Enhancing Ethiopia's Agro-Industrial Competitiveness: The Role of Sectoral Innovation Systems and Integrated Agro-Industrial Parks in Global Value Chain Integration

By

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Declaration

I declare that this Dissertation, entitled **"Enhancing Ethiopia's Agro-Industrial Competitiveness: The Role of Sectoral Innovation Systems and Integrated Agro-Industrial Parks in Global Value Chain Integration"** is my original work. It has not been presented for any academic degree, diploma, or certificate at any other University. All sources of materials used for this Dissertation have been duly acknowledged through appropriate citations.

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Recommendation

We, the supervisors of this dissertation, hereby certify that we have read and revised the dissertation entitled **"Enhancing Ethiopia's Agro-Industrial Competitiveness: The Role of Sectoral Innovation Systems and Integrated Agro-Industrial Parks in Global Value Chain Integration,"** prepared under our guidance by Efa Muleta Boru, submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Technology and Innovation Management. Therefore, we recommend the submission of the dissertation to the department for further review and open defense.

Prof. Junseok HWANG		March 24, 2025
(Major Supervisor)	Signature	Date
Abdi Yuya Ahmad (PhD)		March 24, 2025
(Co-Supervisor)	Signature	Date

Approval Page of PhD. Dissertation

We hereby certify that the recommendations and suggestions made by the board of examiners are appropriately incorporated into the final version of the dissertation, entitled **"Enhancing Ethiopia's Agro-Industrial Competitiveness: The Role of Sectoral Innovation Systems and Integrated Agro-Industrial Parks in Global Value Chain Integration"** by Efa Muleta Boru.

Prof. Junseok HWANG		17/05/2025
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We, the undersigned, members of the Board of Examiners for the dissertation open defense of **Efa Muleta Boru**, have read and evaluated the dissertation entitled **"Enhancing Ethiopia's Agro-Industrial Competitiveness: The Role of Sectoral Innovation Systems and Integrated Agro-Industrial Parks in Global Value Chain Integration"** and examined the candidate during the open defense. This is, therefore, to certify that the dissertation is accepted to partially fulfill the degree requirements for **the Doctor of Philosophy in Technology and Innovation Management.**

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Finally, the dissertation's approval and acceptance are contingent upon the candidate submitting their final copy to the Office of Postgraduate Studies (OPGS) through the candidate's Department Graduate Council (DGC) and School Graduate Committee (SGC).

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With deep humility and great gratitude, I reflect on the journey of completing this Doctoral Dissertation titled *“Enhancing Ethiopia’s Agro-Industrial Competitiveness: The Role of Sectoral Innovation Systems and Integrated Agro-Industrial Parks in Global Value Chain Integration.”* This milestone would not have been possible without the collective support, encouragement, and inspiration of many individuals and institutions who have walked alongside me academically, professionally, and personally.

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Table of Contents

LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Full name
ADLI	Agricultural Development-Led Industrialization
ASTU	Adama Science and Technology University
AVE	Average Variance Extracted
CFI	Comparative Fit Index
CR	Composite Reliability
CSA	Climate-Smart Agriculture
DGC	Department Graduate Council
EGTP	Economic Growth and Transformation Plan
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
GVC	Global Value Chain
HTMT	Heterotrait-Monotrait Ratio
IAIP	Integrated Agro-Industrial Park
IPDC	Industrial Parks Development Corporation
ILO	International Labor Organization
ISO	International Organization for Standardization
KII	Key Informant Interview
MSE	Micro and Small Enterprises
NFI	Normed Fit Index
NGO	Non-Governmental Organization
OPGS	Office of Postgraduate Studies
PLS-SEM	Partial Least Squares Structural Equation Modeling
PPP	Public-Private Partnership
R&D	Research and Development
RMSEA	Root Mean Square Error of Approximation
RTC	Rural Transformation Center
SGC	School Graduate Committee
SIS	Sectoral Innovation System

Abbreviation	Full name
SME	Small and Medium Enterprises
SRMR	Standardized Root Mean Square Residual
SWOT	Strengths, Weaknesses, Opportunities, Threats
TIMA	Technology and Innovation Management
TLI	Tucker-Lewis Index
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization
VIF	Variance Inflation Factor

List of Tables

List of Figures

ABSTRACT

This dissertation examines Ethiopia's agro-industrial competitiveness by analyzing Sectoral Innovation Systems (SIS) that enhance Integrated Agro-Industrial Parks (IAIPs) and their integration into Global Value Chains (GVCs). Despite their central role in Ethiopia's industrial strategy, IAIPs confront structural bottlenecks, including fragmented institutional coordination, underdeveloped innovation ecosystems, and restrictive trade policies, limiting their potential for inclusive transformation. The study employs a novel Integrated Mixed-Methods Framework, aligning sub-thematic inquiry with policy objectives. It combines PLS-SEM and qualitative data from interviews, focus groups, and field observations in Yirgalem and Bulbula IAIPs. This approach validates an analytical framework informed by SIS theory and GVC governance, focusing on: (1) governance frameworks, (2) sustainability-driven innovation, (3) agricultural innovation drivers, and (4) product differentiation and trade policy in global competitiveness. Empirical findings reveal complex, sometimes counterintuitive relationships. Institutional frameworks (β = –0.451, $p < 0.01$) and innovation ecosystems (β = –0.744, $p < 0.01$) negatively impact competitiveness, due to bureaucratic rigidity and poor market responsiveness. However, institutional quality enhances stakeholder coordination (β = 0.583) and innovation ecosystem development (β = 0.717). Sustainability practices are key drivers of innovation (β = 0.504, $p < 0.001$), facilitating market integration (β = 0.422)—the strongest predictor of GVC governance (β = 0.589). Mediation analysis shows the sequential influence: sustainability → innovation → market integration → GVC governance. Key drivers of agricultural innovation are institutional support (β = 0.555), networking (β = 0.352), and policy frameworks (β = 0.209). Technology has a non-significant direct effect (β = 0.098), emphasizing the need for supportive institutional conditions. Networking significantly mediates the relationship between institutions and innovation (β = 0.195, $p < 0.001$). Innovation positively affects product differentiation (β = 0.299) but does not significantly boost competitiveness (β = 0.058). Trade policy negatively impacts competitiveness (β = –0.318), indicating misalignment with global market integration. This dissertation contributes by contextualizing SIS and GVC frameworks in a low-income, resource-constrained setting. It introduces a replicable method for innovation system diagnostics and offers policy recommendations focused on institutional reform, innovation policy alignment, trade facilitation, academia–industry linkages, and future research directions. The research concludes that agro-industrial competitiveness in Ethiopia is best achieved through the strategic integration of innovation, sustainability, and coordinated governance mechanisms.

Keywords: Sectoral Innovation Systems, Agro-industrial Competitiveness, Integrated Agro-Industrial Parks, Global Value Chains, Innovation Policy, Sustainability, Ethiopia

CHAPTER 1. INTRODUCTION

1.1 Background of the Study

The current global economy is undergoing significant changes, marked by the increasing complexity of production systems, rising climate issues, digital advancements, and evolving consumption habits. These factors have contributed to the emergence of a more integrated, knowledge-driven, and sustainability-oriented global value chain (GVC) framework (Gereffi & Lee, 2016; Ponte, 2019). This updated industrial landscape highlights the ability of countries to produce, innovate, differentiate, and connect within fragmented yet functionally interlinked production networks worldwide (Buckley, 2020). For low- and middle-income countries (LMICs), such integration presents both an opportunity for structural change and a challenge in aligning local capabilities with changing global requirements (Todeva & Rakhmatullin, 2016).

Agriculture is one of the sectors most significantly impacted by global changes. Historically neglected in industrial policy discussions, it has recently gained prominence in talks about structural transformation, particularly concerning agro-industrialization, which adeptly links primary agricultural production with manufacturing, services, and innovation systems (FAO, 2017; Khan, 2020). This sector plays a vital role in realizing various United Nations Sustainable Development Goals (SDGs), such as SDG 2 (Zero Hunger), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), and SDG 17 (Partnerships for the Goals) (UN, 2015). Furthermore, the African Union’s Agenda 2063 highlights the necessity of agro-industrial development in fostering inclusive growth, generating sustainable livelihoods, and ensuring regional food sovereignty (African Union Commission, 2015).

Fully harnessing the potential of agro-industrialization involves more than just technological progress. It demands a cohesive integration of innovation ecosystems, policy tools, institutional collaboration, and active engagement in Global Value Chains (GVCs) (Lee et al., 2018). For low- and middle-income countries (LMICs), enhancing agro-industry increasingly depends on firms and sectors implementing climate-smart technologies (Karwani, 2024), adjusting to evolving consumer preferences (Brown, 2022), and creating innovation-driven strategies for added value (Johnson & Lee, 2021). The World Bank (2020) highlights that innovation is not merely a technical role; it forms a systemic basis for competitiveness that emerges from the dynamic interactions between government agencies, private businesses, and knowledge-producing entities.

Ethiopia serves as a fascinating case in this context. Its economy is mainly agricultural, making agriculture essential for national livelihoods, contributing approximately 32% of GDP, over 75% of export revenues, and employing more than two-thirds of the population (Ethiopian Statistics Service [ESS], 2021; National Bank of Ethiopia [NBE], 2023). However, despite its importance, the sector faces challenges like insufficient value addition, weak links among stakeholders, fragmented policy frameworks, and limited participation in global agro-food markets (Minten et al., 2015; Owoo & Lambon-Quayefio, 2018). Agro-processing companies in Ethiopia often struggle with issues such as inadequate infrastructure, inconsistent quality standards, limited access to research and financing, and weak institutional platforms that hinder innovation (ILO, 2021; Smith, 2022).

Recognizing these challenges, the Ethiopian government has introduced ambitious policies to shift from a subsistence agricultural economy to one driven by innovation. Essential aspects of this transition include the Growth and Transformation Plan II (GTP II) (FDRE, 2015), the Ten-Year Development Plan (2021–2030) (Ministry of Planning and Development, 2022), and the creation of Integrated Agro-Industrial Parks (IAIPs) (Wazza, 2022). IAIPs are concentrated, multi-sector hubs that merge agro-processing industries with logistics, educational institutions, and research organizations, fostering systemic innovation and rural industrialization (UNIDO, 2022). At their core, IAIPs represent institutional innovation in economic governance. They strive to link smallholder producers' cooperatives to broader markets via innovation-driven upgrading processes through the Rural Transformation Centers (RTCs) developed for such purposes.

While IAIPs have strategic goals, their actual outcomes reveal significant variability. Recent studies identify issues such as operational inefficiencies, lack of collaboration among institutions, limited capability for innovation, and weak policy coherence (UNIDO, 2020; ADB, 2021; Kebede, 2024) in Ethiopia. These obstacles hinder the parks' efforts to establish backward and forward linkages, attract private investments, and deliver inclusive benefits. Moreover, Ethiopia's involvement in global agro-food value chains is limited and lacks competitiveness, frequently obstructed by trade challenges, low technological readiness, and inadequate sustainability standards (World Bank, 2020; UNCTAD, 2022). Thus, adopting a systemic approach is crucial for understanding the institutional and innovation-related aspects that either hinder or promote Ethiopia's agro-industrial transformation.

From these viewpoints, IAIPs are perceived as industrial zones and institutional ecosystems that reflect SIS principles. They aim to foster sectoral innovation and systemic enhancement by integrating agribusinesses, logistics firms, training institutions, and governance frameworks (UNIDO, 2022; Zhang et al., 2018). However, this theoretical promise requires empirical validation, particularly concerning the interaction of innovation systems with trade policies, sustainability standards, and value chain governance mechanisms.

International experiences offer valuable insights into the role of innovation-policy coherence in boosting agro-industrial competitiveness. Vietnam's government-led investments in agro-processing and export facilitation have successfully integrated the country into high-value agri-food chains (Timmer & Akkus, 2008). Similarly, Thailand and Mexico have leveraged cohesive innovation ecosystems and trade reforms to enhance agro-processing exports and attract foreign direct investment (Taylor, 2010). These cases highlight that strategic coordination among innovation, trade, and institutional policies is beneficial and crucial for advancing agro-industrial development and integrating into global value chains.

In contrast, the Ethiopian situation reveals significant conceptual, empirical evidence, and methodology gaps. On a conceptual level, research lacks coherence among innovation studies, value chain analysis, and trade policy assessment. Empirically, there is a scarcity of investigations regarding IAIPs as innovation systems and their potential to drive functional improvements within agro-food chains (Minten et al., 2015; Kebede, 2024). Methodologically, most existing studies rely on descriptive case analyses, which restricts understanding of the causal relationships between innovation, governance, and competitiveness. As Nguyen (2023) highlights, the lack of systems-oriented empirical research hampers policy learning and restricts the ability to replicate successful interventions.

This study seeks to fill these gaps by utilizing a mixed-methods approach based on Partial Least Squares Structural Equation Modeling (PLS-SEM) to explore the connections between innovation, trade policy, sustainability practices, and GVC governance in Ethiopia's IAIP-driven transformation. PLS-SEM is especially effective for modeling intricate, multidimensional phenomena where theoretical development is still evolving and data limitations are present (Hair et al., 2021). This methodology enables the simultaneous analysis of latent constructs and observed variables, resulting in a more thorough understanding of the systemic factors influencing agro-industrial competitiveness.

This dissertation examines a critical research question: How do sectoral innovation systems (SIS) within Ethiopia's Integrated Agro-Industrial Parks (IAIPs) affect the country's agro-industrial competitiveness and integration into global value chains? Addressing this question deepens our understanding of how innovation, institutional governance, trade policy, and sustainability practices interact to drive structural transformation in agrarian economies. Furthermore, it offers a practical, policy-oriented framework for Ethiopia and other comparable lower-middle-income countries (LMICs) to cultivate innovation-led agro-industrial strategies that foster inclusive and globally competitive growth.

1.2 Statement of the Problem

As the global economy becomes increasingly interconnected, it is essential for developing countries to undergo structural transformation and remain competitive in agro-industrial global value chains (GVCs) to achieve economic diversification and foster inclusive development (Gereffi, 2018; Kaplinsky & Morris, 2001). To this end, Ethiopia, drawing on its abundant agricultural resources, has launched an ambitious plan for industrial transformation aimed at modernizing its agro-industrial sector. A crucial aspect of this strategy is the establishment of Integrated Agro-Industrial Parks (IAIPs), which are designed to serve as catalysts for structural change by connecting smallholders to agro-industry value addition, promoting innovation, and strengthening links to both domestic and international markets (Ministry of Agriculture [MoA],2020; Ministry of Trade and Industry [MoTI], 2020; UNIDO, 2021; Welteji, 2022).

Despite these strategic investments and policy commitments, Ethiopia's agro-industrial sector continues to face persistent structural bottlenecks that limit its global competitiveness and constrain meaningful integration into international value chains (UNIDO, 2022; World Bank, 2020; Owoo & Lambon-Quayefio, 2018). Among the most pressing challenges is the underperformance of the sectoral innovation system, which is critical for driving technological advancement, adaptive learning, and competitiveness in dynamic global markets (Boru et al., 2025c). Innovation systems theory emphasizes that innovation arises from isolated technological breakthroughs and systemic interactions among firms, research institutions, universities, and policy frameworks (Lundvall, 1992; Edquist, 2005). However, Ethiopia's agro-industrial innovation ecosystem is characterized by fragmented governance, limited technological spillovers, and weak inter-institutional coordination (Ayele et al., 2020). Institutional actors within IAIPs often operate in silos, inhibiting the collaborative learning and cross-sectoral collaborations required for sustained innovation-led competitiveness.

Furthermore, the institutional frameworks governing IAIPs have not demonstrated sufficient functionality in fostering localized innovation capabilities, inter-firm learning, or effective public-private partnerships. The gap between policy design and implementation is evident in the limited measurable innovation outcomes, low levels of research and development (R&D) investment, and the absence of strategic alignment between trade policy and innovation goals (Ministry of Agriculture [MoA], 2022; Ministry of Trade & Regional Integration [MoTRI], 2024). This disconnect risks undermining the transformative potential of IAIPs, especially as they are positioned as vehicles for driving Ethiopia's integration into global value chains (Boru et al., 2025c).

The lack of a coherent, empirically grounded analytical framework to model the interdependencies among innovation, trade policy, sustainability, product differentiation, and institutional governance further exacerbates the challenge. While existing literature has addressed individual aspects such as export competitiveness (World Bank, 2014), agricultural commercialization (Minten et al., 2019), or the development of industrial parks (Gebreeyesus, 2013), few studies have adopted an integrated, system-based approach that accounts for the multidimensional dynamics within IAIPs. Specifically, there remains an empirical gap in understanding how sectoral innovation systems and trade policy instruments interact to shape agro-industrial competitiveness and facilitate or constrain Ethiopia's participation in global agro-food value chains.

Moreover, the international agro-food trade landscape is evolving rapidly, with increasing emphasis on product differentiation, sustainability standards, traceability, and supply chain innovation (Humphrey & Schmitz, 2002; Ponte, 2019). For countries like Ethiopia, meeting these emerging requirements is not merely upgrading production capabilities but also aligning innovation systems, institutional frameworks, and policy instruments to support competitive integration. The limited empirical evidence on how these strategic levers interact to influence GVC integration represents a critical blind spot in both academic inquiry and policymaking.

Although Ethiopia's Growth and Transformation Plan II (GTP II), the Ten-Year Perspective Plan, and the Home-Grown Economic Reform agenda have highlighted the strategic role of IAIPs, tangible impacts on global competitiveness remain modest (Planning and Development Commission, 2020; Ministry of Finance, 2019). The persistent challenges—including weak institutional coordination, low R&D intensity, and underutilization of innovation capabilities—point to a deeper systemic misalignment between policy aspirations and operational outcomes (MoTRI, 2024).

Consequently, the central problem addressed in this dissertation is the absence of an integrated analytical and empirical framework that captures how sectoral innovation systems, institutional arrangements, and policy coherence influence Ethiopia's agro-industrial competitiveness and its capacity for global value chain integration through IAIPs. There is an urgent need for a comprehensive modeling approach that elucidates the causal pathways through which innovation, trade policy, product differentiation, and governance mechanisms shape sectoral competitiveness. Equally important is evaluating how institutional and multi-stakeholder coordination within IAIPs either constrain or enhance their performance as platforms for agro-industrial upgrading.

This issue has both theoretical and practical implications. From a policy perspective, understanding how innovation operates within IAIPs is crucial for crafting evidence-based strategies that foster structural change and enhance competitiveness. Academically, there is a lack of research that integrates innovation systems theory, global value chain analysis, and institutional economics into a cohesive empirical framework specifically addressing the context of emerging economies such as Ethiopia. Therefore, this dissertation employs a Structural Equation Modeling (SEM) technique to create and validate a comprehensive model that connects innovation systems, trade policy, and institutional coordination to competitiveness and GVC integration, focusing on Ethiopian IAIPs. The results aim to enrich the innovation and development literature while offering practical recommendations for agro-industrial policymakers and stakeholders in Ethiopia.

1.3 Research Objectives

1.3.1 General Objective

This study aims to evaluate the role of sectoral innovation systems (SIS) in enhancing Ethiopia's agro-industrial competitiveness, particularly how these systems facilitate integration into global value chains through Integrated Agro-Industrial Parks (IAIPs).

1.3.2 Specific Objectives

1. To analyze how governance and institutional arrangements shape innovation ecosystems and facilitate multi-stakeholder coordination within Ethiopia's Integrated Agro-Industrial Parks (IAIPs).

2. To examine the interconnections among sustainability practices, innovation dynamics, market integration, and global value chain governance in agro-industrial contexts.
3. To evaluate the key drivers of agricultural innovation within Ethiopia's Integrated Agro-Industrial Parks.
4. To assess the combined influence of innovation, product differentiation, and trade policy on Ethiopia's agro-industrial competitiveness and participation in global value chains.

