1.7 Limitations of the study

Due to Ethiopia's lack of experience in public-private partnerships, the research was able to access a limited number of experts to participate in the study. Because of difficulties in

accessing the required data for framework validation through case study, the study relied solely on expert opinions for validation.

1.8 Organization of the study

This thesis consists of five chapters, each serving a distinct purpose. The details of each chapter are outlined below.

Chapter one of this thesis is the introduction of the research, and is devoted to providing a general overview of the research. This chapter includes the background of the study, a statement of the problem, the objective of the research, the research questions, the significance of the study, scope of the study, and the limitations of the research. This sets the foundation for the entire study and establishes the context and importance of the research topic.

Chapter two of this thesis is dedicated to the literature review section, which delves into an extensive examination of relevant literature. The chapter begins with a general overview of its contents and proceeds to establish a theoretical foundation for understanding public-private partnerships. It further explores the potential implementation and current status of such partnerships in Ethiopia. The section also provides a comprehensive literature review, drawing insights from previous research, on the driving factors, enabling factors, and selection criteria for PPP models focusing on the housing sector. And the section ends by providing the research gap, which forms the basis of the research.

Chapter three of this thesis is the Research Methodology, which provides an overview of the research methodology, including the respondent selection process, data collection tools, data analysis method, and the overall steps involved in conducting the research. The chapter also briefly presents the process of developing a framework that assists the decision-making process in selecting the appropriate PPP models for housing projects.

Chapter four of this thesis is the Results and Discussion section of the research paper, which provides a comprehensive overview of the research findings and their implications. It entails presenting the key findings in a clear manner, analyzing their significance in relation to the research questions, comparing them with previous studies to provide contextual understanding, and discussing the implications of the findings for theory and practice. Additionally, this section presents the proposed decision support framework.

Chapter Five of the thesis encompasses the Conclusions and Recommendations section, serving as a summary of the findings discussed in the preceding chapter. The study concludes by emphasizing the contributions made to the existing literature, acknowledging the limitations of the research, and offering recommendations for future studies.

1.9 Operational definitions

The operational definitions of the basic terms that are used in this research are clearly outlined in below, as stated in the Ethiopian PPP framework provided by the PPP proclamation no. 1076/2018 of Ethiopia.

Public Private Partnership (PPP): means a long-term agreement between a Contracting Authority and a Private Party. The Private Party agrees to carry out a Public Service Activity that would otherwise be done by the Contracting Authority. In return, the Private Party receives benefits, which can be compensation from the Contracting Authority, tariffs or fees collected from service users or consumers, or a combination of both. Additionally, the Private Party is generally responsible for the risks associated with performing the activity or using state property, as outlined in the Project Agreements.

Contracting Authority: means a Public Body or Public Enterprise which intends to enter into a Public Private Partnership Agreement with a Private Party.

Public Body: means any organ of the Federal Government' which is wholly financed by the Federal Government budget.

Private Party: means a party that enters into a Public private partnership Agreement with a Contracting Authority.

Public Service Activity: means any activity the government has decided to perform for the reason that it has deemed it to be necessary in the general interest of the public and considered that private initiative was inadequate for carrying it out.

Public Private Partnership Agreement: means a contract concluded between the Contracting Authority and a Private Party setting forth the terms and conditions of the Public Private Partnership.

Project Agreement: means the public Private Partnership Agreement and other agreements entered into between the Contracting Authority or another public Entity and the private party for the purpose of the project.

Project company (SPV): means the legal entity incorporated under the laws of the FDRE by the successful bidder whose sole purpose shall be to execute and implement the public-private partnership agreement and other project agreements, if any.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The literature review chapter of this research conducts a thorough analysis of existing scholarly works and relevant studies that establish the groundwork for the present investigation. This chapter delves into key themes, theories, and empirical findings to place the research within the broader academic conversation. By critically assessing the existing state of knowledge in the field, and identifying gaps, the literature review prepares the foundation for the upcoming chapters. It achieves this by offering a strong theoretical framework and guiding the research methodology. By synthesizing previous research, this chapter aims to contribute significant insights to the ongoing discourse and advance the comprehension of the research topic. The following figure graphically represents the content, organization, and flow of the literature review.

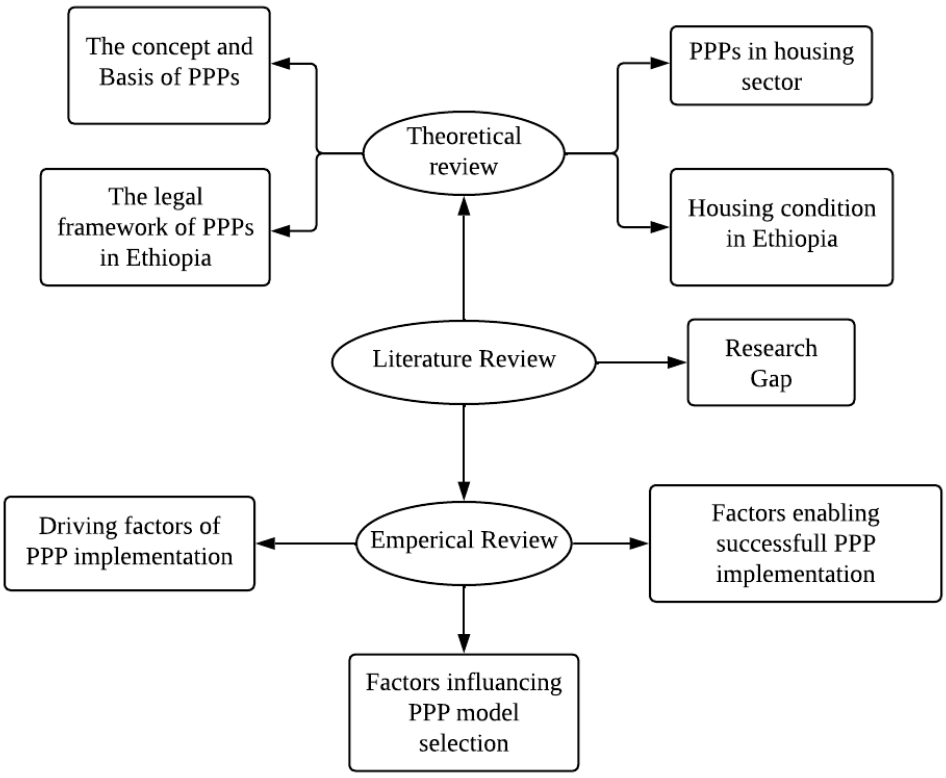

Figure 1. organization of the literature review

2.2 Theoretical Review

The theoretical literature review in this study explores the fundamental concept of public-private partnerships (PPPs) and their fundamental principles. It delves into the application of PPPs within the housing sector, examining how this collaborative approach has been implemented to address housing challenges in many countries. Additionally, the review provides an overview of the prevailing housing conditions in Ethiopia, setting the stage for understanding the potential significance of PPPs in improving the housing landscape.

2.2.1 The Concept and Basis of Public-Private Partnership

2.2.1.1 The Definition of Public-Private Partnership

PPPs have been a vital component of infrastructure procurement strategies for various governments (Liu et al. 2017). In essence, a PPP is a procurement approach that establishes contractual relationships between the public and private sectors to develop assets and deliver infrastructure-related services (Australian Government 2008). These services are typically provided by the public sector (Delmon 2010). However, there is no consensus on the definition of PPPs due to the differences in terms of legal, financial, political, economic, cultural, and industrial backgrounds by countries and organizations (Zhang et al. 2016). Each country has also adopted and customized the definition of PPP in its laws, based on its own institutional and legal requirements. In many cases, definitions of PPP have been created more for convenience and consistency with existing laws and other private sector participation programs (World Bank 2017).

Hence, PPPs encompass diverse definitions from various reputable sources. The EC (2003) defines PPP as a partnership between the public sector and the private sector for the purpose of delivering a project or service traditionally provided by the public sector. According to the IMF (2006), PPP involves an arrangements under which the private sector supplies infrastructure assets and infrastructure-based services that traditionally have been provided by the government. Whereas, the OCDE (2012) characterizes PPP as long-term contractual arrangements between the government and a private partner whereby the latter delivers and funds public services using a capital asset, sharing the associated risks.

Additionally, the World Bank (2017) describes PPP as a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party

bears significant risk and management responsibility and remuneration is linked to performance. Klijn and Teisman (2003) define PPP as co-operation between public and private actors with a durable character in which actors develop mutual products and/or services and in which risk, costs, and benefits are shared. Furthermore, the ADB (2008) defines PPP as a range of possible relationships among public and private entities in the context of infrastructure and other services. Despite the variations in PPP definitions across different approaches, they share several common features, including:

Cooperation between the public and private sectors throughout the project. Which is through the establishment of a relatively long-term contract between the public and private partners, typically lasting from 20 to 30 years, allowing the private sector sufficient time to recoup its investment costs (Xu et al. 2012). However, the concession period depends on factors such as the project type, contract type, and policy considerations. And funding for PPP projects can originate from either public financing or partially/entirely private financing arrangements (World-Bank 2017).

In PPPs, there is a clear distinction in focus between the public and private sectors. The public sector is responsible for defining the objectives and goals of the project, as well as monitoring compliance with these objectives. On the other hand, the private sector is primarily involved in the design, completion, implementation, and funding of the project (Liu et al. 2016). Additionally, PPPs involve the allocation of risks, either through the traditional transfer of some risks from the public sector to the private partner (Yuan et al. 2010), or through risk-sharing with the party best equipped to manage it at the lowest cost (Li et al. 2005b). This risk allocation mechanism is an essential characteristic of PPP arrangements.

Furthermore, the reason for establishing such partnerships vary but generally involve the financing, design, construction, operation, and maintenance of public infrastructure, facilities, and services. In other words, PPPs are not just about the private sector financing capital projects in return for an income stream, but also about the use of private sector skills and management expertise to deliver and operate public projects more efficiently over their lifetime (Babatunde et al. 2012a). The underlying logic for establishing partnerships is that both the public and the private sectors have unique characteristics that provide them with advantages in specific aspects of service or project delivery (Olanike et al. 2021).

In conclusion, the most successful partnership arrangements draw on the strengths of both the public and private sectors to establish complementary relationships. While the roles and responsibilities of the private and public sector partners may differ on individual servicing initiatives, the overall role and responsibilities of the public sector do not change. PPP is one of several ways of delivering public infrastructure, facilities, and related services. It is not a substitute for strong and effective governance and decision-making by the government. In all cases, the government remains responsible and accountable for delivering services and projects in a manner that protects the public interest (Chan et al. 2008).

Although various definitions for PPP are available, this research adopts the specific definition provided by the Ethiopian Proclamation No. I 076/2018.

The proclamation defines PPP as a long-term agreement between a contracting authority (government entity) and a private party. The private party agrees to carry out a public service activity that would otherwise be done by the contracting authority. In return, the private party receives benefits, which can be compensation from the contracting authority, tariffs or fees collected from service users or consumers, or a combination of both. Additionally, the private party is generally responsible for the risks associated with performing the activity or using state property, as outlined in the Project Agreements.

This definition encompasses all the essential characteristics of a broad spectrum of PPP schemes, making it suitable for this study. It incorporates several significant aspects. To begin with, it involves collaboration between the public and private sectors, which may pertain to the development of new project or services or the utilization of existing ones. Additionally, this cooperation is based on a long-term commitment. Furthermore, the primary objective is to deliver public assets or services. Inconclusion, risks are shared between both sectors and the compensation to the private party depends on its performance.

2.2.1.2 Privatization Vs Public-Private Partnership

Governments around the world have been utilizing various of contractual arrangements to deliver public services and infrastructure. These arrangements include the traditional procurement (Design-Bid-Build and Design-Build), public-private partnership, and privatization. These contractual arrangements basically differ in terms of private sectors involvement in the project scope and the ownership of the asset during and after of the

contractual period (Yescombe 2007). Where PPP offer a middle ground between traditional procurements and full privatization (Grimsey and Lewis 2004).

Under traditional procurement, the public sector outlines the desired quantity and quality of a particular service and enters into a single or separate contracts for the design and construction of an infrastructure facility (O'shea et al. 2019). Where the responsibility of financing the facility totally rests on the public sector, additionally the public sector manage and operate the facility itself or select an operator to do it (ADB 2018). Whereas, Under PPP and privatization, the public sector utilizes the capital of the private sector partner to deliver public service and facilities. However, there a clear difference between these two arrangements (ADB 2008)

Privatization is the process of transferring public assets and services to private-sector entities through a variety of methods, from the sale of shares or ownership in a company to the selling off of operating assets. It is most common in non-public service sectors such as manufacturing and construction. When privatization occurs in the infrastructure or utilities sectors, regulations associated with this transfer must be enforced to protect social welfare and policy interests related to public services (ADB 2008). Privatization became a fairly common tool for governments seeking to increase the use of markets to allocate resources (IMF 2006).

Unlike privatization, PPP involves a partnership between the public and private sector in which the government is working together with the private sector to provide public services or infrastructure projects. This model involves the sharing of responsibilities, risks, and rewards between public and private entities. PPP is designed to make use of the expertise and creativity of private sectors, allowing them to inject capital into public projects and programs. This way, government funds can be allocated toward other core economic programs and services that are critical for the nation's development (Li and Akintoye 2003).

According to MOHUA (2017), the distinction between privatization and Public-Private Partnership (PPP) can be summarized as follows: Privatization involves the private sector taking on the responsibility for delivering and funding a specific service. The ownership rights of the service are transferred to the private sector, along with associated benefits and costs. The private provider has the authority to determine the nature and scope of the services provided, and they also bear all the risks inherent in the business. In contrast, under a Public-Private Partnership, the government (public sector) retains the responsibility for providing the services. The legal ownership of assets may still remain with the government. The nature and scope of

the services are determined through a contractual agreement between the government and the private sector. In this arrangement, risks and rewards are shared between the government and the private sector, fostering a collaborative approach to service provision.

2.2.1.3 Principles of Public-Private Partnership

PPPs originated in the developed economies of North America and Western Europe, and over time, they led to the identification of key principles to guide their effective utilization and avoid potential pitfalls. Among the various sets of guidelines available, Canada's 8 "golden" rules stand out as a succinct way of capturing the essentials. These rules emphasize the importance of prioritizing the public interest, maintaining accountability and transparency throughout the project lifecycle, and meticulously planning and defining scope and objectives. Additionally, they stress the need to assess project viability against criteria set by the initiating partner, ensuring value for money and appropriate risk transfer, and conducting competitive and fair tendering processes with proper due diligence (The City Council of Calgary 2008).

Furthermore, these "golden" rules advocate for the integration of the needs of the targeted community into project Key Performance Indicators (KPIs) and responsible project management throughout the agreement's term, incorporating predictability and priority as determined by the partnership. By adhering to these principles, PPPs can effectively serve the public interest and achieve successful outcomes (The City Council of Calgary 2008).

2.2.1.4 Value for Money (VfM) in Public-Private Partnership

Obtaining value for money for a project is one of the main factor that drives governments to adopt and implement PPP to deliver services and public assets (Cherkos and Jha 2021a; Gebremeskel et al. 2021b; Kavishe et al. 2019b; Yuan et al. 2010). Value for money (VfM) is defined as the optimum combination of whole-of-life costs, risk, completion time, and quality (or fitness for purpose) of the good or service to meet the user’s requirement. The term whole-of-life is used to refer to the lifecycle of a good or service. VfM aids public agencies to determine whether to pursue a project as a PPP versus a traditional procurement (Treasury 2006).

In defining VfM, it is also important to determine the factors that contribute to the VfM of a project. In many cases, these factors may be called drivers of VfM. (Treasury 2006) outlines key drivers of Value for Money (VfM) in PPP projects. These drivers include optimal risk allocation among parties, consideration of whole-life costs rather than just upfront expenses,

integrated planning and design to reduce transaction costs and enhance competitiveness, using an outputs specification approach, rigorous risk transfer, flexibility to accommodate changes and technological advancements, appropriate incentives in the procurement process, determining the contract term based on the authority's service requirements, and ensuring sufficient expertise in both public and private sectors.

A study conducted by Ismail (2013) reveal that the following factors are perceived as “most important” to enhance the achievement of VFM for PPP implementation “private sector technical innovation” and “competitive tender” Efficiency risk allocation (allocating the risk to the party best able to manage it), Optimal use of asset/facility and project efficiency, Performance-based payment mechanism.

The main goal of involving the private sector in providing affordable housing as a social good or public service is to ensure superior Value for Money (VfM) compared to solely relying on public provision. Governments must assess if PPP is the better approach, determine the most suitable PPP structure for achieving VfM, and strategically allocate limited finances and assets to create a sustainable and scalable affordable housing delivery system. VfM analysis is often required for PPP programs to assess the optimal balance of benefits and costs in delivering assets and services to end-users. (World Bank 2017).

Since the private sector has been historically involved in design, build, maintenance and operation phases of public services, it can therefore optimize costs associated with these elements of service provision (Chan et al. 2009). In particular, under a PPP scheme, in which the long-term maintainability of built infrastructure will accrue benefits to the private sector operator through reduced operational costs, the PPP contractor can increase design specifications and standards to reduce maintenance costs. Locking in such operational economies and innovations is hard to achieve using traditional procurement models (Grimsey and Lewis 2004).

2.2.1.5 The Public-Private Partnership Process

According to the World Bank (2017), governments are advised to create PPP projects that are economically justified, offer better value for money compared to traditional public procurement, and are financially responsible. However, determining whether a project fulfills these criteria is challenging until the project is fully designed, and confirmation can only occur once bids are received. A project should qualify as a suitable candidate for PPP development

before any public funds are allocated to it. The World Bank has divided the PPP project implementation process into distinct phases to facilitate successful execution of the system, including identifying PPP projects, assessing potential PPP projects, structuring PPP projects, designing PPP contracts, managing PPP Transactions, managing PPP Contracts, and addressing unsolicited Proposals.

In Ethiopia, Directive 55/2010/2018, issued in 2018 to facilitate Public-Private Partnerships (PPP), outlines a five-phase process for PPP development and approval. These phases consist of Project Identification, Pre-Approval by the Board, Feasibility Study, Board Approval for Tendering, and Government Support. This process places a strong emphasis on identifying the most promising projects before they are implemented.

Furthermore, the Ethiopian government has segmented the PPP project life cycle (which involves identifying, developing, implementing, and monitoring a project under a PPP) into a well-defined series of stages. These specified phases include the following: PPP Project Identification and Suitability Analysis, PPP Project Appraisal and Preparation (Feasibility Study), Structuring and Drafting the Tender and Contract Documents, Tender & Award (Implementing PPP Tender), and PPP Contract Management & Performance Reporting. Breaking down the process into these stages facilitates a focused approach to addressing the unique aspects of each phase, ultimately contributing to efficient management and successful project execution (Ministry of Finance 2020). This illustrates that the PPP project life cycle in Ethiopia closely resembles the one developed by the World Bank.

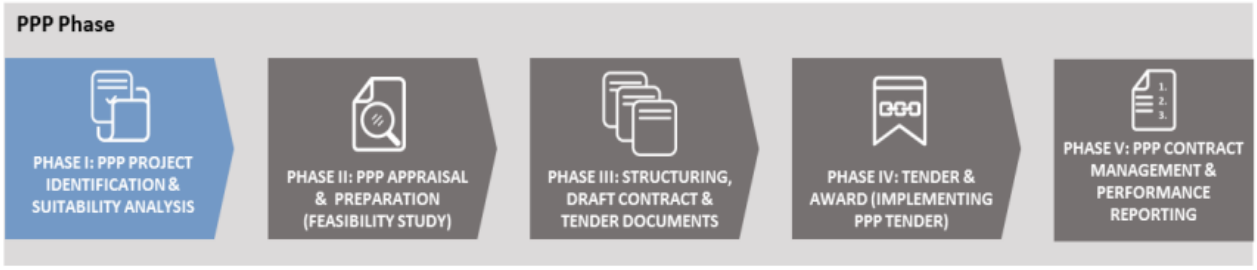

Figure 2. The PPP project life cycle (source: (Ministry of Finance 2020)

2.2.1.7 PPP types (Models)

PPP contracts are typically characterized by bundling multiple project phases and functions. Depending on the type of asset and service, the private party may be responsible for designing, building/construction, rehabilitation, financing, operation, or maintenance. These contract types (models) are described in terms of three parameters: the type of asset, the function of the

private party, and how the private party is compensated for its role in the partnership (World Bank 2017). The following section presents and briefly describes common PPP (Public-Private Partnership) models.

DBO (Design-Build-Operate): DBO (Design, Build, and Operate) is a form of Public-Private Partnership (PPP). Through this type of arrangement, the public sector provides finance for capital investment projects while allowing the private sector to retain responsibility for the design, construction, and delivery of some or all of the operational elements. Accordingly, ownership of the asset remains with the public sector (Grimsey and Lewis 2005).

DBM (Design-Build-Maintain): The private party assumes the responsibility to design, construct and maintain a facility under a long-term maintenance arrangement. The public sector finance the project and retains ownership and operation of the infrastructure (Grimsey and Lewis 2005).

DBOM (Design-Build-Operate-Maintain): Design-Build-Operate-Maintain (DBOM) contract allows the public sector to maintain ownership of the asset and retains the financing responsibility while entrusting a private party to design, construct and then operate, and maintain the facility for a specified period following construction (Dahl et al. 2005).

BOO (Build-Own-Operate): Under the Build-Own-Operate (BOO) model, a private party has full responsibility for designing, financing, constructing, operating, and maintaining the facility during its contractual period. At the end of the concession period, the original agreement may be renegotiated, a new agreement may be negotiated or the facility may be purchased by the government. However, under the BOO agreement, a public authority does not gain ownership of the asset at the termination of contact (Grimsey and Lewis 2004; Yescombe 2007).

ROO (Rehabilitate-Own-Operate): ROO is a form of BOO but, instead it involves the rehabilitation of an existing facility (PPIAF 2009).

DBFOM (Design-Build-Finance-Operate-Maintain): Under DBFOM contract type, the responsibilities of designing, building, financing, operating and maintaining the asset are bundled together and transferred to the private party (World Bank 2017). And the private sector remain the owner of the asset (Yescombe 2007)**.**

DBFO (Design-Build-Finance-Operate): Under DBFO contract the private entity design, build, and finance the project through debt financing or lending while operating the facility

during the concession period before transferring it to the public entity (Amade 2012). It is the same as DBFOM, but under DBFO arrangement the responsibility for maintenance implied as part of operations (World Bank 2017). The same as DCMF or DBFM (Yescombe 2007).

DBFM (Design-Build-Finance-Maintenance): Under a DBFM approach, the private party is not responsible for 'operations' of the asset (except for maintenance and some technical services) in the term of agreement period (World Bank 2017). However, the private party is responsible to designs, builds and finance a project and there after carry out maintenance works as part of the contractual obligations before transferring it to the public entity (Amade 2012).

Build-Operate-Transfer (BOT): Under BOT contract the private party designs, built, maintain, and undertake the operation of some or all elements. Additionally, the private sector finances the whole or part of the project (World Bank 2017). The project company (private sector developer) owns the project assets until they are transferred at the end of the contract. But, at the end of the contract ownership of the asset pass from the investors to the public sector usually for a nominal or no cost (Yescombe 2007).

Build-Own-Operate-Transfer (BOOT): BOOT is an arrangement whereby a facility is designed, constructed, operated, maintained, and fully financed by a private company (World Bank 2017). Ownership of the facility rests with the private party until the end of the concession period, at which ownership and operating rights are transferred to the government (Grimsey and Lewis 2004; Yescombe 2007).

Build-Transfer-Operate (BTO): BTO is a contract in which the private party transfers ownership of the asset to the public sector immediately after the construction is completed, and then is authorized to operate the facility for a period of time depending on the contract. This model also includes some or full private financing of the design, construction, operation and maintenance of a facility (NCSL 2010; World Bank 2017; Yescombe 2007). Under this model the private sector recoups the investment by operating the facilities, and also assumes the risks associated with operating the facilities (Kim 2011).

Rehabilitate-Operate-Transfer (ROT): ROT contract is similar to BOT model but, instead of building a new assets, the private party is responsible for rehabilitating, upgrading, or extending existing assets (World Bank 2017; Yescombe 2007)**.**

Build-Lease-Transfer (BLT) or Build-Own-Lease-Transfer (BOLT): BLT and BOLT contract is an agreement in which a private party builds and owns a facility, then leases it to a

public authority and/or other, for the length of the lease. During this period, the responsibility of operation is given to the public sector, while maintenance is left to either party. At the end of the agreed-upon term, ownership is shifted back to the public body. The two modalities basically differ on the extent of financing, in which the private party fully finance the facility under BOLT contract, but under BLT contract the facility is wholly or partly financed by the private party (World Bank 2017).

Build-Transfer-Lease (BTL): Under BTL contract, the private sector participant builds the infrastructure then transfer the ownership of the asset to the public sector upon completion of construction. And the private party receives facility lease fees (lease payment plus operational cost) based on operational performance (e.g., availability, service quality) from a public authority for an agreed period of time in order to recoup the investment cost. This arrangement was aimed to expand the scope of PPP to widen the range of facilities, to be developed using PPP including educational, welfare, and cultural facilities. (Kim 2011).

Rehabilitate-Lease/Rent-Transfer (RLT): Under RLT the Private parties rehabilitate an existing facility, lease the facility from the government, and then operating and maintaining the facility for a predetermined contract period. Such efforts come with associated risks that must be assumed by the private entity (World Bank 2009). The table below summarizes the major PPP models with the details of the basic features of the models.

Table 1.: PPP models with their salient features

No	**Type of contract**	**Responsibility of the private sector**						**Investment responsibility (Financing)**	**Type of asset**	**Payment source**	**Ownership of the asset**
		Design	Build	Operation	Maintenance	Management	Rehabilitate				
1	DBO	✓	✓	✓	-	-	-	Public sector	New	Gov't	Public
2	DBM	✓	✓	-	✓	-	-	Public sector	New	Gov't	Public
3	DBOM	✓	✓	✓	✓	-	-	Public sector	New	Gov't	Public
4	BOO	✓	✓	✓	✓	-	-	Private sector	New	Gov't/user	Private
5	ROO	-	-	✓	✓	-	✓	Private sector	New	Gov't/user	Private
6	DBFO	✓	✓	✓	-	-	-	Private sector	New	Gov't/user	Private during concession

7	DBFM	✓	✓	-	✓	-	-	Private sector	New	Gov't/user	Same
8	DBFOM	✓	✓	✓	✓	-	-	Private sector	New	Gov't/user	Same
9	BOT	✓	✓	✓	✓	-	-	Partly or 100% private	New	Gov't/user	Private during concession
10	BOOT	✓	✓	✓	✓	-	-	Private sector	New	Gov't/user	Same
11	BTO	✓	✓	✓	✓	-	-	Partly or 100% private	New	Gov't/user	Public
12	BLT	✓	✓	-	O	-	-	Same	New	Gov't	Private during lease
13	BLOT	✓	✓	-	O	-	-	Private sector	New	Gov't	Same
14	BTL	✓	✓	✓	✓	-	-	Same	New	Gov't	Public
15	ROT	-	-	✓	✓	-	✓	Partly or 100% private	Existing	Gov't/user	Private during concession
16	RLT	-	-	✓	✓	-	-	Same	Existing	User	Private during lease
17	OM	-	-	✓	✓	-	-	The private sector for maintenance	Existing	Gov't	Public
18	OMM	-	-	✓	✓	✓	-	Working capital by private sector	Existing	Gov't/user	Public

Source: (ADB 2008; Berechman et al. 2013; Delmon 2010; Grimsey and Lewis 2004, 2005; Groom et al. 2006; Hang and Bconstec 2019; NCSL 2010; PPIAF 2009; World Bank 2017; Yescombe 2007)

Note: The checkmark (✓) denotes, the respective function is transferred to the private partner. And (O) denotes the function can be transferred to the private sector or can be retained by government depending on the contract.

2.2.2 Housing Public-Private Partnership

There is no specific definition for housing PPP, however, World Bank (2020) proposed the following definition to guide its study on affordable housing PPPs:

Housing PPPs can be defined as a collaboration between the public and private sectors, formed through a contractual arrangement aiming to leverage private sector resources and expertise in

financing, designing, constructing, commercializing, maintaining, or managing affordable housing projects, along with supplementary services in certain instances. The public sector's involvement can take the form of cash or equivalents like land, development rights, revenue from land (rents/tariffs), infrastructure and building assets, tax benefits, or a share in the generated equity within a specified timeframe. The compensation for the private party is closely tied to their performance.

2.2.2.1 Motivations for the implementation PPP method for housing projects

The urgency of addressing housing access has reached a critical juncture, with an estimated demand for 100,000 housing units daily until 2030, prompting governments in emerging economies to seek private sector involvement to efficiently manage limited resources. Scarce financial means, mounting unplanned settlements, housing shortages, and fiscal limitations are pushing governments to seek "off-balance sheet solutions" like Housing PPPs to tackle extensive housing needs. Housing PPPs are appealing due to the benefits they offer to both the public and private sectors. For governments, these partnerships allow them to harness the private sector's expertise, efficiency, and financial resources, easing the strain on public funds and enabling investment in other sectors. Housing PPPs also transfer risks to capable entities, minimizing government exposure to potential pitfalls and fluctuations, ensuring cost control, promoting competition, innovation, and diverse developments that extend beyond aiding the extremely disadvantaged (World Bank 2020).

On the private sector front, engaging in housing PPPs can be advantageous if there's a stable administrative framework. It opens doors to untapped market segments that were once deemed too risky or expensive, enabling diversification of portfolios to cater to various demand characteristics. In sum, housing PPPs hold promise as a strategic approach to address the mounting housing demand, offering mutual benefits to governments and private stakeholders, provided the necessary conditions and frameworks are established (World Bank 2020).

2.2.2.2 Differentiations to Facilitate the Understanding of Housing PPPs

The term PPPs has been loosely used in the housing sector. It is important, therefore, to draw boundaries between some commonly conceived notions of housing PPPs in policy discussions and practices (World Bank 2020).

Understanding Housing PPPs: It is essential to distinguish housing Public-Private Partnerships (PPPs) from traditional infrastructure PPPs. The key differentiators lie in the

assets and contractual arrangements involved. Housing PPPs specifically focus on private sector participation in providing affordable housing without solely relying on long-term contracts. To grasp the concept fully, a broader perspective considering the roles of both the public and private sectors is necessary before delving into the specifics of housing PPPs.

Complexity of Affordable Housing PPPs: Compared to large-scale infrastructure PPPs, affordable housing PPPs are more intricate. They involve multiple assets, off-takers, revenue models, and are influenced by political factors. Managing urban areas with various services and resident associations further adds to the complexity. Additionally, the presence of multiple government entities at both national and local levels introduces an additional layer of intricacy, making efficient coordination crucial.

Housing PPPs vs. Government Contracting Builders: In contrast to traditional government contracts with builders for short-term design-build projects, housing PPPs provide a more comprehensive approach. Government contracts often lack long-term maintenance or financial risk-sharing with the private sector. This underutilizes the private sector's valuable resources and expertise, limiting the potential benefits that could be derived from engaging private entities. A more holistic PPP model is required to optimize private sector contributions to housing projects, ensuring sustainable and affordable housing solutions.

2.2.2.3 Advantages and Challenges of housing Public-Private Partnerships

The surveyed literature extensively examines the advantages and challenges associated with housing PPPs, as clearly summarized by the World Bank (2020). The benefits of these partnerships in the housing sector are notable. Firstly, the private sector's profit-driven mindset fosters efficiency gains and cost reductions, resulting in substantial savings. Secondly, PPPs encompass the entire project lifecycle, simplifying procurement complexities by consolidating costs into a single, manageable entity. Thirdly, their performance-linked payment structure ensures that outcomes are directly tied to financial compensation. Fourthly, the distribution of risk aligns with the party most capable of effective management, enhancing overall project success. Additionally, the private sector's financial responsibility encourages adherence to deadlines, as project delays can directly impact profitability. Moreover, housing PPPs enable governments to allocate funds from housing to other essential sectors, thereby expanding public service provision. Lastly, by harnessing the strengths of both sectors, these partnerships enhance asset and service quality in the housing realm.

However, alongside these advantages, housing PPPs are met with distinct challenges. Firstly, the procurement process within PPP frameworks is considerably more intricate than traditional public works tenders, requiring heightened management and coordination. Secondly, the vulnerability of PPPs to shifts in political landscapes during the contract's tenure introduces an element of uncertainty. Thirdly, debates over who reaps the benefits from PPP arrangements can give rise to controversies, potentially hindering collaborative efforts. Fourthly, the substantial transaction costs and fees associated with PPPs create financial strains. Fifthly, governments shoulder significant monitoring expenses to ensure PPP compliance and effectiveness. Additionally, while leveraging private capital often spurs innovation, it tends to be more expensive than funds sourced from the public sector. Furthermore, the imposition of long-term annuities within PPPs places a burden on financially weaker economies. The rigidity of contract structures also poses challenges, leading to risk premiums and reduced flexibility. Lastly, competition tends to wane once PPP contracts are signed, limiting future competitive dynamics.

2.2.2.4 Housing Public-Private Partnership modalities

Housing projects exhibit distinctions in PPP application when compared to projects in other sectors. These variations are evident in the in terms of social objectives and associated risks, long-term consequences, government participation, funding mechanisms, and regulatory structures. Consequently, numerous PPP models must undergo adjustments to align with the unique requirements of the housing projects (MOHUA 2017). Accordingly, the World Bank to developed PPP models to facilitate the development of public housing in emerging markets within developing countries. These models are derived from initiatives of India. These models establish fundamental parameters for a decision-making framework in housing PPPs. Their purpose is to assist housing practitioners and policymakers in guiding the provision of affordable housing through public-private collaborations in emerging economies.

Furthermore, these models have been carefully chosen and integrated into the framework to facilitate the selection of an appropriate PPP model for housing projects. The reason behind the selection of these models is thoroughly explained in section 2.3.3.2 of this chapter. The section below discusses the models. To comprehensively examine the characteristics of these models, the study extensively referred to both the World Bank manual that presents these models and the Indian manual referenced by the World Bank to derive insights from these models, as recommended by the bank. In the following section, the study provide a detailed

overview of the key features and project structure of all six models (Ford Foundation 2019; MOHUA 2017; World Bank 2020)

Under all housing models, the government sets specific project parameters. These parameters encompass technical specifications, land area, the number and sizes of housing units, and construction timelines. The government is also responsible for constructing essential infrastructure. Conversely, the private sector takes on the roles of designing, financing, and constructing the housing units according to predetermined standards, costs, and schedules. This approach effectively leverages the capital and expertise of the private sector to create affordable housing options. Therefore, under all models, the private partner takes risks associated with performance.

The maintenance and operation of these housing units can be managed separately or integrated with the private partner's involvement, depending on the chosen model. Operational duties may involve rent collection from the end-users. To make these housing projects more affordable, the government provides various forms of land subsidies. Furthermore, the government plays a role in ensuring fair distribution by identifying eligible beneficiaries or setting eligibility criteria, or facilitating beneficiary identification.

The methods of housing provision can involve either renting or selling units to the public. In these scenarios, private partners can recover their expenses through direct sales to end-users, rent collection by either the government or the private partner, compensation from the government (in the form of cash payments, land with development rights, or annuity-based payments). When housing is offered for rent, the private partner assumes responsibility for maintenance. Rent collection can be managed either by the government or the private party, depending on the chosen model. The rent or sale price of units is designed to cover all expenses related to design, construction, maintenance, as well as generate profits and accommodate any potential cost escalations.

2.2.2.4.1 Model 1: DBF (cash)

In this model, the public authority will allocate land to a chosen private developer, essentially constituting a state subsidy for the project. Additionally, the public authority will establish technical guidelines detailing aspects such as technical specification, land area, dwelling unit size, number of units, construction time and any other details. Under this arrangement, the private sector contractor assumes responsibility for designing, constructing, and financing the

housing units and related services (referred to as a DBF contract) at predefined quality standards, cost, and within a specified timeframe, before transferring ownership to the government. The public authority commits to compensate the private developer in cash through a payment schedule based on project milestones upon the satisfactory completion and handover of units, adhering to the prescribed standards, cost, and timeframe. Consequently, the public authority bears the responsibility and risk associated with cost recovery. The Concessionaire Agreement should outline the required deliverables for meeting milestones, with an acceptance requirement for payment. In cases without defined milestones, payment can be tied to the percentage of work completed.

The government assumes various responsibilities in this context, including handling the risks associated with selling the housing units and facilitating mortgage financing. Mortgage financing options may come directly from the government or private banks, with potential subsidies provided by the National Housing Bank. This arrangement ensures that loans with favorable interest rates and suitable repayment periods can be made accessible to end-users through housing finance institutions or other intermediaries.

Furthermore, the financial assistance for end-users can encompass interest subsidies integrated into a subsidy program. As part of this setup, end-users are typically required to make a predetermined payment for the housing unit's cost upon handover. Alternatively, they might be obligated to pay predetermined equated monthly installments (EMIs) for a specific period directly to the public authorities. It's important to note that, after the transfer of units to end-users, neither private developers nor public authorities are involved in the maintenance of these units.

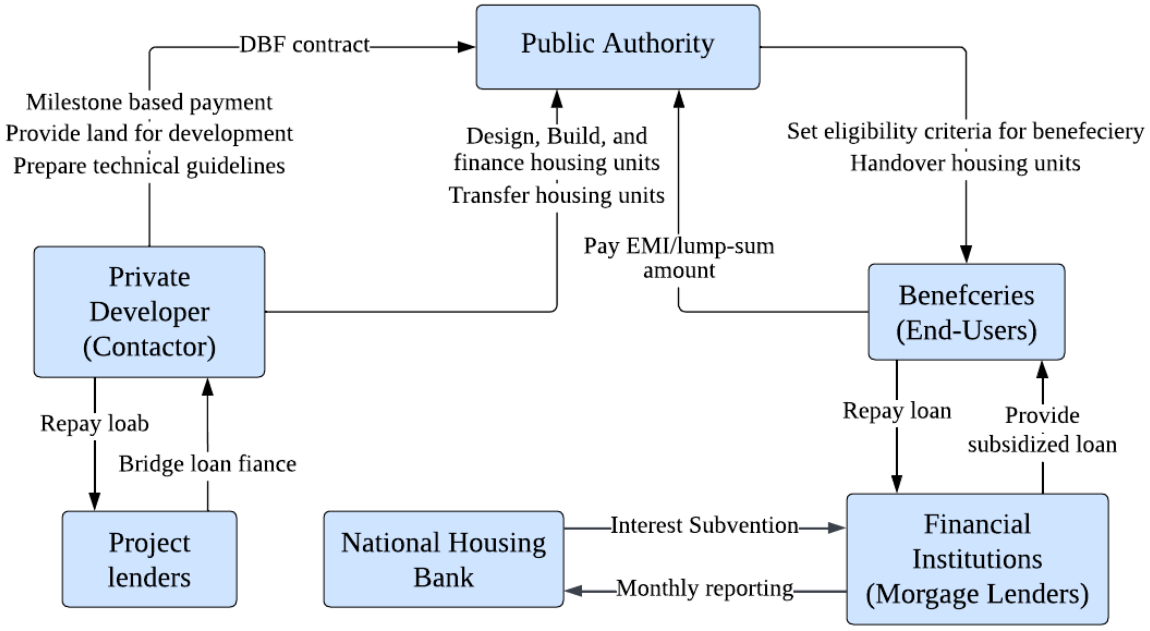

Figure 3. Projects structure of DBF (cash) model

2.2.2.4.2 Model 2: DBF (land)

This model closely resembles the previous one, with a key difference being that instead of giving cash compensation, the government offers land and associated development rights to the private party. In other words, the private party is permitted to construct and sell high-end housing on a designated portion of the provided land. It's essential that the value of the land and development rights matches the cash option in terms of present value to ensure sufficient motivation.

Furthermore, the private developer might have the option to utilize the entire piece of land provided by the government for high-end housing in exchange for building affordable housing at another location. In this case, the private developer would need to secure suitable land, similar in characteristics to that provided by the government. When Transfer of Development Rights (TDR) is involved, the permissible Floor Area Ratio (FAR) or Floor Space Index (FSI) will depend on the prevailing statutory conditions and provisions. Effectively, this approach represents a form of cross-subsidy between high-end and affordable housing, in addition to the subsidy in the form of land granted by the government.

To further boost value creation for private developers, several strategies can be employed, such as increasing the Floor Area Ratio (FAR), providing Transfer of Development Rights (TDR),

and expediting the approval process for high-end housing projects. In exchange for these enhancements in value, private developers would be obligated to offer affordable housing units at no cost. To incentivize private developers to bear off-take risks and maintain high construction standards, adhere to superior architectural designs, ensure timely completion of housing units, and meet other stipulated agreement conditions, the Public Authority may introduce a bonus payment system. Under this arrangement, developers would receive a bonus payment for each housing unit accepted and paid for by an eligible end-user. All other aspects of this model would remain the same as in Model 1.

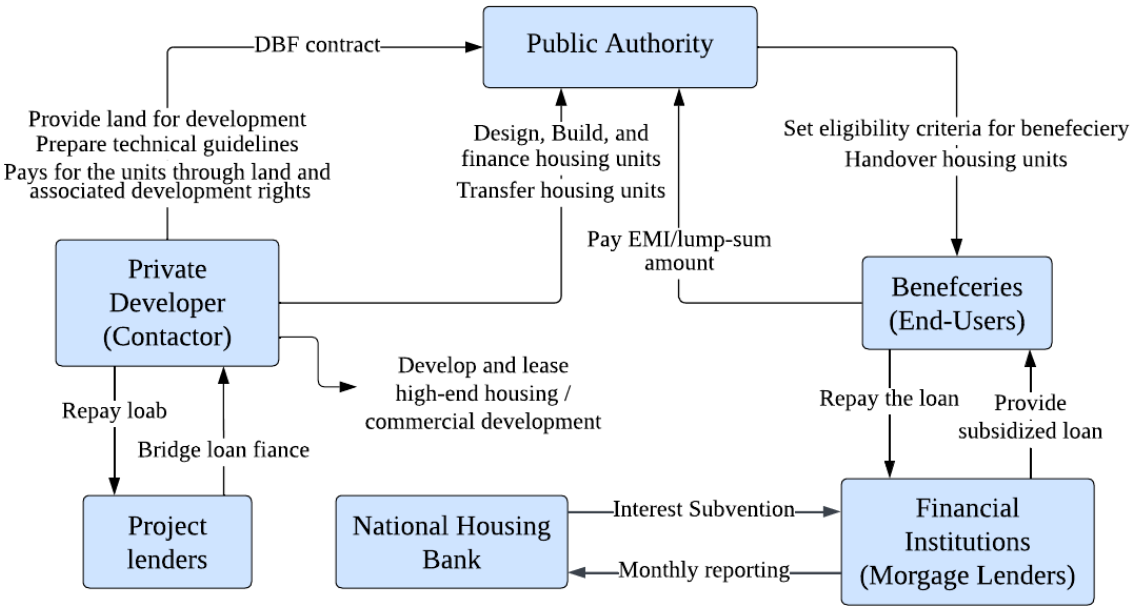

Figure 4. Project structure of DBF (land) model

2.2.2.4 3 Model 3: DBFM (annuity)

Under this model, government will provide land and establish project parameters as model 1. The distinguishing feature of this model is that the developer will receive revenue from the government through regular annuity payments over a specified period (up to 10 years according to India or 10 to 20 years according to the World Bank guidelines), instead of a lump sum payment upon project handover. The annuity payments encompass various components, including construction costs, interest on loans obtained by the developer, maintenance expenses throughout the annuity period, and contributions towards reimbursing other overhead costs. Additionally, these payments may incorporate affordability compensations for eligible tenants.

This extended collaboration between the developer and the project also necessitates the developer's responsibility for maintaining the project assets during this duration and subsequently transferring the dwelling units back to the public sector or its designated entities upon the end of the period. Public authorities will actively oversee the quality of maintenance, with rewards and penalties tied to the long-term quality of service provided to occupants. These rewards and penalties will be factored into the annual annuity amounts disbursed.

The main goal of this model is twofold: first, it aims to shift not only construction risks but also maintenance risks to the private sector. Second, it anticipates an enhancement in construction quality because developers will now bear responsibility for the asset's long-term performance. Furthermore, this model extends the government's obligation to compensate the developer over an extended period through an annuity-based structure.

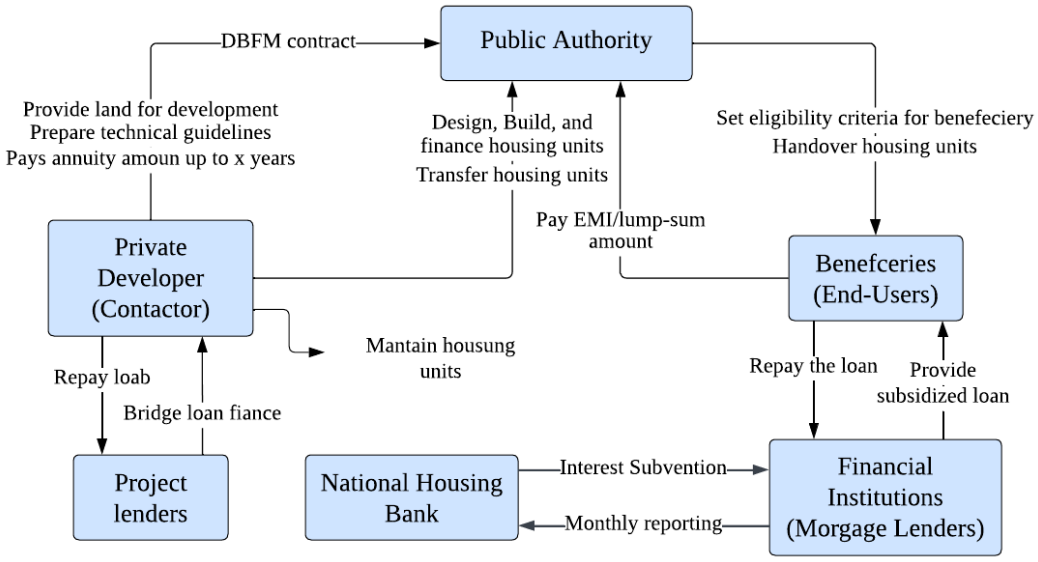

Figure 5. Project structure of DBFM (annuity) model

2.2.2.4.4 Model 4: DBFM (annuity cum capital grant)

This model closely resembles Model 3, except that under this model a significant portion of the project cost, approximately 40-50%, is paid to the private developer during the construction phase itself. Subsequently, the remaining portion is paid to the developer as an annuity over a period of up to 10 years following the successful completion of the project. This capital grant empowers the developer to recoup a portion of their investment after the completion of construction, in addition to the guaranteed returns, thereby making the project more attractive

to private developers. Notably, the annuity amount in this model is expected to be lower than that in Model 3, given that developers will also receive a capital grant.

The capital grants payment to the private developer will depend on the progress of the project, which is measured through defined project milestones. The Public Authority will establish these milestones, which will be linked to the successful completion of specific project tasks or objectives. Each milestone payment will be determined based on the value of the completed work and the acceptance of the associated deliverables. To ensure clarity and adherence to this process, the Concessionaire Agreement will outline the specific deliverables required to meet each milestone and make it clear that the deliverables must be accepted before payment is made. For parts of the contracts that do not have predefined milestones, payments will be structured based on the percentage of work completion.

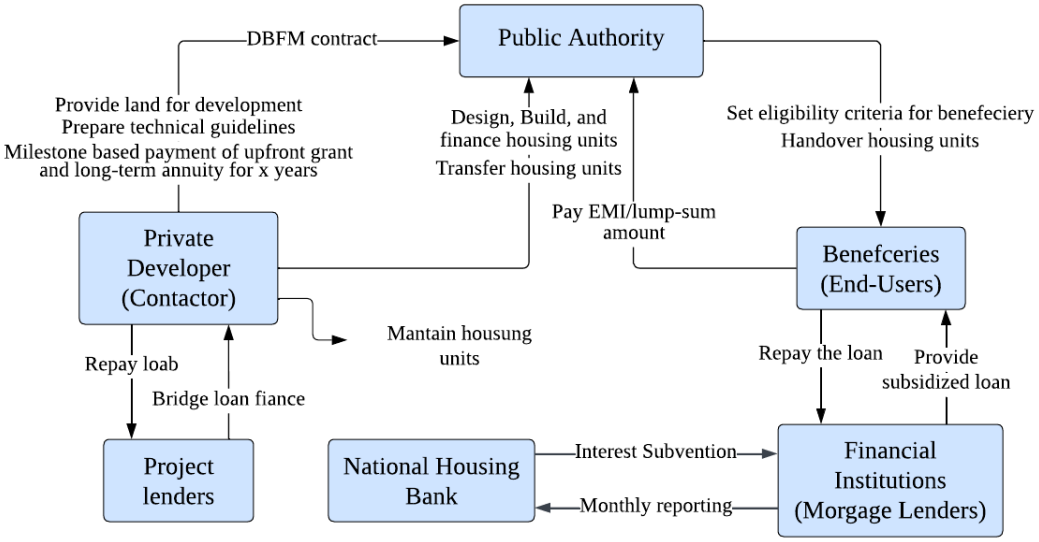

Figure 6. Project structure of DBFM (annuity cum capital grant) model

2.2.2.4.5 Model 5: DBFM (direct sale)

In this model, the government will allocate land, which will serve as a substantial subsidy. The private sector contractor will be responsible for the design, construction, and financing of the housing units. They will recoup their expenses by selling the units to end users. The key distinction between this Model and Model 1 lies in the direct financial interaction between the developer and the end user. Under this model, end users will be obligated to make payments directly to the developer for the cost of the housing unit.

Recovery under this scheme can occur either as a one-time lump-sum payment when transferring the housing unit to the end-user or through a series of equal monthly installments (EMI) over a fixed period until the unit is handed over to the end-user. Consequently, the unit's price or the EMI should encompass all expenses related to design, construction, maintenance, as well as profits and potential cost escalations. The government remains responsible for managing end-user offtake and arranging mortgage financing through private banks capitalized by the National Housing Bank. In this arrangement, the private sector contractor is not required to possess knowledge of the end-user market.

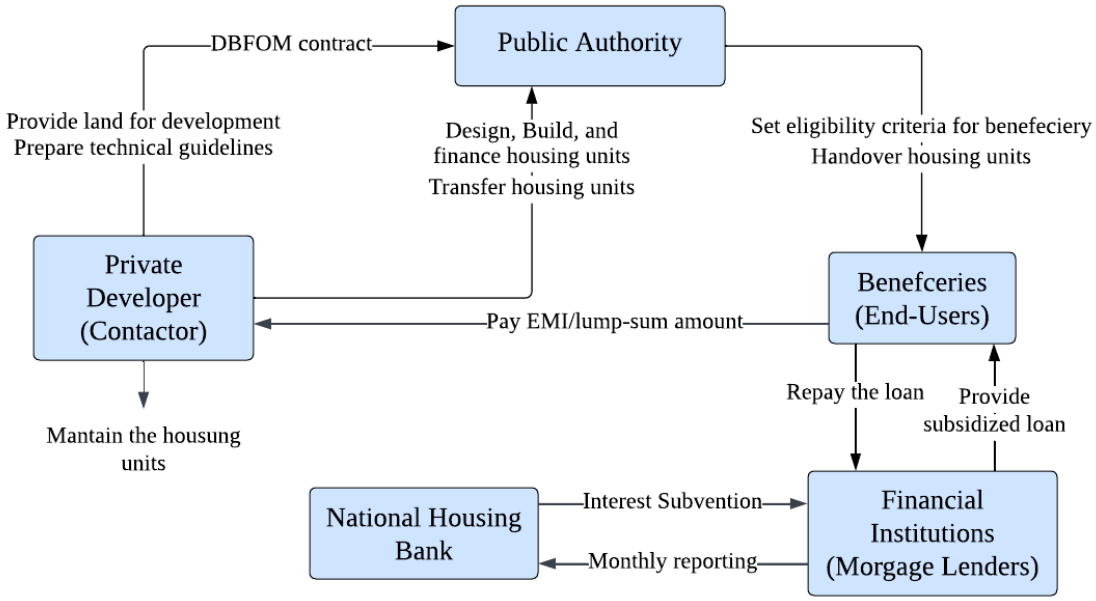

Figure 7. Project structure of DBFM (direct sale) model

2.2.2.4.6 Model 6. DBFOM (direct rent)

The key difference between this Model and Model 5 is that in this version, end-users directly pay the developer for using the housing unit, with the developer retaining ownership. The rental price covers all expenses, including design, construction, maintenance, profit, and any escalations, over a specified contract period (e.g., 10-20 years) until the government takes control of the units. As a result, the private developer aims to recover the cost of affordable housing from end-users, and they are also responsible for maintaining the units for a set period, while end-users are accountable for internal maintenance.

This model transfers the highest risk to the private developer compared to all other models. The developer is responsible for collecting monthly rent payments, which presents a potential

risk. To address this, the developer can impose reasonable penalties for delayed or non-payment of rent. Additionally, the developer will set a fixed payment date for customers and have the right to evict customers who don't pay within a specified timeframe. To ensure the success of this model, efficient dispute resolution between the developer and end-users is essential to make it attractive to private developers.

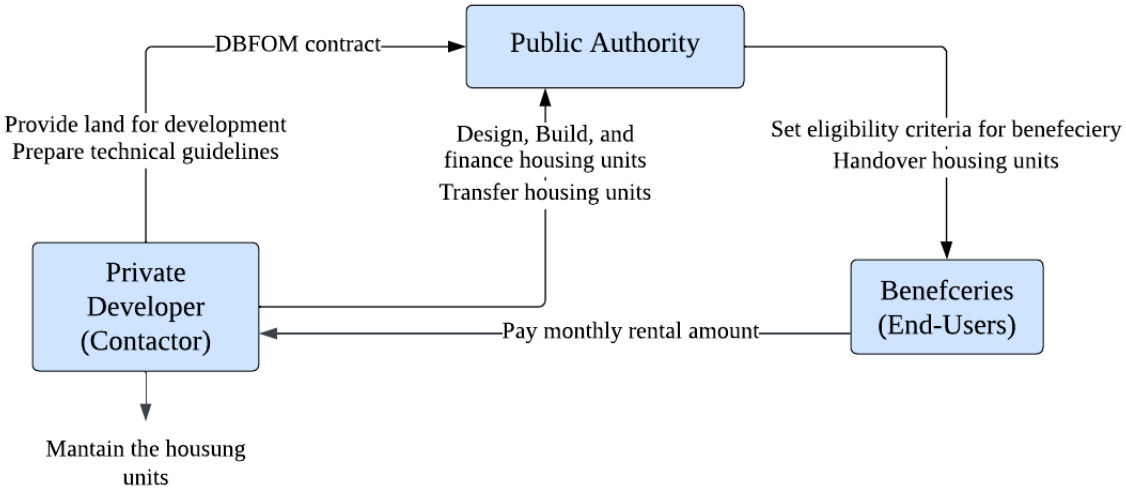

Figure 8. Project structure of DBFOM (direct rental) model

Table 2. Comparative Analysis on the responsibilities of stakeholders in the models

No	Model	Govt. Entity	Private Sector	Beneficiary
1	DBF (cash)	✓ Provides land (the subsidy from the state) ✓ Establishes project parameters (technical specifications, land area, no. of housing units and their sizes, construction time) ✓ Identifies and select eligible beneficiaries ✓ Pays to the private developer in cash based on milestones achieved ✓ Transfers housing units to beneficiaries ✓ Collects payments from beneficiaries toward cost recovery ✓ Construction of trunk infrastructure	✓ Designs builds and finances the project (constructs the housing units of predetermined standards, cast, and time) ✓ Transfers completed housing units to the Govt. entity	✓ Pay to Govt. Entity equated monthly installment (EMIs) or a predetermined lump sum amount upon handover of housing unit ✓ Maintain the common areas, public spaces, utilities, and infrastructure within the premises
2	DBF (land)	✓ The same as Model 1, but instead of cash the govt provides payment with land and associated development rights	✓ The same as model 1, with the key distinction that it grants concessions to the private sector for the development of high-end housing or commercial projects on a designated section of the land or allows for increased FAR or TDR.	✓ The same as Model 1
3	Annuity-based Subsidized Housing (ABSH)	✓ Provides land on a long-term lease ✓ Establishes project parameters, as same as Model 1 ✓ Identifies and select beneficiaries	✓ Designs, builds, and finances the project, same as Model 1 ✓ Maintains the housing units (medium to long-term maintenance of the housing units during the	✓ Pay to Govt. Entity EMIs or a predetermined lump-sum amount upon

		✓ Pays annuity (up to 10 years/10 to 20 years) to a private developer ✓ Transfers housing units to beneficiaries ✓ Collects payments from beneficiaries toward cost recovery	annuity period up to 10 years/ 10 to 20 years) ✓ Transfers completed housing units to the Govt. entity	handover of housing unit
4	DBFM (annuity cum capital grant)	✓ The same as Model 3, but the Govt. Pays capital grant (40% – 50% of project cost) during the construction period as milestone-based payments and pays annuity (up to 10 years) to a private developer.	Same as Model 3	Same as Model 3
5	DBFM (direct sale)	✓ Provides land on a long-term lease ✓ Establishes project parameters like Model 1 ✓ Sets eligibility of beneficiaries	✓ Designs, builds, and finances the project, same as Model 1 ✓ Maintains the housing units (medium to long-term) ✓ Identifies beneficiaries and transfers completed housing units to the beneficiaries through the Govt. Entity ✓ Collects payments from beneficiaries toward cost recovery ✓ Construction of trunk infrastructure	✓ Pay to the Private Entity EMIs or a pre-determined lump-sum amount upon handover of the housing unit
6	DBFOM (direct rental)	Same as Model 5	Same as Model 5	Same as Model 5
		✓ In the context of Model 5 (DROH), ownership was transferred to beneficiaries upon the completion of the cost recovery period. Conversely, in this particular model, the developer retains full ownership of the asset or dwelling unit, thereby aligning its interests entirely with the project. ✓ Developers possess the authority to evict tenants in cases of non-payment of rent. ✓ Areas characterized by substantial migrant populations are well-suited for undertaking projects within this model.		

