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College of Business and Economics
School of Commerce

Titles of the Thesis: Navigating Critical Success Factors in Public Private Partnership Housing Projects.

In Partial Fulfillment of the Requirement for Award of Masters of Arts Degree In project management.

Department: MA in Project Management.

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ECLARATION

I hereby declare that the work which is being presented in this thesis entitled **"Navigating Critical Success Factors in Public–Private Partnership Housing Projects - Fuzzy Analytic Hierarchy Process (FAHP)"** is my original work carried out under his supervision. It has not been presented for a degree of any other university/ Institute and all sources of materials used for this thesis are fully acknowledged.

Name of Candidate Signature

Date Tewodros Sebsibe

15/10/2016

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LIST OF ACRONYMS

BNPi -	Best Non-Fuzzy Performance Value
CSF-	Critical Success Factor
CR-	Consistency Ratio
CI -	Consistency Index
FAHP -	Fuzzy Analytic Hierarchy Process
KMO-	Kaiser-Meyer-Olkin
PPP -	Public Private Partnership
ri -	Fuzzy Geometric Mean Value
SPSS-	Statistical Package for Social Scientists
TFN-	Triangular Fuzzy Numbers
V1 -	Political Factors
V2 -	Social Factors
V3 -	Economic Factors
V4 -	Environmental Factors
V5 -	Administration Factors
V6 -	Technology Factor
wi -	Fuzzy Weights

ABSTRACT

The purpose of this study was to initially identify and subsequently establish a model for evaluating the impact of critical success factors in public-private partnership housing projects. The success of public- private partnerships in housing projects can be evaluated in terms of good governance, effective legal structures, affordability, and quality of the housing environment which are measured through timely completion, cost control, and stakeholder satisfaction. The objective of this study is to evaluate the critical success factors for public-private partnership housing projects in Addis Ababa Ethiopia. A research approach is mixed which involves both quantitative and qualitative and exploratory factor analysis and fuzzy analytic hierarchy process models for assessing the factors impacting the successfulness of public-private partnerships in housing projects. A review of empirical literature came out with 25 critical success factors which were ranked by experts and industry practitioners through semi-structured interviews, questionnaire surveys, and pair-wise comparison. Purposive and simple random sampling was used as an approach that selected participants based on their knowledge, experience, and specific role in public-private partnership housing

projects. These critical success factors were grouped using exploratory factor analysis, and they served as the input variables for fuzzy analytic hierarchy process analysis. The six components were a political factor, social factor, economic factor, environmental factor, administrational factor, and technology factor. The value of the fuzzy analytic hierarchy process model developed can serve as a multi-dimensional critical success factors framework that can be used as a success attainment tool for public-private partnership housing projects. For policy developers and stakeholders, the model serves as a pointer to issues that the government/public sector must focus on to attract huge investments from the private sector in the housing sector.

Keywords: Public-private partnership, Critical success factor, Fuzzy AHP, Factor analysis, Housing project,

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

Public-private partnerships (PPPs) are increasingly vital worldwide for fostering economic development and infrastructure projects. These collaborations between governments and the private sector aim to stimulate entrepreneurial growth, create favorable business environments, and accelerate socio-economic progress. PPPs involve long-term contracts sharing risks and private financing, evolving into various forms and models globally. The concept gained prominence in the 1990s as a response to the limitations of traditional public administration, leading to reforms in governance and service delivery (Ayhan and Üstüner, 2023).

A public- private partnership is a long-term agreement between a contracting authority and a third party to provide or contribute to the provision of a public service activity and obtain a revenue stream for providing such service from end-user charges, government budget, or a combination of the two(Council, 2004.) Eight solar photovoltaic projects, six hydroelectric projects, three toll road projects, five wind power projects, one affordable housing development project, and one petroleum storage depot project are all being approved and implemented by contracting authorities as part of Ethiopia's expanding public-private partnership initiatives under the Ministry of Finance (Ewenetu et al., 2025). The public and private sectors work together to build and administer housing developments through public-private partnerships (Abdullahi and Alias, 2022).

The components of critical success factors (CSFs) play an essential role in ensuring the success of a project when adequately addressed; conversely, their disregard may fail. The methodology employed in addressing CSFs is designed to identify key factors contributing to success in project management. Recognizing CSFs is a fundamental first step in developing a successful framework for public-private partnerships For public-private partnership housing projects to be effective, critical success factors (CSFs) must be identified. Collaboration, openness, assurance, licenses, sociopolitical support, anticipated profitability, technical viability, risk distribution, contract system, infrastructure, transferred assets, transfer acceptance standards, and overhaul data are some of these elements. By focusing on these CSF

stakeholders can enhance project outcomes such as housing quality, affordability, timely completion, cost control, and stakeholder satisfaction (Ramík, 2023). Understanding and implementing these critical factors can lead to the effective implementation of PPP housing projects, ensuring success in both product quality and project management aspects. The critical success factors (CSFs) identified in various studies can indeed serve as a decision support system for decision-makers, project managers, and housing sector professionals. Prioritizing these factors can be effectively done using methodologies like the fuzzy analytic hierarchy process (AHP) to ensure that the most critical aspects are addressed first, enhancing the overall project outcomes. By utilizing CSFs and AHP, decision-makers can make informed decisions, project managers can focus on key areas, and professionals can streamline their efforts toward achieving success in housing projects.

The fuzzy analytic hierarchy process (FAHP) model integrates various levels and sublevels, employing pair-wise comparisons to assess the relative significance and relationships among elements (Chen and Huang, 2022)**.** It allows decision-makers to prioritize criteria and sub- criteria based on participant feedback, enhancing the understanding of critical elements affecting results (Moslem et al., 2022). Additionally, FAHP aids in reducing bias in expert judgments by combining them with algorithmic judgments, ensuring more objective decision results.

Factor analysis is a statistical analytic technique that begins with the examination of the internal relationships between variables in order to reduce certain complex variables to a small number of complete factors. As a result, original data can be categorized and combined, making it easier to classify variables that are more closely related (Wang and Cheng, 2019). and the fuzzy AHP summary to determine the priority weights.

Traditional AHP assumes precise judgments; however, expert opinions regarding PPP housing projects are often subjective and uncertain. In Ethiopia, housing project decisions are influenced by political, economic, social, and institutional uncertainties. Therefore, Fuzzy AHP was selected because it captures linguistic judgments such as "more important" and "very important" more effectively than conventional AHP, thereby reducing ambiguity in decision-making.

1.2. Statement of the Problem

Housing provision refers to the process of ensuring the availability of adequate and suitable housing to encounter the needs of the residents. It involves the planning, development, and implementation of strategies and initiatives to address the housing shortage and provide affordable and accessible housing options. The current situation in Addis Ababa aims to address challenges such as housing shortages, lack of adequate living conditions, and affordable housing options in central neighborhoods.

Public and private sector cooperation is one of the ways to integrate different sectors to improve affordable housing development. These partnerships include cooperation between the government, municipalities, and private entities to address housing needs and encourage urban renewal. Public-private partnerships (PPPs) in housing development represent an important strategy for urban development and encourage cooperation between the public and private sectors. The public-private partnership directorate general under the Ministry of Finance has taken the initiative to implement affordable housing development projects in the PPP modality. The initiative is set to be executed in Addis Ababa via a public-private partnership, targeting around 79,800 households or 399,000 individuals from the low and middle-income groups in Addis Ababa who are predicted to derive benefit from the project (Ewenetu et al., 2025). The Addis Ababa city administration oversees the development of 60,000 housing units through the public-private partnership program. Guidelines and directives have been established to govern the collaboration between governmental and public entities participating in the housing initiative. Various private firms have shown interest and are actively engaged in housing development projects within the PPP framework.

There was a significant problem in understanding the specific project management practices that contribute to the success of such partnerships, particularly in the Addis Ababa context. The specific critical success factors (CSFs) that contribute to the success of PPP housing development projects in the city's unique situation are yet to be studied and adequately understood.

Although PPP housing initiatives have been launched in Addis Ababa and several institutional frameworks have been established, there is still limited empirical evidence identifying and prioritizing the critical success factors that determine project success. Existing initiatives focus on implementation, while little attention has been given to understanding which factors have the greatest influence on project performance. This knowledge gap limits evidence-based decision-making and may contribute to project delays, cost overruns, and stakeholder dissatisfaction.

1.3. Research Questions

In consideration of the problem statement described above, the following fundamental research survey questions will be examined:

- ✓ What critical success factors influence PPP housing projects in Addis Ababa?
- ✓ What are the relative importance and priority rankings of the identified critical success factors?
- ✓ What implications do this critical success factors have for policymakers and PPP stakeholders?

1.4. Objectives of the Study

1.4.1. General Objective

The general objective of this study was the navigation of the critical success factors in public-private partnership housing projects in Addis Ababa Ethiopia.

1.4.2. Specific Objectives

- ✓ To explore the specific critical success factors (CSFs) that have a significant impact on the success of public-private partnership housing projects.
- ✓ To analyze the relative importance of different critical success factors (CSFs) in the context of Addis Ababa.
- ✓ To rank the key success factors (CSFs) according to their relative significance and influence on the success of housing projects involving public-private partnerships.

1.5. Significance of the Study

The study aims to explore and understand the critical success factors in public-private partnership housing projects. The housing sector has conducted few research on the factors that facilitate PPP adoption in Ethiopia, especially in Addis Ababa. This study looked into how Ethiopian stakeholders perceived the key success factors (CSFs) that affect PPP adoption. Nonetheless, the following factors make the study significant.

Firstly, the study provides a sympathetic applied explanation for decision-makers by framing critical success factors (determinants) to enhance the successfulness of public-private partnership housing projects through improving project management practices which can lead to better planning, execution, and overall project outcomes.

Secondly, the study further provides a significant source of secondary data for academicians and researchers to get knowledge, skill, and understanding of critical success factors in public-private partnership housing projects and make further exploration on the topic as required.

Thirdly, the Identification and prioritization of determinants in PPP housing projects offer a means to analyze the most significant factors through the utilization of factor analysis and fuzzy AHP techniques. This approach can further enhance comprehension regarding how scholars and professionals undertake research by integrating these practical methodologies.

Finally, the methodology of the fuzzy analytical hierarchy process is instrumental in optimizing decision-making efficiency by assessing the weight of each affecting factor among uncertainties. Moreover, it aids in facilitating the successful execution of public-private partnership housing projects across the project's entire lifecycle.

1.6. Scope of the Study

The scope of the study is related to concepts that focus on identifying the essential elements that contribute to the achievement of objectives in PPP housing projects. The study would involve reviewing existing literature and consulting with experts to determine these CSFs. when exploring CSFs, how Fuzzy AHP can be applied to assess the relative importance of different CSFs in PPP housing projects, considering the inherent complexities and potential for varying stakeholder perspectives. The geographical scope of the study is urban housing construction in Ethiopia, especially the urban housing construction and development projects in Addis Ababa city. Respondents were selected from the Ministry of Finance PPP Directorate, Addis Ababa Housing Development and Administration Bureau, private real estate developers, housing professionals, and residents. Data collection was conducted between January and March 2026. The study considered 125 survey respondents for EFA, 10 experts for pairwise comparison, and 5 key informants for interviews.

1.7. Limitations of the Study

The first restriction on the research study's data gathering is that it was limited to government officials, commercial developers working on PPP housing projects, and employees of both public and private institutions. As a result, their opinions of the CSFs required for the implementation are limited to that particular situation. The smaller sample size of respondents, which can be linked to Ethiopia's very early adoption of the PPP approach, is another drawback Nevertheless, this study provides an implementation picture and CSFs required for the implementation of PPPs within Ethiopia's housing sectors, notwithstanding the constraints mentioned. Lastly, the factor identification procedure, which necessitates high computational requirements, is the primary limitation of this study. This increases the complexity and duration of the factor analysis and fuzzy AHP integrating model.

CHAPTER TWO

2. Theoretical Literature Review

2.1. Introduction

The effectiveness of public-private partnership housing projects relies heavily on the proficient handling of critical success factors. Numerous research works emphasize the difficulty and obstacles linked with PPP housing activities. Investigations conducted in Nigeria underscore the importance of early detection and distribution of risks to maintain the sustainability of PPP mass housing projects (Ezebilo, 2023)**.** The fuzzy analytic hierarchy process (FAHP) is a decision-making framework that has been widely employed to prioritize and examine factors across several fields. This literature review aims to explore the theoretical, empirical, and methodological foundations of navigating critical success factors in PPP housing projects using fuzzy AHP, examining relevant studies that have applied this approach.

2.1.1. Public-Private Partnerships in Housing Projects

Public-private partnerships (PPPs) in the realm of housing developments entail cooperative efforts between public authorities and private sector organizations to promote and oversee housing accomplishments. The primary objective of these collaborations is to tackle issues related to housing accessibility and standards, by capitalizing on the assets and knowledge of both sectors (Oluwaseyi et al., 2023). The partnerships aim to alleviate the housing needs of both sectors, encourage sustainable growth, and advance the overall quality of housing projects. Public-private partnerships (PPPs) involve collaboration between the public and private sectors to deliver public services or projects, with shared responsibilities and accountabilities. PPPs are recognized for stimulating economic development, fostering entrepreneurial growth, and accelerating infrastructure projects (Fabre and Straub, 2023). In urban regeneration, PPPs play a crucial role in addressing urban degradation and optimizing land use, despite facing obstacles like high investment risks and uncertainty (Kort and Klijn, 2011) . While PPP literature is abundant globally, there is a lack of comprehensive studies on PPPs in Ethiopia, indicating a growing momentum for PPP adoption in the country. The success of PPPs hinges on factors like contract design, regulation, and institutional issues, emphasizing the importance of effective administration and financial frameworks.

2.1.2. Critical Success Factors in PPP Housing Projects

Public-private partnership projects, such as housing initiatives, depend heavily on critical success factors (CSFs). Numerous research has discovered and classified CSFs. For instance, the political climate, national PPP unit, asset quality and social support, strength of association, and partner commitment are the five main CSFs. According to the model's results, these elements generally have a "very high" beneficial impact on a water supply project's successful implementation (Ameyaw and PC Chan, 2016). Similar to this, teamwork and collaboration, financial sustainability, and contractual obligations are emphasised as crucial CSFs for the success of smart city infrastructure projects (Baiyewu et al., 2023). Moreover, the effective execution of the transfer phase in PPP projects, like in Chinese water projects, emphasized critical transfer success factors (CTSFs) such as contract systems and infrastructure, which are vital for achieving successful project outcomes (Baiyewu et al., 2025). These findings collectively underscore the importance of CSFs in driving the achievement of project goals and outcomes in PPP housing projects.

2.1.2.1. Political factor

The political situation is indicative of the stability within the political sphere, while the active engagement and dedication of the government establish conducive circumstances to stimulate the engagement of private developers in public-private partnership initiatives. In general, for the success of the projects, a stable political environment for the country and the government has a great contribution to the public-private partnership (Gudienė et al., 2013b).

2.1.2.1.1. Stability of political system

The stability of the political system constitutes a significant concern that impacts public-private partnership housing initiatives. Frequent changes in government policies can disrupt the long-term nature of public-private partnerships and threaten the enforceability of contracts (Verma and Stellacci, 2010). In environments characterized by high levels of instability, there exists a potential threat of governmental acquisition of privately owned resources. This serves as a deterrent for private enterprises to engage in collaborations with the public sector. A politically stable environment Enhances the feasibility of long-term strategic planning, project advancement, and growth by fostering trust, and reliability, and attracting investment for a public-private partnership.

project. A stable government can have well-defined legal frameworks and transparent processes, which are essential for successful public-private partnerships (Jiboye, 2011).

2.1.2.1.2. Political will

Strong political determination enhances investor trust, guarantees the seamless progression of projects, and empowers the proficient handling of stakeholders. Governments need to prioritize PPP housing projects and allocate necessary resources, such as land or tax breaks, to incentivize private sector participation (Wang et al., 2020). Political will exemplifies dedication and enables the allocation of resources. It serves a crucial function in enhancing communication and overseeing the concerns of different stakeholders, guaranteeing consistency and averting interruptions caused by alterations in policy direction or shifts in governmental and political authority. A lack of robust political determination may result in delays in approval, obstacles posed by bureaucracy, and a dearth of impetus to propel the project as a whole. In the absence of resolute political determination, projects might favor immediate benefits at the expense of long-lasting viability. Consequently, this could give rise to challenges like housing being beyond financial reach or substandard construction principles.

2.1.2.1.3. Providing guarantee/support to developers

Granting assurances and assistance to developers serves as a potent mechanism for fostering prosperous collaborations between the public and private sectors in the realm of housing projects. By alleviating risks, enhancing financial arrangements, and accelerating the progression of development, these strategies have the potential to result in an increased quantity of housing units that are affordable. Nevertheless, it is imperative to exercise prudent deliberation to steer clear of disproportionate burdens on the public budget and to ensure the implementation of conscientious project supervision. Guarantees can mitigate various risks associated with public-private partnership housing projects (Kavishe and Chileshe, 2019). Financial risks such as fluctuations in construction costs and regulatory risks like unexpected changes in building codes are among the considerations to be taken into account. The mitigation of these risks enhances the project's appeal to potential developers.

2.1.2.1.4. Appropriate legal and regulatory framework

Several developing countries have struggled with attracting private sector investment in public-private partnership housing projects due to weak legal frameworks (Trangkanont and Charoenngam, 2014). A suitable legal and regulatory structure serves as the foundation for the efficacy of public-private partnership housing initiatives. This framework fosters confidence, mitigates risks, promotes openness, and safeguards the welfare of the populace. Through the establishment of unambiguous guidelines and processes, governmental bodies can cultivate an appealing atmosphere for involvement from the private sector, consequently delivering essential affordable housing remedies. A lack of clarity in the legal framework acts as a deterrent for private sector involvement, primarily stemming from perceived risks and a deficiency in transparency. Consequently, this constrains the available pool of competent developers and diminishes competitiveness, ultimately resulting in potentially unfavorable conditions for the public sector. Without clear legal safeguards, there is a risk that public-private partnership housing projects will prioritize short-term profits over long-term social benefits (Kumari, 2014). The public may ultimately be faced with inadequately built or financially burdensome residential structures. Ambiguities within statutes and regulatory frameworks have the potential to result in postponements in authorizations, disagreements regarding contractual conditions, and possible litigious situations. Such circumstances introduce unpredictability for every party involved and impede the progression of the project.

2.1.2.1.5. Government commitment in providing land

Acquiring land poses a significant obstacle for developers engaged in housing initiatives. By providing suitable land at a reasonable cost, the government significantly reduces a major expense for developers (Ibem and Aduwo, 2012). This allows them to focus resources on construction and ultimately lowers the final cost of housing units. Locating appropriate land, especially within densely populated regions, may present a significant challenge. Authorities may find it necessary to investigate alternative strategies such as redevelopment or the utilization of public land characterized by limited development prospects.

2.1.2.1.6. Government provision of infrastructure

Accessing fundamental infrastructure such as roads, water supply, sewage systems, and electricity is imperative for housing initiatives. Allocation of resources by the government in these sectors enhances the appeal of the project to private investors and alleviates their financial

obligations. The government's role in providing essential infrastructure is critical for successful public-private partnerships in housing projects (Gudienė et al., 2013a). The absence of infrastructure may cause substantial delays in the construction and occupation process, thus affecting not only the financial gains of the private developer but also the overall schedule of the project. The public-private partnership agreement must unambiguously delineate the respective obligations of each party with the provision of infrastructure. This entails clearly outlining the areas that fall under the purview of the government (such as major thoroughfares and essential services) and those that may be assigned to the private entity (for instance, internal pathways and amenities situated on the premises.

2.1.2.2. Social factor

Cultural values, health, lifestyle, and residents' overall well-being are the main social variables (Un-Habitat, 2012). In a similar vein, it has been observed that the health, safety, and general well-being of the inhabitants are greatly impacted by the location and appropriate design of housing building as well as their relationship to the cultural, social, and economic aspects of the community. Conversely, social CSFs included sustainable housing key performance metrics that take into account the various needs, household sizes, cultural backgrounds, and individual traits. According to Oyebanji et al. (2017), these elements include community involvement, infrastructure provision, stakeholders, security of life and property, and social cohesion. The social component is therefore crucial to the success of PPPs. The factor has been measured using five attributes.

2.1.2.2.1. Security and safety issues

Security and safety represent fundamental aspects to be taken into account for the effective implementation of public-private partnerships (PPPs) in the realm of housing initiatives. By executing a holistic approach that combines physical security protocols, community involvement, and societal inclusiveness, the collaborating entities from the public and private sectors can establish a prosperous and safe habitat for the inhabitants. A safe and secure living environment is a top priority for residents (Putrik et al., 2015) .When a public-private partnership initiative emphasizes security protocols, it enhances its appeal to prospective tenants or purchasers, resulting in increased occupancy levels and possibly warranting elevated rental prices for specific accommodations.

2.1.2.2.2. Housing near the places of work and worship

Residing in proximity to workplaces and places of worship can diminish travel durations, decrease transportation expenses, and offer individuals more opportunities to engage in familial interactions or religious practices. Such proximity has the potential to contribute to increased satisfaction among residents and foster a heightened communal spirit. Reduced travel times result in decreased traffic congestion and a reduction in emissions of greenhouse gases. This is following the objectives of both the public and private sectors in advancing sustainable development. Developing residential properties close to sought-after areas such as offices and religious institutions may present difficulties as a result of constraints such as scarce land resources or elevated land expenses (Kuma and Ighalo, 2015). This can increase project costs and potentially reduce the number of affordable housing units offered.