1.4 Research Questions

This study is directed by the following research questions (RQs):

- RQ_1: How do institutional frameworks, innovation ecosystems, and stakeholder coordination interact to influence global competitiveness in Ethiopia's Integrated Agro-Industrial Parks (IAIPs)?
- RQ_2: What are the interlinkages among sustainability practices, innovation, market integration, and global value chain governance in enhancing IAIP performance?
- RQ_3: What are the key drivers of agricultural innovation in Ethiopia's IAIPs, and how do they contribute to agro-industrial development?
- RQ_4: How do innovation, product differentiation, and trade policy jointly affect Ethiopia's agro-industrial competitiveness and integration into global value chains?

1.5 Significance of the Study

This study is significant for both scholarly advancement and practical development, particularly in the context of Ethiopia's structural transformation agenda. Academically, it contributes to the evolving literature on sectoral innovation systems (SIS) by empirically examining their role in agro-industrial competitiveness settings. It addresses a notable gap in existing research, where innovation, sustainability, and global value chain (GVC) governance are often studied in isolation. The study enhances theoretical understanding of how innovation systems function in complex, resource-constrained environments by providing an integrated analysis of these dimensions within the Integrated Agro-Industrial Parks (IAIPs) framework.

The research is also timely and relevant to policy. It aligns closely with Ethiopia's Ten-Year Perspective Plan (2021-2030) (MoPD, 2022), the Ethiopian Homegrown Economy Reform Agenda II (2024-2026), and global frameworks such as Agenda 2063 and the Sustainable Development Goals (SDGs) (African Union Commission, 2015). IAIPs are a strategic priority for Ethiopia, designed as engines of agro-industrialization, rural employment generation, and export diversification. By critically examining their institutional frameworks, innovation ecosystems, and market linkages, this study offers actionable insights for enhancing the performance and governance of these parks.

The study addresses urgent national challenges related to economic diversification, youth unemployment, and sustainable agro-industrial growth. Ethiopia's agro-industrial sector significantly impacts GDP, employment, and foreign exchange earnings. Enhancing its competitiveness through innovation-driven IAIPs has the potential to generate widespread developmental benefits. This research explores the relationship between sustainability practices, innovation capacity, market integration, and GVC positioning—key factors that ensure long-term resilience and competitiveness in international markets.

Ultimately, the study establishes a foundation for future research on innovation ecosystems, regional industrial policy, and agro-based upgrading strategies in sub-Saharan Africa. Its methodological and conceptual contributions are a reference point for scholars, policymakers, and development practitioners seeking to promote inclusive, innovation-led industrialization in similar contexts.

1.6 Scope of the Study

This study focuses on two Integrated Agro-Industrial Parks (IAIPs) in Ethiopia—Yirgalem in the South and Bulbula in Oromia—serving as representative case studies within the nation's agro-industrial transformation framework. These IAIPs are strategically designed and well-placed hubs that integrate agro-processing businesses with essential services and infrastructure to encourage value addition, facilitate innovation, and boost competitiveness in the sector. Each Park is part of a comprehensive rural-urban development strategy and is complemented by a network of Rural Transformation Centers (RTCs) within a 100-kilometer radius[1]. These RTCs serve as collection points for raw materials sourced from nearby rural areas, enhancing supply chain coordination, fostering rural industrialization, and diversifying agro-based exports, all in alignment with Ethiopia's national agricultural transformation agenda (UNIDO, 2018; AfDB, 2018; MoA, 2020).

The study thematically explores how sectoral innovation systems (SIS) interact with the institutional framework of IAIPs to assess their contribution to enhancing Ethiopia's integration into global value chains (GVCs). It highlights structural and operational challenges, governance structures, and innovation connections within the formal agro-industrial system. However, the analysis does not cover all agro-industrial subsectors or IAIPs nationwide. Instead, the selected cases are exploratory and illustrative examples to generate context-specific insights rather than broad statistical generalizations.

[1] https://www.unido.org/sites/default/files/files/2018-08/Integrated-Agro-Industrial-Parks-in-Ethiopia-booklet.pdf

The research employs a cross-sectional design, which limits its ability to evaluate longitudinal dynamics, temporal trends, or causality over time. Although this design facilitates a snapshot analysis of the current institutional conditions and the relationships between innovation and performance, it hinders the examination of evolving system interactions or learning trajectories. Additionally, the lack of international comparative benchmarking poses a limitation in evaluating Ethiopia's relative standing in the global agro-industrial innovation and competitiveness arenas.

Another important delimitation relates to the scope of innovation systems being analyzed. This study focuses on formal sector innovation mechanisms, including technological advancement, policy tools, quality infrastructure, and institutional coordination. However, it does not include the impacts of informal, traditional, or Indigenous innovation practices, which can significantly influence local production systems and the transmission of knowledge at the community level. The research primarily relies on expert interviews and secondary data for the institutional analysis. Although these approaches provide valuable insights, the lack of institutional ethnographies or immersive fieldwork constrains the exploration of actor behavior, institutional routines, and the micro-foundations of learning and adaptation in IAIPs.

Despite these delimitations, the study offers several significant contributions:

- *Conceptual Contribution:* It broadens the sectoral innovation systems (SIS) framework to encompass a low-income, agrarian setting undergoing structural economic change, thus enhancing its relevance for least developed countries (LDCs).
- *Empirical Contribution:* This research produces original data and insights regarding the performance, coordination issues, and institutional synergies within two flagship

IAIPs in Ethiopia, contributing to the sparse empirical literature on agro-industrial innovation in Sub-Saharan Africa.

- *Methodological Contribution:* The study utilizes Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze complex, multivariate relationships among drivers of innovation, institutional governance, and competitiveness outcomes—elements often examined separately in previous studies.

Thus, although constrained by case selection, methodology, and data availability, this research tackles a significant challenge in innovation, trade governance, and industrial policy. It aims to enhance both academic research and policy by enriching our understanding of how integrated innovation systems in agro-industrial parks strengthen competitiveness and facilitate participation in global value chains. Additionally, it establishes the foundation for future longitudinal, comparative, and nationwide studies on innovation-driven agro-industrial transformation in developing countries.

1.7 Operational Definitions

This section provides clear and concise definitions of the key concepts that underpin this dissertation. The definitions are essential for understanding the dynamics of agro-industrial competitiveness in Ethiopia, particularly regarding how sectoral innovation systems (SIS) and integrated agro-industrial parks (IAIPs) facilitate integration into global value chains (GVCs).

1) *Agro-Industrial Competitiveness:* Denotes the ability of agro-industrial sectors to deliver products and services that satisfy market requirements and sustain economic viability and environmental responsibility. Achieving competitiveness involves enhancing innovation capacity, improving productivity, upgrading value chains, and

expanding linkages with regional and global markets (Gereffi & Fernandez-Stark, 2016).

2) *Global Value Chain (GVC) Integration:* Refers to the participation of firms or industries in international production and distribution systems. This includes engaging in various stages of value creation such as sourcing inputs, processing, marketing, and logistics (Kaplinsky & Morris, 2001; Porter, 1990).
3) *Sectoral Innovation Systems (SIS):* Are networks of institutions, actors, and interactions that foster innovation within a specific sector. In agro-industries, these systems support technological development, knowledge diffusion, and policy coordination essential for sectoral advancement (Lundvall & Johnson, 1994; Malerba, 2002).
4) *Integrated Agro-Industrial Parks (IAIPs):* In Ethiopia, IAIPs have spatially planned zones that co-locate agro-processing firms and support services to promote value addition, innovation, and competitiveness. Each IAIP is linked to Rural Transformation Centers (RTCs) within a 100-kilometer radius, aggregating raw materials from surrounding areas (UNIDO, 2018)[2]. This integrated model facilitates supply chain efficiency, rural industrialization, and agro-export diversification within Ethiopia's agricultural transformation framework (AfDB, 2018; MoA, 2020).
5) *Innovation:* In agro-industrial systems, innovation involves the development or enhancement of products, processes, or organizational practices aimed at boosting efficiency, value addition, and competitiveness. Examples include modern farming technologies, digital platforms, and supply chain improvements (Schumpeter, 1934; Tushman & Anderson, 2004).

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[2] UNIDO, 2018: https://www.unido.org/sites/default/files/files/2018-08/Integrated-Agro-Industrial-Parks-in-Ethiopia-booklet.pdf

6) *Sustainability:* This concept refers to agro-industrial practices that aim to balance economic growth with ecological preservation and social equity, ensuring long-term resource availability and resilience (Elkington, 1997; Moffat & Lee, 2016).
7) *Market Integration:* Is the process by which local economies become increasingly interconnected with broader regional and global markets, enabling smoother flows of goods, services, capital, and information (Balassa, 1961; Krugman, 1991).
8) *Governance:* It encompasses the institutional frameworks, decision-making processes, and coordination mechanisms that guide stakeholder interactions and resource management within the agro-industrial sector (North, 1990; Ostrom, 2005).
9) *Product Differentiation:* The strategy involves creating distinct product attributes or value propositions to appeal to targeted consumer segments, offering competitive advantages in domestic or international markets (Kotler & Keller, 2016; Porter, 1985).

1.8 Structure of the Dissertation

This dissertation is organized into five logically interconnected sections—four formal chapters and one final unnumbered section [3]—each contributing to a coherent and comprehensive exploration of the research problem. The structure is as follows:

- *Chapter One: Introduction*

  This chapter lays the groundwork for the study by providing a contextual overview of the research topic. It articulates the background and rationale, defines the central problem, and specifies the general and specific research objectives and guiding research questions. Additionally, it highlights the significance and scope of the

[1]Final unnumbered chapter session: is formatted according to ASTU's Guidelines for Post Graduate Study: Available @https://www.astu.edu.et/images/linked-pdf/September_-_2021_v1_PG_Final_Guidelines.pdf

study, presents key operational definitions, and concludes with a summary of the dissertation structure, offering readers a roadmap for the following chapters.

- *Chapter Two: Literature Review*

  This chapter critically examines the theoretical and empirical literature relevant to the study. It uses foundational theoretical frameworks—including the National and Sectoral Innovation Systems, Global Value Chain (GVC) Governance Theory, the Resource-Based View (RBV), Dynamic Capabilities Theory, and the Triple Helix Model—to construct a robust conceptual foundation. The review also synthesizes empirical findings to identify knowledge gaps, establish the study's originality, and support the development of research hypotheses. The chapter culminates in presenting the conceptual framework that informs the analytical dimensions of the research.

- *Chapter Three: Materials and Methods*

  This chapter details the methodological approach employed to address the research objectives. It comprehensively describes the study areas, research design, sampling strategies, and data collection instruments. The study applies a mixed-methods design, integrating qualitative and quantitative techniques to examine key dimensions such as governance and institutional arrangements, innovation practices, sustainability, market integration, product differentiation, and trade policy. Pre-testing activities, ethical considerations, and advanced statistical tools—particularly Partial Least Squares Structural Equation Modeling (PLS-SEM)—are also thoroughly discussed.

- *Chapter Four: Results and Discussion*

  This chapter presents the empirical findings and discusses the study's theoretical constructs and research questions. It includes descriptive statistics, measurement, structural model evaluations, and integrated qualitative analyses. The results are organized thematically across the core research domains, offering interpretive insights into how innovation systems, governance, sustainability, and trade policy influence agro-industrial competitiveness and global value chain integration. The discussion synthesizes quantitative and qualitative findings, providing a comprehensive interpretation within the context of the study’s conceptual framework.

- *Conclusions and Recommendations*

  The final section synthesizes the significant empirical findings and presents the research's overarching conclusions. It advances practical and policy-relevant recommendations to strengthen sectoral innovation systems, enhance governance effectiveness, improve alignment between trade policy and industrial competitiveness, and foster sustainability in agro-industrial development. Additionally, the study's limitations are acknowledged, and directions for future research are proposed.

CHAPTER 2. LITERATURE REVIEW

2.1 Theoretical Literature Review

In conceptual terms, agro-industrial competitiveness refers to the ability of a nation or region to sustainably produce value-added agro-products that meet domestic and international market standards while contributing to employment, income generation, and structural transformation (Porter, 1990; Kaplinsky & Morris, 2001). Its key dimensions encompass productivity, innovation capacity, market access, institutional coordination, and technological upgrading (UNIDO, 2020).

As a theoretical foundation, grasping agro-industry competitiveness through Integrated Agro-Industrial Parks (IAIPs) and Global Value Chain (GVC) integration necessitates a robust theoretical framework alongside empirical contexts, particularly in Ethiopia. This framework should address intricate elements such as innovation, institutional dynamics, sustainability, trade policy alignment, and market competitiveness. To construct these foundations, this study utilizes various theoretical frameworks, including National and Sectoral Innovation Systems (NIS and SIS), Global Value Chain (GVC) governance theory, the Resource-Based View (RBV), Dynamic Capabilities Theory, and the Triple Helix Model as described in the following subsequent sessions.

2.1.1 National and Sectoral Innovation Systems

The National Innovation System (NIS) framework, as introduced by Lundvall (1992) and further elaborated by Nelson (1993) and Edquist (2005), posits that innovation performance is deeply embedded in the institutional and organizational contexts of a country. Rather than viewing innovation as an isolated or purely technical activity, NIS emphasizes the importance of systemic interactions between firms, governments, research institutions, and intermediaries in generating and diffusing innovation. Institutions play a central role by shaping incentives, coordinating stakeholders, and setting knowledge-sharing and collaboration norms.

This concept is extended to sectoral levels through the Sectoral Innovation System (SIS) framework, developed by Malerba (2002). This framework focuses on sector-specific technological trajectories, demand characteristics, and institutional structures. The SIS perspective is particularly apt for analyzing agro-industrial development, as it allows for the dissection of interactions among value chain actors, R&D institutions, agricultural producers, and policymakers. In the case of Ethiopia's IAIPs, SIS enables a structured assessment of how sector-specific innovation ecosystems emerge through coordinated stakeholder participation and supportive institutional governance.

2.1.2 Global Value Chain Governance Theory

The Global Value Chain (GVC) theory, developed by Gereffi and colleagues (Gereffi et al., 2005; Gereffi, 2018), analyzes how production, value addition, and innovation are organized across geographically dispersed networks. It introduces the concept of "governance structures" within GVCs, which dictate how knowledge, standards, and resources flow among actors. These governance structures can be producer-driven, buyer-driven, or relational, each having implications for innovation and upgrading in developing economies.

The GVC theory is relevant to understanding product, process, functional, and inter-sectoral upgrading, which determine how firms or regions improve their positions within global chains. Innovation and sustainability practices are no longer optional but essential to participating in high-value segments of global markets, particularly in agri-food value chains where lead firms increasingly mandate compliance with environmental, safety, and traceability standards (Ponte, 2019; Kaplinsky & Morris, 2001). Moreover, GVC participation is shaped by enabling policies that reduce trade frictions, such as streamlined customs procedures, logistics infrastructure, and preferential trade agreements.

2.1.3 Resource-Based View and Dynamic Capabilities Theory

The Resource-Based View (RBV) of the firm, articulated by Barney (1991), posits that firms attain competitive advantage through valuable, rare, inimitable, and non-substitutable (VRIN) resources. In agro-industrial development, these resources encompass innovation capabilities, access to skilled labor, technological infrastructure, and social capital embedded in public-private partnerships.

However, static resources are insufficient for long-term competitiveness in rapidly changing environments. Therefore, the RBV is complemented by the Dynamic Capabilities Theory (Teece, Pisano, & Shuen, 1997), which emphasizes the ability of firms and sectors to integrate, build, and reconfigure internal and external competencies in response to evolving market conditions. Dynamic capabilities such as adaptive learning, technological upgrading, and policy responsiveness are essential for agro-industrial sectors in developing countries, where global markets are rich in opportunities but also susceptible to volatility. In the context of Ethiopia's IAIP, dynamic capabilities manifest in the capacity of firms and institutions to co-evolve through continuous learning, stakeholder coordination, and policy experimentation.

2.1.4 The Triple Helix Model

The Triple Helix innovation model (Etzkowitz & Leydesdorff, 2000) emphasizes the interaction between university, industry, and government as a key mechanism for innovation-led development. This model generates innovation within firms or research labs and through co-evolutionary processes among the three institutional spheres. Universities contribute to knowledge creation and human capital, industries provide commercialization pathways, and governments act as facilitators and regulators.

2.1.5 Spatial Industrial Policy and Cluster Theory

The IAIP model is based on spatial industrial policy, aimed at addressing market failures and coordination issues through localized interventions. Inspired by Porter's (1990) cluster theory, the close clustering of related firms and institutions can enhance productivity, innovation, and competitiveness through knowledge spillovers, labor market pooling, and specialized suppliers. Spatial agglomeration proves to be particularly effective when supported by adequate infrastructure and consistent policies. In Ethiopia, IAIPs represent a focused policy initiative to stimulate these agglomeration benefits, connecting primary agricultural production areas, such as Rural Transformation Centers (RTC), with industrial processing, logistics, and export facilities.

The conceptual foundations of this study were built on an integrative theoretical framework that captures the complexity of innovation-driven development in agro-industrial sectors. National and sectoral innovation systems provide a structure for understanding institutional coordination and stakeholder dynamics. GVC theory clarifies the pathways for global competitiveness and upgrading. The RBV and dynamic capabilities approach explain how innovation translates into competitive advantage. The Triple Helix model emphasizes the role of multi-actor collaboration, while cluster theory and spatial industrial policy underscore the significance of geographic proximity and coordinated investment.

This study aims to develop a nuanced structural equation model (SEM) that captures the direct and indirect relationships among Ethiopia's governance, innovation, trade policy, and agro-industrial performance by synthesizing these theories. These theoretical frameworks not only justify the proposed hypotheses but also provide a comprehensive lens through which to analyze the mechanisms of agro-industrial transformation in the Global South more broadly and in Ethiopia specifically.

2.2 Empirical Literature Review

2.2.1 Ethiopia's Integrated Agro-Industrial Parks (IAIPs) and Global Experience

Ethiopia's Integrated Agro-Industrial Parks (IAIPs) are strategically located hubs that bring together agro-processing companies, logistics services, and support functions to stimulate agro-industrial transformation (UNIDO, 2018; AfDB, 2020). Designed to serve as centers for value addition, job creation, and rural development during Ethiopia's Growth and Transformation Plan II (Waza, 2022). Assessments of IAIP implementation in Ethiopia highlight both opportunities and challenges: while they lay a solid groundwork for agro-based industrialization, issues related to governance, institutional cooperation, and the integration of innovation have hindered their effectiveness (MoA, 2021; World Bank, 2022).

Research on the structural and operational performance of Ethiopia's IAIPs offers initial insights but often overlooks the innovation dynamics at play within these parks. For example, Kebede (2024) examined the infrastructural and operational aspects of IAIPs, identifying challenges such as insufficient private sector involvement, poor logistics, and limited integration with upstream smallholder producers. However, this analysis was primarily descriptive and did not address the systemic innovation processes essential for long-term competitiveness.

Globally, agro-industrial parks have succeeded when embedded within broader innovation ecosystems and supported by adaptive governance, public–private partnerships, and targeted capacity-building (UNIDO, 2020). However, their success in fragile and institutionally complex environments like Ethiopia depends on how much they mobilize knowledge networks, align incentives, and overcome coordination failures.

2.2.2 Global Value Chain (GVC) Integration and Industrial Upgrading

In Ethiopia, agro-exports such as coffee, oilseeds, and horticulture face structural barriers to upgrading within GVCs, including weak regulatory frameworks, limited certification systems, and low innovation capacity (Gebreeyesus, 2013; Altenburg, 2020). Therefore, bridging these gaps requires systemic interventions that combine innovation systems thinking with industrial policy instruments, particularly in strategic platforms like IAIPs.

Owoo and Lambon-Quayefio (2018) expanded the regional perspective by highlighting the suboptimal performance of agro-processing industries across sub-Saharan Africa. They correlated these challenges, the lack of technological advancements, and the limited connections between research institutions and agro-industrial enterprises. Similarly, Kassie et al. (2015) noted ongoing inequalities in the distribution of agricultural innovation, emphasizing how weak institutional frameworks and misaligned policies impede technological advancement.