Table 3. Comparative Analysis of the models based on scope of work

No	Salient feature	Models					
		DBF (cash)	DBF (land)	DBFM (annuity)	DBFM (annuity cum capital grant)	DBFM (direct sale)	DBFOM (direct rent)
1	Design and Build	Under all models, the Private partner (developer) is responsible to design and build the housing units					
2	Maintenance	Beneficiary	Beneficiary	Private partner	Private partner	Private partner	Private partner
3	Distribution of units	Private partner to the public authority	Private partner to the public authority	Private partner to the public authority	Private partner to the public authority	Private partner to the beneficiary	Private partner to the beneficiary
4	Development mix	Affordable housing	Affordable housing and high-end housing (commercial development)	Affordable housing	Affordable housing	Affordable housing	Affordable housing
5	Provision method	Sales	Sales	Sales	Sales	Sales	Rental

Table 4. Comparative Analysis on the models based on Project Structure

No	Salient features	Models					
		DBF (cash)	DBF (land)	DBFM (annuity)	DBFM (annuity cum capital grant)	DBFM (direct sale)	DBFOM (direct rent)
1	Land provision	The government provides land under all models (on long-term lease)					
2	Lease period	The lease period ranges from around 30 to 99 years					
3	Contract period	2 to 4 years	2 to 4 years	15 to 20 years for models 3 4, 5, and 6			

4	Bid parameter	Per unit cost (lowest lump sum amount)	No. of affordable units to be provided	Per unit cost (lowest annuity payment)	Lowest annuity amount or lowest upfront grant	Per unit cost (lowest EMI or lowest lump sum)	Per unit cost (lowest rent)
5	Off-take risk	Govt entity	Govt and private	Govt entity	Govt entity	Govt entity	Govt entity
6	Cost recovery risk	Govt entity	Private partner	Govt entity	Govt entity	Private partner	Private partner

Table 5. Comparative Analysis of the models based on Financing arrangements

Salient features	**Models**					
	DBF (cash)	**DBF (land)**	**DBFM (annuity)**	**DBFM (annuity cum capital grant)**	**DBFM (direct sale)**	**DBFOM (direct rent)**
Project financing	Private partner	Private partner	Private partner	Govt. and private partner	Private partner	Private partner
Source of concessionaire revenue	Govt pays the private partner a lump sum amount upon completion	Revenue generated from high-end housing	Govt pays a long-term annuity to private partners upon completion	Govt pays upfront grant and annuity amount to the private partner	The beneficiary pays lump-sum or EMI to the private partner	The beneficiary pays monthly rent to the private partner
State subsidy for the project (govt support)	Land	Land	Land	Land	Land	Land
Cross subsidy	Not applicable	The land provided for high-end housing	Not applicable	Not applicable	Not applicable	Not applicable
Payment by end-users	Lump sum or EMI to the govt	Lum sum or EMI to the govt	Lump sum or EMI to the govt	Lump sum or EMI to the govt	Lump sum or EMI to the private partner	Rent to the private partner

Financial assistance to end users	Under these models, Loans at an appropriate rate of interest and appropriate tenure could also be made available through housing financing institutions (HFI) or other intermediaries to the end-user.					Not available
Credit risk	Financial Institution	Financial Institution	Financial Institution	Financial Institution	Financial Institution	Financial Institution
Off-take-related performance bonus for the developer	A 10%-15% performance bonus linked to the no of units sold				Not applicable	Not applicable

2.2.3 Housing conditions in Ethiopia

2.2.3.1 Housing shortage and its consequence in Ethiopia

The housing condition in Ethiopia presents multifaceted challenges as the country struggles with rapid urbanization and a growing population. The demand for housing has surged, particularly in urban areas, leading to a considerable gap between supply and demand (World Bank 2004).

In Ethiopia, the consequence of poor housing provision, specifically the shortage of housing, has had significant socio-economic implications for its population. As urbanization accelerates and population growth persists, the inadequate supply of housing has given rise to various challenges. The shortage of affordable and decent housing has led to overcrowding, informal settlements, and substandard living conditions for a considerable portion of the population. The rising need for housing in urban regions has led to the expansion of slums, adversely impacting vulnerable and marginalized communities through substandard living conditions (Gorems 2016).

Additionally, the shortage of housing has also contributed to rising housing costs, aggravating the issue of housing affordability. This can lead to a higher proportion of household income being allocated to housing expenses, leaving less for other essential needs such as education, healthcare, and food. In this regard, the lack of affordable housing options has resulted in increased urban poverty and decreased overall well-being (UNECA 2018).

Furthermore, the scarcity of proper housing hindered economic development by limiting the potential for urban growth and productivity. Inadequate housing impeded workforce mobility and productivity, as workers faced longer travel time due to the mismatch between housing locations and employment centers. This, in turn, had a negative impact on overall economic efficiency. This resulted in poor living conditions and hindered urban economic development and the overall quality of life for residents (World Bank 2004).

In conclusion, the shortage of housing in Ethiopia has far-reaching consequences that encompass social, economic, and human development aspects. It has led to overcrowding, informal settlements, housing affordability challenges, and hindered economic productivity. Addressing the housing shortage is crucial for improving the overall well-being of the population and fostering sustainable urban development in the country. In response to this issue, the government has

implemented various strategies to address the ongoing housing challenge, one of which is the implementation of the Integrated Housing Development Programs (IHDP).

2.2.3.2 Integrated housing development program (IHDP)

Ethiopia is one of the most populated countries in the sub-Saharan African region, where access to affordable housing is one of the major development challenges (Tesfaye 2007; Ojebode 2016), but the challenge is, even more severe in the capital, Addis Ababa, which is the headquarter of the African Union (Rajendra and Kunwar 2022). The government has been using different mechanisms to alleviate the housing problem in the capital including the Integrated Housing Development Program, a state-led program that provides housing for low and middle-income people,

Starting in 2005, Ethiopia initiated an ambitious government-driven endeavor called the Integrated Housing Development Program (IHDP) to address the housing needs of individuals with low and middle incomes. The central aim of this initiative was to build 400,000 condominium units, create 200,000 job opportunities, cultivate the expansion of 10,000 micro- and small-scale businesses, enhance the construction industry's capacities, revitalize urban slum zones, and enable affordable homeownership for households belonging to the low and middle-income brackets (UN-HABITAT 2011b).

The IHDP has recorded significant accomplishments across multiple domains. While it might not have reached all its initial objectives in its entirety, the program has made remarkable advancements, particularly considering the limited capacity of Ethiopia's housing sector before its launch. Most notably, it has substantially elevated the count of individuals becoming homeowners, a prospect that might have remained beyond their reach otherwise. In parallel, the program has yielded positive effects on the housing market by augmenting the supply of both owner-occupied residences and rental units. Furthermore, it has considerably bolstered the construction industry's capabilities, effectively addressed pre-existing slum areas, and played a pivotal role in creating new employment avenues (UN-HABITAT 2011b).

The program is encountering unexpected difficulties. The foremost concern is the affordability of the housing units for those with lower incomes, as escalating prices of condominium homes have rendered them impractical for numerous individuals in this earnings category. Consequently, a

substantial portion of households cannot meet their monthly mortgage and service payments, leading them to move out and rent their units to avoid the risk of bank foreclosure. Furthermore, many of the condominium sites are positioned on the outskirts of the city, neglecting the necessity for available job prospects for residents, even in instances where these sites accommodate as many as 10,000 households. This situation imposes additional financial strains on beneficiaries due to commuting expenses. Additionally, the quality and architectural layout of the condominium buildings, along with post-move-in management, are pivotal aspects that demand attention to enhance the sustainability of the program (Keller and Mukudi-Omwami 2017).

The challenges also continue after the program's implementation, including the continuous appreciation of condominium prices and the unaffordability of units for low-income individuals. These challenges were influenced by factors such as lack of information, the illegitimate role of brokers, and a monopolistic housing supply, all contributing to price increases. A survey showed fluctuating and higher transaction prices concerning cost, quality, and location perspectives. The survey results pointed to several factors influencing the rise of house prices, including a limited of housing supply, corruption, mismanagement costs, material wastage, construction delays, labor and bank interest costs, government financing, and inflation. Additionally, brokers seeking personal excessive gains from condominium properties, flexible government management with limited control, and locational differences were found to have a lesser impact on price instability (Melesse 2020).

In general there are several factors the hindered the approaches that the government has taken many to alleviate the problem but, poor land management practices, lack of diversified housing delivery systems; the absence of a robust and affordable housing construction industry; and the absence of a diversified housing financing system are all factors that hinder the process (Bishu 2017). This could drive the government to look for an alternative approach to deliver and/or finance affordable housing projects.

In this regard, the governments around the world are recognizing the value of establishing partnerships with the private sector to increase the provision of affordable housing projects (Austin 2008). This is because PPP as a delivery system could bundles together multiple phases or functions (i.e. design, build or rehabilitate, finance, maintain and operate) (World-Bank 2017).

And reduce public sector administrative costs, allow shared risk, reduce the problem of public sector budget constraint, the private sector possessing better mobility, and the private sector's ability to raise funds for the project (Robert et al. 2014b). In this regard, PPP could be a potential arrangement for delivering affordable housing projects in Ethiopia. Similarly, the Ethiopian government recognized the need to engage the private sector in resource mobilization for infrastructure development. In the housing sector, they initiated Public-Private Partnerships (PPP) to address housing shortages. Below, we'll explore Ethiopia's PPP legal framework.

2.2.4 Public-Private Partnership legal framework of Ethiopia

2.2.4.1 Definition of Public-Private Partnership in Ethiopian

In Ethiopia, Proclamation No1076/2018 defines a Public Private Partnership (PPP) as a long-term arrangement between a Contracting Authority and a Private Party. Within this framework, the Private Party commits to undertaking a Public Service Activity that the Contracting Authority would otherwise handle. The Private Party derives benefits through avenues such as compensation provided directly or on behalf of the Contracting Authority, tariffs or fees collected from service users or consumers, or a combination of these compensatory methods. Additionally, the Private Party assumes liability for the risks associated with performing the activity or utilizing state property per the stipulations outlined in the Project Agreements.

According to the Ministry of Finance (2020), the benefits of PPP encompass various aspects, including accessing private sector funding, capitalizing on the efficiency gains derived from private sector expertise and risk transfer, potentially enhancing transparency, shifting focus from asset creation to service delivery and infrastructure maintenance throughout its operational life, and emphasizing outputs. Risks are allocated to the party most equipped to handle them, promoting effective risk management. This widened perspective encourages minimizing overall life-cycle expenses, including construction and operational costs, which ultimately leads to improved value for money over the project's lifespan.

According to the Ministry, this Value for Money (VfM) in projects is influenced by several factors. These include the effective allocation of risks to the party with the optimal risk management capabilities, the extended duration of contracts, competition among stakeholders, specifications centered on desired outcomes, the measurement of performance and the incorporation of

incentives, as well as leveraging the management expertise inherent in the private sector. These aspects collectively contribute to achieving enhanced value for money in projects.

2.2.4.2 When Should a PPP be Used?

According to the Ministry of Finance (2020), PPP should be considered for infrastructure projects only under specific conditions. First, the public sector environment needs to be conducive to supporting PPPs, as they are intricate arrangements requiring ongoing public sector involvement. Success is more likely when the public sector support is robust. Second, the project itself must be suitable for a PPP, with certain characteristics making it well-suited while others might hinder the approach.

Moreover, potential barriers to successful project implementation must be recognized and addressable, as many common obstacles can be anticipated ahead of time. If these barriers are insurmountable, the project shouldn't proceed as a PPP. However, if they can be overcome, as is often possible, they should be factored into the PPP's development and carefully planned for.

Furthermore, the project must fulfill two crucial criteria. It should be financially viable for the private sector, ensuring that it offers value for money (VFM) for the public sector. This means that choosing the PPP route should result in lower lifetime costs while maintaining or enhancing service quality compared to public or private sector execution alone. Additionally, the project must be commercially feasible to attract private investors and ensure its viability from a business standpoint.

2.2.4.3 Policy for the Use and Implementation of Public-Private Partnerships

According to FDRE (2017), the Government has a number of overarching goals associated with the implementation of its PPP Policy. These include: expanding public service activities, reduction in project delays and cost overruns; increased utilization of resources from the private sector on public services. The policy outlines Objectives for the use of PPPs; objectives for the PPP Framework; the government commitment (The Government is committed to meeting the infrastructure and public service development needs of the country), government commitment to the protection of public interest, private sector participation, project selection, governance, selection of private sector partner.

The policy covers the scoop and application of PPP which includes definition of Public-Private Partnership; criteria for PPPs, value for money, affordability to end users, ensuring protection to public interest, assurance of sustainability is a project which has the potential to deliver benefits to both parties over its life, and institutional capacity that will be required during the project preparation stage and throughout the life of the project.

The policy outline the issue related to governance of any PPP, which includes the rule and responsibility of the PPP board, the ministry of finance, the PPP units, and the contracting authority; government participation and support which includes, project facilitation, in-kind support, project investment, capital support, contracted payments, and credit enhancement; and the process associated the development of PPP project, which includes, project identification, feasibility and structuring, approval of structure, selection of private partner, contract award and signing, and implementation and monitoring.

2.2.4.6 Administration of PPPs

Article 8 of Proclamation 1076/2018 establishes a PPP Board comprising key government entities, including the Ministry of Finance and Economic Cooperation, the National Bank of Ethiopia, and others. Chaired by the Minister of Finance and Economic Cooperation, the board's secretariat is the PPP Directorate General. The board's responsibilities encompass approving PPP project structures, significant changes in risk allocation or cash flow, amendments to Project Agreements, identifying Contracting Authorities, suggesting tax initiatives, endorsing private sector selection for PPPs, and recommending government support in line with Article 47.

The board's authority encompasses blocking a Contracting Authority from pursuing agreements for Public Private Partnership projects that lack value for money or meet minimal standards specified by the PPP Directorate General. The board can instruct a Public Body or Public Enterprise to execute a project as a PPP. Such entities must comply with the board's directives. The option to delegate duties to the ministry or the PPP Unit is available to the board. It convenes quarterly or more frequently as needed and issues guidelines for its operational procedures. Article 10 of Proclamation 1076/2018 establishes a PPP Directorate General within the Ministry of Finance and Economic Cooperation. This ministry is responsible for staffing the Directorate General and ensuring incentive mechanisms for its employees. The Directorate General's

objectives align with the country's development goals, ensuring PPPs adhere to the Proclamation's provisions.

Article 12 of the proclamation outlines the responsibilities of the Directorate General, including promoting private sector involvement in financing, constructing, maintaining, and operating public services. The Directorate General offers technical assistance to the board, ministry, and contracting authorities on PPP matters. It conceptualizes, identifies, and categorizes projects, reviews project viability, and offers recommendations to the board, ministry, and authorities. Information dissemination about potential PPPs, selection of private sector candidates based on prescribed procedures, and monitoring project progress are part of its tasks. It shares PPP project implementation updates with the public at intervals set by the board, coordinates PPP-related activities, and executes duties delegated by the Board.

2.2.4.7 PPP pipeline projects in Ethiopia

According to FDRE PPP Directirate General (2021), the Ministry of Finance, through its PPP Directorate General, has taken the lead in implementing various projects in public-private partnership (PPP) mode. The projects in the pipeline include 1050 MW of solar power, 1848 MW of hydro power, 710 MW of wind power, and a 297 km toll road. Additionally, there are projects related to affordable housing and a petroleum depot that will also be executed under the PPP modality.

For the successful execution of these projects, five contracting authorities have been identified: Ethiopia Electric Power (EEP), Ethiopia Roads Authority (ERA), Federal Housing Corporation, Ethiopia Petroleum Supply Enterprise, and the Ministry of Health. These authorities will be responsible for overseeing the respective projects based on the existing PPP policy and proclamation.

The PPP Board has already approved Twenty-three (23) projects in the pipeline, including eight solar photovoltaic projects, five hydro-power projects, three toll road projects, five wind power projects, one Affordable Housing development project, and one Petroleum Storage Depot project. Among the solar PV projects, two projects named Gad and Dicheto have been awarded to the winning private developer, while the remaining six solar power projects are currently at the request

for proposal (RFP) stage. As for the other projects, they will be tendered after conducting the necessary studies.

As per the Ministry, one of the proposed projects involves delivering housing through a PPP arrangement. The table below provides the details of this project

Table 6. Proposed housing project, source (FDRE PPP Directirate General 2021a).

Project Title/Name	Affordable Housing Development
Contracting Authority	Federal Housing Corporation
Project Description	The project will be implemented in Addis Ababa through PPP. Low- and middle-income population of Addis Ababa (approximately 79800 households or 399000 people expected to be benefited by the project
Approximate Cost	2.4 Billion USD
Procurement Mode	Competitive bidding
The PPP Proposed Structure (e.g. Concession, BOT, DBO, Management and Operating, etc.)	BOT(DBFOM)
The Proposed partnership period	20-30 years
Region/Area	Addis Ababa
Sector: (i.e. Transport, Energy, etc.)	Housing
Current Status :(i.e. feasibility, under evaluation, bidding stage, etc.)	Under Feasibility Study.

2.3 Empirical Review

The empirical literature review in this study explores into the driving forces behind the adoption and implementation of PPP, examining the factors that propel the utilization of this collaborative approach. It also explores the elements that contribute to the successful execution of PPP projects, shedding light on the critical factors that enable positive outcomes, both in the broader context of infrastructure projects and specifically within housing endeavors. Furthermore, the review investigates the factors that influence the choice of suitable PPP models. By comprehensively analyzing existing research, this review seeks to identify the current research gap and areas where further investigation is needed.

2.3.1 Drivers of Public-Private Partnership adoption and/or implementation

Public-private partnership (PPP) contracts have become increasingly popular worldwide, proving that they can achieve success. As such, governments in many countries encourage these contracts due to their ability to draw on private sector resources and expertise for public services as well as large-scale investments (Bovaird 2004).

Given the importance of Infrastructure development and policy making, it is essential to investigate the motivations behind governments who are choosing to adopt Public-Private Partnership models, because understanding these reasons provide practitioners with valuable insights and enhance decision-making processes involved in infrastructure policy formation (Robert et al. 2014b).

According to World Bank (2022), PPP can be utilized to introduce private sector-led technological advances and innovation. This can improve public infrastructure and services, while also increasing operational efficiency. Utilizing PPPs provides financial certainty for projects by setting current and future costs over time. Additionally, introducing more foreign private sector involvement in state-owned enterprises is beneficial as it increases the transfer of skills that may lead to the rise of national industry leaders who possess professional capabilities that allow for endeavors within their field to be exported. These agreements also help to optimize long-term value for money through properly transferring risk to the private sector over the entire lifetime of a project from design/construction to operation/maintenance.

In this regard, there is growing global interest in PPP contracts. These contracts have had notable success, especially among developed countries like the United States and the United Kingdom (Bovaird 2004). Accordingly, in New Zealand, PPPs have been embraced as a potential solution for infrastructure development, since it provides many advantages such as faster implementation, better risk allocation, cost savings, improved service quality, access to additional revenue sources, local economic and social benefits, and comprehensive project review. This model has helped the government meet its infrastructure needs without relying on private financing only (Liu and Wilkinson 2011b).

In addition, PPP are a central tool for successfully delivering public projects in the Middle East. This was observed by a recent study in UAE, which highlighted that PPPs have become attractive

due to their ability to transfer knowledge and skills from the private sector, utilize private financing, optimize value for money, and transfer risk to the private party (Almarri 2019).

The potential of PPP in addressing infrastructure and public service needs is also apparent in developing nation (Debela 2022c; Gebre and Demsis 2022; Ismail 2014; Kavishe et al. 2019b; Kavishe and Chileshe 2018). The ability of the private sector to raise fund for public projects is one of the key driver in many developing countries to implement PPP in public projects (Chan et al. 2009; Debela 2022c; Gebremeskel et al. 2021b; Ismail 2014; Kavishe and Chileshe 2018; Yuan et al. 2010). This can solve the problem of public sector budget constraint in addressing public infrastructure (Debela 2022c; Gebremeskel et al. 2021b; Robert et al. 2014c; Yuan et al. 2012). Therefore, the utilization of private sector capital in developing public projects can free up public budget that is tied up in capital investment, resulting in accelerated infrastructure projects so that the public demand for infrastructure and public service can be addressed (Chan et al. 2009; Chou and Pramudawardhani 2015a; Gebremeskel et al. 2021b; Yuan et al. 2010) and foster economic development by creating job opportunity and market in an area of project development and by using the freed up public budget to other local economic development program (Cherkos and Jha 2021a; Chou and Pramudawardhani 2015a; Ismail 2014; Robert et al. 2014c).

Furthermore, PPP can facilitate the utilization of creative and innovative approach from the private partner, improve the quality of service, facilitate better resource mobility, save time in delivering projects, and results in construction cost and time certainty (Chou and Pramudawardhani 2015a; Debela 2022c; Gebremeskel et al. 2021b; Ismail 2014; Robert et al. 2014c; Yuan et al. 2010, 2012). The adoption of PPP allows for better risk allocation and risk sharing in a way that risks are transferred to the party that can best manage the risk, this can result in a better success potential of the project (Robert et al. 2014c; Yuan et al. 2010, 2012). PPP can also optimize the whole-life costs of the asset by bundling design, construction, and maintenance responsibilities (Cherkos and Jha 2021a; Debela 2022c; Gebremeskel et al. 2021b; Kavishe et al. 2019b; Kavishe and Chileshe 2018; Yuan et al. 2010), also resulting in the reduction of public sector administration cost that can be spend for consulting and project management at separate stage of the project (Gebremeskel et al. 2021b; Ismail 2014; Yuan et al. 2010).

According to Cherkos and Jha (2021), these drivers of PPP can be understood as a potential solution to public delivery problems, on their study to identify the drivers of road sectors public-private partnership in a new and inexperienced market they were able to identify nine PPP-associated factors acting as a solution for road sector public delivery-associated problems. The PPP-associated solutions include fostering economic development with the private sector's ability to raise project finance, ease the financial burden on public budgets, facilitate ongoing funding for road maintenance activities, construct roads that can ease traffic congestion, facilitate proper and timely maintainability of road infrastructure, optimization of the whole-life costs of the asset by bundling design, construction, and maintenance responsibilities, the certainty of construction costs and timing in case of timely acquisition of complete right of way, improved cost-efficiency of road maintenance and technology transfer and improved local companies' capacity.

Likewise, the Chinese government has proposed ambitious public housing and transportation infrastructure development plans that cannot be fulfilled through state funding alone. However, these plans are achievable with the support of private funding using PPP. Navigating through China's intricate political, financial, and legal landscape can be challenging for private agencies seeking to invest in PPP projects; with a better grasp of the underlying drivers, their chances of success was significantly increased (Yuan et al. 2010, 2012).

Accordingly, the Chinese government decided to engage in PPPs when addressing housing projects for its citizens. The investigation of this phenomenon uncovered four main factors which led to the decision: mitigating public sector budget constraints; leveraging advanced technology and high levels of management expertise; risk transfer/sharing; and encouraging private sector growth (Yuan et al. 2012). Likewise, the Chinese government facilitates the participation of private investors in Metropolitan Transportation Systems (MTS) projects through the use of PPPs. This model enables cost reduction, supports local economic development, increases profits from public services, and provides an opportunity for acquiring additional facilities/services through technology transfer (Yuan et al. 2010). This indicates the china's the prior reason for implementing PPP in housing sector was to solve public sector budget constrain whereas in transport sector the primary driver was to reduce project cost reduction. Therefore, it can be understood that the motive behind the implementation of PPP can differ with the infrastructure type.

Similarly, different researches were conducted in different countries to identify the driving forces behind the utilization of PPP in delivering housing projects to the public, and the results revealed that the advantages that PPP offers was also evident in housing projects (Kavishe et al. 2019b; Kavishe and Chileshe 2018; Yuan et al. 2012). Lack of enough financial capacity to undertake housing project and Provision of housing and other buildings to the general public are the key forces that trigger the Tanzanian government to utilize PPP in housing sector (Kavishe and Chileshe 2018).

Another research conducted in Tanzania was able to identify the motive behind the implementation of PPP in delivering housing projects, which includes encouraging private sector innovation and management skills, possibility of risk sharing between parties, attaining value for money, and encouraging on-time delivery, acceleration of affordable housing provision and improved quality of services, and reduction in whole-life costs of a project (Kavishe et al. 2019b). Despite the overall similarity in the driving forces of PPP adoption, there is a difference in the criticality the factors, this was indicated in researches conducted in china (Yuan et al. 2012) and Tanzania (Kavishe et al. 2019b; Kavishe and Chileshe 2018). This indicates the socio-economic and political climate is essential for determining the forces behind PPP adoption. Evaluating the factors that drive PPP adoption on a country level provides useful insights into best practices for its implementation.

2.3.2 Driving factors for PPP adoption in Ethiopia

The government of Ethiopia has also understood the need for mobilizing resources from different sources to meet the growing demand for public infrastructure (Debela 2022c). In this regard, the government has established the PPP directorate general under the minister of finance, which endeavors to meet the growing demand of the public for service delivery and infrastructure (Proclamation No.1076/2018). In this respect, the Ministry of Finance, (i.e. PPP Directorate General), has taken the initiative to implement solar power, hydropower, wind power, toll road, affordable house, and petroleum depot projects in the PPP modality (FDRE PPP Directirate General 2021a).

Thus, it is important to investigate the reasons that motivated the government of Ethiopia to adopt the PPP model in each sector to provide insights to the practitioners. Because identifying the reasons for adopting PPP may assist in policy-making for infrastructure development (Robert et

al. 2014b). Accordingly (Debela 2022c) studied the driving factors for adopting PPP in the energy sector of Ethiopia. The results of the study revealed that the five top driving factors perceived by the experts include the private sector can raise funds for a project, facilitating creative and innovative approaches, saving time in delivering the project, accelerating project development, and the private sector possessing better mobility. As the private sector is perceived to possess a better capacity in raising funds than the public sector in the energy sector, the private sector must focus on delivering innovative and efficient infrastructure services on time to meet the expectation of the public sector in Ethiopia.

Gebremeskel et al. (2021) conducted a study to create a PPP driver index for the implementation of PPP projects in Ethiopia. The research indicated six separate clusters of drivers, such as benefits for both public and private sectors, private sector attentiveness, social development, cost reduction capabilities, management ability of the public sector, and private sector aptitude. Furthermore, Ethiopia is considering public-private partnerships (PPP) as a means of financing its road sectors. This shift is driven by factors like the lack of government resources, the risks associated with public sector projects, the need for improved services due to current constraints, and the expertise offered by private entities. All of these are valid reasons for Ethiopia's decision to embrace PPPs in this area (Gebre and Demsis 2022). The table below summarizes the result of the systematic literature review on driving factors of PPP implementation/adoption.

Table 7. Driving Factors of public-private partnership adoption and/or implementations

Rank	**Driving factors of PPP adoption**	**Author/s**											
		[1]	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**	**[7]**	**[8]**	**[9]**	**[10]**	**[11]**	**Total**
1	Private sector’s ability to raise funds for public projects	✓	✓	✓		✓		✓	✓	✓	✓	✓	9
2	Offers benefits for local economic development	✓	✓				✓	✓	✓		✓	✓	7
3	Acceleration of infrastructure provision	✓		✓			✓		✓		✓	✓	6
4	Optimization of the whole-life costs of the asset by bundling design, construction, and maintenance responsibilities	✓	✓	✓	✓						✓		6

5	The private sector possesses better resource mobility	✓		✓			✓	✓			✓		5
6	Better risk transfer and sharing	✓		✓					✓	✓	✓		5
7	Improved housing maintainability	✓	✓	✓			✓				✓		5
8	Facilitate creative and innovative approach	✓		✓			✓					✓	4
9	Save time in delivering projects	✓						✓	✓		✓		4
10	Enhances technology transfer to local companies	✓							✓	✓	✓		4
11	Improved quality of housing project/service			✓					✓			✓	3
12	Reduce public sector administration cost			✓				✓			✓		3
13	Certainty of construction costs and time		✓								✓		2

Sources: [1] (Debela 2022); [2] (Cherkos and Jha 2021a); [3] (Gebremeskel et al. 2021b); [4] (Kavishe et al. 2019b); [5] (Kavishe and Chileshe 2018); [6] (Chou and Pramudawardhani 2015a); [7] (Ismail 2014); [8] (Robert et al. 2014c); [9] (Yuan et al. 2012); [10] (Yuan et al. 2010); [11] (Chan et al. 2009)

Note: The checkmark (✓) denotes, the study presented the sources for the findings of driving factors of PPP adoption and/or implementation.

2.3.2 Enabling the successful implementation of public-private partnership

Introduction

Lack of political willingness to develop PPPs, the absence of an enabling institutional environment for PPPs, a lack of project preparation capacity on the part of the public sector, and poorly designed and structured PPP projects are the major barriers that PPP projects face (Mahalingam 2010). Studies have revealed that the failure of many housing PPP projects are inherent in the deficiency of clearly defined enabling factors for the project procurement and implementations (Abdul-Aziz and Jahn Kassim 2011). Therefore, project success largely depends on identifying and analyzing the enabling factors. Assessing these factors is essential in ensuring efficient organizational practices in project management, as well as enabling the successful execution of goals and fulfilling the necessary criteria for judging any project's success (Westerveld 2003).

Accordingly, the presence of an enabling PPP policy, well-organized and committed public agency, stable political and social environment, favorable legal frameworks, good governance, appropriate risk allocation and sharing, transparent procurement process, thorough and realistic assessment of the costs and benefits, adequate knowledge and skills of PPP, competitive procurement process, a strong monitoring and evaluation system for project implementation are the critical factors that will contribute the success road sector PPP in Ethiopia (Debela 2022b). Likewise, a study by Ismail (2013b) revealed that good governance, the commitment of the public and private sectors, a favorable legal framework, sound economic policy, and the availability of the finance market are major success factors of PPP implementation.

Kavishe and Chileshe (2019) conducted a research to identify the critical success factors (CSFs) and key areas for improvement for PPP in affordable housing projects, using Tanzania as a case study. By conducting semi-structured interview with public and private practitioners in Tanzania the author was able to identify six critical success factors, which includes a dedicated team of professionals to oversee the PPP projects, official and unofficial site visits and inspection, government support and guarantees, undertaking checks and balance from the design stage to construction stage, scrutiny of PPP project proposal and trust and integrity. Furthermore, by

The factors that facilitate the success of PPP in housing sectors varies with the geographic jurisdiction, this implies that the socio-economic and political condition determines the success factors of housing PPP projects. This was show on the research conducted on comparative analysis of the critical success factors of housing PPP between Nigeria, the research has revealed that ‘equitable risk allocation’, ‘stable political system’, and ‘reputable developer’ are the most critical success factors in the case of Nigeria, while ‘action against errant developer’, ‘consistent monitoring’, and ‘house buyer’s demand’ are the most critical factors that influenced the success the PPP housing project in Malaysia (Muhammad and Johar 2019). The section below tries to discuss the implication of some enabling factors.

Capacity Strengthening Initiatives (structuring and empowering PPP units)

Several studies, including those by Moskalyk (2011) and Kavishe and Chileshe (2018), emphasize the complexity of implementing Public-Private Partnerships (PPPs). They highlight the need for

thorough preparation, training, experience, and effective monitoring and management skills in PPP projects.

To enhance the capacity of the public sector in India for PPP development, the central government has established a "PPP cell" in each state. These units are staffed with administrative officers and have assembled a panel of transaction advisors with relevant experience and expertise in structuring PPP projects. This approach aims to address capacity issues within local governments and reduce the transaction costs associated with PPP project preparation (Mahalingam 2010).

Moreover, PPP projects often require specialized knowledge not readily available within the public sector. Therefore, creating a central PPP unit with strong support and a connection to higher-level political authorities can bring in the necessary experience and resources from both the government and external parties, fostering a well-organized and conducive environment for PPP project development (Tserng et al. 2012)..

Adequate and reasonable legal framework and PPP policy

Creating an environment attractive to the private sector is a fundamental step in the development of infrastructure through PPPs. To establish this PPP-enabling environment, governments must develop policies, legal and financial frameworks, a dedicated PPP unit, and other support institutions. The success of PPP projects requires appropriate policy and legal frameworks to. Public-private partnerships (PPPs) have been widely used in the procurement of economic and social infrastructure projects. Since the operation of more and more PPP projects, there have been a number of explorations on the factors that contribute to their success. Project success is often expressed by the quality of the product and project management success (Liu et al. 2015).

According to Abdul-Aziz and Jahn Kassim (2011), favorable and efficient legal framework is the factor in the implementation of public housing PPP in Malaysia. And further emphasized that the contractual environment on projects in many developing countries especially in Sub-Saharan Africa is faced with huge uncertainties. Similarly, in Ghana, it is common for government changes to result in legal disputes related to ongoing projects. Withdrawals of contracts, unfair terminations, and lack of protection from the laws can all lead to prolonged litigation with unsatisfactory outcomes. To protect parties and contractors from this, the best option is an efficient and comprehensive legal framework that is prescribed by regulations. This ensures that businesses

remain protected regardless of government turnover. Implementing public housing project through PPP will allow for unhindered progress and safety during and after government changes (Kwofie et al. 2016b).

In this regard, governments in developing countries that are new to PPP need to institute a well-defined legal structure for PPP arrangements. Such a structure makes investors feel secure and protected from any expropriation which may occur in the future (Pongsiri 2002). A well-structured legal framework must encompass a detailed tendering process, tax regime to the private investor, contract awarding, and construction management procedures (IMF 2010). Moreover, the regulatory framework must clearly stipulate the mechanism and procedures for resolving disputes and litigations. South Africa is one of the few developing countries with well-structured legal mechanisms for PPPs. This has helped them to attract both local and foreign investors in their PPP market and also successfully implemented PPP projects (Osei-Kyei and Chan 2015).

Right project identification and project technical feasibility

Chileshe et al. (2022) suggested that the absence or presence of 'technical feasibility' would be an inhibitor (barrier) or enabler respectively. On the other hand, it was identified that those projects that were successful were economically beneficial to the country and helped in its growth. According to Kavishe and Chileshe (2019), this factor is significant at the readiness assessment stage when organizations are expected to carry out housing needs surveys and feasibility studies in an area prior to developing a PPP proposal, and also suggested that careful analysis is needed to verify that a project is likely to be feasible. Likewise, (Ng et al. 2012) identified the initial feasibility of a PPP project as contributing directly to the overall success of a project.

Ghana has had a significant number of unsuccessful housing projects delivered by the government, which have suffered from excessive costs, poor management and outcome, unaffordable units, and other difficulties. which fail in its goal (Bamfo-Agyei et al. 2011). According to (Bamfo-Agyei et al. 2011), the right project identification and project technical feasibility in PPP housing projects is significant towards meeting project objectives and expected debt paying ability of the project in Malaysia. Accordingly, impact of the absence in right project identification and project technical feasibility was apparent in Ghana where the intended affordable housing projects have ended not being affordable to the targeted group (Bamfo-Agyei et al. 2011).

Provision of sovereign guarantee and capital support

The provision of guarantee by government to secure funding by private partners on PPP is crucial to the success of housing projects (Abdul-Aziz and Jahn Kassim 2011). According to, Ismail (2013) and Olusola Babatunde et al. (2012) housing PPP projects in Malaysia and Nigeria respectively often involve colossal funding cost which private partners in the agreement could not have the financial muscle to fund directly. Hence securing funding by governments providing the needed guarantees is thus seen as very crucial towards success on PPP-in the housing sector. However, the absence of clear guidelines, policies and lack of transparency governing the provision of guarantee to PPP agreement is a major challenge. This indicates the necessity of government sovereign guarantees to attract private investment and successfully implement PPP projects (Demeke Cherkos and Jha 2020).

Encouraging community involvement, political support and political stability

According to El-gohary et al. (2006), stakeholders' opposition has been recognized as the leading cause of PPP project failures. In this regard, projects have the potential to be more successful when obtain community acceptance with proactive measures like awareness programs before implementation. In addition, engaging and welcoming community involvement from the start including conceptualization, implementation, and sustainability phases and giving them a seat at the decision table would go a long way towards earning the trust and support of those affected. Furthermore, local leaders could be recruited to act as representatives for project initiatives, ensuring their primary interest is always in that of the wider community (Chileshe et al. 2022). Likewise Osei-Kyei and Chan (2015), also highlight the importance of public support for PPPs to be successful in the long run. Without understanding and acceptance from media outlets, trade unions, civil societies, and non-governmental organizations, the progress of PPPs is highly improbable. Therefore, increased public awareness can help accomplish this goal.

Strong political support for PPPs can assure investors while decreasing the associated risks and further encourages those interested in PPP projects by increasing perceived attractiveness (Ke et al. 2011). Private investors may be reluctant to invest in projects in countries where PPP policy is not securely established. Unfortunately, developing countries often experience intense political opposition to initiated PPP projects due to allegations of corruption and lack of transparency. This

can make the success of these projects difficult to achieve (Demuijnck and Ngnodjom 2011). In this regard, ensuring private sector investments requires governments in developing countries to use the proper measures and strategies to gain support from opposition parties for their PPP projects. This not only prevents unnecessary abrogation of contracts by subsequent governments but also creates a more favorable atmosphere for the successful implementation of these projects (Osei-Kyei and Chan 2017c).

Political stability denotes the "absence of political violence, governmental longevity and existence of a legitimate constitutional regime". Successful political power transfer between parties is a sign of political stability. Legitimacy, or the orderly and peaceful transition from one party to the next, is a key factor in maintaining this type of stability (Sottilotta 2013). Private investors are encouraged to invest in countries with adequate political stability. Stability is a major key for potential investment in PPP projects. It's essential that steps taken by political and civil group leaders adopt measures to prevent any potential cause of political violence. An organized and calming environment triggers prospective private investors to participate in PPP projects, promoting economic development in the region (Osei-Kyei and Chan 2017c).

Competitive and transparent procurement process and process flexibility

According to the study conducted in Nigeria, the identification of the most suitable, efficient and transparent procurement route that ensures value for money remains a step towards project success. The study further indicated that compromising the procurement process is a guarantee for failure (Ogunsanmi 2013). Despite the advantage of competitive procurement in the success of project, the public procurement in Ghana lacks competition and transparency. Indeed, projects are seen to be awarded to friends of the government in power who may not have qualified through effective competitive procurement process. resulting most of these projects to end up with poor quality. As a result, adopting fair, transparent and competitive procurement process can thus be seen as extremely important in the selection of competent contractors to ensure value for money in hosing PPP projects (Kwofie et al. 2016b).

In conclusion, identifying the implementation enablers that are related to project outcomes is a vital step in the successful implementation of project management processes. It ensures delivery success, attainment of goals and objectives, and potentially efficient predictions of success on a

given project. In using a Public-Private Partnership (PPP) arrangement, one of the primary components is developing an understanding of factors deemed to be essential for it to reach its expected results. Therefore, identifying, analyzing, and categorizing various enabling factors is paramount for any such endeavor (Westerveld 2003; Zhang 2005). The table below summarizes the result of the systematic literature review on enabling the successful implementation of public-private partnership.

Table 8. Factors enabling the successful implementation of housing sector public-private partnership in Ethiopia

No	PPP enabling factors	Author/s																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
2	Favorable and efficient legal framework and PPP policy	✓	✓	✓	✓					✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	14
3	Stable macro-economic condition	✓	✓			✓				✓	✓	✓				✓	✓		✓		✓	10
5	Transparent procurement process	✓	✓			✓					✓	✓	✓						✓	✓		8
19	Government involvement by providing a guarantee and financial support	✓					✓	✓		✓	✓					✓			✓		✓	8
6	Competitive procurement process	✓	✓			✓					✓	✓	✓						✓			7
17	Availability of suitable and mature financial market			✓					✓	✓	✓			✓		✓			✓			7
21	Establishing well-organized and committed PPP units	✓		✓			✓			✓		✓							✓		✓	7
9	Good governance	✓				✓							✓	✓			✓		✓			6
10	Political stability	✓	✓			✓				✓										✓	✓	6
13	Right project identification and project technical feasibility	✓					✓				✓						✓		✓		✓	6

18	Availability of strong and reliable private consortium					✓			✓						✓		✓	✓	✓			6
No	**PPP enabling factors**	**Author/s**																				
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**Total**
4	Sound economic policy	✓	✓											✓		✓			✓			5
11	Strong political support	✓						✓	✓	✓									✓			5
8	An efficient evaluation and approval process		✓									✓	✓					✓				4
12	Encouraging community involvement and public acceptance			✓						✓					✓						✓	4
14	Realistic assessment of cost and revenue	✓										✓				✓			✓		✓	4
22	Strengthening public sector capability	✓	✓							✓										✓		4
15	The attractiveness of long-term cash flow to the lenders		✓							✓					✓						✓	4
28	Clear and affordable price design (purchase or rent price)				✓										✓						✓	3
30	Effective negotiation and financial closure												✓					✓	✓			3
16	The existence of long-term demand for the proposed housing projects														✓			✓			✓	2

23	Efficient use of advisory service							✓					✓									2
No	**PPP enabling factors**	**Author/s**																				
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**Total**
24	Preparation of a tact contractual agreement		✓									✓										2
25	Flexibility of contract							✓												✓		2
29	Clear defined roles and responsibilities of parties											✓							✓			2
26	Employing appropriate contractual clauses to manage macro risks							✓												✓		2
27	Creation of model concession agreements																			✓		1
7	Process flexibility																			✓		1
20	The involvement of non-commercial (development) financing				✓																	1
31	In-time land acquisition				✓																	1

Sources: 1 (Debela 2022b); 2 (Hai et al. 2022); 3 (Chileshe et al. 2022); 4 (Muhammad and Johar 2019); 5 (Kavishe and Chileshe 2019); 6 (Mukhtar et al. 2017a); 7 (Kwofie et al. 2016a); 8 (Chou and Pramudawardhani 2015a); 9 (Ismail 2013a); 10 (Ng et al. 2012); 11 (Babatunde et al. 2012b); 12 (Cheung et al. 2012a); 13 (Abdul-Aziz and Jahn Kassim 2011); 14 (Chan et al. 2010); 15 (Zhang 2005);

16 (Mahalingam 2010); 17 (Demeke Cherkos and Jha 2020); 18 (Liu et al. 2015); 19 (Ahmadabadi and Heravi 2018); 20 (Osei-Kyei and Chan 2017c)

Note: The checkmark (✓) denotes, the study presented the sources for the findings of factors enabling the successful implementation of public-private partnership. 2.3.3 Selection of a suitable PPP model for housing projects

The investment and risk preferences of stakeholders in a specific PPP model are influenced by the unique characteristics of the project and the existing environment. Consequently, these factors must be carefully considered when choosing the appropriate PPP model. Therefore an adaptive, standardized, and streamlined decision-making framework is necessary to facilitate the decision-making process in selecting the appropriate PPP model (Vives et al. 2010).

However, the selection of PPP models for housing projects lacked the decision-supporting framework that links project characteristics with the preference of stakeholders. Consequently, there is a pressing need to develop such a framework to aid decision-making in choosing the most suitable PPP models. To build this framework, two key inputs need to be addressed. Firstly, it involves identifying model selection criteria that consider project characteristics, local conditions, stakeholder capacity, and risk preferences. Secondly, the adoption of standardized PPP modes becomes crucial as it can bridge the experience gap and facilitate the successful implementation of the system. The sections below clearly discuss these two important concepts

2.3.3.1 factors influencing PPP model selection

In each project, the unique specifications, characteristics, and environmental conditions play a crucial role. Therefore, choosing a project delivery system that improves quality, minimizes costs, and accelerates the project timeline is highly effective in optimizing resources and preventing the wastage of national funds. As a result, it is crucial for every project owner to carefully select a suitable project delivery system, considering their financial, managerial, and expertise capacities and the level of commitment from other involved parties. This ensures that the project is completed to the highest quality standards, within the shortest possible timeframe, and at the lowest possible cost. This decision holds immense significance, requiring project stakeholders to thoroughly evaluate and distinguish among different project delivery systems. By doing so, they can identify the most appropriate option that best meets the specific needs and objectives of both the project stakeholders and the project itself (Bashiri et al. 2011).

Furthermore, in today's rapidly evolving business landscape, project execution methods worldwide have undergone a significant transformation. Extensive studies and practical experiences confirm that the careful selection of an appropriate project delivery system can result in remarkable cost savings of up to 12% and time reductions of up to 30%. Consequently, choosing the right project delivery system has evolved into a crucial strategic decision, typically made during the final stages of feasibility analysis and in conjunction with determining the project's financial provisions.

Similarly, governments across the globe have exploited various contractual arrangements to cope with the changes in project characteristics and stakeholders involved in public-private partnerships (PPPs). To that end, a number of PPP models have been designed to support the successful implementation of projects (Cherkos et al. 2020b). In this regard, the public sector plays a vital role in determining the type of PPP model best suited for the project. since degree of private sector involvement and risk-sharing mechanisms vary across different PPP modalities, choosing the right one helps reduce potential failures while increasing bankability and attracting investments in long-term projects (Vives et al. 2010).

In this regard, the development of PPP model selection criteria empowers decision-makers to assess and contrast various PPP alternatives, leading them to identify the most suitable model that minimizes conflicts and significantly enhances the likelihood of PPP project success. In light of the diverse and occasionally conflicting interests of stakeholders, it becomes imperative for decision-makers to pinpoint a viable PPP contractual model that effectively addresses the concerns of public accountability, commercial interests, and social considerations for the government, investors, and the community, respectively (Xie and Thomas Ng 2013).

Accordingly, Xie and Thomas Ng (2013) in their research proposed the use of Bayesian network techniques to imitate human reasoning and that conducted multi objective decision making in selecting the feasible PPP scheme. Accordingly, they were able to identify key criteria that can be used to evaluate feasible PPP scheme which includes; availability of potential private investors, utilization of resources. stimulation of innovation, service quality, financial viability, risk transfer, reduce public off-balance budget, early project completion, acceptable tariff/toll, low construction, operational, and maintenance costs, Political support, acceptable to interested groups and general public, environmentally sustainable. Their study developed weighted scores techniques for the selection of a suitable PPP model. However, employing weighted scores techniques has disadvantages due to the difficulty of determining

a credible weighting structure for the preference of different stakeholders. Furthermore, these evaluation criteria are designed for any PPP-related projects. However, due to the unique characteristics and requirement of housing projects, it is essential to developed criteria specifically in the context of housing projects.

Additionally, Cherkos et al. (2020a) conducted a research that aims to develop a framework that assists the decision-making process in selecting the appropriate PPP model for road projects. In doing so, the researchers were able to identify twelve key criteria that influence the selection of a suitable PPP model for road projects by taking in to account the characteristics of the project, the prevailing local condition which may influence the stakeholder's preference. The model selection criteria development process integrated prior researches, PPP user manuals, and case study projects.

The finding revealed that construction phase technical and macroeconomic certainty, private sector interest in construction and maintenance risks, government preference to transfer O&M risks in an integrated way, project commercial viability, certainty of traffic revenue, private sector traffic risk-taking preference, private sector financial capacity, lender's preference, public sector capital support, public sector financial capacity for semi annuity (traffic revenue risk preference, coherence of the project or option with the main objectives of the road sector policy, adequacy of the country environment (political, legal, and institutional framework) to the contractual and organizational arrangements required to rule the project are the major criteria that influences the selection of appropriate PPP model the a particular road project. However, these model selection criteria focus road project, since project characteristics vary and requires different criteria to be successful it is important develop criteria for housing project. While some success criteria may be common across project types, however, some determinants of success are likely to be unique to projects of specific characteristics (Ahadzie et al. 2008).

In conclusion, the successful implementation of PPP modalities in project delivery depends on specific project characteristics, risk allocation mechanisms of the modalities, and stakeholders' risk-taking capacity and preferences. Private sector participation through direct equity investment is typically low, while lenders prioritize the certainty of project cash flow to ensure loan repayments. Sometimes, the financial security provided by private sector developers may not be appealing to lenders because special purpose vehicle companies often have limited assets, and lenders may not have recourse to sponsor companies (Grimsey and Lewis 2002).

Nevertheless, the public sector plays a crucial role in facilitating private sector involvement in infrastructure delivery (Wang et al. 2012). To achieve this, the public sector builds confidence among private sector entities and lenders by offering various certification packages (grants) that encourage investment in PPP models (Jooste et al. 2009). The table below summarizes the result of the systematic literature review on PPP model selection criteria.

Table 9. PPP model selection criteria

Rank	PPP critical success factors	Author/s																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
1	Access to private sector capital to finance the project									✓		✓		✓	✓	✓	✓	6
2	Utilization of skills and expertise of the private sector and stimulation of innovation					✓		✓		✓		✓		✓	✓	✓	✓	8
3	Improved housing project/service quality	✓				✓				✓	✓		✓			✓	✓	7
4	Facilitating technology transfer					✓		✓					✓					3
5	Early project completion/delivery	✓				✓				✓		✓		✓	✓			6
6	Lowering construction, operation, and maintenance cost	✓				✓				✓	✓	✓	✓					6
7	Reduction in public sector administration cost					✓					✓							2
8	Government preference to transfer maintenance risks									✓				✓		✓	✓	4
9	Government preference to transfer operation and maintenance risk in an integrated way		✓													✓	✓	3
10	Private sector off-take and cost recovery risk-taking preference		✓									✓				✓	✓	4
11	Private sector interest in maintenance risk		✓													✓	✓	3
12	Acceptability to the interest group and general public					✓	✓	✓		✓	✓							5
13	Ownership arrangement for the house units								✓					✓		✓	✓	4

14	Alignment of the option with the objective of housing sector policy		✓	✓					✓		✓			✓				5
15	Affordability (acceptability of rent or purchase price)	✓		✓						✓	✓			✓	✓	✓	✓	8
16	Public sector capital support and provision of guarantee	✓			✓		✓	✓	✓	✓					✓			7
17	Availability and form of state subsidy			✓												✓	✓	3
18	Adequacy of the political, legal, and institutional framework of the country to the contractual and organizational arrangements required to rule the project	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓			11
19	Public sector financial capacity		✓				✓									✓	✓	4
20	Macroeconomic certainty		✓		✓		✓	✓							✓			5
21	Political support for the project			✓		✓		✓										3
22	Availability and source of developable land			✓					✓							✓	✓	4
23	Availability of potential private sector		✓					✓		*						✓	✓	5
24	Availability of mature financial institution/market						✓	✓										2
25	Project commercial viability		✓				✓	✓			✓				✓			5
26	Project financial viability		✓			✓	✓	✓		✓	✓				✓			7
27	Project technical feasibility		✓					✓								✓	✓	4
28	Development mix of the proposed housing project															✓	✓	2
29	Environmental sustainability					✓				✓			✓	✓				4
30	Benefits of local economic development					✓								✓				2

Sources: [1] (Osei-Kyei et al. 2022); [2] (Cherkos et al. 2020b): [3] (Adabre and Chan 2019); [4] (Kavishe and Chileshe 2019); [5] (Osei-Kyei and Chan 2017d); [6] (Osei-Kyei and Chan 2017c); [7] (Babatunde et al. 2016); [8] (Woka et al. 2014) [9] (Xie and Thomas Ng 2013); [10] (Ng et al. 2012); [11] (Abdul-Aziz and Jahn Kassim 2011); [12] (Ahadzie et al. 2008); [13] (Zhang 2006); [14] (Zhang 2005) [15] (MOHUA 2017); [16] (World Bank 2020).

Note: The checkmark (✓) denotes, the study presented the sources for the findings of PPP modality selection factors.

2.3.3.2 Standardized Public-Private Partnership Contracts and Their Role in Bridging the Public–Private Partnership Experience Gap

Standardizing PPP agreements that provide all relevant stakeholders with clarity and transparency can result in an increased potential for project financing. By having such templates, private investors will understand what to expect from the public sector and can then enter into PPP arrangements without fear of potential mistrust. This also increases confidence in public sector personnel to enter into PPPs which in turn eliminates any issues regarding political will (Mahalingam 2010).

Developing project-specific contractual conditions and procuring through the public-private partnership (PPP) approach incurs significant transaction costs and time, leading to reduced competition and contract inconsistency (Van Den Hurk and Verhoest 2016). On the other hand, standardizing contracts proves to be a cost-effective and efficient method for PPP procurement. Its benefits governments with limited capacity and experience in PPPs by providing adaptable mechanisms within the contract scope, streamlining the procurement process. Standardized procurement is particularly suitable for numerous projects with similar characteristics. However, some critics argue that standardization's rigidity may hinder its ability to appropriately adapt to changing circumstances (Yong 2010). Consequently, there is a need to develop diverse PPP models tailored to match the specific characteristics of projects and their environment. However, the practice of employing standardized contracts is not as prevalent in long-term and high-risk public-private partnership procurement (World Bank 2019).

However, as PPPs evolved across the globally, certain government agencies made notable strides to enhance the manageability of PPP procurement. They achieved this by devising standardized components for PPP contract design, outlining the terms and conditions under which permits are granted to private entities. Several countries, including Australia, India, New

Zealand, the Philippines, South Africa, and the United Kingdom, have streamlined the PPP bidding process by adopting standardized documents for infrastructure project delivery across various PPP models (World Bank 2017).

On the other hand, developing countries like Ethiopia lack both PPP experience and the standardized use of PPP contracts in bridging their experience gap to facilitate the successful implementation of projects (Cherkos et al. 2020b). Moreover, housing Projects are intrinsically different from another PPP Projects. Private developers do not linger on long after the completion of construction and handing over/sale of the dwelling units. As such, many of the various PPP models may not be suitable for developing affordable housing projects. Those suitable, have to be tweaked to become relevant to the sector (MOHUA 2017).

As a result, countries like Ethiopia that are new to PPPs needs to either establish standardized PPP models or adopt already standardized PPP models in a similar context that meet their objective by assessing the suitability of implementing them in a newly emerging PPP market. Therefore, it is worth assessing the implementation of standardized PPP models that meet their objectives.

Accordingly, numerous studies conducted in developing nations have investigated the driving forces behind the adoption of public-private partnerships (PPPs) in infrastructure delivery. The results reveal that the primary reason for implementing this system is to utilize private sector capital for the development of public projects. This finding is evident in countries such as Ethiopia (Gebremeskel et al. 2021; Debela 2022), Indonesia (Chou and Pramudawardhani 2015a), and China and Hong Kong (Chan et al. 2009).

Furthermore, a study by Cherkos and Jha (2021) identified two primary financial-related drivers contributing to PPP adoption in the road sector of emerging markets: the private sector's ability to raise project finance and the alleviation of financial burdens on public budgets. This suggests that access to private-sector financing is a critical motivator for the adoption of PPPs in road infrastructure projects in new markets like Ethiopia.

Similarly, the use of private sector funding to solve public sector budget constraints is also the primary driving force behind the implementation of PPPs for public housing projects in countries like Tanzania (Kavishe and Chileshe 2018) and China (Yuan et al. 2012). Overall, these findings highlight the importance of considering PPP models that encourage private-

sector financing in infrastructure development. Therefore, this research focuses on PPP models that facilitates the utilization of private-sector financing for developing public housing.

In this regard, PPP models that were developed by the World Bank to facilitate the development of public housing in emerging markets within developing countries were selected, because these models facilitate the utilization of private sector capital to finance the construction of public housing and these models can meets the objective of PPP adoption in most developing nations. These models are derived from initiatives of India. India and China collectively account for 90% of the PPP projects in Asia, which make up half of the total number of PPPs in developing countries. (Deep et al. 2019). These models establish fundamental parameters for a decision-making framework in housing PPPs. Their purpose is to assist housing practitioners and policymakers in guiding the provision of affordable housing through public-private collaborations in emerging economies.

2.4 Research Gap

In a study by Gebremeskel et al. (2021), an investigation was undertaken to establish a PPP driver index for the implementation of PPP projects in Ethiopian economy. However, the unique objectives that each government has for PPP implementation in various sectors necessitate a sector-specific examination of driving factors. As exemplified by (Debela 2022c), research focused on the energy sector's adoption of PPP was conducted. Similarly, (Gebre and Demsis 2022) explored into the reasons behind PPP adoption in road provision within Ethiopia. Despite the government’s motivation for implementing PPPs in housing provision, there is lack of research aimed at evaluating the factors that lead to the adoption of PPPs in Ethiopia's housing industry, indicating a significant research gap.