2.1.2.2.3. Provision of recreational/ sporting facilities

High-grade recreational amenities such as parks, playgrounds, and fitness centers can greatly augment the appeal of development to prospective inhabitants, resulting in increased occupancy levels and possibly warranting elevated rental prices for certain accommodations. Easy access to recreational facilities encourages residents to engage in physical activity and social interaction, fostering a healthier and more vibrant community (Modisane et al., 2019). This is in line with the objectives of public health. The establishment and upkeep of leisure facilities entail a substantial initial capital outlay from the private entity, which could potentially influence the viability of the project. Furthermore, continual expenditures for maintenance must be taken into consideration. The creation of versatile areas that can cater to different functions (for example, a park that also functions as a space for community events) has the potential to optimize the utilization of land and potentially lower construction expenses.

2.1.2.2.4. Level of social mix in the housing environment

A carefully structured social diversity strategy has the potential to enhance public-private partnerships (PPPs) in housing initiatives by fostering a more enduring, appealing, and diverse community (Capp et al., 2022). However, careful strategizing, clear communication, and sustained dedication from all invested parties are imperative for achieving success. The integration of different social groups can cultivate a sense of community and belonging among residents from various income brackets. This process can aid in diminishing

the negative connotations often linked with affordable housing and establish a more comprehensive societal setting. The effective establishment of a social blend necessitates meticulous planning and oversight from both governmental and private collaborators. Disputes arising from the quantity and nature of affordable accommodations, or their positioning within the development, have the potential to generate conflicts.

2.1.2.2.5. Adaptable housing design and construction

Adaptable housing design can be a valuable asset for PPPs in housing projects (Kostourou and Psarra, 2017). Though, both public and private stakeholders must thoroughly evaluate the potential advantages and obstacles. The provision of public incentives or shared-cost initiatives may mitigate initial expenses for developers, whereas coherent design principles can ensure that adaptable features are feasible and align with the future requirements of occupants. Constructing residences that can be readily altered to cater to evolving needs such as expanding families or aging inhabitants enhances the scope of potential buyers. This can draw a more diverse group of residents, resulting in increased occupancy rates and potentially diminishing the long-term vacancy risks faced by private developers.

2.1.2.3. Economic factor

Economic factors represent the economic circumstances impacting the accessibility and cost-effectiveness of housing financing. Through initiatives including cheap rent, lower mortgage interest rates, subsidised building materials, efficient resource usage, and strong governance, economic CSFs support the development of sustainable housing (Oyebanji et al., 2017). claims that a stable macroeconomic climate is necessary to support the property market in Addis Ababa, Ethiopia, and that low-interest long-term financing should be available. In general, a nation's ability to successfully implement PPPs is influenced by its economic climate. Economic factors have been measured using five criteria. Low equity contribution

Insufficient levels of public equity investments within public-private partnership housing initiatives necessitate careful strategizing and innovative resolutions. While it can expedite project initiation and attract private sector expertise, it's crucial to mitigate the potential downsides like reduced affordability and project quality. By employing alternative methods of funding, implementing a phased approach to development, and establishing well-defined

project goals, it is possible to effectively facilitate a collaborative venture that addresses the objectives of both the public and private sectors (Mekawy, 2014).

2.1.2.3.1. Stable macro-economic environment

A stable macroeconomic environment is a critical factor for successful PPPs in housing projects. Fostering investor confidence, reducing project risk, and ensuring long-term sustainability, a stable economy creates fertile ground for collaboration between public and private sectors to deliver much-needed housing solutions.

2.1.2.3.2. Access to housing loan

Access to housing loans is a crucial factor for the success of PPPs in housing projects. Ensuring residents have the financial means to purchase homes; PPPs can achieve their goals of creating a vibrant and sustainable community while also achieving financial viability for private developers. Collaboration between public and private sectors, along with initiatives to improve financial literacy and access to mortgages, can play a key role in overcoming these challenges(Bansal, 2014).

2.1.2.3.3. Low lending cost (interest charged)

Low lending costs can be a powerful tool for making PPPs in housing projects more financially viable and fostering affordable housing opportunities. However, careful planning and clear project objectives are essential to mitigate potential drawbacks and ensure the project delivers long-term benefits for both residents and the community. With lower borrowing costs, private developers can see higher profit margins on the project. This incentivizes them to participate in PPPs and potentially offer more competitive rents or invest in higher-quality construction materials. Lower lending costs can translate into more affordable mortgages for residents purchasing units within the project (Kerubo, 2013). This is arranged in line with public sector goals of increasing access to housing and promo
ting homeownership.

2.1.2.3.4. Housing affordability

Affordable housing units within the PPP project contribute to the public sector's goal of providing decent and accessible housing for all residents (Ibem, 2011). This fosters social inclusion and community stability. It is an option that attracts residents who can invest in the local economy, contributing to the project's long-term sustainability. Balancing affordability with quality construction requires careful planning and cost-effective measures.

Utilizing innovative materials or prefabricated construction techniques can help reduce costs without compromising durability.

2.1.2.4. Environmental Factor

In the built environment, housing, people, and the environment are interdependent (Oyebanji et al., 2017). It was noted that environmental CSFs support the prudent use of sustainable materials, reducing their environmental impact and producing the greatest possible use. These elements frequently encourage environmental pollution, waste reduction, and biodiversity, all of which support a low-carbon economy (Enwin and Ikiriko, 2021).

2.1.2.4.1. Quality of housing environment

Prioritizing a high-quality housing environment in PPP projects is not just about aesthetics; it's about creating a sustainable and livable space that benefits both residents and the project's long-term success (Ezebilo, 2023). Careful planning, collaboration between public and private partners, and a focus on resident well-being are key to achieving this goal. Utilizing sustainable design principles like energy efficiency, water conservation, and use of natural materials can create a healthy living environment while reducing long-term operational costs. Well-designed and well-maintained housing units with access to green spaces, good natural light, and a sense of community are highly desirable to residents. Creating a high-quality environment can require upfront investment from the private developer in terms of using better construction materials, incorporating sustainable design features, and ensuring adequate green space. This needs to be balanced with affordability goals.

2.1.2.4.2. Waste management system

A clean and efficient waste management system reduces unpleasant odors, pests, and potential health hazards. This leads to a more pleasant living environment and higher resident satisfaction. The PPP agreement needs to clearly define the responsibilities of the public and private partners for waste management (Spoann et al., 2019). This includes aspects like collection, sorting, recycling, and disposal, along with cost-sharing mechanisms. Exploring co-investment models where the public sector contributes funding or facilitates access to waste management infrastructure can lessen the burden on private developers.

2.1.2.4.3. Open spaces and green areas

Green spaces have numerous well-documented benefits for physical and mental health. They encourage physical activity, reduce stress, and improve air quality. This aligns with public health goals and promotes a healthier living environment for residents. Open spaces contribute to urban biodiversity, provide natural storm water management, and help mitigate the urban heat island effect. This demanded growing public and private sector commitments to environmental sustainability. Pocket parks, green roofs, or vertical gardens can provide green space in limited areas. Utilizing innovative design solutions can optimize land use and create visually attractive spaces.

2.1.2.4.4. Noise level

Effective noise management is a pivotal element in ensuring the success of public-private partnerships (PPPs) within the realm of housing initiatives. Prolonged exposure to excessive noise has the potential to result in a myriad of health concerns such as disruptions in sleep patterns, elevated levels of stress, and even impairment in auditory functions. Such outcomes run security to the overarching objective of the public sector, which aims to cultivate environments that support overall well-being. The amplified levels of noise stemming from sources like vehicular traffic, ongoing construction activities, or neighboring commercial establishments can markedly diminish the desirability of the housing development among prospective inhabitants. Utilizing building materials with good sound insulation properties, strategic landscaping, and proper building orientation can passively reduce noise intrusion. Additionally, sound barriers or double-glazed windows can be employed in specific locations. Finding the right balance between noise mitigation and affordability is essential.

2.1.2.5. Technological Factor

Technology can have a profound impact on public-private partnerships (PPPs) in housing projects, affecting various aspects from design and construction to resident safety and project management. Advancements in prefabricated construction, modular housing, and sustainable materials can shorten construction times, reduce waste, and potentially make housing development more affordable (Liu et al., 2022). Technology should not be an end in itself. PPP agreements should focus on using technology to create a more sustainable, efficient, and resident-centric living environment.

2.1.2.5.1. Technology innovation

Innovations like prefabricated housing modules and advanced materials can revolutionize construction. This can lead to faster project completion times, reduced waste, and potentially lower overall costs for developers. As technology becomes more integrated, concerns about data security and resident privacy become paramount and ownership protocols need to be established within the PPP agreement. Technological innovation in housing projects for PPP and adopting a collaborative and adaptive approach, public and private partners can create future-proof housing solutions that are sustainable, and resident-centered and contribute to improvements in the housing sector (Korovkina et al., 2021).

2.1.2.5.2. Technology transfer

The process of technology transfer is one of paramount importance within public-private partnerships (PPPs) aimed at housing projects, significantly impacting the success of projects and the overall development of the local housing sector (Selim and ElGohary, 2020).This emphasizes the need for effective measures to promote housing development, such as community-based organization approaches and mortgage housing schemes within PPP initiatives. The PPP agreement should clearly outline intellectual property rights and potential licensing agreements to incentivize knowledge sharing from the private partner. Transfer of knowledge and expertise from the private partner to local construction companies can lead to the adoption of more efficient building methods, better quality materials, and ultimately, higher-performing housing units. PPPs with a focus on technology transfer can create a platform for knowledge exchange between international developers and local stakeholders. This can stimulate local innovation in construction practices and building technologies.

2.1.3. Empirical literature review

2.1.3.1 Fuzzy AHP Approaches to explore critical success factors in PPP housing projects

In this study, multi-criteria decision-making is used, and each critical success factor is determined for successful implementation in public-private partnership housing projects. The study has five main constraints that are determined by evaluating the stakeholders of the public-private partnership modality. In many areas of study, decision-makers must solve the problem systematically, accurately, and reliably according to their preferences. Multi-criteria decision-making (MCDM) is particularly useful in this area, where each problem requires a unique decision and prioritization of alternatives.

Multiple criteria decision-making (MCDM) has grown as a part of procedural research, concerned with designing computational and mathematical tools for supporting the objective assessment of performance criteria by decision-makers (Zavadskas et al., 2014). One of the first research studies on multi-criteria decision-making was when Benjamin Franklin published his research on the concept of moral algebra (Azhar et al., 2021). Since the 1960s, MCDM has been an active research area and has produced many theoretical and practical articles and books (Greco et al., 2016). There are various techniques for solving MCDM problems such as AHP, TOPSIS, ELECTRE, rough sets theory, and multi-objective programming (Esmaili Dooki et al., 2017). The main differences between these methods are the level of complexity of the algorithm, the weighting methods for the criteria, the way of representing the evaluation criteria of choices, the probability of uncertain data, and finally, the type of data aggregation (Taherdoost and Madanchian, 2023).

The AHP method has emerged as a useful decision-making method by dividing the problem into small pieces (Azhar et al., 2021). Decision-makers help to visualize the problem in solving complex problems and analyzing them (Azhar et al., 2021). Fuzzy AHP (FAHP) is one of the most popular MCDM methods for employee selection, where some generated criteria are weighted according to their importance and the candidates are evaluated based on them (Esmaili Dooki et al., 2017).

Therefore, this paper applies the Fuzzy AHP approach to explore the critical success factors in PPP housing projects, which have not been investigated in the literature so far, and the criteria considered in this study are completely new. In real life, the evaluation of various subjective criteria and the weight of criteria are often expressed in linguistic terms. Also, to effectively resolve the frequent ambiguities in available data and to do more justice to the essential fuzziness in human judgment and choice, fuzzy set theory has been used to formulate ill-defined multi-criteria decision-making problems (Hummel et al., 2014).

2.1.3.2 Methods of Fuzzy AHP

The Analytic Hierarchy Process (AHP) established by Thomas L. Saaty is a multi-criteria decision-making (MCDM) method applied in situations of uncertainty or to overcome important problems. By dividing the decision problem into sub-components, each of which can be interpreted separately and more naturally understood, it reduces the risk of making wrong decisions and ensures the correct decision (Mumcu and Gök, 2021).

This study aims to use the fuzzy AHP approach to identify and evaluate the five most important factors that influence the success of a public-private partnership housing project, which in turn influence the successful performance of a housing development project as described above. AHP methods have been widely used to determine the importance of various conditions and actions in multi-criteria problems (Taylan et al., 2014). Unlike previous studies, the current study assessed the five main factors and sub-factors that could affect a PPP housing project. The Analytic Hierarchy Process (AHP) is a method that "relies on pairwise comparisons of measurements and expert judgment to obtain priority scales" (Ayalew et al., 2022).

The AHP method is also a multi-criteria analysis method based on a weighting process, in which several related attributes are represented by their relative importance (Hummel et al., 2014). Through the AHP, the importance of multiple attributes is derived from a paired comparison process where the relevance of intangible asset driver attributes or categories is matched in a hierarchical structure.

The importance of decision criteria relative to others is evaluated using the fuzzy AHP method on quantitative scale linguistic terms on a pairwise comparison matrix and used as a systematic technique to address the inaccuracy of decision-makers (Basahel and Taylan, 2016). In the classic AHP method, the objective is at the first level, the requirements are at the second level, and the available options are at the third level (Khairudin et al., 2020). Therefore, Saaty's AHP application has some weaknesses as follows. They pointed out that the AHP method is mostly used in decision applications with clear data. The AHP method creates and operates a highly unbalanced judgment and does not take into account the uncertainty associated with assigning human judgment to numbers in natural language. The level of the AHP method is highly inaccurate and has a significant impact on the results of the AHP (Hummel et al., 2014). So, the fuzzy numbers were used to describe experts' preferences and fuzzy arithmetic was used to compute fuzzy ranking. Fuzzy AHP is a method in which pairwise comparisons of criteria and alternatives are obtained using fuzzy triangular numbers to represent linguistic variables. One of the first applications of fuzzy AHP is that it provides more accurate results than the original crisp method(Sun, 2010) . When choosing between multiple alternatives under overlapping judgments.

2.1.3.3 Fuzzy numbers and fuzzy sets

Zadeh initially proposed fuzzy logic to address ambiguity-related issues and integrate imprecise data into the decision framework (Esmaili Dooki et al., 2017). Fuzzy numbers can therefore be used to represent the ambiguous data, and these numbers can then undergo mathematical operations in the fuzzy domain. Fuzzy sets, linguistic variables, probability distributions (membership functions), and fuzzy if-then rules are only a few of the many ideas and methods that make up fuzzy logic (Mehrjerdi, 2012). Two fundamental ideas in qualitative evaluation are fuzzy sets and linguistic variables. According to Khairudin et al. (2020) and Zolkepli and Aris (2019), the fundamental concept of fuzzy set theory is that an element has a degree of membership in a fuzzy set.

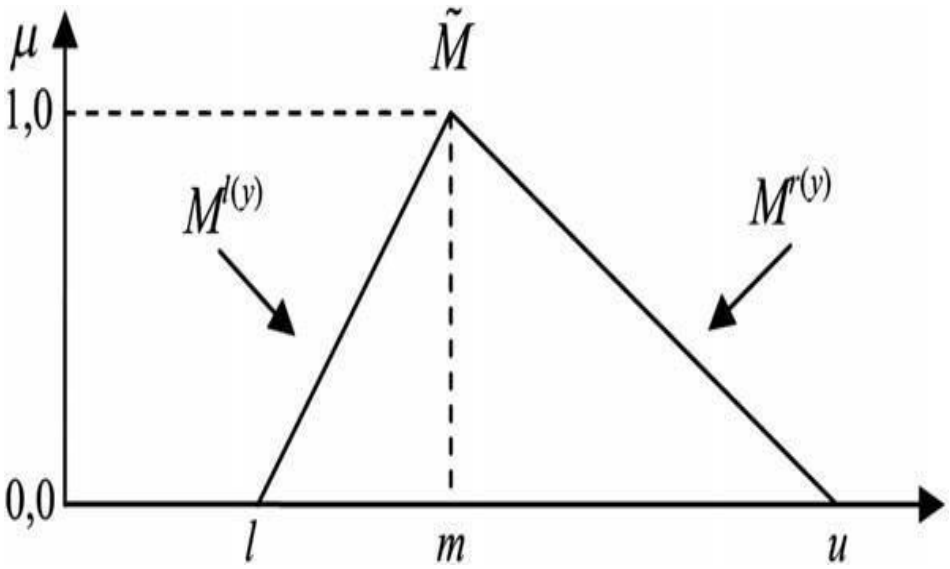
A Triangular Fuzzy Number (TFN) $\tilde{m}$ can be defined by a triplet (l, m, u) as illustrated in Figure 1. The parameters l, m, and u (l< m< u), denote the smallest possible value, the most promising value, and the largest possible value that describes a fuzzy event. Each TFN has linear representations on its left and right sides, such that its membership function can be defined as(Khairudin et al., 2020, Zolkepli and Aris, 2019) .

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

A fuzzy number (FN) can always be given by its corresponding left and right representation of each degree of membership as follows:

$$M = M^{l(y)}, M^{r(y)} = [l + (m - 1)y, u + (m - u)y], y \in [0,1]$$

Where, $l(y)$ and $r(y)$ denote the left-side representation and the right-side representation of a fuzzy number (FN), respectively.



Triangular fuzzy number (Zolkepli and Aris, 2019).

Fuzzy numbers are created by fuzzification from crisp values. A membership function serves as a representation of this conversion. According to Getawa Ayalew et al. (2024), a membership function is a curve that shows how each point between 0 and 1 is characterised by a membership value (degree of membership) between 0 and 1.

Triangular Fuzzy Numbers (TFN), a center-based triangulation technique, was employed in this work using a triangle membership function. An intuitive and computationally efficient representation is the primary justification for the use of triangular fuzzy numbers (Fathi et al., 2011). A variable whose values are words or phrases in a natural or artificial language rather than numbers is called a linguistic variable. According to Zolkepli and Aris (2019), the idea of language dynamics is seen to be a helpful way to give an approximate description of extremely complicated or ambiguous phenomena that cannot be explained using traditional numerical words.

2.2 Conclusion

The potential applications and benefits of CSFs are now used in many organizations. In this sense, previous researchers have focused on identifying critical success factors for public-private partnerships to successfully implement PPP projects. Therefore, CSFs selected by prior researchers for PPP projects by different authors are presented in table 2.1. Critical success factors for PPP projects have specific features in different countries, but this background provides a basis for evaluating the CSFs and organizing semi-structured interviews and surveys as early as possible.