The literature on innovation systems often highlights the importance of institutional coherence and stakeholder coordination, especially in low-income economies (Williams, 2018; Khan, 2021). Nonetheless, empirical studies are scarce examining how institutional frameworks within IAIPs influence innovation performance in Ethiopia. Boru et al. (2025a) observed that Ethiopia's agro-processing sector continues encountering challenges stemming from fragmented innovation networks and inconsistent trade policies. Although this research points out significant structural deficiencies, it does not provide a formal methodological framework for assessing causality or interactions at the system level.

Research into sustainability-driven innovation is still limited. UNEP (2019) and Karwani (2024) pointed out that climate-smart technologies and efficient resource practices can enhance agro-industrial resilience; however, these insights do not fit within broader structural transformation or SIS contexts. Furthermore, digital agriculture has gained recent attention, as noted by Johnson and Lee (2021), who support digitalization to enhance competitiveness. However, research evaluating the implementation of digital tools in Ethiopia's IAIP-focused agro-industrial sector is still developing and lacks thorough analysis.

Worldwide, evidence from countries such as Vietnam, Mexico, and Thailand showcases the success of merging innovation with industrial policy to enhance agro-industrial practices. Timmer and Akkus (2008) highlighted how Vietnam effectively utilized coordinated investments in agro-processing infrastructure alongside innovation platforms to integrate into global agri-food value chains. Similarly, Taylor (2010) demonstrated that national innovation systems and aligned policy strategies supported the growth of high-value agricultural exports in Mexico and Thailand. However, there remains a shortage of contextually relevant studies evaluating these international experiences in light of Ethiopia's socio-economic and institutional contexts (Rodrik, 2004).

Most empirical research on Ethiopia's agro-industrial development uses descriptive statistics or qualitative case studies. Although these methods offer valuable contextual insights, they typically do not adequately address complex, multidimensional relationships. For instance, Deressa et al. (2011) examined factors affecting agricultural productivity without considering innovation or GVC integration aspects. Sophisticated methodologies such as Structural Equation Modeling (SEM), capable of analyzing latent variables and structural interdependencies, are predominantly absent from the existing empirical literature (Hair et al., 2019).

2.2.3 Innovation, Governance, and Industrial Policy in Agro-Transformation

Innovation in agro-industrial settings encompasses technological, organizational, and institutional elements. Recent literature emphasizes that innovation is intertwined with governance structures and shaped by the alignment of regulatory, trade, and innovation policies (Rodrik, 2004; Hausmann & Rodrik, 2006). Moreover, research on the developmental state highlights the importance of strategic coordination in addressing market and systemic failures (Chang, 2002).

Ethiopia's industrial policy has embraced this approach; however, challenges in execution, including a lack of inter-ministerial coordination, regulatory fragmentation, and varying capacities, have diminished its effectiveness. Recent research indicates a need for more integrated governance systems and evidence-based monitoring tools to align Industrial Aligned Investment Programs (IAIPs) more effectively with national innovation and export strategies (UNCTAD, 2021; World Bank, 2023).

2.3 Positioning the Study in the Literature

Despite the proliferation of research on innovation systems, agro-industrial parks, and GVCs, few studies have attempted to integrate these dimensions into a unified analytical framework focused on Ethiopia's agro-industrial transformation. Existing literature treats innovation, policy, and trade as isolated variables, neglecting their dynamic interplay within specific spatial-industrial contexts like IAIPs.

Moreover, the methodological gap is particularly pronounced as Ethiopian policymakers increasingly regard IAIPs as tools for promoting innovation and enhancing global integration (FDRE, 2015; Wazza, 2022). Nevertheless, there exists a lack of empirical evidence to support these policy objectives. The current literature has not sufficiently delineated IAIPs as sectoral innovation platforms, nor has it comprehensively analyzed their effect on firm competitiveness and value chain positioning (Zhang et al., 2018; UNIDO, 2022).

This study addresses a significant gap by employing a Sectoral Innovation Systems perspective to investigate how the Integrated Agro-Industrial Parks (IAIPs) function as institutionalized platforms for innovation, learning, and export enhancement. It contributes to theoretical and practical domains by offering a diagnostic framework (IAIRI) and a coordination model (AICM) to align policy, governance, and innovation at the park level. By integrating qualitative and quantitative insights, the study presents an empirically grounded understanding of how Ethiopia can improve its agro-industrial competitiveness through systems thinking.

2.4 Literature Insights, Hypotheses, and Conceptual Framework

This literature review presents a cohesive synthesis that emphasizes the theoretical intersection of four principal domains: agro-industrial competitiveness, sectoral innovation systems, Integrated Agro-Industrial Parks (IAIPs), and global value chain (GVC) integration. Moreover, it identifies significant empirical gaps in their interconnectedness. These insights enhance the study's multi-scalar, systems-oriented, and policy-relevant analytical framework.

To fill the identified gaps, this study utilizes an integrative conceptual framework that explores the interactions among innovation actors, institutional arrangements, and competitiveness outcomes within Ethiopia's IAIP-driven agro-industrial ecosystem. This framework merges several theoretical perspectives, including the National and Sectoral Innovation Systems (Lundvall, 1992; Malerba, 2002), Global Value Chain Governance Theory (Gereffi et al., 2005), Resource-Based View and Dynamic Capabilities Theory

(Barney, 1991; Teece et al., 1997), the Triple Helix Model (Etzkowitz & Leydesdorff, 2000), and Cluster Theory (Porter, 1990). These frameworks offer a thorough perspective on the institutional, technological, and policy dimensions of agro-industrial transformation.

At its core, the conceptual model argues that governance quality, institutional coordination, and innovation ecosystems (H_1) are crucial enablers of global competitiveness in agro-industrial environments. It also theorizes that sustainability practices, innovation performance, and market integration are interconnected determinants of effective GVC governance (H_2), especially as they align with international environmental and quality standards.

The framework recognizes the systemic traits of agricultural innovation (H_3), shaped by the interaction of institutional support mechanisms, technological resources, policy coherence, and knowledge-sharing networks. This perspective is consistent with both the SIS and dynamic capabilities viewpoints. In conclusion, it suggests that product differentiation, innovative strategies, and cohesive trade policies (H_4) are essential for boosting a sector's competitiveness in global markets by improving value addition, branding, and access to international markets.

Figure 1 illustrates how this conceptual architecture corresponds with the study's mixed-methods research design and facilitates empirical analysis through Structural Equation Modeling (SEM). It allows for the exploration of both direct and mediated relationships between innovation, institutional performance, and trade integration. By placing these dynamics in Ethiopia's IAIP initiative context, the framework offers a robust basis for evaluating the structural and systemic elements influencing agro-industrial competitiveness in developing economies.

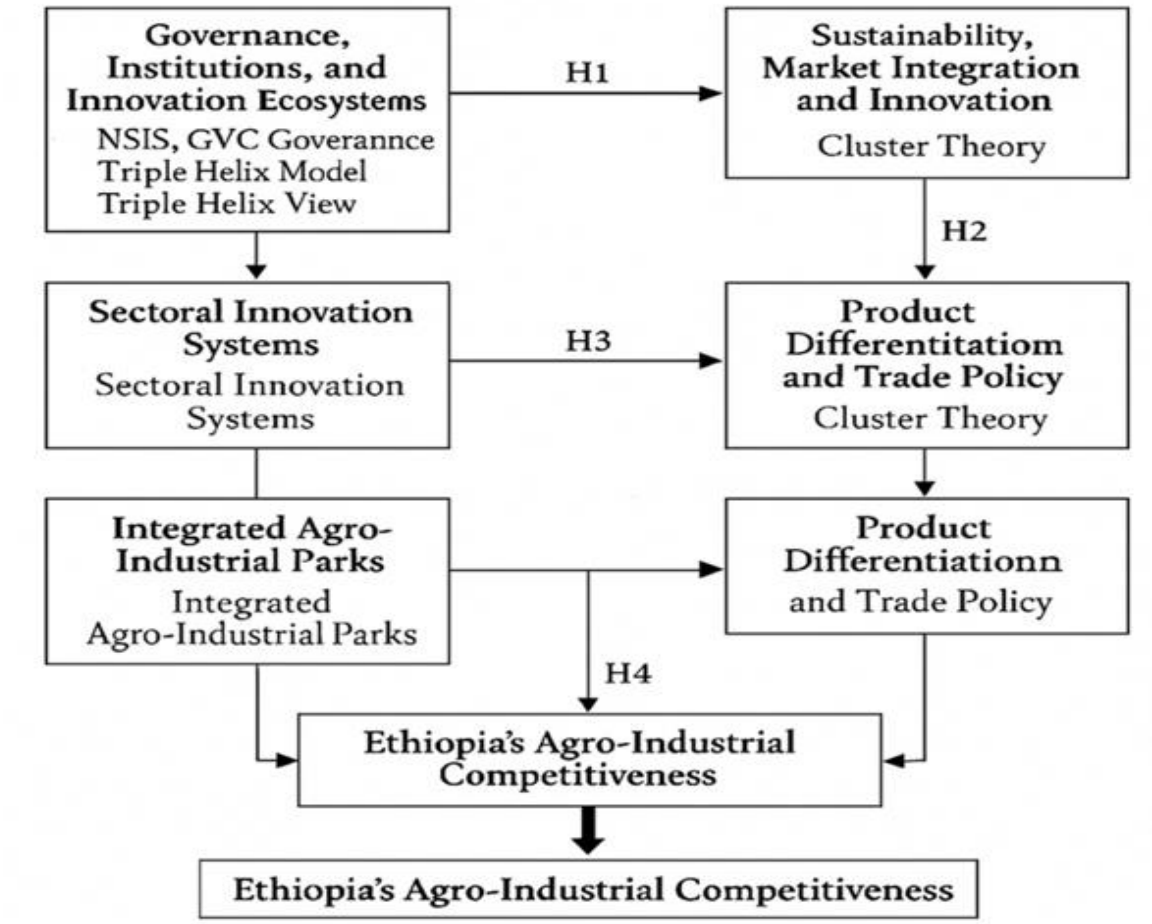

Figure 1. Conceptual Frameworks of the Study

Note that: Figure 1 and Its Logic Flow[4]

[4] The framework is logically structured to reflect a **causal and mediating pathway**:- Foundational factors (governance and SIS) lead to intermediate enablers (IAIPs, sustainability, and product strategies); These, in turn, affect the outcome variable—agro-industrial

2.5 Description of the Developed Hypotheses

Building on the theoretical frameworks and empirical insights discussed earlier, this study presents four research hypotheses that logically develop from the conceptual foundation. These hypotheses provide testable propositions that delineate the expected relationships among key constructs, including institutional frameworks, innovation ecosystems, sustainability practices, trade policy, and competitiveness in Ethiopia's Integrated Agro-Industrial Parks (IAIPs).

The placement of hypotheses following the literature review exemplifies best practices in empirical research design, as hypotheses should be rooted in and supported by the theoretical models and literature previously examined. Creswell and Creswell (2018) underscore that formulating hypotheses at this juncture facilitates a smooth transition from conceptual exploration to empirical testing. Likewise, Yin (2018) and Punch (2014) highlight the necessity of clearly defining hypotheses that stem from systematic theoretical inquiry, thus creating a strong connection between theory and empirical work that bolsters internal validity and methodological coherence.

Thus, the hypotheses outlined in Table 1 below are designed to directly correspond to the research objectives and questions of the study. They provide the empirical basis for the Structural Equation Modeling (SEM) method described in Chapter Three. Each hypothesis illustrates a specific relationship to be evaluated to determine the impacts of institutional coordination, innovation, sustainability practices, and trade policy on agro-industrial competitiveness and global value chain integration.

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competitiveness, And: Arrows represent **directional influence**; Hypotheses are labeled (H1–H4) to denote testable paths in the empirical analysis; **Feedback loops** are implicit, especially between competitiveness outcomes and ongoing institutional performance.

Table 1. Hypotheses, Descriptions, and Literature Justifications

Code	Description of Hypothesis Developed	Justification from the Literature
H1	Institutional frameworks (IF), innovation ecosystems (IE), and stakeholder coordination (SC) have a statistically significant and positive effect on global competitiveness (GC) within Ethiopia’s Integrated Agro-Industrial Parks (IAIPs).	Adequate institutional arrangements and well-coordinated innovation systems enhance collaborative governance, strengthening industrial sectors' global competitiveness (Lundvall, 1992; Freeman, 1987).
H2	Sustainability practices (SP), innovation (IN), and market integration (MI) are positively associated with the effectiveness of global value chain governance (GVCG) in Ethiopia’s IAIPs.	Sectoral innovation systems that integrate sustainability and facilitate market connectivity are more likely to engage successfully in value chain governance structures (OECD, 2013; Gereffi, Humphrey & Sturgeon, 2005).
H3	Institutional support (IS), networking (NW), policy support (PS), and technological input (TI) significantly and positively influence agricultural innovation (AI) outcomes in Ethiopia’s IAIPs.	Robust institutional and policy support, technological infrastructure, and knowledge-sharing networks are critical drivers of agricultural innovation in developing contexts (Hall et al., 2006; World Bank, 2007).
H4	Innovation (IN), product differentiation (PD), and trade policy frameworks (TP) exert a significant and positive impact on global market competitiveness (GMC) in Ethiopia’s agro-industrial sector.	Innovation and product differentiation are key strategic drivers of competitiveness, particularly when supported by coherent trade policies that facilitate international market access (Porter, 1990; UNIDO, 2019).

The hypotheses developed in this study have been meticulously matched with the primary research questions and specific objectives presented in Table 2. This alignment guarantees internal consistency in the research design and strengthens the study's scientific rigor and coherence, as highlighted by Creswell and Creswell (2018).

Table 2. Matrix of the Study's RQs and Objectives with respective hypotheses

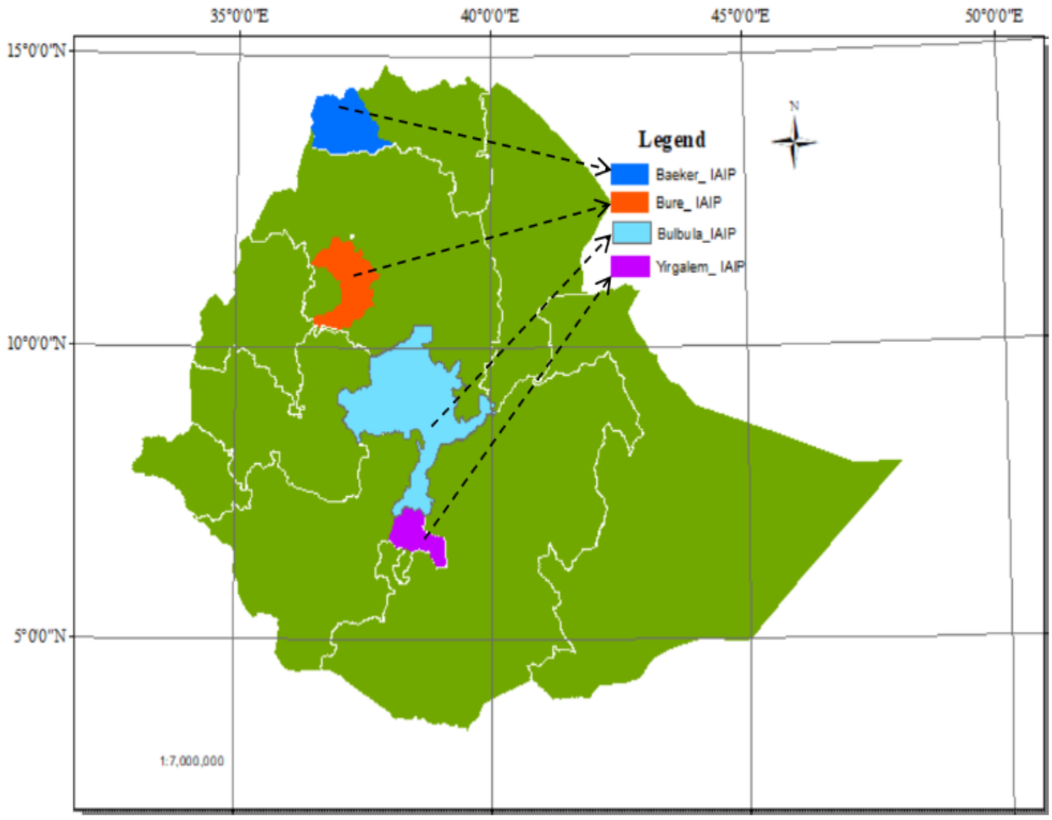
Research Question (RQ)	Corresponding Objective	Aligned Hypothesis	Rationality
RQ1: How have governance and institutional frameworks within Ethiopia's IAIPs facilitated innovation ecosystems and multi-stakeholder coordination for improved global competitiveness?	Objective 1: To analyze the governance and institutional frameworks in Ethiopian IAIPs, focusing on enhancing innovation ecosystems and facilitating multi-stakeholder coordination.	H1: Governance and institutional quality within IAIPs significantly influence the development of innovation ecosystems and stakeholder coordination.	Institutions and governance structures enable learning, innovation, and collaboration in industrial clusters (Scott, 2001; UNIDO, 2022). Effective governance enhances coordination and reduces transaction costs in innovation systems (Spielman & Birner, 2008), which is crucial for competitiveness.
RQ2: How are sustainability practices, innovation dynamics, and market integration interlinked within the IAIP model, and how do these influence GVC governance?	Objective 2: To examine the interlinkages between sustainability, innovation, market integration, and global value chain governance in Ethiopia's Agro-Industrial Parks.	H2: Sustainability practices positively mediate the relationship between innovation capacity and global value chain integration	Sustainability practices—such as eco-certification and resource efficiency—strengthen firms' competitiveness and GVC entry potential (Barbier, 2020; Okereke et al., 2019). Innovation aligned with environmental standards enhances compliance and helps firms adapt to shifting global demands (Gereffi, 2014; Tezera & Gebremenfas, 2022).
RQ3: What are the key drivers of agricultural innovation within Ethiopia's IAIPs, and how do they impact agro-industrial transformation?	Objective 3: To identify and analyze the key drivers of agricultural innovation within Ethiopia's Integrated Agro-Industrial Parks.	H3: Product differentiation significantly contributes to Ethiopia's agro-industrial competitiveness and market positioning in global value chains.	Innovation in agro-industry is shaped by technological infrastructure, knowledge systems, public-private partnerships, and access to research (Malerba, 2004; Spielman & Birner, 2008). These factors are key to sectoral transformation and sustainable industrial development (Lundvall, 2007; Chaminade & Edquist, 2010).

Research Question (RQ)	Corresponding Objective	Aligned Hypothesis	Rationality
RQ4: To what extent have innovation, product differentiation, and trade policy collectively influenced Ethiopia’s agro-industrial competitiveness and GVC integration through IAIPs?	Objective 4: To assess the impact of innovation, product differentiation, and trade policy on Ethiopia’s agro-industrial competitiveness and GVC integration through IAIPs.	H4: Trade policy coherence has a significant moderating effect on the relationship between innovation and GVC integration.	Differentiation strategies such as organic labeling and value-added processing enhance market entry and competitiveness (Kaplinsky, 2000; Humphrey & Schmitz, 2002). Coherent trade policy improves the regulatory environment for innovation diffusion and supports GVC participation (Gereffi, 2014; Wakaso et al., 2024). Misaligned trade regimes constrain exports and innovation (Whitfield et al., 2020).

CHAPTER 3. MATERIALS AND METHODS

3.1 Study Area Description

This study examines the two pioneering Integrated Agro-Industrial Parks (IAIPs) in Ethiopia—Yirgalem and Bulbula IAIPs—selected from four IAIPs (see Figure 2). Furthermore, it includes each Rural Transformation Center (RTC) within a 100 km radius[5]. Their selection is based on strategic importance to Ethiopia's agro-industrialization, current operational status, innovation potential, and contributions to global value chain (GVC) integration.