When it comes to enabling the successful application of PPPs, Demeke Cherkos and Jha (2020) investigated the facilitation of successful PPP in emerging markets. The research aimed to uncover potential reasons for failure and factors that support the implementation of PPPs in new road sector markets. Similarly, in another study, Debela (2022a) examined the critical success factors (CSFs) of PPP road projects in Ethiopia. However, applying the findings from these studies to housing projects poses challenges due to the fact that the unique characteristics of each project type and sector play a crucial role in determining its success (Ahadzie et al. 2008), this signifies a notable research gap, in enabling successful execution of PPP in housing Provision.

Furthermore, in identifying the factors influencing PPP model selection, Xie and Thomas Ng (2013) proposed using Bayesian network techniques to replicate human reasoning and executed multi-objective decision-making to determine viable PPP schemes. Yet, the application of weighted scores techniques faces drawbacks due to challenges in establishing credible preference weights for diverse stakeholders. Furthermore, the assessment criteria designed for general PPP projects lack alignment with the distinct features and needs of housing projects, necessitating criteria specific to housing contexts. Additionally, Cherkos et al. (2020a) devised a framework to aid model selection in PPP road projects. However, given the diversity of project characteristics and their requisite criteria for success, tailoring criteria to housing projects becomes essential. Although some success factors may be shared across project types, unique determinants are likely to exist for projects of distinct attributes (Ahadzie et al. 2008). This triggers the necessity for research aimed at identifying the factors that influence the choice of a PPP model for housing projects, highlighting a potential gap in existing research.

To conclude, even though there is substantial public demand for housing facilities and the Ethiopian government is actively pursuing PPP strategies to alleviate the housing shortage, no research has been carried out to investigate the prospect for the implementation of PPP in the housing sector of Ethiopia. Thus, the primary objective this research is to study the reason behind adopting public-private partnerships and to enable the successful implementation of the system in Ethiopian housing sector.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The research methodology plays a crucial role in establishing the study's theoretical basis and philosophical framework. It encompasses various strategies and approaches to address the primary research objectives, guiding the entire problem-solving journey within the research process. Thus, the research methodology holds significant importance in shaping the overall research design, data collection, and analysis. Choosing the right research methodology is crucial for ensuring the validity, reliability, and generalizability of the findings. Consequently, researchers must carefully determine the optimal methodology to address the research questions. This involves selecting the appropriate sampling technique, data collection tools, and data analysis methods (Liu 2008). This chapter provides an overview of the research methodology, outlining the respondent selection process, data collection tools, data analysis methods, and the overall activities and steps involved in conducting the research.

3.2 Research design

The study began by defining the problem and establishing research objectives, aimed at understanding the reasons behind the adoption of PPP in housing provision in Ethiopia and facilitating its potential implementation of the system in the sector. Subsequently, a systematic literature review was conducted to identify the driving factors for housing PPP adoption, critical factors enabling successful implementation in Ethiopia, factors affecting PPP model selection for housing projects, and to develop a decision-supporting framework. To achieve the research objectives, primary data was collected through a questionnaire survey and discussions with professionals. The gathered data was analyzed, leading to the formulation of the findings and framework. Finally, conclusions were drawn, and recommendations were provided based on the findings.

Furthermore, because each specific objective has unique characteristics, a distinct methodology tailored to the needs of each objective is employed. This approach ensures that the most suitable methodology is used for each specific objective. As a result, the methodology used to achieve each objective is presented separately, contributing to a clearer presentation of the research process. In this context, the methodology is organized into three parts. The first part outlines

the methodology adopted to achieve specific objectives one and two, which involve exploring the key drivers of housing PPP adoption in Ethiopia and identifying the critical factors that enable the successful implementation of housing PPP in the same context. Part two focuses on the methodology employed to address specific objective three, which involves identifying PPP model selection factors for housing projects. Lastly, the third part describes the method used to address specific objective four, which is the development of a framework to assist in the decision-making process for selecting a suitable PPP model for housing projects. The whole research process employed in conducting the research is summarized in Figure 3

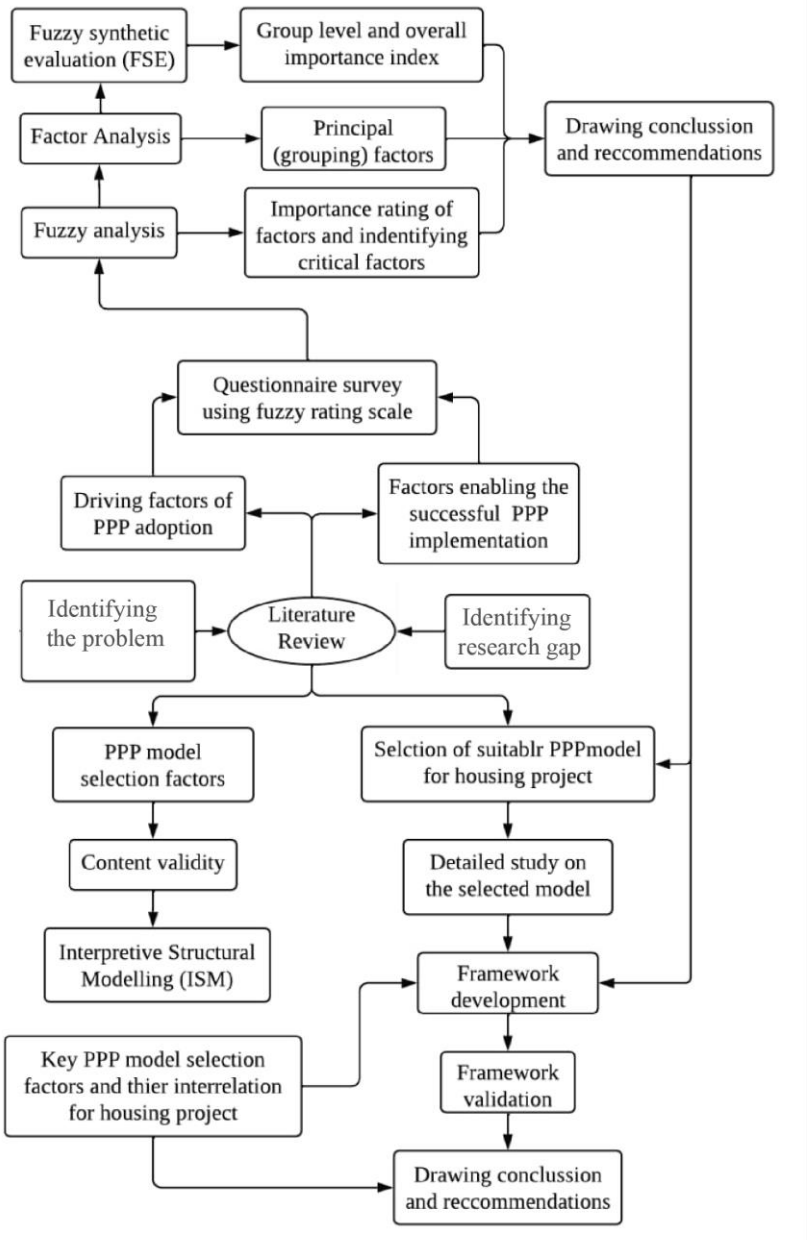

Figure 9. The research processes.

3.3 Part 1: Exploring the key drivers of PPP adoption in the provision of housing in Ethiopia and identifying the critical factors enabling the successful implantation of the system in Ethiopian

3.3.1 Introduction

In order to explore the critical drivers of PPP adoption in the housing provision in Ethiopia and to identify the critical factors enabling the successful implementation of housing provision through PPP in the country, a systematic approach was employed. The process began with a systematic literature review, identifying the key drivers and critical implementation enablers. The findings from this review guided the development of a questionnaire, with responses then subjected to a multi-step data analysis involving fuzzy analysis, factor analysis, and fuzzy synthetic evaluation. The fuzzy analysis involved the following processes; fuzzification (converting fuzzy responses into triangular fuzzy numbers); aggregation (combining these fuzzy numbers across various expert responses); and defuzzification (transforming fuzzy results into crisp values).

Next, the crisp values were normalized with λ-cut set method to identify the critical factors driving PPP adoption and enabling the successful implementation of the system in Ethiopia. Subsequently, an exploratory factor analysis based principal factors analysis was conducted to group the identified critical factors into a smaller set of independent common factors. This clustering facilitates a clearer understanding of the problem being studied.

Finally, a fuzzy synthetic evaluation was employed to determine the importance index of the factors at principal factor (groups) level, overall importance index of the factors and facilitate the development of models. This comprehensive approach ensures a systematic exploration of the factors driving PPP adoption in Ethiopian housing provision and factors enabling the successful implementation of the system. Moreover, it provides valuable insights into relative significance of the factors. The detail of each processes involved is clearly presented in the following sections.

3.3.2 Target Population

Determination of an eligible population (i.e. study participants) is a significant step in planning a research, because it determines the validity of the research. The target participants of this

study were professionals from both the public and private sectors who were involved in the housing provision initiative using the PPP modality.

3.3.3 Study participants

Representative participants with adequate experience were targeted from the public and private sectors including practitioners (contractors, consultants, and real estate developers) participating in the initiative of housing delivery through PPP modality. To get reliable information, these participants were selected based on an purposive sampling method from the target participants of the public and private sector with predefined criteria (Osei-Kyei and Chan 2017). The advantage of purposive sampling technique is that targeting professionals in the subject area of study allows the collection of reliable information (Bhattacherjee 2012). In this regard respondents from both public and private sectors were selected purposively. From the public sectors in addition professionals from PPP directorate general under Ministry of finance, participants from other organization that are taking part in housing provision initiative using the PPP modality were selected.

Accordingly, participants from PPP directorate general (under Ministry of Finance), Federal housing corporate, Ministry of Planning and development, Minister of urban and infrastructure development, Addis Ababa housing development and administration bureau and Addis Ababa city administration were selected. Respondents from these organization were selected based on four main criteria (Debela 2022b); (i) the participant must possess a minimum of bachelor degree; (ii) they must possess adequate knowledge in the area of the Ethiopian government policies and regulations of infrastructure development; (iii) they must be involved very closely in the procurement of large infrastructure projects; or (iv) they must serve as senior experts or managerial position in their respective area of specialization. Furthermore, they must be taking part or must have close understanding on the currents initiations that the government is taking to deliver housing project through PPP.

Professionals from the private sector which is currently involved in real estate development or construction industry and is preparing to engage in partnership with the public sector to develop housing through PPP was carefully selected to participate in the research. Any professional who specializes in traditional procurement and is intimately involved in construction contracts that the company undertakes, as well as the handling of issues related to PPP engagements between private sectors and the government, and who has sufficient understanding of PPPs,

was selected purposively to participate in the research as an eligible respondent to the questionnaire. In this regard, professionals from four private companies which includes Ovid construction (under Ovid Group), Midroc construction Ethiopia (under Midroc investment group), Al-Sam real estate (under Al-Sam PLC), and Flint Stone Homes were selected to study the drives and enablers of PPP implementation in Ethiopia.

In this regard, a total of 63 professionals from both public and private sector were identified as an eligible participant for the study, due the small number of these professionals, all professionals were taken for the study. accordingly, 61 questionnaires were distributed among these professionals. And a total of 53 valid responses were collected and used for analysis.

3.3.4 Data collection

3.3.4.1 Source of data

Both primary and secondary data were used to collect relevant information for the research. While primary date was gathered through questionnaire survey, secondary data was obtained from a review of relevant books, journal articles, PPP related user manuals, and others. The secondary data served as a source of identifying the problem and as a source for creating and analyzing the primary data.

3.3.4.2 Data collection instrument

The primary data for the study was obtained using a questionnaire survey. Within the realm of questionnaire-based data collection, there exist several methods to gather responses. One of the most widely used techniques is the Likert scale. The Likert Scale was developed by Resins Likert in 1932, and it is the most commonly used psychometric scale for survey research (response/data collection). It involves respondents providing their opinion or level of agreement with a given statement. This can provide valuable insight that can help shape outcomes and allow researchers to understand public opinion more clearly. The Likert scale can be easily constructed and modified, the numerical measurements can be easily used for statistical inference. With Likert scaling it is possible to easily collect and analyze a large quantity of data with less time and effort. despite these advantages, the Likert scale has several weaknesses (Li 2013).

The debate over whether a Likert Scale is ordinal or interval measure leads to uncertainty in data interpretation (Jamieson 2004). While Rensis Likert assumed interval qualities, many

views Likert scaling as ordinal. Conventional interval scales assume equal differences between consecutive scales, but it's illegitimate to equate intensity of feeling across Likert categories (Davison and Smith 2018). The ordinal scale measures response order without interval information, so considering Likert as purely interval or ordinal is misleading. The closed response format of Likert scaling limits respondents to a restricted range of options that may not align with their exact responses, leading to potential distortion of collected information (Hodge and Gillespie 2003).

The Fuzzy sets theory provides the basis of a new rating scale for psychometric measurement. This theory combines verbal-conceptual and math-analytical approaches to turn an ordinal variable into a continuous one, yet it still maintains the semantic meaning. Analyzing data from open responses in this manner can reduce information loss, limiting distortion throughout the measurement process. As such, fuzzy sets theory provides an ideal tool for capturing interval details within an ordinal variable (Jónás et al. 2018; Li 2013; Vonglao 2017).

Furthermore, in the real world, many kinds of uncertain or imprecise knowledge exist. Sources of this uncertainty may come from physical measurements being imprecise, as well as from language being vague and ambiguous. To properly reason with natural language which is often difficult to precisely quantify, fuzzy set theory comes in as a powerful tool for dealing with these challenges. Fuzzy set theory helps to better deal with inexact and probabilistic information in the world (Chakrabotry 2013).

3.3.4.3 Basics of Fuzzy Set Theory and Triangular Fuzzy Numbers

Making decision in a vague and uncertain environment poses significant difficulties (Esmaili-Dooki et al. 2017). To effectively tackle this vagueness and uncertainty, Zadeh (1965) first articulated fuzzy logic concepts. This type of logic is based on the idea that there is uncertainty surrounding most things in life. This component of uncertainty refers to two characteristics: randomness and fuzziness. As such, fuzzy logic seeks to capture this element of unpredictability.

Fuzzy systems have gained significant success in developing advanced control systems due to their simplicity. They excel in applications that resemble human decision making by generating precise solutions from uncertain or approximate information (Vinodh and Vimal 2012). In the real world, there is a wealth of fuzzy knowledge characterized by vagueness, imprecision, uncertainty, ambiguity, and probabilistic nature. Uncertainty arises from imprecise

measurements or vague language, and fuzzy set theory provides a means to quantify and reason using natural language, where words often have ambiguous meanings (Chakrabotry 2013).

In mathematics, an undefined set is a group containing members that cannot be specifically identified. Such groups are referred as "fuzzy sets." It refers to the set of things for which it cannot be identified whether each thing in question is a member of the set or not. Despite the impossibility to discern if something qualifies for membership or not, its tendency can be indicated through the use of a membership function, whose value ranges between 0 and 1. If the membership value of something gets closer to 1, it has a high level of membership. In contrast, if the membership value gets closer to 0, it has a low level of membership (Li 2013; Vonglao 2017). Fuzzy sets involve elements with degrees of membership (Sun 2010).

Fuzzy set: If X is not an empty set, x is any member of X and A is a fuzzy set whose membership function is $\mu_{(x)}$, then fuzzy set A can be written in the form of a pair set as follows (Vonglao 2017):

$$A = \{(x, \mu_{(x)})/x \epsilon X\}, \mu_{(x)} : X \rightarrow [0,1] \qquad \text{Equation 3.1}$$

Membership function $\mu_{(x)}$ is used to determine the membership level for *x*, in this study a triangular membership function was used to develop the fuzzy set and it is discussed in the next section.

Fuzzy membership functions

In fuzzy sets theory, every linguistic label A in a statement is matched with a fuzzy set X. A membership function $\mu_{(x)}$ is defined on each fuzzy set X to return a membership degree in the unit interval [0,1]. For an element x in X, the membership degree $\mu_{(x)}$ quantifies the grade of membership of element x in fuzzy set X (Li 2013). In this regard, Membership function ($\mu_{(x)}$) is used to determine the membership level for x in a given set. There are many types of membership function. Which type to be used is depends on suitability and relevant information based on the expert's consideration. The types include triangular membership function, trapezoidal membership function, Gaussian membership function, and bell-shaped membership function. Each function has different parameters and shape. The triangular membership function is the most commonly used membership function which allows for simple computation to transform crisp input variables into fuzzy variables (Li 2013). This triangular membership function is represented by a triangular fuzzy number.

A triangular fuzzy number (TFN) is a fuzzy number that is represented by three points (l, m, u). A fuzzy number Ḿ on real number $\mathbb{R}$ is a TFN, if its membership function $\mu_{(\acute{M})}: \mathbb{R} \rightarrow [0,1]$ is equal to the following (Chang 1996; Sirisawat and Kiatcharoenpol 2018; Sun 2010):

$$\mu_{(x)} = \begin{cases} (x-l)/(m-l), & l \leq x \leq m \\ (u-x)/(u-m), & m < x \leq u \\ 0, & elsewhere \end{cases} \qquad \text{Equation 3.2}$$

Where l and u are the lower and upper bounds of fuzzy number Ḿ, and m is the modal value for Ḿ. The TFN can be denoted by $\acute{M} = (l, m, u)$, and is represented by geometric space as shown figure 4.

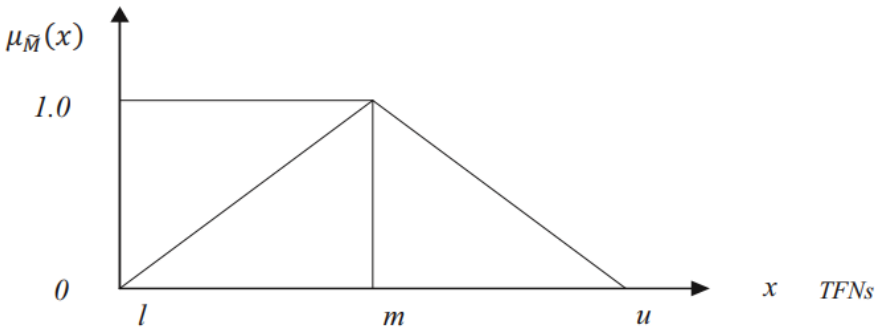

Figure 10. Membership function of the triangular fuzzy numbers. source: (Kahraman et al. 2003)

3.3.4.4 Questionnaire Survey

After a systematic literature review was conducted to identify the driving factors for PPP adoption and factors enabling the successful implementation of the system, a questionnaire was developed using the out of a systematic literature review and utilized a seven-point fuzzy rating scale that was developed by (Mazher et al. 2018), to study the risk-assessment approach PPP infrastructure projects from a developing country perspective. This fuzzy rating scale with linguistic variable and their associated fuzzy number was used because it was developed from the perception of PPP experts in developing nations making it best fit for this study since this research is on PPP in the context of Ethiopia, which belongs to the broad category of developing nation.

Furthermore, a questionnaire survey was selected for this study because it is one of the widely used research methods in PPP studies and due to its ability to provide insight into a broad range of essential questions and topics, as well as its advantageous response rate (Chan et al. 2010;

Osei-Kyei and Chan 2015; Robert et al. 2014a). The questionnaire contained three parts, the first part was about the respondent's information, the second section assess the perceptions of experts on the drivers of housing sector PPP in Ethiopia, and the third section concerned about the factors that enables the successful implementation of the system in Ethiopian housing sector.

The finalized questionnaire was subject to a pilot study to verify the clarity of the questions with five professionals selected from the PPP Directorate General of Ethiopia (three experts) and the Federal housing corporate (two experts). And the targeted respondents were requested to evaluate the importance of the intended variables based on a seven-point fuzzy rating scale, as presented in table 6. The questionnaire was distributed among targeted experts from the public sector and private sector. Each respondent was provided with a questionnaire in a hard copy with a consent form.

Table 10 Membership function of the triangular fuzzy numbers. Source *:* (Mazher et al. 2018)

Linguistic Variables	**Linguistic Variables**	**Triangular Fuzzy Numbers (TFN)**	**Equivalent crisp rating**
Extremely Low Importance (ELI)	Extremely Low Significance (ELI)	(0.0, 0.0, 0.15)	0.05
Very Low Importance (VLI)	Very Low Significance (VLI)	(0.0, 0.15, 0.3)	0.15
Low Importance (LI)	Low Significance (LI)	(0.15, 0.3, 0.5)	0.3167
Moderate Importance (MI)	Moderate Significance (MI)	(0.3, 0.5, 0.7)	0.5
Hight Importance (HI)	Hight Significance (HI)	(0.5, 0.7, 0.85)	0.683
Very High Importance (VHI)	Very High Significance (VHI)	(0.7, 0.85, 1)	0.85
Extremely High Importance (EHI)	Extremely High Significance (EHI)	(0.85, 1, 1)	0.95

3.3.5 Data quality assurance

Data quality assurance is crucial in research, as it directly impacts reliability (consistency) and validity (accurate measurement). Poor data quality undermines research credibility, introducing errors and biases. Rigorous measures ensure data accuracy, consistency, and proper collection, enhancing trust in research outcomes. Reliable and valid data enable meaningful

insights, informed decisions, and knowledge advancement. In this regard, validity and reliability tests are conducted to assure the quality of data and measurements.

3.3.5.1 Validity test

Validity in research refers to the extent to which a study accurately measures or assesses what it is intended to measure. It ensures that the research methods and instruments effectively capture the underlying construct or concept being studied, without significant bias, error, or distortion (Yusoff 2019). There are several types of validity that researchers consider to ensure the credibility and accuracy of their findings (Heale and Twycross 2015).

In this research, a comprehensive systematic literature review was undertaken to ensure an extensive and thorough exploration of crucial concepts. Additionally, the advisor conducted a rigorous assessment of the final questionnaire, examining its content, face validity, construct validity, and measurement scales. This thorough evaluation aimed to guarantee that the instruments accurately captured the intended concepts, adequately covered essential constructs, and considered factors such as question length, structure, and wording. Furthermore, the questionnaire underwent a review by five experts before distribution, ensuring its clarity and suitability for measuring the intended concept.

3.3.5.2 Reliability test

The degree to which a data collection instrument generates steady and consistent outcomes is known as reliability. A measurement is considered highly reliable if it consistently yields similar results under similar conditions. This evaluation is crucial in confirming the broader applicability, dependability, and consistency of the research (Field 2005). Cronbach's alpha is a prevalent method used to assess the internal consistency of the dataset (Oyedele 2013). It generates a coefficient ranging from 0 to 1, and according to Field (2005), a value exceeding 0.70 indicates a reliable dataset and survey instrument.

In this research, data was gathered from a cross-sectional group of respondents using purposive sampling to ensure that the right individuals provide consistent information. Additionally, well-defined and unambiguous questions were formulated. Furthermore, the reliability coefficient and the questionnaire's reliability were determined using the Cronbach's alpha test.

3.3.6 Data analysis

Quantitative and qualitative research methods are the two major types of research strategies for data analysis. The research area and the availability of data mainly dictate the type of research method to follow (Naoum 2007). According to Creswell (2009), quantitative research measures a problem in numbers based on a theory composed of variables objectively. But, qualitative research underlines meanings, experiences, and descriptions to subjectively evaluate the opinion, views, or perceptions of respondents toward a particular issue. In this study, both qualitative and quantitative research methods were employed for data analysis.

3.3.6.1 Qualitative Data Analysis

The prior researches were analyzed by using systematic literature review, to identify relevant variable to meet the research objectives (Osei-Kyei and Chan 2015). Following a qualitative approach, the result of the systematic literature review was used to develop the questionnaire to collect the participants' perceptions on the importance of the intended variables. The method used to conduct the systematic literature review is presented as follows.

3.3.6.1.1 Method of systematic literature review

To properly review and analyze the findings of previous research studies on a particular topic, methodical analysis of publications in academic journals is necessary. In this respect, systematic reviews offer a comprehensive and reliable means to synthesize research findings. Authors can use a systematic literature review to assess whether an effect is consistent across studies, examine how different cultural contexts may influence results, and ascertain which additional studies are necessary to demonstrate the effect. These specialized searches and rigorous selection criteria make them valuable tools in uncovering the impacts of certain factors on policy and practice. Furthermore, systematic reviews generate a valuable and reliable source of information due to their reproducibility, accuracy, and transparency. This will make the conclusions derived from systematic reviews valid (Davis et al. 2014; Snyder 2019).

In this regard, a similar three-stage search process adopted by (Osei-Kyei and Chan 2015) was employed to conduct a content analysis. The three stages include the identification of academic journals and/or publishers, selection of target papers, and examination of the target papers.

Identifying academic journals and/or publishers

To achieve the research objectives, academic journals publisher with good index in construction engineering and management has been identified. The list of publishers includes American Society of Civil Engineers (ASCE), Elsevier, Emerald insight, Tayler and Francis, and Springer. The lists of journal publications from these publishers were obtained by using a powerful search engine "Google Scholar" and "science Direct" for a comprehensive search on the subject area. The Google Scholar and Science Direct search engines were chosen because they cover most publication databases in different research areas.

The keywords to search for publications on PPP driving factors includes "PPP attractive factors", "PPP driving factors", "Drivers of PPP adoption", "Positive factors of PPP", "Benefits of PPP" and "Reasons for PPP implementation"; the keywords to search publications on factors enabling the successful implementation of PPP included "critical success factors of PPP", "success factors of PPP", "factors enabling successful application", and "PPP implementation enables"; and the key words to search publication on PPP model selection criteria includes "PPP model selection criteria", "procurement selection criteria", "factors attracting private sectors investors in PPP", "PPP success factors for housing projects", "success factors for housing projects", and "PPP success criteria for housing project". In general, the overall search was limited to the area of PPP by using the keyword "public-private partnership", "private-finance initiative", "Public-private relationships" and "public-private alliance".

Selecting target papers

In selecting the target papers for further examination, a more visual and comprehensive search was conducted at this stage. Accordingly, a journal must satisfy the following inclusion criteria to be eligible for the review, it must be published in the English language and contain research conducted in developing countries since 2005 and journal articles referred in them. This approach enables the identification of context-specific factors relevant to Ethiopia and encompasses up-to-date publications. It should focus on road sector, housing sector, energy sector, or general infrastructure-related topics related to PPP. To meet these criteria, the content also needs to discuss driving factors of PPP adoption and/or implementation, enablers of successful PPP implementation, and a set of selection criteria for appropriate PPP modality. In addition to previous research, PPP user guides were exceptionally used to develop initial list of PPP modality selection criteria.

Examining the target papers

A detailed analysis of the selected papers was conducted in order to identify and highlight the most relevant findings. The frequency of factors appearing across the chosen set of research was used to determine which factors should be included in the study. To avoid repetition, all similarly worded or expressed factors were consolidated into a single, representative phrase. Figure 5 summarizes the overall method of systematic review.

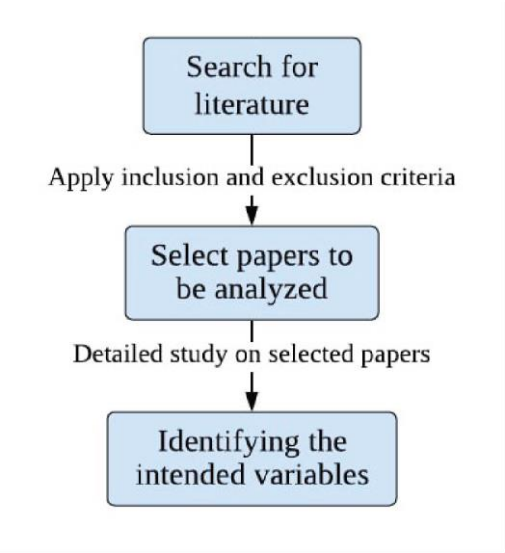

Figure 11. Method of systematic literature review

3.3.6.2 Quantitative Data Analysis

Quantitative data analysis produces quantified outcomes and conclusions derived from the evaluation of results from the literature and collected data (Liu 2008) The descriptive method of data analysis including the measure of central tendency (mean score) was employed to investigate the distributions of the data given by the respondents (Naoum 2007). Furthermore, the inferential method of data analysis will also be used to measure the relationship between variables.

In this study, data from the questionnaire survey underwent analysis using SPSS software version 26 and Microsoft Excel. SPSS is a statistical data analysis program initially designed for social sciences, but it has expanded to other data markets (Finn 2005). It was selected for its comprehensive features, user-friendliness, flexibility across research fields, and ability to generate tabulated charts and distribution plots. Microsoft Excel, the second analysis tool, serves as a spreadsheet program for tracking and analyzing numerical data.

3.3.6.3 Techniques for qualitative data analysis

The collected data were analyzed using the Statistical Package for Social Science (SPSS) version 27 and MS Excel. The data analysis techniques that were used in this research include the reliability test, fuzzy analysis, λ-cut set technique, factor analysis (FA), and fuzzy synthetic evaluation (FSE) modeling.

3.3.6.3.1 Fuzzy data analysis

A fuzzy analysis generally consists of several steps including specification of the type of fuzzy numbers and membership functions, scale of preference, fuzzy values assignment to attributes, fuzzy aggregation, defuzzification, and ranking of alternatives (Singh and Tiong 2005). This system convers the crisp inputs that are collected from the perception of experts to a crisp out put that can be used for further analysis (Li 2013; Vonglao 2017).

Fuzzification: It is the process of transforming input variables into fuzzy values that are described by membership degrees and their associated membership functions. In other words, it involves assigning a degree of membership to a value in a range of possible values, based on how well it fits a set of criteria. The fuzzification procedure results in a set of paired fuzzy values $\{\mu_{label(x)}, label\ (x)\}$ with $\mu_{label(x)}$ representing the membership degree and *label (x)* representing its associated membership function/fuzzy set (Li 2013). In this research fuzzification was used to replace fuzzy responses the associated triangular fuzzy number in table 6.

Aggregation: For aggregation of fuzzy numbers across multiple experts' inputs, this study used the notion of average value (Buckley 1985). For a given alternative, if $\hat{R}_i^{\ k}$ represents the fuzzy assessment of a factor i by expert k then the evaluation will be given by $\hat{R}_i^{\ k} = (l, m, u)$. The fuzzy average of assessments by all the experts will be given by

$$\hat{R}_i = \left(\frac{1}{q}\right) \otimes (\hat{R}_i^{\ 1} \oplus \hat{R}_i^{\ 2} \oplus \ldots \oplus \hat{R}_i^{\ q}) \qquad \text{Equation 3.3}$$

Where $\hat{R}_i$ = average fuzzy number encapsulating the judgment of all the experts. Once the fuzzy aggregates are obtained, defuzzification to a crisp value is necessary for further processing.

Defuzzification: is the process that transforms the results in fuzzy values to common crisp values so that they can be interpreted in the traditional non-fuzzy sense. This process involves

converting the fuzzy output values, which can be represented by membership functions, into a single, crisp output value that can be used for decision-making or control purposes. Defuzzification can be used to determine the overall score or rating based on the fuzzy responses (Vonglao 2017).

The defuzzification process of converting triangular fuzzy numbers into crisp numbers was employed in this study. There are multiple methods available to perform this function; however, the most commonly used method is the centroid defuzzification, center of gravity, or center of area defuzzification. As employed by (Wang and Elhag 2007; Zhao et al. 2013), for a TFN $\hat{\mathrm{R}}$, the centroid defuzzification (R') is given by:

$$R' = \frac{\hat{\mathrm{R}}}{3} = \frac{l+m+u}{3} \qquad \text{Equation 3.4}$$

Here, l, m, and u represent the lower, modal, and upper values, respectively, of the TFN $\hat{\mathrm{R}}$. The TFN is denoted as $\hat{\mathrm{R}} = (l,\ m, u)$. Basic arithmetic operations on two TFNs, $A = (l_1, m_1, u_1)$ and $B = (l_2, m_2, u_2)$, are given below (Chen and Hwang 1993)

Addition: $\mathrm{A} \oplus \mathrm{B} = (l_1, m_1, u_1) \oplus (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2)$ Equation 3.5

Subtraction: $\mathrm{A} \ominus \mathrm{B} = (l_1, m_1, u_1) \ominus (l_2, m_2, u_2) = (l_1 - l_2, m_1 - m_2, u_1 - u_2)$ Equation 3.6

Multiplication: $A \otimes \mathrm{B} = (l_1, m_1, u_1) \otimes (l_2, m_2, u_2) = (l_1 l_2,\ m_1 m_2,\ u_1 u_2),\ for\ l_i > 0,\ m_i > 0,\ u_i > 0$ Equation 3.7

Division: $A \oslash \mathrm{B} = (l_1, m_1, u_1) \oslash (l_2, m_2, u_2) = (l_1/l_2,\ m_1/m_2,\ u_1/u_2),\ for\ l_i > 0,\ m_i > 0,\ u_i > 0$ Equation 3.8

3.3.6.3.2 A λ-Cut Set Method: Identifung the critical factors

In this study, a λ-cut set method as part of the fuzzy set theory was formulated to identify critical factors. This method involves uncertainties and fuzzy variables. The implementation of fuzzy set theory is found to be favourable for the present study as the data is subjective and qualitative, most of them, in identifying the criticality of factors. The fuzzy set theory was used to reduce the fuzziness and uncertainty (Zadeh 1965) and to help identify the critical factors (Shen et al. 2011; Yadollahi et al. 2017).

The symbol $\tilde{\mathrm{A}}$ was used to represent a set of factors, noted as PPP driving factors and PPP successful implementation enablers. This factor set is designed as a fuzzy set (Equation 3.9) (Shen et al. 2011).

$$\tilde{A} = \frac{\mu_{\tilde{A}}(x_0)}{x_0} + \frac{\mu_{\tilde{A}}(x_1)}{x_1} \ldots = \sum_{i=1}^{n} \mu_{\tilde{A}}(x_i)/x_i \qquad \text{Equation 3.9}$$

where x_i is the factors; n is the number of PPP drivers and enabling factors; $\mu_{\tilde{A}}(x_i)$ is the degree of membership of x_i in the fuzzy set $\tilde{A}$ and $\mu_{\tilde{A}}(x_1)$ ϵ [0.1]. Particularly, in Equation 3.9, "+" and "/" are the symbols of the fuzzy set. They don't stand for "plus" and "divided by," respectively. $\mu_{\tilde{A}}(x_i)/x_i$ means that the degree of membership of x_i in $\tilde{A}$ is $\mu_{\tilde{A}}(x_i)$ "+" can be read as "and." (Zadeh 1965; Zimmermann n.d.).

The descriptive analysis is computed based on the influence of the factors. Accordingly, crisp importance rating (I_r) and Standard Deviations (SDs) are calculated for all initial list of factors that provide the basic data to employ fuzzy set theory. The value of the standard deviation determines whether a factor belongs to the critical factors set. In this regard, the larger the standard deviation, the less critical the identified factor. Moreover, the factor's criticality is recorded from extremely low (0.0, 0.0, 0.15) with crisp value of 0.05 to extremely high (0.85, 1, 1) with crisp value of 0.95. With a score of moderate (0.3, 0.5, 0.7) having a crisp value 0.05 as a neutral marking between non-critical and critical factors. Thus, if the importance rating of a factor is less than 0.5, the possibility for the factor to be one of the critical factors set is less than 50%. Then after, a new parameter Z can be defined to determine whether a factor should be encompassed in the critical factors set based on the two aforementioned indicators (Shen et al. 2011; Yadollahi et al. 2017). Using Equation 3.10, the variable Z is determined for each factor.

$$Z = \frac{I_r - 0.5}{SD} \qquad \text{Equation 3.10}$$

Nevertheless, because of the fuzziness involved in the subjective judgment process engaged in by individual respondents, the scoring result from the questionnaire survey usually is not in a normal distribution (Shen et al. 2011). Therefore, this study was adopted as a fuzzy distribution instead. On the basis of fuzzy set theory (Zadeh 1965; Zimmermann n.d.), the degree of membership, $\mu_{\tilde{A}}(x_i)$, of the variable in the fuzzy set is the probability that a variable belongs to a group and is described using Equation 3.12 (Yadollahi et al. 2017):

$$\mu_{\tilde{A}}(x_i) = \int_{0.5}^{\infty} f(S_{(x_i)}) d_x = 1 - P_f \qquad \text{Equation 3.11}$$

Where $\mu_{\tilde{A}}(x_i)$ is the degree of membership for each factor in each category and P_f is the possibility that the factor does not belong to the group (critical factors).

Hence, after the Z score for each factor is computed, calculations for the degree of membership, $\mu_{\tilde{A}}(x_i)$ or f_Z can be derived. The f_Z score is the standard normal density function command in Microsoft Excel. The standard normal density function fz is computed using Equation 3.12 (Yadollahi et al. 2017).

$$f(Z) = \frac{1}{\sqrt{2\pi}} e^{\frac{-Z^2}{2}} \qquad \text{Equation 3.12}$$

Accordingly, to identify the critical factors from amongst other factors, the λ-cut set approach was adopted. λ-cut set method can transfer a fuzzy set to a classical set. The optimistic outcome is λ = 1 and the least preferred outcome is λ = 0. For this study, three cut-off points are tested to identify the critical factors: λ = 0.85, 0.90, and 0.95. In this study, the factor x_i was selected as a critical factor if its degree of membership, $\mu_{\tilde{A}}(x_i)$,was equal to or greater than 0.95 (Figueira and Lahdelma 2009).

3.3.6.3.3 Factor Analysis (FA)

FA is a statistical technique used to reduce a set of many interrelated variables to a relatively small number of groupings which is capable of explaining the observed variance in the larger number of variables, with the aim to explain the studied problem in a clearer manner (Brown 2008). It is mostly adopted to explain complex phenomena (Xu et al. 2010b). In other words, it is a technique which is used for explaining the variance of a large set of interrelated factors by transforming them into a new or smaller set of noncorrelated factors (Fang et al. 2004). Several previous studies on PPP have used factor analysis to cluster the most significant factors from a large set of factors (Chan et al. 2010; Gebremeskel et al. 2021b; Kavishe and Chileshe 2019; Li et al. 2005a). Therefore, it can be concluded that there exists a general consensus on the suitability and applicability of the factor analysis in identifying and clustering the critical factors. Hence, considering the large number of PPP drivers and enabling factors of PPP implementation, FA technique using principal component analysis (PCA) was conducted to regroup the critical factors in each attributes of PPP into a smaller group of principal factors. To obtain these independent common factors, crisp importance rating, evaluated from defuzzified factors ratings obtained from each respondent expert were utilized as inputs for the FA (Mazher et al. 2018).

To obtain the principal factors, extraction with varimax rotation and Kaiser normalization was conducted with aid of SPSS as carried out in (Osei-Kyei and Chan 2017). However, there are two key conditions that need to be assessed whether or not the collected data are suitable for

factor analysis including the strength of the correlations among the factors and sample size (Hsueh and Chang 2017). In this regard, prior to using the FA, the appropriateness of the factor model was evaluated by conducting some preliminary statistical tests including reliability test, correlation matrix, Kaiser-Meyer-Olkin (KMO), and Bartlett's test of sphericity (Chan et al. 2010).

Cronbach's alpha (α) was carried out to examine the reliability and internal consistency of the collected data, Cronbach's α value between 0.70 and 1 is considered reliable (Field 2005). Furthermore, The KMO statistic and Bartlett's test of sphericity measure the sampling adequacy (Osei-Kyei and Chan 2017). In this regard, KMO test is one of the tests to define the appropriateness of factor analysis. The KMO measures the sufficiency of sampling by comparing the observed correlation coefficients to the partial correlation coefficients (Asiedu and Adaku 2019). KMO values are between 0 and 1, values close to 1 show robust correlations among variables, creating high suitability for factor analysis. On the contrary, values close to 0 show low correlations between variables, creating less suitability for factor analysis (Field 2013). Accordingly, Yang et al. (2009) recommended that a minimum KMO value greater than 0.6 is acceptable for developing a factor analysis.

Bartlett's test of sphericity could be employed to consider whether or not the correlation matrix is an identity matrix among variables. An identity matrix indicates that all diagonal terms are one and all off-diagonal terms are zero. This examination shows the sufficient distribution of Bartlett's test of sphericity $\chi 2$ value. High correlations between variables and high $\chi 2$ value indicate greater appropriateness for factor analysis (Hsueh and Chang 2017), The value of Bartlett's test of sphericity is measured with chi-square test and its associated significance level (p), indicating that whether or not the population correlation matrix is an identity matrix (Chan et al. 2010).

3.3.6.3.4 Fuzzy Synthetic Evaluation: Model development

Fuzzy set theory (FST) is a useful tool for decision-making regarding uncertainty based on expert opinion. This tool can express and calculate these uncertain variables through mathematical logic, despite the challenge of giving them a single numerical value (Ameyaw and Chan 2015). As a branch of Fuzzy Set Theory (FST), Fuzzy Synthetic Evaluation (FSE) is able to solve the complex issues having multiple levels and attributes of variables (Islam et al. 2017). FSE is also considered as a prominent method for multi-criteria synthetic evaluation (Xu et al. 2010b) in real-life problems, which contain numerous aspects such as multi-criteria,

ambiguous, incorrect data, uncertain information and many decisionmakers use it (Singh and Tiong 2005). Thus, FSE method is suitable to assess the important level of identified driving variables and success factors in this study at group and overall level. It is used as the main tool in this study to formulate PPP adoption driving index (DI) and successful PPP implementation enabling index (EI) for housing PPP projects in Ethiopia. It is considered appropriate compared to the normal weighted method because it has the ability to objectify and manipulate the subjective judgement that is inherent in human cognitive processes (Ameyaw and Chan 2015).

Despite strong implications, there is still a limited number of researches that employs the strengths of the FSE method in PPP studies. Some of the research used FSE model for assessing CSFs (Osei-Kyei and Chan 2017), risk management (Xu et al. 2010b) and assessment of project success level (Osei-Kyei and Chan, 2018). This study thus to applied the FSE method to integrate driving factors into a comprehensive index and to develop project's successful implementation enabling condition index. The process of the FSE method is described as follows (Gebremeskel et al. 2021a; Osei-Kyei and Chan 2017d; Xu et al. 2010b):

Step 1: Establish a basic set of principal variables/factors. $F = \{f_1,\ f_2,\ f_3,\ f_i \ldots, f_m\}$

Step 2: Construct a set of grade alternatives. $L = \{l_1,\ l_2,\ l_3 \ldots, l_j\}$ is the scale measurement adopted for the research (l_1 = extremely low importance, l_2 = very low importance, l_3 = low important, l_4 = moderate important, l_5 = high important, l_6,= very high importance l_7 = extremely high importance);

$$w_i = \frac{I_r}{\sum_{i=1}^{7} I_r} \quad 0 \le w_i \le 1, \sum w_1 = 1 \qquad \text{Equation 3.13}$$

Where Wi = weighting; I_r = crisp importance rating of a particular variable or factor component; and $\sum w_1$ = summation of weight ratings.

Step 3: Calculate the weightings of each factor f_i. Importance rating (the crisp output) can be used to determine the weightings of each variable/factor $W = \{w_1,\ w_2,\ w_3,\ w_i \ldots, w_m\}$, where $0 \le w_i \le 1$; i = 1 ÷ m

Step 4: Establish a fuzzy matrix for each criterion or principal variable/factor $R = [r_{ij}]_{m \times n}$. Where r_{ij} represents the degree of l_j regarding the criterion f_m. It is constructed by the fuzzy membership function of $l_j (j = 1 \div n)$ within the criterion f_m. The fuzzy matrix R can be presented as:

$$R = \begin{bmatrix} r_{11} & r_{12} & r_{13} & \dots & r_{1n} \\ r_{21} & r_{22} & r_{23} & \dots & r_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ r_{m1} & r_{m2} & r_{m3} & \dots & r_{mn} \end{bmatrix} \qquad \text{Equation 3.14}$$

Step 5: Calculate the final evaluation matrix via the equation below:

$$D = W_i \bullet R_i \qquad \text{Equation 3.15}$$

Where: D = final evaluation matrix; W = weighting vector; R = fuzzy evaluation matrix; and "•" = fuzzy composite operation

From step 3 and step 4, Equation 3.16 can be shown as follows:

$$D = \{w_1, w_2, w_3, w_i, \dots, w_m\} \bullet \begin{bmatrix} r_{11} & r_{12} & r_{13} & \dots & r_{1n} \\ r_{21} & r_{22} & r_{23} & \dots & r_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ r_{m1} & r_{m2} & r_{m3} & \dots & r_{mn} \end{bmatrix} = [d_1, d_2, d_3, d_i, \dots, d_n]$$

Equation 3.16

Step 6: Calculate the index of each principal component by the following equation:

$$G = \sum_{j=1}^{7} D \times L \qquad \text{Equation 3.17}$$

Where: L = Linguistic variable (table 6)

3.4 Part 2: Identifying PPP model selection factors of housing projects

To identify the factors that influence the selection of PPP models for housing projects and to analyze the interrelationships among these selection factors, Interpretive Structural Modelling (ISM) was employed. Additionally, a MICMAC analysis was conducted to assess the strength and nature of the connections between these factors and to categorize them into distinct groups based on the extent of their influence. This approach allowed for a comprehensive understanding of the dynamics among the factors and provided insights into their hierarchical structure, facilitating more informed decision-making in the context of PPP model selection for housing projects.

3.4.1 The basis of Interpretive Structural Modelling (ISM)

Interpretive Structural Modeling (ISM) was proposed by Warfield in 1973 and serves as a computer-assisted learning process. It is a highly effective methodology for addressing complex issues by enabling individuals or groups to create a comprehensive map of

relationships among various elements in intricate situations (Hocking 1978). ISM is a process that transforms vague and poorly articulated mental models of systems into well-defined models, serving multiple purposes. Malone (1975) defines ISM as a systematic and logical approach to tackle complex problems and communicate the outcomes effectively to others. Furthermore, ISM can be utilized to evaluate and select alternatives based on different criteria and analyze their interrelationships and levels (Saxena et al. 1992). Additionally, it proves valuable for the hierarchy building of sub-elements, graphically presenting their driver power and dependence, and classifying them into categories such as autonomous, dependent, linkages, and independent variables (Saxena et al. 1992).

ISM is commonly employed to gain a fundamental comprehension of intricate scenarios and to formulate problem-solving strategies (Sohani and Sohani 2012). It combines three modeling languages: words, digraphs, and discrete mathematics, providing a structured approach to dealing with complex issues. ISM's interpretive nature proves beneficial, as the participants' judgments in a group determine the relationships and connections between variables (Janes 1988). In general, ISM is a versatile methodology used in various fields. Its primary purposes encompass complex problem analysis, hierarchical structuring, decision-making support, and policy formulation. To begin with, ISM uncovers intricate interrelationships among variables, aiding in the analysis of complex problems and providing a structured approach for their representation. In addition, it assists decision-makers by facilitating the identification of critical factors and understanding cascading effects within the system (Bolaños et al. 2005; Feng et al. 2021; Janes 1988; Majumdar and Sinha 2019; Malone 1975; Saxena et al. 1992; Upreti et al. 2019).

In the context of selecting the most appropriate PPP model for housing projects, the decision-making process can be quite complex due to the presence of numerous factors that need to be considered. Additionally, these factors often interact with each other, further complicating the selection process. To streamline and facilitate this decision-making process, it becomes essential to identify the key factors that influence the selection and examine how they interact with one another. In this regard, ISM proves to be an appropriate and effective tool.

ISM allows decision-makers to comprehensively analyze the complex relationships among the various factors involved in the PPP model selection for housing projects. By employing ISM, it is possible to construct a hierarchical representation of these factors, illustrating their influence. This hierarchical structuring enables decision-makers to focus on critical elements

and comprehend the chain of effects that result from changes in the system (Ansari et al. 2013; Attri et al. 2013; Sohani and Sohani 2012).

In summary, the complexity of selecting a suitable PPP model for housing projects necessitates a systematic approach to consider and assess all relevant factors and their interdependencies. ISM serves as a valuable tool in simplifying this process by providing a clear and coherent understanding of the factors' interactions, ultimately supporting informed and effective decision-making.

3.4.2 Development of Interpretive structural modeling (ISM)

The various steps/processes, which are involved in the development of an ISM, are presented as follows (Ansari et al. 2013; Bhatt and Sarkar 2020; Feng et al. 2021; Guan et al. 2020; Iyer and Sagheer 2010; Kumar et al. 2013):

Step 1: Identify the variables or components that are related to the problem. In this research, these variables are PPP model selection factors or criteria for housing projects. This step involved the identification of initial list of PPP model selection factor through systematic literature review and content validation of the factors to assess their relevance to the context of housing project and to the context of Ethiopia.

Step 2: The development of contextual relationships among the variables identified in Step 1, with respect to which pairs of variables are examined. This pair-wise comparison was done through focus group discussion among PPP experts.

Step 3: To indicate a pairwise relationship among variables, a structural self-interaction matrix (SSIM) was developed.

The following four symbols have been used for developing SSIM to denote the direction of relationship between two factors i and j: V denotes row factor ‘i’ will influence the corresponding column factor ‘j'; A denotes row factor ‘i’ will be influenced the corresponding column factor ‘j’; X denotes corresponding factors ‘i' and ‘j’ will influence each other; O denotes factor ‘i’ and ‘j’ are unrelated.

Step 4: From the SSIM a reachability matrix was developed. Then the matrix is checked for transitivity. The transitivity of the contextual relationships is a basic assumption made in ISM and it states that if variable A is related to variable B and variable B is related to variable C, then variable A is necessarily related to variable C.

The initial reachability matrix is a binary matrix, developed by substituting V, A, X, O by binary numbers 1 or 0 and using following rules: The (i, j) value in the reachability matrix will be 1 and (j, i) value will be 0, if (i, j) value in the SSIM is V. The (i, j) value in the reachability matrix will be 0 and (j, i) value will be 1, if (i, j) value in the SSIM is A. The (i, j) and (j, i), both values will be 1 in the reachability matrix, if (i, j) value in the SSIM is X. The (i, j) and (j, i), both values will be 0 in the reachability matrix, if (i, j) value in the SSIM is O. By adding transitivity to initial reachability matrix as explained earlier in this step, the final reachability matrix has been developed. From the final reachability matrix, the driving power and the dependence power of each model selection factor have been obtained.

Step 5: Partitioning of levels was done from the final reachability matrix obtained in Step 4.

The partitioning of levels aims to determine the importance of each model selection factor. The final reachability matrix yields the reachability and antecedent sets for individual factors. The reachability set comprises factors influenced by a given factor, including the factor itself, while the antecedent set includes factors that might influence the given factor, along with the factor itself. This process identifies the reachability set, antecedent set, and intersection sets for all factors. In the ISM hierarchy, factors with identical reachability and intersection are categorized at the same level. This particular level is then excluded in next iterations to identify subsequent levels. This iterative process is repeated until the level of each factor is determined. In this stage the conical matrix was developed by clustering factors in the same level across the rows and columns of the final reachability matrix. This process streamlines the complex relationships among various factors, providing a more structured and manageable representation for model selection factors (Malone 1975)

Step 6: Draw a directed graph based on the contextual relationships developed in the reachability matrix.

Step 7: By replacing variable nodes with statements and by removing transitivity, the diagraph was converted into final ISM model. Before formulating the final model, the conical matrix was reduced to eliminate weak relationships and identify significate once, to create a more manageable and streamlined representation of the model selection factors, and to avoid circular relations which can cause inconsistencies in the model. Moreover, this was made to remove maximum edges from digraph while maintaining the levels and structure of variables and

reachability of variables. This was done to improve the readability of the final model (Ahmad and Qahmash 2021).

Step 8: The ISM model developed in Step 7 was reviewed to check for conceptual inconsistency and necessary modifications are made. In this regard, the final output of the ISM was compared with the literature to check for any conceptual inconsistencies.

3.4.3 Tool to develop the ISM

The application of ISM computation, whether partially automated or manual, has often resulted in errors due to the complex mathematical steps involved. To address this issue, this study used SmartISM, an end-to-end graphical software, for implementing the ISM technique and MICMAC analysis. SmartISM ensures the creation of a high-confidence final model that illustrates the interrelationships among the model selection factors. SmartISM is designed to facilitate error-free, user-friendly, and graphical implementation of ISM and MICMAC analysis. Furthermore, it introduces a reduced conical matrix to eliminate excessive edges from the digraph while preserving the hierarchical structure of variables and their reachability to one another. This enhancement is aimed at enhancing the readability of the final model (Ahmad and Qahmash 2021).

Identification of initial list of model selection factors (criteria)

The criteria (factors) influencing the selection of PPP models were initially identified through a systematic literature review, which is thoroughly discussed in part one of the research methodology. The review covered various aspects, including PPP success criteria, PPP model selection criteria, success factors in housing projects, critical success factors of PPP implementation in housing projects, and factors attracting private sector investment in PPP. Additionally, two PPP user manuals were utilized to develop an initial list of model selection criteria. This initial list of criteria was then subjected to content validation in order to assess their relevance to housing projects and to the context of Ethiopian initiative to PPPs.

Content validation/refining of model selection factors

Content validity offers evidence regarding the extent to which components within an assessment tool align with and accurately represent the intended construct for a specific assessment purpose (Almanasreh et al. 2018). The initial list of model selection factors was established via systematic literature review. However, the relevance of these model selection

factors to the housing project context and the Ethiopian initiative needs evaluation before subjecting the factors to the ISM process. Content validation is a suitable method for appraising the factors' relevance in this context (Almanasreh et al. 2018; Beckstead 2009; Polit et al. 2007; Polit and Beck 2006; Yusoff 2019).

The process of content validation involves the following processes: Preparing content validation form; Selecting a review panel of experts; Conducting content validation, which includes reviewing domain and items and providing score on each item; and Calculating CVI (Yusoff 2019).

Step1: Preparing Content Validation Form

The first stage of content validation involves creating a content validation form, which aims to provide the review panel of experts with a precise anticipation and comprehension of the task. A relevance rating scale with four points (Polit et al. 2007) has been employed to score each individual factors. In line with this scale, ratings of 1, 2, 3, and 4 indicate that the factor is not relevant, somewhat relevant, quite relevant, and highly relevant, respectively.

Step 2: Selecting a Review Panel of Experts

To ensure data validity and outcome reliability (Xu et al. 2010a), participants were purposively selected for content validation/refining of PPP model selection factors for housing projects. Purposive sampling allowed focused selection of experts in the study's subject, ensuring dependable, valuable data collection (Bhattacherjee 2012). In this regard, experts ware selected based on pre-determined criteria, which includes the requirement for the individual to possess a minimum of bachelor degree and the requirement for individuals to possess in-depth knowledge of PPP models and a thorough understanding of the current PPP legal framework in the country. Additionally, participants should be actively involved in housing PPP projects identification and/or development process the country is currently undertaking. Accordingly, a total of 9 individuals voluntarily participated in the process, representing various backgrounds. Among the participants, 7 were PPP experts from the PPP Directorate General under the Ministry of Finance, 2 were PPP experts from the Federal Housing Corporation. This participant count is appropriate because the number of experts for content validation should be at least six and does not exceed 10 (Polit et al. 2007).

Step 3: Conducting Content Validation

The content validation procedure utilized a questionnaire that covered sections related to consent, expert background, and the content validation form. Each expert participant received a hard copy of this questionnaire. Within the content validation form, a precise explanation of the domain and the items representing the domain was presented to the experts. The experts were then asked to thoroughly assess the domain and its corresponding items before assigning scores to each item. Subsequently, after the comprehensive review of the domain and items, the experts were requested to independently assign scores to each item according to the relevant scale.

Step 4: Calculating CVI

The Item-Level Content Validity Index (I-CVI) was employed to determine the validity index of the model selection factors. To compute the CVI, the responses gathered from chosen experts were transformed into binary values: ratings 1 and 2 were recorded as 0, while ratings 3 and 4 were recorded as 1. The instances of "1" were tallied as the number of agreements. CVI was computed for each item using the following equations (Yusoff 2019).

$$Item\ level\ Content\ Validity\ Index = \frac{\text{Experts in agreement}}{\text{Number of experts}} \qquad \text{Equation 3.18}$$

$$\text{Experts in agreement} = \text{The sum of relevant rating provided by all experts for each item} \qquad \text{Equation 3.19}$$

For content validation involving at least nine experts, an item having a CVI value of at least 0.78 and above are validated as relevant factor (Lynn 1986; Polit and Beck 2006).

Focus group discussion and selection of participants for pair-wise comparison of the factor

The pair-wise comparison to investigate the interrelation between the model selection factors was done through focus group discussion, which included experts from the field of the study. Focus group discussions belong to the category of qualitative research methodology. The name of this method directly indicates its key features, which involve in-depth exploration of particular issues through interactive discussions among a carefully chosen group of individuals. The main reason for choosing focus group discussions is because it allows to gather diverse perspectives on a specific research topic, allowing for a comprehensive understanding of the issues from the participants' viewpoints. (Morgan 1984; Nyumba et al. 2018) Focus group discussions were introduced to address limitations of traditional one-on-one interviews, aiming

to overcome artificiality and restrictions imposed by closed-ended questions. The goal was to minimize interviewer influence and encourage diverse participant responses. (Krueger 2015).