Table 2.1. Items measures of the proposed critical success factors for PPPs housing projects

Factors	Items	Items measures	Literature sources
Political Factors	V11	Stability of the political system	(Ademiluyi, 2010)
	V12	Political will	(Jiboye, 2011)
	V13	Providing guarantee /support to developers	(Debela, 2022)
	V14	Appropriate legal and regulatory framework	(Chou and Pramudawardhani, 2015)
	V15	Government commitment in providing land	(Ibem et al., 2018)
	V16	Government provision of infrastructure	(Mukhtar et al., 2017)
	V21	Security and safety issues	(Ibem et al., 2011)
	V22	Housing near to the places of work and worship	(Ibem et al., 2011)
	V23	Provision of recreational / sporting facilities	(Ibem et al., 2011)
	V24	Level of social mix in housing environment	(Ibem et al., 2011)
	V25	Adaptable housing design and construction	(Mukhtar et al., 2017)
Economic Factors	V31	Low equity contribution	(Lambrecht and Tollin, 2017)
	V32	Stable macro-economic environment	(Kahwajian et al., 2014)
	V33	Access to housing loan	(Ibem, 2011)
	V34	Low lending cost (interest charged)	(Ibem, 2011, Ibem et al., 2011)
	V35	Housing affordability	(Ibem et al., 2011)
Environmental Factors	V41	Quality of housing environment	(Ibem et al., 2011)
	v42	Waste management system	(Ibem et al., 2011)
	V43	Open spaces and green areas	(Ibem et al., 2011)
	V44	Noise Level	(Ibem et al., 2011)

Technology factors	V51	Technology innovation	(Osei-Kyei and Chan, 2017)
	V52	Technology transfer	(Osei-Kyei and Chan, 2017)
Administrational factors	V61	Appropriate risk allocation and sharing	(Chileshe et al., 2022)
	V62	Government providing financial support	(Babatunde et al., 2016)
	V63	Environmental impact of project	(Berisha et al., 2022)

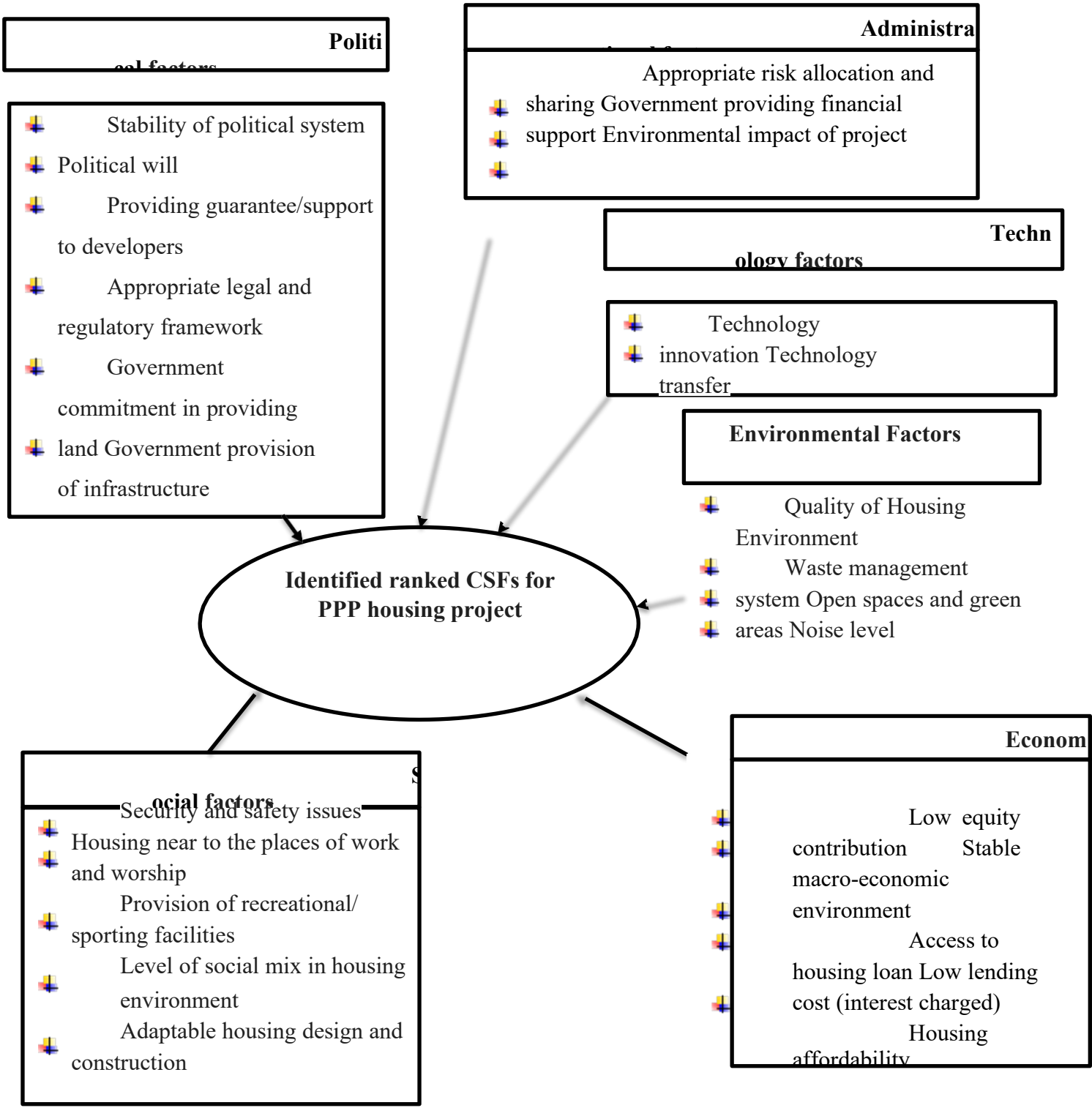
2.3 Research Gaps

When exploring critical success factors (CSFs) in public-private partnership housing projects, a notable gap arises it's the lack of extensive prior research, as seen in the context of affordable housing PPPs in Addis Ababa. This gap places interest in the need for further investigation into CSFs specific to housing projects, especially in the context of PPP implementation. Existing studies emphasize the significance of factors such as financial sustainability, partnership and collaboration, and contractual duties in enhancing PPP performance in smart city infrastructure projects in the context of other nations.

Additionally, it is acknowledged that the evaluation of important success criteria is inherently subjective and imprecise in terms of methodology. As a result, it appears that the traditional AHP is not adequate to capture the needs of the decision maker. Fuzzy sets can be used as an extension of AHP with pairwise comparison to represent such ambiguity in human choice. As a result, fuzzy AHP was developed to take use of people's capacity for accepting ambiguity and uncertainty in their thought processes (de FSM Russo and Camanho, 2015).

2.4 Conceptual Framework

Developing a solid conceptual framework using the fuzzy analytical hierarchy process (FAHP) is critical to guide the research on critical success factors (CSFs) in public-private partnership housing projects. Using the conceptual framework of various factors involved, we can conduct a comprehensive and insightful analysis of critical success factors in public-private partnership housing projects. This can contribute valuable knowledge to improve the design, implementation, and impact of such projects to address housing needs and promote sustainable development.



Conceptual framework

CHAPTER THREE

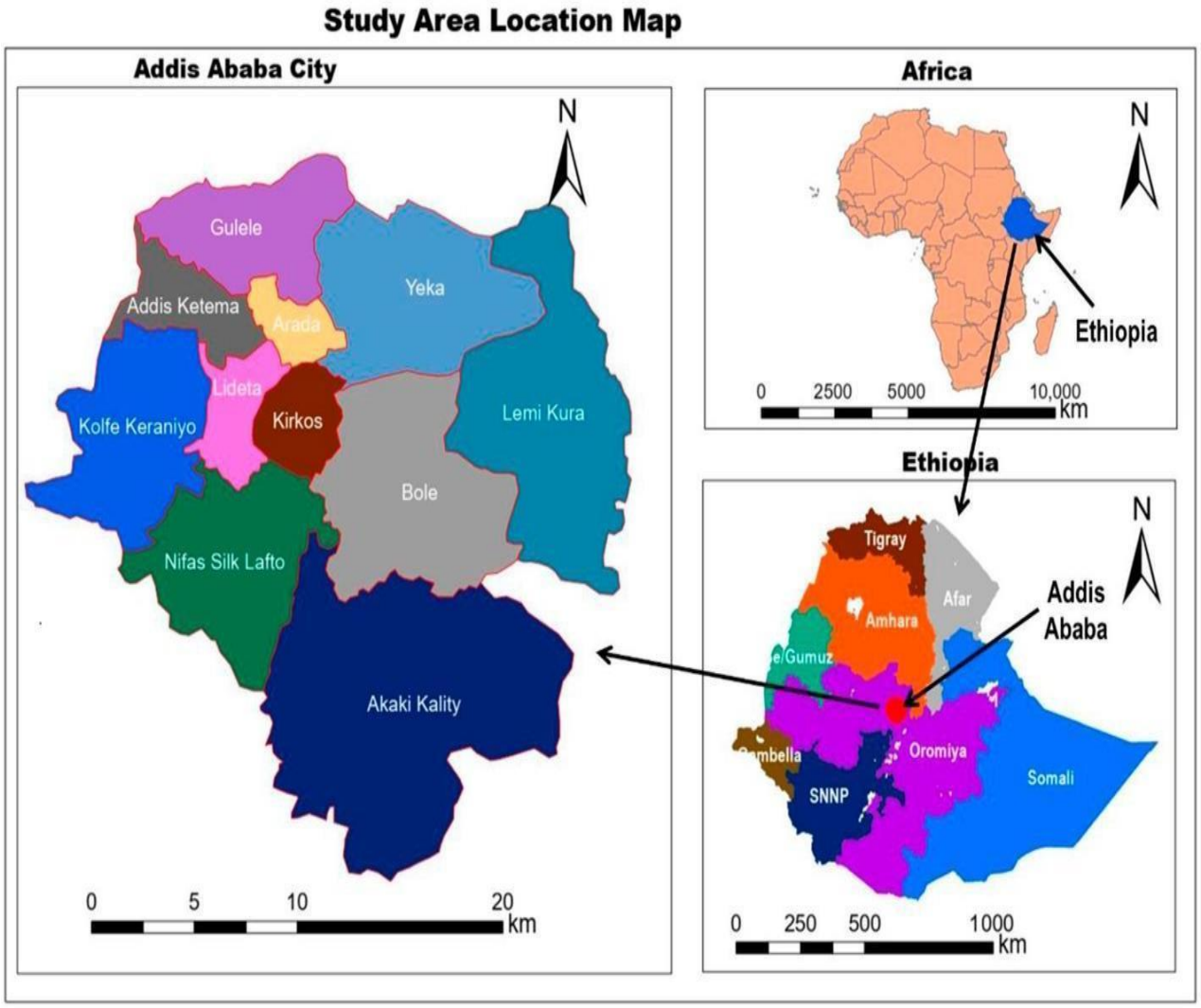
3. RESEARCH METHODOLOGY

3.1. Introduction

This section covers the research approach, research design, demographic characteristics of the study population, sample size and sampling technique, and sampling procedure. Furthermore, explains the method and procedures for data collection and analysis through statistical analysis which involves factor analysis and Fuzzy AHP analysis model finally interpretation of the research findings.

3.2. Location of Study Area

The investigation will be carried out on the principal and most populous urban center of Ethiopia, Addis Ababa, which has expanded into a major city with a population exceeding 5.7 million in the year 2024. Situated on a highland in the central region of Ethiopia, Addis Ababa is positioned at an elevation of approximately 8,200 feet (2,500 meters). This elevated position results in the city experiencing a moderate and vitalizing climate, characterized by an average temperature of approximately 15 degrees Celsius. Addis Ababa is currently experiencing a notable surge in housing development efforts to challenge the rising need for housing, especially in terms of affordable alternatives. There exist two primary strategies for housing development in Addis Ababa, namely public-private partnerships and largest private housing project. The municipal administration is engaging in cooperation with private developers through a 70/30 arrangement. Under this scheme, developers construct 70% of the housing units for commercial sale, while the remaining 30% are designated for low-income residents at subsidized prices (Gitu Nijhawan and Singh, 2023). This strategy aims to enhance the housing supply and cater to various income brackets within the public-private partnership framework. Recently, a large project by the Ovid group received approval. This particular project represents a significant infusion of private sector funds directed towards alleviating the housing deficit.



Source from Google map

Figure 3.1- Study Area Location Map

3.3. Research Design

A mix research methodology is utilized, integrating elements of both quantitative and qualitative research, in order to gather data for the study's purpose. Quantitative approaches will employees through the distribution of questionnaires to gather data on the magnitude of variables utilizing the Likert scale. Conversely, qualitative investigation will be carried out to address the fuzzy AHP multi-criteria decision-making (MCDM) issue in order to rank the significance of input factors employing Saaty's scale. The utilization of Fuzzy AHP frequently involves subjectivity and demands extensive expertise in the field from practitioners and professionals in the industry. The fuzzy analytic hierarchy process (AHP) model facilitates the conversion of subjective expert knowledge into an objective input variable index. On the other

hand, exploratory factor analysis is a quantitative multivariate technique that defines the connections among a group of continuously measured variables using various linearly independent reference variables. Exploratory Factor Analysis (EFA) was used to reduce and validate the large number of critical success factors identified from the literature into meaningful dimensions. Subsequently, Fuzzy AHP was applied to prioritize these validated dimensions by incorporating expert judgments and handling uncertainty in pairwise comparisons. The integration of EFA and FAHP therefore provides both statistical validation and practical prioritization

This research employs descriptive research designs concerning the methods to be utilized. The objective of descriptive approaches is to clarify and interpret occurrences while assessing the current state of affairs. In order to identify and quantify the significant achievements of public-private partnerships in Addis Ababa and to identify important areas for improvement, this study verifies and chooses a suitable methodology. This study was conducted in six steps: literature review, semi-structured interviews, survey questionnaire, data analysis, identification of CSFs, and conclusion and recommendation.

As shown in Figure 3.2 a step- by-step procedure is followed to achieve the goal of this study. The primary aim of this research was to navigate critical success factors in public–private partnership housing projects through the combination of exploratory factor analysis and fuzzy AHP methodologies. Exploratory factor analysis is one of the statistical techniques used to reduce correlational data into fewer dimensions or factors. In a similar vein, the Fuzzy AHP is a popular method for building an assessment model.

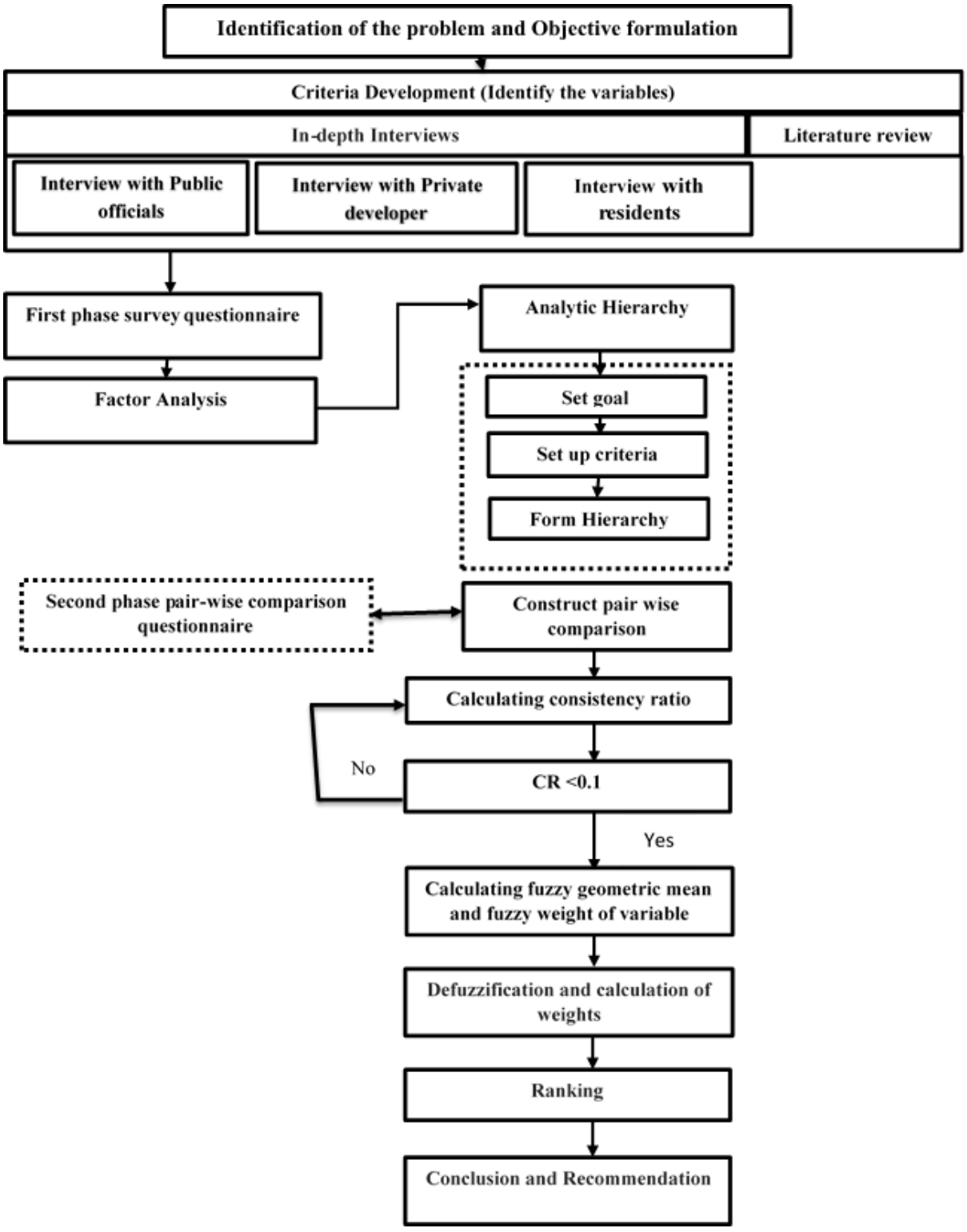


Figure 3.2-Methodology Flowchart

3.4. Population of the Study Area

The word "people" usually does not refer to specific people. Rather, it specifies the total number of the type of object being examined. Perhaps there are only subgroups of this demographic that the researchers are interested. The selected category is the sample frame. The target demographic of the study will involve public authorities, private housing developers, and professionals who worked at the Addis Ababa Housing Development and Corporation Bureau, Ovid Group, Gift Real State, the Finance Minister PPP department, and residents.

3.5. Sampling Technique

This study employed both simple random sampling and purposive sampling techniques. Simple random sampling was used to select respondents for the Exploratory Factor Analysis (EFA) survey to ensure that each participant had an equal chance of being selected. The respondents included public officials, housing professionals, private developers, and residents involved in or affected by PPP housing projects in Addis Ababa.

Purposive sampling was employed for the Fuzzy Analytic Hierarchy Process (FAHP) analysis. Experts were selected based on their professional knowledge, educational background, and experience in PPP housing projects. Only experts possessing a Master's degree or higher and having a minimum of five years of relevant PPP experience were considered for participation in the pairwise comparison process.

3.6 Sample Size

The study was conducted in two phases with different sample groups.

Group 1: Exploratory Factor Analysis (EFA) Survey Respondents

For Exploratory Factor Analysis, a total of **125 respondents** were selected. The sample consisted of:

- Public officials involved in PPP projects
- Housing professionals
- Private developers
- Residents associated with PPP housing projects

The sample size was determined based on the rule of thumb commonly used in factor analysis, which recommends a sufficient number of observations to ensure reliable factor extraction and validation.

Group 2: Fuzzy Analytic Hierarchy Process (FAHP) Expert Panel

For the FAHP analysis, **10 experts** were purposively selected to conduct pairwise comparisons and evaluate the relative importance of the identified critical success factors. The experts met the following criteria:

- Minimum qualification of a Master's degree
- At least five years of professional experience in PPP projects, housing development, project management, or related fields
- Demonstrated technical and practical knowledge of PPP housing projects

The use of 10 experts is consistent with FAHP studies, where emphasis is placed on the quality and expertise of respondents rather than a large sample size.

This separation clearly distinguishes the respondents used for **factor validation (EFA)** from those used for **factor prioritization (FAHP)**, thereby enhancing the methodological rigor of the study

3.6. Sources of Data Collection

First, an interview, questionnaire survey, and Saaty's scale questionnaire will be the main sources of data used in this study to investigate the most important success factors in public-private partnership housing projects. In the second section, the data collection method is defined in the literature to address the research question and is extracted based on what was indicated in earlier studies that are appropriate for conducting the current study.

The assessment of critical success factors (CSFS) in public-private partnership housing projects utilizing the analytic hierarchy process (AHP) emphasizes the importance of appropriate data sources. The necessity of acquiring primary data through interviews and initial and follow-up surveys, involving public officials and private developers, is crucial for comprehending CSFS in PPP projects. These interviews and surveys will offer valuable insights into elements vital for the achievement of PPP accomplishments in housing projects. Through the direct acquisition of data from the specified population, scholars can access firsthand information that can guide decision-making procedures and enhance the efficiency of PPP policies and practices in housing.

The secondary data is obtained through a review of existing material such as published journals, PPP records, newspapers, published and unpublished theses, books, and the internet regarding public-private partnerships and their critical success factor. National and Addis

Ababa city housing authorities publish reports on PPP projects, housing needs, and demographics. The World Bank, UN-Habitat, and other organizations collect and publish data on public-private partnerships and the housing sector.

3.7. Method of Data Collection

The potential applications and benefits of CSFs are now used in many organizations. In this sense, previous researchers have focused on identifying critical success factors for public, private partnerships to successfully implement PPP projects. Therefore, CSFs selected by prior researchers for PPP projects by different authors are presented in Table 2.1. Critical success factors for PPP projects have specific features in different countries, but this background provides a basis for evaluating the CSFs and organizing semi-structured interviews and surveys as early as possible.

3.7.1. Interview

The process of data collection through in-depth interviews will conducted in Addis Ababa with the finance minister PPP department, Addis Ababa Housing Development and Administration, and the Gift real estate. First, a list of CSFs of PPP success factors is determined following thorough research reviews. These in-depth, semi-structured interviews are carried out with various academic and construction industry professionals who have at least five years of PPP implementation experience. The purpose of the interview is to help the researchers determine the measuring tool's content validity with regard to PPPs in the Addis Ababa environment.

3.7.2. Questionaries'

There are two phases to conduct a survey the first phase questionnaire has two sections. The first section gathers demographic details of the respondents, while the second section focused on collecting data for factor analysis, ensuring a comprehensive data collection process. The respondents of the questionnaire are drawn across the public officials, private developers, and residents in the PPP housing project in Addis Ababa to rate the level they consider these factors as critical towards success from a conventional five-point Likert scale as 1-strongly unimportant, 2-unimportant, 3-neutral, 4-important and 5-strongly important. On the other hand, fuzzy AHP approach evaluation has two sections the first section gathers demographic details and the second section collects data for fuzzy AHP analysis. The respondents of the questionnaire rated the level they consider these factors as critical towards success from Saaty's scale pair-wise comparison as 1 – equally important, 3 – slightly important, 5 – strongly important, 7 – very strongly important, 9 – extremely important and 2,4,6,8 as the expression of intermediate value for pair-wise comparison.

3.8. Methods of Data Analysis

The study employs two main data analysis methods which are exploratory factor analysis (Khl, 2023). and fuzzy analytic hierarchy process (AHP) models, these were integrated to assess the factors influencing critical success factors for public-private partnerships housing projects. Quantitative data is analyzed using statistical methodologies. The study utilizes exploratory factor analysis as the primary method for analyzing quantitative data, with the statistical package for social science (SPSS-Version -25) employed as the statistical software tool. After the process of editing, coding, and filtering inaccuracies, the quantitative data was first inputted into the SPSS program (version -25) to enable the analysis of descriptive statistics for carried out factor analysis., qualitative data is analyzed using fuzzy AHP models which were then applied to determine preference weights of input variables and rank them, providing a structured approach to decision-making in the assessment process.

Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis (EFA) was employed to identify the underlying dimensions of the critical success factors (CSFs) affecting Public-Private Partnership (PPP) housing projects. Before extracting factors, the suitability of the data for factor analysis was assessed using the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity.

The following criteria were used:

- **KMO value > 0.50** indicating adequate sampling adequacy.
- **Bartlett's Test of Sphericity ($p < 0.05$)** indicating significant correlations among variables.

- **Extraction Method:** Principal Component Analysis (PCA).
- **Rotation Method:** Varimax Rotation with Kaiser Normalization.
- **Factor Loading ≥ 0.50** was considered acceptable for retaining variables within a factor.

Variables with factor loadings below 0.50 or exhibiting significant cross-loadings were removed from the final factor structure.

3.9.3 Fuzzy Analytic Hierarchy Process (FAHP)

The Fuzzy Analytic Hierarchy Process (FAHP) was employed to prioritize the identified critical success factors under conditions of uncertainty and subjective judgment. Expert opinions were collected through pairwise comparison questionnaires using linguistic scales that were converted into triangular fuzzy numbers (TFNs).

Triangular Fuzzy Numbers (TFNs)

Linguistic Scale	**TFN (l,m,u)**
Equal Importance	(1,1,1)
Weak Importance	(1,2,3)
Moderate Importance	(2,3,4)
Strong Importance	(4,5,6)
Very Strong Importance	(6,7,8)
Extreme Importance	(8,9,10)

Where:

- l = lower value
- m = most likely value
- u = upper value

3.8.1. Exploration of critical success factors (CSFs)

This research study makes significant contributions to both academia and practitioners within an area that has received limited attention. Of particular note was the identification of critical success factors (CSFs) that can serve as a foundation for future frameworks in public-private partnership implementation. Notably, the CSFs identified are tailored to the Ethiopian context, a key factor in understanding the varied motivations driving PPP development, the diverse practices employed, and the varying levels of success observed across different nations. The

importance of recognizing and adapting the research to specific contexts is also emphasized in the context of international development initiatives.

To accomplish these aims, initially, an extensive and all-encompassing literature investigation is conducted on the critical success factors (CSFs) of public-private partnership execution in both advanced and emerging economies based on the value of mean score ranking. The majority of the studies are also similar, with a few exceptions. Subsequently, a qualitative methodology involving semi-structured interviews is employed with professionals from the public and private sectors in Addis Ababa Ethiopia.

3.8.2. Factor Analysis

A family of multivariate statistical techniques known as factor analysis is used to improve the reliability of a scale by identifying and eliminating inappropriate items. This simplifies the data structure by exposing fewer underlying factors, eliminating redundant, ambiguous, and irrelevant variables, and identifying and grouping improved inter-correlated factors. The two primary factor analytical methods for doing factor analysis are principal component analysis and common factor analysis. The principal component analysis method will be used in this investigation. The steps and procedures listed below are used to apply principal component analysis-based exploratory factor analysis.

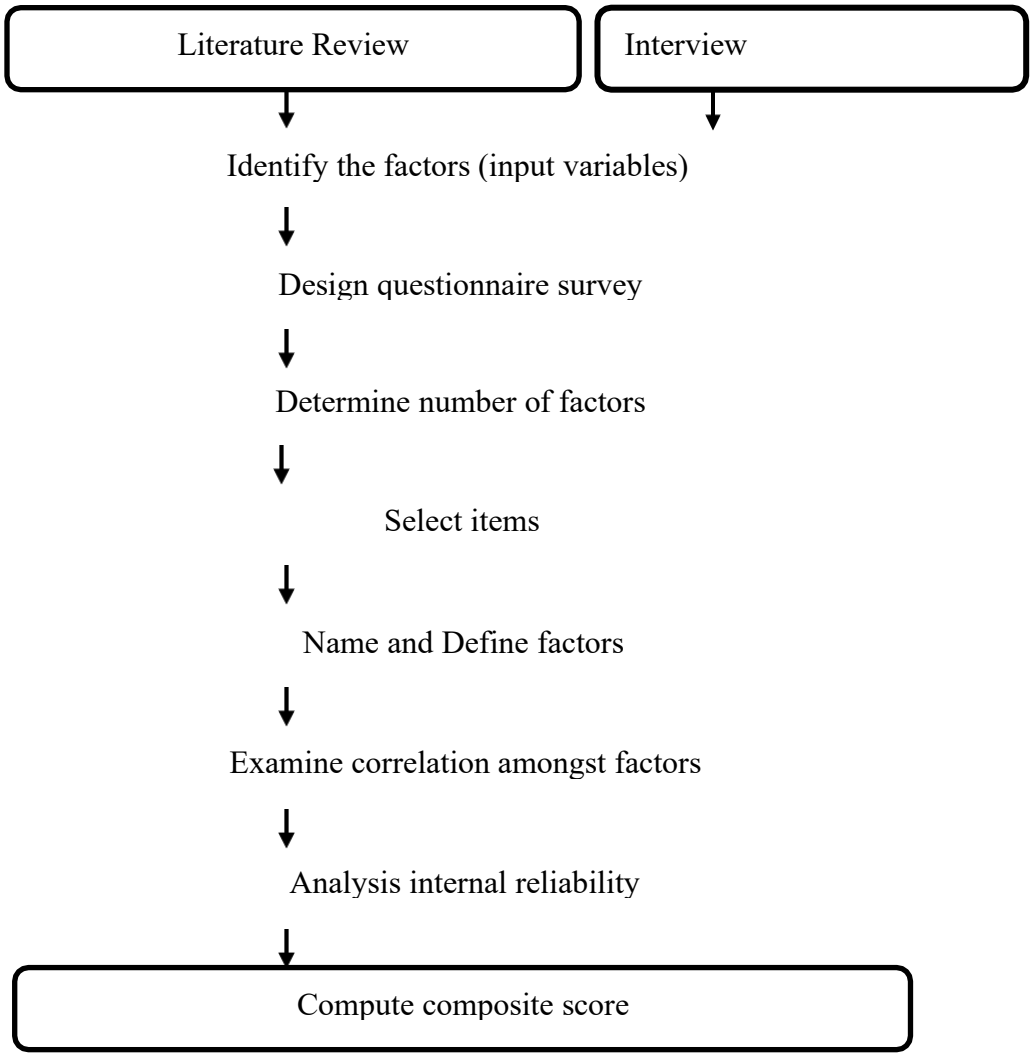


Figure 3.3-Factor Analysis Flowchart

3.8.3. Fuzzy AHP Model

The fuzzy analytical hierarchy process (AHP) is a powerful method which solving complex decision problems. Any complex problem can be decomposed into many sub-problems using stepwise hierarchy (AHP), where each step represents variables or attributes relative to each sub-problem. The fuzzy AHP method evaluates the relative weights of input variables and compares group variables based on their ratio and hierarchical ranking based on the importance

of each factor. The variable groups and input variables derived from factor analysis undergo a process of hierarchical structuring to convert these categorized input variables, with the ultimate goal of recognizing critical success factors within public-private partnership housing projects, based on the relative importance weights assigned to the input variables. Consequently, the fuzzy AHP method is employed to outline and quantify the significance of variable groups and individual input variables within each variable group. The research will be conducted by utilizing a 9-point Likert scale questionnaire established through input variables generated from factor analysis. Statistical analysis was carried out using Microsoft Excel and Super Decisions V3.2 software. The data derived from factor analysis is transformed into fuzzy sets, incorporating fuzzy number scales linked to linguistic variables. Next, by employing fuzzy arithmetical operations, the geometric mean of survey data for each variable is calculated, producing a new set of fuzzy values forming the pairwise comparison matrix. Each comparison matrix is evaluated based on the geometric mean method, and the resulting fuzzy weights are determined using the center of gravity method. Ultimately, the clarified values are derived to indicate the level of significance regarding the criteria of each critical success factor in PPP housing projects. Then, we will briefly introduce how to carry out the process of decision support (data analysis) in the study can be summarized in the following steps and mathematical equations.

Step 1: Analyzing decision problems

The structures of the analytic hierarchy process are established by identifying variable groups, and input variables which are resulting from factor analysis.

Step 2: Establishing the hierarchy

The methodology of the study is carried out according to the research aim, and the relationships among main variables and input variables are determined and reflected in the hierarchical model.

Step 3: Questionnaire survey and construct the pairwise comparison matrices, *A* for all criteria

Based on the predetermined hierarchical structure, a questionnaire is formulated to categorize the critical success factors of the PPP housing project. These factors are determined through prior experience and knowledge in the building construction and management sector. Subsequently carrying out the questionnaire survey, the results of the input variables for each objective are converted into a triangular fuzzy scale to reflect the significance ratings provided by the experts.

The matrix used for pairwise comparisons was a real matrix of dimensions n x n, with n representing the total number of criteria under consideration. Within this matrix, each entry signifies the level of significance assigned to the i^{th} criterion about the j^{th} criterion. Experts engaged in pairwise comparisons to assess the relative importance or preference between every pair of criteria. The pair-wise comparison judgments are represented by fuzzy triangular numbers denoted by (Getawa Ayalew et al., 2024).

$\tilde{a}_{ij} = (l_{ij}, m_{ij}, u_{ij})$ and n (n − 1)/2 judgments are required for each comparison group for a level to construct a positive fuzzy reciprocal comparison matrix *A*=(Getawa Ayalew and Ayalew)

$$\tilde{A}=\{\tilde{a}_{ij}\}=\begin{bmatrix} 1 & a_{12} & \dots & \dots & \dots & a_{1n} \\ a_{21} & 1 & \dots & \dots & \dots & a_{2n} \\ a_{31} & a_{32} & 1 & \dots & \dots & a_{3n} \\ \dots & \dots & \dots & 1 & \dots & \dots \\ \dots & \dots & \dots & \dots & 1 & \dots \\ a_{1n} & a_{n2} & \dots & \dots & \dots & 1 \end{bmatrix}=\begin{bmatrix} 1 & a_{12} & \dots & \dots & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & \dots & \dots & a_{2n} \\ 1/a_{13} & 1/a_{23} & 1 & \dots & \dots & a_{3n} \\ \vdots & \dots & \dots & 1 & \dots & \vdots \\ \vdots & \dots & \dots & \dots & 1 & \vdots \\ 1/a_{1n} & 1/a_{2n} & \dots & \dots & \dots & 1 \end{bmatrix} \quad (1)$$

Step 4: Calculating consistency ratio for criteria pairwise comparison matrix

To measure the consistency of experts' judgments arranged in pairwise comparisons from the results of the survey. The consistency ratio of experts' judgments is arranged in pairwise comparison measurements put in the Super Decisions V3.2 software package for checking inconsistency indexes. Super Decisions v3 is the latest version of the software package developed for the analysis, synthesis, and justification of complex decisions based on the Analytic hierarchy process (AHP) methodology.

Super Decisions V3.2 software package is preferred over than Eigenvalue method; this is due to the Super Decisions V3.2 software package used and inconsistency measurement as compared to the Eigenvalue method.

Step 5: Transforming fuzzy scales into triangular fuzzy numbers

To simplify the implementation of this thesis, triangular fuzzy numbers (TFNs) are used. TFN is represented by three points (l, m, u) which represent the minimum, most likely, and maximum values respectively. The membership function of a triangular fuzzy number can be found in Figure 3.4 which illustrates a fuzzy number and shows four main fuzzy arithmetical operations of two TFNs.

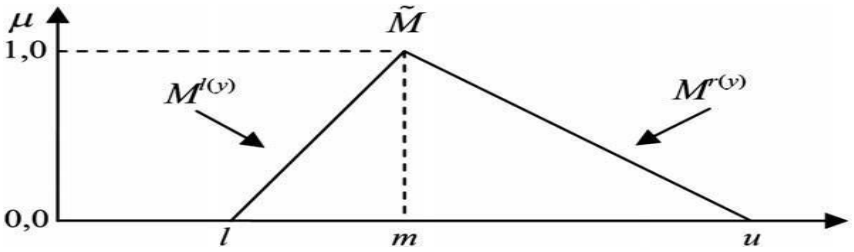


Figure 3.4 -Triangular fuzzy number

Basic arithmetic operations on triangular fuzzy numbers where A and B are positive, and A= (l1, m1, u1); B= (l2, m2, u2) can be shown as follows (Issar, 2010)

Summation:

A+B = (l1+l2, m1+m2, u1+u2) (1)

Subtraction:

A-B = (l1-l2, m1-m2, u1-u2) (3)

Multiplication:

A*B = (l1*l2, m1*m2, u1*u2) (4)

Division:

A/B = (l1/l2, m1/m2, u1/u2) (5)

Step 6: Calculate the geometric mean of fuzzy comparison values

To establish the results of the fuzzy geometric mean, the fuzzy analytical procedure may be conducted through the utilization of Microsoft Excel to compute the importance coefficient as determined by the formula provided (Ayalew et al., 2023).

$$\tilde{r}_i = (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \tilde{a}_{i3} \otimes \tilde{a}_{i4} \otimes \ldots\ldots\ldots \otimes \tilde{a}_{in})^{1/n} \quad (6)$$

Step 7: Calculating the fuzzy preference weights

Based on the results derived from the fuzzy geometric mean, the fuzzy weight can be determined by applying the formula provided here(Ayalew et al., 2023).

$$\tilde{w}_i = \tilde{r}_i \otimes (r_1 \oplus r_2 \oplus r_3 \oplus r_4 \oplus \ldots\ldots\ldots \oplus \tilde{r}_n)^{-1} \quad (7)$$

wi is the fuzzy weight of the i-th variables and can be indicated by a triangular fuzzy number.

$\oplus$ is the symbol of a matrix plus

Hence, wi = (Lwi, Mwi, Uwi). Lwi, Mwi, and Uwi stand for the lower, middle, and upper values of the fuzzy weight of the i-th variables, respectively.

The finding of the vector summation of each ri is shown in Equation 8 which states(Ayalew et al., 2023) the inverse of the summation vector would be considered.

$$\text{Vector summation} = \sum \tilde{r}i \quad (8)$$

Step 8: DE fuzzifying the fuzzy preference weights of variables

Before utilizing fuzzy numbers for comparison, it is vital to first undergo the process of defuzzification. The crisp value transforms a fuzzy weight into a non-fuzzy value, which is a process widely utilized in defuzzification and can be mathematically represented by the equation introduced by(Wang et al., 2019) through the utilization of the following Equation.

$$BNPi=[((UWi-LWi)+(MWi-LWi)3)]+LWi \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(9)$$

BNPi stands for Best Non-fuzzy Performance value which represents a simple and efficient method without the necessity to emphasize the preferences of decision-makers.

Step 10: Normalize the DE fuzzified weight of the criterion

After computing the non-fuzzy value, it can normalize to obtain local weights for the input variables. The sum of weights for group variables and input variables in the same hierarchy is 1.00. Step 10 will result in the normalized weights for the criterion, BNPi: The results are then ordered according to the normalized weights for each of the criteria(Ayalew et al., 2022)

$$\mathbf{BNP_w} = \frac{\mathbf{BNPi}}{\sum_{i=1}^{n} \mathbf{BNPi}} \quad \textbf{(10)}$$

As stated by(Kil et al., 2016) , the value of global weights is determined by the product of the normalized local weight in each variable group and the normalized local weight in each input variable.

Global Weight = Normalized local weight in each variable group ×

Normalized local weight in each input variable. **(11)**

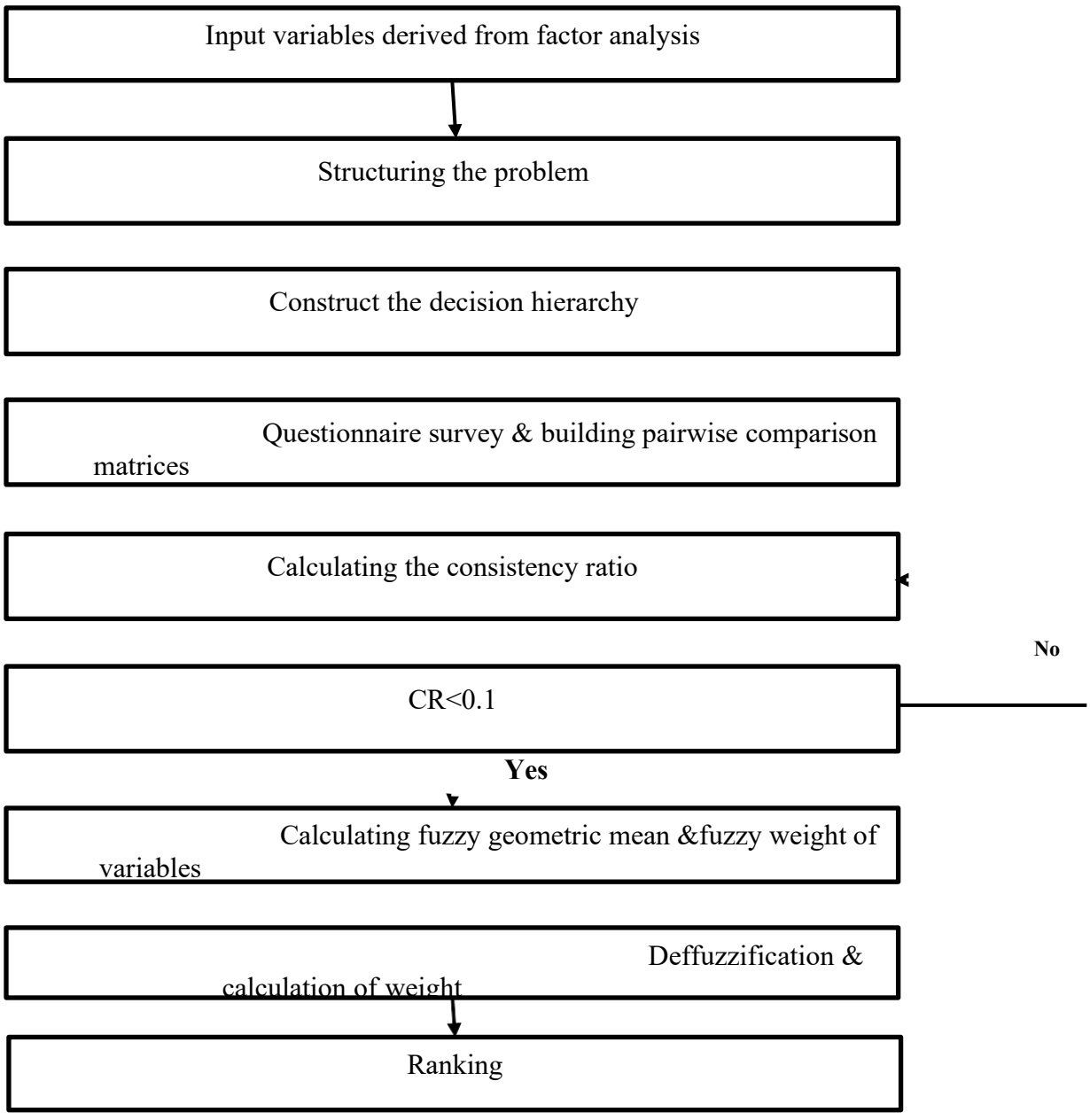


Figure 3.5-Fuzzy AHP Analysis Flowchart

3.9. Reliability and Validity of the Questionnaire

3.9.1. Reliability of the questionnaire

A questionnaire is a set of questions designed to collect data with a specific purpose. A questionnaire used in a study can be developed from a questionnaire that has already been tested by other researchers, or it can be developed as a new data instrument to measure certain factors. Therefore, it is necessary to test the reliability and validity of a questionnaire. A reliable questionnaire means that the questions in the questionnaire will give the same answer when used multiple times on the same research object. Therefore, the results of a study using measuring instruments, especially instruments, can only be interpreted when the assessment conditions and statistical approach are displayed by the researcher. Reliability tests were conducted at the beginning of the analysis of the results to ensure the reliability of the data before selection (Heale and Twycross, 2015). To measure the reliability of the questionnaire, Cronbach's alpha can be used. Cronbach's alpha indicates the level of internal consistency. The reliability coefficient normally varies between 0 and 1. The conceptual formula of Cronbach's Alpha is defined by (Hajjar, 2018).

$$\bar{\alpha} \quad \frac{Kr}{1+(K-1)r} \tag{12}$$

Table 3.2- Interpreting Cronbach's Alpha

Interpreting Alpha for Likert scale questionnaires	
Cronbach's α	Internal consistency
0.9 and above	Excellent
0.8-0.89	Good
0.7-0.79	Acceptable
0.6-0.69	Questionable
0.5-0.59	Poor
Below 0.5	Unacceptable

The Cronbach' s coefficient alpha was calculated for each field of the questionnaire. The value of Cronbach's Alpha for each field of the questionnaire is more than 0.70 (Table 3.2.) which indicates the excellent reliability of the entire questionnaire.

3.9.2. Validity test of the questionnaire

The validity of the questionnaire shows the accuracy of the questionnaire. It determines how well the questionnaire meets the standards set by certain criteria. During the survey, the test should be relevant, appropriate, and used correctly, in combination with the data to indicate the assessment results. The validity of the questionnaire was tested using content validity. Reliability calculations must be carried out only on questionnaire questions that have been validated, so validation tests must be carried out first before conducting reliability tests.