Source: Created by the authors

Figure 2. Map showing the locations of Ethiopia's Integrated Agro-Industrial Parks (IAIPs) under Study.

[5] UNIDO (2018). https://www.unido.org/sites/default/files/files/2018-08/Integrated-Agro-Industrial-Parks-in-Ethiopia-booklet.pdf

Both parks are in agriculturally rich areas and aim to enhance value addition, market access, and public-private collaboration within a structured framework. They are case studies on how integrated infrastructure, innovation ecosystems, and policy coordination can boost Ethiopia’s global agro-industrial competitiveness.

Yirgalem IAIP is located in the latter Southern Nations, Nationalities, and Peoples' Region (SNNPR)[6] and the current Sidama Region, while Bulbula IAIP is in the Oromia Region. These two parks serve as key sites that reflect the strengths and economic roles of different IAIPs, stemming from their slightly different agro-ecological zones and the potential accessibility of agricultural commodities in Ethiopia (See pictures 3a1 & 3b1 below).

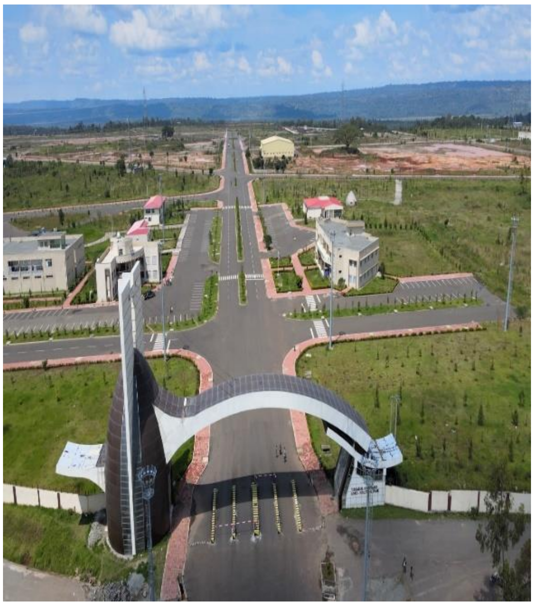


Figure 3a1. Yirgalem IAIP 3b 1. Bulbula IAIP

The Park is famous for its productive soil and high agricultural yield, especially in coffee and fruit (MoA, 2022). Yirgalem, a key center for the Sidama coffee industry, plays a vital role in Ethiopia’s agro-export market. The Ethiopian National Agricultural Investment Plan highlights the essential function of coffee in supporting livelihoods and generating foreign

[6]The Southern Nations, Nationalities, and Peoples' Regional State (SNNPR) of Ethiopia, which existed until six years ago, has since been divided into four independent regional states: Sidama Regional State (where Bulbula IAIP is located), Southern Ethiopia Regional State, Central Ethiopia Regional State, and South West Ethiopia Regional State.

exchange (2022). The Park improves the coffee and fruit value chains by offering advanced processing facilities, fostering local entrepreneurship, and creating job opportunities (MoI, 2020). Collaborating with international investors and buyers helps Yirgalem integrate into global value chains (GVCs), improving the quality and competitiveness of its products (World Bank, 2019). This network allows smallholders to reach global markets, fostering inclusive growth and sustainability.

Bulbula IAIP, located in the Oromia Region, is a vital agro-industrial hub for processing oilseeds and pulses—crops essential for food security and nutrition (Bachewe et al., 2017). The Park enhances value addition, boosts market access for smallholders, and fosters regional economic growth (MoI, 2020). Its participation in global value chains is demonstrated through partnerships with international companies to improve product quality for domestic and export markets (AICS [7], 2025). Additionally, Bulbula prioritizes sustainable practices and increased productivity, supporting Ethiopia’s agro-industrial strategy.

Comparative Perspective: Choosing Yirgalem and Bulbula IAIPs presents a strategic perspective for analyzing Ethiopia’s agro-industrial transformation. Yirgalem focuses on high-value, export-driven commodities like coffee and fruit, whereas Bulbula concentrates on food security crops that serve dual market purposes. These areas' varied agro-ecological conditions and production specializations illustrate how distinct innovation strategies can foster GVC integration and promote sustainable development (MoA, 2022; World Bank, 2019).

Consequently, examining these IAIPs offers greater insight into how sectoral innovation systems enhance agro-industrial competitiveness. Their distinctive models demonstrate that

[7] Italian Agency for Development Cooperation

focused actions in processing, market accessibility, and international partnerships can stimulate innovation, enhance value addition, and fortify Ethiopia’s standing in global markets. This comparative analysis guides policy and strategic planning to foster inclusive and sustainable growth in the agro-industrial sector.

3.2 Research Design

This study utilized a mixed-methods approach to comprehensively investigate the research objectives related to Ethiopia’s agro-industrial competitiveness, highlighting the role of sectoral innovation systems (SIS) within Integrated Agro-Industrial Parks (IAIPs). The research design combines qualitative and quantitative methods to depict the intricate, multi-dimensional interactions between governance, innovation, product differentiation, trade policy, and global value chain (GVC) integration (See Table 3).

Table 3. Research Design Components by Sub-Thematic Study Area

Sub-Thematic Study Area	Aligned Research Objective	Research Design & Method	Key Methodological Details & Rationale
Governance and Institutional Frameworks	Obj. 1 – Analyze governance and institutional frameworks	Mixed-Methods: SWOT + PLS-SEM	○ Stratified sampling ensures stakeholder representation (Teddlie & Yu, 2007). ○ SWOT identifies governance strengths/policy gaps (Gürel & Tat, 2017). PLS-SEM models causal links between governance, innovation, and competitiveness (Hair et al., 2019).
Sustainability, Innovation, and Global Market Integration	Obj. 2 – Examine interconnections among sustainability, innovation, market integration, and GVC governance	Quantitative, Deductive Design	- Positivist philosophy with hypothesis testing (Creswell & Creswell, 2018). - Mediation and moderation via SEM to assess indirect effects (Baron & Kenny, 1986; Hair et al., 2021). - Informed by GVC and SIS frameworks (Gereffi et al., 2005; Lundvall, 2010).
Drivers of Agricultural Innovation	Obj. 3 – Identify key drivers of agricultural innovation	Mixed-Methods Triangulation	- PLS-SEM assesses institutional and technological drivers (Chin, 1998; Hair et al., 2019). - KIIs and FGDs contextualize statistical results (Kvale, 2007; Morgan, 1997). - Triangulation enhances validity and construct interpretation (Patton, 2015).

Sub-Thematic Study Area	Aligned Research Objective	Research Design & Method	Key Methodological Details & Rationale
Innovation, Product Differentiation, and Trade Policy	Obj. 4 – Assess the effects of innovation, product differentiation, and trade policy on competitiveness	Explanatory Sequential Design	- Phase 1: Surveys to quantify innovation–trade linkages (Dillman et al., 2014). - Phase 2: FGDs/KIIs interpret contradictory or complex results (Creswell & Plano Clark, 2017). - Sequential design reveals causality and policy-market dynamics (Ivankova et al., 2006).

Note that[8]*:*

[8] Integrated Research Design Components by Sub-Thematic Study Area and Objective

3.3 Sample size and sampling

A purposive sampling method involved IAIPs that showcase a variety of agro-industrial contexts and development approaches. This technique is frequently advised in qualitative and mixed-methods research to ensure cases rich in information (Patton, 2002; Coyne, 1997). The sample included significant stakeholders from different levels of the agro-industrial value chain, such as public sector officials, agro-processing companies, farmer cooperatives, private investors, and research institutions in general. This multi-sector approach boosts the representativeness and depth of the findings by incorporating insights from institutional, technological, and market factors (Stake, 2010).

Quantitative data were collected using structured questionnaires sent to 175 targeted respondents, including cooperative farmers' heads (of small farmers) within a 100 km radius of the rural transformation centers (RTCs), agro-processors in the IAIPs (Yirgalem.[9] and Bulbula[10]), and other service providers in the parks. As discussed in the results section, a high response rate from these respondents was prioritized to ensure the reliability and generalizability of the quantitative findings (Ahmed et al., 2024; Fincham, 2008). The questionnaire evaluated stakeholders' perspectives on institutional effectiveness, innovation dynamics, and market integration processes within the IAIPs.

[9] Yirgalem IAIPs agro-processors: Process agricultural products like milk, avocado, honey, and coffee. Notable companies operating here include SUNVADO, Douely Foods Processing PLC, Hebron Ethiopia Trading Plc, and YBM Avocado Oil Processing. Also, the park offers essential infrastructure such as electricity, water, and waste treatment facilities to support these businesses.

[10] Bulbula: TK-Agro Processing PLC (That has Six Firms under its Complements working on various agro-commodity processing interventions such as: Edible Oil, Animal Feed, Fattening (Meat Industry), Poultry Feed, Tikur Azimud, Dairy, and Vegetable Processing).

Then from the 175 questionnaires distributed 160 respondents were returned that meets the requirements for PLS-SEM based on several criteria. The criteria include, the Rule of Thumb, that explains 10 times Rule (Hair et al., 2021). This rule recommends that the minimum sample size be 10 times the maximum number of structural paths directed at any construct in the model. Again also, according to the Hair et al., (2019) one of the strengths of PLS-SEM is its robustness in small to moderate samples especially in exploratory research with formative or reflexive latent constructs.

Alongside the survey, qualitative data were gathered through twenty-four key informant interviews (KIIs) and four focus group discussions (FGDs) of six members with chosen stakeholders. Participants in the KIIs and FGDs included top leaders from the Ministry of Agriculture (MoA), the Ministry of Trade and Regional Integration (MoTRI), and the Ministry of Industry (MoI), as well as officials from the two Regions' Industrial Parks, the UNIDO Ethiopian office, the FAO Ethiopian office, and the GIZ Ethiopian office. These approaches provided vital contextual insights regarding governance structures, operational challenges, and the perceived impacts of policy tools on IAIP performance (Bryman, 2016).

The data integration process encompassed a comprehensive analysis of quantitative survey data by applying Partial Least Squares Structural Equation Modeling (PLS-SEM). Concurrently, the Key Informant Interviews (KIIs) were subjected to a thorough thematic analysis and systematically coded utilizing the advanced QDA Miner Lite v.2.0.9 software. By amalgamating qualitative and quantitative methodologies, methodological triangulation substantially enhances the validity of the findings and facilitates the cross-verification of data sourced from various origins (Creswell & Plano Clark, 2017; Denzin, 2012).

Furthermore, to integrate data, the quantitative survey was analyzed using PLS-SEM. In contrast, the KIIs were thematically analyzed and coded using QDA[11] Miner Lite V. 2.0.9. Software. Triangulation was employed during the discussion phase to strengthen and contextualize the findings derived from models in conjunction with qualitative insights (Denzin, 2012; Tashakkori & Teddlie, 2010). The data from diverse institutions were not statistically amalgamated; they were analytically synthesized to reflect institutional perspectives on systemic challenges and innovation dynamics (Lundvall, 2010). Thus, using Lundvall's (2010) approach, data were not statistically aggregated but analytically synthesized to capture institutional perspectives on systemic constraints and innovation dynamics.

3.4 Instrumentation

The instruments utilized in this study were designed to collect primary data aligned with the overall research objectives—specifically, to evaluate the role of Sectoral Innovation Systems (SIS) in enhancing Ethiopia's agro-industrial competitiveness, with a particular emphasis on integrating Integrated Agro-Industrial Parks (IAIPs) into Global Value Chains (GVCs).

Three complementary data collection instruments were developed to achieve a comprehensive and methodologically sound assessment: a structured questionnaire, Focus Group Discussions (FGDs), and Key Informant Interviews (KIIs). These tools, presented in Annex I, were designed to capture latent constructs and observable indicators central to the study's conceptual framework. The instruments targeted five thematic dimensions critical for understanding the interplay between innovation systems and global competitiveness:

[11] Qualitative Data Analysis

governance and institutional frameworks, agricultural innovation, product differentiation, trade policy, and global market integration.

The structured questionnaire primarily aimed to gather quantitative data from a stratified sample of participants. Meanwhile, the FGDs and KIIs provided qualitative insights from key stakeholders, including policymakers, industry experts, and representatives of agro-processing companies operating in Ethiopia's IAIPs. Before full deployment, the instruments were pre-tested to verify their reliability, validity, and contextual relevance. The feedback obtained from this pre-test led to slight modifications that clarified questions, removed ambiguity, and enhanced the cultural relevance of the tools. This iterative validation process aligns with established best practices in mixed-methods research (Bryman, 2016; Creswell & Creswell, 2018). Hence, all variables were operationalized through structured, Likert-scale based survey items, designed based on validated constructs from innovation and GVC literature, as explained under the following four thematic areas.

3.4.1 Governance and Institutional Frameworks

Given the complexity and interconnected nature of the examined constructs—such as institutional frameworks, innovation ecosystems, stakeholder coordination, and global competitiveness—this study employed a structured questionnaire that utilized a 5-point Likert scale. The Likert items, ranging from "Strongly Disagree" (1) to "Strongly Agree" (5), allowed for the quantification of respondents' attitudes, perceptions, and experiences. This scaling method, first introduced by Rensis Likert in 1932, is widely used in social science research due to its simplicity, reliability, and effectiveness in capturing ordinal data (Boone & Boone, 2012).

Initially, the questionnaire was organized into five main sections, each corresponding to a specific latent variable: (1) Institutional Framework (IF), (2) Innovation Ecosystem (IE), (3) Stakeholder Coordination (SC), (4) Global Competitiveness (GC), and (5) Other Exogenous Variables (OE). Each latent construct was operationalized with multiple indicators carefully adapted from validated sources in the innovation and development literature (Hair et al., 2017; Sarstedt, Ringle, & Hair, 2021; Jing et al., 2022).

The indicators were derived from an extensive literature review and empirical evidence presented in this session, as indicated in the Annex-1: Table B-1:1. For instance, the Institutional Framework was assessed using six indicators (inst_1 to inst_6), including access to financial support, skilled labor, technology costs, infrastructure availability, and policy support. Likewise, the Innovation Ecosystem included access to R&D facilities, involvement in process and technological innovation, innovation diffusion strategies, and partnerships with universities and private firms (Pigford et al., 2018; Liu et al., 2022). Stakeholder Coordination was evaluated using indicators such as the presence of public–private partnerships (PPPs) and multi-stakeholder innovation platforms (Ebrahimi et al., 2021). Global Competitiveness was assessed based on export share, the level of international competition, and competitiveness indicators such as quality, productivity, and market access.

3.4.2 Sustainability, Innovation, and Global Market Integration of Ethiopian IAIPs

This research study employed instrumentation to measure various forms of innovation within Ethiopia’s IAIPs, including product, process, technological, and organizational innovation. Additionally, it evaluates innovation awareness and diffusion strategies, such as knowledge transfer mechanisms, innovation hubs, and public-private partnerships. These dimensions are crucial for understanding how innovation drives sustainability and integrates IAIPs into global value chains. The survey instrument was structured to assess several latent variables, each aligning with the research's specific objectives. The latent variables measured include sustainability practices, innovation, market integration, and global value chain governance. The items in the survey were drawn from existing literature and adapted to the specific context of Ethiopia's IAIPs (Gereffi et al., 2005). The survey utilized reflective and formative indicators, ensuring that multiple dimensions of each construct were captured. Each latent variable was measured using a set of six carefully selected items that reflect key aspects of the concept. The constructs measured in this study include: Sustainability, Innovation, Market Integration, and Global Value Chain Governance as defined below.

Sustainability Practices (SP): This variable captures the various practices implemented within the IAIPs. It was measured using six items: crop rotation practices (CRP), climate-smart agriculture (CSA), water resource management (WRM), sustainable farming (SF), soil conservation practices (SC), and renewable energy adoption (REA). These practices are essential for ensuring the long-term viability of agro-industrial activities within IAIPs and their integration into global markets (UNEP, 2013).

Innovation (IN): The innovation construct includes six items that evaluate various types of innovation in IAIPs. These consist of product innovation (PRI), such as new product development and improved seed varieties; process innovation (PI), like enhanced production methods; technological innovation (TI), such as the use of digital and precision agriculture; organizational innovation (OI), which involves new management practices; the existence of innovation hubs within IAIPs (IH); and awareness of innovation (IA). Innovation plays a crucial role in boosting the competitiveness of agro-industrial sectors and integrating them into global value chains (Teece, 2010; Porter, 1990).

Market Integration (MI): This construct was measured using six items that focus on strategies and support mechanisms for integrating IAIPs into broader and global markets. These items include the support mechanisms in place for market integration (SBM), the extent of transactions with international buyers (MTA), the effectiveness of existing market channels (EMC), global market competitiveness (CGM), the percentage of total production exported (PPE), and the effectiveness of trade policies supporting IAIPs (TPE). Market integration is critical for ensuring that products from Ethiopia's IAIPs can compete and succeed in global markets (Porter, 1998).

Global Value Chain Governance (GVCG): The GVCG construct assesses governance mechanisms within global value chains. It includes elements that evaluate the effectiveness of the institutional framework (EIF), coordination mechanisms (CM), product differentiation strategies (PD), specific strategies to enhance participation in global value chains (SIAIP), competitiveness within global value chains (CGVC), and the role of IAIPs in global value chains (IGVC). Effective governance is essential for facilitating the seamless integration of IAIPs into global value chains and ensuring that Ethiopia's agro-industrial products meet international standards (Gereffi et al., 2005).

3.4.3 Drivers of Agricultural Innovation in Ethiopia's IAIPs

A structured questionnaire was created to gather data on the study's primary constructs, including institutional support, government policies, technological advancements, networking, various exogenous factors, and innovation outcomes. This instrument was adapted from established scales in the literature (Brown, 2019; Smith & Brown, 2020) to ensure content validity.

The questionnaire included both closed-ended and Likert-type scale questions, ranging from 1 (strongly disagree) to 5 (strongly agree), a standard method for measuring attitudes and perceptions in agricultural innovation studies (Taylor, 2018). Each construct's items were pre-tested with a small group of IAIP stakeholders to refine the questions and enhance clarity, following the guidelines set forth by Dillman et al. (2009). The survey assessed the following constructs to examine the various factors influencing agricultural innovation within IAIPs, as indicated in Annex-1: Table B-2:1, including:

Institutional Support: This construct evaluates the involvement of both governmental and non-governmental organizations in supporting agro-industrial development. It encompasses financial assistance, regulatory frameworks, and infrastructure development essential for fostering innovation within IAIPs (Da Silva & Mhlanga, 2024; Green & Lee, 2018). Institutional support is crucial for ensuring sustainable growth and development within agro-industrial systems.

Government Policies: This construct examines the role of national and regional policies in fostering innovation within the agricultural sector. It includes policy measures, strategic frameworks, and regulations that create an enabling environment for innovation, such as trade policies, market integration, and public-private partnerships (Johnson, 2018; Smith, 2021). Effective government policies are essential for cultivating an environment conducive to agro-industrial innovation and integration.

Technological Advancements: This construct evaluates the adoption and integration of new technologies to enhance productivity and sustainability in IAIPs. Areas of focus include precision agriculture, climate-resilient crops, and digital tools (Taylor, 2018). Technological advancements serve as crucial drivers of efficiency and competitiveness within Agro-Industrial Parks.

Innovation Outcomes: This construct measures the results of innovation activities, focusing on enhancements in productivity, the introduction of new practices, and the implementation of resilience-building strategies within the agro-industrial sector (Brown, 2019; Green & Lee, 2018). These outcomes are essential for assessing the effectiveness of innovation in enhancing the overall performance of Agro-Industrial Parks.