Since selection of eligible participants for data collection holds significant importance as it directly influences the validity of the process and the reliability of its outcomes (Xu et al. 2010a), participants for the focus group discussion were purposively selected to carry out the pair-wise comparison of PPP model selection factors for housing PPP initiative in Ethiopia. The benefit of using the purposive sampling technique is that it enables the targeted selection of professionals who possess expertise in the subject area of study. This approach ensures the collection of reliable and valuable information (Bhattacherjee 2012).

In order to accomplish this, specific criteria were established to identify eligible participants for the focus group discussion, which is conducted to undertake the pair-wise comparison. The criteria included the requirement for the individual to possess a minimum of bachelor degree and the requirement for individuals to possess in-depth knowledge of PPP models and a thorough understanding of the current PPP legal framework in the country. Additionally, participants should be actively involved in housing PPP projects identification and/or development process the country is currently undertaking. Accordingly, seven (7) PPP experts from the PPP Directorate General under the Ministry of Finance voluntarily participated in the survey. Since past literature does not indicate the minimum number of experts to be contacted for their opinion, it is presumed that responses from even fewer experts would sufficient (Iyer and Sagheer 2010), and this participant count is consistent with previous research studies conducted using similar methodology (Ansari et al. 2013; Guan et al. 2020; Iyer and Sagheer 2010; Kumar et al. 2013; Majumdar and Sinha 2019; Wang et al. 2018).

3.4.4 Classification of PPP model selection factors: MICMAC analysis

After constructing the final ISM framework and establishing connections among the factors, it becomes essential to determine the extent of these relationships. To achieve this, the application of the MICMAC principle, representing 'Matrice d'Impacts croises-multipication applique' and classment (cross-impact matrix multiplication applied to classification), proves beneficial (Sohani and Sohani 2012). The utilization of MICMAC analysis aids in classifying factors and validating the ISM factors within the study, thereby facilitating the derivation of conclusions (Ahmad et al. 2019). Since relationships between factors can exhibit varying strengths, wherein

certain connections might be more potent than others, the MICMAC analysis serves as an additional step to address this variability (Kumar et al. 2015).

The primary objective of this section was to assess the driving power and dependency power of factors that impact the choice of PPP model for housing projects. When a factor has higher dependency values, it implies that numerous other factors need to be eliminated if that factor is to be removed. Conversely, a high driving value for a factor signifies that a substantial number of factors can be eliminated by removing that particular factor. (Majumdar and Sinha 2019)**.** Derived from the final reachability matrix, the driving power encompasses the cumulative count of binary digit "1" for each corresponding factor in the respective row, while the dependence power of each factor is determined by summing up the occurrences of "1's" within its corresponding column. Based on the concepts of driving and dependence powers, MICMAC analysis investigates the impact and reliance relationships among issues, categorizing them into four distinct groups: autonomous, dependent, relay/linkage, and independent. These categories are explained in detail below (Ahmad et al. 2019; Attri et al. 2013; Kumar et al. 2015; Sohani and Sohani 2012). The flowchart below (figure 6) summarizes the process Interpretive Structural Model development and clustering of the factors using MICMAC analysis (Sohani and Sohani 2012; Thakkar 2021).

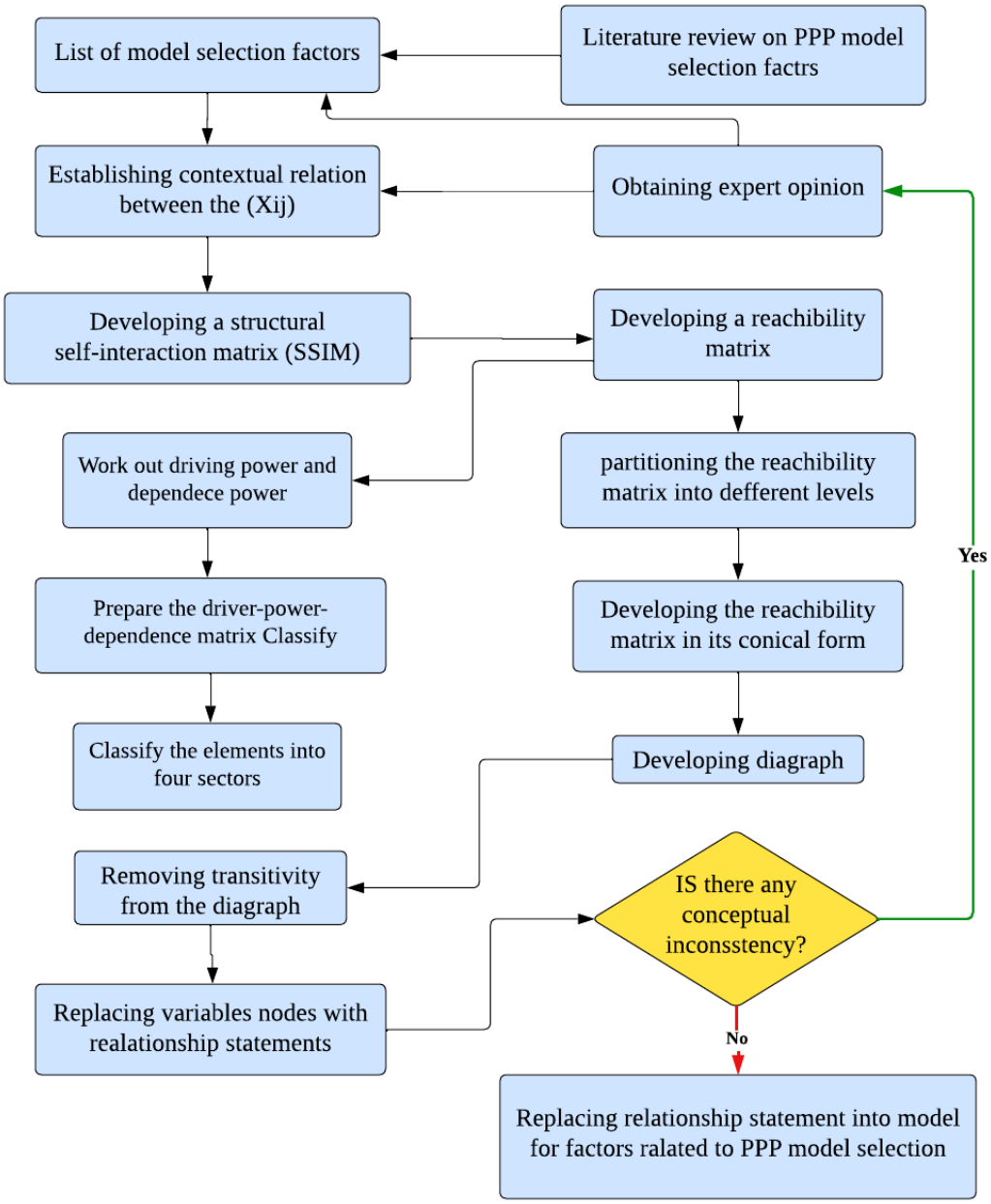

Figure 12. The process ISM and MICMAC analysis

3.5 Part 3: Development and validation of decision supporting framework

3.5.1 Development of decision supporting framework

This research developed a framework that can assist decision-making process in selecting a suitable PPP modality for housing projects using housing PPP model selection criteria. The overall framework development involved the following processes; Identification of model selection factors for housing projects, selection of standardized PPP models for housing

projects, detailed study to identify the salient features of the selected standardized models, construction of the framework, and validation of the framework.

Identification of the factors influencing PPP model selection for housing projects

Rigorous model selection criteria are essential for enabling decision-makers to objectively compare and contrast different PPP options. In doing so, potential conflict can be minimized, resulting in a higher likelihood of success for any given PPP project (Xie and Thomas Ng 2013). Accordingly, PPP model selection factors were identified in the previous stage of the research. These factors took into consideration the characteristics of the housing projects, stakeholders' preference, as well as the country conditions that may influence stakeholder's capacity and preference for risk-taking.

Selection of suitable PPP models for housing project

Housing Projects have unique characteristics and requirements that differentiate them from other PPP projects. For this reason, many of the typical PPP models may not apply to develop housing projects. Therefore, the suitable ones must be identified and adjusted as needed in order to be relevant to this sector (MOHUA 2017). This initiates the to look for standardize PPP models from housing project that can meet the objectives of the country. Furthermore, the utilization of standardized PPP model could bridge the experience gap and can facilitate the successful implementation of the system in countries that are new to PPP.

Accordingly, this stage of the framework development aimed to identify viable PPP models for housing projects to various developing nations, where PPP market is emerging. The selection process was conducted by analyzing the main motivating factors behind PPP implementation in these countries with respect to public housing supply, this was clearly discussed in section 2.3.3.2 of chapter 2. This stage enabled the identification of the most applicable and viable PPP models that would enable these countries to meet their housing objectives.

In this regard, standardized PPP models that were developed by the World Bank to facilitate the development of public housing in emerging markets within developing countries were selected, because these models facilitate the utilization of private sector capital to finance the construction of public housing and these models can meets the objective of PPP adoption in most developing nations, where the PPP market is in an emerging state.

Given that Ethiopia falls into the broader category of developing nations and its PPP market is in an emerging phase, these models are well-suited for Ethiopia. Moreover, these models draw inspiration from successful initiatives in India and Kenya. They establish essential parameters for a decision-making framework in housing PPPs. Their primary aim is to assist housing professionals and policymakers in steering the provision of affordable housing through collaborations between the public and private sectors in emerging economies.

The World Bank developed a total of seven models, with five of them originating from Indian initiatives and two from Kenyan initiatives. However, the two models stemming from the Kenyan initiative leaned towards a market-oriented approach. As a result, these two models were excluded from the list considered for framework development. Five models derived from the Indian initiative were chosen for inclusion in this study. Despite having different names assigned to them by the World Bank and India, these models shared identical features. Additionally, one crucial Indian model, which was not part of the original seven models developed by the World Bank, was selected to be incorporated into this study. Consequently, a total of six models were integrated into the framework.

To enhance clarity and considering the variations in naming by the World Bank and India, this study introduced a new nomenclature for these models. Table 7 presents the names assigned to each model by the World Bank, India, and this research. The bold letters in the coined names represent the base PPP contract type, while the phrase or word within brackets signifies how the private party is compensated for its role in the partnership or how it recoups its investment costs.

Table 11. Different names of the models incorporated in the framework

Model	**Indian name**	**World Bank name**	**Coined name**
1	Government-land Based Subsidized Housing (GLSH)	Government Offtake/ Government Pays [Sale]	DBF (cash)
2	Mixed Development Cross-subsidized Housing (MDCH)	Government Offtake/ Government Pays with Land [Sale]	DBF (land)
3	Annuity Based Subsidized Housing (ABSH)	Government Offtake/ Government Pays with Annuity [Rental]	DBFM (annuity)
4	DBFMT –Annuity cum Capital Grant based Subsidized Housing (AGSH)	—	DBFM (annuity cum capital grant)

5	Direct Relationship Ownership Housing (DROH)	Government Offtake/ End-User Pays [Sale]	DBFM (direct sale)
6	Direct Relationship Ownership Housing (DROH)	Government Offtake/ End-User Pays [Rental]	DBFOM (direct rent)

Detailed study on the characteristics of the selected PPP models

PPP contracts involves combining multiple phases and tasks into a single agreement. The private party could be in charge of designing, constructing, financing, operating, or maintaining the asset or service. These contract types are described in terms of three major parameters: the type of asset, the role of the private party, and how the private party will be paid for their role in the partnership (World Bank 2017). Therefore, under this stage an in-depth study on the salient features of each PPP model was conducted to determine the responsibilities of the private party, the government, and the beneficiaries, how the private party is compensated, asset ownership during the contract period and after the contract termination, bid awarding criteria, the responsibility of taking off-take and cost recovery risks, how the end-users possess housing ownership, and etc.

Construction of the decision-supporting framework for selection of suitable PPP modality

In order to guide the selection of the appropriate PPP model for housing projects, a framework was constructed. This framework linked the PPP model selection factors with the characteristics and features of the selected PPP models. As a result, the framework is capable of identifying the PPP model that best fits the project characteristics and project objectives, taking into consideration the prevailing local conations, and stakeholders' preference and capacity. This enables stakeholders to select the most suitable PPP model for a proposed housing project.

3.5.2 Validation of decision supporting framework

It's essential to validate a framework using experts' opinion to ensure its reliability, validity, and relevancy. Experts can critically evaluate a framework for potential flaws, inconsistencies, or gaps. Their inputs also strengthen the credibility of the framework, ensuring it meets necessary quality standards and reflects best practice. As a result, validated frameworks are more likely to be widely accepted and used by practitioners, policymakers, and researchers, contributing to better decision-making and improved outcomes. In this regard, a questionnaire with a 5 point Likert scale with clear description of the validation aspect was distributed among

selected PPP experts (2 experts from the federal housing corporation and 2 experts from the PPP directorate general of Ethiopia, under the ministry of finance) to assess the validity of the decision support framework, as carried out by Hang and Bconstec (2019). The validation aspect includes; the degree of appropriateness, objectivity, replicability, practicality, and the overall reliability and suitability of the framework. Figure 7 summarizes the process of framework development.

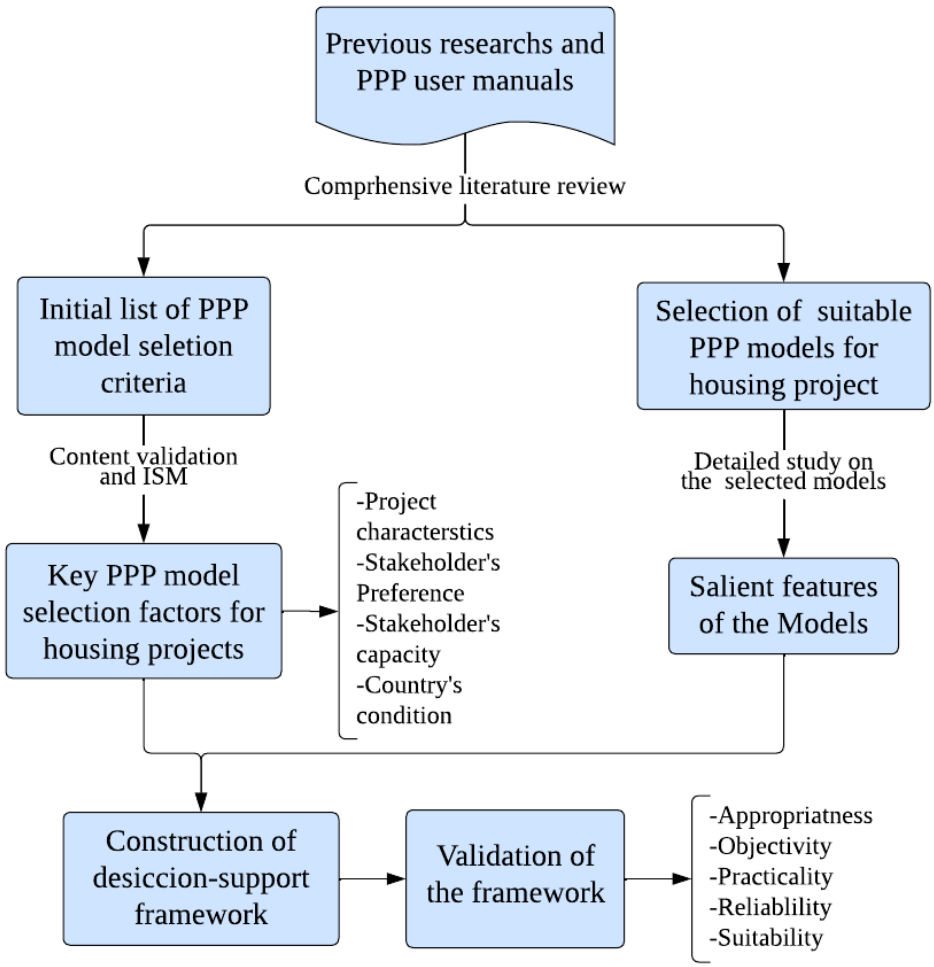

Figure 13. The process of decision support framework

3.6 Ethical considerations

Ethical considerations are an integral component of the research methodology, encompassing both the questionnaire survey and the focus group discussions. The research is deeply committed to upholding the fundamental rights, privacy, and overall well-being of the participants. Prior to data collection, informed consent was meticulously obtained from each

participant, ensuring their clear understanding of the research's objectives, voluntary participation, and the confidential treatment of their responses. Proactive measures were diligently incorporated to anticipate and mitigate any potential harm or discomfort to participants, and their identities were diligently anonymized to ensure the preservation of privacy. The research activities strictly adhered to established ethical guidelines, maintaining transparency and unwavering integrity throughout the entire research process. The research acknowledges the paramount importance of ethical research practices, demonstrating the highest standards of respect, transparency, and comprehensive protection for every individual who contributed to the study.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 Introduction

This chapter of the research paper provides demographic information about the respondents, assesses the reliability of the data collection instrument, presents the analysis results, highlights key findings, and discusses these findings by comparing them to prior research findings. Additionally, it explores the implications of these findings, emphasizing their broader significance. The chapter is structured to present results and discuss findings for each specific objective, including drivers of PPP adoption in Ethiopian housing provision, enablers of successful PPP implementation in housing provision in Ethiopia, factors influencing the selection of PPP models for housing projects, and the development and validation of a framework that aids the decision-making process in selecting suitable PPP models for housing projects.

4.2 Demographic Information

A questionnaire survey was conducted to explore the key drivers influencing the adoption of PPPs in the realm of housing provision in Ethiopia. Furthermore, a questionnaire survey was used to explore the critical factors enabling the effective implementation of this system within the housing sector of Ethiopia. From an initial pool of 63 eligible participants from both the public and private sectors, 61 questionnaires were distributed to select participants from diverse professional backgrounds. Each eligible respondent received a questionnaire accompanied by a consent letter. Subsequently, 53 valid responses were collected, signifying an 86.88% response rate. The relatively small participant count can be attributed to Ethiopia's limited exposure to the PPP system, resulting in the country's scarcity of PPP professionals. However, the 53 collected responses were deemed sufficient for the study's objectives. A comprehensive overview of the participants' demographic details is presented in Table 8-10.

Table 8 highlights the sector specific information of respondents. It is observed that the majority of participants, comprising 66%, belong to the public sector, while the remaining 34% are from the private sector which includes practitioners (contractors, consultants, and real estate developers). This distribution provides valuable insight into the representation of both sectors

within the study, allowing for an exploration of potential sector-specific perceptions of the drivers and success enablers of PPP implementation in Ethiopia.

Table 12. Table: sector-specific response distribution

Sector	**Target response**	**Actual response**	**Actual response rate (%)**	**% response rate of sectors from the actual response**
Public	40	35	87.5%	66%
private	21	18	85.7%	34%
Total	61	53	86.9%	100%

Table 9 demonstrates the diversity of specialization among the questionnaire respondents, offering a valuable spectrum of perspectives to address the study's objective. Among the total respondents, individuals with expertise in PPP constituted 26.5%, while Directors from various domains represented 18.8%. The group also encompassed professionals in roles such as construction contract specialists (15.1%), senior office engineers (9.4%), and project engineers (7.5%). Project managers and business development executives accounted for 5.7% and 3.8%, respectively. A portion of 1.9% each included senior claim experts and PPP unit team leaders. Furthermore, 9.4% of respondents belonged to other professional categories.

Table 13 Position or profession of respondents

Position	**No of respondent**	**Percentage (%)**
PPP experts	14	26.5
Contract Specialist	8	15.1
Project manager	3	5.7
Director	10	18.8
Project engineer	4	7.5
Senior office engineer	5	9.4
Senior claim expert	1	1.9
Business development executive	2	3.8
PPP unit team leader	1	1.9
Others	5	9.4
Total	53	100

To participate in the study, individuals were required to have at least a BSc degree. The data in Table 10 provides insights into the educational backgrounds of the respondents. It indicates that 39.65% of the participants had a BSc degree, 56.6% had completed an MSc degree, and a smaller group, comprising 3.8% of the total, held PhDs. These figures together emphasize that the entire group of participants meets the necessary educational criteria that are crucial for the research study.

Table 14. Educational level and years of experience of respondents

Demographic Information	**Category**	**No. of respondents**	**Percentage (%)**
Educational background	BSc	21	39.6
	MSc	30	56.6
	PhD	2	3.8
	Total	53	100
Experience	≤ 5 years	6	11.3
	6 – 10 years	15	28.3
	11 – 15 years	21	39.6
	16 – 20 years	10	18.9
	> 20 years	1	1.9
	Total	53	100

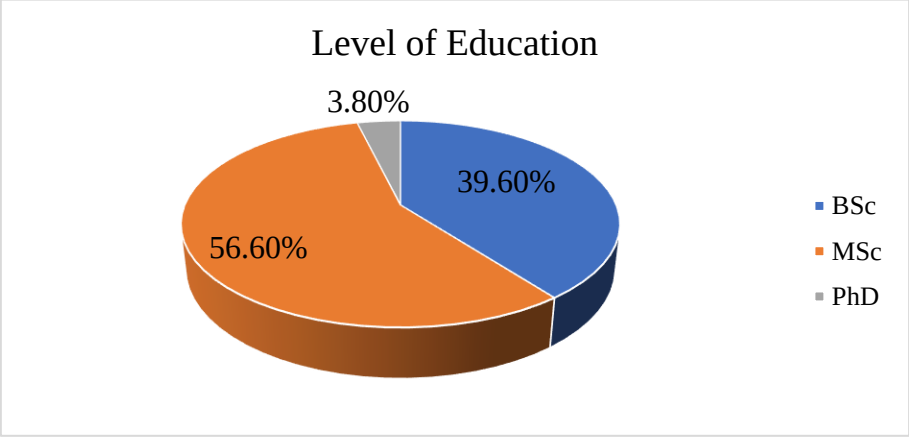

Figure 14. Education level of respondents

Additionally, the participants had diverse of experiences. As indicated in Table 10, the distribution reveals that 1.9% had an experience of 5 years or less, 28.3% had 6 to 10 years of experience, 39.6% fell within the 11 to 15 years range, 18.9% had 16 to 20 years of experience, and 1.9% boasted more than 20 years of experience. These figures collectively highlight that nearly all participants hold substantial expertise in this particular field. Moreover, 56.6% of the respondents possessed experience in the public sector, while 22.6% had experience in the private sector. Additionally, 20.8% of the respondents reported having experience working in both sectors.

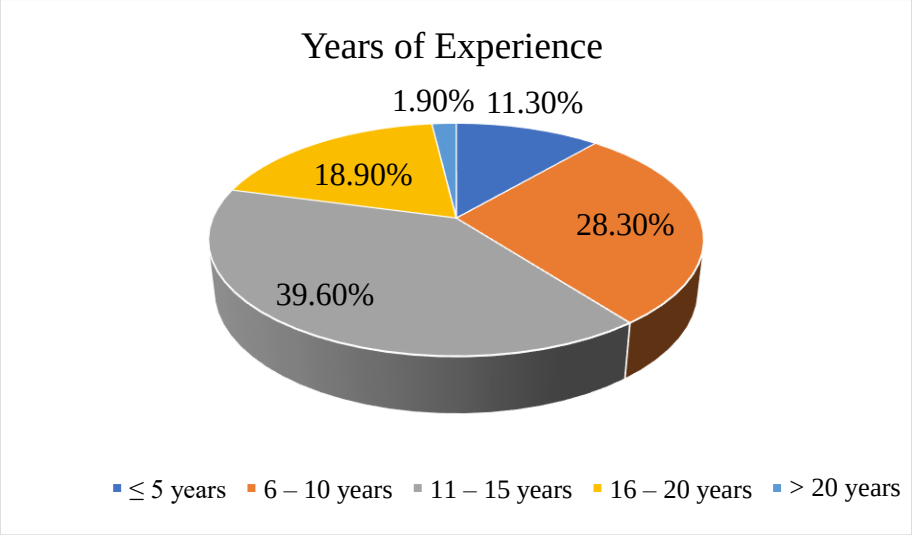

Figure 15. Years of experience of respondents

Furthermore, content validation was conducted to assess the relevance of PPP model selection factors identified in the literature review to the context of a housing project within Ethiopia's initiative. This process involved nine professionals, comprising seven from the PPP Directorate General and two from the Federal Housing Corporation's PPP Unit. These professionals were selected based on predetermined criteria. Among the nine respondents, eight were PPP experts, while one served as a team leader. Furthermore, seven of the participants held MSc degrees, and two possessed BSc degrees. Additionally, the participants brought a diverse range of experiences. The table below (Table 11) provides a summary of the demographic information of the content validation participants.

Table 15. Demographic Information of Participants in Content Validation

Demographic information	**Category**	**No**	**Percent (%)**
Level of education	BSc	2	22.2
	MSc	7	77.8
	Ph.D.	-	-
Years of experience	< 5 years	3	33.3
	6 – 10 years	1	11.1
	11 – 15 years	3	33.3
	16 – 20 years	2	22.2
	➢ 20 years	-	-
Organizational position	PPP expert	8	88.9
	Other	1	11.1

Moreover, in the study, the same experts from the PPP Directorate General were employed to facilitate the focus group discussion. The purpose of this discussion was to formulate ISM models designed to explore the interconnections and influence among the housing PPP model selection factors that were identified through content validation.

4.3 Reliability the responses

Reliability refers to the extent to which a data collection tool produces consistent and stable results. A measurement is considered highly reliable when it consistently yields similar outcomes in similar conditions (Field 2005). To assess the internal consistency of the measurement used in the questionnaire, Cronbach's alpha coefficient was calculated. Cronbach's alpha is a widely employed method to evaluate the internal consistency of the dataset (Oyedele 2013). The computed Cronbach's coefficient alpha values were 0.85 and 0.94 for the driving factors influencing PPP adoption in Ethiopia and for the factors facilitating the successful implementation of the system in Ethiopia. These results clearly show that both datasets for the specified objectives display robust internal consistency, as signified by the value of α exceeding 0.7, in accordance with the criteria outlined by Field (2005). This confirms the broader applicability, dependability, and consistency of the research findings.

4.4 Factors driving the adoption of PPP in the provision of housing in Ethiopia

This section presents the findings and discusses the factors that drives the adoption of housing public-private partnerships (PPPs) in Ethiopia. It encompasses the results of the process of identifying the importance levels of these factors, the identification of critical factors (key drivers), the clustering of these critical factors into principal groups for clarity, and the development of a model using fuzzy synthetic evaluation.

Before presenting the results and discussing the findings on the drivers of Public-Private Partnership (PPP) adoption in housing provision in Ethiopia, the study presents the result of assessment conducted to examine the respondents' perception regarding whether the adoption of PPP in the housing sector could help alleviate the prevalent housing shortage in the country using yes or no question. In this context, 96.2% of the respondents answered "yes," expressing their belief in the potential of PPP to reduce the housing problem in the country. Meanwhile, 3.8% of the respondents answered "no idea," indicating a neutral opinion, and no respondent

answered "no." This demonstrates the significant potential of PPP in addressing the housing issue in the county. The pie chart below (Figure10) summarizes these responses. The next section will delve into the factors that drive the adoption of PPP in the housing sector of Ethiopia.

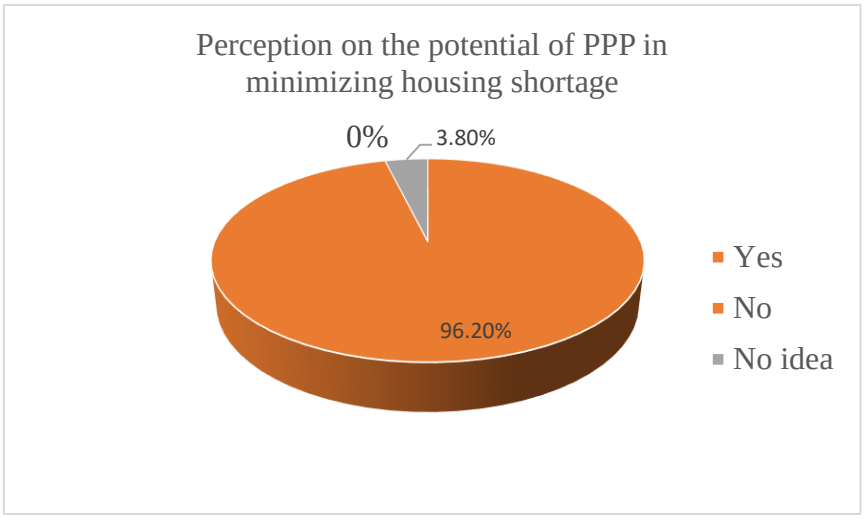

Figure 16. Perception on the potential of PPP in minimizing housing shortage

4.4.1 Fuzzy analysis to identify the importance level of the driving factors

Since the respondents evaluated the driving factors using linguistic terms, there was a necessity to transform these linguistic assessments into numerical values using triangular fuzzy numbers. This conversion was done before any further analysis was conducted. The linguistic ratings provided by respondents regarding the importance of the factors driving the adoption of PPP in the provision of housing in Ethiopia were initially translated into corresponding fuzzy numbers (Table 6) (Mazher et al. 2018). Subsequently, these ratings were combined across all respondents using Equation (3.3) to derive the average aggregate fuzzy importance of the driving factors (Buckley 1985). Following this, the aggregated fuzzy importance rating was converted into a precise crisp value using Equation (3.4), a centroid method of defuzzification (Wang and Elhag 2007; Zhao et al. 2013). Furthermore, the fuzzy set representing the importance level of the driving factors on each rating scale was computed (Mazher et al. 2018). This calculation employed the triangular membership function (Equation 3.2) (Chang 1996; Sirisawat and Kiatcharoenpol 2018; Sun 2010). To illustrate the process, the section presented a sample calculation for the factor "The private sector's ability to raise funds for public projects."

In this context, respondent 1 rated the importance of the factor "The private sector's ability to raise funds for public projects" as extremely high, respondent 2 as very high, and respondent 53 as extremely high as well, in this way all the 53 respondents rated the importance of the factor. This collective rating of importance by all 53 participants was subsequently translated into numerical values using triangular fuzzy numbers (see Table 6) (Mazher et al. 2018). Accordingly, respondent 1's "extremely high importance" rating was transformed to a triangular fuzzy number, specifically (0.85, 1, 1), while respondent 2's "very high importance" rating was transformed into (0.7, 0.85, 1). This fuzzification process was applied to all respondents' ratings, including respondent 53's rating, which was also converted to (0.85, 1, 1). These ratings were combined across all the 53 respondents to determine “the fuzzy aggregated importance rating” using Equation (3.3) (Buckley 1985 and Mazher et al. 2018).

$$\begin{aligned} &Fuzzy\ aggregated\ importance\ rating \\ &= \frac{1}{53} \times [(0.85 + 0.7 + \cdots + 0.85), (1 + 0.85 + \cdots + 1) + (1 + 1 + 1)] \\ &= (0.725, 0.881, 0.956) \end{aligned}$$

Subsequently, the aggregated fuzzy importance rating was transformed into a precise crisp value (referred to as the "crisp importance rating") through the application of centroid defuzzification as described in Equation (3.4) (Wang and Elhag 2007; Zhao et al. 2013). This crisp importance rating served as the basis for ranking the driving factors and was employed in subsequent analyses (Mazher et al. 2018), including Factor analysis and Fuzzy synthetic evaluation.

$$Crisp\ importance\ rating\ (I_r) = \frac{0.725 + 0.881 + 0.956}{3} = 0.854$$

Among the seven rating scales represented by triangular fuzzy numbers, the fuzzy aggregated importance rating (0.725, 0.881, 0.956) is derived from the combination of two rating scales (lies on these two rating scales), extremely high importance and very high importance represented by the triangular fuzzy numbers (0.7, 0.85, 1) and (0.85, 1, 1) respectively, as illustrated in blue color in Figure 11. To quantify the level of importance of the driving factor on these rating scales or to determine the degree to which the fuzzy aggregated importance rating is the member of the rating scale extremely high importance (0.7, 0.85, 1) and very high

importance (0.85, 1, 1), a triangular membership function represented by a triangular fuzzy number was applied (Mazher et al. 2018).

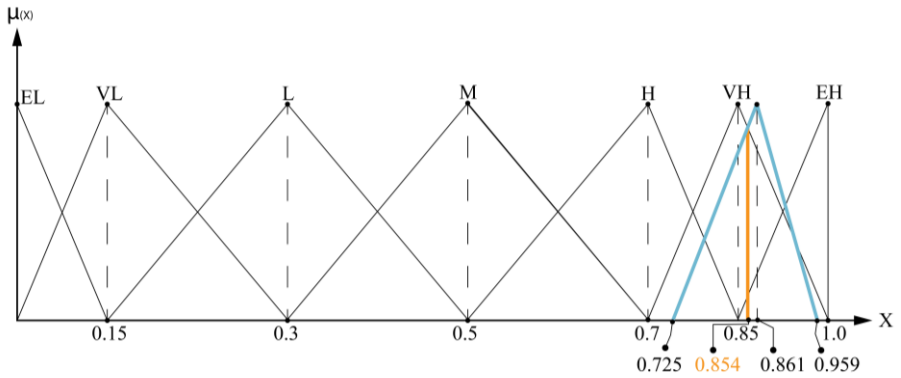

Figure 17. Aggregated fuzzy response

In order to do this the fuzzy aggregated importance rating, (0.725, 0.881, 0.956), was converted to crisp importance rating as previously discussed. This crisp importance rating ($I_r = x = 0.854$) as shown in orange color in Figure 11, rests on the triangles representing extremely high importance and very high importance. First, to what degree $I_r = x = 0.854$ is the member of the rating scale of extremely high importance represented by the triangle (0.7, 0.85, 1) was calculated as follows:

To achieve this, the fuzzy aggregated importance rating (0.725, 0.881, 0.956) was transformed into a crisp importance rating, identified as $I_r = x = 0.854$, as discussed earlier. This specific crisp importance rating (highlighted in red in figure 11) rests on or crosses the triangles representing "extremely high importance" and "very high importance." Initially, the extent to which $I_r = x = 0.854$ belongs to the rating scale of "very high importance," which is defined by the triangle (0.7, 0.85, 1), was calculated as follows:

$$\mu_{(x)} = \begin{cases} (x-l)/(m-l), & l \le x \le m \\ (u-x)/(u-m), & m < x \le u \\ 0, & elsewhere \end{cases}$$

Since $m = 0.85 \le x \; or \; I_r = 0.854 \le u = 1$, the equation, $(u-x)/(u-m)$, was used

$\mu_{(0.854)} = (1-0.854)/(1-0.85) = 0.9733 \approx 0.97 = 97\%$. This implies that the fuzzy aggregate importance rating (0.725, 0.881, 0.956) or the crisp importance rating $I_r = x = 0.854$ corresponds to 97% membership in the very high rating (VH) category.

Then the extent to which $I_r = x = 0.854$ belongs to the rating scale of "extremely high importance," which is defined by the triangle (0.85, 1 ,1), was calculated as follows:

Since $l = 0.85 \leq x \; or \; I_r = 0.854 \leq m = 1$, the equation, $(x - l)/(m - l)$, was used

$\mu_{(0.854)} = (0.854 - 0.85)/(1 - 0.854) = 0.02739 \approx 0.03 = 3\%$. This implies that the fuzzy aggregate importance rating (0.725, 0.881, 0.956) or the crisp importance rating $I_r = x = 0.854$ corresponds to 2% membership in the extremely high rating (VH) category. Because the fuzzy aggregated or crisp value does not fall within the five triangles representing the other five rating scales (extremely low (EL), very low (VL), low (L), moderate (M), and high importance (H), as shown in Figure 11, the degree to which the fuzzy aggregate or crisp value belongs to these rating scales is zero.

Therefore, the fuzzy set indicating the importance level of the driving factor (the private sector's ability to raise funds for public projects), can be represented as follows, where the "+" and "/" symbols don't stand for "plus" and "divided by," respectively. $\mu_{\tilde{A}}(x_i)/x_i$ means that the degree of membership of x_i in a set A is $\mu_{\tilde{A}}(x_i)$ "+" can be read as "and." (Zadeh 1965; Zimmermann n.d.).

$$Importance\ level\ of\ the\ driving\ driving\ factor = \frac{0}{EL} + \frac{0}{VL} + \frac{0}{L} + \frac{0}{M} + \frac{0}{H} + \frac{97}{VH} + \frac{3}{EM}$$

This can be interpreted as the importance of the factor "The private sector's ability to raise funds for public projects" in driving the adoption of PPP in provision of housing in Ethiopia is 97% high and 3% extremely high. For simplicity this can be presented as [0, 0, 0, 0, 0, 97, 3], where the order indicates from extremely low to extremely high importance. The complete analysis, along with rankings, is presented in Table 12. This table presents the ranking of the driving factors for PPP adoption in housing provision in Ethiopia based on their importance.

This can be interpreted as, the importance (significance) of the factor "The private sector's ability to raise funds for public projects" in driving the adoption of PPP for housing provision in Ethiopia is 97% high and 3% extremely high. For simplicity, this can be represented as [0.00, 0.00, 0.00, 0.00, 0.00, 0.97, 0.03], with the order indicating importance levels from extremely low to extremely high importance. The complete analysis, including rankings, can be found in Table 12, which presents the ranking of driving factors for PPP adoption in housing provision in Ethiopia together with the importance level of the factors across the rating scales.

The collective analysis reveals that nine driving factors hold very high importance, with crisp importance rating of 0.789 and above. The result revealed that, the private sector's ability to raise funds for public projects is the top ranked driver holding the importance rating of 0.854, signifying its very high importance in motivating the adoption of PPP for housing provision in Ethiopia, It is interpreted by referring to any linguistic term in Table 6 that provides the highest membership to the assessed importance value (Hwang et al. 2013). Save time in delivering projects and Better risk transfer and sharing were identified as the second and third driving factors holding an importance rating of 0.841 and 0.832 respectively, indicating their "very high" importance in triggering the adoption of in the housing provision. The fourth and fifth factors are Facilitate creative and innovative approach with importance rating of 0.831 and Acceleration of infrastructure provision with importance rating of 0.813 respectively. Implying their very high significance in driving the adoption of PPP for housing provision.

The collective analysis reveals that nine driving factors hold very high importance, with crisp importance rating of 0.789 and above. The results show that the top-ranked driver, with an importance rating of 0.854, is the private sector's ability to raise funds for public projects. This signifies its "very high importance" in motivating the adoption of PPP for housing provision in Ethiopia. This interpretation is based on the linguistic term in Table 6 that provides the highest membership to the assessed importance value (Zhao et al. (2013).

Following closely, the second and third driving factors are identified as "Save time in delivering projects" and "Better risk transfer and sharing," with importance ratings of 0.841 and 0.832, respectively. These ratings indicate their "very high" importance in promoting the adoption of PPP in housing provision. The fourth and fifth factors, with importance ratings of 0.831 and 0.813, respectively, are "Facilitate creative and innovative approaches" and "Acceleration of infrastructure provision." These findings underscore their very high importance in driving the adoption of PPP for housing provision.

Following these factors, optimization of the whole-life costs of the asset by bundling design, construction, and maintenance responsibilities, reduce public sector administration cost, the private sector possesses better resource mobility, improved quality of service, and enhances technology transfer to local companies holds a very high significance in triggering the adoption of PPP for housing provision in Ethiopia with importance rating of 0.803, 0.802, 0.796, and 0.793 respectively.

Table 16. Importance of the factors driving the adoption of PPP in the provision of housing in Ethiopia

Code	PPP Driving Factors	Fuzzy Aggregated I_r	Crisp I_r	Importance level of the drivers on each rating scales	Rank
DF-1	The private sector's ability to raise funds for public projects	(0.725, 0.881, 0.956)	0.854	[0.00, 0.00, 0.00, 0.00, 0.00, 0.97, 0.03]	1
DF-8	Save time in delivering projects	(0.702, 0.861, 0.959)	0.841	[0.00, 0.00, 0.00, 0.00, 0.06, 0.94, 0.00]	2
DF-9	Better risk transfer and sharing	(0.695, 0.856, 0.944)	0.832	[0.00, 0.00, 0.00, 0.00, 0.06, 0.94, 0.00]	3
DF-4	Facilitate creative and innovative approach	(0.688, 0.850, 0.955)	0.831	[0.00, 0.00, 0.00, 0.00, 0.13, 0.87, 0.00]	4
DF-2	Acceleration of infrastructure provision	(0.672, 0.835, 0.933)	0.813	[0.00, 0.00, 0.00, 0.00, 0.25, 0.75, 0.00]	5
DF-11	Optimization of the whole-life costs of the asset by bundling design, construction, and maintenance responsibilities	(0.657, 0.820, 0.934)	0.803	[0.00, 0.00, 0.00, 0.00, 0.31, 0.69. 0.00]	6
DF-12	Reduce public sector administration cost	(0.656, 0.802, 0.931)	0.802	[0.00, 0.00, 0.00, 0.00, 0.32, 0.68, 0.00]	7
DF-6	The private sector possesses better resource mobility	(0.644, 0.812, 0.931)	0.796	[0.00, 0.00, 0.00, 0.00, 0.36, 0.64, 0.00]	8
DF-5	Improved quality of service	(0.639, 0.805, 0.935)	0.793	[0.00, 0.00, 0.00, 0.00, 0.38, 0.62, 0.00]	9
DF-10	Enhances technology transfer to local companies	(0.638, 0.806, 0.924)	0.789	[0.00, 0.00, 0.00, 0.00, 0.41, 0.59, 0.00]	10
DF-3	Offers benefits for local economic development	(0.568, 0.741, 0.877)	0.729	[0.00, 0.00, 0.00, 0.00, 0.81, 0.19, 0.00]	11
DF-13	Certainty of construction costs and time	(0.577, 0.740, 0.878)	0.732	[0.00, 0.00, 0.00, 0.00, 0.79, 0.21, 0.00]	12
DF-7	Improved housing maintainability	(0.474, 0.658, 0.815)	0.649	[0.00, 0.00, 0.00, 0.26, 0.74, 0.00, 0.00]	13

Moreover, four driving factors, including acceleration of infrastructure provision, offers benefits for local economic development, certainty of construction costs and time, and improved housing maintainability, have a "high importance" in motivating the adoption of PPP with importance rating of 0.789, 0.729, 0.732, and 0.649 respectively. Furthermore, to identify the most critical or key drivers, the importance ratings of these factors were further normalized using the λ-cut set technique. Table 12 presented the ranking of the driving factors alongside their respective importance levels on each rating scale.

4.4.2 Identifying the critical (key) driving factors of housing PPP adoption

In this research, the λ-cut set technique was used to identify the key or critical factors driving the adoption of PPP for housing provision in Ethiopia. Fuzzy set theory was used to reduce the vagueness and uncertainty (Zadeh 1965) and facilitate the identification of key factors (Shen et al. 2011; Yadollahi et al. 2017). The λ-cut set method transforms a fuzzy set into a classical set. λ=0 corresponds to a pessimistic outcome, while λ=1 indicates an optimistic one. At λ=0.5, the outcome is neutral. In this study, three cut-off points were employed as criteria to determine the total number of critical factors from Table 5: λ=0.85, 0.90, and 0.95 (Yadollahi et al. 2017; Figueira and Lahdelma 2009).

To accomplish this the standard deviations (SDs) were calculated for all initial list of factors that provide the basic data to employ fuzzy set theory and the crisp importance ratings (I_r) were used. The value of the standard deviation determines whether a factor belongs to the critical factors set. In this regard, the larger the standard deviation, the less critical the identified factor. Moreover, the factor's criticality was recorded from extremely low (0.0, 0.0, 0.15) with crisp value of 0.05 to extremely high (0.85, 1, 1) with crisp value of 0.95. With a score of moderate (0.3, 0.5, 0.7) having a crisp value 0.05 as a neutral marking between non-critical and critical factors. Thus, if the importance rating of a factor is less than 0.5, the possibility for the factor to be one of the critical factors set is less than 50% (Shen et al. 2011; Yadollahi et al. 2017).

Then after, a new parameter Z defined to determine whether a factor should be encompassed in the critical factors set based on the two aforementioned indicators (SD and I_r) and using 0.5 as a neutral making between factors criticality and non-criticality (Shen et al. 2011; Yadollahi et al. 2017). Finally, for each factor f(z) or the degree of membership ($\mu_{\tilde{A}}(x_i)$), which is the probability of the factor to belong in the fuzzy set of critical factors (Yadollahi et al. 2017) was calculated. The $\mu_{\tilde{A}}(x_i)$ or f_Z score is the standard normal density function command in

Microsoft Excel. Accordingly, each factor's membership value ($\mu_{\tilde{A}}(x_i)$) needed to meet a specified benchmark value of λ = 0.95 or above to be considered as critical factor (Figueira and Lahdelma 2009). The degree of membership calculations' results is presented in Table 13.

Table 17. Identification of the critical drivers of housing PPP adoption in Ethiopia

Driving Factors	**Statistical Result**				**Critical Factor**		
	Crisp I_r	**SD**	**Z-score**	$\mu_{\tilde{A}}(x_i)$	**λ = 0.85**	**λ = 0.90**	**λ = 0.95**
DF-1	0.854	0.152	2.320	0.990	✓	✓	✓
DF-2	0.813	0.167	1.874	0.970	✓	✓	✓
DF-3	0.729	0.178	1.287	0.901	✓	✓	–
DF-4	0.831	0.123	2.700	0.997	✓	✓	✓
DF-5	0.793	0.134	2.179	0.985	✓	✓	✓
DF-6	0.796	0.135	2.191	0.986	✓	✓	✓
DF-7	0.649	0.171	0.871	0.808	✓	–	–
DF-8	0.841	0.126	2.704	0.997	✓	✓	✓
DF-9	0.832	0.162	2.051	0.980	✓	✓	✓
DF-10	0.789	0.152	1.898	0.971	✓	✓	✓
DF-11	0.803	0.155	1.955	0.975	✓	✓	✓
DF-12	0.802	0.157	1.923	0.973	✓	✓	✓
DF-13	0.732	0.214	1.082	0.860	✓	✓	–

According to the result presented in Table 13, the number of key driving factors identified under different thresholds λ values of 0.85, 0.90, and 0.95 were 13, 12, and 10 respectively. In this research, the factor was designated as a critical (key) factor if its membership degree was equal to or greater than 0.95 (Figueira and Lahdelma 2009). Accordingly, Table Y revealed that 10 factors are critical (key) factors in driving the adoption of PPP in Ethiopian housing provision. However, three factors, namely, offering benefits for local economic development, improving housing maintainability, and certainty of construction costs and time, have been identified as less critical in driving housing PPP adoption in Ethiopia. Their respective membership values are 0.901, 0.808, and 0.860, which do not meet the threshold of 0.95.

Subsequently, these identified critical factors were reorganized to undergo further analysis i.e. exploratory factor analysis via principal component analysis to group them into more compact clusters. This analytical process aimed to condense a set of interrelated variables into a smaller number of clusters that could effectively explain the observed variance among numerous variables. The primary objective was to provide a clearer understanding of the addressed issue.

4.4.3 Factor analysis on the drivers of housing PPP adoption in Ethiopia

Utilizing the rate associated with the crisp importance score for each of the ten key factors, an exploratory factor analysis based on principal component analysis was conducted as computed by Mazher et al. (2018). The goal was to identify factors that relate to the same core idea and organize them into non-correlated clusters. To accomplish this, the analysis was carried out using SPSS version 27.

Reliability analysis: The reliability of the dataset on the 10 critical factors was evaluated using the Cronbach's alpha coefficient. Applying this method to the information provided by 53 valid and completed respondents producing the dataset. The computed Cronbach's α coefficient for the dataset is 0.853, surpassing the 0.7 threshold. According to Field (2005) the result indicates that the dataset can be deemed reliable. Table 14 presents this result.

Table 18. Reliability statistics for the data set of the 10 critical factors.

Cronbach's Alpha Coefficient	Number of factors
0.853	10

Preliminary analysis: Before proceeding with factor analysis, the assessment of the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test was conducted at this stage. These measurements are essential prerequisites for performing factor analysis on the provided dataset. Table 15 depicts the KMO measure of sample adequacy and Bartlett's test for sphericity for driving factors. As a result, the KMO measure confirmed the adequacy of the sample for the analysis, with a value of 0.722. This value significantly exceeds the acceptable threshold of 0.6 as indicated by Yang et al. (2009). This indicates the adequacy of the data for performing a factor analysis, which means that the dataset is appropriate for extracting meaningful factors, in other word the dataset have a high degree of common variance, making them suitable for factor analysis.

The Bartlett's test of sphericity is significant with degree of freedom (df) value of 45 and the chi-square value of 289.032 and the associated significant level (p) < 0.001. This result indicated that the correlation matrix is not an identity matrix (Chan et al., 2010), indicating that the correlations between items were sufficiently large for factor analysis. Therefore, the results of KMO and Bartlett's test revealed that factor analysis is appropriate and acceptable.

Table 19. KMO and Bartlett's Tests.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO)	0.722	
Bartlett's Test of Sphericity	Approx. Chi-Square	289.032
	df	45
	Sig.	< 0.001

Through complex correlation analysis, SPSS automatically identified three principal components or factor groups within the dataset. These three components were extracted and treated as a principal category using principal component analysis. In this process, an initial evaluation was conducted to determine the eigenvalues for each component in the provided dataset. These eigenvalues, linked to each linear component, indicate the extent to which that specific component explains variance. This concept is crucial in comprehending the importance and contribution of factors to the overall variability in observed variables. Higher eigenvalues suggest that the corresponding principal factor accounts for more variance in the data. According to Robert et al. (2014), the eigenvalues of the principal factors surpass 1. Consequently, three main components exhibited eigenvalues exceeding Kaiser's criterion of 1, collectively explaining 73.475% of the total variance. This implies that only three factors explain a relatively substantial portion of the variance.

Moreover, in exploratory factor analysis factor loading reveals how an observed variable or factor and a latent factor (principal component) are linked in strength and direction. It measures how much a specific variable contributes to a certain factor (principal component). Each factor is connected to each principal component factor through a factor loading coefficient, usually a number from -1 to 1. The factor loading's sign (positive or negative) indicates the relationship's direction. Positive means higher variable values align with higher factor values, while negative means the opposite. The factor loading's absolute value shows relationship strength: larger loading values indicates stronger connections, while values near zero imply weaker connection (Hair et al. 2010).

Accordingly, one variables “The private sector possesses better resource mobility” with loadings less than 0.5 were deleted, because a factor loading value less than 0.5 indicates a weak connection between the latent variable (principal component) and an observed variable (Kim et al. 2020). The remaining 9 items were retained into 3 clusters, accounting for 73.475% of the total variance. Table 16 illustrates the result of factor analysis. The three principal factors

were named as “Utilization of private sector expertise and improved housing project quality,” “Improving risk allocation and cost-efficiency,” and “Private sector’s potential to finance the delivery of public projects.” Among them, “Utilization of private sector expertise and improved housing project quality” accounted for the variance of 28.473%, explaining 28.473% of the variability in the data set and holds the highest eigenvalue of 2.847 in the data. This was followed by the measurement of “Improving risk allocation and cost-efficiency” with an eigenvalue of 2.546, presenting 25.404% of the total variance. The last measure was, “Private sector’s potential to finance the delivery of public projects” was indicated with an eigenvalue of 1.96, which explains 19.598% of the total variance in the data set.

Table 16 shows the rotated component matrix, also called the rotated factor matrix that is a matrix of the factor loadings for each variable onto each component. Using the calculated loading factors and eigenvalue, the critical drivers of housing PPP adoption were effectively clustered into three categories.

Table 20. Factor groupings of 10 drivers

Code	**Group Drivers**	**Factor Loading**	**Eigenvalue**	**The % variance explained**	**The cumulative % of variance explained**
PC-1	**Utilization of private sector expertise and improved housing project quality**		2.847	28.473	28.473
DF-5	Improved housing project and service quality	0.893			
DF-4	Facilitate creative and innovative approach	0.867			
DF-10	Enhances technology transfer to local companies	0.873			
DF-8	Save time in delivering projects	0.582			
PC-2	**Improving risk allocation and cost-efficiency**		2.546	25.404	53.873
DF-9	Better risk transfer and sharing	0.926			

DF-11	Optimization of the whole-life costs of the asset by bundling design, construction, and maintenance responsibilities	0.873			
DF-12	Reduce public sector administration cost	0.579			
PC-3	**Private sector's Potential to finance the delivery of public projects**		1.96	19.598	73.475
DF-2	Acceleration of infrastructure provision	0.948			
DF-1	The private sector's ability to raise funds for public projects	0.813			
Notes: Extraction method: principal component analysis, Rotation method: varimax with Kaiser normalization					

4.4.4 Fuzzy Synthetic Evaluation: Model development

Fuzzy synthetic evaluation was utilized to identify the importance index of key driving factors at the principal factor (group) level. This was done to determine the overall driving index for the adoption of PPP in the Ethiopian housing sector and to facilitate the development of models. The resultant model will enable a more comprehensive and adaptable evaluation of proposed PPP projects in the housing sector, assessing their capacity to fulfill the sector's objectives for adopting this system.

To compute the fuzzy synthetic evaluation, the weight of each driving factor within each principal component, $W = \{w_1, w_2, w_3, w_i \ldots, w_m\}$, was calculated based on the crisp importance rating value Mazher et al. (2018). The Equation of weightings was given as (Osei-Kyei and Chan 2017b): $w_i = \frac{I_r}{\sum I_r} \quad 0 \leq w_i \leq 1, \sum w_1 = 1$

To demonstrate this, a sample calculation was done for the driving factor "Improved project and service quality" and the principal driver "Utilization of private sector expertise and improved housing project quality." Consequently, within the category of "utilization of private sector expertise improved housing project quality," there are four factors, each with its respective importance rating are: Improved housing project and service quality (0.793), facilitation of creative and innovative approaches (0.831), enhancement of technology transfer to local companies (0.789), and time-saving in project delivery (0.841).

I_r = $important\ rating\ of\ the\ driver$ "$Improved\ housing\ project\ \ quality$" = 0.793

$\sum I_r$ = $total\ of\ the\ crisp\ important\ rating\ of\ driving\ factor\ in\ the\ group$ = 0.793 + 0.831 + 0.789 + 0.841 = 3.254. The table 17 presents the total crisp importance score of the remaining two principal drivers.

w_i = $weighting\ of\ the\ driver$ "$Improved\ quality\ of\ service$" = $\frac{0.793}{3.254}$ = 0.244. Table X summarized weights of all driving factors.

Furthermore, in order to calculate the weight of the principal driver "utilization of private sector expertise and improved housing project quality," the importance ratings of all the three principal drivers were computed (Table 17), and then these ratings were added together. Subsequently, the importance rating of the principal component factor was divided by the obtained sum.

$$\sum I_r = total\ of\ the\ crisp\ important\ rating\ of\ the\ principal\ driving\ factor$$
$$= 3.254 + 2.437 + 1.667 = 7.358$$

w_i = $weighting\ of\ the\ principal\ driver$ = $\frac{3.254}{7.358}$ = 0.442. Table 17 summarized weights of all principal driving factors.

Table 21. The weights assigned to the driving factors and principal drivers

Code	**Driver groups**	I_r	**Weightings of drivers**	I_r **of driver groups**	**Weightings of driver groups**
DF-5	Improved housing project and service quality	0.793	0.244		
DF-4	Facilitate creative and innovative approach	0.831	0.255		
DF-10	Enhances technology transfer to local companies	0.789	0.242		
DF-8	Save time in delivering projects	0.841	0.258		
PC-1	**Utilization of private sector expertise**			3.254	0.442
DF-9	Better risk transfer and sharing	0.832	0.341		

DF-11	Optimization of the whole-life costs of the asset by bundling design, construction, and maintenance responsibilities	0.803	0.330		
DF-12	Reduce public sector administration cost	0.802	0.329		
PC-2	**Improving risk allocation and cost-efficiency**			2.437	0.331
DF-1	The private sector's ability to raise funds for public projects	0.854	0.512		
DF-2	Acceleration of infrastructure provision	0.813	0.488		
PC-3	**Private sector's Potential to finance the delivery of public projects**			1.667	0.227
	Total $\boldsymbol{I_r}$			7.358	

To compute the group-level driving index, determine the overall driving index, and develop the fuzzy model, membership functions (MFs) were constructed at three levels. The second level, representing principal drivers, consisted of three principal driving factors, while the third level, encompassing driving factors, included nine driving factors. The MF for the second level was initially determined, followed by an analysis of the MF for the first level, which represents the overall driver. At the third level, MFs for each driving factor were established based on ratings provided by the respondents. These membership functions indicate the proportion of respondents who rated each driving factor as having extremely low, very low, low, moderate, high, very high, and extremely high importance.

For example, when considering the factor "Facilitate a creative and innovative approach," the collected data indicated that none of the respondents rated this driving factor as having "extremely low importance," none as having "very low importance," none as having "low importance," 6% as "moderately important," 19% as "highly important," 43% as "very highly important," and 32% as "extremely highly important." Consequently, the membership function (MF) of this driver was presented as follows:

$$MF = \frac{0.00}{ELI} + \frac{0.00}{VLI} + \frac{0.00}{LI} + \frac{0.06}{MI} + \frac{0.19}{HI} + \frac{0.43}{VHI} + \frac{0.32}{EHI}$$

It can also be presented as [0.000, 0.000, 0.00, 0.06, 0.19, 0.43, 0.32]. Likewise, Table 18 presents the MF of the remaining drivers.