3.10. Ethical Consideration

Studying public-private housing projects using FAHP involves various ethical issues that require careful consideration. Make sure participants understand the purpose of the study and consider the identities would be protected. Obtain informed consent before collecting any data and following established ethical guidelines with human subjects. Try to be inclusive and fair in the data collection which involves input from a variety of stakeholders including residents, project managers, government officials, and private developers to avoid bias in the selection process or analysis. Protect the privacy and confidentiality of the participants while not sharing personal information without expressing their permission. Be clear about the research methods, limitations, and findings, and share the results with relevant stakeholders and communities in an accessible and understandable manner. As well as be responsible for the conduct of the research and resolve any issues that arise.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1. Introduction

This chapter presents the data that was found on the practice of public-private partnerships in housing projects for evaluating the status of their critical success factors in public officials and private developers. The research was conducted on a sample of 5 respondents for exploring CSFs, 125 respondents for factor analysis, and 10 respondents for the fuzzy analytic hierarchy process model to which questionnaires were administered. The data collected was keyed and analyzed through factor analysis using Statistical Package for Social Scientists (SPSS) version 25 software and ranked by using fuzzy AHP model by applying super decision version 3.2 for measuring expert judgment of their consistency the response and Microsoft Excel were used for computing the weight and ranked the critical success factors. The data was then presented through tables, narrative analysis, and diagrams.

4.2. Questionnaire Response Rate

The respondents consist of PPP experts, engineers, managers, team leaders, residents, and construction professionals from the public officials who worked in the finance minister PPP department, Addis Ababa housing development and corporation biro, and professionals from private developers like Ovid real estate and gift real estate.

Table 4.1- Response Rate

No questionnaires distributed	Returned questionnaires	Response rate	Item
5	5	100	Interview
131	125	100	1st phase survey
15	10	100	2nd pairwise comparison survey

Source: - own survey, (2024)

The minimal criteria for response rate were adequately met when conducting research for each item.

4.3. Demographic Characteristics of Respondents

4.3.1. Demographic Characteristics of Respondents for Factor Analysis

Demographic analysis of the characteristics of the respondents participating in the survey for factor analysis was summarized in Table 4.2.

Table 4.2-Respondents Demographics for Factor Analysis

Parameter	Frequency	Percentage (%)
Gender		
Male	92	73.6
Female	33	26.4
Field of Specialization		
Civil Engineering	39	31.2
Project Management	31	24.8
A mix of engineering and management	19	15.2
Other	36	28.8
Work experience of respondents		
Less than 2 years	5	4
2 to 5 years	47	37.6
6 to 10 years	43	34.4
More than 10 years	30	24

The results of the study presented in table 4.2 show that 73.6 of the respondents were male and 26.4 were female. In the field of specialization, 31.2 were civil engineering, 24.8 were project management, 15.2 were a mix of engineering and management and 28.8 were other a mix fields of specialization. Regarding with the working experience, 24 of the respondents have More than 10 years of working experience, 34.4 of the respondents have between 6 and 10 years of working experience, 37.6 of the respondents have between 2 and 5years of working experience and .4 of the respondents have less than 2 years of working experience.

4.3.2. Demographic Characteristics of Respondents for Fuzzy AHP Analysis

Demographic analysis of the characteristics of the respondents participating in the pairwise comparison survey for fuzzy AHP Analysis. In the analysis, 15 experts were chosen to participate in the pairwise survey. Among these experts' answers, 5 questionnaires contained inconsistent answers. These questionnaires were sent back to the respondents to be filled out

again but 5 experts refused to revise and correct their answers. Consequently, their answers were excluded from the analysis. Therefore, the result of this research is based on responses of 10 experts. Among the 10 experts, 6 of them were educated in the project management field and 2 of them had international business management and participated in some business and management courses, 2 of them were construction technology and management Therefore, 60% of the respondents were project management experts and the remaining 20% had international business and 20% were educated in construction technology and management.

4.4. Reliability of the Questionnaire

A study was carried out to analyze the items to assess the reliability of each factor influencing the success of housing projects under the PPP framework. The Cronbach's alpha values exceeding 0.70 for every factor of the questionnaire suggest a high level of reliability. The overall Cronbach's alpha coefficient calculated for the entire questionnaire was 0.94. All six factors evaluated in this study demonstrated a notably high level of reliability which was described in the following table 4.3.

Table 4.3- Cronbach Alpha pre-test

No	Factors	number of items	Cronbach Alpha
1	Political factors	6	0.853
2	Social factors	5	0.804
3	Economic factors	5	0.896
4	Environmental factors	4	0.741
5	Administration factors	3	0.781
6	Technology factors	2	0.945
	Overall results	25	0.94

4.5. Exploring critical success factors (CSFs)

The first result was related to the identification of CSFs. It is also considered important to identify CSF in public-private partnership housing scheme projects to use the experience of Ethiopia. The interview participants were asked: "What were the critical success factors (CSFs) of the PPP in housing projects in their organizations?" The results of the interviewer's responses were summarized and presented in Table 4.4. As can be seen from Table 4.4, a total

of 25 CSFs were allowed by the interviewers, which was evaluated from the previous study based on their high mean score ranking.

Table 4.4- Identification of critical success factors of the PPP projects

CSFs.	Critical Success Factors	Interviewees					
		A	B	C	D	E	No
V1	Stability of the political system	√	√	√	√	√	5
V2	Political will	√	√	√	√		4
V3	Providing guarantee/support to developers		√	√	√	√	4
V4	Appropriate legal and regulatory framework	√	√	√	√	√	5
V5	Government commitment to providing land		√		√		2
V6	Government provision of infrastructure	√	√	√			3
V7	Security and safety issues	√	√	√	√	√	5
V8	Housing near the places of work and worship		√	√			2
V9	Provision of recreational/ sporting facilities	√				√	2
V10	Level of social mix in the housing environment	√	√		√		3
V11	Adaptable housing design and construction		√	√		√	3
V12	Low equity contribution	√			√	√	3
V13	Stable macro-economic environment	√	√	√		√	4
V14	Access to housing loan	√	√				2
V15	Low lending cost (interest charged)		√			√	2
V16	Housing affordability	√		√	√	√	4
V17	Quality of Housing Environment	√	√	√		√	4
V18	Waste management system	√			√	√	3
V19	Open Spaces and Green areas	√		√			2
V20	Noise Level		√	√			2
V21	Technology innovation	√	√		√	√	4
V22	Technology transfer	√	√	√	√	√	5
V23	Appropriate risk allocation and sharing	√			√	√	3
V24	The government provides financial support		√		√	√	3
V25	Environmental impact of the project		√		√		2
	Sub-total	17	19	14	15	13	

The initial set of CSFs was established through an examination of existing literature with a notably high mean score, and extensive interviews with specialists in public-private partnership. The researcher specifically chose five experts for their extensive experience in

managing construction projects under the PPP framework as the interviewee participants. These five experts collectively represent a broad spectrum of relevant industry entities. Before commencing a comprehensive study, a thorough review of the literature was undertaken, alongside consultations with established professionals in the field of construction management, to authenticate the critical success factors list. Ultimately, a total of 25 CSFs impacting the implementation of PPP were identified (refer to Table 4.4).

4.6. Factor analysis results

4.6.1. Factor analysis for validity

Based on the results of the initial exploratory factor analysis, the researcher identifies 25 indicator data that were tested by KMO and Bartlett sphere using SPSS statistical software. Table 4.4 shows that the KMO test value is 0.751 and greater than 0.3, indicating that the information overlap between variables is high. The approximate chi-square value of the Bartley sphericality test is 1806.632, and the significance probability is 0.000 and less than 0.05, indicating that there is a correlation between various variables. It is appropriate to measure the factor analysis method, indicating that the variables and data selected in this study are suitable for factor analysis.

Table 4.5-KMO and Bartlett test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.751
Bartlett's Test of Sphericity	Approx. Chi-Square	1806.632
	Df	300
	Sig.	0

In this study, factor analysis is used to analyze the correlation matrix, and the sample data is dimensionally reduced. Six common factors are extracted according to the principle that the cumulative variance contribution rate exceeds 69%. According to the slope of Figure 4.1, it is appropriate to select six factors. It can be seen from Table 7 that the cumulative contribution rate after rotation reaches 69.969%, indicating that the six extracted factors can interpret the original variable by 69.969%, and the factor analysis method can fully explain the original variable. Among them, the variance contribution rates of common factors V1, V2, V3, V4, V5

and V6 are 23.248%, 14.838%, 10.775%, 9.719%, 6.965% and4.42% respectively, indicating that the common factor V1 has the greatest impact on the overall data.

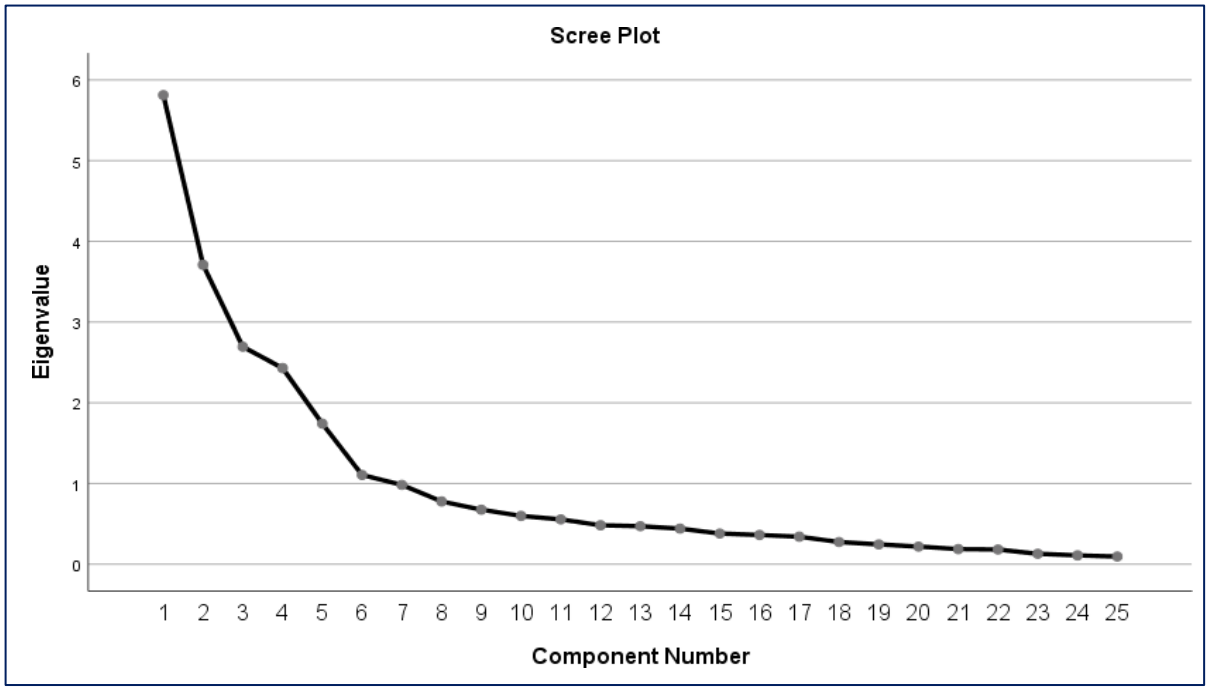


Figure 4.1- diagram

Table 4.6-Eigenvalues, total variances explained for the final six-factor structure

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.81	23.248	23.248	5.81	23.248	23.248	4.3	17.201	17.201
2	3.71	14.838	38.087	3.71	14.838	38.087	3.278	13.112	30.314
3	2.69	10.775	48.862	2.69	10.775	48.862	3.274	13.095	43.409
4	2.43	9.72	58.581	2.43	9.72	58.581	2.907	11.63	55.039
5	1.74	6.965	65.546	1.74	6.965	65.546	2.099	8.397	63.436
6	1.11	4.423	69.969	1.11	4.423	69.969	1.633	6.533	69.969

To analyze the rotating component matrix more clearly and conveniently and observe the attribution of various problem factors, this study sets the operation of prohibiting the display of small coefficients and sets the absolute value of prohibiting the display of small coefficients to 0.3.

According to the results of Table 4.6, it is found that the V1 factor has a great impact on V11, V12, V13, V14, V15 &V16. According to the common characteristics of these indicators, we named them the political factors. The V2 factor has a great impact on V21, V22, V23, V24 and V25. According to the commonality, it is named as a social factor. The V3 factor has a great impact on V31, V32, V33, V34 and V35. According to the commonality, it is named as an economic factor. The V4 factor has a great impact on V41, V42, V43 and V44. According to the commonality, it is named as an environmental factor. The V5 factor has a great impact on V51, V52 and V53. According to the commonality, it is named as administrational factor. The V6 factor has a great impact on V61, V62. According to the characteristics of this index, we will use the technology factor obtained from factor analysis for fuzzy analytic hierarchy process analysis.

Table 4.7- Rotated Component Matrix [a]

	Component					
	1	2	3	4	5	6
Providing guarantee/support to developers	0.879					
Political will	0.87					
Appropriate legal and regulatory framework	0.859					
Government commitment to providing land	0.803					
Stability of the political system	0.8					
Government provision of infrastructure	0.667					
Housing near the places of work and worship		0.836				
Provision of recreational/ sporting facilities		0.819				
Adaptable housing design and construction		0.775				
Level of social mix in the housing environment		0.774				
Security and safety issues		0.708				
Housing affordability			0.858			
Access to housing loan			0.806			
Stable macro-economic environment			0.78			
Low lending cost (interest charged)			0.729			
Low equity contribution			0.723			
Open Spaces and Green areas				0.881		
Waste management system				0.841		
Quality of Housing Environment				0.806		
Noise Level				0.663		
The government provides financial support					0.847	
Appropriate risk allocation and sharing					0.841	
Environmental impact of the project					0.71	
Technology transfer						0.85
Technology innovation						0.775

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

4.7. Results of the fuzzy analytic hierarchy process

The results of the fuzzy analytic hierarchy process (AHP) methodology engaged in this study were defined subsequently, and this finding can be confirmed by its alignment with the results of factor analysis.

Step 1: Analyzing decision problems, and establishing the hierarchy

The group variables and input variables derived from the factor analysis undergo a conversion process to a hierarchical structure. This transformation is aimed at reorganizing the grouped input variables into a schematic structure as illustrated in Figure 4.2. The primary goal is to determine the key success factors in PPP housing projects by evaluating the significance weight of the input variables, which were placed in the first level in the hierarchical structure based on the pairwise comparison. The second and third levels contain five groups of variables and twenty-five input variables, respectively. The top of the hierarchy is the overall objective or goal, the intermediate nodes are the relevant attributes (group of variables), and the last level is the decision input variables or sub-factors of decision problems and the relationships between the main variables and the input variables are well-defined and reflected in a hierarchical model as shown in Figure 4.2.



Figure 4.2-Hierarchical structure of Fuzzy AHP model. Source: own work.

Step 2: Construct the pairwise comparison matrices for all group and input variables

The data acquired from the group and input variables resulting from the factor analysis carried out during a pairwise questionnaire survey were transformed into a triangular fuzzy scale to represent the importance ratings provided by experts. After, these results of the input variables for each objective were then converted into linguistic terms fuzzy numbers and the comparison of the criterion was measured according to the numerical scale 1-9 in the form of linguistic variables adapted from (Fu, Chen, & Wang, 2020)as shown in Table 4.8.

Table 4.8- The triangular fuzzy number of positive/negative linguistic scale

Linguistic variables	Fuzzy scale (positive linguistic variable)	Triangular fuzzy number	Fuzzy scale (negative linguistic variable)	Triangular fuzzy number
Equally important	$\tilde{1}$	(1, 1, 1)	$\tilde{1}^{-1}$	$(\frac{1}{1},\frac{1}{1},\frac{1}{1})$ –
Equal to moderate important	$\tilde{2}$	(1, 2, 3)	$\tilde{2}^{-1}$	$(\frac{1}{3},\frac{1}{2},\frac{1}{1})$ –
Moderate important	$\tilde{3}$	(2, 3, 4)	$\tilde{3}^{-1}$	$(\frac{1}{4},\frac{1}{3},\frac{1}{2})$ –
Moderate to strong important	$\tilde{4}$	(3, 4, 5)	$\tilde{4}^{-1}$	$(\frac{1}{5},\frac{1}{4},\frac{1}{3})$ –
Strong important	$\tilde{5}$	(4, 5, 6)	$\tilde{5}^{-1}$	$(\frac{1}{6},\frac{1}{5},\frac{1}{4})$ –
Strong to very strong important	$\tilde{6}$	(5, 6, 7)	$\tilde{6}^{-1}$	$(\frac{1}{7},\frac{1}{6},\frac{1}{5})$ –
Very strong important	$\tilde{7}$	(6, 7, 8)	$\tilde{7}^{-1}$	$(\frac{1}{8},\frac{1}{7},\frac{1}{6})$ –
Very strong to absolutely Important	$\tilde{8}$	(7, 8, 9)	$\tilde{8}^{-1}$	$(\frac{1}{9},\frac{1}{8},\frac{1}{7})$ –
Absolute important	$\tilde{9}$	(9, 9, 9)	$\tilde{9}^{-1}$	$(\frac{1}{9},\frac{1}{9},\frac{1}{9})$ –

Step 3: Calculating consistency ratio for the variables pairwise comparison matrix

The Analytic Hierarchy Process (AHP) is utilized to assess a consistency ratio (CR) which serves as a measurement for evaluating the consistency of expert judgments that are organized

in pairwise comparisons derived from the result of the survey. The value CR < 0.1 validates the consistency of the comparison matrix, if not, efforts should be made to identify the cause of inconsistency and repeat the calculations. The consistency ratio in AHP analysis can be calculated by using the Eigenvalue method, and Super Decisions V3.2 software package. In the Eigenvalue method, the analytical hierarchy process (AHP) determines a consistency ratio (CR) by assessing the consistency index (CI) of the specific matrix in question in comparison to the consistency index of a random-like matrix. The Eigenvalue method involves the random input of expert judgments, leading to an expected high level of inconsistency. However, in this investigation, the objective is to assess the reliability of assessments made by experts' judgments through pairwise comparisons, where measurements are conducted using the Super Decisions V3.2 software package to automatically verify inconsistency indices. The consistency ratio value of all pairwise comparison matrices generated by Super Decisions V3.2 software indicates comparisons between the goal and local priorities of the input variables for each variable in the model illustrated in Figures 4.3–4.9 which are below 0.10. Thus, it can be inferred that the judgment matrix of pairwise comparisons has reached a satisfactory level of consistency for AHP analysis.

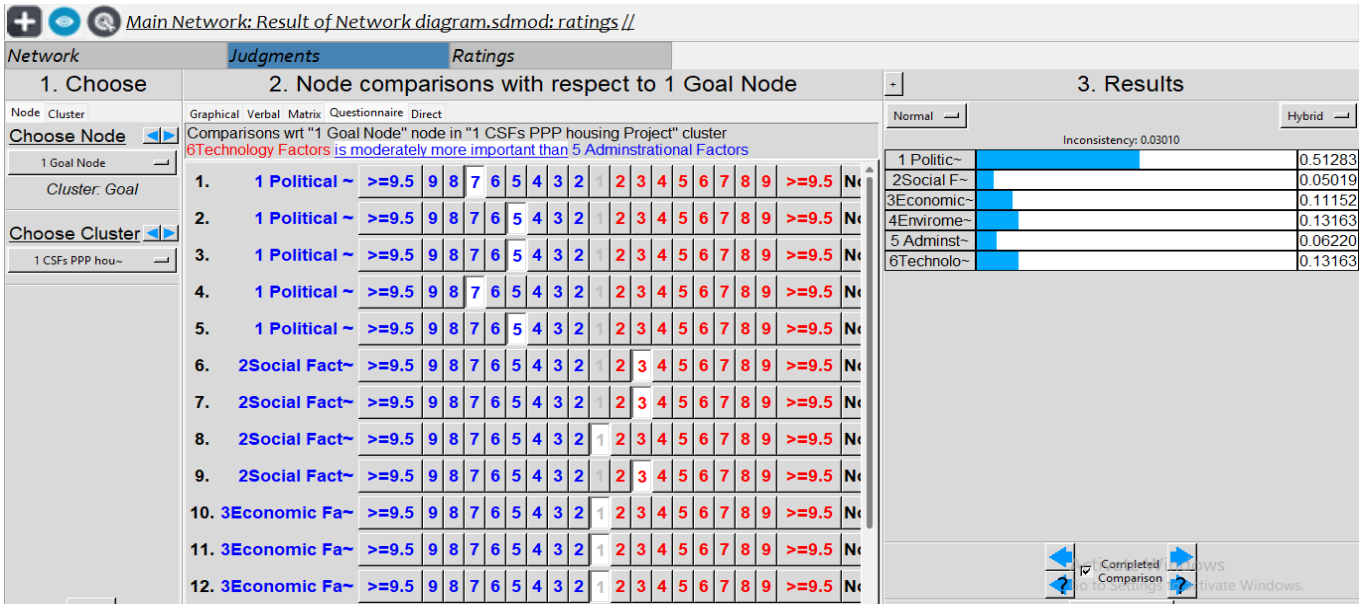


Figure 4.3-Inconsistency report of group variables under the goal created in Super Decision software. Source: own work.