3.4.4 Innovation, Product Differentiation, and Trade Policy in Ethiopia's IAIPs

In this study of the interlinkages among innovation, product differentiation, and the trade policy impact of Ethiopia's IAIPs, the survey instrument was designed to measure several latent constructs, each aligned with the study's research objectives. These constructs encompass innovation, product differentiation, trade policy, global market competitiveness, and other relevant contextual variables. The questionnaires, FGDs, and KII guidelines were developed based on established scales and adapted to the Ethiopian context (Gereffi et al., 2005; Kaplinsky & Morris, 2001). Reflective and formative indicators were included to ensure a thorough assessment of each construct. Utilizing multi-item measurement scales is a well-established practice for capturing the complexity of multidimensional concepts in social research (DeVellis, 2017).

Each latent variable is measured using a specific set of items that correspond to the core dimensions of the concept being evaluated. The following constructs and their associated variables were included in the study as follows: -

Innovation (IN): The innovation construct encompasses the diverse forms of innovation implemented within Ethiopia's IAIPs. Six items were developed to evaluate the following sub-categories of innovation:

- Product Innovation (PRI): Introducing new or improved products within the IAIPs.
- Process Innovation (PI): Improvements in production methods and workflows.
- Technological Innovation (TI): Adopting advanced processing technologies, including digital agriculture tools and precision farming.
- Organizational Innovation (OI): Introducing new management practices and organizational structures that facilitate efficiency.

- Innovation Awareness (IA): Knowledge of innovation and its relevance to the agro-industrial sector within the IAIPs.
- Innovation Diffusion Strategies (IDS): The presence of knowledge transfer mechanisms, innovation hubs, capacity building initiatives, and collaborative research (Teece, 2010; Drucker, 2002).

Product Differentiation (PD): The product differentiation construct is critical for understanding how IAIPs can enhance their competitiveness in global markets. Five items were used to measure product differentiation:

- Quality Differentiation (QD): Developing high-quality products that meet international standards (Porter, 1990).
- Branding and Marketing (BM): Strategies for improving product visibility and positioning (Kotler & Keller, 2016).
- Cultural and Regional Relevance (CRR): Tailoring products to meet local and regional consumer preferences.
- Value Addition (VA): The extent to which agro-processing activities enhance the value of raw agricultural products (Kaplinsky, 2000).
- Packaging and Presentation (PP): Innovations in product packaging that improve consumer appeal and marketability.

Trade Policy (TP): This construct assesses how trade policies influence the operations of IAIPs and their integration into global value chains. Five items were designed to measure trade policy:

- Infrastructure Support for Trade (TPIS): Evaluation of the trade-related infrastructure supporting IAIPs.

- Effectiveness of Trade Policy (TPE): The role of national and regional trade policies in supporting IAIPs' integration into global value chains.
- Market Access (TPMA): Strategies for improving access to domestic and international markets.
- Policy Support (TPS): The role of government policy in promoting IAIP operations (Rodrik, 2004).
- Compliance and Standards (TPCS): Adherence to international certifications and standards, such as ISO and carbon credit frameworks (Gereffi, 2018).

Global Market Competitiveness (GMC): This construct evaluates how IAIPs can compete in international markets. Three dimensions were used to assess global market competitiveness:

- Integration into Global Value Chains (GVC): The extent to which IAIPs participate in global supply chains (Gereffi, 2018).
- Market Positioning (MP): The IAIPs' ability to position themselves in global markets (Porter, 1990).
- Export Performance (EP): The volume and value of IAIP exports reflect the international competitiveness of their products (Humphrey & Schmitz, 2002).

Control Variables: The study also includes several control variables for contextual factors influencing outcomes. These include:

- Organization Type (Org_type): The nature of the organization within the IAIP (e.g., private sector, public sector, cooperative).
- Location of IAIP (IAIPs_location): The geographical location of the IAIP may affect its market access and operational effectiveness.
- Length of Operation within IAIP (IAIPs_duration): The number of years the IAIP has been in operation may influence its capacity for innovation and competitiveness.

3.4.5 Pre-Testing and Pilot Study

Before data collection, a pilot study was conducted at two Agro-Industrial Parks (IAIPs) in Ethiopia: Bulbula and Yirgalem IAIPs, to validate the survey instrument. A total of 40 stakeholders, including IAIP managers, company representatives, cooperative members, and officials from the Industrial Parks Development Corporation (IPDC), participated, with 20 respondents from each IAIP, representing the broader agro-industrial sector stakeholders.

The feedback from the pilot study was analyzed to evaluate the survey items' clarity, comprehensibility, and relevance. Adjustments were made to the instrument based on the responses to ensure that the questions were clear, contextually appropriate, and aligned with the participants' experiences (Creswell, 2014). Minor modifications were made to the wording of specific items to enhance their clarity while ensuring the instrument retained its validity. No significant changes to the original survey structure were necessary, confirming the instrument's suitability for the primary data collection phase (Bryman, 2016; Dillman, Smyth, & Christian, 2009).

The survey was conducted in English and translated into Amharic and Afaan Oromo to enhance inclusivity and ensure participants fully understood the questions. This multilingual approach provided cultural and contextual authenticity, establishing a strong foundation for examining governance, institutional support, innovation ecosystems, and stakeholder coordination concerning Ethiopia’s agro-industrial competitiveness.

3.5 Data Collection and Administration

The finalized structured survey was conducted with selected Bulbula and Yirgalem Integrated Agro-Industrial Parks (IAIPs) stakeholders. The data collection was meticulously designed to ensure the findings were valid and reliable. Participants assessed a series of statements on a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly

Agree), providing detailed insights into their perceptions and experiences (Likert, 1932; DeVellis, 2017). Skilled enumerators conducted the fieldwork, ensuring the survey was administered consistently and offered clarifications as necessary. Their extensive training was crucial in minimizing interviewer bias, clarifying ambiguities, and ensuring consistency and accuracy in all responses.

After collecting data, completed questionnaires underwent in-depth statistical analysis using IBM SPSS Statistics Version 27 (Field, 2013). Descriptive and inferential techniques explored the fundamental connections among key variables such as innovation, governance, trade policy, and competitiveness. Furthermore, results were supported by insights from Focus Group Discussions (FGDs), Key Informant Interviews (KIIs), and relevant secondary sources, including sectoral and policy reports, to enhance analytical depth and contextual significance. Utilizing the Likert scale, a well-established tool in empirical social science research, was particularly effective in capturing stakeholder attitudes across various thematic dimensions. The methodological rigor and mixed-method validation ensured robust, context-sensitive data appropriate for advanced modeling and evidence-based interpretation.

3.6 Data Analysis

This study employs a robust research design integrating qualitative and quantitative methods to explore the key factors influencing Ethiopia's agro-industrial competitiveness. Through various data analysis approaches, including PLS-SEM, thematic analysis, and SWOT analysis, the research examines complex relationships across four sub-thematic areas: governance frameworks, sustainability and innovation, agricultural innovation drivers, and the interplay between innovation, product differentiation, and trade policy. By combining these methods, the study provides a comprehensive understanding of the factors shaping Ethiopia’s agro-industrial sector, particularly IAIPs (See Table 4 below).

Table 4. Data Analysis Methods by Sub-Thematic Study Area

Sub-Thematic Area	Research Design	Data Analysis Methods	Rationale
1. Governance and Institutional Frameworks	Mixed-Methods Approach	○ Qualitative Analysis: Thematic analysis to identify patterns in governance structures and stakeholder perceptions (Braun & Clarke, 2006); SWOT analysis to evaluate the strengths, weaknesses, opportunities, and threats in institutional frameworks (Gürel & Tat, 2017). ○ Quantitative Analysis: Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine complex causal relationships between governance, innovation, and competitiveness (Henseler et al., 2009).	○ The mixed-methods approach integrates rich qualitative insights with robust quantitative validation. Stratified sampling ensures representation across diverse stakeholders (Bryman, 2016). ○ PLS-SEM allows for assessing latent constructs and multi-path relationships under non-normal data conditions (Chin, 2010; Kock & Hadaya, 2018). This triangulation enhances analytical depth and reliability.
2. Sustainability, Innovation, and Global Market Integration	Quantitative, Deductive Research Design	○ Quantitative Analysis: Structural Equation Modeling (SEM) assesses direct, indirect, and moderated effects among sustainability, innovation, and global market integration variables. ○ Statistical Techniques: SEM tools, including mediation and moderation testing, support causal modeling.	○ The deductive design is suitable for hypothesis testing based on established theory. The positivist paradigm endorses empirical validation of theoretical relationships (Cooper & Schindler, 2014; Creswell & Creswell, 2017). ○ SEM enables rigorous testing of complex interdependencies between constructs and supports robust conclusions in large-scale quantitative inquiries (Bryman, 2016).

Sub-Thematic Area	Research Design	Data Analysis Methods	Rationale
3. Drivers of Agricultural Innovation	Mixed-Methods Approach	○ Quantitative Analysis: PLS-SEM evaluates the impact of institutional support, policy interventions, and technological advancements on innovation outcomes (Hair et al., 2017). ○ Qualitative Analysis: Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) capture in-depth perspectives on innovation drivers. Thematic analysis structures and interprets qualitative insights (Braun & Clarke, 2006).	○ This mixed-methods strategy ensures a comprehensive understanding of agricultural innovation drivers. Quantitative analysis identifies measurable patterns, while qualitative methods enrich contextual understanding. ○ Data triangulation enhances interpretive validity (Krueger & Casey, 2014; Patton, 2002), and thematic analysis assists in synthesizing qualitative findings aligned with policy and technological innovation trends.
4. Innovation, Product Differentiation, and Trade Policy	Explanatory Sequential Research Design	○ *Quantitative Phase: Conduct structured surveys to gather data on innovation capacity, product differentiation, and trade policy interactions. Utilize descriptive and inferential statistics to identify patterns and relationships.* ○ *Qualitative Phase: Implement KIIs and FGDs to explain and contextualize quantitative results; perform thematic analysis to explore stakeholder perspectives on innovation-policy linkages.*	○ The explanatory sequential design enables an in-depth exploration of relationships by identifying trends quantitatively, then explaining them qualitatively (Ivankova et al., 2006). ○ This two-phase approach ensures interpretive depth and policy relevance (Subedi, 2016), supporting a nuanced understanding of how innovation and trade policy influence sectoral competitiveness.

3.7 Ethical Considerations

Ethical considerations were pivotal throughout this study's design, implementation, and data collection. We prioritized participants' rights and adhered strictly to ethical standards, following the guidelines of the American Psychological Association (APA, 2017).

Informed consent was obtained from all participants, ensuring they understood the study's objectives, the voluntary nature of their participation, and their right to withdraw at any moment without facing negative consequences. This information was communicated clearly, and participants received sufficient details about the study's procedures, allowing them to make informed decisions regarding their involvement (Denzin & Lincoln, 2011).

To ensure confidentiality, we collected no personally identifiable information during the study, protecting participants' privacy. All responses remained anonymous, and participants were assured that their data would be used exclusively for research purposes, with no identities revealed in any published results or reports. These measures were implemented to prevent potential participant harm and maintain the research's integrity.

Furthermore, ethical approval was obtained from the ASTU Postgraduate Studies Guidelines (2021) and the University’s Anti-Plagiarism Guidelines, further protecting participants' rights and privacy. Thus, this study was conducted with a strong commitment to ethical integrity, emphasizing the importance of participants' well-being while ensuring that their contributions enriched the research without compromising their rights or privacy.

CHAPTER 4. RESULTS AND DISCUSSIONS

This chapter assesses the study's principal empirical findings, emphasizing the performance of Ethiopia's Integrated Agro-Industrial Parks (IAIPs) and their strategic positioning in relation to global market integration and national competitiveness. The analysis is informed by insights derived from four interconnected research components, each concentrating on essential aspects of the agro-industrial transformation process: governance and institutional coordination, sustainability and innovation, determinants of agricultural innovation, and the interplay of product differentiation, trade policy, and market access.

Thus, the chapter includes five primary sub-sections designed to create a cohesive narrative integrating the study's quantitative and qualitative aspects. The first section outlines the general results of the descriptive statistics that inform the backgrounds of the survey participants, enhanced by thematic insights from Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs). These crucial elements lay the empirical groundwork for the subsequent analytical exploration.

The second to fifth sub-sessions examine the results and discussions as findings of the four interrelated agro-industrial transformation processes derived from the quantitative study using Partial Least Squares Structural Equation Modeling (PLS-SEM) and those of the qualitative study. The quantitative technique generally assesses the structural relationships among key latent constructs in the four studies, as outlined in the subsequent sessions, by triangulating with the qualitative findings via the discussions.

4.1 General Results of Descriptive Statistics

This section delineates the comprehensive outcomes derived from the descriptive statistics of the study, thereby offering an initial overview of the respondent profiles within the

Bulbula and Yirgalem IAIPs areas. The survey attained a commendable response rate of 91.43% (160 out of 175 questionnaires), with Bulbula IAIP contributing 41.71% (73 respondents) and Yirgalem IAIP contributing 49.71% (87 respondents), as elaborated in Table 3. Respondents were classified by actor type—public sectors, private sectors, producers, research and academia, and development partners—alongside their respective levels of experience (E1 to E6, representing years of involvement: E1 = <2 years, E2 = 2-5 years, E3 = 5-10 years, E4 = 10-15 years, E5 = 15-20 years, E6 = >20 years).

The public sectors consistently showed high response rates (e.g., 100% in Bulbula, 23/24 in Yirgalem), as did research and academia (100% in both areas). However, Bulbula's private sector response rate was lower (60%, 12/20), while development partners in Bulbula had a 0% response rate (0/5), in contrast to Yirgalem's 100% (5/5) for the same category.

Table 5 shows strong stakeholder engagement, particularly in Yirgalem IAIP, which achieved 100% response rates in most categories, with a slight deficit in the public sector (23/24). In contrast, Bulbula's overall response rate is 41.71%, notably due to no responses from development partners (0/5), possibly indicating disengagement, logistical issues, or perceived irrelevance (Brown, 2019). Producers showed high participation (28/29 in Bulbula and 24/24 in Yirgalem), reflecting their interest in IAIP outcomes, likely driven by agricultural economic incentives. The distribution of responses across experience levels (e.g., E6 >20 years: 37/38 returned) indicates strong representation from experienced stakeholders, providing valuable insights into long-term trends and challenges.

Table 5. Summary profile of returned questionnaires from each respondent/actor's category.

IAIPs	Actors	# Of Questionnaire Distributed per Educational Level							# Of Questionnaire Returned per Educational Level							Response Rate (%)
		E1	E2	E3	E4	E5	E6	Total	E1	E2	E3	E4	E5	E6	Total	
Bulbula IAIP	Public Sectors (Regulatory Bodies)	-	8	9	4	-	-	21	-	8	9	4	-	-	21	100.0%
	Private Sectors (Agro-processing)	1	3	12	4	-	-	20	1	2	5	4	-	-	12	60.0%
	Producers (Farmer Cooperatives)	-	-	-	6	3	20	29	-	-	-	6	3	19	28	96.6%
	Research and Academia	4	7	1	-	-	-	12	4	7	1	-	-	-	12	100.0%
	Development Partners	-	-	3	2	-	-	5	-	-	0	0	-	-	0	0.0%
	Sub-Total	5	18	25	16	3	20	87	5	17	15	14	3	19	73	41.71%
Yirgalem IAIP	Public Sectors (Regulatory Bodies)	-	8	11	3	2	-	24	-	8	10	3	2	-	23	100.0%
	Private Sectors (Agro-processing)	-	8	7	8	2	-	25	-	8	7	8	2	-	25	100.0%
	Producers (Farmer Cooperatives)		-	-	4	2	18	24	-	-	-	4	2	18	24	100.0%
	Research and Academia	3	6	1	-	-	-	10	3	6	1	-	-	-	10	100.0%
	Development Partners	1	3	-	1	-	-	5	1	3	-	1	-	-	5	100.0%
	Sub-Total	4	25	18	16	6	18	88	4	25	18	16	6	18	87	49.71%
	Grand-Total	9	43	43	32	9	38	175	9	42	33	30	9	37	160	91.43%

4.2 Governance and Institutional Frameworks

4.2.1 The Structural Model Analysis

This sub-section outlines the regression analysis findings performed using Partial Least Squares Structural Equation Modeling (PLS-SEM) in Figure 4 below. The relationships among key constructs such as institutional frameworks, innovation ecosystems, stakeholder coordination, and global competitiveness are initially explored. Subsequently, the model is refined to improve parsimony, ensuring that each variable's contribution to the overall model is clearly understood, as illustrated in Fig. 4 below.

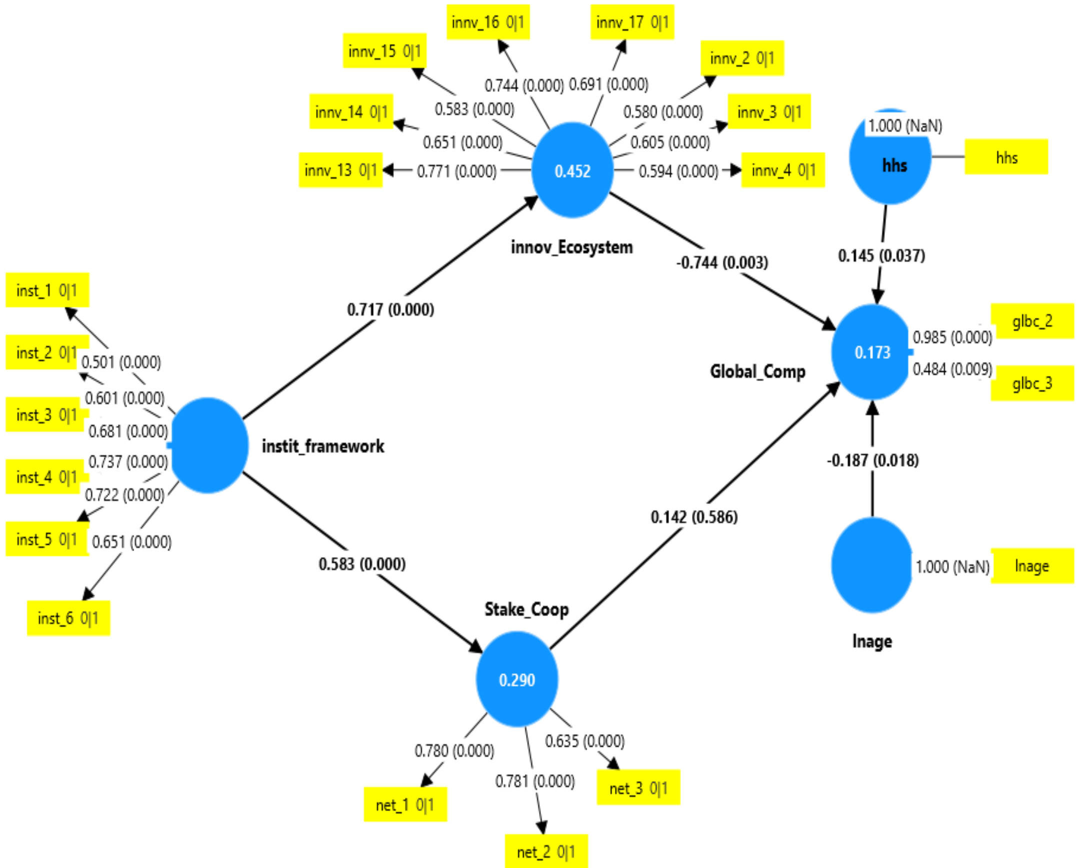


Figure 4. Results from PLS_SEM estimation using SmartPLS

Figure 4 illustrates the model with path coefficients, loading values, and p-values, analyzed using SmartPLS 4.0 following the works of Hair et al. (2017) and Ringle et al. (2023). Table 6 summarizes the model quality criteria, including key metrics used to assess the validity and reliability of latent constructs within the PLS-SEM framework. Average Variance

Extracted (AVE) values indicate how constructs explain the variance in observed indicators, with higher values reflecting stronger construct validity. Composite Reliability (CR) provides insight into internal consistency, while Cronbach's Alpha further supports reliability evaluation.

Table 6. Summary of quality criteria.