Next, the membership function (MF) of the second level was computed using Equation 18, employing the membership values of factors from the third-level categories under the second level, as described in previous studies (Gebremeskel et al. 2021a; Osei-Kyei and Chan 2017d; Xu et al. 2010b). For instance, to illustrate this calculation, let's consider the principal driving factor "Utilization of private sector expertise and improved project quality." The MF is demonstrated as follows:

$$D_1 = W_1 \bullet R_1 = (0.244, 0.255, 0.242, 0.258) \bullet \begin{bmatrix} 0.00 & 0.00 & 0.00 & 0.11 & 0.21 & 0.51 & 0.17 \\ 0.00 & 0.00 & 0.00 & 0.06 & 0.19 & 0.43 & 0.32 \\ 0.00 & 0.00 & 0.00 & 0.15 & 0.21 & 0.38 & 0.26 \\ 0.00 & 0.00 & 0.02 & 0.02 & 0.17 & 0.43 & 0.36 \end{bmatrix}$$

$D_1 = [0.244 \times 0.00 + 0.255 \times 0.00 + 0.242 \times 0.00 + 0.258 \times 0.00 + \cdots + 0.244 \times 0.17 + 0.255 \times 0.32 + 0.242 \times 0.258 + 0.26 \times 0.36] = [0.00, 0.00, 0.01, 0.08, 0.19, 0.44, 0.28]$.

The MF for the remaining driving factors has been calculated and is presented in Table 18. Similarly, the MF for the overall driver (at the first level) of PPP adoption in the housing sector of Ethiopia was calculated by using the weights of the three principal driver factors and the MF of the second level, as demonstrated below.

$$D_1 = W_1 \bullet R_1 = (0.441, 0.331, 0.227) \bullet \begin{bmatrix} 0.00 & 0.00 & 0.01 & 0.08 & 0.19 & 0.44 & 0.28 \\ 0.00 & 0.01 & 0.01 & 0.10 & 0.15 & 0.39 & 0.34 \\ 0.00 & 0.01 & 0.02 & 0.07 & 0.13 & 0.32 & 0.45 \end{bmatrix}$$

$$D_1 = [0.441 \times 0.00 + 0.331 \times 0.00 + 0.227 \times 0.01 + \cdots + 0.441 \times 0.28 + 0.331 \times 0.34 + 0.227 \times 0.45] = [0.00, 0.00, 0.01, 0.09, 0.17, 0.4, 0.3$$

Table 22. Membership function of driver groupings (level 2) and drivers (level 3)

Code	Factor groupings	Weightings of drivers	MF of level 3	MF of level 2
PC-1	**Utilization of private sector expertise**			[0.00, 0.00, 0.01, 0.08, 0.19, 0.44, 0.28]
DF-5	Improved housing project quality	0.244	[0.00, 0.00, 0.00, 0.11, 0.21, 0.51, 0.17]	
DF-4	Facilitate creative and innovative approach	0.255	[0.00, 0.00, 0.00, 0.06, 0.19, 0.43, 0.32]	
DF-10	Enhances technology transfer to local companies	0.242	[0.00, 0.00, 0.00, 0.15, 0.21, 0.38, 0.26]	
DF-8	Save time in delivering projects	0.258	[0.00, 0.00, 0.02, 0.02, 0.17, 0.43, 0.36]	

PC-2	**Improving risk allocation and cost-efficiency**			[0.00, 0.01, 0.01, 0.10, 0.15, 0.39, 0.34]
DF-9	Better risk transfer and sharing	0.341	[0.00, 0.02, 0.00, 0.08, 0.13, 0.34, 0.43]	
DF-11	Optimization of the whole-life costs of the asset by bundling design, construction, and maintenance responsibilities	0.330	[0.00, 0.00, 0.02, 0.11, 0.15, 0.43, 0.28]	
DF-12	Reduce public sector administration cost	0.329	[0.00, 0.00, 0.02, 0.11, 0.17, 0.4, 0.30]	
PC-3	**Private sector's Potential to finance the delivery of public projects**			[0.00, 0.01, 0.02, 0.07, 0.13, 0.32, 0.45]
DF-1	The private sector's ability to raise funds for public projects	0.512	[0.00, 0.02, 0.00, 0.09, 0.17, 0.34, 0.38]	
DF-2	Acceleration of infrastructure provision	0.488	[0.00, 0.00, 0.04, 0.04, 0.09, 0.30, 0.53]	

Table 23. MF of overall driver (level 1) of PPP adoption for housing provision in Ethiopia

Code	Factor groupings	Weight	MF of level 2	MF of level 1
PC-1	Utilization of private sector expertise and improved project quality	0.442	[0.00, 0.00, 0.01, 0.08, 0.19, 0.44, 0.28]	[0.00, 0.00, 0.01, 0.09, 0.17, 0.4, 0.34]
PC-2	Improving risk allocation and cost-efficiency	0.331	[0.00, 0.01, 0.01, 0.10, 0.15, 0.39, 0.34]	
PC-3	Private sector's Potential to finance the delivery of public projects	0.227	[0.00, 0.01, 0.02, 0.07, 0.13, 0.32, 0.45]	

Finally, all membership functions (MFs) corresponding to the principal driving factors at the second level were defuzzified to determine the crisp driving index (DI) for the principal drivers (PCs) using Equation 3.17 (Gebremeskel et al. 2021a; Osei-Kyei and Chan 2017d; Xu et al. 2010b). This DI subsequently became the coefficient for the overall DI (model), achieved by

dividing it by the sum of the crisp driving indices of the principal drivers. Given that the weights derived from the crisp importance ratings of third-level factors were used in constructing the membership functions of second-level drivers (MF of principal drivers), the driving index of the principal drivers obtained from the second-level MF is inherently crisp in nature. As an illustration, the coefficient for the principal factor "utilization of private sector expertise and improved project quality" was calculated as follows:

$$DI_1 = \sum_{J=1}^{7} D_1 \times L$$

"In this context, L = (0.05, 0.15, 0.317, 0.5, 0.683, 0.85, 0.95) represents the crisp values of the importance rating scales. These crisp values were employed instead of fuzzy aggregated importance scores for simplicity, as they yield the same output for driving the MFs of the second-level drivers. The crisp values of the importance rating scale were utilized to defuzzify the membership functions (MFs) of the second-level drivers."

$DI_1 = [0.000, 0.000, 0.005, 0.084, 0.193, 0.439, 0.280] \times (0.05, 0.15, 0.317, 0.5, 0.683, 0.85, 0.95) = 0.000 \times 0.05 + 0.000 \times 0.15 + 0.005 \times 0.317 = 0.814$. Using the same approach, the DI for the other two principal drivers were determined as shown in Table 20

Table 24. The driving index and coefficients of driver groupings (principal drivers) of PPP adoption

Code	Factor groupings	DI	Coefficient
PC-1	Utilization of private sector expertise and improved housing project quality	0.814	0.331
PC-2	Improving risk allocation and cost-efficiency	0.813	0.330
PC-3	Private sector's Potential to finance the delivery of public projects	0.833	0.339
	Total	2.460	-
	Overall driving index	0.818	-

Developing Overall driving index (overall DI) for adoption of PPP in the Ethiopian housing sector

A linear and additive model was employed to formulate an overall Driving Index (DI) or the model that can assess the significance or relevance of proposed housing PPP projects in addressing the underlying objectives of PPP adoption in the Ethiopian housing sector. A linear

model was chosen because the three principal component drivers (PCs) for housing sector PPP adoption are not correlated with each other. This implies that they are nonlinear. As explained by (Xu et al. 2010a), a linear but not nonlinear model is deemed appropriate if the correlation among variables is insignificant. Therefore, given that the correlation coefficients among the PCs are zero, a linear and additive approach is considered suitable.

Accordingly, prior to constructing the overall Diversity Index (DI), the DIs corresponding to all principal component drives (PCs) serving as coefficients in the linear model undergo further normalization. This normalization process ensures that they collectively sum to one or are confined within unity (Gebremeskel et al. 2021b; Osei-Kyei and Chan 2017d). The resulting normalized values, representing the coefficients of the PCs, are presented in Table 20. This normalization step is both logical and valid since it enhances the representation of the relative influence of each factor in the linear equation. Importantly, it permits the use of different measurement scales for principal component factors within the evaluation model (Hair et al. 2010). For clarity, the coefficient of the DI pertaining to the principal factor "utilization of private sector expertise and improved project quality" is illustrated as follows (Gebremeskel et al. 2021b; Osei-Kyei and Chan 2017d).

$$\sum_{i=1}^{3} DI = 0.814 + 0.813 + 0.833 = 2.460$$

$$Coeffiecient = \frac{DI_i}{\sum_{i=1}^{3} DI} = \frac{0.814}{2.460} = 0.331$$

The coefficients of the other principal component drivers (PCs) is summarized and presented in Table 20. The overall driving index (DI) for PPP adoption in Ethiopian housing provision is therefore expressed by the following model:

$DI = [(0.331 \times$
Utilization of private sector expertise and improved housing project quality$) + (0.330 \times$
mproving risk allocation and cost efficiency$) + (0.339 \times$
Private sector's Potential to finance the delivery of public projects$)]$ … Equation 20

This model can be employed to assess any proposed PPP project within the housing sector of Ethiopia. It can be used to determine its effectiveness in addressing the core objective or rationale behind adopting PPPs in the Ethiopian housing sector, specifically evaluating the

extent to which the proposed housing PPP project can offer a solution to the challenges in traditional housing delivery methods in the country. In other words, this model can be used to assess the motivation behind implementing any housing PPP project.

In general, Table 20 demonstrates that the overall driving index (DI) of all the nine factors collectively in driving the adoption of PPP in housing in Ethiopia is 0.818. This indicates that the motivation for adopting PPP in the housing sector in Ethiopia is 1%f "low," 9% "moderate," 17% "high," 39% "very high," and 34% "extremely high." This further signifies that, the motivation for adopting PPP for housing provision in Ethiopia is "very high," as determined by referencing the linguistic term that assigns the highest membership to scale. the driving index value (Zhao et al. (2013). The coming section provides a comprehensive discussion of the implication of these critical drivers, comparing the findings of this study with previous research. Additionally, Table 21 presents a summary of the results, including the complete ranking of the drivers and the principal drivers together with their corresponding importance levels across the rating scales.

Table 25. The ranking of the drivers and principal drivers together with their importance level across the rating scales

Code	Driving Factors	I_r or DI	Membership Function	Linguistic Term	Group Rank	Global Rank
PC-3	**Private sector's Potential to finance the delivery of public projects**	**0.833**	**[0.00, 0.00, 0.00, 0.00, 0.11, 0.89, 0.00]**	**Extremely High Importance**	**1st**	
DF-1	The private sector's ability to raise funds for public projects	0.854	[0.00, 0.00, 0.00, 0.00, 0.00, 0.97, 0.03]	Very High Importance	1st	1st
DF-2	Acceleration of infrastructure provision	0.813	[0.00, 0.00, 0.00, 0.00, 0.25, 0.75, 0.00]	Very High importance	2nd	5th
PC-1	**Utilization of private sector expertise and improved project quality**	**0.814**	**[0.00, 0.00, 0.00, 0.00, 0.24, 0.76, 0.00]**	**Very High importance**	**2nd**	
DF-8	Save time in delivering projects	0.841	[0.00, 0.00, 0.00, 0.00, 0.06, 0.94, 0.00]	Very High Importance	1st	2nd
DF-4	Facilitate creative and innovative approach	0.831	[0.00, 0.00, 0.00, 0.00, 0.13, 0.87, 0.00]	Very High Importance	2nd	4th
DF-5	Improving project quality	0.793	[0.00, 0.00, 0.00, 0.00, 0.38, 0.62, 0.00]	Very High Importance	3rd	8th
DF-10	Enhances technology transfer to local companies	0.789	[0.00, 0.00, 0.00, 0.00, 0.41, 0.59, 0.00]	Very High Importance	4th	9th
PC-2	**Improving risk allocation and cost-efficiency**	**0.813**	**[0.00, 0.00, 0.00, 0.00, 0.25, 0.75, 0.00]**	**Very High importance**	**3rd**	
DF-9	Better risk transfer and sharing	0.832	[0.00, 0.00, 0.00, 0.00, 0.06, 0.94, 0.00]	Very High Importance	1st	3rd
DF-11	Optimization of the whole-life costs of the asset by bundling design, construction, and maintenance responsibilities	0.803	[0.00, 0.00, 0.00, 0.00, 0.31, 0.69. 0.00]	Very High Importance	2nd	6th
DF-12	Reduce public sector administration cost	0.802	[0.00, 0.00, 0.00, 0.00, 0.32, 0.68, 0.00]	Very High Importance	3rd	7th
	Overall importance	**0.818**	**[0.00, 0.00, 0.01, 0.09, 0.17, 0.39, 0.34]**	**Extremely High Importance**	**-**	**-**

4.4.5 Discussion on the implication of the driving factors

The current study categorizes the driving factors for adopting PPPs in Ethiopian housing provision into three distinct groups using exploratory factor analysis: (1) Private sector's potential to finance the delivery of public projects, (2) the utilization of private sector expertise and improving project quality, and (3) improving risk allocation and cost-efficiency. The results are thoroughly discussed and subsequently compared with the findings of past studies. All the results discussed in this section are referred from Table 21.

4.4.5.1 Private sector's Potential to finance the delivery of public projects

Drawing from the result of the exploratory factor analysis, the foremost principal driver identified as "Private sector's Potential to finance the delivery of public projects" exhibited an eigenvalue of 1.96, surpassing Kaiser's criterion of 1.0. This eigenvalue accounts for 19.6% of the variability inherent in the dataset. Consequently, the result of the fuzzy synthetic evaluation positioned "Private sector's Potential to finance the delivery of public projects" as the first ranked principal driver. This factor held an enabling index of 0.833, and as per the fuzzy analysis, its significance was distributed with 11% signifying high importance and 89% denoting very high importance. This combined evidence underscores the "very high importance" of this principal factor in driving the adoption of PPP for housing provision in Ethiopia.

Within this cluster, two key factors emerge, each holding a factor loading value exceeding 0.5. This indicates a substantial contribution of the observed variables (factors) to the latent variable (principal factor). As the factor loading value approaches 1, it signifies a strong relationship between the factor and the principal factor, as noted by Hair et al. (2010). The elements within the "Private sector's Potential to finance the delivery of public projects" category, along with their associated factor loadings, includes: The private sector's ability to raise funds for public projects (0.95) and acceleration of infrastructure provision (0.81).

The private sector's ability to raise funds for public projects is ranked first in its designated category as well as globally, with importance rating of 0.833, resulting in an importance distribution of 97% very high and 3% of extremely high and having an overall importance rating of 0.854, signifying its overall "very high importance" in triggering the government of Ethiopia to adopt PPP in housing sector. This driving factor highlights the private sector's role in contributing funds to support the development and implementation of housing projects that

typically fall under the responsibility of the public sector. This financial contribution from the private sector can alleviate the burden on public budgets and resources, enabling the realization of housing projects that have been challenging solely through public funding.

Bishu (2017) highlighted that a significant challenge in Ethiopia's attempts to tackle housing issues is the absence of diversified housing financing systems. Consequently, the adoption of PPPs becomes crucial to leverage private sector resources for housing project development. This approach aims to enhance housing provision by utilizing into private sector funding. This finding aligns with research in Ethiopia by Gebremeskel et al. (2021), which unveiled that drivers such as the "Ability to raise funds of the private sector" and "Reduce public money in capital investment" motivated the adoption of PPPs in the Ethiopian overall economy. Furthermore, this discovery is in line with the work of Kavishe and Chileshe (2018), who identified "Lack of enough financial capacity to undertake housing project" as one of the seven key drivers compelling PPP adoption in housing projects in Tanzania. Additionally, a study conducted by Yuan et al. (2012) pinpointed that "Solving the problem of public sector budget restraint" stands as the pivotal factor attracting the Chinese government to implement housing projects through PPPs.

Ranked second within its category and fifth overall, "Acceleration of infrastructure provision" possesses importance rating of 0.813, resulting a importance level distribution that indicates 25% high and 75% very high importance of the factor. By mobilizing private sector funding, the government can free up budgets bound by capital investments, enabling the acceleration of vital infrastructure development. Through this approach, private sector capital can accelerate housing provision, meeting the substantial public demand for housing facilities. Moreover, channeling private sector finance into housing projects allows the government to reallocate budget earmarked for housing, thus expediting other infrastructure projects. In this manner, PPPs empower governments to advance crucial projects, while also enhancing their capacity for comprehensive solutions.

As highlighted by Gebremeskel et al. (2021), this observation is evident in the Ethiopian economy, where a key driver for PPP adoption is the acceleration of infrastructure under the theme "Accelerate the project development." Similarly, a study conducted by Kavishe et al. (2019) illustrated that the outcomes linked with housing PPP project delivery in Tanzania include the acceleration of affordable housing provision and the enhancement of service quality.

4.4.5.2 Utilization of private sector expertise and improving housing project quality

According to the result of the exploratory factor analysis, the principal factor labeled "Utilization of private sector expertise and improving housing project quality" exhibited an eigenvalue of 2.85, explaining 28.47% of the variability within the dataset. Following this, the results of the fuzzy synthetic evaluation ranked the factor “Utilization of private sector expertise and improving housing project quality" as the second most significant principal driver. It achieved an enabling index of 0.814, with an importance level distribution indicating 24% of high importance and 76% of very high importance, signifying an overall very high importance of the principal driver in triggering the adoption of PPP in housing provision in Ethiopia. The factors encompassed in the “Utilization of private sector expertise and improving housing project quality" category, together with their corresponding factor loadings, include: Save time in delivering projects (0.58), facilitate creative and innovative approaches (0.87), Improved project quality (0.89), and Enhances technology transfer to local companies (0.87).

"Saving time in delivering projects" stands as the number one ranked factor within its group and secures the second rank across the entirety of the driver set. It possesses an importance distribution of 6% high and 94% very high, classifying it as of "very high importance," with an overall rating of 0.841. Through the engagement of private sector partners, PPPs enable the incorporation of innovative technologies, technical expertise, and efficient management practices from the private sector, leading to quick project delivery. Additionally, PPPs create incentives for private sector collaborators to meet project deadlines, driven by their financial investment and contractual obligations (World Bank 2020). Furthermore, the utilization of private funds can mitigate any delays that could arise due to shortages in public capital, showcasing the interplay of this driving factor.

This observation aligns with a comparative study by Chan et al. (2009) conducted between China and Hong Kong Special Administrative Region, which identified "Saving time in delivering the project" as a key driver for adopting PPPs in infrastructure provision. Similarly, a study by Yuan et al. (2012) discovered that "Advanced technology and high management skills" which can lead to time-saving in project delivery is the key advantage associated with the implementation PPPs on housing projects. This observation is evident in Ethiopia due to previous challenges encountered in the timely delivery of housing projects.

Facilitate creative and innovative approach is the second critically important factor in its cluster and holds the fourth position across the entire set of drivers. It exhibits a distribution of 13% for high importance and 87% for very high importance, having an importance rating of rating of 0.831. This finding aligns with other studies that reinforce the role of this factor in driving PPP adoption (Chou and Pramudawardhani 2015; Chan et al. 2009). Similarly, "Encourage private sector innovation and management skills" emerges as a top-ranked factor in the context of Tanzania housing sector (Kavishe et al. 2019b).

Facilitate creative and innovative approach highlights the potential unlocked by collaboration between the public and private sectors, which harnesses into their diverse expertise, resources, and perspectives. This synergy creates an environment prepared for the exploration and realization of novel ideas. For instance, private sector collaborators could introduce cutting-edge technologies, innovative construction methods, or new design concepts, thus enhancing housing quality, sustainability, and cost-effectiveness. The integration of these inventive strategies can result in housing projects that can better accommodate the dynamic needs of communities (Bovaird 2004). By promoting creative and innovative strategies, housing PPPs go beyond traditional approaches, offering new solutions.

Moreover, PPP contracts create abundant room for the private sector to foster innovation throughout the entire project life cycle. By leveraging innovative techniques and managerial skills that stem from the synergy between both sectors, end-users are more likely to receive better services and housing facility. In this study, the factor "Improving project quality" ranks as the third most important within its category and secures the eighth position across the entire spectrum of driving factors. It carries an associated importance distribution of 38% for high and 62% for very high, with crisp rating of 0.793, which falls within the "very high importance" range. The positioning of this factor being at the least signifies that while Ethiopia has a significant motivation to elevate the quality of housing projects through PPPs, the primary drive behind adopting PPPs is to access private sector capital to bolster housing project provision (a topic addressed in the previous section). This observation is consistent with the findings of Kavishe et al. (2019), where "Improving project quality" ranks fifth in importance within a set of six drivers. However, in New Zealand, it holds the position of the second most significant driver (Liu and Wilkinson 2011c). This could be attributed to the country's relatively lesser financial constraints in housing development when compared to Tanzania and Ethiopia. This highlights two key points: firstly, that governments exhibit diverse motivations for

adopting PPPs, and secondly, the adaptability of the system in accommodating a wide range of interests (Gebremeskel et al. 2021b; Kavishe et al. 2019b).

The factor "Enhances technology transfer to local companies" is the least ranked factor both in its cluster and throughout the drivers set with importance rating of 0.789, resulting in membership distribution of 41% high and 59% very high, overall having “very high importance” in triggering the adoption of PPP in housing provision. The drive to enhance technology transfer to local companies within the housing sector can be a pivotal factor in promoting the adoption of PPPs. This effort facilitates the exchange of advanced technologies, expertise, and knowledge from private sector collaborators to local firms engaged in housing projects. This transfer empowers local companies with innovative tools and methods, strengthening their capabilities and increasing the quality and efficiency of housing development.

Beyond enhancing technical competence, this factor contributes to broader sustainable economic growth objectives by advancing local industries, generating employment, and cultivating a self-sustaining ecosystem for housing development. this in a sense, through the enhancement of technology transfer, local contractors can gain access to cutting-edge technologies and technical expertise. This capability not only strengthens their skillset but also has the potential to conserve foreign currency that would otherwise be expended on international contractors for comparable projects. This observation aligns with previous studies (Chan et al. 2009; Chou and Pramudawardhani 2015a; Gebremeskel et al. 2021b), confirming that fostering technology transfer is one of the driving factors motivating different countries to participate in such arrangements.

4.4.5.3 Improving risk allocation and cost-efficiency

Based on the outcomes of the exploratory factor analysis, the factor “Improving risk allocation and cost-efficiency” exhibited an eigenvalue of 2.55, explaining 25.40% of the variability present in the dataset. Subsequently, as a result of the fuzzy synthetic evaluation, the principal factor “Improving risk allocation and cost-efficiency” was ranked third. It achieved an enabling index of 0.813, with an importance level distribution of 25% indicating high importance and 75% indicating very high importance. The factors grouped under the “Improving risk allocation and cost-efficiency” category, along with their corresponding factor loadings, encompass: Better risk transfer and sharing (0.93), optimization of the whole-life costs of the asset by

bundling design (0.87), construction, and maintenance responsibilities, and reduce public sector administration cost (0.58).

Ranked as the leading factor within its category, "Better risk transfer and sharing" secures the position of the third most significant driver across the entire spectrum. This is underlined by an importance rating of 0.832 and importance membership distribution of 6% for high importance and 94% for very high importance, signifying its "very high importance." In a study conducted by Kavishe et al. (2019), the "Possibility of risk sharing between parties" emerged as the second most prominent driver motivating the adoption of PPPs for housing delivery. Similarly, Yuan et al. (2012) discovered that "Risk transfer and sharing" ranked as the third essential factor enticing the implementation of PPPs for housing development. Furthermore, the concept of enhanced risk transfer and sharing is revealed as a pivotal driver not only in housing projects but also in infrastructure projects across developing nations (Chan et al. 2009; Gebremeskel et al. 2021b).

This is because in traditional public-sector-driven projects, the government typically shoulders the majority of risks, including financial, construction, operational, and even regulatory risks. However, in a PPP arrangement, risks can be allocated and shared more effectively between the public and private sectors. By engaging private sector partners, particularly those with expertise in risk management, the housing project benefits from their experience in identifying, mitigating, and handling various risks. The private sector's involvement often leads to better risk evaluation and allocation mechanisms, enhancing the project's overall risk management strategy. Additionally, the private sector's financial stake in the project encourages them to take on and manage risks more efficiently.

Optimization of the whole-life costs of the asset by bundling design is the second important driver in its category and the sixth important driver overall, with importance rating of 31% high and 69% very high possessing a crisp rating of 0.803 indicating “very high importance.” This outcome aligns with the discovery made by Kavishe et al. (2019), highlighting that "PPPs provide value for money" ranked as the third crucial driver for adopting PPPs in housing provision. This aligns with the study of Yuan et al. (2010), where "Life-cycle cost reduction" emerges as the foremost driver in PPP implementation within China.

By bundling the design, construction, and maintenance responsibilities into a single contract, PPPs encourage private sector partners to consider the long-term costs and benefits of their

decisions. This approach minimizes unexpected expenses that may arise during the asset's lifecycle (Cheung et al. 2009). This is because in traditional procurement, costs are often focused on the initial construction phase, without adequate consideration for ongoing maintenance and operational expenses. PPPs, driven by the desire to optimize whole-life costs, compel private partners to create designs that prioritize durability, energy efficiency, and long-term performance. This results in housing projects that are not only built to last but are also cost-efficient to maintain over time.

By aligning the interests of private partners with long-term cost optimization, PPPs encourage innovative design solutions that maximize the value of investments (Ismail 2013c). This approach not only benefits the private sector by enhancing their reputation and long-term returns but also benefits the government and end-users through cost-effective and sustainable housing solutions.

Moreover, by bundling multiple functions in a single contract and transferring some or all of the risks to a private investor there's no separate administrative cost for each project phase, it can reduce public sector administration costs significantly. This is especially useful when compared to the traditional procurement process which requires financial and temporal investments in consultant fees and project management. Reduce public sector administration cost.

Within this study, the factor "Reduce public sector administration cost" emerges as the third vital driver within its category and ranks as the seventh significant driver across all the factors considered. The distribution of importance membership showcases 32% for high importance and 68% for very high importance, leading to a crisp importance rating of 0.802 and a broader linguistic categorization as "very high importance." This observation resembles the findings of Chan et al. (2009) where it stands as the ninth driver of importance. Similarly, this alignment is seen in the study by (Gebremeskel et al. 2021b), conducted to evaluate the drivers behind PPP adoption within the Ethiopian economy.

Furthermore, in traditional public-sector projects, administrative processes can be tedious and costly, causing inefficiencies and delays. However, PPPs introduce private sector efficiency, streamlining administrative procedures and cutting bureaucratic expenses. By delegating certain administrative responsibilities to private partners, governments can strategically allocate resources, focusing on policymaking and oversight rather than administrative tasks.

This accelerates decision-making and project execution, reducing administrative costs and ensuring optimal utilization of public funds for housing development. This driver underscores how PPPs offer a path to more efficient and cost-effective housing project delivery, aligning with the overarching goal of maximizing the value of public resources.

4.5 Enabling the successful implementation of PPP in the provision of housing in Ethiopia

This section presents the findings and discusses the factors that enable the successful implementation of housing public-private partnerships (PPPs) in Ethiopia. It encompasses the results of the process of identifying the importance levels of these factors, the identification of critical factors, the clustering of these critical factors into principal groups for clarity, and the development of a model using fuzzy synthetic evaluation. Accordingly, the methodology employed for this specific object is similar to the approach used for previous specific objects, as extensively discussed in the section addressing that particular objective. Therefore, this section briefly presents and discusses only the findings that are unique to this specific objective.

Before presenting the results and discussion on the finding on the factors enabling the successful implementation of PPP in the housing provision in Ethiopia, the study assessed to perception of the respondent if the overall conditions and resources of Ethiopia adequate enough to enable the successful implementation of PPP in Ethiopian hosing provision. In this regard, 20.8% of the respondents replied “Yes”, 7.5% of the respondents replied “No idea,” indicating their neutral opinion, and 71.1% respondent replied “No.” this signifies the country’s inadequate resource and conditions to successfully enable the proposed PPP initiative. the pie chart below summarized the responses. The next section delves in to the factors enabling the successful implantation of PPP for housing provision in Ethiopia.

Before discussing the findings related to the factors that support the successful implementation of PPP in housing provision in Ethiopia, this section presents the result on the assessment of the respondents' perceptions regarding whether Ethiopia possesses the necessary conditions and resources to facilitate the effective implementation of PPP in housing provision which was conducted through yes or no question. In this context, 20.8% of the respondents answered affirmatively with a "Yes," while 7.5% expressed uncertainty with a "No idea," indicating a neutral stance. However, a significant majority of 71.1% of the respondents responded negatively with a "No." This substantial negative response suggests that the country lacks the

requisite resources and conditions to successfully implement the proposed PPP initiative. The following pie chart (Figure 12) provides a visual summary of these responses. The subsequent section will delve into the factors that contribute to the successful implementation of PPP in housing provision in Ethiopia.

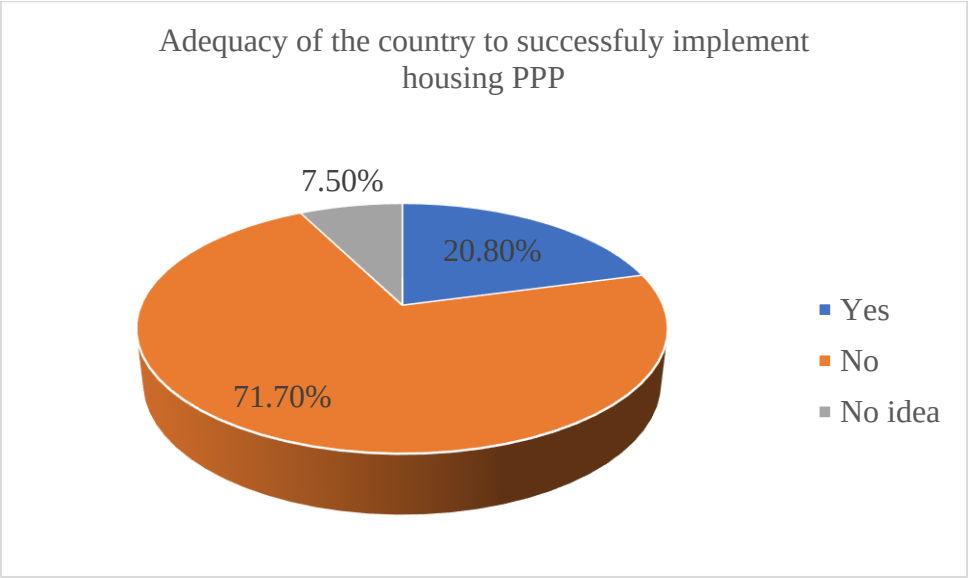

Figure 18. Respondent's perception on the adequacy of the country to successfully implement housing PPP.

4.5.1 Fuzzy analysis to identify the importance level of the enabling factors

The enabling factors were assessed by the respondents using linguistic terms. These linguistic assessments were subsequently converted into numerical values using triangular fuzzy numbers, as described in (Mazher et al. 2018). This conversion was completed prior to any further analysis. Next, these ratings were combined across all respondents using Equation (3.3) to determine the average aggregate fuzzy importance of the enabling factors, following the approach outlined by (Buckley 1985). Subsequently, the aggregated fuzzy importance rating was transformed into a precise crisp value using Equation (3.4), which utilizes the centroid method of defuzzification (Wang and Elhag 2007; Zhao et al. 2013).

Furthermore, the fuzzy set representing the importance level of the enabling factors on each rating scale was computed (Mazher et al. 2018). This calculation involved the use of the triangular membership function described in Equation (3.2), as referenced in the works of (Chang 1996; Sirisawat and Kiatcharoenpol 2018; Sun 2010). Consequently, Table 22 presents the ranking of the enabling factors based on their crisp importance rating, along with the level of importance of these factors on each rating scale. Furthermore, to identify the most critical

enablers, the importance ratings of these factors were further normalized using the λ-cut set technique. Table 22 presents the ranking of the enabling alongside their respective importance levels on each rating scale.

Table 26. Importance of the factors enabling the adoption of PPP in the provision of housing in Ethiopia

Code	Enabling factors	Fuzzy Aggregated I_r	Crisp I_r	Importance level of the enablers on each rating scales	Rank
EF-21	Establishing well-organized and committed PPP units	(0.726, 0.885, 0.957)	0.856	[0.00, 0.00, 0.00, 0.00, 0.00, 0.96, 0.04]	1
EF-10	Political stability	(0.725, 0.886, 0.955)	0.855	[0.00, 0.00, 0.00, 0.00, 0.00, 0.97, 0.03]	2
EF-31	In-time land acquisition	(0.704, 0.866, 0.960)	0.843	[0.00, 0.00, 0.00, 0.00, 0.04, 0.96, 0.00]	3
EF-13	Right project identification and project technical feasibility	(0.703, 0.863, 0.954)	0.840	[0.00, 0.00, 0.00, 0.00, 0.07, 0.93, 0.00]	4
EF-1	Appropriate risk identification and risk sharing	(0.699, 0.858, 0.959)	0.839	[0.00, 0.00, 0.00, 0.00, 0.08, 0.92, 0.00]	5
EF-2	Favorable and efficient legal framework and PPP policy	(0.709, 0.872, 0.948)	0.843	[0.00, 0.00, 0.00, 0.00, 0.09, 0.91, 0.00]	6
EF-11	Strong political support	(0.692, 0.856, 0.948)	0.832	[0.00, 0.00, 0.00, 0.00, 0.12, 0.88, 0.00]	7
EF-30	Effective negotiation and financial closure	(0.681, 0.842, 0.960)	0.828	[0.00, 0.00, 0.00, 0.00, 0.15, 0.85, 0.00]	8
EF-16	The existence of long-term demand for the proposed housing projects	(0.674, 0.842, 0.934)	0.816	[0.00, 0.00, 0.00, 0.00, 0.22, 0.78, 0.00]	9
EF-6	Competitive procurement process	(0.668, 0.828, 0.951)	0.816	[0.00, 0.00, 0.00, 0.00, 0.23, 0.77, 0.00]	10
EF-29	Clearly defined roles and responsibilities of parties	(0.673, 0.831, 0.934)	0.813	[0.00, 0.00, 0.00, 0.00, 0.25, 0.75, 0.00]	11
EF-18	Availability of strong and reliable private consortium	(0.669, 0.829, 0.939)	0.812	[0.00, 0.00, 0.00, 0.00, 0.25, 0.75, 0.00]	12
EF-24	Preparation of a tact contractual agreement	(0.664, 0.829, 0.943)	0.812	[0.00, 0.00, 0.00, 0.00, 0.25, 0.75, 0.00]	12
EF-5	Transparent procurement process	(0.662, 0.825, 0.934)	0.807	[0.00, 0.00, 0.00, 0.00, 0.29, 0.71, 0.00]	14

EF-19	Government involvement by providing a guarantee and financial support	(0.660, 0.824, 0.937)	0.807	[0.00, 0.00, 0.00, 0.00, 0.29, 0.71, 0.00]	15
EF-23	Efficient use of advisory service	(0.650, 0.816, 0.940)	0.802	[0.00, 0.00, 0.00, 0.00, 0.32, 0.68, 0.00]	16
EF-14	Realistic assessment of cost and revenue	(0.650, 0.816, 0.940)	0.802	[0.00, 0.00, 0.00, 0.00, 0.32, 0.68, 0.00]	16
EF-22	Strengthening public sector capability	(0.642, 0.813, 0.938)	0.798	[0.00, 0.00, 0.00, 0.00, 0.35, 0.65, 0.00]	18
EF-4	Sound economic policy	(0.648, 0.815, 0.929)	0.797	[0.00, 0.00, 0.00, 0.00, 0.35, 0.65, 0.00]	19
EF-9	Good governance	(0.641, 0.808, 0.928)	0.792	[0.00, 0.00, 0.00, 0.00, 0.38, 0.62, 0.00]	20
EF-26	Employing appropriate contractual clauses to manage macro risks	(0.640, 0.808, 0.929)	0.792	[0.00, 0.00, 0.00, 0.00, 0.39, 0.61, 0.00]	21
EF-3	Stable macro-economic condition	(0.642, 0.812, 0.921)	0.792	[0.00, 0.00, 0.00, 0.00, 0.39, 0.61, 0.00]	22
EF-15	The attractiveness of long-term cash flow to the lenders	(0.640, 0.805, 0.929)	0.791	[0.00, 0.00, 0.00, 0.00, 0.39, 0.61, 0.00]	23
EF-8	An efficient evaluation and approval process	(0.620, 0.792, 0.913)	0.775	0.00, 0.00, 0.00, 0.00, 0.50, 0.50, 0.00]	24
EF-17	Availability of suitable and mature financial market	(0.616, 0.788, 0.910)	0.771	[0.00, 0.00, 0.00, 0.00, 0.65, 0.35, 0.00]	25
EF-27	Creation of model concession agreements	(0.603, 0.779, 0.912)	0.765	[0.00, 0.00, 0.00, 0.00, 0.61, 0.39, 0.00]	26
EF-12	Encouraging community involvement and public acceptance	(0.597, 0.774, 0.904)	0.758	[0.00, 0.00, 0.00, 0.00, 0.61, 0.39, 0.00]	27
EF-28	Clear and affordable price design (purchase or rent price)	(0.600, 0.768, 0.886)	0.751	[0.00, 0.00, 0.00, 0.00, 0.66, 0.34, 0.00]	28
EF-25	Flexibility of contract	(0.558, 0.727, 0.873)	0.719	[0.00, 0.00, 0.00, 0.00, 0.87, 0.13, 0.00]	29
EF-7	Process flexibility	(0.539, 0.710, 0.840)	0.696	[0.00, 0.00, 0.00, 0.02, 0.98, 0.00, 0.00]	30
EF-20	The involvement of non-commercial (development) financing	(0.519, 0.692, 0.842)	0.684	[0.00, 0.00, 0.00, 0.12, 0.88, 0.00, 0.00]	31

The results in the table demonstrates that, among the 31 factors considered, the top 24 factors possess a significance rating of 0.775 or higher, categorizing them as "very highly significant" in facilitating the successful implementation of PPP in the Ethiopian housing sector. Notably, the factor "Establishing well-organized and committed PPP units" ranks as the highest among them, with a significance rating of 0.856. This indicates that this particular factor holds 96% high significance and 4% extremely high significance in enabling the successful execution of the PPP system within the sector. Overall, the factor collectively holds a “high level” of significance, as determined by the linguistic term associated with the highest membership to the rating value.

Following this, the factors of "Political stability" and "In-time land acquisition" are ranked as the second and third most significant contributors, with significance ratings of 0.855 and 0.843, respectively. These ratings underscore their "very high" importance in facilitating the successful implementation of housing PPP in Ethiopia. Additionally, the fourth and sixth most influential factors are "Proper project identification and technical feasibility" and "Appropriate risk identification and risk sharing," with importance scores of 0.840 and 0.839, respectively. These scores also indicate their "very high" importance in ensuring the successful execution of PPPs in housing provision within Ethiopia.

In contrast, the factors encouraging community involvement and public acceptance, clear and affordable price design (purchase or rent price), flexibility of contract, process flexibility, the involvement of non-commercial (development) financing are the five least ranked factors, with significance ratings of 0.758, 0.751, 0.719, 0.696, and 0.684, respectively. According to their significance scores, these factors are deemed of "high" importance in facilitating the efficient implementation of housing PPP. This highlights that, despite their lower ranking within the list of enabling factors, these elements play a crucial role in contributing to the successful execution of the system. A more comprehensive discussion on the implications of critical factors will be provided later in this chapter.

4.5.2 Identifying the critical enablers of successful PPP implementation in housing provision

In a similar manner to the driving forces, the λ-cut set technique was employed to identify the critical factors that enable the successful implementation of PPP in the context of housing provision in Ethiopia (Shen et al. 2011; Yadollahi et al. 2017). In this regard, three specific cut-

off points were applied as criteria to establish the overall count of critical factors: λ=0.85, 0.90, and 0.95, as outlined by (Yadollahi et al. 2017; Figueira and Lahdelma 2009). Accordingly, to qualify as a critical factor, each factor's membership value ($\mu_{\tilde{A}}(x_i)$ needed to surpass or equal the predefined benchmark value of λ=0.95 (Figueira and Lahdelma 2009). The outcomes of this membership calculation, along with the critical factors, are presented in Table 23

Table 27. Identification of the critical drivers of housing PPP adoption in Ethiopia

Enabling Factors	**Statistical Result**				**Critical Factor**		
	Crisp I_r	**SD**	**Z-score**	$\mu_{\tilde{A}}(x_i)$	**λ = 0.85**	**λ = 0.90**	**λ = 0.95**
EF 1	0.839	0.130	2.603	0.995	✓	✓	✓
EF 2	0.843	0.144	2.379	0.991	✓	✓	✓
EF 3	0.792	0.153	1.910	0.972	✓	✓	✓
EF 4	0.797	0.148	2.005	0.978	✓	✓	✓
EF 5	0.807	0.161	1.902	0.971	✓	✓	✓
EF 6	0.816	0.132	2.394	0.992	✓	✓	✓
EF 7	0.696	0.218	0.902	0.816	–	–	–
EF 8	0.775	0.141	1.956	0.975	✓	✓	✓
EF 9	0.792	0.140	2.087	0.982	✓	✓	✓
EF 10	0.855	0.138	2.571	0.995	✓	✓	✓
EF 11	0.832	0.135	2.466	0.993	✓	✓	✓
EF 12	0.758	0.137	1.890	0.971	✓	✓	✓
EF 13	0.840	0.137	2.482	0.993	✓	✓	✓
EF 14	0.802	0.125	2.414	0.992	✓	✓	✓
EF 15	0.791	0.153	1.909	0.972	✓	✓	✓
EF 16	0.816	0.141	2.240	0.987	✓	✓	✓
EF 17	0.771	0.156	1.739	0.959	✓	✓	✓
EF 18	0.812	0.156	1.999	0.977	✓	✓	✓
EF 19	0.807	0.150	2.041	0.979	✓	✓	✓
EF 20	0.684	0.199	0.922	0.822	–	–	–
EF 21	0.856	0.145	2.463	0.993	✓	✓	✓
EF 22	0.798	0.102	2.906	0.998	✓	✓	✓
EF 23	0.802	0.125	2.414	0.992	✓	✓	✓
EF 24	0.812	0.129	2.413	0.992	✓	✓	✓
EF 25	0.719	0.196	1.119	0.868	✓	–	–
EF 26	0.792	0.140	2.087	0.982	✓	✓	✓
EF 27	0.765	0.119	2.230	0.987	✓	✓	✓
EF 28	0.751	0.200	1.256	0.895	✓	–	–
EF 29	0.813	0.177	1.770	0.962	✓	✓	✓
EF 30	0.828	0.108	3.040	0.999	✓	✓	✓
EF 31	0.843	0.111	3.092	0.999	✓	✓	✓

According to the result presented in Table 23, the number of critical enabling factors identified under different thresholds λ values of 0.85, 0.90, and 0.95 were 29, 27, and 27 respectively. In this research, the factor was designated as a critical factor if its membership degree was equal to or greater than 0.95 (Figueira and Lahdelma 2009). Accordingly, Table 23 revealed that 27 factors are critical in enabling the successful implementation of PPP in Ethiopian housing provision. However, four factors, namely, clear and affordable price design (purchase or rent price), flexibility of contract, process flexibility, and the involvement of non-commercial (development) financing have been identified as less critical in enabling successful implementation housing PPP in Ethiopia. Their respective membership values are 0.895, 0.868, 0.816, and 0.822 which do not meet the threshold of 0.95.

Subsequently, these identified critical factors were reorganized to undergo further analysis i.e. exploratory factor analysis via principal component analysis to group them into more compact clusters. This analytical process aimed to condense a set of interrelated variables into a smaller number of clusters that could effectively explain the observed variance among numerous variables. The primary objective was to provide a clearer understanding of the addressed issue.

4.5.3 Factor analysis on the enablers of successful housing PPP implementation

In this study, an exploratory factor analysis was performed using principal component analysis, as employed by Mazher et al. (2018). The objective was to discern common themes among the 27 critical factors by employing the crisp importance score associated with each factor. The aim was to group these factors into distinct and uncorrelated clusters. This analysis was conducted using SPSS version 27 as the statistical tool.

Reliability analysis: The dataset's reliability concerning the 27 critical factors was assessed utilizing the Cronbach's alpha coefficient. This evaluation was conducted based on data provided by 53 valid and fully completed respondents, resulting in the dataset. The computed Cronbach's α coefficient for the dataset yielded a value of 0.942, which exceeds the commonly accepted threshold of 0.7 Field (2005), this outcome signifies that the dataset can be considered reliable. You can find this result presented in Table 24.

Table 28. Reliability statistics for the data set of the 27 critical factors.

Cronbach's Alpha Coefficient	Number of factors
0.942	27

Preliminary analysis: Before proceeding with factor analysis, the assessment of the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test was conducted at this stage. These measurements are essential prerequisites for performing factor analysis on the provided dataset. Table 25 depicts the KMO measure of sample adequacy and Bartlett's test for sphericity for enabling factors. As a result, the KMO measure confirmed the adequacy of the sample for the analysis, with a value of 0.703. This value significantly exceeds the acceptable threshold of 0.6 as indicated by Yang et al. (2009). This indicates the adequacy of the data for performing a factor analysis, which means that the dataset is appropriate for extracting meaningful factors, in other word the dataset have a high degree of common variance, making them suitable for factor analysis.

The Bartlett's test of sphericity is significant with degree of freedom (df) value of 351 and the chi-square value of 1220.908 and the associated significant level (p) < 0.001. This result indicated that the correlation matrix is not an identity matrix (Chan et al., 2010), indicating that the correlations between items were sufficiently large for factor analysis. Therefore, the results of KMO and Bartlett's test revealed that factor analysis is appropriate and acceptable.

Table 29. KMO and Bartlett's Tests.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO)	0.703	
Bartlett's Test of Sphericity	Approx. Chi-Square	1220.908
	df	351
	Sig.	< 0.001

Through complex correlation analysis, SPSS automatically identified six principal components or factor groups within the dataset. These six components were extracted and treated as a principal category using principal component analysis. In this process, an initial evaluation was conducted to determine the eigenvalues for each component in the provided dataset. These eigenvalues, linked to each linear component, indicate the extent to which that specific component explains variance. Consequently, the six main components exhibited eigenvalues exceeding Kaiser's criterion of 1 (Robert et al. 2014), collectively explaining 73.475% of the total variance. This implies that only six factors explain a relatively substantial portion of the variance.

Moreover, in exploratory factor analysis factor loading reveals how an observed variable or factor and a latent factor (principal component) are linked in strength and direction (Hair et al. 2010). In this regard, factor loading value exceeding 0.5 indicate sufficient connection between the factors and the principal component (Kim et al. 2020). The results of the factor analysis reveal that all the variables examined in this analysis exhibit factor loadings exceeding 0.5. This indicates a robust and substantial connection between each variable and its respective latent variable, or principal component. A comprehensive summary of the factor analysis findings is provided in Table 26, which includes details such as the factor loadings for each variable, eigenvalues, and the percentage of variance accounted for by the principal component factors.

Table 30. Factor groupings of 27 enablers

Code	**Group Enablers**	**Factor Loading**	**Eigen value**	**The % variance explained**	**The cumulative % of variance explained**
PC-1	**Enhancing public sector capacity and strategic projects execution**		**4.884**	**18.09**	**18.09**
EF-23	Efficient use of advisory service	0.789			
EF-31	In-time land acquisition	0.768			
EF-24	Preparation of a tact contractual agreement	0.722			
EF-30	Effective negotiation and financial closure	0.676			
EF-16	The existence of long-term demand for the proposed housing projects	0.674			
EF-26	Employing appropriate contractual clauses to manage macro risks	0.612			
EF-22	Strengthening public sector capability	0.594			
EF-21	Establishing well-organized and committed PPP units	0.56			
PC-2	**Robust risk allocation, procurement process, and PPP legal framework**		**4.13**	**15.297**	**33.388**
EF-5	Transparent procurement process	0.848			

EF-1	Appropriate risk identification and risk sharing	0.827			
EF-6	Competitive procurement process	0.815			
EF-2	Favorable and efficient legal framework and PPP policy	0.689			
PC-3	**Adequacy of the country's political and economic environment for effective project execution**		**3.88**	**14.37**	**47.758**
EF-10	Political stability	0.818			
EF-3	Stable macro-economic condition	0.815			
EF-9	Good governance	0.758			
EF-14	Realistic assessment of cost and revenue	0.583			
EF-4	Sound economic policy	0.542			
PC-4	**Right project selection with public and political acceptance**		**3.162**	**11.71**	**59.467**
EF-12	Encouraging community involvement and public acceptance	0.816			
EF-11	Strong political support	0.657			
EF-13	Right project identification and project technical feasibility	0.656			
EF-8	An efficient evaluation and approval process	0.62			
EF-15	The attractiveness of long-term cash flow to the lenders	0.527			
PC-5	**Effective partnership with clearly defined roles**		**2.507**	**9.284**	**68.752**
EF-29	Clearly defined roles and responsibilities of parties	0.847			
EF-18	Availability of strong and reliable private consortium	0.781			
EF-17	Availability of suitable and mature financial market	0.676			
EF-19	Government involvement by providing a guarantee and financial support	0.543			

PC-6	**Standardizing housing PPP implementation models**		**1.573**	**5.827**	**74.579**
EF-27	Creation of model concession agreements	0.788			

4.5.4 Fuzzy Synthetic Evaluation: Model development

Fuzzy synthetic evaluation was utilized to identify the importance index of critical enabling factors at the principal factor (group) level. This was done to determine the overall enabling index for the successful implementation of PPP in the housing provision in Ethiopia and to facilitate the development of models. The resultant model will enable a more comprehensive and adaptable evaluation of the adequacy of the country's resources and conditions to successfully implement PPP in the housing sector.

To compute the fuzzy synthetic evaluation, the weight of each enabling factor within each principal component, was calculated based on the crisp importance rating value Mazher et al. (2018). Using Equation 3.13 (Osei-Kyei and Chan 2017b). Subsequently, the weight of the principal factor was determined using the similar equation. Table 27 provides a summary of the weights assigned to the enabling factors and principal enabling factors.

Table 31. Table. The weights assigned to the enabling factors and principal enablers

Code	**Enabling groups**	I_r	**Weightings of enablers**	I_r **of enabler groups**	**Weightings of enabler groups**
EF-23	Efficient use of advisory service	0.802	0.122		
EF-31	In-time land acquisition	0.843	0.129		
EF-24	Preparation of a tact contractual agreement	0.812	0.124		
EF-30	Effective negotiation and financial closure	0.828	0.126		
EF-16	The existence of long-term demand for the proposed housing projects	0.816	0.125		
EF-26	Employing appropriate contractual clauses to manage macro risks	0.792	0.121		
EF-22	Strengthening public sector capability	0.798	0.122		

EF-21	Establishing well-organized and committed PPP units	0.856	0.131		
PC-1	**Strengthing public sector capacity and strategic projects execution**			**6.548**	**0.300**
EF-5	Transparent procurement process	0.807	0.245		
EF-1	Appropriate risk identification and risk sharing	0.839	0.254		
EF-6	Competitive procurement process	0.816	0.247		
EF-2	Favorable and efficient legal framework and PPP policy	0.836	0.254		
PC-2	**Robust risk allocation, procurement process, and PPP legal framework**			**3.297**	**0.151**
EF-10	Political stability	0.855	0.212		
EF-3	Stable macro-economic condition	0.792	0.196		
EF-9	Good governance	0.792	0.196		
EF-14	Realistic assessment of cost and revenue	0.802	0.199		
EF-4	Sound economic policy	0.797	0.197		
PC-3	**Adequacy of the country's political and economic environment for effective project execution**			**4.039**	**0.185**
EF-12	Encouraging community involvement and public acceptance	0.758	0.190		
EF-11	Strong political support	0.832	0.208		
EF-13	Right project identification and project technical feasibility	0.840	0.210		
EF-8	An efficient evaluation and approval process	0.775	0.194		
EF-15	The attractiveness of long-term cash flow to the lenders	0.791	0.198		

PC-4	**Right project selection with public and political acceptance**			**3.997**	**0.183**
EF-29	Clearly defined roles and responsibilities of parties	0.813	0.254		
EF-18	Availability of strong and reliable private consortium	0.812	0.254		
EF-17	Availability of suitable and mature financial market	0.771	0.241		
EF-19	Government involvement by providing a guarantee and financial support	0.807	0.252		
PC-5	**Effective partnership with clearly defined roles**			**3.203**	**0.147**
EF-27	Creation of model concession agreements	0.758	1.000		
PC-6	**Standardizing housing PPP implementation models**			**0.758**	**0.035**
	Total	**21.842**			

To calculate the group-level and the overall enabling index, a multi-step process was undertaken. Initially, membership functions (MFs) were created at three distinct levels. The second level, comprising six principal enabling factors, represented the principal enablers, and its MF was determined first. Subsequently, the MF for the first level, reflecting the overall enablers, was analyzed. The third level encompassed 27 enabling factors, and for each of them, individual MFs were established based on respondent ratings. These membership functions quantified the proportion of respondents who assigned various levels of importance, ranging from extremely low to extremely high, to each enabling factor. The resulting MFs for the third-level enablers can be found in Table 28.

Subsequently, the membership function (MF) for the second level was determined using Equation 3.15. This calculation utilized the MFs of factors drawn from the third-level categories under the second level (Gebremeskel et al. 2021a; Osei-Kyei and Chan 2017d; Xu et al. 2010b). The resulting MFs for the second level enablers are presented in Table 28.

Table 32. Membership function of driver groupings (level 2) and drivers (level 3)

Group drivers	**Driving factors**	**Weightings of drivers**	**MF of level 3**	**MF of level 2**
PC-1	EF-23	0.122	[0.00, 0.00, 0.02, 0.02, 0.30, 0.47, 0.19]	[0.00, 0.00, 0.01, 0.04, 0.26, 0.39, 0.30]
	EF-31	0.129	[0.00, 0.00, 0.00, 0.02, 0.23, 0.38, 0.38]	
	EF-24	0.124	[0.00, 0.00, 0.00, 0.08, 0.23, 0.43, 0.26]	
	EF-30	0.126	[0.00, 0.00, 0.00, 0.04, 0.19, 0.55, 0.23]	
	EF-16	0.125	[0.00, 0.00, 0.02, 0.02, 0.34, 0.23, 0.40]	
	EF-26	0.121	[0.00, 0.00, 0.00, 0.11, 0.25, 0.42, 0.23]	
	EF-22	0.122	[0.00, 0.00, 0.00, 0.00, 0.42, 0.42, 0.17]	
	EF-21	0.131	[0.00, 0.00, 0.02, 0.06, 0.11, 0.26, 0.55]	
PC-2	EF-5	0.245	[0.00, 0.00, 0.02, 0.13, 0.11, 0.42, 0.32]	[0.00, 0.00, 0.02, 0.07, 0.16, 0.42, 0.34]
	EF-1	0.254	[0.00, 0.00, 0.02, 0.04, 0.13, 0.47, 0.34]	
	EF-6	0.247	[0.00, 0.00, 0.02, 0.06, 0.15, 0.57, 0.21]	
	EF-2	0.254	[0.00, 0.00, 0.02, 0.04, 0.23, 0.25, 0.47]	
PC-3	EF-10	0.212	[0.00, 0.00, 0.00, 0.08, 0.15, 0.21, 0.57]	[0.00, 0.00, 0.02, 0.07, 0.28, 0.35, 0.32]
	EF-3	0.196	[0.00, 0.00, 0.00, 0.13, 0.26, 0.28, 0.32]	
	EF-9	0.196	[0.00, 0.00, 0.02, 0.06, 0.30, 0.40, 0.23]	
	EF-14	0.199	[0.00, 0.00, 0.02, 0.02, 0.30, 0.47, 0.19]	
	EF-4	0.197	[0.00, 0.00, 0.00, 0.13, 0.21, 0.38, 0.28]	
PC-4	EF-12	0.190	[0.00, 0.00, 0.00, 0.11, 0.42, 0.30, 0.17]	[0.00, 0.00, 0.02, 0.07, 0.28, 0.35, 0.29]
	EF-11	0.208	[0.00, 0.00, 0.02, 0.02, 0.25, 0.32, 0.40]	

	EF-13	0.210	[0.00, 0.00, 0.02, 0.04, 0.17, 0.36, 0.42]	
	EF-8	0.194	[0.00, 0.00, 0.04, 0.00, 0.45, 0.30, 0.21]	
	EF-15	0.198	[0.00, 0.00, 0.00, 0.17, 0.13, 0.47, 0.23]	
PC-5	EF-29	0.254	[0.02, 0.02, 0.00, 0.02, 0.21, 0.42, 0.32]	[0.01, 0.01, 0.00, 0.06, 0.24, 0.41, 0.27]
	EF-18	0.254	[0.00, 0.00, 0.00, 0.04, 0.23, 0.43, 0.28]	
	EF-17	0.241	[0.00, 0.02, 0.00, 0.08, 0.36, 0.34, 0.21]	
	EF-19	0.252	[0.00, 0.00, 0.02, 0.09, 0.17, 0.43, 0.28]	
PC-6	EF-27	1.000	[0.00, 0.00, 0.00, 0.06, 0.51, 0.30, 0.13]	[0.00, 0.00, 0.00, 0.06, 0.51, 0.30, 0.13]

Similarly, the MF for the overall driver (at the first level) for enabling the successful implementation of PPP in the housing sector of Ethiopia was calculated by using the weights of the six principal enablers and their MFs, Table 29 presents the MFs of the first level.