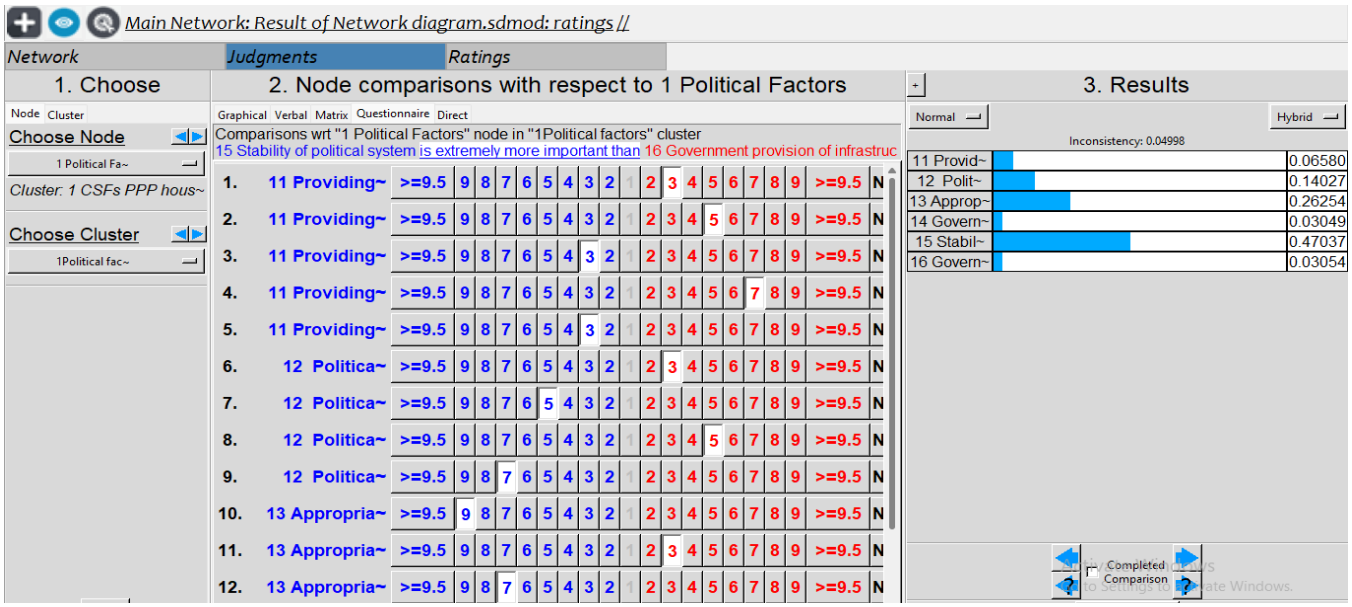


Figure 4.4-Inconsistency report of input variables under political factor created in Super Decision software. Source: own work.

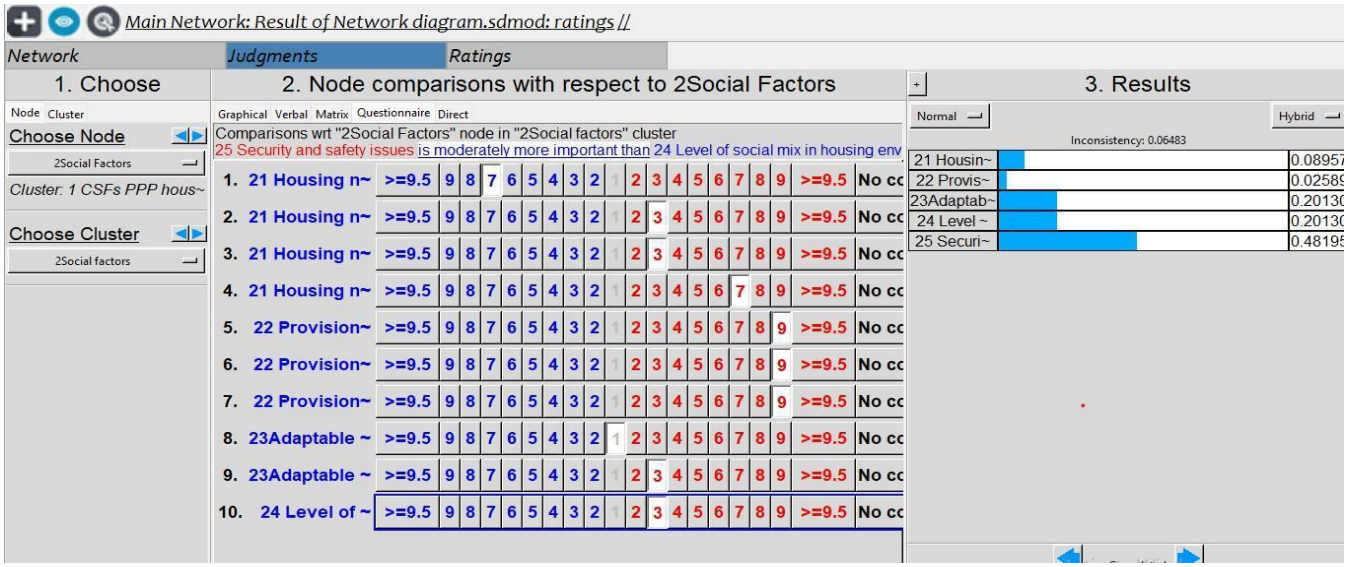


Figure 4.5- Inconsistency report of input variables under social factor created in Super Decision software. Source: own work.

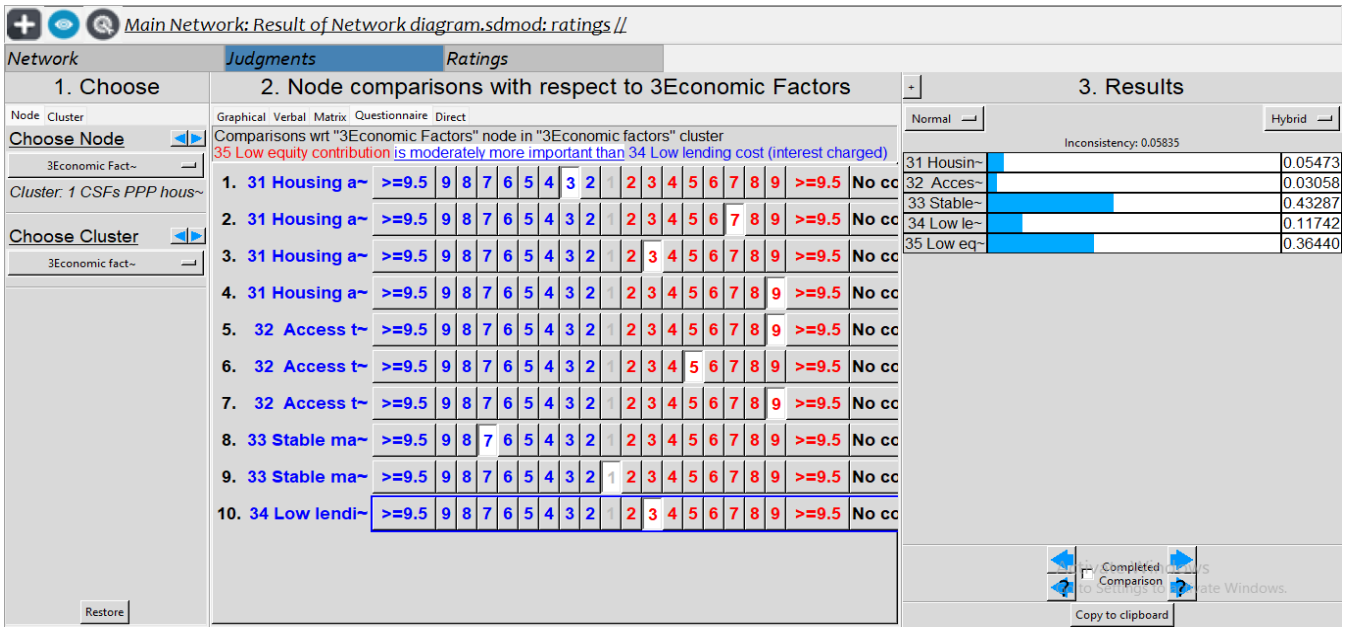


Figure 4.6- Inconsistency report of input variables under economic factor created in Super Decision software. Source: own work.

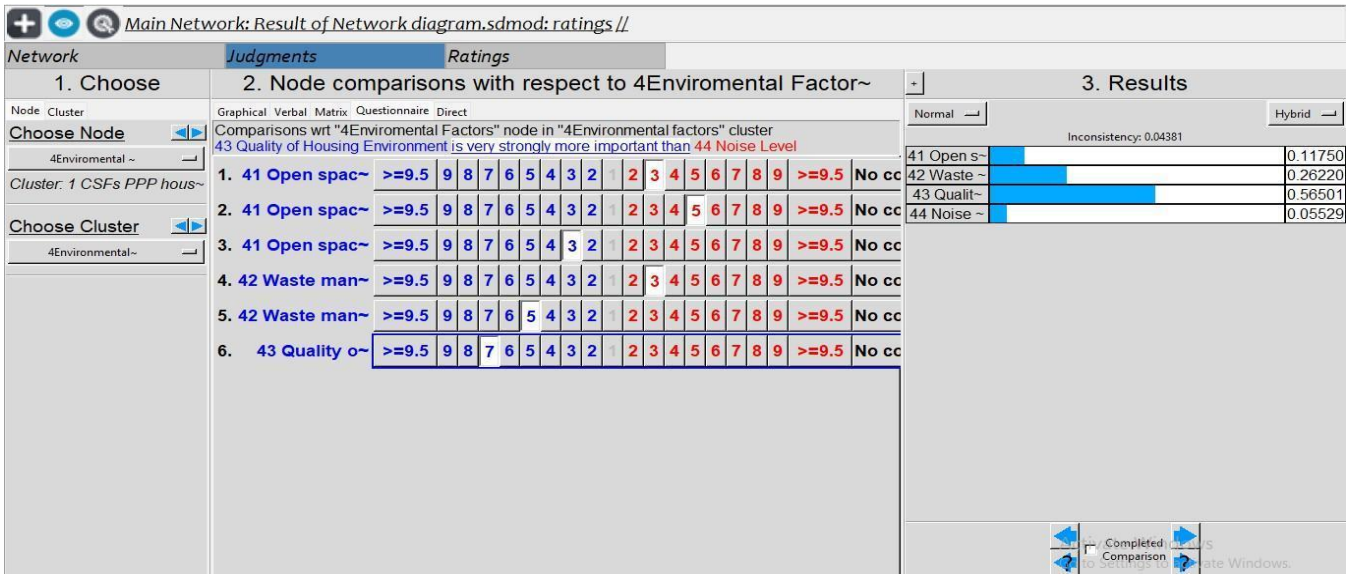


Figure 4.7- Inconsistency report of input variables under environmental factor created in Super Decision software. Source: own work.



Figure 4.8-Inconsistency report of input variables under administrational factor created in Super Decision software. Source: own work.

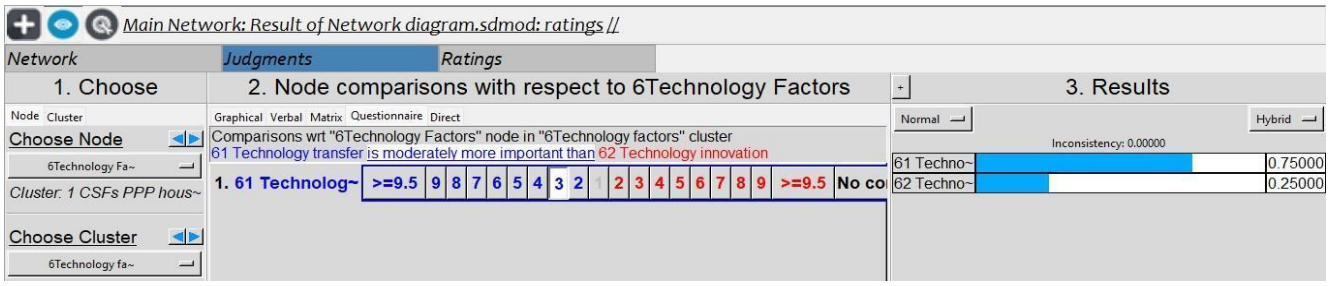


Figure 4.9-Inconsistency report of input variables under technology factor created in Super Decision software. Source: own work.

Step 4: Fuzzification, and aggregating the experts' decision

The expert's answers to pair-wise comparisons are gathered using linguistic definitions based on a 9-point scale. The answers need to be converted to an analyzable format because mathematical operations cannot be applied to qualitative definitions. Therefore, the answers need to be converted to a fuzzy format. All the fuzzy scales can be transferred into the corresponding triangular fuzzy numbers to weigh the significance of each variable in a fuzzy nine-scale linguistic scaling, and for carrying out further analysis. This work transformed all fuzzy scales into triangular fuzzy numbers to weigh the significance of each variable in a fuzzy nine-scale linguistic scaling.

This work transformed all fuzzy scales into triangular fuzzy numbers as shown in table 4.9 and 4.10 to weigh the significance of each variable in a fuzzy nine-scale linguistic scaling.

Table 4.9- Transforming fuzzy scales into triangular fuzzy numbers under factors with respect to the political factor.

Crisp	Providing guarantee /support to developers	Political will	Appropriate legal and regulatory framework	Government commitment in providing land	Stability of political system	Government provision of infrastructure
Providing guarantee /Support to developers	1	1/3	1/5	3	1/7	3
Political will	3	1	3	5	5	7
Appropriate legal and regulatory framework	5	1/3	1	9	1/3	7
Government commitment in providing land	1/3	1/5	1/9	1	1/9	1
Stability of political system	7	1/5	3	9	1	9
Government provision of infrastructure	1/3	1/7	1/7	1	1/9	1

Transforming fuzzy scales into Triangular fuzzy numbers

Fuzzy																		
	1	1	1	1/4	1/3	1/2	1/6	1/5	1/4	2	3	4	1/8	1/7	1/6	2	3	4
	2	3	4	1	1	1	2	3	4	4	5	6	4	5	6	6	7	8
	4	5	6	1/4	1/3	1/2	1	1	1	9	9	9	1/4	1/3	1/2	6	7	8
	1/4	1/3	1/2	1/6	1/5	1/4	1/9	1/9	1/9	1	1	1	1/9	1/9	1/9	1	1	1
	6	7	8	1/6	1/5	1/4	2	3	4	9	9	9	1	1	1	9	9	9
	1/4	1/3	1/2	1/8	1/7	1/6	1/8	1/7	1/6	1	1	1	1/9	1/9	1/9	1	1	1

Table 4.10- Fuzzy weight of the input variable with respect to political factors.

	V11			V12			V13			V14			V15			V16		
V11	1.000	1.000	1.000	0.250	0.500	0.333	0.167	0.250	0.200	2.000	3.000	4.000	0.125	0.143	0.167	2.000	3.000	4.000
V12	2.000	3.000	4.000	1.000	1.000	1.000	2.000	4.000	3.000	4.000	5.000	6.000	4.000	5.000	6.000	6.000	7.000	8.000
V13	4.000	5.000	6.000	0.250	0.500	0.333	1.000	1.000	1.000	9.000	9.000	9.000	0.250	0.333	0.500	6.000	7.000	8.000
V14	0.250	0.333	0.500	0.167	0.250	0.200	0.111	0.111	0.111	1.000	1.000	1.000	0.111	0.111	0.111	1.000	1.000	1.000
V15	6.000	7.000	8.000	0.167	0.250	0.200	2.000	4.000	3.000	9.000	9.000	9.000	1.000	1.000	1.000	9.000	9.000	9.000
V16	0.250	0.333	0.500	0.125	0.167	0.143	0.125	0.167	0.143	1.000	1.000	1.000	0.111	0.111	0.111	1.000	1.000	1.000

Step 5: Calculate the geometric mean of fuzzy comparison values

The geometric mean of the fuzzy comparison values was determined through the application of the fuzzy analytic hierarchy process (FAHP) and Microsoft Excel for every variable. The fuzzy geometrical mean technique was employed to establish the fuzzy geometrical mean of each criterion, which was computed using the equation (6).

$$\tilde{r}_i = (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \tilde{a}_{i3} \otimes \tilde{a}_{i4} \otimes \ldots\ldots \otimes \tilde{a}_{in})^{1/n}$$

The geometric mean for the input variable (V1) was calculated as follows:

$$\tilde{r}_1 = (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \tilde{a}_{i3} \otimes \tilde{a}_{i4} \otimes \ldots\ldots \otimes \tilde{a}_{in})^{1/6}$$

l: $\tilde{r}_1 = (1 \otimes 0.25 \otimes 0.167 \otimes 2 \otimes 0.125 \otimes 2)^{1/6} = 0.021$

m: $\tilde{r}_1 = (1 \otimes 0.333 \otimes 0.2 \otimes 3 \otimes 0.143 \otimes 3)^{1/6} = 0.086$

u: $\tilde{r}_1 = (1 \otimes 0.5 \otimes 0.25 \otimes 4 \otimes 0.167 \otimes 4)^{1/6} = 0.333$

$r_1 = (0.021, 0.086, 0.333)$

Using similar procedures, the geometric mean calculations of fuzzy comparison values for each variable are determined. This process encompasses the aggregate values, the reciprocal values, and the values arranged in increasing order.

$r_2 = (384, 1575, 4608)$

$r_3 = (13.5, 35, 108)$

$r_4 = (0.0004, 0.0008, 0.0015)$

$r_5 = (162, 340, 648)$

r_6= (0.0004, 0.0008, 0.0015)

Step 6: Calculate the fuzzy preference weights

By incorporating the subsequent procedures, such as determining the vector summation for each fuzzy geometric mean value (r_i) the fuzzy preference weights are determined through the calculation process following the computation of fuzzy weights for individual input variables utilizing Equation (7).

$\tilde{W}_1 = \tilde{r}_1 \otimes (r_1 \oplus r_2 \oplus r_3 \oplus r_4 \oplus \tilde{r}_5)^{-1}$

l: W_1 =0.021/ (0.021+384+13.5+0.0005+162+0.0004) =0.00003723

m: w_1=0.086/ (0.086+15 75+35+0.0008+340.2+0.0008) =0.00004395

u: W_1 =0.333/ (0.333+4608+108 +0.0015+648+0.0015) =0.00006214

W_1= (0.00003723, 0.00004395, 0.00006214)

The product of $\tilde{r}_i$ and the reciprocal of the summation vector was calculated in increasing order. Likewise, the other fuzzy weights (w_i) are as follows:

W2= (0.68630036, 0.80757333, 0.85900653)

W3= (0.006922057, 0.020132965, 0.024127747)

W4= (0.00000029, 0.00000042, 0.000000920)

W5= (0.12079779, 0.17443584, 0.28953296)

W6= (0.00000029, 0.00000039, 0.00000078)

Step 6: Defuzzifying the fuzzy preference weights of variables

Defuzzification was employed to transform a fuzzy number into a singular crisp value, as discussed by (Fu et al., 2020). The conversion of a fuzzy weight into a non-fuzzy value is primarily facilitated by the central point of the region, which is a process widely utilized in defuzzification and can be mathematically represented by the equation (9).

.

$$BNP_1=\left[\frac{(0.00006214-0.00003723)+(0.00004395-0.00003723)}{3}\right]+0.00006214=0.00006438$$

$$BNP_2=\left[\frac{(0.85900653-0.68630036)+(0.80757333-0.68630036)}{3}\right]+0.68630036=0.89943085$$

$$BNP_3=\left[\frac{(0.02412775-0.00692206)+(0.02013297-0.00692206)}{3}\right]+0.02412775=0.02853138$$

$$BNP_4=\left[\frac{(0.00000092-0.00000029)+(0.00000042-0.00000029)}{3}\right]+0.00000029=0.00000096$$

$$BNP_5=\left[\frac{(0.28953296-0.12079779)+(0.17443584-0.12079779)}{3}\right]+0.12079779=0.30741231$$

$$BNP_6=\left[\frac{(0.00000078-0.00000029)+(0.00000039-0.00000029)}{3}\right]+0.00000029=0.00000048$$

$$\sum BNP = 1.23544037$$

Step 7: Normalizing the defuzzified weight of the criterion

As stated by (Kil et al., 2016) it was necessary to normalize the defuzzified weight of the criterion since BNP_i is a non-fuzzy number. After, the defuzzified weights need to undergo normalization through Equation (10).

Hence, the calculation of the normalization weight of political factor (V1) can be carried out in the following manner:

$$BNP_{w\,1}=\frac{0.00006438}{1.23544037}=0.00005211$$

$$BNP_{w\,2}=\frac{0.89943085}{1.23544037}=0.72802449$$

$$BNP_{w\,3}=\frac{1.23544037}{1.23544037}=0.02309410$$

$$BNP_{w\,4}=\frac{0.00000096}{1.23544037}=0.00000078$$

$$BNP_{w\,5}=\frac{0.30741231}{1.23544037}=0.24882813$$

$$BNP_{w\,6} = \frac{0.30741231}{1.23544037} = 0.00000039$$

Equivalently, the BNP_{wi} value for the remaining group variables and input variables can be derived through the same computational procedure, and the results are presented in tables 4.11-4.17.

Table 4.11-The fuzzy weights of the variable groups with respect to the goal.

Variable Group(V)	Fuzzy Weight(wi)			Local Weight	Normalized Local Weight	Rank
Political Factors	2304.000	6125.000	13824.000	0.998834	0.999068	1
Social Factors	0.002	0.005	0.021	0.000002	0.000002	6
Economic Factors	0.333	0.600	1.000	0.000057	0.000057	3
Enviromental Factors	0.667	1.800	4.000	0.000057	0.000057	3
Adminstrational Factors	0.008	0.016	0.042	0.000003	0.000003	5
Technology Factors	0.667	1.800	11.250	0.000814	0.000815	2

Table 4.12-The fuzzy weights of the variable groups with respect to the political factor.