	AVE	CR	Cr-Alpha
Global Comp	0.603*** (0.058)	0.731 *** (0.085)	0.494 *** (0.081)
Stake Coop	0.540 *** (0.037)	0.777 *** (0.028)	0.580 *** (0.062)
hhs	1.000 (0.000)	1.000 (0.000)	1.000 (0.000)
innov_Ecosystem	0.430 *** (0.032)	0.857 *** (0.017)	0.811 *** (0.025)
instit_framework	0.428 *** (0.035)	0.815 *** (0.023)	0.729 *** (0.039)
lnage	1.000 (0.000)	1.000 (0.000)	1.000 (0.000)
Threshold	0.500	0.700	0.700

Note: standard deviation in parentheses; *** $p < 0.01$; AVE = Average variance extracted; CR = Composite reliability; Cr-alpha = Cronbach's alpha.

Notably, some constructs exhibit Cronbach's Alpha values below the conventional threshold of 0.7. Nevertheless, these constructs remain statistically significant at the 1% level, implying that despite minor deviations in internal consistency, they meaningfully represent the underlying concepts. As Cronbach (1951) discussed, rigid thresholds may mislead model interpretation, and slight departures from optimal values do not necessarily invalidate construct utility. Consequently, model refinement was carried out iteratively, eliminating constructs with weaker quality indicators to improve model accuracy.

Indicators representing the Innovation Ecosystem and Institutional Framework exhibit robust loadings, underscoring their effectiveness in capturing nuanced dimensions of innovation performance and governance within IAIPs. The low p-values (typically <0.01) further confirm the statistical relevance of these constructs within the structural model (Ringle et al., 2023).

Table 7 presents the outer loadings of the measurement indicators across constructs. The consistently high loading values (>0.5) demonstrate strong correlations between indicators and their respective latent variables, reflecting their reliability and explanatory strength (Ringle et al., 2023)

Table 7. Outer loadings (Mean, Standard deviation, t-values, p-values).

Measurement indicators	Coefficient	Standard Deviation	t-Statistics	*p* Values
glbc_2 <- Global_Comp	0.985	0.033	30.185	0.000 ***
glbc_3 <- Global_Comp	0.484	0.186	2.601	0.009 ***
innv_13 <- innov_Ecosystem	0.771	0.040	19.239	0.000 ***
innv_14 <- innov_Ecosystem	0.651	0.055	11.759	0.000 ***
innv_15 <- innov_Ecosystem	0.583	0.067	8.669	0.000 ***
innv_16 <- innov_Ecosystem	0.744	0.051	14.502	0.000 ***
innv_17 <- innov_Ecosystem	0.691	0.055	12.512	0.000 ***
innv_2 <- innov_Ecosystem	0.580	0.071	8.190	0.000 ***
innv_3 <- innov_Ecosystem	0.605	0.072	8.439	0.000 ***
innv_4 <- innov_Ecosystem	0.594	0.081	7.296	0.000 ***
inst_1 <- instit_framework	0.501	0.074	6.760	0.000 ***
inst_2 <- instit_framework	0.601	0.068	8.866	0.000 ***
inst_3 <- instit_framework	0.681	0.064	10.718	0.000 ***
inst_4 <- instit_framework	0.737	0.056	13.242	0.000 ***
inst_5 <- instit_framework	0.722	0.061	11.814	0.000 ***
inst_6 <- instit_framework	0.651	0.069	9.426	0.000 ***
net_1 <- Stake_Coop	0.780	0.045	17.172	0.000 ***
net_2 <- Stake_Coop	0.781	0.044	17.722	0.000 ***
net_3 <- Stake_Coop	0.635	0.085	7.439	0.000 ***

*** $p < 0.01$.

Table 8 below displays the estimated path coefficients and total effects derived from the PLS-SEM analysis. The results reveal a statistically significant relationship between the innovation ecosystem and global competitiveness. Specifically, the negative coefficient (−0.744, $p < 0.01$) suggests that the current innovation ecosystem in IAIPs adversely affects global competitiveness. This counterintuitive outcome may indicate inefficiencies or misalignments within the innovation processes that fail to translate into competitive advantage, highlighting the need for more market-aligned innovation strategies. This concern aligns with Fagerberg et al. (2005), who argue that innovation systems must be strategically tailored to meet market demands to foster competitiveness.

A similar trend is observed between institutional frameworks and global competitiveness, where a negative coefficient (-0.451, $p < 0.01$) suggests that robust institutional structures may, paradoxically, be linked to reduced competitiveness. While institutions are essential for ensuring economic order and stability, their rigid implementation could introduce bureaucratic constraints and limit responsiveness in fast-paced global markets. This paradox is also highlighted by North (1990), who cautions that overly rigid institutional arrangements may stifle innovation and adaptability.

The analysis also highlights a strong positive association between institutional frameworks and stakeholder coordination, with a coefficient of 0.583 ($p < 0.01$). This result implies that well-established institutional arrangements enhance stakeholder collaboration, consistent with Helfat's (2011) view that effective governance fosters interaction and innovation. This underscores the importance of governance in facilitating multi-stakeholder collaboration, which is essential for fostering innovation and enhancing competitive outcomes.

Moreover, the institutional framework is found to positively influence the Innovation Ecosystem in the IAIPs as depicted in Table 8 below. The coefficient of 0.717 ($p < 0.01$) reflects a significant positive impact of the institutional framework on the innovation ecosystem. This finding aligns with the work of Ebrahimi et al. (2021), who suggest that solid institutions provide essential support and resources, enhancing stakeholder coordination and overall innovative output. It supports the notion that strong institutions facilitate creating and enhancing an innovative environment. By providing the necessary support and resources, robust institutional frameworks can help stakeholders collaborate more efficiently, thus improving overall innovative output and capabilities.

Table 8. Final results (Path coefficients and total effects Mean, STDEV, and p values).

Path Relationship	Path Coefficient	Standard Deviation (SD)	p-Value	Total Effect	SD	p-Value
Stakeholder Cooperation → Global Competitiveness	0.142	0.260	0.586	0.142	0.260	0.586
Innovation Ecosystem → Global Competitiveness	−0.744	0.251	0.003 ***	−0.744	0.251	0.003 ***
Institutional Framework → Global Competitiveness	—	—	—	−0.451	0.130	0.001 ***
Institutional Framework → Stakeholder Cooperation	0.583	0.058	0.000 ***	0.583	0.058	0.000 ***
Institutional Framework → Innovation Ecosystem	0.717	0.045	0.000 ***	0.717	0.045	0.000 ***
Log of Firm Age (lnage) → Global Competitiveness	−0.187	0.079	0.018 **	−0.187	0.079	0.018 **
Household Size (hhs) → Global Competitiveness	0.145	0.070	0.037 **	0.145	0.070	0.037 **

*** $p < 0.01$, ** $p < 0.05$,

- **Note**: The dash (—) indicates that the direct path was not estimated; only the total effect is reported.

Household size and age act as exogenous variables within the analytical framework. The positive coefficient (0.145, $p < 0.05$) associated with household size indicates a relationship between larger households and increased competitiveness, likely driven by a larger labor supply or higher consumption that boosts market activity. In contrast, the age variable negatively impacts global competitiveness, suggesting that older individuals may struggle to adapt to changing global market dynamics. This finding highlights the necessity of leveraging intergenerational strengths to foster a competitive agro-industrial sector.

The findings illustrate the complex interconnections between institutional frameworks, innovation ecosystems, and stakeholder coordination influence IAIPs' global competitiveness. While innovation systems are crucial, their effectiveness depends on alignment with market expectations and support from enabling governance structures. The results inform policy interventions prioritizing strengthening institutions and enhancing stakeholder coordination to boost competitiveness. The unexpected negative association between innovation ecosystems and competitiveness further necessitates an in-depth exploration of practical strategies for translating innovation into market-relevant outcomes.

These results have significant implications for practitioners and scholars in the agro-industrial development field. Firstly, the strong connection between institutional frameworks and innovation ecosystems highlights the central role of adaptive and transparent governance in promoting innovation. This necessitates clear institutional roles and efficient decision-making processes to improve engagement and knowledge sharing. Secondly, the moderate positive impact of stakeholder coordination on competitiveness indicates the importance of building strong stakeholder networks—encompassing public institutions, private entities, development partners, and communities—to advance collective innovation objectives. Collaborative models like joint ventures and multi-actor platforms are recommended to facilitate mutual learning and innovation investment.

Furthermore, the negative impact of innovation ecosystems on competitiveness raises significant concerns regarding market alignment. It suggests a disconnect between innovative outputs and consumer needs, emphasizing the necessity for more agile, market-driven innovation strategies. Practitioners are encouraged to conduct regular market analyses, integrate feedback loops, and adopt flexible development models that respond promptly to evolving global demand.

In general, the results in Table 8 partially support Hypothesis H1 of the dissertation. This indicates that while the hypothesized variables are significantly interrelated, their direct influence on competitiveness, especially that of innovation ecosystems and institutional frameworks, appears negative in the current IAIP landscape, likely due to structural inefficiencies, poor policy-market alignment, or implementation constraints.

Thus, the empirical evidence yields nuanced insights into the complex dynamics shaping competitiveness within Ethiopia's IAIPs. Hypothesis H_1 is only partially confirmed: while institutional frameworks and innovation ecosystems are statistically significant, their unexpected negative associations with global competitiveness reveal systemic weaknesses in the current configuration. These findings suggest the need for:

- *Recalibrating institutional frameworks* to be more adaptive, less bureaucratic, and better aligned with market signals;
- *Reorienting innovation ecosystems* toward demand-driven outcomes, ensuring that innovation efforts are responsive to consumer preferences and export market requirements;
- *Strengthening stakeholder coordination*, particularly through public-private partnerships, innovation platforms, and collaborative governance models.

4.2.2 Qualitative Analysis Results and Discussions

4.2.2.1 Thematic Analysis

This section synthesizes key themes emerging from focus group discussions (FGDs), key informant interviews (KIIs), and government documents, analyzed using QDA software LITE V. 2.0.9. Figure 5 provides an overview of major thematic categories, while Figures 6 and 7 delve into the specific strengths, weaknesses, challenges, and opportunities associated with IAIPs.

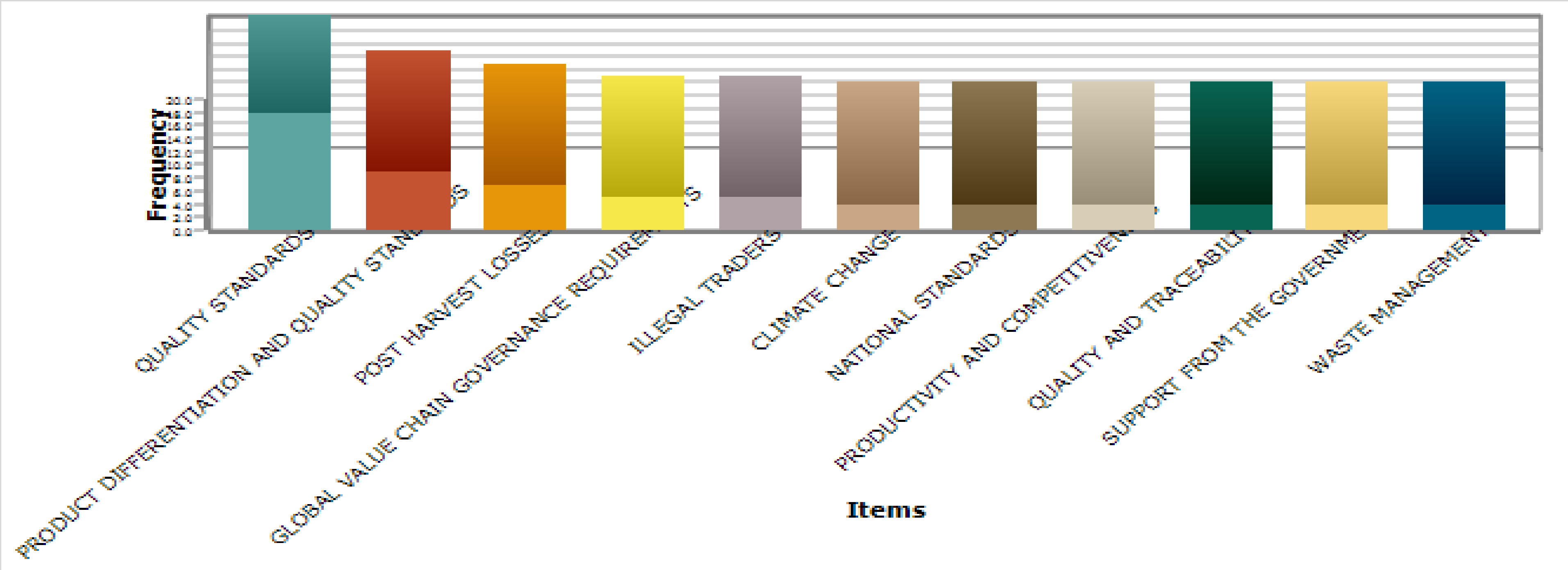


Figure 5. Distribution of key phrases (frequency) fetched from FGD and KII using QDA software

The selection of IAIP sites in Ethiopia was strategically guided by alignment with high-potential agricultural products. This targeted site allocation is seen as a significant strength and a promising opportunity (as shown in Fig. 5 below), fostering the development of specialized agro-industrial clusters.

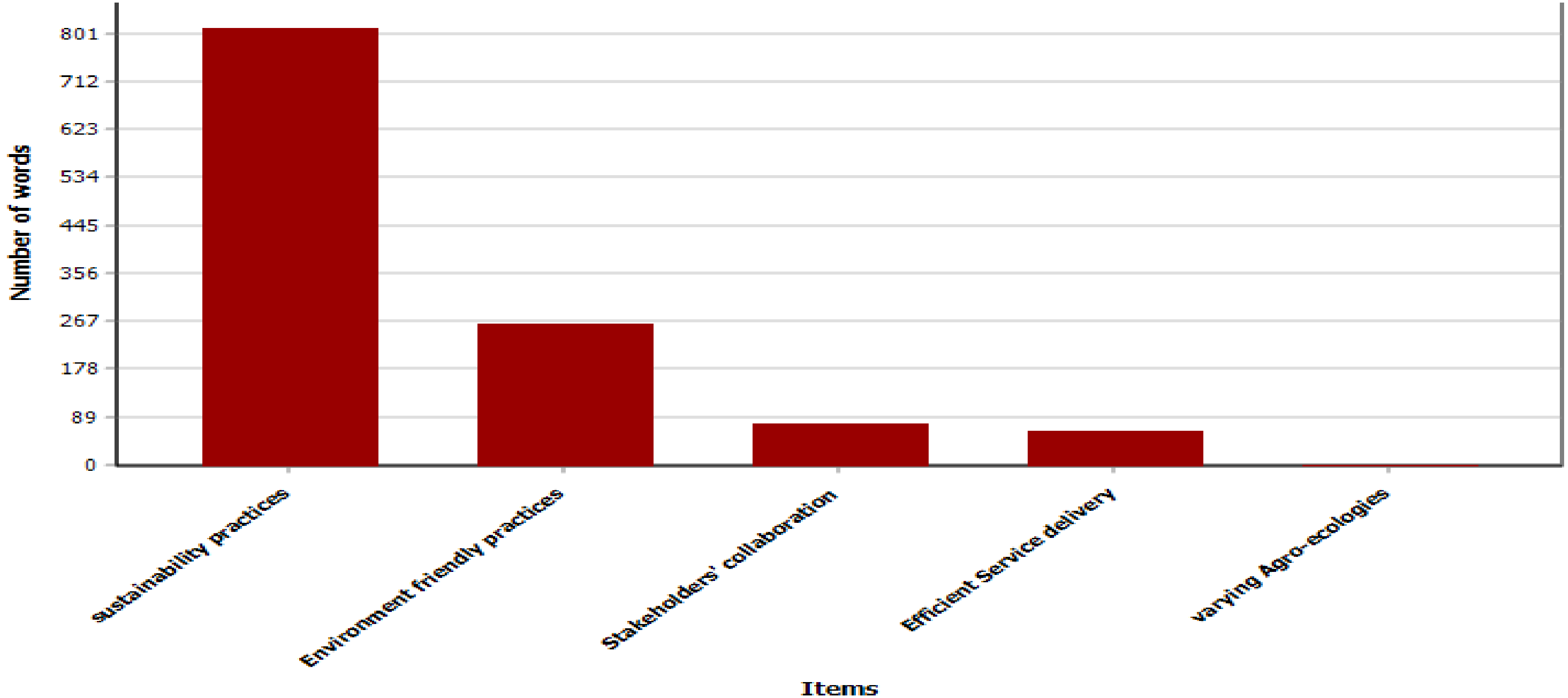


Figure 6. Key Themes identified as strengths/opportunities/in IAIPs using QDA software

IAIPs offer substantial potential for promoting specialization, product differentiation, and clustering within the agricultural sector. As shown in Table 9, each IAIP is strategically aligned with region-specific commodities, enabling tailored production processes that enhance regional economic contributions. For instance, in Yirgalem and Bulbula, five of the seven key commodities are exclusive to each park, establishing a solid foundation for product-specific value chain development.

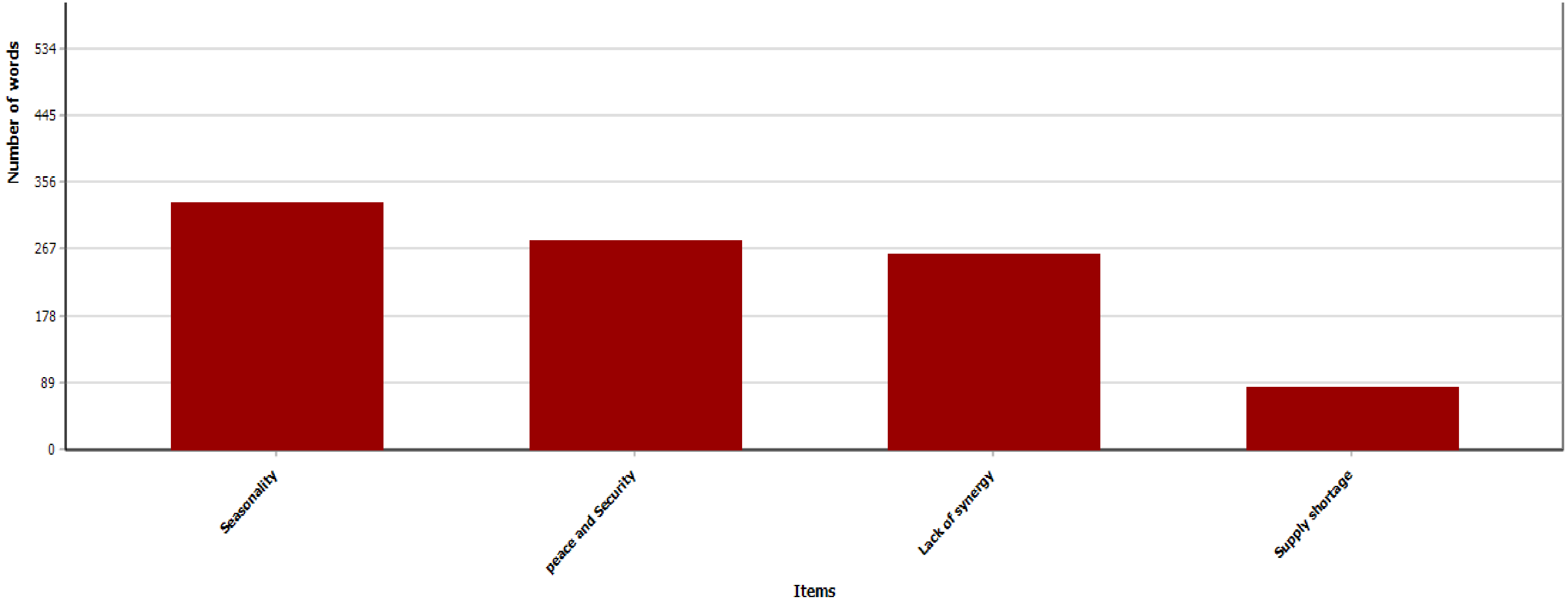


Figure 7. Key themes identified as weaknesses/threats in IAIPs using QDA software

Moreover, the identified commodities, such as avocado, support climate-smart agricultural practices and are also available for recycling, aligning with national and international climate regulations as depicted in Table 9 below. Furthermore, the region benefits from a relatively low-cost labor force, and partnerships with nearby academic institutions can facilitate access to research and development, further boosting productivity within the value chains. This multifaceted approach, emphasizing the linkage between infrastructure development, agricultural innovation, and market access, positions the IAIPs as a catalyst for sustainable economic growth and enhanced productivity in Ethiopia.