Table 33. MF of overall driver (level 1) of PPP adoption for housing provision in Ethiopia

Group driver	Weight	MF of level 2	MF of level 1
PC-1	0.300	[0.00, 0.00, 0.01, 0.04, 0.26, 0.39, 0.30]	[0.00, 0.00, 0.01, 0.06, 0.25, 0.38, 0.30]
PC-2	0.151	[0.00, 0.00, 0.02, 0.07, 0.16, 0.42, 0.34]	
PC-3	0.185	[0.00, 0.00, 0.02, 0.07, 0.28, 0.35, 0.32]	
PC-4	0.183	[0.00, 0.00, 0.02, 0.07, 0.28, 0.35, 0.29]	
PC-5	0.147	[0.01, 0.01, 0.00, 0.06, 0.24, 0.41, 0.27]	
PC-6	0.035	[0.00, 0.00, 0.00, 0.06, 0.51, 0.30, 0.13]	

Finally, all membership functions (MFs) corresponding to the principal enabling factors at the second level were defuzzified to determine the crisp enabling index (EI) for the principal enablers (PCs) using equation x (Gebremeskel et al. 2021a; Osei-Kyei and Chan 2017d; Xu et al. 2010b). This EI subsequently became the coefficient for the overall EI (model), achieved by dividing it by the sum of the crisp enabling indices of the principal enablers. Table 30 presents the enabling index and coefficient of the principal enablers.

Table 34. The enabling index and coefficients of driver groupings (principal drivers) of PPP adoption

Code	Factor groupings	DI	Coefficient
PC-1	Strengthing public sector capacity and strategic projects execution	0.819	0.170
PC-2	Robust risk allocation, procurement process, and PPP legal framework	0.825	0.171
PC-3	Adequacy of the country's political and economic environment for effective project execution	0.808	0.168
PC-4	Right project selection with public and political acceptance	0.801	0.166
PC-5	Effective partnership with clearly defined roles	0.801	0.166
PC-6	Standardizing housing PPP implementation models	0.758	0.158
	Total	4.812	
	overall enabling index	0.810	

Developing the Overall enabling index (overall EI)/model for enabling the successful execution of PPP in the Ethiopian housing sector

A linear and additive model was employed to formulate an overall Driving Index (DI) or model that can assess the adequacy of the country's resources and condition required to successfully implementation of PPP the housing sector. In this regard, prior to constructing the overall Enabling Index (EI)/models, the EIs corresponding to all principal component enablers (PCs) serving as coefficients in the linear model undergo further normalization using. This normalization process ensures that they collectively sum to one or are confined within unity (Gebremeskel et al. 2021b; Osei-Kyei and Chan 2017d). The resulting normalized values, representing the coefficients of the PCs, are presented in table X. This normalization step is both logical and valid since it enhances the representation of the relative influence of each factor in the linear equation. Importantly, it permits the use of different measurement scales for principal component factors within the evaluation model (Hair et al. 2010).

Therefore, the overall enabling index (EI) for the successful implementation of PPP for housing provision in Ethiopia is:

$$EI = [(0.170 \times Enhancing\ public\ sector\ capacity\ and\ strategic\ projects\ execution) + (0.171 \times Robust\ risk\ allocation, procurement\ process, and\ PPP\ legal\ framework) + (0.168 \times Adequacy\ of\ the\ country's\ political\ and\ economic\ environment\ for\ effective\ project\ execution)$$

$(0.166 \times Right\ project\ selection\ with\ public\ and\ political\ acceptance) + (0.166 \times Effective\ partnership\ with\ clearly\ defined\ roles) + (0.158 \times Standardizing\ housing\ PPP\ implementation\ models)$ … Equation 21

This model serves as a valuable tool for assessing the adequacy and suitability of a country's resources, including financial, manpower, experience, and the necessary system knowledge, as well as evaluating the prevailing conditions such as political, economic, legal, social, and institutional aspects that are essential for the effective implementation of PPP within the Ethiopian housing sector. Furthermore, it aids in identifying the critical conditions that can facilitate the successful implementation of PPP in housing provision prior to its execution.

In general, table x shows that the overall Enabling Index (EI) for the 27 factors critical to the successful implementation of PPP in housing provision in Ethiopia is 0.810. This score signifies that the combined importance of these 27 critical enablers towards the successful execution of PPP in Ethiopia's housing sector can be categorized as follows: 1% low, 6% moderate, 25% high, 38% very high, and 30% extremely high. In essence, these factors collectively hold a "very high" level of significance in facilitating success. This classification is determined by referring to the linguistic term that assigns the highest membership to the scale, as proposed by (Zhao et al. (2013). The coming section provides a comprehensive discussion of the implication of these critical enablers, comparing the findings of this study with previous research. Additionally, Table 31 presents a summary of the results, including the complete ranking of the enablers and the principal enablers together with their corresponding importance levels across the rating scales.

Table 35. The ranking of the enablers and principal principal together with their importance level across the rating scales

Code	Enabling Factors	I_r	Membership Function	Linguistic Rating	Group Rank	Overall Rank
PC-2	**Robust risk allocation, procurement process, and PPP legal framework**	**0.825**	**[0.00, 0.00, 0.00, 0.00, 0.17, 0.83, 0.00]**	**Very High**	**1st**	
EF-1	Appropriate risk identification and risk sharing	0.839	[0.00, 0.00, 0.00, 0.00, 0.08, 0.92, 0.00]	Very High	1st	5th
EF-2	Favorable and efficient legal framework and PPP policy	0.836	[0.00, 0.00, 0.00, 0.00, 0.09, 0.91, 0.00]	Very High	2nd	6th
EF-6	Competitive procurement process	0.816	[0.00, 0.00, 0.00, 0.00, 0.23, 0.77, 0.00]	Very High	3rd	10th
EF-5	Transparent procurement process	0.807	[0.00, 0.00, 0.00, 0.00, 0.29, 0.71, 0.00]	Very High	4th	14th
PC-1	**Enhancing public sector capacity and strategic projects execution**	**0.819**	**[0.00, 0.00, 0.00, 0.00, 0.21, 0.79, 0.00]**	**Very High**	**2nd**	
EF-21	Establishing well-organized and committed PPP units	0.856	[0.00, 0.00, 0.00, 0.00, 0.00, 0.96, 0.04]	Very High	1st	1st
EF-31	In-time land acquisition	0.843	[0.00, 0.00, 0.00, 0.00, 0.04, 0.96, 0.00]	Very High	2nd	3rd
EF-30	Effective negotiation and financial closure	0.828	[0.00, 0.00, 0.00, 0.00, 0.15, 0.85, 0.00]	Very High	3rd	8th
EF-16	The existence of long-term demand for the proposed housing projects	0.816	[0.00, 0.00, 0.00, 0.00, 0.22, 0.78, 0.00]]	Very High	4th	9th

EF-24	Preparation of a tact contractual agreement	0.812	[0.00, 0.00, 0.00, 0.00, 0.25, 0.75, 0.00]	Very High	5th	12th
EF-23	Efficient use of advisory service	0.802	[0.00, 0.00, 0.00, 0.00, 0.32, 0.68, 0.00]	Very High	6th	16th
EF-22	Strengthening public sector capability	0.798	[0.00, 0.00, 0.00, 0.00, 0.35, 0.65, 0.00]	Very High	7th	18th
EF-26	Employing appropriate contractual clauses to manage macro risks	0.792	[0.00, 0.00, 0.00, 0.00, 0.39, 0.61, 0.00]	High	8th	21st
PC-3	**Adequacy of the country's political and economic environment for effective project execution**	**0.808**	**[0.00, 0.00, 0.00, 0.00, 0.28, 0.72, 0.00]**	**Very High**	**3rd**	
EF-10	Political stability	0.855	[0.00, 0.00, 0.00, 0.00, 0.00, 0.97, 0.03]	Very High	1st	2nd
EF-14	Realistic assessment of cost and revenue	0.802	[0.00, 0.00, 0.00, 0.00, 0.32, 0.68, 0.00]	Very High	2nd	16th
EF-4	Sound economic policy	0.798	[0.00, 0.00, 0.00, 0.00, 0.35, 0.65, 0.00]	Very High	3rd	19th
EF-9	Good governance	0.793	[0.00, 0.00, 0.00, 0.00, 0.38, 0.62, 0.00]	Very High	4th	20th
EF-3	Stable macro-economic condition	0.792	[0.00, 0.00, 0.00, 0.00, 0.39, 0.61, 0.00]	Very High	5th	22nd
PC-5	**Effective partnership with clearly defined roles**	**0.801**	**[0.00, 0.00, 0.00, 0.00, 0.33, 0.67, 0.00]**	**Very High**	**4th**	
EF-29	Clearly defined roles and responsibilities of parties	0.813	[0.00, 0.00, 0.00, 0.00, 0.25, 0.75, 0.00]	Very High	1st	11th

EF-18	Availability of strong and reliable private consortium	0.812	[0.00, 0.00, 0.00, 0.00, 0.25, 0.75, 0.00]	Very High	2nd	12th
EF-19	Government involvement by providing a guarantee and financial support	0.807	[0.00, 0.00, 0.00, 0.00, 0.29, 0.71, 0.00]	Very High	3rd	15th
EF-17	Availability of suitable and mature financial market	0.771	[0.00, 0.00, 0.00, 0.00, 0.65, 0.35, 0.00]	High	4th	25th
PC-4	**Right project selection with public and political acceptance**	**0.801**	**[0.00, 0.00, 0.00, 0.00, 0.33, 0.67, 0.00]**	**Very High**	**5th**	
EF-13	Right project identification and project technical feasibility	0.840	[0.00, 0.00, 0.00, 0.00, 0.07, 0.93, 0.00]	Very High	1st	4th
EF-11	Strong political support	0.832	[0.00, 0.00, 0.00, 0.00, 0.12, 0.88, 0.00]	Very High	2nd	7th
EF-15	The attractiveness of long-term cash flow to the lenders	0.791	[0.00, 0.00, 0.00, 0.00, 0.39, 0.61, 0.00]	Very High	3rd	23rd
EF-8	An efficient evaluation and approval process	0.775	[0.00, 0.00, 0.00, 0.00, 0.50, 0.50, 0.00]	Very High	4th	24th
EF-12	Encouraging community involvement and public acceptance	0.758	[0.00, 0.00, 0.00, 0.00, 0.61, 0.39, 0.00]	High	5th	27th
PC-6	**Standardizing housing PPP implementation models**	**0.759**	**[0.00, 0.00, 0.00, 0.00, 0.61, 0.39, 0.00]**	**High**	**6th**	
EF-27	Creation of model concession agreements	0.759	[0.00, 0.00, 0.00, 0.00, 0.61, 0.39, 0.00]	High	1st	26th

4.5.5 Discussion on the implications critical factors enabling successful housing PPP implementation in Ethiopia

This study has organized the factors that enable the successful implementation of PPP in Ethiopian housing provision into six clusters. These clusters were determined through an exploratory factor analysis, as discussed earlier in this chapter. The principal factors encompass the following: (1) robust risk allocation, procurement process, and PPP legal framework, (2) enhancing public sector capacity and strategic project execution, (3) adequacy of the country's political and economic environment for effective project implementation, (4) effective partnerships with clearly defined roles, (5) right project selection with public and political acceptance, and (6) standardizing housing PPP implementation models. The results are then thoroughly discussed and compared with the findings of past studies. All results discussed in this section are referred from Table 31.

4.5.5.1 Robust risk allocation, procurement process, and PPP legal framework

Based on the results of the exploratory factor analysis, the factor "Robust risk allocation, procurement process, and PPP legal framework" held an eigenvalue of 4.13, surpassing the Kaiser's criterion of 1. This eigenvalue accounts for 15.297% of the variance within the dataset. Subsequently, the outcome of the fuzzy synthetic evaluation ranked "Robust risk allocation, procurement process, and PPP legal framework" as the 1st ranked principal factor. It obtained an enabling index of 0.825, and according to the fuzzy analysis, this principal factor exhibited an importance level distribution of 17% high importance and 83% very high importance. This collective evidence underscores the "very high importance" of this factor in enabling the successful implementation of PPP within the Ethiopian housing sector.

Within this cluster, there are four critical factors, each with a factor loading value exceeding 0.5. This indicates a substantial contribution of the observed variables (factors) to the latent variable (principal factor). When the factor loading value approaches 1, it signifies a strong relationship between the factor and the principal factor Hair et al. (2010). The factors within the "Robust risk allocation, procurement process, and PPP legal framework" cluster, along with their associated factor loading, include: Appropriate risk identification and risk sharing (0.83), Favorable and efficient legal framework and PPP policy (0.69), Competitive procurement process (0.82), and Transparent procurement process (0.85). The upcoming section thoroughly discusses these factors and compare the finding with prior studies.

Appropriate risk identification and risk sharing

Appropriate risk identification and risk sharing is the 1st ranked factor in its grouping and secures the 5th place in the general ranking, with importance rating of 0.839 and rating membership distribution of 8% high and 92% very high importance, signifying an overall “very high importance” in enabling the successful application of the PPP in Ethiopian housing sector. Appropriate risk identification and risk sharing entail the identification of potential risks and the distribution of housing project-related risks among the public and private sector entities, allocating these risks to the party that possesses the optimal capabilities for managing them.

This finding aligns with the research undertaken by Kwofie et al. (2016a), which demonstrated that "Appropriate risk allocation" played a pivotal role in the success of PPP-based public housing delivery in Ghana. Additionally, the study by Muhammad et al. (2018) highlighted the significant of "appropriate risk allocation" in the execution of housing projects via PPP in Nigeria. This underscores the crucial nature of proper risk identification and allocation in ensuring the effective implementation of PPP within housing projects, a viewpoint that is similarly reflected in a range of other researches centering on infrastructure (Zhang 2005; Mahalingam 2010).

Favorable and efficient legal framework and PPP policy

Favorable and efficient legal framework and PPP policy is 2nd ranked factor in its group and holds overall ranking of 6th position with importance rating of 0.836 indicating 9% high and 91% very high importance of the factor. This finding is consistent with prior research that underscores the significance of efficient legal framework including: The laws, regulations and guidelines put in place (Chileshe et al. 2022); Action against errant developer (Abdul-Aziz and Jahn Kassim 2011); Predicable and reasonable legal framework (Zhang 2005), (Hai et al. 2022); Establishing effective PPP laws (Demeke Cherkos and Jha 2020); Effective conflict management (Liu et al. 2015).

A well-structured legal framework must encompass a detailed tendering process, tax regime to the private investor, contract awarding, and construction management procedures (IMF 2010). Moreover, the regulatory framework must clearly stipulate the mechanism and procedures for resolving disputes and litigations. In this respect, South Africa is one of the few developing countries with well-structured legal mechanisms for PPPs. This has helped them to attract both

local and foreign investors in their PPP market and also successfully implemented PPP projects (Osei-Kyei and Chan 2015).

Furthermore, various studies, including those conducted by (Babatunde et al. 2012 in Nigeria, (Ogunsanmi 2013), and Abdul-Aziz (2010) in Malaysia, underscore the pivotal role of sound economic policies in fostering successful housing public-private partnerships (PPPs). These policies contribute to market stability, economic growth, and enhanced confidence among private-sector participants, yielding favorable outcomes for project stakeholders. Additionally, Abdul-Aziz and Jahn Kassim (2011) emphasize the importance of a favorable and efficient legal framework in implementing public housing PPPs, particularly in Malaysia. They highlight the challenge of legal uncertainties in many developing countries, such as Sub-Saharan Africa, where government changes often result in disputes and terminations of contracts. To address this, a robust legal framework is crucial, providing protection and stability for all parties involved. This framework ensures continuity and progress even amidst government transitions, as highlighted in the study by (Kwofie et al. 2016b) in Ghana.

Competitive and transparent procurement process

Competition and transparency in procurement are key attributes that facilitate the selection of competent private partner in PPPs. Transparency in procurement involves the process of creating transparency during the bidding process and procurement phase. It involves evaluating the bids based on pre-determined criteria to select the most competent partner without bias and corruption. Whereas, competitive procurement process involves participating many private sectors for the bid and identifying the most competitive bid which would be capable of providing the required housing services at the optimal cost, time, and quality.

According to the result of the study, competitive procurement was positioned as the 3rd most influential element within its cluster and secured the 10th position across all the enabling factors. Its importance rating stood at 0.816, signifying a distribution of 23% for high importance and 77% for very high importance. Conversely, the transparent procurement process, with an importance rating of 0.807 (comprising 29% high importance and 71% very high importance), emerged as the 4th significant factor within its category and claimed the 14th rank overall. This underlines the "very high importance" of both factors in facilitating the effective implementation of the system. These conclusions align with the findings of Muhammad and Johar (2019), affirming the critical role of a "Competitive procurement

process" in contributing to the successful application of housing PPP. Furthermore, the significance of fostering both competitive and transparent procurement processes finds reinforcement in multiple studies (Hai et al. 2022; Kwofie et al. 2016b).

According to the study conducted in Nigeria, the identification of the most suitable, efficient and transparent procurement route that ensures value for money remains a step towards project success. The study further indicated that compromising the procurement process is a guarantee for failure (Ogunsanmi 2013). Despite the advantage of competitive procurement in the success of project, the public procurement in Ghana lacks competition and transparency. Indeed, projects are seen to be awarded to friends of the government in power who may not have qualified through effective competitive procurement process. resulting most of these projects to end up with poor quality. As a result, adopting fair, transparent and competitive procurement process can thus be seen as extremely important in the selection of competent contractors to ensure value for money in housing PPP projects (Kwofie et al. 2016b).

4.5.5.2 Enhancing public sector capacity and strategic projects execution

Based on the results of the exploratory factor analysis, the factor "Enhancing public sector capacity and strategic projects execution" displayed an eigenvalue of 4.884 accounting for 18.09% of the variance within the dataset. Subsequently, the outcome of the fuzzy synthetic evaluation ranked "Enhancing public sector capacity and strategic projects execution" as the second ranked principal factor. It obtained an enabling index of 0.819, having importance membership distribution of 21% high and 79% very high importance. The factors within the "Enhancing public sector capacity and strategic projects execution" cluster, along with their associated factor loading, include: Establishing well-organized and committed PPP units (0.56), in-time land acquisition (0.77), effective negotiation and financial closure (0.68), the existence of long-term demand for the proposed housing projects (0.67), preparation of a tact contractual agreement (0.722), efficient use of advisory service (0.79), strengthening public sector capability (0.6), and employing appropriate contractual clauses to manage macro risks (0.61).

Establishing well-organized and committed PPP units, Efficient use of advisory service, **and Strengthening public sector capability**

Establishing well-organized and committed PPP units, strengthening public sector capability, and Efficient use of advisory service are very related factors that focuses in enhancing the

capacity of the public sectors (contacting authority) in successfully identifying, developing, and monitoring housing PPPs. Such that, establishing well-organized and committed PPP units involves the establishment of a government organization that is structured in a way to support effective and efficient identification and development of PPP projects, and is committed to achieving the goals. The result of this study revealed that "Establishing well-organized and committed PPP units" is the top (1st) ranked factor both in its category and throughout the factors set, with importance rating of 0.856 signifying 96% very high and 4% extremely high importance in enabling the successful application of the system in housing sector.

The critical importance of this factors had justified in various research with diverse contextualization of how a well-organized of committed PPP unit can enable the successful implementation of the system, such that; Adequate knowledge and skills of PPP and A strong monitoring and evaluation system for project implementation (Debela 2022b), Effective project management (Mukhtar et al. 2017a), Strong and capable project team (Zhang 2005). Moreover this finding is consistent with the finding of (Mukhtar et al. 2017a), such that A dedicated team of professionals to oversee the PPP projects, Official and unofficial site visits and inspection, Undertaking checks and balance from the design stage to construction stage (Kavishe and Chileshe 2019) can result in a successful implementation of housing PPP, that can be achieved with a will-organized and committed PPP unit.

The critical significance of this factors has been substantiated through diverse research endeavors, each presenting unique contextual insights into how a well-organized and committed PPP units can effectively facilitate the implementation of the system. For instance, various studies have outlined the following aspects as contributing to success: possessing sufficient expertise and competencies in PPP, establishing a robust monitoring and evaluation mechanism for project execution (Debela 2022b), ensuring adept project management practices (Mukhtar et al. 2017a), and assembling a proficient and capable project team (Zhang 2005). Furthermore, these findings harmonize with the conclusions of (Mukhtar et al. 2017a), indicating that the presence of a committed team of professionals overseeing PPP projects, conducting both official and unofficial site visits and inspections, and maintaining checks and balances from the design to construction phases (Kavishe and Chileshe 2019) can conclude in the successful realization of housing PPP. Such achievement can be attained through the establishment of a well-organized and dedicated PPP unit.

Whereas, strengthening public sector capability focuses on empowering public organizations and PPP professionals with necessary knowledge that can facilitate successful PPP project identification, implementation, and management. And enabling sector organizations to identify and develop relevant projects of high social value that might otherwise not be visible to the central government. This effort may require institutional reform and training for staff members. This will also create the capability and experience to consider the dynamic macroeconomic environments when selecting proper procurement methods. According to this study "Strengthening public sector capability" is 7th critical factor in this category and 18th critical factor overall with importance rating of 0.798 (i.e. 35% high and 65% very high importance). The importance of having public sector capacity strengthening initiative is also apparent on the study by Mahalingam (2010).

Whereas, efficient use of advisory service involves making the most effective and productive use of advice or guidance provided by a professional advisor or consultant. It involves utilizing the advice provided in a way that optimizes the benefits gained while minimizing any costs or risks associated with implementing the advice. This is when the contracting authority do not have the necessary experience and competence to undertake the proposed PPP transaction by the available PPP units and staff. According to the result of this study "Efficient use of advisory service" is the 6th ranked factor in this category and the 16th. factor overall, with importance rating of 0.802 (i.e. 32% high, and 68% very importance). The importance of efficient utilization of advisory service in enabling successful application of road sector PPP in an emerging market had been confirmed by a case study based research conducted by Demeke Cherkos and Jha (2020).

In this regard, the studies by (Moskalyk 2011) highlighted the complexity that comes with implementing Public-Private Partnerships (PPPs) requiring a huge amount of preparation, training and experience, as well as good monitoring and management skills. Kavishe and Chileshe (2018) reinforced this point by citing the need for PPP training as a way of mitigating issues related to inadequate procurement skills, inexperienced private partners, the importance of having well-trained personnel to meet the challenge in a timely manner, and other similar concerns.

Accordingly, to strengthen public sector capacity to develop and implement PPPs, the central government of India has created a "PPP cell" in each state and the unit has been staffed with an administrative officer, and has created a panel of transaction advisors who have been

selected based on their experience and expertise in formulating and structuring PPP projects (Department of Economic Affairs 2008). This approach was taken to minimize the incapacity within the local governments in bidding out PPP projects. This allowed the government to eliminate a call for bids for the provision of consulting services, thereby greatly reducing the transaction costs involved in preparing PPP project reports (Mahalingam 2010).

Furthermore, project development through PPP arrangements necessitates specialized knowledge and expertise that usually do not exist inside the public sector, making it crucial for practices to be properly regulated and monitored. Therefore, establishing a central PPP unit, having strong support, and creating a link with a higher-level political authority will offer the opportunity to bring the necessary experience and resources from the government and external parties to form a well-organized and enabling environment for project development under a PPP route (Tserng et al. 2012).

In-time land acquisition

In-time land acquisition is the 2nd top ranked enable under the category of "Enhancing public sector capacity and strategic projects execution" and the 3rd ranked throughout the factors set with importance rating of 0.843 (i.e. 4% high, and 94% very high). This signifies that land acquisition process must be completed quickly to avoid delays or possible opposition during and after the housing PPP project implementation. This can minimize any potential delays or resistance due to unresolved ownership claims. The previous experience of Ethiopia in developing housing through Integrated Housing Development Program (IHDP) under condominium program had experience challenge and opposition related to land issue, in order to avoid this and successfully implement the system land issue must be resolved prior to project implementation.

This is because timely, transparent, and efficient acquisition boosts investor confidence, reduces uncertainties, and maintains project stability. It manages costs, gains public support, and enhances project viability, ensuring timely completion and legal compliance. In short, timely land acquisition is foundational for PPP housing success by reducing delays, enhancing trust, managing risks, securing public support, and maintaining project viability. The Timely acquisition of project right-of-way has been recognized as a pivotal element facilitating the effective implementation of PPP projects within the road sector of countries with emerging PPP markets (Demeke Cherkos and Jha 2020).

Effective negotiation and financial closure

According to this study “Effective negotiation and financial closure” holds the 3rd position under its category and 8th position overall with rating of 0.828 (i.e. 15% high and 85% very high importance). "Effective negotiation and financial closure" encompass two crucial aspects that are essential in strategic execution housing delivery through PPP (i.e. Effective negotiation and Financial closure).

Effective negotiation in housing sector PPPs entails adept discussions between public and private stakeholders to establish mutually beneficial terms, roles, and responsibilities governing the partnership. This involves defining project scope, risk allocation, rewards, timelines, and dispute resolution. Successful negotiation considers all parties' interests, fostering a balanced agreement that supports housing project viability. This criticality of the phenomenon aligns with the finding of Abdul-Aziz and Jahn Kassim (2011), which justified that the success of housing PPPs in Malaysia is heavily reliant on the "negotiation skills of the public agency." Because housing is a critical social facility in Ethiopia that impacts public interests, effective negotiation empowers the public agency to secure advantageous terms, establish clear responsibilities, allocate risks suitably, and achieve a harmonious partnership agreement. leading to well-structured projects that address housing needs efficiently and enhance the overall success of the partnership.

Moreover, financial closure involves securing and committing the necessary funding for the project. This entails finalizing financial arrangements, detailing contributions from both sectors, setting disbursement schedules, and ensuring funds for the project's entire duration. According to a study by Liu et al. (2015), “Efficient procedure for financial close” is among the life cycle critical success factors for PPP infrastructure projects. Allowing for smooth project execution and preventing disruptions.

The existence of long-term demand for the proposed housing projects

The existence of long-term demand for the proposed housing projects ranks 4th within the cluster, marking the 9th critical factor across the set of enablers, with an importance rating of 0.816 (comprising 22% high and 78% very high importance). This indicates that, in the context of utilizing PPPs for housing, sustained demand must persist throughout lengthy contractual periods. This is owing to the extended nature of PPP contracts, necessitating private investors to be assured of a continuous need for housing units.

For housing projects in Ethiopia, a significant demand for housing is evident. However, essential to this is the consideration of the project's development mix (i.e. the configuration of diverse housing units, ranging from affordable housing to market-rate options, or a blend of both). Thus, to ensure sustained demand for the proposed housing projects, the project's development mix must address to the accessibility of these units for the targeted group. Notably, studies by Ng et al. (2012) and Zhang (2005) underscore that the presence of long-term demand for services and products significantly influences PPP success during the feasibility stage.

Preparation of a tact contractual agreement and Employing appropriate contractual clauses to manage macro risks

Within the category of Enhancing public sector capacity and strategic project execution, there are two enabling factors that center around the efficiency of contractual agreements: Preparation of a tact contractual agreement and Employing appropriate contractual clauses to manage macro risks.

Preparation of a tact contractual agreement focuses on making contractual agreements specific, simply worded, unambiguous, and leaving no space for alternative interpretations of the intention of the respective clauses or provisions. It involves the process of making the terms, conditions, and provisions of a housing PPP agreement clearer and more understandable to all parties. This can minimize potential disputes and safeguards the interests of public and private parties as well as the end-users.

The result of this study positioned “Preparation of a tact contractual agreement” as the 5th most significant within its category and the 12th most crucial factor overall. It holds an importance rating of 0.812, reflecting a composition of 25% high and 75% very high importance. This finding corresponds with the findings of Hai et al. (2022), which indicated the pivotal role of "Clear and precise briefing documents" in the successful execution of PPP infrastructure projects in developing nations. Similarly, Chou and Pramudawardhani (2015) emphasized that the "Clarification of contract documents" stands as a critical success factor in PPP project implementation. Furthermore, the consequences of compromising such factors were revealed in a study by Kavishe et al. (2018), wherein "Poor contracting and tendering documents" emerged as a significant challenge during the implementation of housing PPP projects in Tanzania.

Whereas, “Employing appropriate contractual clauses to manage macro risks” involves the use of specific contractual terms and conditions to mitigate or manage macro-level risks that are outside of the control of the parties involved in a business transaction. This is because the extended duration of housing PPP contracts exposes projects to various risks stemming from changes in the country's political, legal, and economic conditions. As a result, the inclusion of contract clauses designed to manage macro-level risks becomes critically important. Consequently, the findings of this study position this factor at the 8th place within its category and the 21st place throughout the array of enabling factors, with a rating of 0.792 (indicating 39% high and 61% very high importance).

In this regard, a study by Mahalingam (2010) highlights the need for adaptable contract models in long-term PPP infrastructure projects that can be subject to external socio-economic and political forces. A suggested hierarchical contract model includes a renegotiation mechanism, allowing a panel to review specific clauses triggered by certain conditions. This approach offers flexible adaptation while considering local legal systems and social processes. Integrating this structure into contracts could enhance PPP project resilience and decrease risks tied to sole sector responsibility for unforeseen variables.

4.5.5.3 Adequacy of the country's political and economic environment for effective project execution

Based on the outcomes of the exploratory factor analysis, the principal factor titled "Adequacy of the political and economic environment for effective project execution within the country" exhibited an eigenvalue of 3.88, explaining 14.37% of the variability present in the dataset. Consequently, the fuzzy synthetic evaluation yielded the principal factor "Adequacy of the country's political and economic environment for effective project execution" as the third-ranking factor. It achieved an enabling index of 0.808, with an importance membership distribution of 28% indicating high importance and 72% indicating very high importance. The factors grouped under the "Adequacy of the country's political and economic environment for effective project execution" category, alongside their corresponding factor loadings, encompass: Political stability (0.82), Realistic assessment of cost and revenue (0.58), Sound economic policy (0.54), Good governance (0.76), and Stable macro-economic condition (0.82).

Political stability

Political stability holds the top rank within its category and secures the 2nd position among all enabling factors, with a rating of 0.855 (reflecting 97% very high and 3% extremely high importance). Political stability refers to the lack of political violence, sustained government duration, the presence of a legitimate constitutional system, and successful political power transfer between parties (Sottilotta 2013). When a country maintains a stable political environment, it creates a favorable atmosphere for long-term housing initiative. Political stability enhances investor confidence, encourages private sector participation, and reduces the uncertainty associated with changing political landscapes.

Moreover, a politically stable environment minimizes the risks of sudden policy shifts, or contract renegotiations that could negatively impact project continuity and financial viability and also fosters an environment conducive to attracting investment. This finding is consistent with various studied that confirmed the importance of stable political system in allowing for a smooth execution of PPP projects and investment attraction (Debela 2022b; Hai et al. 2022; Zhang 2005). Similarly, a comparative analysis of critical success factors in housing sector PPP between Malaysia and Nigeria identified political stability as a shared attribute in both countries signifying the criticality of the factor irrespective to the geographical jurisdiction (Muhammad and Johar 2019).

Realistic assessment of cost and revenue

The result of this study placed "Realistic assessment of cost and revenue" at the 2nd top position in its cluster and at 17th place overall, with rating of 0.802 (implying 32% high and 68% very high importance). This implies that a thorough and accurate evaluation of the project's costs and potential revenue streams is essential for establishing financial feasibility and attractiveness to both public and private stakeholders. This assessment aids in avoiding overoptimistic projections that could lead to financial shortfalls during project execution. By realistically evaluating costs and revenue, project parties can negotiate terms that are sustainable and aligned with market conditions, preventing future disputes or financial distress.

Moreover, a precise understanding of financial aspects enables effective risk management and strategic planning, ensuring the housing project remains on track and viable throughout its lifecycle. Accordingly, the significance of "Thorough and realistic assessment of the cost and benefits" in facilitating the successful implementation of PPP had revealed in studies conducted

in Indonesia(Chou and Pramudawardhani 2015a), Nigeria (Babatunde et al. 2012b), and China (Chan et al. 2010). More over Zhang (2005) identified that “Sound financial analysis” to be critical Success Factors for PPPs in infrastructure development by a study by conducted with experts from various countries.

Sound economic policy

According to the study's findings, "Sound economic policy" holds the 3rd position within its category and the 19th position overall in facilitating the successful implementation of PPP in Ethiopian housing provision. It received a rating of 0.798, indicating 35% high importance and 65% very high importance. An effective economic policy framework provides a stable and conducive environment for both public and private entities involved in housing projects. It ensures that regulations, incentives, and financial mechanisms align with project objectives, fostering investor confidence and attracting private investments.

In this context, a study conducted by Kwofie et al. (2016a) highlighted "sound economic policy" as a critical success factor in the delivery of PPP-based public housing in Ghana. The significance of sound economic policy in ensuring the successful implementation of PPP projects is evident across diverse infrastructure endeavors in various countries. Examples include the Ethiopian road sector (Debela 2022b) and infrastructure projects of Vietnam's (Hai et al. 2022), Malaysian (Ismail, 2013), Nigerian (Babatunde et al. 2012b), and (Chan et al. 2010). This underscores the substantial impact of sound economic policy regardless of project type or country. Furthermore, in PPP arrangements in housing development, involvement of foreign companies can introduce challenges related to currency convertibility. Here, a robust financial policy plays a pivotal role in attracting foreign investors and safeguarding the country's interests.

Furthermore, the studies of (Babatunde et al. 2012b) in Nigeria and (Ogunsanmi 2013), as well as Abdul-Aziz (2010) from Malaysia, conclude that sound economic policies are the key to promoting successful PPPs. Market stability and economic growth, yield positive results for stakeholders, making them highly desirable outcomes for those involved in these projects. Babatunde et al. (2012) and (Ogunsanmi 2013) have both asserted that sound economic policy can lead to reduced spending and increased confidence among private-sector entities regarding their investments in PPP agreements. Similarly, Li et al. (2005a) argued that a stable economic

climate leads to greater market certainty, reducing the risk for private firms when engaging in such contracts.

Good governance

The findings of this study position "Good governance" as the fourth-ranked factor within its category and the 20th ranked factor overall, contributing to the successful implementation of PPP in Ethiopian housing provision. It achieved a rating of 0.793, indicating 38% high importance and 62% very high importance. Good governance creates a framework for transparent and accountable governance ensuring efficient collaboration between the public and private sectors, fostering trust and credibility. Effective governance mechanisms streamline decision-making processes, reduce bureaucratic hurdles, and enhance project oversight. Furthermore, good governance minimizes corruption risks and ensures adherence to ethical standards, boosting investor confidence and attracting capital for housing projects.

The significance of good governance extends beyond the construction phase as it plays a pivotal role in ensuring the equitable distribution of housing units to eligible recipients, free from bias. This, in turn, influences the effective delivery of services and the acceptance of subsequent PPP housing initiatives. In developing nations, achieving good governance remains a significant challenge. Numerous studies assessing PPP implementation in various developing countries have consistently found that good governance is a pivotal factor in facilitating the successful adoption of this system. This trend is observed in countries such as Nigeria (Muhammad and Johar 2019), Malaysia (Ismail 2013a), and Hong Kong (Cheung et al. 2012a).

Stable macro-economic condition

The result of this study place Stable macro-economic condition at the last place in its cluster and at 22th place overall in enabling the successful application of the PPP in housing Ethiopian housing provision, having rating of 0.792 signifying 39% high and 61% very high importance.

A stable macro-economic condition entails a balanced, consistent, and predictable state of key economic indicators such as inflation, interest rates, and currency exchange rates over a substantial time frame. This stability offers the private sector the confidence to make well-informed decisions, invest securely, and strategize for the future. It encompasses price stability, manageable inflation rates, and predictable currency exchange risks. Given the extended duration of PPP contracts, which require substantial time for investment returns, a steady and reliable macroeconomic environment becomes pivotal.

Given the substantial inflation within the Ethiopian economy, this factor holds paramount importance, as indicated by the result the study. Despite the challenges of managing inflation, the government must offer compatible guarantees or capital support to incentivize private investment. Multiple studies in developing nations reaffirm the significance of this factor (Chan et al. 2010; Chou and Pramudawardhani 2015b; Debela 2022; Osei-Kyei and Chan 2017a). Moreover, Kwofie et al. (2016a) underscored the critical role of a stable macro-economic condition in their study on PPP-based public housing delivery in Ghana.

4.5.5.4 Effective partnership with clearly defined roles

Based on the outcomes of the exploratory factor analysis, the factor termed "Effective partnership with well-defined roles" exhibited an eigenvalue of 2.0507, accounting for 9.28% of the variability present in the dataset. Subsequently, as a result of the fuzzy synthetic evaluation, the principal factor "Effective partnership with clearly defined roles" was ranked fourth. It achieved an enabling index of 0.801, with an importance membership distribution of 32.9% indicating high importance and 67.4% indicating very high importance. The factors grouped under the "Effective partnership with clearly defined roles" category, along with their corresponding factor loadings, encompass: Clearly defined roles and responsibilities of parties (0.85), Availability of a strong and dependable private consortium (0.78), Government involvement through guarantees and financial support (0.54), and the presence of a suitable and well-established financial market (0.68).

Clearly defined roles and responsibilities of parties

According to the study's findings, "Clearly defined roles and responsibilities of parties" emerged as the top most crucial factor within its category and ranked 11^{th} among all enablers, with importance rating of 0.813, comprising 25% high and 75% very high importance. This factor establishes a structured framework that outlines the distinct roles, tasks, and obligations of each involved entity. Clarity in responsibilities streamlines decision-making, reduces conflicts, and fosters efficient collaboration. With well-defined roles, public and private partners understand their contributions and commitments, facilitating effective resource allocation and risk management.

Moreover, clear demarcation prevents overlaps and gaps, ensuring accountability and smooth project progression. This clarity builds trust, mitigates misunderstandings, and promotes alignment towards common goals. This assertion is supported by Chou and Pramudawardhani

(2015), which ranked "Clear defined responsibilities and roles" as the fourth most important factor for enabling PPP implementation in Indonesia. Furthermore, another study by Chan et al. 2010) highlighted that "Shared authority between public and private sectors" is the pivotal factor contributing to the success of PPP implementation in China.

Availability of strong and reliable private consortium

The "availability of a strong and reliable private consortium" refers to the presence of a private partner possessing the essential technical, technological, and managerial expertise, along with experience and financial capabilities. This factor plays a vital role in contributing to the proposed housing project and ensuring its successful realization.

The result of the study positioned the "Availability of strong and reliable private consortium" as the 2nd most significant factor within its category and the 11th most important enabler across all factors. It garnered an importance rating of 0.812, with a notable composition of 25.2% indicating high importance and 74.8% indicating very high importance. According to Muhammad and Johar (2019), the competence of the private partner is ranked as the fourth critical factor contributing to the success of housing PPP projects in Nigeria. Similarly, the "reputable developer" factor stands as the fourth important element enabling successful PPP in Malaysian housing projects (Abdul-Aziz and Jahn Kassim 2011). This pattern also holds true in other developing countries across various sectors (Mukhtar et al. 2017b; Ng et al. 2012).

Government involvement by providing a guarantee and financial support

The result of the study placed "Government involvement by providing a guarantee and financial support" at the 3rd most critical factor within its category and the 15th among all driving factors. It attained an importance rating of 0.807, with 29% indicating high importance and 71% indicating very high importance. The government guarantee and financial support in projects that are not financially attractive to the private partner but have high social values is very essential. It involves the provision of viability gap funding and the provision of a guarantee by the government to secure funding from private partners.

As stated by Babatunde et al. (2012), housing projects are less conducive to PPP execution in Nigeria as compared to other PPP infrastructures due to challenges in achieving financial viability. This issue is linked with the affordability criteria prevalent in most housing projects within developing nations. This necessitates government intervention through mechanisms like

viability gap funding or upfront grants to attract private investment and improve affordability for the intended beneficiaries.

Consequently, the provision of government guarantees to secure private partner funding in PPPs becomes pivotal for housing project success (Abdul-Aziz and Jahn Kassim 2011). Ismail (2013) and Olusola Babatunde et al. (2012) also highlight that housing PPP projects in Malaysia and Nigeria, respectively, often involve substantial funding requirements that private partners may lack the financial capacity to cover directly. Recognizing this, government involvement by providing guarantees for housing development emerges as the foremost critical factor for successful implementation in Ghana, as indicated by (Kwofie et al. 2016a)**.**

Availability of suitable and mature financial market

The result of the study placed "Availability of suitable and mature financial market" as the 4th critical factor within its category and the 25th among overall enabling factors. It obtained an importance rating of 0.771, with a notable distribution of 65% high and 35% very high importance. A well-developed financial market provides a robust platform for securing necessary funds and investment for housing projects. This includes channels for raising capital, accessing loans, and issuing bonds, ensuring a stable source of funding over the project's lifecycle. Since one of the objectives of PPP implementation is to reduce the financial burden of the government, with the private sector financing the PPP projects, the availability of flexible and attractive financial instruments, such as debt, equity, supplier and purchaser credit, and securities, is considered important to enable the private sector to finance the PPP projects (Zhang 2005).

According to the study by Mukhtar et al. (2017), the significance of an "effective housing finance system" is emphasized as a critical factor in the successful execution of housing project development in Nigeria. Additionally, a study by Chileshe et al. (2022) positioned "the availability of a financial market" as the 4th critical element in Kenyan housing delivery via PPP. The necessity of a mature financial market is underscored due to the predominant practice of distributing housing projects to the public through mortgage arrangements.

4.5.5.5 Right project selection with public and political acceptance

According to the findings from the exploratory factor analysis, the factor labeled "Right project selection with public and political acceptance" exhibited an eigenvalue of 3.162, explaining 11.71% of the variability within the dataset. Following this, the results of the fuzzy synthetic

evaluation ranked the factor "Right project selection with public and political acceptance" as the fifth most significant principal factor. It achieved an enabling index of 0.801, with an importance membership distribution indicating 32.9% for high importance and 67.1% for very high importance.

The factors encompassed in the "Right project selection with public and political acceptance" category, together with their corresponding factor loadings, include: Identifying the right project and ensuring its technical feasibility (0.66), securing strong political backing (0.66), appealing to lenders through promising long-term cash flow (0.53), expediting evaluation and approval processes effectively (0.62), and fostering community engagement and public endorsement (0.82).

Right project identification and project technical feasibility

Right project identification and project technical feasibility holds the 1st position within its group and ranks 4th among enabling factors, with a rating of 0.840, signifying 7% high importance and 93% very high importance. According to Bamfo-Agyei et al. (2011), the significance of this aspect in PPP housing projects in Malaysia is underscored in achieving project objectives and the project's ability to meet debt obligations. Conversely, in Ghana, the absence of proper project identification and technical feasibility led to affordable housing projects not being truly affordable for the intended beneficiaries (Bamfo-Agyei et al. 2011). The relevance of accurate project identification and technical feasibility lies in stakeholders engaging in a robust process such as value engineering. This process helps assess project needs, objectives, and involves potential beneficiaries, resulting in a comprehensive understanding of scope and cost during housing project implementation (Kwofie et al. 2016b).

Similarly, Ng et al. (2012) emphasized the direct contribution of the initial feasibility assessment of a PPP project to its overall success. Consequently, evaluating the project's technical, economic, social, and environmental dimensions becomes imperative to ascertain its viability across these aspects. The selection process favors projects with elevated social value, addressing the housing needs of the public. This selection process also involves ensuring project alignment with national and sectoral objectives and policies. This alignment is further supported by Kwofie et al. (2016a), who highlighted the pivotal role of "Right project identification and project technical feasibility" in successful housing PPP implementation in Ghana. Furthermore, the importance of "project technical feasibility" in the successful

application of PPP is evident in China (Chan et al., 2010) and Hong Kong (Cheung et al., 2012b).

Strong political support

"Strong political support" is ranked 2nd in the group and 7th among the overall set of enablers, with rating of 0.832 indicating 12% high, 88% very high importance. Strong political support for PPPs can assure investors while decreasing the associated risks and further encourages those interested in PPP projects by increasing perceived attractiveness (Ke et al. 2011). Unfortunately, developing countries often experience intense political opposition to initiated PPP projects due to allegations of corruption and lack of transparency. This can make the success of these projects difficult to achieve (Demuijnck and Ngnodjom 2011).

In this regard, ensuring private sector investments requires governments in developing countries to use the proper measures and strategies to gain support from opposition parties for their PPP projects. This not only prevents unnecessary abrogation of contracts by subsequent governments but also creates a more favorable atmosphere for the successful implementation of these projects (Osei-Kyei and Chan 2017c). Given the critical importance and high demand for housing facilities in Ethiopia, any endeavor aimed at housing development through PPP must secure essential political acceptance to ensure successful implementation. This is reinforced by the research conducted by Mukhtar et al. (2017), which underscored the significance of "Adequate political support" in the effective implementation of PPP for housing provision in Nigeria.

The attractiveness of long-term cash flow to the lenders

"The attractiveness of long-term cash flow to the lenders " secured the 3rd position within its category and ranked 23rd among the overarching set of enablers, achieving a rating of 0.791, signifying 39% high importance and 61% very high importance. Due to the prolonged duration of housing PPP arrangements, private partners require an extended period to recoup their investment expenses. Thus, projects should yield sustained profits over the contract's duration, attracting private investors to allocate funds in exchange for a portion of the earnings. Ensuring the attractiveness of long-term cash flow to lenders is established during the project identification phase. Selecting projects with appealing cash flow becomes feasible with accurate project identification. Additionally, if a project's cash flow lacks attractiveness,

essential government guarantees and capital support can be arranged before project implementation.

This factor has limited importance for housing projects, primarily due to their relatively lower financial attractiveness when compared to other types of projects. As a result, the main focus shifts towards securing government guarantees for cost recovery and ensuring a minimum off-take. (MOHUA 2017). However, across the broader spectrum of PPP implementation, multiple studies emphasize the importance of factors such as long term cash flow to lenders and private investors Sufficient profitability of the project to attract investors (Hai et al. 2022), Cost effectiveness and financial attractiveness and Project is of financial interest to private sector (Ng et al. 2012). Furthermore, Sufficient profitability of the project to attract investor and Long-term cash flow that is attractive to lenders (Zhang 2005).

An efficient evaluation and approval process

"The effectiveness of the evaluation and approval procedure" holds the 4th position within its category and ranks 24th among the complete set of enabling factors, receiving a rating of 0.775, wherein 49.9% signifies high importance and 50.1% represents very high importance. The list rank of this factor is consistent with other researches on housing PPP, where this factor is not in their top five lists (Kavishe and Chileshe 2019; Kwofie et al. 2016b; Mukhtar et al. 2017b).

For successful housing PPP projects, effective evaluation and approval of proposals are imperative. This involves comprehensive reviews of proposals, thorough assessment of project feasibility, and proper allocation of funds. This collectively constitutes an efficient evaluation and approval process that fosters confidence in private partners, assuring them of fair consideration for their bids. This process ensures rigorous assessment and quick approval of projects, facilitating the timely commencement of critical housing initiatives. By streamlining the evaluation process, delays and uncertainties are minimized, making project approval more transparent and quicker. Bureaucratic obstacles are reduced, enhancing transparency and bolstering investor confidence, as partners can expect timely project initiation.

Encouraging community involvement and public acceptance

“Encouraging community involvement and public acceptance" holds the last position within its category and stands as the least critical (27th) among the overall critical factors that facilitate the successful implementation of housing PPP. It is rated at 0.758, with 61% representing high and 39% signifying very high importance. The global PPP experience indicates that PPP

projects are often at risk from community mobilization against the project. Community involvement in PPP projects ensures inclusivity, participation, and a lack of opposition to the project, therefore, contributing to the success of the PPP project by creating an enabling environment to minimize the opposition that projects might face over their lifecycle (Mahalingam 2010).

According to El-gohary et al. (2006), stakeholders' opposition has been recognized as the leading cause of PPP project failures. In this regard, projects have the potential to be more successful when obtain community acceptance with proactive measures like awareness programs before implementation. In addition, engaging and welcoming community involvement from the start including conceptualization, implementation, and sustainability phases and giving them a seat at the decision table would go a long way towards earning the trust and support of those affected. Furthermore, local leaders could be recruited to act as representatives for project initiatives, ensuring their primary interest is always in that of the wider community (Chileshe et al. 2022). Likewise Osei-Kyei and Chan (2015), also highlight the importance of public support for PPPs to be successful in the long run. Considering the criticality of housing issue in Ethiopia without understanding and acceptance from the general public, media outlets, trade unions, civil societies, and non-governmental organizations, the progress of housing PPPs is highly improbable. Therefore, increased public awareness can help accomplish this goal.

4.5.5.6 Standardizing housing PPP implementation models

According to the result of the factor analysis "Standardizing housing PPP implementation models" constitutes the 6th cluster with an eigenvalue of 1.573 explaining 5.827% of variance in the data. This principal factor revolves solely around "Creation of model concession agreements." This factor is ranked 26th among the collection of critical enabling factors, with an enabling index of 0.756, indicating 61% high importance and 39% very high importance of the factor in enabling the successful application of the housing PPP.

Given the array of diverse PPP models designed to align with evolving project attributes and stakeholder preferences, it becomes crucial to select a model that best aligns with project goals and characteristics (Cherkos et al. 2020b). This necessity often triggers the requirement to customize these models to better suit the specific project attributes and stakeholder preferences. Considering Ethiopia's limited experience with housing PPPs and the intricate nature of such

projects, standardizing PPP agreements that offer transparency and clarity to all stakeholders can substantially enhance the prospects for project financing.

By having readily available templates, private investors can gain insights into the expectations of the public sector, leading to more confident participation in PPP agreements and reduced concerns about potential mistrust. This approach also fosters greater confidence in public sector personnel to engage in PPPs, thereby alleviating concerns related to political will (Mahalingam 2010). Moreover, using standardize model can facilitate successful implementation of the PPP and bridge the experience gap (Cherkos et al. 2020b).

On the other hand, standardizing contracts emerges as a cost-efficient and effective approach to PPP procurement. This method benefits governments with limited PPP experience and capabilities by incorporating adaptable mechanisms within contract frameworks, simplifying the procurement process. Standardized procurement is especially well-suited for multiple projects sharing similar characteristics. However, as PPP practices have evolved worldwide, several government bodies have taken notable steps to enhance the manageability of PPP procurement. They have achieved this through the formulation of standardized components for PPP contract design, delineating terms and conditions for granting permits to private entities. Multiple nations, including Australia, India, New Zealand, the Philippines, South Africa, and the United Kingdom, have streamlined PPP bidding by adopting standardized documents for infrastructure project execution across various PPP models (World Bank 2017). In this context, this research tried to explore standardized models for housing PPPs that align with the requirements driving the adoption of PPPs in Ethiopian housing provision.

4.6 Identification of PPP model selection factors for housing projects and an investigation of the influence between the factors

4.6.1 Identification of PPP model selection factors for housing projects

This section presents the results of two distinct phases of the study undertaken to identify housing PPP selection factors and an exploration of the relationship between these factors. First, the section presents the result of the content validation process, which was conducted to identify the relevant PPP model selection factors for housing projects. These factors were initially identified through a systematic literature review. It then delves into a comprehensive discussion of these factors and compares the findings with existing research in the field.

Furthermore, it presents and discusses the result of Interpretive Structural Modelling (ISM). This process was carried out to explore the intricate interactions among the model selection factors, with the primary objective of facilitating the decision-making process in PPP model selection for housing projects. This section also presents and discusses the results of the MICMAC analysis. This approach was employed to categorize the model selection factors into four distinct clusters, based on their driving and dependence powers.

Identification of the initial list of model selection factors (criteria)

The factors influencing the selection of PPP models were first identified through a systematic literature review. The result of the systematic literature review is summarized and presented in Table 5 in Chapter Two. This comprehensive review encompassed several key aspects, including PPP success criteria, PPP model selection criteria, factors affecting the success of housing projects, critical success factors for PPP implementation in housing projects, and elements that attract private sector investment in PPP initiatives. This extensive review aimed to identify the factors that consider the unique characteristics of housing projects, the preferences of stakeholders (including the public sector, private sector, and end-users), and the adequacy of the local condition to the PPP arrangement. Furthermore, the review considered factors that contribute to the successful implementation of PPP arrangements in the housing sector. In addition to prior research, two PPP user manuals from the World Bank and India were utilized to develop an initial list of model selection factors. This initial list underwent a process of content validation to evaluate its relevance within the context of housing projects and the specific PPP initiatives of Ethiopia.

Content validation: refining the model selection factors

The relevance of the model selection factors identified through a systematic literature review for addressing the specific requirements of the housing project within the context of the Ethiopian initiative needs to be assessed before proceeding with the ISM. Content validation is an appropriate method for evaluating the relevance of these factors within this context (Almanasreh et al. 2018; Beckstead 2009; Polit et al. 2007; Polit and Beck 2006; Yusoff 2019).

Accordingly, to compute the CVI, the responses gathered from chosen experts were transformed into binary values: ratings 1 and 2 were recorded as 0, while ratings 3 and 4 were recorded as 1. The instances of “1” were tallied as the number of agreements. CVI was computed for each item using the following equations (Yusoff 2019). Table 32 presents the

complete process of refining the model selection factors. To illustrate the CVI calculation process, a sample calculation is done for the factor "Access to private-sector capital to finance the project." Among the nine experts, two experts rated this factor as "quite relevant," while seven experts rated it as "highly relevant." Since all experts deemed this factor relevant, a binary value of 1 was assigned to all their responses. Consequently, the expert agreement value, determined by counting all relevant ratings (1), was 9. This resulted in an item-level content validation index of 1. As this value exceeds 0.78, the factor was validated as relevant (Lynn 1986; Polit and Beck 2006).

Expert in agreement = The sum of relevant rating provided by all experts for each item = 9

$$Item\ level\ Content\ Validity\ Index = \frac{\text{Experts in agreement}}{\text{Number of experts}} = \frac{9}{9} = 1 \geq 0.78, \quad validated$$

Table 5 summarizes the results of the content validation process. The findings indicate that out of the 30 PPP model selection factors identified through a systematic literature review, the experts have validated 25 of these factors as relevant to the housing project within the context of Ethiopia's initiative. These factors exhibit an item-level content validity index equal to or greater than 0.78, as per the criteria established by Lynn (1986; Polit and Beck (2006). However, there are five factors that did not meet this threshold, including: Availability and form of state subsidy, political support for the project, availability of mature financial institution/market, environmental sustainability, and benefits of local economic development. These factors have an item-level content validity index of less than 0.78, indicating their limited relevance. Consequently, these factors are excluded from the list that undergone in to interpretive structural modeling.

Table 36. Result of the content validation

No	PPP model selection factors	Experts									Expert in agreement	I-CVI
		1	2	3	4	5	6	7	8	9		
1	Access to private-sector capital to finance the project	1	1	1	1	1	1	1	1	1	9	1
2	Utilization of skills and expertise of the private sector and stimulation of innovation	1	1	1	1	1	1	1	1	1	9	1
3	Improved housing project/service quality	0	1	1	1	1	1	1	1	1	8	0.89
4	Facilitating technology transfer	1	0	1	1	1	1	1	1	1	8	0.89

5	Early project completion/delivery	1	1	0	1	1	1	1	1	1	8	0.89
6	Lowering construction, operation, and maintenance cost	1	0	1	1	1	0	1	1	1	7	0.78
7	Reduction in public sector administration cost	0	1	1	1	1	0	1	1	1	7	0.78
8	Government preference to transfer maintenance risks	1	1	1	0	1	1	0	1	1	7	0.78
9	Government preference to transfer operation and maintenance risk in an integrated way	1	1	0	1	1	1	1	0	1	7	0.78
10	Private sector off-take and cost recovery risk-taking preference	1	1	1	0	1	1	1	1	1	8	0.89
11	Private sector interest in maintenance risk	1	1	1	0	1	1	1	1	1	8	0.89
12	Acceptability to the interest group and general public	1	1	1	1	1	1	0	1	1	8	0.89
13	Ownership arrangement for the house units	1	1	1	1	1	1	1	1	1	9	1
14	Alignment of the option with the objective of housing sector policy	1	1	1	1	1	1	1	1	1	9	1
15	Affordability (acceptability of rent or purchase price)	1	0	1	1	1	1	1	0	1	7	0.78
16	Public sector capital support and provision of guarantee	1	0	1	1	1	1	1	1	1	8	0.89
17	Availability and form of state subsidy	0	1	1	0	1	1	1	0	0	5	0.56
18	Adequacy of the political, legal, and institutional framework of the country to the contractual and organizational arrangements required to rule the project	1	1	1	1	1	1	1	1	1	9	1
19	Public sector financial capacity	1	1	1	1	1	0	1	1	1	8	0.89
20	Macroeconomic certainty	0	1	1	1	1	1	1	1	0	7	0.78
21	Political support for the project	0	0	0	1	1	1	1	0	1	5	0.56
22	Availability and source of developable land	1	1	1	1	1	0	1	1	1	8	0.89
23	Availability of potential private sector	1	1	1	1	1	1	1	0	1	8	0.89
24	Availability of mature financial institution/market	0	0	1	0	0	1	1	1	0	4	0.44
25	Project commercial viability	1	1	1	0	1	1	1	1	1	8	0.89
26	Project financial viability	0	1	1	1	1	0	1	1	1	8	0.89
27	Project technical feasibility	0	0	1	1	1	1	1	1	1	7	0.78
28	Development mix of the proposed housing project	1	1	1	1	0	1	1	1	1	8	0.89
29	Environmental sustainability	0	0	0	1	1	1	0	1	0	4	0.44
30	Benefits of local economic development	1	1	0	0	1	1	0	1	1	6	0.67

Before proceeding directly into the development of the ISM to investigate the interaction between the model selection factors, it is important to discuss these factors and compare them with the findings of previous studies. This facilitates a better understanding of the interaction between these factors. Accordingly, the model selection factors were clustered into three categories and were discussed under their respective categories facilitating further clarity, the cluster includes stakeholders' preferences, project characteristics, and the adequacy of the country's environment and public sector capability to cope with the contractual arrangement.