Variable Group(V1)	Fuzzy Weight(wi)			Local Weight	Normalized Local Weight	Rank
Providing guarantee /support to developers	0.021	0.086	0.333	0.0000644	0.0000521	4
Political will	384.000	1575.000	4608.000	0.8994309	0.7280245	1
Appropriate legal and regulatory framework	13.500	35.000	108.000	0.0285314	0.0230941	3
Government commitment in providing land	0.001	0.001	0.002	0.0000010	0.0000008	5
Stability of political system	162.000	340.200	648.000	0.3074123	0.2488281	2
Government provision of infrastructure	0.000	0.001	0.002	0.0000005	0.0000004	6

Table 4.13-The fuzzy weights of the variable groups with respect to the social factor.

Variable Group(V2)	Fuzzy Weight(wi)			Local Weight	Normalized Local Weig	Rank
Housing near to the places of work and worship	0.0469	0.1111	0.3333	0.00027437	0.00027437	4
Provision of recreational/ sporting facilities	0.0002	0.0002	0.0002	0.0000000 5	0.00000005	5
Adaptable housing design and construction	4.5000	9.0000	18.0000	0.0136092 2	0.01360922	2
Level of social mix in housing environment	4.5000	9.0000	18.0000	0.0136092 2	0.01360922	2

Security and safety issues	216.0000	567.0000	1152.0000	0.9725071	0.97250714	1

Table 4.14-The fuzzy weights of the variable groups with respect to the economic factor.

Variable Group(V3)	Fuzzy Weight(wi)			Local Weight	Normalized Local Weight Rank	
Housing affordability	0.007	0.016	0.037	0.000044	0.000044	4
Access to housing loan	0.001	0.001	0.002	0.000002	0.000002	5
Stable macro-economic environment	324.000	441.000	576.000	0.631132	0.631132	1
Low lending cost (interest charged)	0.250	0.714	2.000	0.002394	0.002394	3
Low equity contribution	162.000	243.000	324.000	0.366429	0.366429	2

Table 4.15-The fuzzy weights of the variable groups with respect to the environmental factor.

Variable Group(V4)	Fuzzy Weight(wi)			Local Weight	Normalized Local Weight	Rank
Open spaces and green areas	0.083	0.200	0.500	0.0025	0.0025	3
Waste management system	2.000	5.000	12.000	0.0605	0.0605	2
Quality of housing environment	48.000	105.000	192.000	0.9369	0.9369	1
Noise Level	0.005	0.010	0.021	0.0001	0.0001	4

Table 4.16-The fuzzy weights of the variable groups with respect to the administrational factor.

Variable Group(V5)	Fuzzy Weight(wi) No			Local Weight	rmalized Local Wei	ght Rank
Government providing financialsupport	0.25	0.33	0.50	0.017	0.017	2
Appropriate risk allocation and sharing	0.17	0.20	0.25	0.008	0.008	3
Environmental impact of project	8.00	15.00	24.00	0.975	0.975	1

Table 4.17-The fuzzy weights of the variable groups with respect to the technology factor.

Variable Group(V6)	Fuzzy Weight(wi) No			Local Weight	rmalized Local Wei	ght Rank
Technology innovation	0.25	0.33	0.50	0.107	0.107	2
Technology transfer	2.00	3.00	4.00	0.893	0.893	1

Table 4.18. Illustrates the local weights and normalized local weights of the input variables at the third level in the hierarchy structure, along with their ranking among all variables evaluated by the decision makers. Subsequently, the results were arranged based on the normalized weights assigned to each criterion.

Table 4.18- Summarized weights of first and second level factors

Variable group	Local weight	Input variable (Vij)	Local weights	Global weights	Ranking by category	Overall ranking
Political Factors	0.999068	Providing guarantee /support to developers	0.0000521	0.0000520602	4	7
		Political will	0.7280245	0.7273458193	1	1
		Appropriate legal and regulatory framework	0.0230941	0.0230725711	3	3
		Government commitment in providing land	0.0000008	0.0000007797	5	13
		Stability of political system	0.2488281	0.2485961655	2	2
		Government provision of infrastructure	0.0000004	0.0000003911	6	14
Social Factors	0.000002	Housing near to the places of work and worship	0.0002744	0.0000000004	4	23
		Provision of recreational/ sporting facilities	0.0000001	0.0000000000	5	25
		Adaptable housing design and construction	0.0136092	0.0000000206	2	19
		Level of social mix in housing environment	0.0136092	0.0000000206	2	19
		Security and safety issues	0.9725071	0.0000014695	1	12
Economic Factors	0.000057	Housing affordability	0.0000440	0.0000000025	4	22
		Access to housing loan	0.0000018	0.0000000001	5	24
		Stable macro-economic environment	0.6311319	0.0000357892	1	8
		Low lending cost (interest charged)	0.0023935	0.0000001357	3	16
		Low equity contribution	0.3664288	0.0000207788	2	9
Enviromental Factors	0.000057	Open spaces and green areas	0.0024951	0.0000001415	3	15
		Waste management system	0.0604867	0.0000034300	2	10
		Quality of Housing Environment	0.9369222	0.0000531294	1	6
		Noise Level	0.0000960	0.0000000054	4	21
Adminstrational Factors	0.000003	Government providing financialsupport	0.0174541	0.0000000479	2	17
		Appropriate risk allocation and sharing	0.0077922	0.0000000214	3	18

		Environmental impact of project	0.9747537	0.0000026757	1	11
Technology Factors	0.000815	Technology innovation	0.1074074	0.0000874881	2	5
		Technology transfer	0.8925926	0.0007270565	1	4

4.8. Discussion of Main Findings and Implications

4.8.1. Discussion of Main Findings

The popularity and importance of this CSF were consistent within various literature. For instance, stability of the political system, appropriate legal and regulatory framework, security and safety issues, and technology transfer were fully acknowledged by the interviewees. Whereas, political will, providing guarantee/support to developers, stable macro-economic environment, housing affordability, quality of housing environment, and technological innovation were approved by 4 interviewees, government provision of infrastructure, level of social mix in housing environment, adaptable housing design and construction, low equity contribution, waste management system, appropriate risk allocation and sharing and government providing

financial support recognized by 3 interviewees. The rest critical success factors are accepted by 2 interviewees. On the contrary, the participants who expressed approval towards the complete set of critical elements for success amounted to 68%, 76%, 56%, 60%, and 52%, as recognized by individuals A, B, C, D, and E, respectively. The expertise of these professionals in supervising PPP projects has been recognized in earlier studies related to PPP.

This research examined into the suitable selection of input factors for conducting factor analysis and fuzzy analytic hierarchy process (AHP) techniques. The combined approach of factor analysis and fuzzy AHP was applied to enhance the inclusive important variables influencing the success of public-private partnership housing initiatives. Within this investigation, a total of 25 variables were identified as determinants impacting the effectiveness of housing projects under the PPP framework.

The results of the exploratory factor analysis indicated that the six-factor structure concerning the influences on the efficiency of public-private partnership housing development accounted for 69.969% of the variance in the interrelationships among the variables. All six factors demonstrated strong reliabilities, as evidenced by Cronbach's Alpha coefficients exceeding 0.7. Following items exhibiting cross-loading on multiple factors, a total of twenty-five items were engaged in the final survey instrument. Consequently, this investigation has confirmed the presence of a six-factor framework influencing the success of housing projects. After assessing the validity and reliability of the data, the findings of the fuzzy analytic hierarchy process shall be described as follows. To gain more insight into these discussions, readers are advised to refer to Table 4.18 the decision experts weighted the value of the group variables, and input variables were presented.

As illustrated in Table 4.18, the experts in decision-making conducted a comparison of localized weights within each group variable, resulting in the identification of political factors (0.9990) and technology-related factors (0.00081) as the primary and secondary factors of significance influencing the outcomes of public-private partnership housing initiatives. Therefore, decision-making experts suggest that factors associated with politically related and technology-related factors should be considered the most critical elements impacting the success of public-private partnership housing projects. Political factors were of utmost importance in the achievement of public-private partnership housing initiatives, as highlighted in numerous academic studies. Studies underline the significance of political support and

stability as key determinants of success for PPPs involved in the provision of affordable housing (Abdullahi & Alias, 2022). Additionally, the presence of a stable political system is identified as a key variable for success in Nigeria's PPP housing projects (Alteneiji, Alkass, & Abu Dabous, 2020b). Moreover, good governance, government guarantees, and political support are highlighted as essential factors in the implementation of PPPs in the affordable housing sector in the United Arab Emirates (Alteneiji, Alkass, & Abu Dabous, 2020a). These findings underscore the importance of political factors in creating an enabling environment for successful PPP housing projects, emphasizing the need for favorable political conditions and governmental commitment to ensure project viability and sustainability. Furthermore, the success of PPP in providing affordable housing in Nigeria is linked to technological factors such as project economic viability, a strong private sector, and an effective procurement process (Alshahrani et al., 2023).

On the other hand, the impact of social and administrational factors (0.000002) and (0.000003) respectively on the successfulness of public-private partnership housing initiatives were found to be the least significant factor. The findings suggest that decision experts' perceptions are influenced by the priority given to political-related factors and technology-related factors, thereby overshadowing the success of housing projects. However, this does not imply that social and administrational factors do not affect project success; rather, they exhibit a relatively lower level of significance compared to other factors. Individually, a more in-depth analysis of each input variable within their respective group variable reveals that the most significant factor within the political-related category factors was political will (0.728), stability of political system (0.249), appropriate legal and regulatory framework (0.023), and providing guarantee /support to developers (0.00005) following accordingly. On the contrary, government commitment to providing land (0.0000008) and government provision of infrastructure (0.0000004) were perceived as the least significant factors by the decision experts.

The most prominent weighted factor within social-related aspects was the security and safety issue (0.973), followed by the adaptable housing design and construction (0.014). Similarly, the Level of social mix in the housing environment shared a similar weight (0.014). On the contrary, housing near the places of work and worship (0.0003), along with the provision of

recreational/ sporting facilities (0.00000005) were the least significant factors in the perception of the decision experts.

Furthermore, the most significant factor of input variables under the economic-related factor was stable macro-economic environment (0.631), low equity contribution (0.366) low lending cost (interest charged) (0.0024), this finding can be supported by (Alshahrani et al., 2023). The availability of a stable economic system is emphasized as a key driver for successful PPP housing projects, ensuring sustainable financing and project delivery. housing affordability (0.00004), and access to housing loans (0.000002), In Saudi Arabia, the success of PPPs for affordable housing relies on critical success factors, including financial considerations, to involve the private sector effectively (Alshahrani et al., 2023). Similarly, in India, the involvement of the private sector in affordable housing projects through PPPs is essential to alleviate the burden on the government and ensure housing for all income groups (Sharma, 2020). Contrariwise, access to housing loans (0.0000018) was the least significant factor that affected the success of housing projects identified by the decision experts.

Moreover, the predominant determinants among the input variables within the context of environmental factors were the quality of the housing environment (0.937), waste management system (0.061), and open spaces and green areas (0.0025). Conversely, the noise level (0.00009) was the least factor identified by the decision experts.

According to these results, the input variables under the administrational-related factor, the environmental impact of the project (0.975), government providing financial support (0.0175) and appropriate risk allocation and sharing (0.0078) were ranked as the first, the second, and the third factors affecting the housing project success in PPP framework. (Temitope, Emmanuel, & Olaniyi, 2023) supported that research in Kebbi State, Nigeria, underscores the importance of effective risk management in PPP housing projects to ensure better housing delivery and project sustainability.

Finally, the results of input variables under the technology-related factor, show that the technology transfer (0.893) and technology innovation (0.107) were the most significant factors affecting the success of public-private partnership housing projects.

On the whole, the input variables that presented the highest-ranked final weights in the global weights analysis were political will (0.727), stability of political system (0.249), appropriate legal and regulatory framework (0.023072), technology transfer (0.0007), technology

innovation (0.00009), and quality of housing environment (0.00005). This finding can be supported by (Ezebilo, 2023), which emphasizes the significance of political support and stability, a stable economic system, and a favorable legal framework as critical success factors for PPP housing projects.

On the other hand, the sub-factor with the lowest ranking was the provision of recreational/ sporting facilities (0.00000000000008), followed by access to housing loans (0.00000000009), housing near to the places of work and worship (0.0000000004), housing affordability (0.0000000025), and noise level (0.000000005). This does not imply that these identified factors lack significance in housing project success under the PPP framework. However, their impact is relatively minor when compared to the aforementioned factors. This indicates that the provision of recreational/ sporting facilities, access to housing loans, housing near places of work and worship, housing affordability, and noise level had a limited influence on housing project success as perceived by the respondents. Generally

1.Political Factor (Rank 1)

The political factor emerged as the most influential critical success factor in PPP housing projects in Addis Ababa. This result indicates that government commitment, political will, land provision, infrastructure support, and a stable regulatory environment are fundamental requirements for successful PPP implementation. Since PPP housing projects involve long-term investments, private developers require confidence that government policies and commitments will remain consistent throughout the project lifecycle. In the Ethiopian context, where land ownership and housing policy are largely controlled by the government, political support becomes even more critical. This finding is consistent with the study of Gudienė et al. (2013), which identified political stability and government commitment as key determinants of PPP project success.

2. Economic Factor (Rank 2)

The economic factor was ranked second, indicating that financial viability is a major determinant of PPP housing project success. Variables such as housing affordability, access to housing loans, low lending costs, and a stable macroeconomic environment significantly influence both developers and homebuyers. High inflation, limited access to mortgage financing, and rising construction costs can reduce the attractiveness of PPP housing projects. Therefore, improving access to affordable financing and maintaining economic stability can enhance the effectiveness of PPP housing schemes. This finding supports Oyebanji et al.

(2017), who emphasized the importance of economic sustainability in housing development projects.

3. Social Factor (Rank 3)

The social factor ranked third, demonstrating the importance of community well-being and resident satisfaction in PPP housing projects. Factors such as security and safety, proximity to workplaces and places of worship, recreational facilities, social integration, and adaptable housing design contribute to the long-term acceptance and sustainability of housing developments. Housing projects that respond to the social needs of residents are more likely to achieve higher occupancy rates and community support. This result aligns with the findings of Ibem et al. (2011), who highlighted social sustainability as a key component of successful housing projects.

4. Environmental Factor (Rank 4)

The environmental factor was ranked fourth, suggesting that environmental quality remains an important consideration in PPP housing projects. Variables such as waste management systems, green spaces, housing environment quality, and noise control contribute to creating healthy and sustainable living environments. Although environmental concerns may not receive the same priority as political and economic issues in developing countries, they remain essential for improving residents' quality of life and ensuring sustainable urban development. This finding is consistent with Oyebanji et al. (2017), who identified environmental sustainability as an important dimension of housing project success.

5. Administrative Factor (Rank 5)

The administrative factor was ranked fifth among the critical success factors. This factor includes appropriate risk allocation, government financial support, and environmental impact management. Although administrative issues received a lower ranking compared to political and economic factors, they still play an important role in facilitating effective project implementation. Clear allocation of responsibilities and risks between public and private partners can reduce conflicts and improve project performance. This result is supported by Babatunde et al. (2016), who emphasized the importance of institutional arrangements and risk-sharing mechanisms in PPP projects.

6. Technology Factor (Rank 6)

The technology factor received the lowest ranking among the major factors. This result suggests that although technological innovation and technology transfer contribute to

improved construction efficiency and project quality, stakeholders currently perceive them as less critical than political, economic, and social factors. This may be because PPP housing projects in Addis Ababa continue to face more pressing challenges related to governance, financing, and land availability. Nevertheless, technological advancement remains important for improving construction productivity, reducing project costs, and promoting sustainable housing development in the long term. This finding agrees with Liu et al. (2022), who emphasized the growing role of technology in modern housing development.

Overall, the findings reveal that political and economic factors exert the greatest influence on the success of PPP housing projects in Addis Ababa. This indicates that creating a supportive policy environment, ensuring government commitment, improving financial accessibility, and maintaining economic stability should be prioritized by policymakers and project stakeholders. While social, environmental, administrative, and technological factors also contribute to project success, their effectiveness largely depends on the existence of strong political and economic foundations. These results provide practical guidance for improving PPP housing implementation and addressing the growing housing demand in Addis Ababa.

4.8.2. Implications of the finding

The findings of this study provide some significant implications for identifying and ranking factors influencing the success of public-private partnership housing projects. This study presents a way to analyze the most important factors using factor analysis and fuzzy AHP methods. It also helps us to understand how academics conduct research by combining the methods used. This research offers noteworthy implications for policymakers, project managers, and practitioners. Policymakers in the field are required to establish a distinct mission and vision for the development, execution, and assessment of their public-private partnership initiatives.

Based on the result and discussion of the study the following implications are described:

- First of all, this study is based on the data gathered from PPP public officials and private developer professionals. There are no studies conducted in Ethiopia in the field of PPP housing projects and their success factors. Therefore, the results of this research will be useful to Ethiopian construction companies that are investing huge amounts of money in developing housing projects.

- Identify and prioritize the most critical factors contributing to the success of public-private partnership housing projects. This finding holds significant value for stakeholders engaged in the planning, execution, and implementation of such projects,

although enabling them to allocate resources, efforts, and investments towards factors with the greatest impact. Ranking the greatest critical factors are easy stakeholders recognizing potential pitfalls and developing strategies to mitigate risks and avoid project failures.

- Various factors (i.e. political-related factors, social-related factors, economic-related factors, environmental-related factors, administrational-related factors, and technology-related factors) affect the success of PPP housing development. Neglecting these factors leads to a significant effect on housing project success. Recognizing these factors is critical to the ability of the developing housing success.
- Continuous monitoring and evaluation of public private partnership housing projects, incorporating lessons learned will help improve future initiatives and improve implementation.
- Investing in developing skills and competencies among public officials and private developers will strengthen their ability to effectively manage the complexity of public private partnership housing projects.
- Engaging with various stakeholders, including residents, throughout the project lifecycle can enhance transparency, community ownership, and long-term sustainability.
- Fostering efficient collaboration between the public and private sectors is critical for the effective execution of housing projects under public-private partnerships (PPP), guaranteeing coherence of goals and mutual dedication to project result.

CHAPTER FIVE

5. Conclusion and Recommendation

5.1. Introduction

Based on the result derived from the investigation, a discussion of the theoretical and practical implications will be presented in this chapter. Additionally, recommendations will be provided for policymakers, and professionals operating within the realm of public-private partnership housing initiatives, and a future baseline for further research will be explored within this chapter.

5.2. Conclusion

Upon thoroughly analyzing the content of the literature review chapter, it was observed that there exist numerous variables that have the potential to influence the success of public-private partnership housing projects. After revision of these variables through expert interviews, a total of twenty-five factors were identified. A certain number of experts mentioned that some of the measures were derived from the literature review phase. Consequently, the final set of 25 key factors comprises political, social, economic, environmental, administrative, and technological factors.

By using factor analysis, the FAHP method, and completing the questionnaire through face-to-face meetings we finally were able to provide a ranking of all factors and sub-factors. This ranking shows the relative importance of success factors compared to each other. This will provide a clear map to private developers and public officials who are trying to improve their PPP implementation, and performance and reach customer satisfaction.

The ultimate ranking of critical success factors for public-private partnership housing initiatives and their corresponding weights are shown in Table 4.18. These findings approve the relations derived from expert interviews and reviewing the literature. The significance of the weights and rankings effectively clarifies two primary inquiries addressed in this thesis.

The ranking of the main factors from most important to least important are political factors, technology factors, environmental factors, economic factors, administrational factors, and social factors respectively.

Based on the viewpoint of Ethiopian experts related to housing development, the most important factor affecting the success of PPP housing projects is political factors. Hence, the assurance of political support, stability, and effective governance is critical for the success of

public-private partnership housing initiatives, as they establish a conducive atmosphere for cooperation between governmental and private entities, ultimately resulting in favorable project results. The second important factor is technology factors which is the effective integration of technology into public-private partnership housing initiatives has the potential to improve efficiency, transparency, and overall project results, thereby making an extensive contribution to their success. On the other hand, environmental and economic factors lie along the intermediate range of critical factors in comparison to other variables. These two factors do not have a noticeable difference in their weights. Consequently, it can be asserted that they hold equivalent levels of significance. Lastly, the main factors with the lowest ranking are administrative and social.Based on the results and discussions, the following conclusions are suggested:

- This research aims to construct an exploratory factor analysis and fuzzy AHP models to explore the factors that affect the success of PPP housing projects. Success in housing development depends on the perspective of stakeholders.
- In this study, factor analysis and fuzzy AHP were employed to analyze the results using SPSS software version 25, Super decision software, and Microsoft Excel, respectively. Factor analysis helps to eliminate inappropriate factors that decrease the standard of correlation, and the most important factors that affect the project's success were determined via the fuzzy AHP model.
- The fuzzy AHP method has not been used much in the studies of the construction sector especially housing development and its success factors and using the fuzzy analytic hierarchy process as the data analysis method on the other side forms the contribution part of this thesis.
- Furthermore, utilizing fuzzy AHP the study is capable of addressing the inherent vagueness and subjectivity associated with evaluating success factors in complex projects such as PPP housing projects.

- The concept of successful housing development has many aspects beyond just building structures. It requires delivering safe, secure, and affordable housing options that meet the needs of the target demographic while minimizing environmental impact by incorporating energy-efficient features, water conservation methods, and sustainability. On the other hand, it delivers the project on time, within budget, and according to the planned specifications, as well as generates economic activity through job creation, increased property values, and potential tax revenue for the local government.