Table 9. Shortlisted and long-listed commodity potentials in each region.

	IAIPs	
	Yirgalem	Bulbula
Shortlisted Commodities	Avocado processing; Coffee processing; Pineapple processing; Animal feed; Organic fertilizer; Packaging material	Tomato processing; dairy processing; production of bakery products; Animal feed; Canning of beans; Honey; Pasta production

Source: FDRE Ministry of Industry, 2021.

On the other hand, apart from the highlighted strengths and potential opportunities, some weaknesses and potential threats were underscored during the interview. Persistent peace and security concerns significantly challenge sustainable investment and operational stability.

As participants noted, peace and security emerged as critical enablers of private sector investment. Safety concerns continue to be a significant deterrent to investor confidence. Ensuring secure conditions for moving goods and investment flows is vital for strengthening agro-industrial initiatives.

FGD participants highlighted that food safety, product traceability, and quality control initiatives remain underdeveloped. Traceability systems, crucial for tracking product origin and ensuring consistent quality, are not yet fully operational. This gap undermines compliance with global standards and constrains competitiveness. Addressing these deficiencies is imperative to meet international market expectations.

Inconsistent quality standards and inadequate traceability mechanisms hinder producers' ability to meet market requirements. Strengthening food safety systems and aligning production with traceability protocols are essential for improving market access and competitiveness.

Weak coordination and misalignment among development partners are recognized as governance challenges. To tackle this, a structured coordination platform is essential for enhancing collaboration, minimizing duplication, and ensuring effective resource utilization. Clearly delineated roles and strategic alignment among stakeholders can bolster development efforts and maximize impact.

Ethiopia's agricultural sector remains primarily informal and under-commercialized, resulting in a fragmented market structure. Post-harvest losses (PHL) worsen inefficiencies, particularly in crops like avocado, where losses can reach up to 40% (Urugo et al., 2024). Insufficient post-harvest infrastructure, including storage and aggregation facilities, contributes to seasonal supply fluctuations and price volatility. Moreover, cooperative centers frequently lack adequate warehousing and cold chain systems, disrupting efficient market linkages.

4.2.2.2 SWOT Analysis

This section presents a SWOT analysis based on thematic findings. Table 10 outlines the strategic landscape of IAIPs, encompassing key strengths, weaknesses, opportunities, and threats influencing their operational performance and global competitiveness. The analysis explores implications for firms and local communities, providing insights into how IAIPs can be leveraged for broader economic development.

Table 10. SWOT Analysis of Key Operational and Strategic Themes in Integrated Agro-Industrial Parks (IAIPs)

Theme	*Strengths*	*Weaknesses*	*Opportunities*	*Threats*
1. Infrastructure within the Park	- Well-developed infrastructure supports enhanced operational efficiency, logistics, and productivity.	- Risk of underutilization, leading to inefficient resource allocation and economic wastage.	- Ability to attract domestic and foreign investment by showcasing infrastructure readiness.	- Elevated maintenance and operational costs may burden park management and investors.
2. Adoption of Climate-Smart Varieties	- Improved resilience to climatic variability and extreme weather events. - Higher agricultural yields and productivity. - Private sector interest in supporting climate-resilient practices among local farmers.	- Limited availability of climate-resilient seeds and planting materials. - Knowledge deficits among farmers necessitate extensive training and extension support.	- Enhanced access to global markets seeking sustainably sourced agricultural products. - Alignment with global sustainability and environmental objectives.	Dependence on external suppliers for improved seed varieties may create supply vulnerabilities. The displacement of indigenous crop varieties may also result in biodiversity loss.
3. Quality Standards, Food Safety, and	*Not applicable as a strength.*	- Minimal government and NGO focus on quality assurance and traceability. - Absence of robust systems	- Implementing traceability mechanisms can enhance product competitiveness and consumer trust. - Improved	Non-compliance with traceability requirements may restrict entry into high-value markets, and heightened

Theme	*Strengths*	*Weaknesses*	*Opportunities*	*Threats*
Traceability (Underdeveloped)		to ensure food safety and monitor product flow.	transparency could boost export market access.	regulatory scrutiny may pose compliance challenges.
4. Seasonality of Agricultural Inputs	- Possibility to leverage seasonal peaks for targeted market strategies. - Ability to schedule infrastructure maintenance during off-seasons to reduce disruptions.	- Irregular availability of raw materials due to seasonal fluctuations. - Challenges in aligning production planning with agricultural cycles.	- Investment in cold storage and processing infrastructure to smooth seasonal supply gaps. - Introduction of off-season crops and diversification strategies.	- Climate change may exacerbate supply volatility and yield inconsistencies. - Market instability due to unpredictable supply-demand dynamics.
5. Limited Supply from Local Farmers	Small-scale supply may prompt processors to prioritize quality, enhancing product reputation. This opens up the scope for direct engagement with farmers, strengthening local sourcing and community development.	Supply constraints limit industrial processing capacity, causing uncertainty and inefficiencies. Limited raw material availability drives increased input costs.	- Capacity-building programs can improve farmer productivity and market responsiveness. - Promotion of crop diversification to mitigate reliance on a few commodities.	- Food insecurity risks arising from insufficient agricultural output. - Excessive reliance on a few suppliers heightens exposure to supply shocks.
6. Low Participation of Foreign Firms	Reduced competition may enable domestic firms to build capacity and gain market share. Prior to engaging foreign partners, there is also an opportunity to strengthen local industry.	- Diminished foreign direct investment slows infrastructure development and knowledge transfer. - Limited access to international markets and best practices.	- Development of targeted incentives and policies to attract foreign investors. - Strategic branding and marketing of the park's competitive advantages.	- Competing regions may offer more appealing investment conditions. - Political or macroeconomic instability may deter long-term investment.

Theme	*Strengths*	*Weaknesses*	*Opportunities*	*Threats*
7. Investor Concerns Regarding Peace and Security	- Increased interest in peacebuilding efforts from both local and international stakeholders. - The scope is to invest in security infrastructure, thereby boosting investor confidence.	- Persistent instability may undermine the operational environment, discouraging investment.	- Engagement of development partners in peacebuilding and resilience-focused investments. - Appeal to firms with strong corporate social responsibility (CSR) agendas.	- Ongoing unrest could result in business disruptions, financial losses, and reputational damage. - Perceived insecurity may reduce investor inflow and tourism potential.

Source: Authors' analysis: 2025.

The presence of well-developed infrastructure, including water, electricity, transportation networks, and waste treatment facilities, is repeatedly acknowledged as a major asset within IAIPs. Such infrastructure enhances operational efficiency, facilitates logistics, and improves productivity, thereby attracting investment. However, this strength is accompanied by risks such as potential underutilization and inefficiencies if infrastructure capacity surpasses current demand. Furthermore, the high maintenance cost poses sustainability challenges, especially if long-term revenues fall short of covering these expenditures. Effective planning and strategic resource allocation are thus essential for ensuring long-term return on investment.

IAIP investors are increasingly embracing climate-resilient crop varieties to boost productivity and sustainability. This trend is supported by a rising interest in establishing connections with local farmers and promoting collaborative agricultural practices. However, challenges remain, such as restricted access to improved seed varieties and insufficient farmer training. Despite these shortcomings, opportunities exist to enhance market access and sustainability by encouraging the broader adoption of resilient practices. Nevertheless, risks include dependence on external seed suppliers and the possible loss of indigenous crop diversity.

Traceability systems enhance global market competitiveness by fostering transparency, ensuring regulatory compliance, and building consumer trust. They allow for tracking product origins throughout the value chain, facilitating prompt responses to safety concerns and bolstering brand credibility. Nonetheless, IAIPs encounter notable weaknesses in this area, as traceability systems remain underdeveloped, hindering competitiveness. This shortcoming also presents opportunities for stakeholders to adopt modern tracking technologies. The variety of agroecological zones and seasonal fluctuations complicate traceability, especially when sourcing from areas beyond the designated 100 km radius, as illustrated by cases in avocado processing. Ongoing regulatory compliance demands highlight the pressing need to improve traceability mechanisms.

Weak backward linkages and low agricultural production capacity create bottlenecks in meeting processing demand. While encouraging processors to prioritize quality and build closer ties with farmers presents opportunities, these supply limitations disrupt production schedules and elevate costs. Investment in farmer training and crop diversification initiatives can mitigate these constraints. However, insufficient supply also threatens local food security and may lead to price surges, making local market access more difficult during shortages.

Seasonal variation in agricultural supply presents both challenges and strategic planning opportunities. Firms can align maintenance schedules with off-seasons to reduce production interruptions. However, inconsistent raw material availability complicates planning and increases costs. These weaknesses can be addressed through investments in storage, processing solutions, and crop diversification. Nevertheless, climate variability may intensify seasonal supply gaps, necessitating adaptive strategies.

The limited engagement of foreign investors in IAIPs presents both a challenge and an opportunity. While this allows domestic firms to develop their capabilities with minimal competition, it also restricts international market penetration. Foreign investors often have the resources and networks essential for accessing global markets. Tailored incentives and proactive marketing strategies should be devised to address this gap. Nonetheless, geopolitical and security-related concerns continue deterring foreign investments, constraining economic growth and diversification.

Effective governance and institutional frameworks are crucial for harnessing the full benefits of IAIP infrastructure and climate-smart agricultural practices. Proper management can prevent underutilization and ensure cost efficiency in infrastructure use. Strong institutions also enhance food safety and traceability while supporting the adoption of innovative, climate-resilient crops. Addressing knowledge gaps among farmers through training is essential. Furthermore, improved stakeholder coordination can alleviate supply challenges and strengthen engagement between firms and producers. As competitiveness increasingly relies on quality standards and responsiveness to market needs, investing in traceability systems can significantly enhance product value and elevate Ethiopia’s global agricultural reputation.

This study highlights the intricate connections between institutional frameworks, innovation ecosystems, infrastructure development, and stakeholder coordination in enhancing Ethiopia's Integrated Agro-Industrial Parks (IAIPs) competitiveness and global integration. The econometric results reveal that although innovation systems are essential, their influence on competitiveness is not always beneficial, especially when they fail to align with market expectations or lack institutional backing. A significant negative correlation observed between innovation ecosystems and competitiveness indicates that innovation lacking market relevance can impede, rather than facilitate, integration into global value chains, reflecting concerns about the misalignment between innovation and market needs discussed in the literature (Adner, 2006; Hair et al., 2022).

From a qualitative perspective, structural weaknesses—such as inadequate post-harvest infrastructure, ineffective traceability systems, and seasonal volatility—continue to hinder market efficiency. Significant post-harvest losses, particularly in perishable crops like avocados, along with limited cold storage facilities, obstruct consistent supply chains, diminishing the ability of IAIPs to comply with international quality standards. Furthermore, the absence of robust traceability systems erodes regulatory compliance and consumer trust in global markets, which are increasingly demanding transparency and product provenance (UNIDO, 2018).

On a practical policy level, these findings underscore the urgency of strengthening governance institutions to create a more transparent, coordinated, and responsive innovation ecosystem. Clearly defined institutional roles and streamlined decision-making processes can significantly improve stakeholder engagement, innovation diffusion, and knowledge transfer. Investment in traceability infrastructure, climate-resilient farming systems, and market-responsive innovation strategies is imperative for translating technological advancement into competitiveness gains. Furthermore, enhancing backward linkages through farmer training, improved seed accessibility, and diversified cropping systems will help address raw material shortages while ensuring inclusive growth.

The moderate positive impact of stakeholder coordination on competitiveness underscores the value of developing collaborative innovation platforms that include public agencies, private investors, cooperatives, and development partners. Joint ventures, co-innovation labs, and public-private dialogue forums can promote shared objectives and mutual learning. Furthermore, aligning IAIP planning with seasonal cycles and enhancing logistical coordination can mitigate raw material fluctuations, thereby reducing processing downtimes and cost overruns.

For academia, the unexpected negative impact of innovation ecosystems opens a new research frontier: how can innovations be better aligned with real-time market signals and institutional capabilities? There is a need for more context-specific models that examine how innovation systems function within underdeveloped agricultural markets. Further empirical inquiry is also warranted into the dynamics between institutional maturity, infrastructure utilization, and global market penetration.

This study offers a nuanced understanding of how integrated agro-industrial development in Ethiopia must evolve from infrastructure-centric planning to ecosystem-centric innovation and governance reform. Ethiopia’s IAIPs can catalyze sustainable agro-industrial transformation and meaningful integration into global value chains by addressing institutional coordination, market relevance, and traceability gaps.

4.3 Sustainability, Innovation, and Global Market Integration

This section investigates the interrelationships among sustainability practices, innovation, market integration, and global value chain (GVC) governance within Ethiopian IAIPs, based on the results from Partial Least Squares Structural Equation Modeling (PLS-SEM) and relevant literature.

4.3.1 Assessment of the measurement model

The first step involves evaluating the outer measurement models to assess PLS-SEM results. Once the measurement models meet all criteria, the structural model is then evaluated (Hair et al., 2019; Hult et al., 2017). In this study, the measurement model includes reflective and formative constructs, each assessed using different criteria. For reflective constructs, indicators are considered manifestations or outcomes of the latent variable; therefore, outer loadings, convergent validity, discriminant validity, and composite reliability are used for evaluation (Fornell & Bookstein, 1982; Hair et al., 2019; Henseler et al., 2015). In contrast, formative constructs treat the indicators as causes or defining factors of the latent variable. For these constructs, outer weights and collinearity tests are employed for evaluation (Diamantopoulos & Winklhofer, 2001; Hair et al., 2017).

4.3.1.1 Reflective Constructs

For the reflective constructs (sustainability and innovation), outer loadings for most indicators exceeded the threshold of 0.7, confirming indicator reliability. Initially, there were 12 items for the reflective constructs, comprising six items to measure innovation and six items for sustainability practices. After running the first PLS-SEM path model, five items were removed due to their loadings falling below 0.4. If an item's outer loading is less than 0.4, the researcher must remove those items from the construct, as Hair et al. (2011) and Sarstedt et al. (2022) suggested.

The reflective constructs from which items were removed include REA, SF, PRI, OI, and IA. Notable loadings for the reflective construct "Sustainability" were CSA (0.722) and SC (0.768), while for the "Innovation" construct, the notable loading was IH (0.773), as indicated in Table 9. According to Hair et al. (2019), outer loadings ranging from 0.4 to 0.7 are generally acceptable but require careful evaluation. When determining whether to retain these indicators, it is essential to consider the Average Variance Extracted (AVE) of the construct, its overall effect on reliability, and its theoretical relevance (Hair et al., 2011, 2019; Haji-Othman & Yusuff, 2022).

Thus, indicators with loadings between 0.4 and 0.7 and those exceeding 0.7 were retained in this study due to their theoretical and practical significance to the constructs. For sustainability, CRP (crop rotation practices) and WRM (water resource management) highlight essential components of sustainable agriculture and are thus retained for further analysis. By enhancing nutrient cycling and naturally controlling pests, CRP improves soil health and production, crucial for minimizing environmental degradation (Diacono et al., 2021).

Similarly, WRM emphasizes precision irrigation and soil water conservation to ensure long-term agricultural output in the context of climate change and increasing water scarcity (Alsaeed et al., 2022; Buytaert et al., 2012). Regarding the construct of innovation, PI (process innovation) and TI (technological innovation) represent improved approaches to enhance efficiency and competitiveness. TI includes digital and precision technologies that streamline operations and boost productivity, particularly in agriculture under resource constraints, while PI focuses on optimizing production processes, aiding in the reduction of resource consumption and environmental impact (Sami et al., 2021; Xing & Wang, 2024).

Convergent validity is assessed through outer loadings and by evaluating the Average Variance Extracted (AVE) and Composite Reliability (CR) to verify the construct's reliability and validity. An AVE greater than 0.5 indicates adequate convergent validity, meaning the construct explains at least 50% of the variance in its indicators (Hair et al., 2019; Henseler et al., 2015). AVE is calculated by dividing the sum of squared outer loadings by the number of indicators. Composite Reliability (CR) measures the internal consistency of a construct's indicators, with a threshold of ≥ 0.7 indicating acceptable reliability (Hair et al., 2011; Hult et al., 2017). As presented in Table 11, the construct "Innovation" exhibited a CR of 0.761 and an AVE of 0.516, both meeting the criteria for CR ≥ 0.7 and AVE ≥ 0.5. Similarly, the "Sustainability" construct showed a CR of 0.774 and an AVE of 0.564, fulfilling the required thresholds for both CR and AVE (See Table 11).

Table 11. Quality criteria for reflective constructs

Reflective Constructs	Items	Outer loadings	AVE	CR
Sustainability	CRP	0.550	0.564	0.774
	CSA	0.722		
	SC	0.768		
	WRM	0.667		
Innovation	IH	0.773	0.516	0.761
	PI	0.697		
	TI	0.682		

Note(s): CRP= Crop rotation practices, CSA= Climate-smart agriculture, SC= Soil conservation, WRM= Water resource management, IH= Innovation hubs, PI= Process innovation, TI= Technological innovation, AVE= Average Variance Extracted, CR= Composite Reliability

Source: Author's calculation based on survey data (2024)

To evaluate discriminant validity, we applied the Fornell-Larcker criterion and HTMT ratios. The findings from this criterion are summarized in Table 12. As shown in Table 12, the square root of the AVE for each construct (presented in italics within brackets) exceeds the inter-construct correlations (values off the diagonal), supporting the discriminant validity between innovation and sustainability (Hult et al., 2017). The HTMT ratio between sustainability and innovation was 0.797, below the threshold of 0.85. This indicates no substantial overlap between the two constructs, further reinforcing the discriminant validity evidence.

Table 12. Discriminant Validity Using Fornell-Larcker Criterion and HTMT ratio

Fornell-Larcker Criterion		
Constructs	Innovation	Sustainability
Innovation	*(0.516)*	
Sustainability	0.231	*(0.564)*
HTMT(Heterotrait-Monotrait) ratio		
Sustainability ↔ Innovation	0.797	

Source: Author's calculation based on survey data (2024)

4.3.1.2 Formative Constructs

This study evaluated formative constructs like market integration and GVC governance by analyzing the outer weights and collinearity statistics (VIF). According to et al. (2017), significant outer weights (p-value < 0.05) suggest that indicators substantially contribute to the latent variable (construct). Initially, six items were considered for the market integration and GVC governance construct.

After running the PLS algorithm and bootstrapping the sample 5000 times with 95% bias-corrected confidence intervals, three items from each construct—market integration and GVC governance—were removed. The items discarded from market integration are MTA, CGM, and PPE, while those removed from GVC governance are EIF, SIAIP, and CGVC. All six items were excluded due to their p-values exceeding 0.05 (Refer to Table 13).

In Table 13, indicators with italicized outer weights denote those removed from the construct due to their insignificance. Additionally, we assessed collinearity statistics using VIF, with values below 5 indicating no multicollinearity issues within the model.