4.6.1.1 Stakeholder's preference related factors

In a PPP arrangement, there are three key stakeholders: the public sector, private sector, and end-users. Within the context of PPP arrangements, there can be divergent interests among each of these stakeholders. Consequently, the chosen models for such partnerships should aim to align with and address the interests of all parties involved (Xie and Thomas Ng 2013). This study grouped15 identified housing sector PPP model selection factors under this cluster.

One of the factors considered relevant in selecting a suitable PPP model for a housing initiative is "access to private sector capital to finance the projects". This factor considers the government's interest in utilizing private capital to finance housing projects, which may be driven by budget limitations within the public sector. Moreover, the utilization of private sector capital to finance public projects enables the government to free up the public budget that would have otherwise been tied up in capital investment (Gebremeskel et al. 2021b; Numminen 2022). The government can allocate its limited financial resources to other critical areas of economic development programs by relying on private funding sources (Cherkos and Jha 2021a).

This factor has been recognized as a crucial element in the implementation of PPPs in various contexts. According to Abdul-Aziz and Jahn Kassim (2011), "obtaining capital for development" emerged as a significant success factor for housing PPPs in Malaysia. Similarly, in a study by Zhang (2006), "Reducing the size of public borrowing via off-balance-sheet financing" was identified as a key success factor for PPPs in infrastructure projects. This underscores the importance of exploring options that facilitate private finance access for housing development projects depending on the objective behind the adoption of the system in the country, thereby contributing significantly to the successful execution of the PPP

framework. Furthermore, this finding aligns with the findings of a study conducted by Xie and Thomas Ng (2013), which corroborated that “Reducing public off-balance budget” is a critical criterion in evaluating the PPP model.

Under the category of stakeholder’s preference “utilization of skills and expertise of the private sector and stimulation of innovation” is one of the key factors identified to be relevant to model selection in housing delivery through PPP arrangement. This factor recognizes the value of involving the private sector's specialized skills and innovative approaches. This criterion ensures that the chosen PPP model utilizes the private sector's competence to deliver housing projects efficiently, cost-effectively, and with innovative solutions that may not be readily available within the public sector. It emphasizes the collaborative advantage of PPPs in harnessing the private sector's expertise to enhance the overall success and quality of housing projects. The significance of this factor has been recognized through various research studies, each offering unique insights into its critical role in facilitating the successful execution of PPP arrangements. Notable research findings include Abdul-Aziz and Jahn Kassim (2011), which emphasized the importance of innovation in design. Additionally, Zhang (2006) highlighted the utilization of private managerial skills and technologies as a crucial element. Technical innovation was underscored by Babatunde et al. (2016), and the pursuit of sound and cost-effective technical solutions was highlighted in Zhang (2005). Together, these studies highlight the broad nature of this factor and its significant impact on the execution of different PPP initiatives.

“Facilitating technology transfer” is factor that evaluates the partnership's capacity to transfer cutting-edge technologies and expertise from the private sector to the public sector and, to local contractors, particularly when the private partner is a foreign company. This transfer ultimately improves the quality and efficiency of housing projects while concurrently fostering local capacity development and economic growth. Previous studies have established the significance of technology transfer, highlighting it as a crucial factor contributing to success (Ahadzie et al. 2008; Osei-Kyei and Chan 2017c). This emphasizes the necessity of taking technology transfer into account when choosing a PPP model for housing projects.

“Improved housing project/service quality” focuses on achieving higher standards and enhanced overall quality in the project's delivery and outcomes. By prioritizing improved project quality, the selection process aims to ensure that the selected PPP model will result in housing infrastructure that meets the community's expectations and needs. Several studies

support this finding. For instance, a study conducted by Xie and Thomas Ng (2013) confirmed that “service quality” is a crucial factor in determining the choice of PPP type in PPP projects. Similarly, Ahadzie et al. (2008) highlighted the critical significance of the “Quality of individual house-units” for the success of mass house building projects in developing countries.

“Lowering construction, operation, and maintenance costs” refers to the specific consideration given to reducing the expenses associated with the construction, ongoing operation, and long-term maintenance of the housing infrastructure. This criterion emphasizes the importance of selecting a PPP model that offers cost-effective solutions throughout the project lifecycle. It involves seeking a PPP model that can demonstrate strategies to minimize construction costs, optimize operational efficiency, and implement sustainable maintenance practices. Numerous research studies have consistently underscored the significance of various factors in distinct aspects. For instance, Xie and Thomas Ng (2013) highlight that low construction, operational, and maintenance costs play a pivotal role in the selection of a Public-Private Partnership (PPP) model across various sectors. This underscores the importance of minimizing project expenses in housing PPP projects, akin to other sectors.

Additionally, Ng et al. (2012) emphasize the critical role of cost effectiveness when compared to conventional project delivery methods. Cost effectiveness and financial attractiveness are identified as key factors influencing the success of PPP projects during the feasibility stage. Furthermore, Ahadzie et al. (2008) underscored on the essential nature of reducing overall project costs as a critical success criterion for mass housing projects in developing countries. All these findings collectively signify the importance of considering PPP option that minimizes project associated costs.

“Reduction in public sector administration cost” considers to the private sector taking on administrative responsibilities that would otherwise be handled by the government. Additionally, by transferring multiple responsibilities to the private party simultaneously, the government can lower administrative costs across various phases of the project. This shift can lead to cost savings, allowing the government to allocate resources more efficiently for other essential services or projects. This factor holds significant importance as it serves as a driving factor for the adoption of Public-PPP across diverse sectors and countries. For example, it has played a crucial role in the adoption of PPP in the Ethiopian economy (Gebremeskel et al. 2021b), the development of Malaysian infrastructure (Ismail 2014), and the enhancement of China's transport sector (Yuan et al. 2010). Consequently, when selecting a model for PPP

implementation, careful consideration of this factor is imperative to ensure alignment with the objectives driving the adoption of this collaborative arrangement.

“Early project completion/delivery” focuses on achieving the timely completion and delivery of the housing project. This factor emphasizes the importance of selecting a PPP model to accelerate project development and minimize delays. This factor is identified as the primary determinant in choosing a PPP model for any PPP arrangement, as highlighted by Xie and Thomas (Ng 2013). Additionally, other studies by Abdul-Aziz and Jahn Kassim (2011), as well as Zhang (2006), have confirmed the significance of early project completion and timely delivery of products or services for the successful implementation of PPP initiatives. Consequently, it is essential to choose for an approach that enables expedited project delivery.

There are two key factors within the stakeholder preference category that relate to the government's preference to shift post-construction risks. These factors encompass “the government preference to transfer maintenance risks” and “the government preference to transfer operation and maintenance risks in an integrated way”. Government preference to transfer maintenance risks considers the government's intent to shift the responsibility for housing maintenance to the private sector, which offers several advantages. Private entities typically excel in infrastructure management, leading to improved maintenance outcomes and cost control over the long term. This approach enhances budget predictability by replacing unpredictable expenses with known maintenance costs (Liu and Wilkinson 2011c). Additionally, when the private sector takes on maintenance risks, they are motivated to construct high-quality housing units to avoid frequent maintenance expenses. This preference not only drives cost savings but also ensures better maintenance and utilization of private sector expertise, ultimately resulting in improved housing outcomes (Numminen 2022). This finding aligns with the findings of Xie and Thomas Ng (2013), which identified “risk transfer” as a key factor influencing the choice of PPP type for a project. This underscores the importance of factoring in preferences for risk transfer, especially in relation to maintenance, when selecting a PPP model for housing projects.

Whereas, government preference to transfer operation and maintenance risk in an integrated way considers the government's preference toward a comprehensive and integrated approach to transferring the responsibility of operating, maintaining, and assuming risks associated with operation and maintenance to the private sector. This preference is intended to utilize the capital and expertise of the private sector, control costs effectively, establish accountability for

performance, and foster long-term sustainability in housing projects. In a study conducted by Cherkos et al. (2020), it was determined that one of the key criteria for choosing the PPP model in the road sector is “government preference to transfer operation and maintenance risk in an integrated way.” This underscores the relevance of this factor across various sectors.

The government's sole preference for transferring post-construction risks does not ensure the successful transfer of these risks. It is equally important to consider the private sector's preferences. Consequently, this study has identified two factors that consider the private sector's preferences regarding these risks: “The private sector's interest in maintenance risk” and “Private sector preference for off-take and cost recovery risk-taking.” The first factor considers the private sector’s clear willingness (interest) and capability to bear and effectively manage the cost and risks associated with ongoing maintenance, repairs, and upkeep of the housing project throughout the contract period. According to a study by Cherkos et al. (2020), The private sector's interest in maintenance risk is one of the key factors influencing the choice of PPP modality in the road sector. This underscores the significance of considering the private sector's willingness to assume maintenance risks across all sectors. The subsequent section further studies the factors influencing such preference and the outcomes of this interest, utilizing the ISM model.

The second factor to consider regarding the private sector's inclination toward risk-taking is “the private sector off-take and cost recovery risk-taking preference.” In a PPP arrangement, the private entity may assume the responsibility for both end-users off-take and revenue collection to recoup its investment costs. This entails bearing associated risks, including the possibility of missed or delayed payments and non-sale risks. To transfer this responsibility effectively, the private sector must have the capacity and willingness to retain these associated risks In 2017, India's Ministry of Housing and Urban Affairs (MOHUA 2017) and the World Bank (2020) independently developed standardized models for PPP in affordable housing delivery. Within these models, there are models where the private sector is tasked with bearing the risks tied to demand and cost recovery. Hence, it is crucial to factor in the private sector's preferences regarding these risks when choosing such models.

“Affordability (acceptability of rent or purchase price)” refers to the reasonable and acceptability of the rent or purchase price for the public, ensuring that it is reasonable and within the mean of the target population. This factor focuses on choosing a PPP model that delivers housing units within predetermined affordability requirements to ensure accessible and

affordable housing facility. This factor has been recognized as criterion for selecting the type of PPP in project development, as highlighted in a study conducted by Xie and Thomas Ng (2013). Furthermore, a study conducted by Osei-Kyei and Chan (2017a) emphasized the significance of "Reduced public and political protests" in the successful implementation of PPP arrangements. These findings underscore the importance of selecting a PPP model that aligns with the needs of the general public and interest groups. Moreover Adabre and Chan (2019), indicated that "Incentives for developers to include affordable housing/ sustainable designs" is critical success factors for sustainable affordable housing delivery. Signifying the importance of ensuring the selection of PPP model that facilitate the delivery of housing accessible to the target group.

"Alignment of the option with the main objectives of the housing sector policy" considers that the PPP contractual model should contribute to producing an outcome that effectively aligns with the government's housing sector objectives. The research conducted by Cherkos et al. (2020) highlighted the significance of ensuring that a project or option aligns coherently with the primary objectives of the road sector policy when determining the appropriate Public-Private Partnership (PPP) model for the road sector. This underscores the critical nature of this factor, regardless of the specific sector involved. Additionally, Ng et al. (2012) identified "Alignment with the government's strategic objectives" as a key success factor for PPP projects during the feasibility stage. Moreover, "effective housing policy implementation" has been recognized as a crucial factor for achieving sustainable social housing in Nigeria in a study conducted by Woka et al. (2014). This underscores the importance of considering this factor when choosing a public-private partnership (PPP) model for housing delivery.

"Ownership arrangements for housing units" focuses on the ownership of housing units both during and at the end of the contract period. It determines whether the asset will continue to be under government control, become the full property of the private sector, or be permanently available to end users. This consideration also involves determining the preferred method of housing provision for end-users, whether it involves rental or purchase options. In their study, Woka et al. (2014), emphasized the significance of "Housing project ownership" as a critical success factor in achieving sustainable social housing in Nigeria. This underscores the importance of considering the preferred ownership structure when selecting a PPP model for housing delivery. Additionally, ownership arrangement stands out as a pivotal determinant in

defining the type of PPP arrangement in general (World-Bank 2017). Hence, it is imperative to consider the intended ownership structure when making choices about the PPP model.

4.6.1.2 Project characteristics related factors

Each project has its own unique characteristics, and the factors that contribute to its success are likely to be specific to those characteristics (Ahadzie et al. 2008). In this regard, this study has identified four relevant factors for selecting a PPP model that can accommodate the specific characteristics of a project.

Within the category of project characteristics, two key factors concentrate on assessing the project's marketability and profitability. These factors are project commercial and financial viability. “Project commercial viability” considers the ability of the proposed housing project to generate sufficient demand and sales in the market. It assesses whether there is a market need or desire for the project, whether customers are willing to pay for it, and whether it can effectively compete with existing alternatives. Since PPP contracts are long-term by nature, there must be a long-term demand for the proposed housing project. This factor, as highlighted in the study by (Cherkos et al. 2020b), plays a crucial role in selecting a Public-Private Partnership (PPP) model for the road sector. It underscores the significance of this factor in model selection across various sectors because private sectors tend to prefer investments in areas with a robust market, ensuring a return on their investments. Furthermore, two critical success factors for housing PPP projects have been identified in prior researches. Babatunde et al. (2016) highlight the importance of assessing the project's economic viability, while Ng et al. (2012) emphasize the significance of establishing long-term demand for the proposed services. These findings underscore the importance of evaluating the commercial viability of PPP projects during the selection process, enabling the government to provide the requisite support and guarantees to attract private sector investments.

Whereas, “Project financial viability” refers to the ability of the proposed housing project to generate and sustain profits over the long term. It evaluates the financial feasibility and sustainability of the project, considering factors such as revenue generation, cost structure, profitability, cash flow, and return on investment. It considers the ability of the project to cover costs and generate profits. It includes the attractiveness of the project cash flow to lenders and private investors. The study conducted by (Cherkos et al. 2020b) identified the importance of “certainty of traffic revenue” as a pivotal factor when choosing the PPP model for road sector

PPPs. Additionally, various research has underscored the significance of a project's financial viability in contributing to its success, although within different context. These aspects include the financial viability of projects as noted by Osei-Kyei and Chan (2017b), the necessity for sufficient profitability to attract investors, the need for a robust long-term cash flow to appeal to lenders as per Zhang (2005), and the emphasis on profitability, as outlined by Osei-Kyei and Chan (2017a), along with cost effectiveness and financial attractiveness, as highlighted by Ng et al. (2012). Collectively, these findings emphasize the criticality of factoring in a project's financial viability when selecting the PPP model for housing initiatives. Such consideration plays a key role in determining the nature of risk transfer, risk-taking preferences, and the essential financial support and guarantees required for the project's success.

Another factor under the category of projects characteristics is “project technical feasibility”. This factor considers whether the project can be effectively and efficiently implemented from a technical perspective. This criterion considers factors such as housing requirements, construction complexity, and technical challenges. It determines the type of risk to transfer, the competence requirement of the private partner, the support and guarantee to provide, and the compensation to be made to the private partner. The significance of the factor known as “Construction phase technical and macroeconomic certainty” in the context of PPP within the road sector has been affirmed by Cherkos et al. (2020b). This factor is recognized as one of the pivotal elements when choosing a PPP model in the road sector. This observation underscores the broader applicability of this factor beyond the housing sector. Additionally, a study conducted by Babatunde et al. (2016) emphasized the crucial role of “Project technical feasibility” in determining the successful implementation of PPP projects. This underscores the importance of factoring in this criterion when selecting a PPP model to ensure project success.

The last factor within the project characteristics category relates to the “development mix of the proposed project focuses.” This factor considers the composition of different housing units planned for construction. It involves the specific types of housing units, such as affordable housing, market-rate housing, or a mix of both, that will be included in the project. It also determines the type of facilities to be included in the project, this includes core facilities such as residential units with one, two, or three bedrooms, commercial spaces (shops, stores, offices, supermarkets, cafes, etc.), basement (parking space, storage area, etc.); non-core facilities, such as common facilities, such as corridors, common area, lifts and staircases inside the apartment buildings, and children playground and slaughter room/house outside the building; and support

facilities, such as solid waste management fire safety, sewerage, security, water supply system, etc. The World Bank (2020) and MOHUA (2017) have created various standardized models for developing housing units. These models are tailored to accommodate different types of housing units. When choosing a public-private partnership (PPP) model for housing delivery, it is essential to consider the specific mix of housing units planned for development.

4.6.1.3 Adequacy of the country's environment and public sector capability to cope with the contractual arrangement related factors

The complexity of the PPP system stems from various contributing factors. These include the long-term nature of PPP contracts, the participation of many stakeholders, the system's susceptibility to political instability and macroeconomic uncertainty, and the nation's limited familiarity with the system. Therefore, it is of utmost importance to carefully consider the country's readiness and the public sector's capacity to manage the contractual arrangements when selecting on a PPP model for housing initiatives. In this context, this study has identified six key factors that impact the selection of a PPP model for housing projects, which accounts for the country's adequacy and the public sector's capabilities to the selected model. These factors are discussed below.

“Public sector financial capacity” is one of the factors under this category. This factor considers the government's ability to finance its obligations and contribute financially to the partnership arrangement. This factor encompasses the public sector's capacity to offer either upfront capital grants or consistent, long-term payments (such as annuities) to a private partner as part of a contractual agreement, serving as compensation for the private partner's involvement. It involves the public sector’s capacity to adjust affordability (with various types of subsidies), offer mortgage financing, etc. In the context of PPP projects in Developing Countries, the study by (Osei-Kyei and Chan 2017c) has underscored the significance of the “Adequate financial capacity of contracting authority” as a crucial success factor. This emphasizes the importance of evaluating the public sector's financial capability to effectively select the PPP model. Furthermore, Cherkos et al. (2020) have also identified the importance of “Public sector financial capacity for semi-annuity (traffic revenue risk preference)” as a key criterion when selecting PPP projects, specifically in the road sector. This highlights the critical nature of this factor, irrespective of the sector under consideration.

“Public sector capital support and provision of guarantee” is another factor under the category of the adequacy of the country condition and public sector capability. This factor accounts for government’s capability and readiness to offer financial assurances and funding to private partners for projects that are not financially attractive but have high public importance. This includes viability gap funding and guarantees to secure private funding and ensure investment protection. The goal is to encourage private sector involvement in significant projects that may lack sufficient financial appeal on their own. This factor has been identified as a critical element for success in various research studies. It has been referred to using different phrases, such as “Government support” (Zhang 2005), “Government support and guarantees” (Kavishe and Chileshe 2019), and “Government involvement by providing a guarantee” (Babatunde et al. 2016). Furthermore, in the road sector, “Public sector capital support” was recognized as a key factor influencing the selection of Public-PPP models (Cherkos et al. 2020b), indicating the significance of the factor regardless of the sector under consideration. Additionally, factors like “adequate financial capacity of the contracting authority” and “Government providing guarantees” (Osei-Kyei and Chan 2017c) are essential in attracting private sector investments. Given that attracting private sector investment is crucial for achieving housing provisions through PPP, it is imperative to consider these factors during model selection, as they help secure private sector investments.

“Availability of potential private sector” is another factor in the cluster of adequacies of the country's environment and public sector capability to cope with the contractual arrangement. This factor considers the availability of a private partner that has expertise (i.e. technical, technological, innovation, and managerial), experience, and financial resources to contribute to the project and ensure its success. This finding aligns with the findings of Xie and Thomas Ng (2013), who identified “Availability of potential private investors” as a key factor in assessing the PPP model for any project. Additionally, Babatunde et al. (2016) also recognized “Strong and well-equipped private consortiums” as a critical success factor for PPP initiatives in Nigeria. This underscores the significance of considering the presence of capable private entities with the requisite resources when choosing a PPP model.

“Macroeconomic certainty” refers to the state of balance, consistency, and predictability in crucial economic indicators such as inflation interest rates, and currency exchange over a period of time. Because PPP contracts have a long-term nature, it requires a substantial amount of time for the private partner to recoup their investment costs. This underscores the importance

of factoring in macroeconomic stability and certainty when deciding on the PPP model to use for housing delivery projects. In their research Cherkos et al. (2020a) confirmed the significance of "construction phase technical and macroeconomic certainty" as a crucial criterion in road sector PPP model selection. This finding underscores the importance of this factor across various sectors. Furthermore, Stable macro-economic indicators, as indicated by Osei-Kyei and Chan (2017b), serve as a key factor attracting private sector investments in PPPs in developing countries. Additionally, the Abilities to deal with fluctuations in interest/exchange rates, as indicated by Zhang (2005), is vital element for successful implementation of such partnerships. This collectively underscores the importance of considering macroeconomic certainty during the model selection process. The next section of this chapter, focusing on the ISM model, will elaborate on the influence of this factor in the model selection process.

"Adequacy of the political, legal, and institutional framework of the country to the contractual and organizational arrangements required to rule the project" is the fifth factor under the cluster that considers the country's capability to manage the necessary contractual arrangements associated with the chosen PPP model. It encompasses elements such as political stability, the adequacy of the legal framework and PPP policy, the favorability of economic policies, the availability of adequate PPP units and professionals to oversee the project, as well as the effective utilization of advisory services. This factor has a significant impact on the selection of the PPP model in road projects, as indicated by Cherkos et al. (2020a), signifying its criticality across various sectors. Furthermore, research conducted by (Osei-Kyei and Chan 2017c) has identified key factors under this factor influencing private sector interest in partnerships, including a favorable existing legal framework and policy, a well-organized and committed contracting authority, and favorable existing economic policies. Additionally, Xie and Thomas Ng (2013) and Osei-Kyei and Chan (2017b) have emphasized the importance of political support and political stability as a part of creating favorable environment to implement PPP in housing sector, respectively, in enabling the successful implementation of PPP in housing delivery. Collectively, these findings underscore the importance of assessing the country's environment's suitability to accommodate the selected model for delivering housing projects.

"Availability and source of developable land" the final factor under the category of Adequacy of the country's environment and public sector capability to cope with the contractual

arrangement. It focuses on evaluating the accessibility and source of suitable land for housing projects. Availability assesses if there is enough land for housing, considering factors like size, location, and zoning. The source examines whether the land is publicly or privately owned. Understanding this helps determine the feasibility and complexities of acquiring or leasing land for the project. The availability further determines whether the government can compensate the private party with land and associated development rights (MOHUA 2017; World Bank 2020). Accordingly, a study conducted by Adabre and Chan (2019) found that one of the critical success factors for achieving sustainable affordable housing is an "Improved supply of low-cost developed land by the government." Moreover, another study by Woka et al. (2014) identified "Land issues" as a key success factor for sustainable social housing in Nigeria. These findings collectively underscore the significance of taking into account the availability and source of land when choosing a PPP model for housing delivery.

4.6.2 Investigation on the interrelation between the housing PPP model selection factor: Development ISM

Experts have validated 25 factors (Table 33) for their relevance to the housing sector and Ethiopia's initiative. These factors form the basis for the development of an ISM. The ISM played a crucial role in transforming vague and poorly articulated mental models of the PPP scheme selection process into well-defined models, serving various purposes (Saxena et al. 1992; Upreti et al. 2019). It revealed the intricate interrelationships among the model selection factors in housing projects. This aided in the analysis of the complex model selection process and provided a structured approach for representing these factors. Moreover, ISM assisted in establishing a clear hierarchy of the factors based on their influence and dependence (Bolaños et al. 2005; Feng et al. 2021). The following section presents the result of the ISM development and discusses the results achieved at each phase of the process.

Table 37. Validated housing PPP model selection factors

Code	Housing PPP Mode selection factor	Code	Housing PPP Mode selection factor
F-1	Access to private-sector capital to finance the project	F-14	Alignment of the option with the main objectives of the housing sector policy
F-2	Utilization of skills and expertise of the private sector and stimulation of innovation	F-15	Ownership arrangements for the housing units
F-3	Facilitating technology transfer	F-16	Public sector financial capacity

F-4	Improved housing project/service quality	F-17	Public sector capital support and provision of guarantee
F-5	Lowering construction, operation, and maintenance cost	F-18	Availability of potential private sector
F-6	Reduction in public sector administration cost	F-19	Project commercial viability
F-7	Early project delivery/completion	F-20	Project financial viability
F-8	Government preference to transfer maintenance risks	F-21	Project technical feasibility
F-9	Government preference to transfer operation and maintenance risks in an integrated way	F-22	Development mix of the proposed project
F-10	The private sector's interest in maintenance risk	F-23	Macroeconomic certainty
F-11	Private sector off-take and cost recovery risk-taking preference	F-24	Adequacy of the political, legal, and institutional framework of the country to the contractual and organizational arrangements required to rule the project
F-12	Affordability (acceptability of rent or purchase price)	F-25	Availability and source of development land
F-13	Acceptability to the interest group and general public		

4.6.2.1 Structural Self-Interaction Matrix (SSIM)

A structural self-interaction matrix (SSIM) was created to represent pairwise relationships between factors. Four symbols (V, A, X, O) were employed in the development of SSIM to indicate the direction of the relationship between two factors, i and j: “V” denotes row factor ‘i’ will influence the corresponding column factor ‘j'; “A” signifies row factor ‘i’ will be influenced the corresponding column factor ‘j’; “X” denotes corresponding factors ‘i' and ‘j’ will influence each other; “O” indicates factor ‘i’ and ‘j’ are unrelated. Table 34 displays the Structural Self-Interaction Matrix (SSIM) of the ISM.

Factor 12, “Affordability (acceptance of rent or purchase price),” exerts an influence on factor 13, “Acceptability to the interest group and general public.” This connection between these two factors, 12 and 13, was denoted by the symbol “V.” In another relationship, factor 4, “Improved housing project/service quality,” is achieved or influenced by factor 2, “Utilization of skills and expertise of the private sector and stimulation of innovation.” Hence this specific interaction between factor 4 and 2 was represented by the symbol “A.”

Factors 5 and 17, namely “Lowering construction, operation, and maintenance cost” and “Early project delivery/completion,” play roles in helping each other achieve their respective goals.

Thus, this mutual influence between factors 5 and 17 was denoted by the symbol “X,” signifying a bidirectional relationship where both factors influence each other. However, when it comes to factor 3, representing “Facilitating technology transfer,” and factor 25, which represents “the availability and source of developable land,” there is no relationship between them. Thus, the relationship between these two factors was represented by the symbol “O.”

Table 38. Structural Self-Interaction Matrix (SSIM)

MSFs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
F1		O	O	O	O	O	V	V	V	O	O	O	O	O	O	A	A	A	A	A	O	O	A	A	O
F2			V	V	V	O	V	V	V	V	O	O	O	O	O	O	O	A	O	O	A	A	O	O	O
F3				O	O	O	O	V	V	O	O	O	O	O	O	O	O	A	O	O	A	A	O	O	O
F4					O	O	O	V	V	V	O	O	V	A	O	A	O	A	V	V	O	A	O	O	O
F5						O	X	O	O	O	V	V	V	O	O	O	O	A	V	V	O	O	O	O	O
F6							O	V	V	A	A	V	O	O	A	O	O	O	O	O	O	O	O	O	O
F7								O	O	O	O	O	V	A	O	A	O	A	O	O	A	A	A	A	O
F8									O	O	O	O	O	O	A	A	O	O	O	O	A	A	O	O	O
F9										O	O	O	O	O	A	O	O	O	O	O	O	A	O	O	O
F10											X	O	O	O	A	O	A	O	O	A	A	A	A	A	O
F11												O	O	O	A	O	A	O	A	A	O	A	A	A	O
F12													V	A	O	A	A	O	V	O	O	A	A	O	A
F13														A	A	O	O	O	A	O	O	A	O	O	A
F14															V	O	O	O	V	O	O	V	O	O	O
F15																A	O	O	O	O	O	A	A	A	O
F16																	V	O	O	O	O	O	O	O	O
F17																		O	A	A	A	A	A	A	O
F18																			O	O	O	O	O	O	O
F19																				O	O	A	A	O	A
F20																					O	A	A	A	O
F21																						A	O	O	O
F22																							O	O	A
F23																								A	O
F24																									O
F25																									

4.6.2.2 Reachability Matrix

The reachability matrix in ISM is a crucial tool for understanding the hierarchical relationships among the model selection factors. It helps identify the flow of influence between the factor, allowing to determine which factors can directly impact others (Attri et al. 2013). This reachability matrix is a binary matrix, developed from SSIM by substituting V, A, X, O by binary numbers 1 or 0 using following rules (Ahmad et al. 2019; Majumdar and Sinha 2019; Warfield 1973): The (i, j) value in the reachability matrix will be 1 and (j, i) value will be 0, if (i, j) value in the SSIM is V. The (i, j) value in the reachability matrix will be 0 and (j, i) value will be 1, if (i, j) value in the SSIM is A. The (i, j) and (j, i), both values will be 1 in the reachability matrix, if (i, j) value in the SSIM is X. The (i, j) and (j, i), both values will be 0 in the reachability matrix, if (i, j) value in the SSIM is O. By following these rules, the initial reachability is matrix developed, as shown below in Table 35.

4.6.2.3 Final Reachability Matrix

By adding transitivity to initial reachability matrix, the final reachability matrix was developed. Transitivity is a fundamental assumption that results in the final reachability matrix in ISM, which states that "if variable A is related to variable B and variable B is related to variable C, then variable A is necessarily related to variable C" (Kumar et al. 2013). This transitivity consideration allowed to identify indirect relationship between the factors. For example, factor 2 is related to factors 3, 4, 5, 7, 8, 9, and 10. Factor 4 is related to factors 8, 9, 10, 13, 19, and 20. Therefore, factor 2 is necessary related to 13, 19, and 20. This matrix simplified the complex web of interactions into a clear structure, aiding in understanding the direct and indirect relation between the factors.

The final reachability matrix yielded two critical parameters: driving power (Dr P) and dependence power (Dp P) for each factor. This analysis is vital as it highlights on the dynamics and importance of relationships within a complex system (Bolaños et al. 2005). Driving power (Dr P) identifies the factors with the most significant influence on the overall system. It's calculated by summing the "1's" and "1*'s" values in the corresponding row of the final reachability matrix (Sushil 2012). This insight guides decision-makers in prioritizing actions and interventions to achieve desired outcomes.

The result from the final reachability matrix revealed that "Alignment of the option with the main objectives of the housing sector policy" and "Availability and source of development

land" emerge as the factors with the highest driving power of 20. This signifies their substantial influence within the model, indicating that changes in these factors can significantly affect many other factors in the model. In contrast, factors like "government preference to transfer maintenance risks," "government preference to transfer operation and maintenance risks in an integrated way," and "acceptability to the interest group and general public" exhibit the lowest driving power (1). This implies that changes in these factors have a limited impact on the entire model.

On the other hand, dependence power (Dp P) in ISM indicates which model selection factors depend on others, highlighting crucial dependencies that impact successful selection. It's calculated by summing the "1's" and "1*" in the respective column of the final reachability matrix (Sushil 2012). From the final reachability matrix, it was revealed that two factors, namely "Government preference to transfer maintenance risks" and "Government preference to transfer operation and maintenance risks in an integrated way," have the highest dependence power (23). This indicates that these factors rely heavily on or are influenced by many other factors in the model, meaning changes in other factors can significantly impact them.

Conversely, three factors, including "Public sector financial capacity," "Adequacy of the political, legal, and institutional framework of the country for project arrangements," and "Availability and source of development land," have the lowest dependence power of 1. This implies that these factors have minimal influence or reliance on other factors within the integrated structural model, meaning changes in other factors don't significantly affect them. Table 36, below, shows the final reachability matrix that is built based on the initial reachability matrix with the applied transitivity rule, and the transitivity is marked as 1*.

Table 39. Reachability Matrix

MSFs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Dv P
F1	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
F2	0	1	1	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
F3	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
F4	0	0	0	1	0	0	0	1	1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	7
F5	0	0	0	0	1	0	1	0	0	0	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	7
F6	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4
F7	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3
F8	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
F9	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
F10	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
F11	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
F12	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	3
F13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
F14	0	0	0	1	0	0	1	0	0	0	0	1	1	1	1	0	0	0	1	0	0	1	0	0	0	8
F15	0	0	0	0	0	1	0	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	7
F16	1	0	0	1	0	0	1	1	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	8
F17	1	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	5
F18	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7
F19	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	5
F20	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	5
F21	0	1	1	0	0	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	7
F22	0	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	0	0	0	16
F23	1	0	0	0	0	0	1	0	0	1	1	1	0	0	1	0	1	0	1	1	0	0	1	0	0	10
F24	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	1	0	0	1	0	0	1	1	0	9
F25	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	1	0	0	1	5
Dp P	8	4	5	6	4	4	11	10	8	11	10	9	10	1	6	1	8	1	8	6	2	3	2	1	1	

Table 40. Final Reachability Matrix

MSFs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Dv P
F1	1	0	0	0	1*	1*	1	1	1	1*	1*	1*	1*	0	0	0	1*	0	1*	1*	0	0	0	0	0	13
F2	1*	1	1	1	1	1*	1	1	1	1	1*	1*	1*	0	0	0	1*	0	1*	1*	0	0	0	0	0	16
F3	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
F4	1*	0	0	1	1*	1*	1*	1	1	1	1*	1*	1	0	0	0	1*	0	1	1	0	0	0	0	0	14
F5	1*	0	0	0	1	1*	1	1*	1*	1*	1	1	1	0	0	0	1*	0	1	1	0	0	0	0	0	13
F6	1*	0	0	0	1*	1	1*	1	1	1*	1*	1	1*	0	0	0	1*	0	1*	1*	0	0	0	0	0	13
F7	1*	0	0	0	1	1*	1	1*	1*	1*	1*	1*	1	0	0	0	1*	0	1*	1*	0	0	0	0	0	13
F8	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
F9	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
F10	1*	0	0	0	1*	1	1*	1*	1*	1	1	1*	1*	0	0	0	1*	0	1*	1*	0	0	0	0	0	13
F11	1*	0	0	0	1*	1	1*	1*	1*	1	1	1*	1*	0	0	0	1*	0	1*	1*	0	0	0	0	0	13
F12	1*	0	0	0	1*	1*	1*	1*	1*	1*	1*	1	1	0	0	0	1*	0	1	1*	0	0	0	0	0	13
F13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
F14	1*	1*	1*	1	1*	1*	1	1*	1*	1*	1*	1	1	1	1	0	1*	0	1	1*	1*	1	0	0	0	20
F15	1*	0	0	0	1*	1	1*	1	1	1	1	1*	1	0	1	0	1*	0	1*	1*	0	0	0	0	0	14
F16	1	0	0	1	1*	1*	1	1	1*	1*	1*	1	1*	0	1	1	1	0	1*	1*	0	0	0	0	0	16
F17	1	0	0	0	1*	1*	1*	1*	1*	1	1	1	1*	0	0	0	1	0	1*	1*	0	0	0	0	0	13
F18	1	1	1	1	1	1*	1	1*	1*	1*	1*	1*	1*	0	0	0	1*	1	1*	1*	0	0	0	0	0	17
F19	1	0	0	0	1*	1*	1*	1*	1*	1*	1	1*	1	0	0	0	1	0	1	1*	0	0	0	0	0	13
F20	1	0	0	0	1*	1*	1*	1*	1*	1	1	1*	1*	0	0	0	1	0	1*	1	0	0	0	0	0	13
F21	1*	1	1	1*	1*	1*	1	1	1*	1	1*	1*	1*	0	0	0	1	0	1*	1*	1	0	0	0	0	17
F22	1*	1	1	1	1*	1*	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	0	0	0	19
F23	1	0	0	0	1*	1*	1	1*	1*	1	1	1	1*	0	1	0	1	0	1	1	0	0	1	0	0	15
F24	1	0	0	0	1*	1*	1	1*	1*	1	1	1*	1*	0	1	0	1	0	1*	1	0	0	1	1	0	16
F25	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1	1	0	1*	0	1*	0	1	1*	1*	1	0	0	1	20
Dp P	21	6	7	8	21	21	21	23	23	21	21	21	22	1	7	1	21	1	21	21	4	3	2	1	1	

4.6.2.3 Level partitioning

Level partitioning in ISM is crucial for organizing and simplifying the complex relationships among the model selection factors. It helped to create a structured hierarchy by grouping the factors into different levels based on their influence and dependence on each other. This partitioning process clarified the relationships, making it easier to analyze and prioritize factors. It also aids in identifying key influential factors at lower levels and those that are more influenced at higher levels. In essence, level partitioning enhances the comprehensibility and manageability of the model, enabling decision-makers to focus on critical factors and their interactions, which is essential for effective model selection process (Bolaños et al. 2005; Janes 1988; Thakkar 2021; Warfield 1973).

From the final reachability matrix, the reachability and antecedent set for each model selection factor have been obtained (Janes 1988; Thakkar 2021). The reachability set of a factor is the set of factors influenced by it and the factor itself, whereas the antecedent set of a factor is the set of factors which may influence it and the factor itself. Reachability set, antecedent set and intersection sets for all the factors have been found. In the ISM hierarchy, factors with identical reachability and intersection are categorized at the same level. This particular level is then excluded in next iterations to identify subsequent levels. This iterative process is repeated until the level of each factor is determined.

At the first iteration (Appendix A6), three factors, factor 8 (Government preference to transfer maintenance risks), factor 9 (Government preference to transfer operation and maintenance risks in an integrated way), and factor 13 (Acceptability to the interest group and general public) were found to be lower-level factors, because they possess the same reachability set and intersection set. Indicating that they had no associations with other factors above their level, and were thus placed at level 1. After the identification of a top-level factors, they are discarded from the pool of remaining factors, in order to find the next level on the ISM hierarchy, the process is repeated, and this is performed until the level of every factor is determined.

The second iteration (Appendix A6), led to factors 1 (Access to private-sector capital to finance the project), 3 (Facilitating technology transfer), 5 (Lowering construction, operation, and maintenance cost), 6 (Reduction in public sector administration cost), 7 (Early project delivery/completion), 10 (The private sector's interest in maintenance risk), 11 (Private sector off-take and cost recovery risk-taking preference), 12 (Affordability (acceptability of rent or purchase price)), 17 (Public sector capital

support and provision of guarantee), 19 (Project commercial viability), and 20 (Project financial viability). These eleven factors were removed and placed at Level 2. At this level, factors exclusively influence the factors directly above them (Level 1) and, in turn, are influenced by the factors below them.

In the third iteration (Appendix A6), factor 14 (Alignment of the option with the main objectives of the housing sector policy) and factor 15 (Ownership arrangements for the housing units) were removed and placed at Level 3. Factors at this level directly influence the factors at the second level, as well as have influence to the first level but with different extent. In the fourth iteration (Appendix A6), factors 2 (Utilization of skills and expertise of the private sector and stimulation of innovation), 16 (Public sector financial capacity), and 23 (Macroeconomic certainty) were removed and placed at Level 4. The factors at this level will influence the factors at the higher level, indicating that any variation on the factors at this level will create change on the factors above this level (level 1 to 3).

In the third iteration (Appendix A6), factor 14 (Alignment with housing sector policy objectives) and factor 15 (Ownership arrangements for housing units) were moved and placed at Level 3. At this level, they directly influence Level 2 factors and also have an influence on Level 1 factors to a varying degree. In the fourth iteration (Table Appendix Y), factors 2 (Utilization of private sector skills and innovation stimulation), 16 (Public sector financial capacity), and 23 (Macroeconomic certainty) were placed to Level 4. Factors at this level influence factors at higher levels, indicating that changes in Level 4 factors will impact factors from Level 1 to 3.

In the fifth iteration (Appendix Table), factors 18 (Availability of potential private sector), 21 (Project technical feasibility), and 24 (Adequacy of the political, legal, and institutional framework of the country for project arrangements) were moved and placed at Level 5. In the sixth iteration (Appendix A6), factor 22 (Development mix of the proposed project) was placed at Level 6. Finally, in the seventh iteration (Appendix A6), factors 14 (Alignment of the option with the main objectives of the housing sector policy) and 25 (Availability and source of development land) were shifted to Level 7. Factors at Level 7 exert influence across all model selection factors, meaning changes in these factors will impact the entire model selection process. Conversely, these factors are not influenced by other factors in the model selection process. These determined levels contributed to the construction of the final framework, and Table 37 summarizes the partitioning of levels in the ISM.

Table 41. Summarized level Partitioning (LP)

MSFs	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi)∩A(Ni)	Level
1	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
2	2,	2, 14, 18, 21, 22, 25,	2,	4
3	3,	2, 3, 14, 18, 21, 22, 25,	3,	2
4	4,	2, 4, 14, 16, 18, 21, 22, 25,	4,	3
5	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
6	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
7	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
8	8,	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	8,	1
9	9,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	9,	1
10	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
11	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
12	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
13	13,	1, 2, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	13,	1
14	14,	14,	14,	7
15	15,	14, 15, 16, 22, 23, 24, 25,	15,	3
16	16,	16,	16,	4

17	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
18	18,	18,	18,	5
19	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
20	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
21	21,	14, 21, 22, 25,	21,	5
22	22,	14, 22, 25,	22,	6
23	23,	23, 24,	23,	4
24	24,	24,	24,	5
25	25,	25,	25,	7

It is crucial to simplify the final reachability matrix before creating the final models. This simplification process is essential to ensure clarity and manageability, moreover, it enables to clearly perceive the relationships between the factors. To achieve this, the final reachability matrix was modified into a conical matrix by clustering factors in the same level across the rows and columns of the final reachability matrix (Malone 1975). Subsequently, this modified matrix is further reduced to identify the most significant relationships.

4.6.2.5 Conical Matrix (CM)

The conical matrix was developed by clustering factors in the same level across the rows and columns of the final reachability matrix. This process streamlines the complex relationships among various factors, providing a more structured and manageable representation for model selection factors (Malone 1975). As a result, decision-makers can more easily grasp and visualize the complex interconnections between the model selection factors, facilitating more effective model selection process. This matrix was then reduced to identify the most significant relationships. Table 38 presents the conical matrix of the ISM.

4.6.2.6 Reduced Conical Matrix (CM)

The Reduced Conical Matrix was derived from the conical matrix, which, in turn, was initially generated from the final reachability matrix. The final reachability matrix serves as an initial representation of pairwise relationships among system elements or factors. Conversely, the reduced conical matrix simplifies the complexity inherent in the original reachability matrix. It

highlights the core factors that hold the most significant influence within the system, emphasizing the most relevant and influential relationships. The significance of a Reduced Conical Matrix in ISM lies in its ability to offer a concise and clear depiction of the crucial relationships within a complex system. By eliminating weaker or less significant relationships, the reduced conical matrix created a more manageable and streamlined representation the model selection factors. Moreover, it aids in the avoidance of circular relationships, which can cause inconsistencies in the model's structure and findings. Ultimately, the reduced conical matrix served as the foundation for establishing strong and final relationships between model selection factors, which are then used to construct the final diagram or model. Table 39 presents the reduced conical matrix of the ISM. The reduced conical matrix, has been introduced to convert the digraph into a final model with lesser edges while retaining the digraph structure and reachability of variables (Ahmad and Qahmash 2021).

Table 42. Conical Matrix (CM)

MSFs	8	9	13	1	3	5	6	7	10	11	12	17	19	20	4	15	2	16	23	18	21	24	22	14	25	Dv P	Level
8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
13	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1	1	1	1*	1	0	1*	1*	1	1*	1*	1*	1*	1*	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
3	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2
5	1*	1*	1	1*	0	1	1*	1	1*	1	1	1*	1	1	0	0	0	0	0	0	0	0	0	0	0	13	2
6	1	1	1*	1*	0	1*	1	1*	1*	1*	1	1*	1*	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
7	1*	1*	1	1*	0	1	1*	1	1*	1*	1*	1*	1*	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
10	1*	1*	1*	1*	0	1*	1	1*	1	1	1*	1*	1*	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
11	1*	1*	1*	1*	0	1*	1	1*	1	1	1*	1*	1*	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
12	1*	1*	1	1*	0	1*	1*	1*	1*	1*	1	1*	1	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
17	1*	1*	1*	1	0	1*	1*	1*	1	1	1	1	1*	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
19	1*	1*	1	1	0	1*	1*	1*	1*	1	1*	1	1	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
20	1*	1*	1*	1	0	1*	1*	1*	1	1	1*	1	1*	1	0	0	0	0	0	0	0	0	0	0	0	13	2
4	1	1	1	1*	0	1*	1*	1*	1	1*	1*	1*	1	1	1	0	0	0	0	0	0	0	0	0	0	14	3
15	1	1	1	1*	0	1*	1	1*	1	1	1*	1*	1*	1*	0	1	0	0	0	0	0	0	0	0	0	14	3
2	1	1	1*	1*	1	1	1*	1	1	1*	1*	1*	1*	1*	1	0	1	0	0	0	0	0	0	0	0	16	4
16	1	1*	1*	1	0	1*	1*	1	1*	1*	1	1	1*	1*	1	1	0	1	0	0	0	0	0	0	0	16	4
23	1*	1*	1*	1	0	1*	1*	1	1	1	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	15	4
18	1*	1*	1*	1	1	1	1*	1	1*	1*	1*	1*	1*	1*	1	0	1	0	0	1	0	0	0	0	0	17	5
21	1	1*	1*	1*	1	1*	1*	1	1	1*	1*	1	1*	1*	1*	0	1	0	0	0	1	0	0	0	0	17	5
24	1*	1*	1*	1	0	1*	1*	1	1	1	1*	1	1*	1	0	1	0	0	1	0	0	1	0	0	0	16	5
22	1	1	1	1*	1	1*	1*	1	1	1	1	1	1	1	1	1	1	0	0	0	1	0	1	0	0	19	6
14	1*	1*	1	1*	1*	1*	1*	1	1*	1*	1	1*	1	1*	1	1	1*	0	0	0	1*	0	1	1	0	20	7
25	1*	1*	1	1*	1*	1*	1*	1*	1*	1*	1	1*	1	1*	1*	1*	1*	0	0	0	1*	0	1	0	1	20	7
Dp P	23	23	22	21	7	21	21	21	21	21	21	21	21	21	8	7	6	1	2	1	4	1	3	1	1		
Level	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3	4	4	4	5	5	5	6	7	7		

Table 43. Reduced Conical Matrix (CM)

MSFs	8	9	13	1	3	5	6	7	10	11	12	17	19	20	4	15	2	16	23	18	21	24	22	14	25	Dv P	Level
F8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
F9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
F13	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
F1	1	1	1*	1	0	1*	1*	1	1*	1*	1*	1*	1*	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
F3	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2
F5	1*	1*	1	1*	0	1	1*	1	1*	1	1	1*	1	1	0	0	0	0	0	0	0	0	0	0	0	13	2
F6	1	1	1*	1*	0	1*	1	1*	1*	1*	1	1*	1*	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
F7	1*	1*	1	1*	0	1	1*	1	1*	1*	1*	1*	1*	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
F10	1*	1*	1*	1*	0	1*	1	1*	1	1	1*	1*	1*	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
F11	1*	1*	1*	1*	0	1*	1	1*	1	1	1*	1*	1*	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
F12	1*	1*	1	1*	0	1*	1*	1*	1*	1*	1	1*	1	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
F17	1*	1*	1*	1	0	1*	1*	1*	1	1	1	1	1*	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
F19	1*	1*	1	1	0	1*	1*	1*	1*	1	1*	1	1	1*	0	0	0	0	0	0	0	0	0	0	0	13	2
F20	1*	1*	1*	1	0	1*	1*	1*	1	1	1*	1	1*	1	0	0	0	0	0	0	0	0	0	0	0	13	2
F4	0	0	0	1*	0	1*	1*	1*	1	1*	1*	1*	1	1	1	0	0	0	0	0	0	0	0	0	0	14	3
F15	0	0	0	1*	0	1*	1	1*	1	1	1*	1*	1*	1*	0	1	0	0	0	0	0	0	0	0	0	14	3
F2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	16	4
F16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	16	4
F23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	15	4
F18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	17	5
F21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	17	5
F24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	16	5
F22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	19	6
F14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	20	7
F25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	20	7
Dp P	23	23	22	21	7	21	21	21	21	21	21	21	21	21	8	7	6	1	2	1	4	1	3	1	1		
Level	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3	4	4	4	5	5	5	6	7	7		

4.6.2.7 Formation of ISM based model for factors influencing PPP model selection in housing sector

Based on the level of partition generated from the final reachability matrix and using the most significant relationships generated from the reduced conical matrix which is developed from the final reachability matrix, an initial ISM diagram was developed, which represents a graphical representation of the elements, their hierarchical levels and directed relationships i.e. It shows which factors influence others and the overall structure of the system (Ahmad and Qahmash 2021; Feng et al. 2021; Kumar et al. 2013). These interrelationships between the different model selection factors are indicated by directional arrows representing the relationship direction or influence direction. This initial resultant graph formulated is called a "diagraph". The diagraph was then transformed into a final ISM model for housing PPP model selection factors after removing transitivity (Wang et al. 2020) (relationships indicated by "1*****" in the reduced conical matrix), as shown in Figure 13. To gain a better understanding of the final models, some relationships within the model are discussed.

Factors at lower levels, such as those at levels 7 and 6, creates substantial influential within the model. This influence extends to even higher-level factors, resulting in an indirect impact. To illustrate this, let's take the example of the factor "Adequacy of the political, legal, and institutional framework of the country for the contractual and organizational arrangements required for the project," which is situated at level 5. This factor influences "Macroeconomic certainty," a factor at level 4. In turn, "Macroeconomic certainty" influences "Ownership arrangements for the housing units," a factor at level 3, which directly influences "Private sector off-take and cost recovery risk-taking preference," factors at level 2. This implies that deficiencies in the country's environment, necessary for handling contractual arrangements (such as political instability and inadequacy of PPP legal framework and policies), can impact macroeconomic certainty, by inducing changes in microeconomic indicators like high inflation, subsequently affecting the ownership arrangements for housing units, such that options where the private partner owns the houses and provides services on a rental basis may become unfeasible, directly influencing private sector off-take and cost recovery risk-taking preference.

Therefore, the country must possess an adequate political, legal, and institutional framework to meet the project's contractual and organizational requirements, along with maintaining a stable macroeconomic environment. These factors instill confidence in the private sector regarding cost recovery and off-take risk. Furthermore, the private sector's off-take and cost

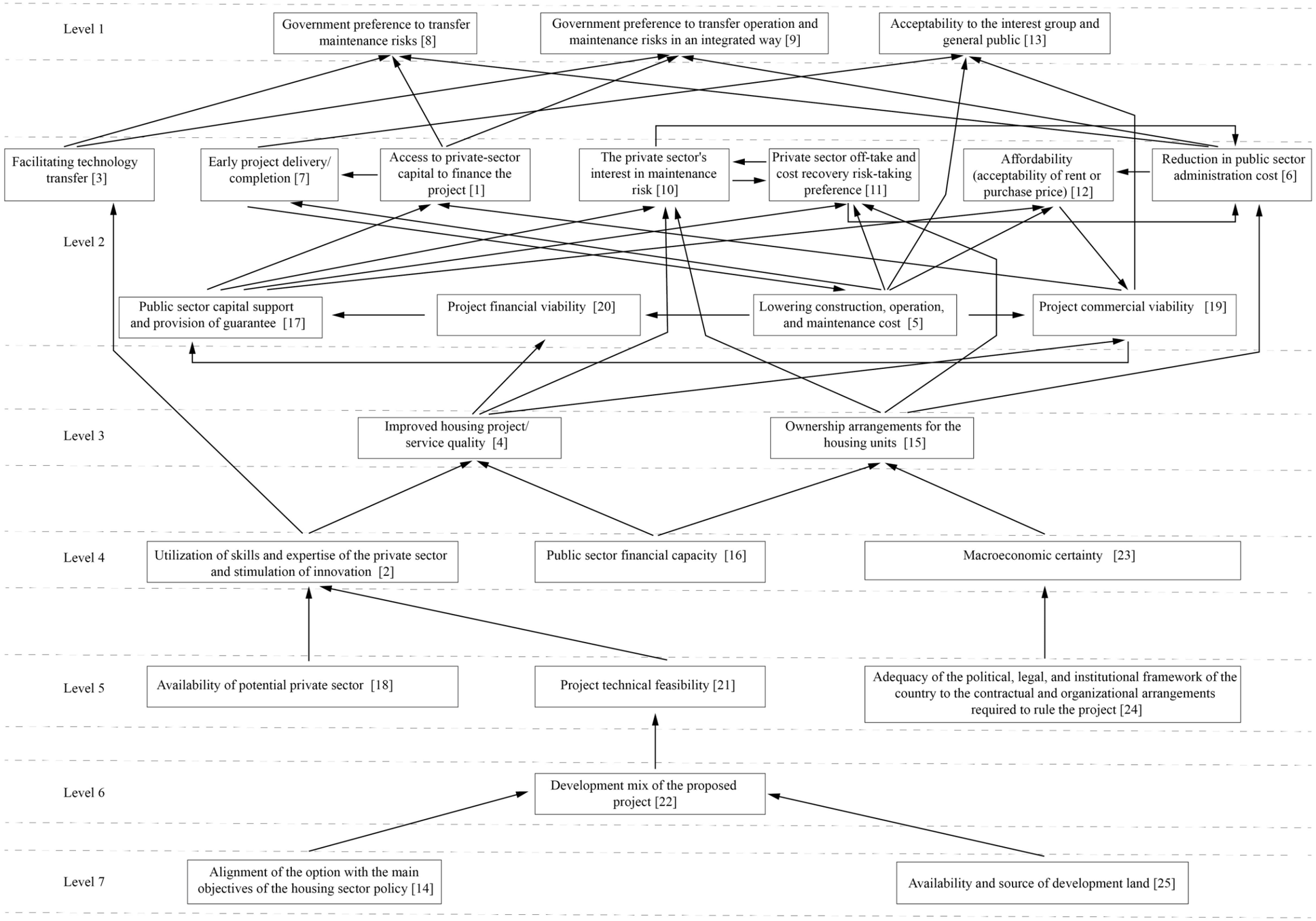

Figure 19. The final ISM model for factors influencing the selection of PPP model for housing projects.

recovery risk-taking preference is also influenced by “Public sector capital support and provision of guarantees,” a factor situated at the same level with it. This implies that in situations where a country exhibits political instability, legal shortcomings, and macroeconomic instability, the provision of public sector capital support and guarantees enhances the private sector's preference on cost recovery and off-take risks.

In conclusion, lower-level factors exert significant influence on the model, and any alterations in these factors introduce substantial variations in the model selection process. Hence, it underscores the critical importance of careful consideration of these factors during the model selection process, as they play a pivotal role. It's important to note that the labels “top,” “high,” or “low” used to denote the levels do not imply the magnitude of their influence; instead, they simply signify their position within the model.

Conversely, factors at the top-level like factors at levels 1 and 2 hold relatively minimal influence over the model, signifying that alterations in these factors yield only minor impacts on the system. Nonetheless, these top-level factors exhibit a marked tendency to be dependent on (or influenced by) other factors within the process. This entails meeting several prerequisites or considering various elements to attain these top-level factors. For instance, to secure the “acceptability of the interest group and general public”, several conditions must be met. These include ensuring early project delivery or completion, achieving project commercial viability by making housing units affordable to the target groups, maintaining high project quality, which can be achieved by utilizing the skills and expertise of the private sector and stimulation of innovation, which depends on the availability of potential private sector entities possessing the necessary technical expertise. This underscores the importance of considering all these factors in order to gain the acceptance of interest groups and the general public.

One of the primary driving factors behind the adoption of PPPs in housing sector is the ability to tap into private-sector funding for financing public projects (Kavishe et al. 2019b; Kavishe and Chileshe 2018). According to this model, this factor is influenced by numerous factors and, in turn, exerts an influence on another factor in model selection. To access private-sector capital, it is essential that the project demonstrates commercial viability. This implies that if a project holds promise in the market, private-sector entities will express interest in funding it. Additionally, the provision of public sector capital support becomes crucial in certain scenarios. This support can take the form of viability gap funding, particularly when a project carries high social value but lacks strong financial attractiveness. It also involves providing

guarantees to attract private sector investment, especially in risky environments. Since private sectors are generally hesitant to invest in projects that lack financial feasibility, this underscores the necessity for public sector backing and guarantees.