Recommendations

Recommendations for Practitioners

Managers, professionals, and private developers operating within the public-private partnership framework have the opportunity to utilize the ranking and weighting of factors as a strategic guide for optimizing success and performance in their housing development projects. This is particularly relevant for public officials and private developers involved in housing construction, a topic extensively explored in the present study.

In light of the results and discussions, the following recommendations for practitioners are suggested:

- Managers are strongly advised to incorporate this ranking into their strategic plans to enhance and optimize their service delivery more efficiently. Through resource management and prioritizing these elements as an objective for all teams, they are guaranteed to attain a more advantageous market position and standing within their industry, ultimately resulting in increased customer base, profitability, and community service.
- House construction firms have the potential to enhance their strategic approaches through a sharp focus on the prioritization of success factors that influence the effectiveness of public-private partnership agreements. These firms could allocate additional financial resources towards residential construction and service provision, while also adapting their methodologies to encourage overall service delivery.
- The findings of this research are particularly beneficial for organizations that are in the process of initiating housing development projects through public-private partnerships in Ethiopia. These organizations can utilize the prioritization of various factors outlined in the study for incorporation into their strategic business plans. Furthermore, when making decisions regarding the infrastructure and architectural aspects of their construction projects, they must carefully consider several factors.
- Policymakers should prioritize creating a stable political environment and supporting technological innovations in the housing sector.

- Developers should focus on sustainable design and ensuring housing affordability to address both environmental and economic considerations.
- Stakeholders should foster strong partnerships and align their objectives to enhance the chances of successful PPP housing project outcomes.
- The findings of this research provide valuable insights for policymakers, public officials, and private developers, enabling them to prioritize their efforts and allocate resources more effectively towards the most critical success factors for PPP housing projects.

Recommendations for future research

To enhance the long-term significance of this investigation, for the coming studies will center on the utilization of an alternative widely-recognized multiple-criteria decision-making (MCDM) approach, the following recommendations for practitioners are suggested:

- Specifically, the ELECTRE (Elimination and Choice Expressing Reality) method. This method is dedicated to the selection of the optimal course of action from a range of possibilities and is also employed in addressing three primary concerns: selection, prioritization, and arrangement.
- Moreover, the methodology employed in this study may undergo analysis through alternative statistical approaches like factor analysis and structural equation modeling. By designing a different questionnaire for the same factors and choosing a large sample of professionals, managers, house developers, and residents, we will reach more reliable results. Our best suggestion to other researchers interested in this field is to choose another statistical method such as structural equation modeling and test this framework with a large sample of stakeholders.

APPENDIX -I

Interview Questions

Interview questions for navigating critical success factors in public-private partnership housing projects using FAHP both English and Amharic versions.

FIRST -PHASE

General Questions:

1. In your experience, what are the key factors that contribute to the success of PPP housing projects?
   (በተሞክሮዎ፣ ለህዝብ የግል አጋርነት ቤቶች ፕሮጀክቶች ስኬት አስተዋጽኦ የሚያደርጉ ቁልፍ ነገሮች ምንድን ናቸው?)
2. What are the biggest challenges you see in ensuring the success of PPP housing projects?
   (የመንግስት የግል አጋርነት ቤቶች ፕሮጀክቶችን ስኬት በማረጋገጥ ረገድ የሚያዩዋቸው ትልልቅ ፈተናዎች ምንድን ናቸው?)
3. How do you think the priorities for success factors might differ for different stakeholders (public, private, residents)?
   (ለተለያዩ ባለድርሻ አካላት (የመንግስት መሥሪያ ቤት፣ የግል ገንቢ፣ ነዋሪዎች) ለስኬት ምክንያቶች ቅድሚያ የሚሰጣቸው ነገሮች እንዴት ሊለያዩ ይችላሉ ብለው ያስባሉ?)
4. How do you think the specific context of a project (location, size, and type) might influence the critical success factors?
   (የፕሮጀክት ልዩ አውድ (ቦታ፣ መጠን እና ዓይነት) ወሳኝ በሆኑ የስኬት ሁኔታዎች ላይ እንዴት ተጽዕኖ ሊያሳድር ይችላል ብለው ያስባሉ?)
5. Have you encountered any examples of Public Private Partnership housing projects that were particularly successful or unsuccessful? If so, what factors do you think contributed to their outcomes?
   (በተለይ የተሳካላቸው ወይም ያልተሳኩ የፐብሊክ የግል አጋርነት ቤቶች ፕሮጀክቶች ምሳሌዎች አጋጥመውዎት ያውቃሉ? ከሆነ፣ ለውጤታቸው አስተዋጽኦ ያደረጉት ምን ነገሮች ይመስላችኋል?),

Specific Questions for Different Stakeholders: Public Officials:

1. What are the primary policy objectives you hope to achieve through Public Private Partnership housing projects?
   (በሕዝብ የግል አጋርነት ቤቶች ፕሮጀክቶች ልታሳካላቸው የምትፈልጋቸው ተቀዳሚ የፖሊሲ ዓላማዎች ምንድን ናቸው?)
2. How do you measure the success of a Public Private Partnership housing project from your perspective?
   (የመንግስት የግል አጋርነት የመኖሪያ ቤት ፕሮጀክት ስኬት ከእርስዎ እይታ እንዴት ይለካሉ?)
3. What are your biggest concerns regarding the potential risks or drawbacks of Public Private Partnership housing projects?
   (የመንግስት የግል አጋርነት ቤቶች ፕሮጀክቶች ሊኖሩ የሚችሉትን አደጋዎች ወይም መዘዞች በተመለከተ የእርስዎ ትልቅ ስጋት ምንድን ነው?)
4. How do you ensure that the needs and voices of residents are adequately represented in the decision-making process for Public Private Partnership housing projects?
   (ለመንግስት የግል አጋርነት ቤቶች ፕሮጀክቶች የውሳኔ አሰጣጥ ሂደት የነዋሪዎች ፍላጎት እና ድምጽ በበቂ ሁኔታ መወከላቸውን እንዴት ያረጋግጣሉ?)

Private Developers:

1. What are the main financial and commercial considerations you take into account when evaluating potential Public Private Partnership housing projects?
   (የመንግስት የግል አጋርነት ቤቶች ፕሮጀክቶችን ሲገመግሙ ማየት የሚገቡት ዋና ዋና የገንዘብ እና የንግድ ጉዳዮች ምንድን ናቸው?)
2. What challenges do you face in partnering with the public sector in the context of Public Private Partnership housing projects?
   (የመንግስት የግል አጋርነት ቤቶች ፕሮጀክቶች ውስጥ ከመንግስት ሴክተር ጋር በመተባበር ምን ችግሮች ያጋጥሙዎታል?)
3. How do you ensure the long-term sustainability and financial viability of Public Private Partnership housing projects?

(የመንግስት የግል አጋርነት ቤቶች ፕሮጀክቶችን የረዥም ጊዜ ዘላቂነት እና የፋይናንስ አዋጭነት እንዴት ያረጋግጣሉ?)

4. What role do you see social impact and community development playing in successful Public Private Partnership housing projects?
   (ስኬታማ በሆነ የመንግስት የግል አጋርነት ቤቶች ፕሮጀክቶች ውስጥ ማህበራዊ ተፅእኖ እና የማህበረሰብ ልማት ምን ሚና ሲጫወቱ ይመለከታሉ?)

Residents:

1. What are your main concerns and priorities regarding housing affordability, quality, and access?
   (የመኖሪያ ቤት አቅምን፣ ጥራትን እና ተደራሽነትን በተመለከተ ዋና ዋና ጉዳዮችዎ እና ቅድሚያ የሚሰጧቸው ነገሮች ምንድን ናቸው?)
2. How do you perceive the potential benefits and drawbacks of PPP housing projects in your community?
   (በማህበረሰብዎ ውስጥ ያሉትን የመንግስት የግል አጋርነት ቤቶች ፕሮጄክቶችን ጥቅሞች እና ጉዳቶች እንዴት ይገነዘባሉ?)
3. Have you been involved in any consultations or decision-making processes related to PPP housing projects in your area? If so, how satisfied were you with the level of engagement and transparency?
   በማህበረሰብዎ ውስጥ ያሉትን የመንግስት የግል አጋርነት ቤቶች ፕሮጄክቶችን ጥቅሞች እና ጉዳቶች እንዴት ይገነዘባሉ?
4. What specific features or qualities would make a PPP housing project successful from your perspective?

(የህዝብ የግል አጋርነት የመኖሪያ ቤት ፕሮጀክት ከእርስዎ እይታ የተሳካ እንዲሆን ምን አይነት ባህሪያቶች ወይም ባህሪያት ናቸው?)

APPENDIX -II

Second- Phase Survey Questionnaire

Dear respondents

I wish to express my appreciation beforehand for the generosity of your kindness, time, and appropriate response. The purpose of this questionnaire survey is to examine critical success factors in public-private partnership housing projects using a fuzzy analytic hierarchy process this is to inform that this research question will belong in partial fulfillment of a Masters of Art (MA) degree in Project Management from Addis Ababa University at School of Commerce. All data furnished in the questionnaire survey will be exclusively utilized for academic purposes, specifically as input for this thesis or research. The confidentiality of all responses shared herein will be strictly maintained. Finally, the quality and accuracy of this study depend on your responses therefore, please provide your responses wisely. The general instructions are:

- ✓ You are not expected to write your name
- ✓ Please put this mark (√) to your response
- ✓ Please provide only one answer for each item

SECTION: A

DEMOGRAPHIC PROFILE OF RESIPONDENT

Please respond as appropriate as is to you and your response will be kept confidential and will be used for academic research purposes.

1. Sex: Male Female Age…….

2. How many years have you been active in your current position?

Less than 2 years 2 to 5 years 6 to 10 years More than 10 years

3. In which field does your academic education fit?

Civil Engineering Project Management

A mix of engineering and management other ……

SECTION: B

Instructions:

Based on your perceived values, experience, and facts rate the critical success factors for the public-private partnership housing project in Addis Ababa. Please put your important and unimportant level for the following points which are related to the factors for the successfulness of the public-private partnership housing project in Addis Ababa. 1-strongly unimportant, 2-unimportant, 3-neutral, 4-important and 5-strongly important.

	Scale: 1-strongly unimportant, 2-unimportant, 3-neutral, 4-important and 5-strongly important.	1	2	3	4	5
V1	Stability of political system					
V2	Political will					
V3	Appropriate legal and regulatory framework					
V4	Government commitment in providing land					
V5	Stability of political system					
V6	Government provision of infrastructure					
V7	Housing near to the places of work and worship					
V8	Provision of recreational/ sporting facilities					
V9	Adaptable housing design and construction					
V10	Level of social mix in housing environment					
V11	Security and safety issues					
V12	Housing affordability					
V13	Access to housing loan					
V14	Stable macro-economic environment					
V15	Low lending cost (interest charged)					
V16	Low equity contribution					
V17	Open spaces and green areas					
V18	Waste management system					
V19	Quality of Housing Environment					
V20	Noise Level					
V21	Technology innovation					
V22	Technology transfer					
V23	Appropriate risk allocation and sharing					
V24	Government providing financial support					
V25	Environmental impact of project					

APPENDIX -III

Third phase Pair Wise-Questionnaire

Background

This study aimed at navigating critical success factors in public-private partnership housing projects using a fuzzy analytics hierarchy process to evaluate and prioritize success factors that have been identified from existing literature and your expert decision is needed to rank each of the factor's pair-wise comparison.

The researcher of this study will leverage your response in assessing the appropriate weight of each element using the multi-criteria decision-making (MCDM) process. Please trace the table row by raw.

Section A

Please respond as appropriate as is to you and your response will be kept confidential and will be used for academic research purposes.

1. Sex: Male ☐ Female ☐ Age…….
2. How many years have you been active in your current position?

   Less than 2 years ☐ 2 to 5 years ☐ 6 to 10 years ☐ More than 10 years ☐
3. In which field does your academic education fit?

   Civil Engineering ☐ Project Management ☐

   A mix of engineering and management ☐ other ……

Section- B

Instructions:

If you believe that the factor located in the right column of the table is more important than the factor in the left column (located in the same row) then mark one of the checkboxes located in the right side of "Equal". You can choose one of the checkboxes based on the level of importance in comparison to two factors.

If you believe that the factor located in the left column of the table is more important than the factor in the right column (located in the same row) then mark one of the checkboxes located on the left side of "Equal".

Note 1: The space between two levels of importance shows an important level between two main levels.

Note 2: From right to left, the importance of the right factor in comparison to the left factor decreases.

Note 3: If you need more information about the comparing factors in the table you can read the table of factors attached in at the end of the questionnaire.

Note 4: Please consider the logical consistency of your answers. For instance, consider table 1. If you have marked “political factor” extremely important in comparison to “social factor” and marked “social factor “extremely important in comparison to “economic factor” then your judgment would be “political factor “extremely more important than “economic factor”.

By following the same procedures, you are requested to kindly complete the pair-wise comparison scale of different conditioning factors.

THANKS FOR YOUR COOPERATION

Table 1. Pair-wise comparison scale (Saaty 1980)

Scale of importance	Meaning
1	Equally important
3	Slightly important
5	Strongly important
7	Very strongly important
9	Extremely Important
2,4,6,8	Expression of intermediate value

4. Please determine the importance and priority of factors in the right side of this table compared to the factors in the left side regarding “critical success factors of PPP housing project in Addis Ababa city” (for instance in the first row on the table please determine how importance are “Social” and “Political” compared to each other regarding “critical success factors of PPP housing project in Addis Ababa city”) for more information about the factors please read the table of factors attached to this questionnaire. The white columns show importance level between two main levels.

	Extremely important		very strongly important		strongly important		Slightily important		Equal		Slightily important		strongly important		very strongly important		Extremely important	
Political Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Social Factors
Political Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Economic Factors
Political Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Environmental Factors
Political Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Administrational Factor
Political Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Technology Factors
Social Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Economic Factors
Social Factors	□	□	□	□	□	□				□	□	□	□	□	□	□	□	Environmental Factors
Social Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Administrational Factor
Social Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Technology Factors
Economic Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Environmental Factors
Economic Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Administrational Factor
Economic Factors	□	□	□	□	□	□				□	□	□	□	□	□	□	□	Technology Factors
Environmental Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Administrational Factor
Environmental Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Technology Factors
Administrational Factors	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Technology Factors

5. Please determine the importance and priority of factors on the right side of this table compared to the factors on the left side regarding “political factors” (for instance in the first row of the table please determine how important is “political will” and “Providing guarantee” compared to each other regarding “political factors”). For more information about the factors please read the table of factors attached to this questionnaire.

	Extremely important	very strongly important	strongly important	Slightly important	Equal	Slightly important	strongly important	very strongly important	Extremely important	
Political will	□	□	□	□	□	□	□	□	□	Providing guarantee /support to developers
Appropriate legal and regulatory framework	□	□	□	□	□	□	□	□	□	Providing guarantee /support to developers
Government commitment in providing land	□	□	□	□	□	□	□	□	□	Providing guarantee /support to developers
Stability of political system	□	□	□	□	□	□	□	□	□	Providing guarantee /support to developers
Government provision of infrastructure	□	□	□	□	□	□	□	□	□	Providing guarantee /support to developers
Appropriate legal and regulatory framework	□	□	□	□	□	□	□	□	□	Political will
Government commitment in providing land	□	□	□	□	□	□	□	□	□	Political will
Stability of political system	□	□	□	□	□	□	□	□	□	Political will
Government provision of infrastructure	□	□	□	□	□	□	□	□	□	Political will
Government commitment in providing land	□	□	□	□	□	□	□	□	□	Appropriate legal and regulatory framework
Stability of political system	□	□	□	□	□	□	□	□	□	Appropriate legal and regulatory framework
Government provision of infrastructure	□	□	□	□	□	□	□	□	□	Appropriate legal and regulatory framework
Stability of political system	□	□	□	□	□	□	□	□	□	Government commitment in providing land
Government provision of infrastructure	□	□	□	□	□	□	□	□	□	Government commitment in providing land

Government provision of infrastructure	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Stability of political system

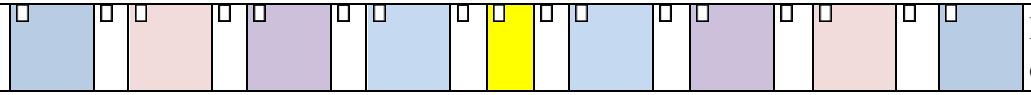
6. Please determine the importance and priority of factors on the right side of this table compared to the factors on the left side regarding “Social factors” (for instance in the first row of the table please determine how important “Housing near to the places of work and worship” and “Provision of recreational/ sporting facilities” compared to each other regarding “Social factors”) For more information about the factors please read the table of factors attached to this questionnaire.

	Extremely important	very strongly important	strongly important	Slightly important	Equal	Slightly important	strongly important	very strongly important	Extremely important	
Provision of recreational/ sporting facilities	☐	☐	☐	☐	☐	☐	☐	☐	☐	Housing near to the places of work and worship
Adaptable housing design and construction	☐	☐	☐	☐	☐	☐	☐	☐	☐	Housing near to the places of work and worship
Level of social mix in housing environment	☐	☐	☐	☐	☐	☐	☐	☐	☐	Housing near to the places of work and worship
Security and safety issues	☐	☐	☐	☐	☐	☐	☐	☐	☐	Housing near to the places of work and worship
Adaptable housing design and construction	☐	☐	☐	☐	☐	☐	☐	☐	☐	Provision of recreational/ sporting facilities
Level of social mix in housing environment	☐	☐	☐	☐	☐	☐	☐	☐	☐	Provision of recreational/ sporting facilities
Security and safety issues	☐	☐	☐	☐	☐	☐	☐	☐	☐	Provision of recreational/ sporting facilities
Level of social mix in housing environment	☐	☐	☐	☐	☐	☐	☐	☐	☐	Adaptable housing design and construction
Security and safety issues	☐	☐	☐	☐	☐	☐	☐	☐	☐	Adaptable housing design and construction

Security and safety issues																						Level of social mix in housing environment

7. Please determine the importance and priority of factors on the right side of this table compared to the factors on the left side regarding “Economic factors” (for instance in the first row of the table please determine how important “Housing affordability” and “Access to housing loan” compared to each other regarding “Social factors”) For more information about the factors please read the table of factors attached to this questionnaire.

	Extremely important		**very strongly important**		**strongly important**		**Slightly important**		**Equal**		**Slightly important**		**strongly important**		**very strongly important**		**Extremely important**	
Access to housing loan	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Housing affordability
Stable macro-economic environment	□	□	□	□	□	□	□	□			□	□	□	□	□	□	□	Housing affordability
Low lending cost (interest charged)	□	□	□	□	□	□	□	□	□		□	□	□	□	□	□	□	Housing affordability
Low equity contribution	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Housing affordability
Stable macro-economic environment	□	□	□	□	□	□	□	□			□	□	□	□	□	□	□	Access to housing loan
Low lending cost (interest charged)t	□	□	□	□	□	□	□	□	□		□	□	□	□	□	□	□	Access to housing loan
Low equity contribution	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Access to housing loan
Low lending cost (interest charged)	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Stable macro-economic environment
Low equity contribution	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	Stable macro-economic environment

Low equity contribution		Low lending cost (interest charged)

8. Please determine the importance and priority of factors in the right side of this table compared to the factors in the left side regarding “Environmental factors” (for instance in the first row on the table please determine how importance are “Open spaces and green areas” and “Waste management system” compared to each other regarding “Environmental factors”) For more information about the factors please read the table of factors attached to this questionnaire.

	Extremely importa		very strongly important		strongly important		Slightily important		Equal		Slightily important		strongly important		very strongly important		Extremely importa	
Waste management	☐	☐	☐		☐		☐				☐		☐		☐		☐	Open spaces and
Quality of housing	☐		☐		☐						☐		☐		☐		☐	Open spaces and
Noise level	☐		☐		☐		☐		☐		☐		☐		☐		☐	Open spaces and
Quality of housing	☐		☐		☐		☐		☐		☐							Waste management
Noise level	☐		☐		☐		☐				☐		☐		☐		☐	Waste management
Noise level	☐		☐		☐		☐		☐									Noise level

9. Please determine the importance and priority of factors on the right side of this table compared to the factors on the left side regarding “Administration factors” (for instance in the table please determine how important “Government providing financial support” and “Appropriate risk allocation and sharing” compared to each other regarding “Environmental factors”)

For more information about the factors please read the table of factors attached to this questionnaire.	Extremely important	very strongly important	strongly important	Slightily important	Equal	Slightily important	strongly important	very strongly important	Extremely important	
Appropriate risk allocation	☐	☐	☐	☐	☐	☐	☐	☐	☐	Government providing
and sharing Environmental	☐	☐	☐	☐	☐	☐	☐	☐	☐	financial Government
impact of project	☐	☐	☐	☐	☐	☐	☐	☐	☐	providing financial
Environmental impact of project										Appropriate risk allocation and sharing

	Extremely important		very strongly important		strongly important		Slightly important		Equal		Slightly important		strongly important		very strongly important		Extremely important	
Technology transfer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	Technology innovation

10. Please determine the importance and priority of factors on the right side of this table compared to the factors on the left side regarding “Technological factors” (for instance in the first row of the table please determine how important “Technology transfer” and “Technology innovation” compared to each other regarding “Technological factors”)

For more information about the factors please read the table of factors attached to this questionnaire.

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