Furthermore, access to private sector capital to finance the project exerts influence on several other factors. These factors encompass the government's preference to transfer maintenance risks, driven by the need for ongoing funding for maintenance. Additionally, access to private sector capital to finance the project influences the government preference to transfer operation and maintenance risk in an integrated way, which can be initiated by the need to access private fund to maintain and operate the housing projects in an integrated way. Furthermore, early project delivery and completion can be achievable with a sufficient injection of private finance, by avoiding delays due to a lack of continuous fund for the project. Furthermore, early project delivery and completion contribute to Acceptability to the interest group and general public, as evidenced in the model. This underscores how the utilization of public sector capital can indirectly lead to acceptance among interest groups and the general public.

In cases where a project necessitates the adoption of new technologies, such as precast and modular technology, renowned for its cost-effectiveness, there exists the potential for foreign developers to undertake the project. This, in turn, may trigger the requirement to facilitate the transfer of this technology to local companies, thereby enhancing their capabilities for future projects. To accomplish this objective, it is imperative to utilize the skills and expertise of the private sector and foster innovation. The availability of a competent private sector, capable of handling the required technology, significantly influences this technology transfer process this was clearly depicted in the model.

Furthermore, the transfer of maintenance risks, either independently or in conjunction with operation, facilitate the transferring technologies from the private sector to both the public sector and local contractors. As a result, facilitating technology transfer influence governments toward a preference for transferring maintenance risk and may also encourage integrated transfers of operation and maintenance risk as clearly shown in the model.

4.6.3 MICMAC Analysis: Factor Classifications based on driving and dependence power

After constructing the final ISM framework and establishing connections among the factors, it becomes essential to determine the extent of these relationships. Because relationships between

factors can exhibit varying strengths, wherein certain connections might be stronger than others, the MICMAC (cross-impact matrix multiplication applied to classification) (Sohani and Sohani 2012) analysis serves as an additional step to address this variability (Kumar et al. 2015). The utilization of MICMAC analysis aids in classifying factors and validating the ISM factors within the study, thereby facilitating the derivation of conclusions (Ahmad et al. 2019).

In this regard, the classification of the factors has been carried out based on dependence and driving power. When a factor has higher dependency values, it implies that numerous other factors need to be eliminated if that factor is to be removed. Conversely, a high driving power for a factor signifies that a substantial number of factors can be eliminated by removing that particular factor (Majumdar and Sinha 2019). Derived from the final reachability matrix, the driving power encompasses the cumulative count of binary digit "1 and 1*" for each corresponding factor in the respective row, while the dependence power of each factor is determined by summing up the occurrences of "1 and 1*" within its corresponding column (Sushil 2012). Table 40 presents the driving and dependence power of each factor resulted from the final reachability matrix of the ISM.

Table 44. driving and dependence of the model selection factors

Code	Model selection factors	Driving power	Dependence power
F1	Access to private-sector capital to finance the project	13	21
F2	Utilization of skills and expertise of the private sector and stimulation of innovation	16	7
F3	Facilitating technology transfer	3	8
F4	Improved housing project/service quality	14	9
F5	Lowering construction, operation, and maintenance cost	13	21
F6	Reduction in public sector administration cost	13	21
F7	Early project delivery/completion	13	21
F8	Government preference to transfer maintenance risks	1	23
F9	Government preference to transfer operation and maintenance risks in an integrated way	1	23
F10	The private sector's interest in maintenance risk	13	21
F11	Private sector off-take and cost recovery risk-taking preference	13	21
F12	Affordability (acceptability of rent or purchase price)	13	21
F13	Acceptability to the interest group and general public	1	22
F14	Alignment of the option with the main objectives of the housing sector policy	20	1
F15	Ownership arrangements for the housing units	14	7

F16	Public sector financial capacity	16	1
F17	Public sector capital support and provision of guarantee	13	21
F18	Availability of potential private sector	17	1
F19	Project commercial viability	13	21
F20	Project financial viability	13	21
F21	Project technical feasibility	17	5
F22	Development mix of the proposed project	19	4
F23	Macroeconomic certainty	15	3
F24	Adequacy of the political, legal, and institutional framework of the country to the contractual and organizational arrangements required to rule the project	16	2
F25	Availability and source of development land	20	2

Based on the concepts and values of driving and dependence powers, MICMAC analysis investigates the influence and reliance relationships among factors, categorizing them into four distinct groups: autonomous, dependent, linkage, and independent (Ahmad et al. 2019; Ahmad and Qahmash 2021; Attri et al. 2013; Guan et al. 2020; Kumar et al. 2015; Sohani and Sohani 2012; Thakkar 2021; Wang et al. 2020).

4.6.3.1 Autonomous factors

Autonomous factors have both weak driving power and weak dependence power. They are relatively disconnected from the system, with which they have few links, which may, however, be very strong. In this study, one factor, facilitating technology transfer, falls into this category with a driving and dependence power 3 and 8 respectively. As can be observed from the model and the reduced conical matrix, this factor influences only two model selection factors including: government preference to transfer maintenance risks and government preference to transfer operation and maintenance risk in an integrated way. And it is directly influenced by only one factor (utilization of skills and expertise of the private sector and stimulation of innovation). This implies that any change in the factors within the model has limited influence on these specific factors. Likewise, any change in these factors also exerts minimal influence throughout the model selection process.

4.6.3.2 Dependent factors

Dependent factors exhibit a weak drive power but possess strong dependence power. This study identified three factors that fall into this category: government preference to transfer maintenance risks, government preference to transfer operation and maintenance risk in an integrated way, and acceptability to interest groups and the general public. As evidenced by

the model, these factors occupy the top level, indicating that they are influenced by numerous other factors within the system. However, it is important to note that these factors themselves do not exert influence over any other factors in the model selection process. This underscores the point that alterations in other factors within the model can lead to significant variations in these specific factors. To ensure the stability of these factors, several conditions must be met. For instance, as it can be seen from the model the factor "the government preference to transfer maintenance risk" is directly influence by many factors including: access to private-sector capital to finance the project, facilitating technology transfer, and reduction in public sector administration cost. Where these factors are also influenced by many other factors, projecting the impact to the top-level factor. However, the government preference to transfer maintenance risk do not influence any other factor in model.

4.6.3.3 Linkage factors

Linkage factors exhibit both strong driving power and strong dependence power. These factors are inherently unstable, given that any manipulation of these variables will not only impact other factors but also trigger a feedback effect on themselves. In this study, a cluster of 10 factors resides, encompassing: access to private-sector capital to finance the project, lowering construction, operation, and maintenance cost, reduction in public sector administration cost, early project delivery/completion, the private sector's interest in maintenance risk, private sector off-take and cost recovery risk-taking preference, Affordability (acceptability of rent or purchase price), public sector capital support and provision of guarantee, project commercial viability, and project financial viability.

As evident from their driving and dependence power in the final reachability matrix and the model formulated, these factors both influence and are influenced by numerous other factors. Any alteration during the model selection process results in significant fluctuations within these factors. Likewise, any modifications to these factors can induce variations in numerous other factors within the model selection process. For instance, the factor "Affordability (acceptability of rent or purchase price)" in influenced (achieved) by many factors in the model including public sector capital support and provision of guarantee, lowering construction, operation, and maintenance cost, reduction in public sector administration cost, and other factors. It also influences the following factors: project commercial viability, which intern influences acceptability to interest groups and the general public and other factors. Therefore, any change

in this factor can induce variation in the model, and also any alteration on other factors will also exert impact on this factor.

4.6.3.4 Independent factors

Independent factors exhibit strong drive power but weak dependence power. A factor possessing exceptionally robust drive power, referred to as the 'key factor,' falls within the realm of independent or driver factor. Within this study, eleven factors align within this cluster, including: utilization of skills and expertise of the private sector and stimulation of innovation, improved housing project/service quality, alignment of the option with the main objectives of the housing sector policy, ownership arrangements for the housing units, public sector financial capacity, availability of potential private sector, project technical feasibility, development mix of the proposed project, macroeconomic certainty, adequacy of the political, legal, and institutional framework of the country to the contractual and organizational arrangements required to rule the project, and availability and source of development land. These factors significantly influence the model selection process, signifying that any alteration in these factors can result in a substantial impact on various factors of the model selection process, underscoring their critical importance. However, these factors do not tend to be influenced by other factors in the model.

For example, the factor “adequacy of the political, legal, and institutional framework of the country to the contractual and organizational arrangements required to rule the project” influence macroeconomic certainty, which inter influences ownership arrangements for the housing units, which intern influences the private sector's interest in maintenance risk, the private sector off-take and cost recovery risk-taking preference, and reduction in public sector administration cost, which they intern influence many other factors in the model. However, adequacy of the political, legal, and institutional framework of the country to the contractual and organizational arrangements required to rule the project is not influenced by any other factor in the model. This indicated the criticality of such factor in model selection, since any alteration in these factors can induced a significant change in within the model.

Furthermore, to enhance the clarity and visualization of the classification, the MICMAC analysis graphically categorizes the factors influencing model selection into four quadrants. This categorization is based on their dependence power along the X-axis and driving power along the Y-axis. In this graphical representation, the first quadrant (I) includes autonomous

factors, the second quadrant (II) consists of dependent factors, the third quadrant (III) represents linkage variables, and the fourth quadrant (IV) signifies independent factors. Figure 14 shows MICMAC analysis for factors influencing the selection of PPP models for housing initiatives

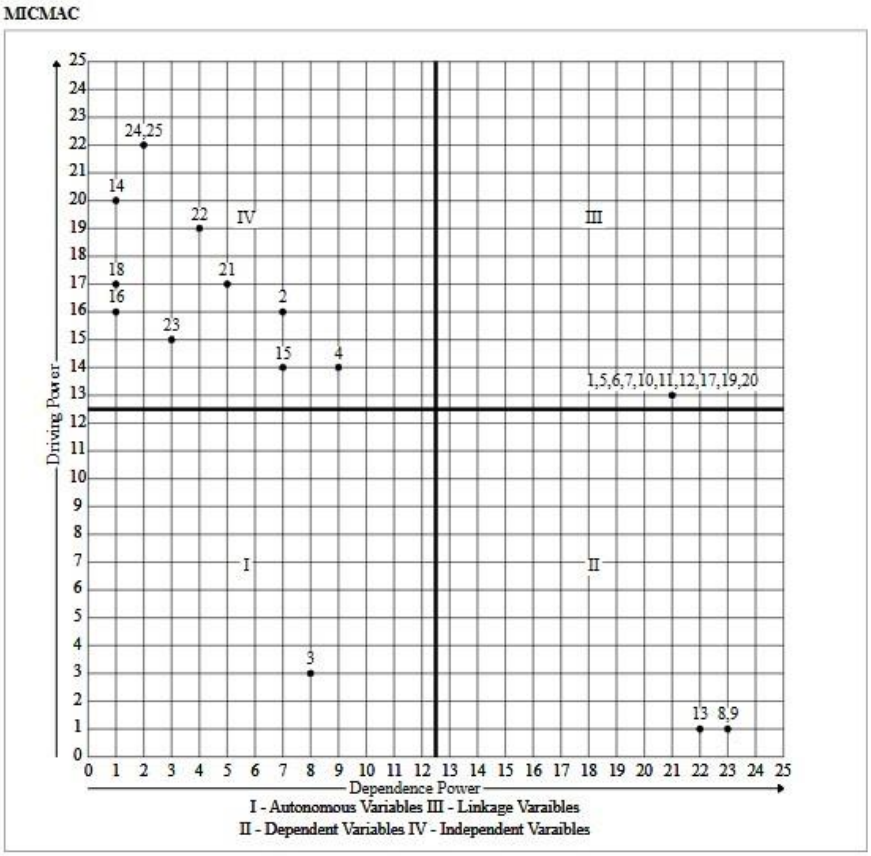

Figure 20. MICMAC analysis for factors influencing the selection of PPP models for housing initiatives.

4.7 Development and validation of the decision supporting framework

4.7.1 Development of decision supporting framework

As detailed in the methodology section, the framework includes five standardized PPP models developed by the World Bank. These models are designed to facilitate the development of affordable housing in emerging markets within developing countries. These models draw upon practices from India. Furthermore, the framework also incorporates an additional model called "DBFM (annuity cum capital grant)," which was developed by India but was not included in the World Bank's list of models. The description, the salient feature and the project structure of the models was clearly discussed in section 2.2.2.4 of chapter two. Figure 21 presents the developed decision support framework.

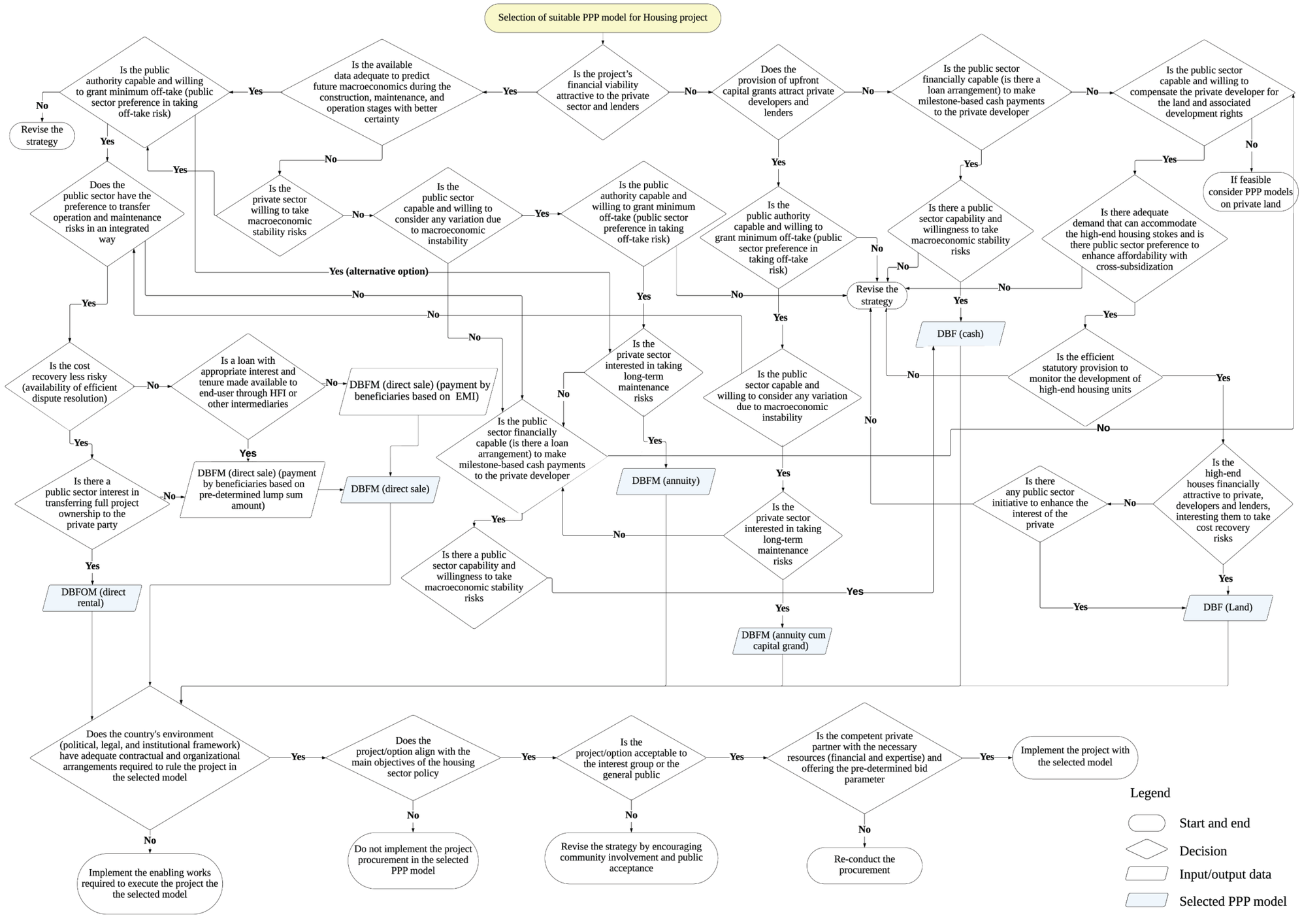

Figure 21. Decision supporting framework in selecting suitable PPP model for housing projects

The framework illustrates how project characteristics and stakeholder preferences interact in the selection process of PPP models. This interaction has the potential to enhance project value by reducing the likelihood of project rebidding and failure. It achieves this by taking into account stakeholders' preferences and considering the unique characteristics of each project.

Additionally, framework plays a pivotal role in aiding the decision-making process when choosing the appropriate PPP model for housing projects. The decision elements of the framework (factors influencing the selection of the PPP model in the framework) were explored in the previous phase of this study. Consequently, the final ISM model can indicate the factors that both influence and are influenced by each decision element within the framework. This facilitates more informed decision-making. Essentially, the ISM models and the framework collaborate to support the decision-making process, resulting in selecting the most suitable PPP models.

For instance, if a decision-maker seeks to determine whether the private sector prefers retaining long-term maintenance risk, the ISM model can furnish essential insights into the factors influencing the private sector's preference regarding maintenance risk. This information enables necessary actions to be taken to enhance this preference if deemed necessary.

Application of Model Selection

For illustration, the study considered one scenario that led to the implementation of DBF (land) procurement for a specific project. The decision-making process involves various decision points, which trigger decision-makers to make choices based on the project's specific characteristics. For instance, imagine a scenario where the public sector must choose an appropriate approach for procuring a new housing project. After conducting a feasibility study, it becomes evident that the project's financial viability is not attractive to the private sector and lenders. Additionally, the provision of an upfront capital grant (VGF) cannot enhance the financial attractiveness of the project to private developers and lenders. The public sector lacks financial capability and does not have any loan arrangements in place to make milestone-based cash payments to a private developer.

However, the government does possess the capacity and willingness to compensate the private developer with the land and associated development rights. Under this arrangement, the private developer would be permitted to construct and sell high-end housing on a designated portion of

the allocated land. The feasibility study has also provided assurance that there is sufficient demand to support the sale of high-end housing units, and there exist effective legal provisions to oversee the development of these high-end houses. Furthermore, private developers and lenders find the prospect of high-end housing financially attractive. In this particular situation, decision-makers can proceed as follows:

1. Is the project's financial viability attractive to the private sector and lenders? No.
2. Does the provision of an upfront grant attract the private developers and lenders? No.
3. Is there public sector's financial capacity (loan arrangement) to make mile-stone-based cash payments to the private developer? No.
4. Is there adequate demand to accommodate the high-end housing stoke and is there public sector preference to enhance affordability with cross-subsidization? Yes.
5. Are there efficient legal provisions to oversee the development of these high-end houses? Yes.
6. Are the high-end houses financially attractive to private developers and lenders? If the answer is "Yes," DBF (land) is a suitable model. If the answer is "No," check if there is any public sector initiative to attract private sector investment, like providing a higher floor area ratio (FAR), fast-track clearances for undertaking the development of high-end housing, or a bonus payment by the Public Authority may be included for the developer for every housing unit accepted and paid for by an eligible end-user. If there are such initiatives, DBF (land) is a suitable model. following this the selected model should undergo further decisions to optimize the likelihood of success and ensure maximum benefits from the selected approach
7. Does the country's environment (political, legal, and institutional framework) have adequate contractual and organizational arrangements to rule the project in the selected PPP model? Yes.
8. Does the project/option align with the main objectives of the housing sector policy? Yes
9. Is the project/option acceptable to the general public and interest groups? Yes.
10. Is there a competent private developer with the necessary resources (financial and expertise) offering the pre-determined bid parameter? If yes, the decision would be to implement the project procurement in the DBF (land) model.

Following the nodes as listed, the decision makers would choose the DBF (land) model as the most appropriate for the given scenario.

4.7.2 Validation of decision supporting framework

Validating a framework is vital as it guarantees its reliability, effectiveness, and alignment with its purpose. It confirms accurate representation of real-world scenarios, goal attainment, credibility, and aid to decision-making. In essence, validation makes the framework a dependable and valuable tool for its intended tasks. In this regard, validating a framework by expert opinions ensures the reliability, validity, and relevance of the framework. Because experts can assess it for flaws, inconsistencies, and gaps, enhancing its credibility, meeting quality standards, and reflecting best practices. This research validated the framework with expert opinion in five major aspects (the implications of each aspect were provided in the validation format), each measuring the various specific features of the framework. The table below represents the mean rating for each validation aspect provided by the experts, using a point rating scale.

Table 45. Result of framework validation

No	**Validation Aspect**	**Rating of experts**				**Mean Score (MS)**
		E1	E2	E3	E4	
1	Applicability	5	5	3	4	4.25
2	Reliability	5	4	3	4	4
3	Appropriateness	5	4	3	4	4
4	Suitability	5	4	3	4	4
5	Objectivity	5	4	4	5	4.5

According to experts' ratings, the aspect of "Applicability" has a mean score of 4.5, indicating the framework's high applicability. This means the framework is highly effective in aiding decision-makers to choose the best PPP model for housing projects in real-world situations. It underscores the framework's high practicality, relevance, and value in supporting informed decisions for housing PPP projects. Similarly, the aspect “reliability” holds a mean score of 4, indicating the high reliability of the framework. This implies that the framework can provide highly dependable and consistent guidance when choosing the most appropriate PPP model for a given housing

project. Decision-makers can trust that the framework's recommendations remain stable and accurate across multiple evaluations, ensuring reliable support in making PPP model choices.

Furthermore, with an average rating of 4 from experts in the "Appropriateness" aspect, it highlights the framework's high ability to adapt to specific decision-making contexts. It signifies its ability to accommodate various aspects of decision-making including project characteristics, stakeholder preferences, local conditions, and the particular initiative under review. The framework was assessed and found to have an average rating of 4 for its suitability, indicating its strong effectiveness in aiding decision-makers in selecting the best PPP model for a project or situation. They ensure the framework offers valuable guidance and criteria for evaluating and matching project needs with PPP models, leading to well-informed and optimal decisions. The framework is also noted for its user-friendly application.

Moreover, as per the expert's assessment, the element of "objectivity" has received an average rating of 4.5. This score suggests that the framework can deliver an impartial and unbiased evaluation, unaffected by personal biases or external pressures. Such a framework guarantees that decisions regarding PPP model selection are grounded in equitable and neutral criteria rather than subjective viewpoints or personal interests. It fosters fairness and transparency in the decision-making process.

In conclusion, the result of the expert's evaluation of the framework demonstrated that the framework possesses high quality across all validation aspects. This validation confirms the framework's suitability and usability for real-world use by practitioners, policymakers, and researchers, ultimately enhancing decision-making and improving outcomes when choosing a PPP model for housing projects.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Ethiopia's housing sector faces significant challenges in meeting the housing needs of its growing population, particularly in Addis Ababa. To address this problem, the government has initiated the implementation of affordable housing delivery through public-private partnerships (PPPs). This study aimed to identify factors influencing the successful implementation of PPPs and develop a framework for selecting suitable modalities based on housing project characteristics. A questionnaire survey and data analysis were conducted, leading to several key findings.

- ✓ Ten key factors have driven the adoption of PPPs in housing provision in Ethiopia. Each of these factors holds very high importance in triggering the adoption of this system within the sector with the potential to offer promising PPP-based solutions to address the current housing provision challenges. Notably, among these factors, the private sector's ability to raise funds for public projects, save time in delivering projects, better risk transfer and sharing, facilitate creative and innovative approaches, and accelerate infrastructure provision stands out as the top five drivers for the adoption of PPPs in Ethiopia's housing provision. Each of these factors can offer very important PPP solutions to tackle the housing provision challenges.
- ✓ In the study, twenty-seven critical factors have been identified as holding very high significance in facilitating the successful execution of PPP in the housing sector. Consequently, ensuring the availability of these factors or conditions before project execution significantly enhances the chances of success. Among these factors, establishing well-organized and committed PPP units, political stability, in-time land acquisition, right project identification and project technical feasibility, and appropriate risk identification and risk sharing are the top five critical factors that can enable the successful implementation of PPP in housing provision in Ethiopia.
- ✓ The successful execution of a PPP system depends on the careful selection of an appropriate PPP model that aligns with the project's unique characteristics,

stakeholder preferences, and the local conditions that influence the stakeholder's risk-taking preferences and capacities. In this context, the study has identified 15 stakeholder preferences, 4 project characteristics, and 6 factors related to the country's conditions that collectively influence the selection of the PPP model for housing projects. These factors are intricately interconnected and mutually influential, indicating the sensitivity of the model selection process. Any alteration in one of these factors can introduce variations in the model selection process, emphasizing the need for a comprehensive and adaptable approach to PPP model selection.

- ✓ The study also found that the selection of a suitable PPP model depends on stakeholder preferences, project characteristics, and the country's conditions. These factors have complex interrelationships, requiring a comprehensive and adaptable approach to model selection. Furthermore, specific factors, such as the utilization of private sector expertise, housing project quality, and the availability of development land, independently impact the choice of PPP model for housing projects, emphasizing the need for careful consideration when selecting models. Additionally, a conceptual framework has been developed, utilizing PPP model selection factors to align project characteristics with the preferences of clients, the private sector, and lenders for a specific PPP model. The framework has been validated by experts, and the results show high quality across all validation aspects.

The findings of this study can help policymakers assess the alignment of housing PPP initiatives with their intended objectives and provide practical insights and frameworks for the successful implementation of PPPs in the housing sector.

5.2 Recommendation

Based on the research findings, the following recommendations have been forwarded for the practical implementation of PPP in housing provision:

- ✓ Before initiating housing development through a PPP, assessing whether the proposed PPP project aligns with the original objectives of adopting this system within the sector is crucial. This involves checking whether the PPP arrangement can provide the desired solution to the prevailing challenges.
- ✓ Before implementing the development of housing using PPP arrangements, it is essential to assess the sufficiency of the country's political, legal, economic, and institutional framework necessary to govern the project under the chosen model. Additionally, it is crucial to undertake the enabling works required to ensure the successful execution of the project with a PPP arrangement.
- ✓ Given Ethiopia's limited experience with PPP, the research suggests the need for standardizing the PPP implementation process. This involves the utilization of predefined model selection criteria for choosing PPP models and the adoption of standardized PPP models. Such an approach can help bridge the experience gap and facilitate the successful execution of the system. To this end, this study recommends the utilization of model selection criteria and a decision-support framework developed within the scope of this research.

For future research, this study forwarded the following recommendations:

- ✓ Further research that investigates the current challenges in providing housing to the public and establishes connections between these challenges and potential PPP solutions for addressing them.
- ✓ Further study that identified the PPP model’s selection criteria using case studies, from housing projects that are implemented in other countries.
- ✓ Further study to develop and prioritize the criteria used for selecting or evaluating housing PPP models for a single relevant model that aligns with the country's objectives for adopting the system and prioritizing the criteria with respect to the model.
- ✓ A similar study to identify the driving, enabling, and model selection factors for PPP implementation in other sectors, like railway in the road sector, health sector, and others

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APPENDIX

Appendix A1: Questionnaire

Adama Science and Technology University

School of Civil Engineering and Architecture

MSc. Program in Construction Engineering and Management

Questionnaire

Dear Respondent,

I am currently undertaking a Master of Science (MSc.) degree in construction engineering and management at Adama Science and Technology University (ASTU). As a partial fulfillment of the academic program, I am conducting research entitled "**A Prospect for the Implementation of Public-private Partnership in the Ethiopian Housing Sector**" which aims to study the rationale behind adopting public-private partnerships in the Ethiopian housing sector and to support the potential implementation of the system in the country. In this regard, I respectfully request you to participate in this research, because your contribution to this study is essential, and I highly value your input.

This questionnaire has three (3) parts and it will take an average of 30 to 45 minutes of your time. Please read each question or statement carefully and try to answer all questions honestly and to the best of your knowledge. Please note that your responses will be kept confidential and anonymous and will be used only for academic purposes. I greatly appreciate your cooperation and contribution to the realization of this research. If you have any questions about the survey, please contact me at +251924335275/ eyobaww@gmail.com, or my telegram account @Yobid.

Thank you, Eyob Wondwossen

Adama, Ethiopia, May 2023

A public-private partnership (PPP) is a collaborative arrangement between a government or public entity and a private sector company or organization, to achieve a mutually beneficial goal. This involves sharing risks, resources, and expertise to create and deliver services or infrastructure that would have been done solely by the government. PPPs typically involve a long-term contractual agreement between the public and private partners and aim to combine the strengths and capabilities of each party to deliver high-quality and cost-effective services to the public.

Part 1: Information of the Respondent

1.1 Your company/organization name (optional):

1.2 Type of your organization:

Public sector ☐ Private sector ☐ Other ☐

If other please specify: _____

1.3 If your answer to question 1.2 is "Private sector", please select the type of your organization

Local contractor ☐ Local consultant ☐

Foreign Contractor ☐ Foreign Consultant ☐ Other ☐

If other please specify: _____

1.4 Please state your level of education:

BSc. degree ☐ MSc. degre ☐ Ph.D. ☐

1.5 What is your current position/role in your organization?

Project Manager ☐ Director ☐ Project engineer ☐

Procurement Specialist ☐ PPP expert ☐ Other ☐

If your answer to question 1.4 is "Other" please specify: _____

1.6 State your years of experience:7

≤ 5 years ☐ 6 to 10 year ☐ 11 to 15 years ☐ 16 to 20 years ☐ >20 years ☐

1.7 Which sector do you have experience with?

Public ☐ Private ☐ Both ☐ Other ☐

If other please specify: _____

Part 2: The driving factors for the adoption of public-private-partnership in the Ethiopian housing sector

Driving factors for adopting public-private partnerships in the housing sector are influential elements or forces that strongly motivated or caused the government of Ethiopia to adopt public-private partnerships in the housing sector.

2.1 What are the key drivers that motivated or caused the government of Ethiopia to adopt PPP in the housing provision in Ethiopia? Please rate the driving factors/reasons for adopting a public-private partnership in the housing sector of Ethiopia based on their level of importance. Use the rating scale provided in Table 2.1.

Use the **(✓)** sign to provide your answer in the space provided. For further clarity please refer to the definitions provided in page 3 for each driving factor.

Table 2.1: Rating linguistic variables with the associated triangular fuzzy numbers

Linguistic Variables	**Triangular Fuzzy Numbers**
Extremely Low Importance (EL)	(0.0, 0.0, 0.15)
Very Low Importance (VL)	(0.0, 0.15, 0.3)
Low Importance (L)	(0.15, 0.3, 0.5)
Moderate Importance (M)	(0.3, 0.5, 0.7)
Hight Importance (H)	(0.5, 0.7, 0.85)
Very High Importance (VH)	(0.7, 0.85, 1)
Extremely High Importance (EH)	(0.85, 1, 1)

Table 2.2: List of the driving factors for adopting PPP in the provision of affordable housing.

No	**PPP driving factors**	**EL**	**VL**	**L**	**M**	**H**	**VH**	**EH**
1	The private sector's ability to raise funds for public projects							
2	Acceleration of infrastructure provision							
3	Offers benefits for local economic development							
4	Facilitate creative and innovative approach							

5	Improved quality of service							
6	The private sector possesses better resource mobility							
7	Improved housing maintainability							
8	Save time in delivering projects							
9	Better risk transfer and sharing							
10	Enhances technology transfer to local companies							
11	Optimization of the whole-life costs of the asset by bundling design, construction, and maintenance responsibilities							
12	Reduce public sector administration cost							
13	Certainty of construction costs and time							

2.2 Do you think that the adoption of public-private partnerships in the housing sector could contribute to minimizing the current housing problem in Ethiopia?

Yes, ☐ No ☐ No idea ☐

Part 3: Critical factors that enable the successful implementation of public-private partnerships in the Ethiopian housing sector.

Enabling factors are conditions, or resources that can provide support or assistance to successful implementation of public-private partnerships in the Ethiopian housing sector.

3.1 Do you think the overall current conditions or resources could enable the successful implementation of public-private partnerships in the Ethiopian housing sector?

Yes ☐ No ☐ No idea ☐

3.2 What are the key factors that enable the successful implementation of private partnerships in the provision of housing in Ethiopia? Please rate the following enabling factors based on their level of significance in contributing to the successful implementation of PPP in the Ethiopian housing sectors. Use the rating scale provided in **Table 3.1**.

Use the (✓) sign to provide your answer in the space provided. For further clarity please refer to the definitions provided in page 6 for each enabling factor.

Table 3.1: *Rating linguistic variables with the associated triangular fuzzy numbers*

Linguistic variables	**Fuzzy number**
Extremely Low significance (EL)	(0.0, 0.0, 0.15)
Very Low Significance (VL)	(0.0, 0.15, 0.3)
Low Significance (L)	(0.15, 0.3, 0.5)
Moderate Significance (M)	(0.3, 0.5, 0.7)
Hight Significance (H)	(0.5, 0.7, 0.85)
Very High Significance (VH)	(0.7, 0.85, 1)
Extremely High Significance (EH)	(0.85, 1, 1)

Table 3.2: List of desirable factors that will enable the successful implementation of housing PPP.

No	**Enabling factors**	**EL**	**VL**	**L**	**M**	**H**	**VH**	**EH**
1	Appropriate risk identification and risk sharing							
2	Favorable and efficient legal framework and PPP policy							
3	Stable macro-economic condition							
4	Sound economic policy							
5	Transparent procurement process							
6	Competitive procurement process							
7	Process flexibility							
8	An efficient evaluation and approval process							
9	Good governance							
10	Political stability							
11	Strong political support							
12	Encouraging community involvement and public acceptance							
13	Right project identification and project technical feasibility							
14	Realistic assessment of cost and revenue							
15	The attractiveness of long-term cash flow to the lenders							
16	The existence of long-term demand for the proposed housing projects							
17	Availability of suitable and mature financial market							

18	Availability of strong and reliable private consortium							
19	Government involvement by providing a guarantee and financial support							
20	The involvement of non-commercial (development) financing							
21	Establishing well-organized and committed PPP units							
22	Strengthening public sector capability							
23	Efficient use of advisory service							
24	Preparation of a tact contractual agreement							
25	Flexibility of contract							
26	Employing appropriate contractual clauses to manage macro risks							
27	Creation of model concession agreements							
28	Clear and affordable price design (purchase or rent price)							
29	Clearly defined roles and responsibilities of parties							
30	Effective negotiation and financial closure							
31	In-time land acquisition							

Appendix A2: Content Validation of housing PPP model selection factors

Adama Science and Technology University

School of Civil Engineering and Architecture

MSc. Program in Construction Engineering and Management

Dear Participants,

I am currently undertaking a Master of Science (MSc.) degree in construction engineering and management at Adama Science and Technology University (ASTU). As a partial fulfillment of the academic program, I am conducting research entitled "**A Prospect for the Implementation of Public-private Partnership in the Ethiopian Housing Provision**" which aims to study the rationale behind adopting public-private partnerships in the Ethiopian housing provision and to support the potential implementation of the system

in the country. In this regard, I respectfully request you to participate in this research, because your contribution to this study is essential, and I highly value your input. This questionnaire is designed to assess the relevance of predetermined criteria for selecting PPP models within the specific context of housing projects and the Ethiopian initiative.

This questionnaire consists of two sections. The first section gathers information about the participant, while the second section focuses on content validation. Completing the entire questionnaire is expected to take approximately 20 to 30 minutes of your time. Please read each question or instructions carefully and try to answer all questions honestly and to the best of your knowledge. Please note that your responses will be kept confidential and anonymous and will be used only for academic purposes. I greatly appreciate your cooperation and contribution to the realization of this research. If you have any questions about the survey, please contact me at +251924335275/ eyobaww@gmail.com, or my telegram account @Yobid.

Thank you!
Eyob Wondwossen
Adama, Ethiopia
May 20

Governments around the world are utilizing various PPP contractual arrangements (PPP models) to cope with the change in project characteristics and stakeholders' preferences. These PPP models differ basically in the type of asset involved, what function the private party is responsible for, and how the private party is compensated for its role in the partnership. DBF, DBFM, DBFOM, and so on are among the few models. Selecting the appropriate model that best fits the project characteristic, project objective, and stakeholders' preference is the first step towards the successful implementation of the system, this modality selection process must be conducted based on pre-determined criteria that consider the project characteristics, stakeholders' preference, and prevailing local condition

Part 1: Information of the Respondent

1.1 Name of your organization: _____

1.2 Please state your level of education

BSc. degree ☐ MSc. degree ☐ Ph.D. ☐

1.3 What is your current position/role in your organization?

Project Manager ☐ Director ☐ Project engineer ☐

Procurement specialist ☐ PPP expert ☐ Other ☐

1.4 Please state your years of experience

≤ 5 years	6 – 10 years	11 – 15 years	16 – 20 years	> 20 years
☐	☐	☐	☐	☐

Part 2: Content validation format

What are the criteria for the selection of a Public-Private Partnership (PPP) model for housing projects? Table 2 outlines the factors that influence the choice of a PPP model for housing projects. These factors have been identified from previous research conducted in various countries and sectors, as well as from reference to the PPP user manual of India and the World Bank. Please evaluate the relevance of these model selection factors in relation to housing projects, considering the goals and objectives of the Ethiopian housing sector PPP initiative. Use the rating scale available in Table 1 for your evaluation. For additional clarification, please refer to the short descriptions of each factor.

Table 1. Four-point rating scale to evaluate factor relevance

Rating scale	**Implication**
1	The factor is not relevant
2	The factor is somewhat relevant
3	The factor is quite relevant
4	The factor is highly relevant

Table 2. PPP model selection factors

No	**PPP model selection factors**	**1**	**2**	**3**	**4**
1	Access to private-sector capital to finance the project				
2	Utilization of skills and expertise of the private sector and stimulation of innovation				
3	Improved housing project/service quality				
4	Facilitating technology transfer				
5	Early project completion/delivery				
6	Lowering construction, operation, and maintenance cost				
7	Reduction in public sector administration cost				
8	Government preference to transfer maintenance risks				

9	Government preference to transfer operation and maintenance risk in an integrated way				
10	Private sector off-take and cost recovery risk-taking preference				
11	Private sector interest in maintenance risk				
12	Acceptability to the interest group and general public				
13	Ownership arrangement for the house units				
14	Alignment of the option with the objective of housing sector policy				
15	Affordability (acceptability of rent or purchase price)				
16	Public sector capital support and provision of guarantee				
17	Availability and form of state subsidy				
18	Adequacy of the political, legal, and institutional framework of the country to the contractual and organizational arrangements required to rule the project				
19	Public sector financial capacity				
20	Macroeconomic certainty				
21	Political support for the project				
No	**PPP model selection factors**	**1**	**2**	**3**	**4**
22	Availability and source of developable land				
23	Availability of potential private sector				
24	Availability of mature financial institution/market				
25	Project commercial viability				
26	Project financial viability				
27	Project technical feasibility				
28	Development mix of the proposed housing project				
29	Environmental sustainability				
30	Benefits of local economic development				

Appendix A3: Focus Group Discussion

Adama Science and Technology University

School of Civil Engineering and Architecture

MSc. Program in Construction Engineering and Management

Dear Participants,

I am currently undertaking a Master of Science (MSc.) degree in construction engineering and management at Adama Science and Technology University (ASTU). As a partial fulfillment of the academic program, I am conducting research entitled "**A Prospect for the Implementation of Public-private Partnership in the Ethiopian Housing Provision**" which aims to study the rationale behind adopting public-private partnerships in the Ethiopian housing provision and to support the potential implementation of the system in the country. As a part of the research, this focus group discussion aims to investigate the interconnection between the factors that influence the selection of the PPP model for housing projects, this will streamline the complex decision-making process in selecting a suitable PPP model for housing projects. In this regard, I respectfully request you to participate in this focus group discussion, because your contribution to this study is essential, and I highly value your input. Please note that your participation and opinion will be kept confidential and anonymous and will be used only for academic purposes. I greatly appreciate your cooperation and contribution to the realization of this research. Please note that your participation and opinion will be kept confidential and anonymous and will be used only for academic purposes. I greatly appreciate your cooperation and contribution to this research.

Thank you,

Eyob Wondwossen

Adama, Ethiopia

May 2023

The table below presents a list of 25 relevant factors that play a crucial role in determining the appropriate PPP model for housing projects. In this focus group discussion, our primary objective is to explore the relationships between these factors through pairwise comparisons. For instance, when comparing two factors, A and B, we aim to examine the type of influence or connection between them. There are four potential scenarios: Factor A influencing Factor B, Factor A being influenced by Factor B, Factors A and B mutually influencing each other, or Factors A and B having no influence on each other. Consequently, in this focus group discussion, our goal is to investigate these relationships among the model selection factors.

Table. PPP model selection factor for housing projects

No	Model selection factors	No	Model selection factors
1	Access to private-sector capital to finance the project	14	Alignment of the option with the main objectives of the housing sector policy
2	Utilization of skills and expertise of the private sector and stimulation of innovation	15	Ownership arrangements for the housing units
3	Facilitating technology transfer	16	Public sector financial capacity
4	Improved housing project/service quality	17	Public sector capital support and provision of guarantee
5	Lowering construction, operation, and maintenance cost	18	Availability of potential private sector
6	Reduction in public sector administration cost	19	Project commercial viability
7	Early project delivery/completion	20	Project financial viability
8	Government preference to transfer maintenance risks	21	Project technical feasibility
9	Government preference to transfer operation and maintenance risks in an integrated way	22	Development mix of the proposed project
10	The private sector's interest in maintenance risk	23	Macroeconomic certainty
11	Private sector off-take and cost recovery risk-taking preference	24	Adequacy of the political, legal, and institutional framework of the country to the contractual and organizational arrangements required to rule the project
12	Affordability (acceptability of rent or purchase price)	25	Availability and source of development land
13	Acceptability to the interest group and general public		

Appendix A4: Framework Validation

Adama Science and Technology University

School of Civil Engineering and Architecture

MSc. Program in Construction Engineering and Management

Dear Experts,

I am currently undertaking a Master of Science (MSc.) degree in construction engineering and management at Adama Science and Technology University (ASTU). As a partial fulfillment of the academic program, I am conducting research entitled "**A Prospect for the Implementation of Public-private Partnership in the Ethiopian Housing Provision**" which aims to study the rationale behind adopting public-private partnerships in the Ethiopian housing provision and to support the potential implementation of the system in the country. As a specific research objective, this study has created a framework designed to facilitate the decision-making process when choosing an appropriate Public-Private Partnership (PPP) model for housing projects. The validation of this framework by experts can enhance its credibility, ensuring that it aligns with essential quality standards and embodies best practices. Therefore, I respectfully request your validation of the framework, as your feedback is valuable, and I greatly appreciate your input. Please note that your participation and opinion will be kept confidential and anonymous and will be used only for academic purposes.

I greatly appreciate your cooperation and contribution to this research. If you have any questions about the survey, please contact me at +251924335275/ eyobaww@gmail.com, or my telegram account @Yobid.

Thank you,

Eyob Wondwossen

Adama, Ethiopia

May 2023

Please evaluate the framework in terms of the following aspects: Applicability, Reliability, Appropriateness, Suitability, and Objectivity. Using the rating scale provided in Table 1. Please refer to the short definition provided for each validation aspect.

Table 1: Rating scale

Rating scale	**Value of the scale**
Very Low	1
Low	2
Moderate	3
High	4
Very High	5

Table 2: validation form

Validation aspect	1	2	3	4	5
Applicability					
Reliability					
Appropriateness					
Suitability					
Objectivity					

A short definition of the validation aspects

Applicability: This refers to the framework's ability to effectively assist decision-makers in selecting the most suitable PPP model for a housing project in real-world scenarios. Essentially, it measures the framework's practicality, relevance, and usefulness in facilitating informed decisions regarding housing PPP projects.

Reliability: This means how well the framework consistently provides dependable and consistent guidance when choosing the most appropriate PPP model for a given housing project. Decision-makers can trust that the framework's recommendations remain stable and accurate across multiple evaluations, ensuring reliable support in making PPP model choices.

Appropriateness: This refers to the extent to which the framework proves its effectiveness and appropriateness in adapting to the particular circumstances and needs of the decision-making process. It assesses the framework's capacity to consider the distinct features of the project, the preferences of stakeholders, the dynamic local conditions in the country, and the specific initiative being considered. Making the framework a valuable instrument for making well-informed decisions concerning the selection of a Public-Private Partnership (PPP) model.

Suitability: This means that the framework is effective in helping decision-makers choose the most appropriate PPP model for a given project or situation. It ensures that the framework provides valuable guidance and criteria to assess and match the specific needs and characteristics of the project with the available PPP models, resulting in a well-informed and optimal decision.

Objectivity: This means that it provides an unbiased and impartial assessment, free from personal bias or external influence. Such a framework ensures that decisions about which PPP model to choose are made based on fair and neutral criteria rather than subjective opinions or interests. It promotes fairness and transparency in the decision-making process.

Appendix A5: Factor Analysis

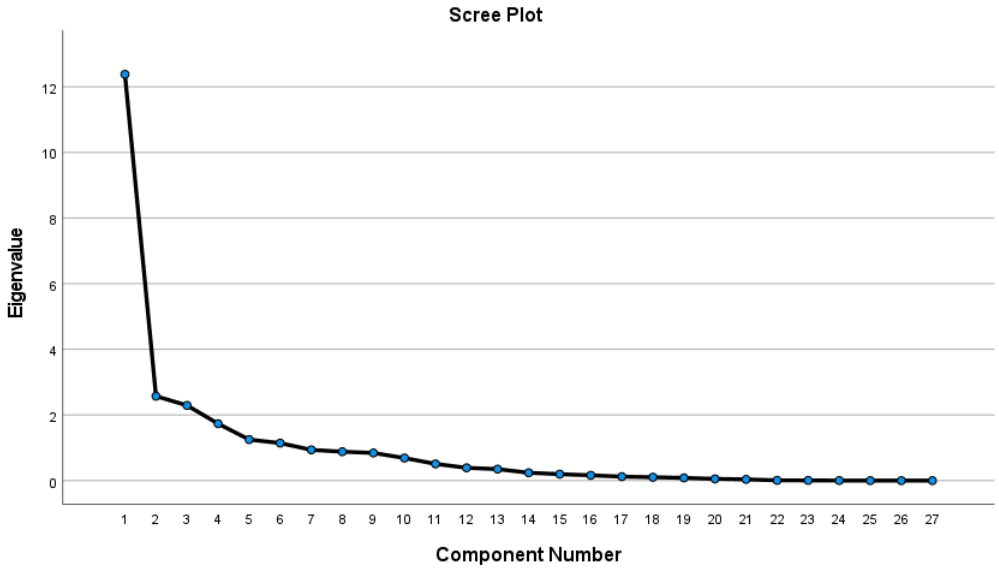

Figure: Screen Plot of the factor analysis on the driving factors

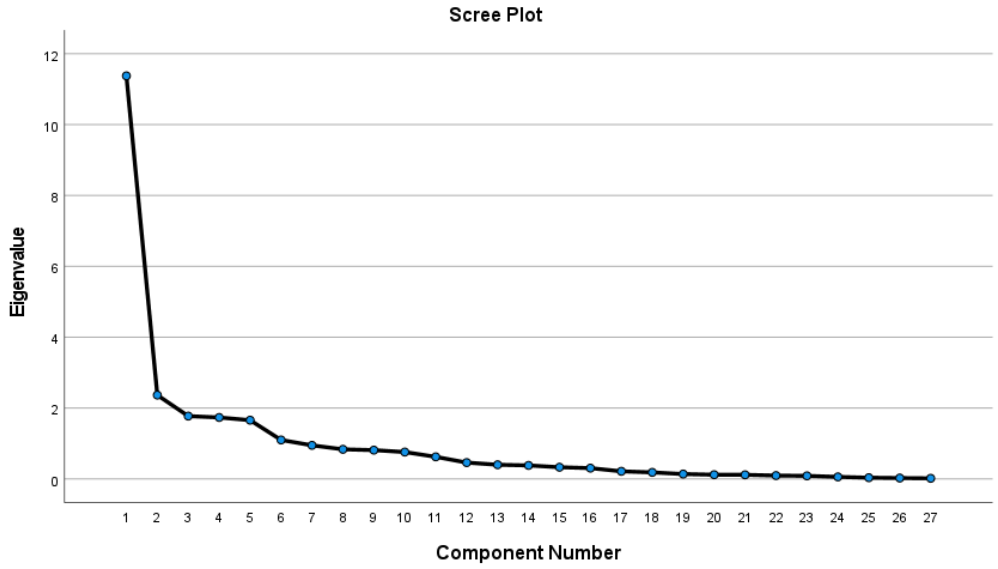

Figure: Figure: Screen Plot of the factor analysis on the enabling factors

Appendix A6: Level Partitioning of Interpretive Structural Modelling (ISM)

Table E. Level Partitioning 1st Iterations

MSFs	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi)∩A(Ni)	Level
1	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	

2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20,	2, 14, 18, 21, 22, 25,	2,	
3	3, 8, 9,	2, 3, 14, 18, 21, 22, 25,	3,	
4	1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20,	2, 4, 14, 16, 18, 21, 22, 25,	4,	
5	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	
6	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	
7	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	
8	8,	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	8,	1
9	9,	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	9,	1
10	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	
11	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	
12	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	
13	13,	1, 2, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	13,	1
14	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21, 22,	14,	14,	
15	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17, 19, 20,	14, 15, 16, 22, 23, 24, 25,	15,	
16	1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 19, 20,	16,	16,	
17	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	

18	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 18, 19, 20,	18,	18,	
19	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	
20	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	
21	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20, 21,	14, 21, 22, 25,	21,	
22	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17, 19, 20, 21, 22,	14, 22, 25,	22,	
23	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17, 19, 20, 23,	23, 24,	23,	
24	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17, 19, 20, 23, 24,	24,	24,	
25	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17, 19, 20, 21, 22, 25,	25,	25,	

Table: Level Partitioning Iterations 2

MSFs	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi)∩A(Ni)	Level
1	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
2	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2, 14, 18, 21, 22, 25,	2,	
3	3,	2, 3, 14, 18, 21, 22, 25,	3,	2
4	1, 4, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2, 4, 14, 16, 18, 21, 22, 25,	4,	
5	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
6	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
7	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2

8		1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,		1
9		1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,		1
10	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
11	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
12	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
13		1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,		1
14	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 14, 15, 17, 19, 20, 21, 22,	14,	14,	
15	1, 5, 6, 7, 10, 11, 12, 15, 17, 19, 20,	14, 15, 16, 22, 23, 24, 25,	15,	
16	1, 4, 5, 6, 7, 10, 11, 12, 15, 16, 17, 19, 20,	16,	16,	
17	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
18	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 17, 18, 19, 20,	18,	18,	
19	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
20	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,	1, 5, 6, 7, 10, 11, 12, 17, 19, 20,	2
21	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 17, 19, 20, 21,	14, 21, 22, 25,	21,	
22	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 15, 17, 19, 20, 21, 22,	14, 22, 25,	22,	
23	1, 5, 6, 7, 10, 11, 12, 15, 17, 19, 20, 23,	23, 24,	23,	

24	1, 5, 6, 7, 10, 11, 12, 15, 17, 19, 20, 23, 24,	24,	24,	
25	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 15, 17, 19, 20, 21, 22, 25,	25,	25,	

Table: Level Partitioning Iterations 3

MSFs	**Reachability Set R(Mi)**	**Antecedent Set A(Ni)**	**Intersection Set R(Mi)∩A(Ni)**	**Level**
1		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		2
2	2, 4,	2, 14, 18, 21, 22, 25,	2,	
3		2, 14, 18, 21, 22, 25,		2
4	4,	2, 4, 14, 16, 18, 21, 22, 25,	4,	3
5		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		2
6		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		2
7		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		2
8		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		1
9		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		1
10		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		2
11		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		2
12		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		2
13		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		1
14	2, 4, 14, 15, 21, 22,	14,	14,	
15	15,	14, 15, 16, 22, 23, 24, 25,	15,	3
16	4, 15, 16,	16,	16,	
17		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		2
18	2, 4, 18,	18,	18,	
19		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		2
20		2, 4, 14, 15, 16, 18, 21, 22, 23, 24, 25,		2
21	2, 4, 21,	14, 21, 22, 25,	21,	
22	2, 4, 15, 21, 22,	14, 22, 25,	22,	
23	15, 23,	23, 24,	23,	

24	15, 23, 24,	24,	24,	
25	2, 4, 15, 21, 22, 25,	25,	25,	

Table: Level Partitioning Iterations 4

MSFs	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi)∩A(Ni)	Level
1		2, 14, 16, 18, 21, 22, 23, 24, 25,		2
2	2,	2, 14, 18, 21, 22, 25,	2,	4
3		2, 14, 18, 21, 22, 25,		2
4		2, 14, 16, 18, 21, 22, 25,		3
5		2, 14, 16, 18, 21, 22, 23, 24, 25,		2
6		2, 14, 16, 18, 21, 22, 23, 24, 25,		2
7		2, 14, 16, 18, 21, 22, 23, 24, 25,		2
8		2, 14, 16, 18, 21, 22, 23, 24, 25,		1
9		2, 14, 16, 18, 21, 22, 23, 24, 25,		1
10		2, 14, 16, 18, 21, 22, 23, 24, 25,		2
11		2, 14, 16, 18, 21, 22, 23, 24, 25,		2
12		2, 14, 16, 18, 21, 22, 23, 24, 25,		2
13		2, 14, 16, 18, 21, 22, 23, 24, 25,		1
14	2, 14, 21, 22,	14,	14,	
15		14, 16, 22, 23, 24, 25,		3
16	16,	16,	16,	4
17		2, 14, 16, 18, 21, 22, 23, 24, 25,		2
18	2, 18,	18,	18,	
19		2, 14, 16, 18, 21, 22, 23, 24, 25,		2
20		2, 14, 16, 18, 21, 22, 23, 24, 25,		2
21	2, 21,	14, 21, 22, 25,	21,	
22	2, 21, 22,	14, 22, 25,	22,	
23	23,	23, 24,	23,	4
24	23, 24,	24,	24,	
25	2, 21, 22, 25,	25,	25,	

Table: Level Partitioning Iterations 5

MSFs	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi)∩A(Ni)	Level
1		14, 18, 21, 22, 24, 25,		2
2		14, 18, 21, 22, 25,		4
3		14, 18, 21, 22, 25,		2
4		14, 18, 21, 22, 25,		3
5		14, 18, 21, 22, 24, 25,		2

6		14, 18, 21, 22, 24, 25,		2
7		14, 18, 21, 22, 24, 25,		2
8		14, 18, 21, 22, 24, 25,		1
9		14, 18, 21, 22, 24, 25,		1
10		14, 18, 21, 22, 24, 25,		2
11		14, 18, 21, 22, 24, 25,		2
12		14, 18, 21, 22, 24, 25,		2
13		14, 18, 21, 22, 24, 25,		1
14	14, 21, 22,	14,	14,	
15		14, 22, 24, 25,		3
16				4
17		14, 18, 21, 22, 24, 25,		2
18	18,	18,	18,	5
19		14, 18, 21, 22, 24, 25,		2
20		14, 18, 21, 22, 24, 25,		2
21	21,	14, 21, 22, 25,	21,	5
22	21, 22,	14, 22, 25,	22,	
23		24,		4
24	24,	24,	24,	5
25	21, 22, 25,	25,	25,	

Table: Level Partitioning Iterations 6

MSFs	**Reachability Set R(Mi)**	**Antecedent Set A(Ni)**	**Intersection Set R(Mi)∩A(Ni)**	**Level**
1		14, 22, 25,		2
2		14, 22, 25,		4
3		14, 22, 25,		2
4		14, 22, 25,		3
5		14, 22, 25,		2
6		14, 22, 25,		2
7		14, 22, 25,		2
8		14, 22, 25,		1
9		14, 22, 25,		1
10		14, 22, 25,		2
11		14, 22, 25,		2

12		14, 22, 25,		2
13		14, 22, 25,		1
14	14, 22,	14,	14,	
15		14, 22, 25,		3
16				4
17		14, 22, 25,		2
18				5
19		14, 22, 25,		2
20		14, 22, 25,		2
21		14, 22, 25,		5
22	22,	14, 22, 25,	22,	6
23				4
24				5
25	22, 25,	25,	25,	

Level Partitioning Iterations 7

MSFs	**Reachability Set R(Mi)**	**Antecedent Set A(Ni)**	**Intersection Set R(Mi)∩A(Ni)**	**Level**
1		14, 25,		2
2		14, 25,		4
3		14, 25,		2
4		14, 25,		3
5		14, 25,		2
6		14, 25,		2
7		14, 25,		2
8		14, 25,		1
9		14, 25,		1
10		14, 25,		2
11		14, 25,		2
12		14, 25,		2
13		14, 25,		1
14	14,	14,	14,	7
15		14, 25,		3
16				4
17		14, 25,		2
18				5
19		14, 25,		2
20		14, 25,		2
21		14, 25,		5
22		14, 25,		6
23				4
24				5
25	25,	25,	25,	7