Table 13. Outer weights for indicators of formative constructs

Construct	**Indicator**	**Outer Weight**	**Significance(p-value)**
Market Integration	EMC	0.510	0.000***
	SBM	0.413	0.000***
	TPE	0.570	0.000***
	MTA	*0.068*	*0.616**

Construct	Indicator	Outer Weight	Significance(p-value)
GVC governance	CGM	0.277	*0.051***
	PPE	*-0.085*	*0.454**
	CM	0.474	0.000***
	IGVC	0.596	0.000***
	PD	0.380	0.002***
	EIF	*-0.029*	*0.883**
	SIAIP	*0.033*	*0.820**
	CGVC	*0.028*	0.833*

*** $p < 0.01$, ** $p < 0.05$, ** $p < 0.1$*Note(s)[12]

Source: Author's calculation based on survey data (2024)

4.3.2 Assessment of the structural model

After assessing the measurement (outer) model, the next step is assessing the structural (inner) model (Henseler et al., 2015). Path coefficients (β), effect size, and the statistical significance of direct and indirect effects were examined to assess the structural model, emphasizing the study's hypothesized mediation relationships. Figure 7 depicts the relationships between variables and the coefficients of determination (R-squared) for endogenous latent variables.

As indicated in Figure 7 once more, the coefficients of determination (R-squared) for endogenous latent variables ranged from moderate (R^2 for Innovation = 25.4%) to substantial (R^2 for GVC governance = 34.7%), as suggested by Henseler et al. (2009). To evaluate the overall fit of the structural model, we applied the Standardized Root Mean

[12] EMC = Effectiveness of market channels, SBM = Strategies or support mechanisms in place to help IAIPs integrate into broader markets, TPE = Trade policies' effectiveness in supporting IAIPs' integration into GVC, MTA = Market transactions with international buyers, CGM = Competitiveness in global markets, PPE = Percentage of production exported to international markets, CM = Coordination mechanisms, IGVC = Role of IAIPs in GVC, PD = Product differentiation, EIF = Effectiveness of the existing institutional framework, SIAIP = Strategies used in IAIPs for global value chain, CGVC = Competitiveness in the global value chain, GVC = Global Value Chain. Indicators with italicized outer weights indicate that the indicator is removed from the construct due to its insignificance.

Square Residual (SRMR), which is a commonly reported index in PLS-SEM (Afthanorhan et al., 2016; Pavlov et al., 2021; Shi et al., 2018). The threshold for SRMR is generally considered acceptable if its value for the estimated model is below 0.08 (Henseler et al., 2015; Hu & Bentler, 1999). The estimated model's SRMR value (0.055) fell within an acceptable range, demonstrating a good match between the hypothesized model and the data. This indicates that the model accurately captures the relationships between the constructs. Table 14 depicts the structural model results to evaluate both direct and mediated relationships among the hypothesized model constructs, their statistical significance, and decision status.

Hypothesis 1[13] of this sub-thematic study predicted that Sustainability practices positively influence Innovation within IAIPs. In line with this prediction, the results suggested that the direct effect of Sustainability on Innovation was significant ($\beta=0.504$, $t=10.122$, $p<0.001$), indicating that higher sustainability practices lead to greater innovation outputs.

Hypothesis 2 predicted that innovation positively impacts market integration. The prediction was confirmed since the direct path from innovation to market integration was significant ($\beta=0.422$, $t=6.901$, $p<0.001$), indicating that innovation enhances the market integration of firms located in the Integrated Agro-Industrial Parks (IAIPs).

Hypothesis 3 predicted that Market integration positively affects GVC governance. The results suggested that the direct path from market integration to GVC governance was strong and significant ($\beta=0.589$, $t=11.861$, $p<0.001$), indicating that firms (private sectors) with better market integration have stronger global value chain governance.

[13] Hypothesis 1-Hypothesis 6 (the sub-thematic study) are also found in our study article under pre-print process: https://www.preprints.org/manuscript/202502.0673/v1, AND also, they (H1-H6) are the corollary of our H_2 of the Dissertation Hypothesis.

Hypothesis 4 predicted that Sustainability indirectly influences Market integration through Innovation. This hypothesis was supported by the findings, which demonstrated a significant indirect effect of sustainability on market integration through innovation (effect = 0.213, t =5.168, p<0.001), suggesting partial mediation in which innovation contributes to the explanation of the relationship between market integration and sustainability.

Hypothesis 5 predicted that innovation indirectly influences GVC governance through market integration. The results supported this hypothesis, indicating that the indirect effect of innovation on GVC governance via market integration was significant (effect=0.248, t=5.514, $p<0.001$). This implies that the effect of innovation on GVC governance is fully mediated through market integration. Hypothesis 6 predicted that sustainability indirectly influences GVC governance through innovation and market integration. The results supported this hypothesis, showing that the full mediation path (Sustainability → innovation → market integration → GVC governance) was significant (effect = 0.125, t = 4.400, $p<0.001$).

Table 14. Structural Model Results

Path/Hypothesized relationship	**Path Coefficient(β)/Effect**	**t-value**	**P-value**	**Decision (Supported?)**
Sustainability → Innovation	0.504	10.122	<0.001	Yes (Direct effect)
Innovation →Market Integration	0.422	6.901	<0.001	Yes (Direct effect)
Market Integration →GVC governance	0.589	11.861	<0.001	Yes (Direct effect)
Sustainability → Innovation → Market Integration	0.213	5.168	<0.001	Yes (Mediation)
Innovation →Market Integration → GVC governance	0.248	5.514	<0.001	Yes (Mediation)
Sustainability → Innovation → Market Integration → GVC governance	0.125	4.400	<0.001	Yes (Full Mediation)

Source: Author’s calculation based on survey data (2024)

As shown in Table 15 and Figure 8, the findings support the mediating effects of innovation and market integration in the relationship between sustainability and GVC governance.

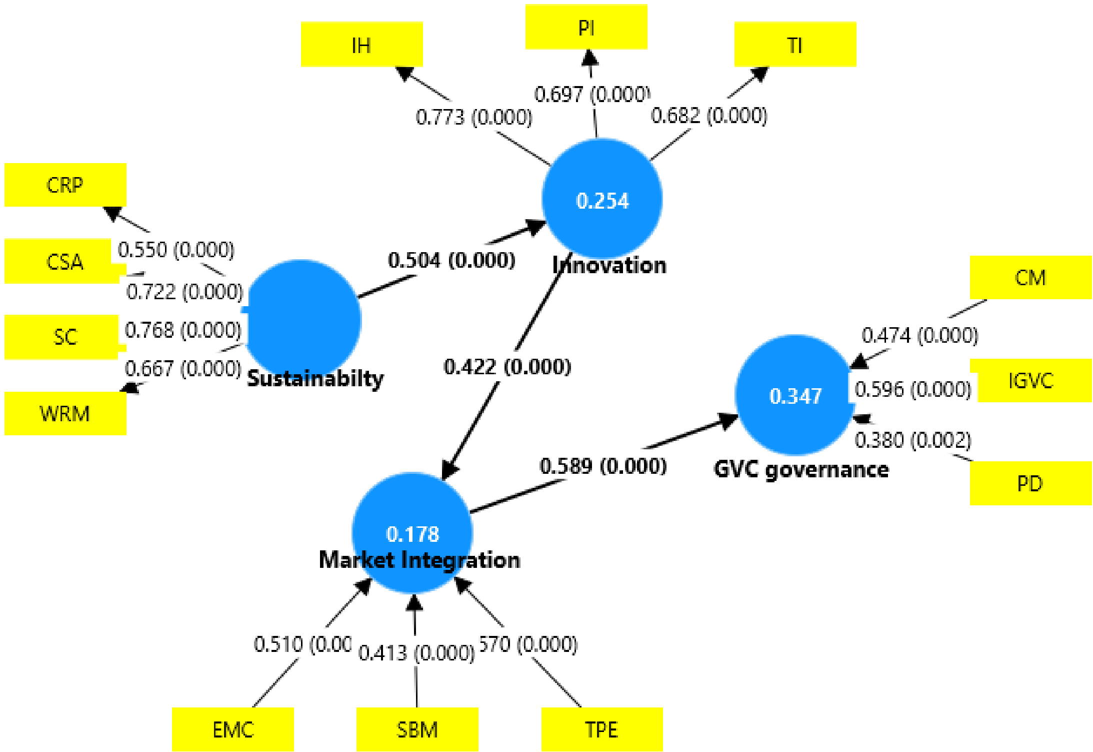


Figure 8. Structural Relationships between Constructs and Indicators

Innovation explicitly mediates the influence of sustainability on market integration, while the combined mediating roles of innovation and market integration clarify the effect of sustainability on GVC governance. Moreover, Market Integration fully mediates the influence of Innovation on GVC Governance, highlighting the interconnectedness of these constructs.

Table 15. Predictive Relevance of the Structural Model

Construct	Q^2predict	PLS-SEM RMSE	PLS-SEM MAE	LM RMSE	IA RMSE	PLS loss	IA loss
GVC Governance	0.096	0.962	0.802	1.404	1.336	1.404	1.467
Innovation	0.224	0.888	0.737	1.100	1.153	0.198	0.216
Market Integration	0.112	0.952	0.795	1.033	1.039	1.288	1.333
Overall	0.057	1.404	1.467	1.317	1.322	0.964	1.005

Source: Author's calculation based on survey data (2024)

In order to assess the predictive relevance of the proposed model, we executed a Partial Least Squares (PLS) Predict analysis, which evaluates the model's out-of-sample prediction performance. Table 16 encapsulates the findings concerning the predictive relevance of the constructs. The PLS analysis substantiates the strong predictive relevance and accuracy of the model's predictive analysis, illustrated in Table 16. More specifically, the Q^2 predict values for GVC governance (0.096), innovation (0.224), and market integration (0.112) exhibit considerable predictive potential, consistent with the guidelines established by Ringle et al. (2020) and Joseph et al. (2022).

Innovation exhibited the lowest RMSE (0.888) and MAE (0.737), indicating good predictive accuracy. Market Integration produced comparable results (RMSE = 0.952, MAE = 0.795). The model's higher predictive accuracy was supported by cross-validation, which revealed statistically significant t-values ($p < 0.001$) and a smaller PLS loss compared to IA loss (Hair & Alamer, 2022).

We used the f^2 values to assess the effect sizes of the relationships in the model. Effect sizes (f2) are evaluated in PLS-SEM according to Cohen's (2013) guidelines, which have been customized for structural equation modeling scenarios (Figure 7).

Table 16. Effect Sizes (f2) for hypothesized relationship

Path	Endogenous Construct	Effect size(f^2)	Interpretation
Sustainability→ Innovation	Innovation	0.341	Medium effect
Innovation → Market Integration	Market Integration	0.216	Medium effect
Market Integration → GVC governance	GVC governance	0.532	Large effect

Source: Author’s calculation based on survey data (2024)

The effect size of the model quantifies the extent to which an exogenous variable influences an endogenous variable. According to the thresholds proposed by Cohen (2013), an f^2 value of 0.02 or greater indicates a small effect, an f^2 value of 0.15 or greater represents a medium effect, and an f^2 value of 0.35 or greater signifies a substantial effect. As presented in Table 16, the Sustainability → Innovation path exhibited a medium effect ($f^2 = 0.341$), while the relationship between Market Integration and GVC Governance demonstrated a strong effect ($f^2 = 0.532$). Additionally, the Innovation → Market Integration path indicated a medium effect ($f^2 = 0.216$). These results exemplify the differing degrees of strength in the relationships that the structural model posits.

As a result, this study's findings offer essential insights into the complex relationships among sustainability practices, innovation, market integration, and global value chain (GVC) governance within Ethiopia's Integrated Agro-Industrial Parks (IAIPs). The structural model results showed that sustainability practices significantly impact innovation ($\beta = 0.504$, $p < 0.001$), which in turn drives market integration ($\beta = 0.422$, $p < 0.001$).

Furthermore, market integration has been recognized as a significant predictor of Global Value Chain (GVC) governance ($\beta = 0.589$, $p < 0.001$), emphasizing the essential function of market engagement in improving coordination and control within global value chains. These findings substantiate Hypothesis H2 of the dissertation, demonstrating a systemic interaction wherein sustainability promotes innovation, innovation enhances market integration, and market integration ultimately fortifies participation in GVC governance frameworks.

Thus, the mediation analysis further supports the systemic nature of these relationships. Innovation was found to partially mediate the impact of sustainability on market integration. In contrast, the combined mediating role of innovation and market integration fully explains the link between sustainability and GVC governance. These findings emphasize the necessity of viewing IAIPs as dynamic systems, where sustainability does not function in isolation but requires translation through innovation and integration mechanisms to influence global competitiveness and governance structures (Hair et al., 2019; Ringle et al., 2020).

For policymakers, the results suggest that sustainable practices, in isolation, may not produce direct enhancements in global competitiveness unless they are judiciously directed by innovation and strategies that are responsive to market demands. Policies ought to prioritize investments in innovation infrastructure, including research and development facilities, climate-smart technologies, and systems for digital traceability, which augment the capacity of firms to incorporate sustainability into solutions that are both marketable and compliant with global standards. Furthermore, the enhancement of market integration via trade facilitation, export readiness programs, and support for cross-border logistics is essential for the improvement of governance outcomes in global value chains (GVC).

This study introduces a validated structural model for the academic community, enhancing our theoretical understanding of how sustainability-driven interventions evolve through innovation and market dynamics. The model offers empirical support for the innovation–integration–governance nexus, reinforcing the mediating roles proposed by systems-based value chain theories (Anandajayasekeram & Gebremedhin, 2009; Cohen, 2013). Future research should investigate longitudinal designs to assess temporal dynamics and explore sectoral differences in these interconnections within the agro-industrial context.

The empirical validation of Hypothesis H_2 within the overarching hypothesis [the dissertation] reveals crucial insights into the structural levers that enhance GVC governance in Ethiopia’s agro-industrial sector. The results indicate that while sustainability is the foundation, its most significant benefits are realized through innovation capacity and strategic market integration.

Thus, policymakers and practitioners need to consider: - Expanding their focus beyond basic green initiatives to invest in innovation infrastructure, which includes R&D hubs, climate-smart technologies, and digital platforms that facilitate sustainable practices, ultimately leading to competitive outputs; implementing market integration strategies like export facilitation, certification programs, and enhancements in trade logistics, which are crucial for IAIP-based firms to successfully engage and prosper in global value chains; and recognizing that comprehensive interventions are essential, as enhancements in governance within GVCs arise from a blend of well-coordinated sustainability strategies, ongoing innovation, and robust market relationships.

4.4 Drivers of Agricultural Innovation

This subsection investigates the underlying factors that influence the emergence and advancement of agricultural innovation within Ethiopia’s Integrated Agro-Industrial Parks (IAIPs), focusing on the Bulbula and Yirgalem IAIPs. By synthesizing findings from descriptive statistical analyses, insights drawn from Partial Least Squares Structural Equation Modeling (PLS-SEM), and qualitative data, the study presents an integrated perspective on the key enablers shaping innovation in these agro-industrial ecosystems.

4.4.1 Quantitative Descriptive Statistics

Descriptive statistics offer an important overview of innovation adoption patterns across Bulbula and Yirgalem IAIPs. Hence, innovation adoption was assessed using a five-point Likert scale (1 = strongly disagree, 5 = strongly agree), aggregating responses across both IAIPs. The results revealed product innovation as the most adopted type, with 66.03% of respondents rating it 4 or 5 (mean = 4.01, SD = 0.87), followed by process innovation at 38.46% (mean = 3.67, SD = 0.91), technological innovation at 30.13% (mean = 3.51, SD = 0.95), and organizational innovation at 22.64% (mean = 3.38, SD = 1.02). These findings are visually represented in Figure 9.

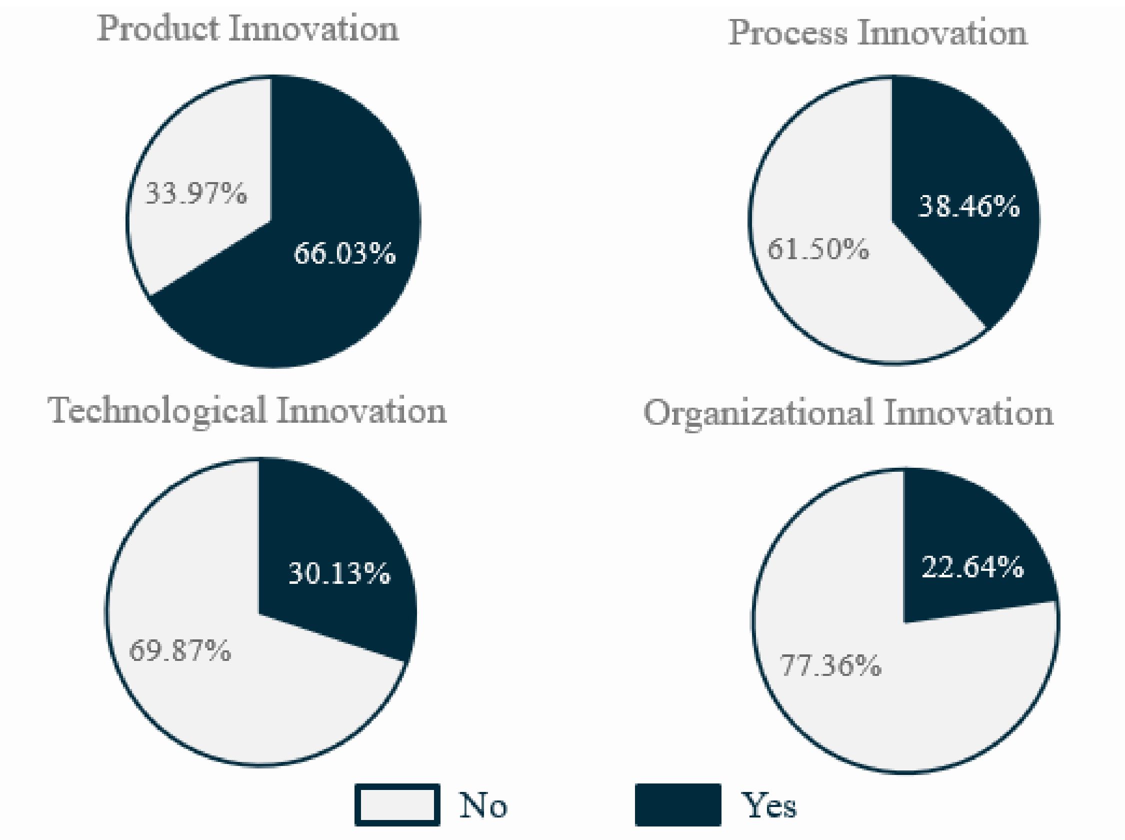


Figure 9. Innovation adoption by innovation types in both IAIPs

Figure 9 underscores the prominence of product innovation (66.03%), indicating a strong focus on developing new or improved agricultural products (e.g., processed foods or novel crop varieties) to enhance market competitiveness. This aligns with the Sectoral Innovation Systems (SIS) framework, emphasizing product development as a key driver in agro-industrial contexts (Edquist, 2011).

Process innovation (38.46%) reflects efforts to optimize operational efficiencies, such as improved post-harvest handling or packaging, while the lower adoption rates for technological (30.13%) and organizational (22.64%) innovations suggest limited investment in advanced technologies (e.g., automation) or management restructuring. The higher standard deviation for organizational innovation (SD = 1.02) indicates greater variability in perceptions, possibly due to differing organizational capacities across IAIPs (Zanello et al., 2016). These patterns suggest that IAIPs prioritize tangible outputs over systemic changes, potentially constrained by resource availability or strategic focus.

The high response rate (91.43%) and detailed adoption data provide a solid empirical basis for the study, enhancing its reliability and representativeness (Tabachnick & Fidell, 2013). The emphasis on product innovation supports IAIP objectives of value addition. However, the lower adoption of technological and organizational innovations highlights potential gaps in infrastructure or capacity that could be addressed to bolster overall competitiveness.

4.4.2 Quantitative Inferential Results and Discussion

Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed to examine the relationships among the core drivers of agricultural innovation, adhering to established guidelines for variance-based structural modeling (Hair et al., 2017; Sarstedt et al., 2020). The analysis focused on five key latent variables identified as the drivers—technology, networking, policy, institutions, and innovation—drawing on previous empirical and theoretical literature regarding innovation systems in agriculture (Lundvall, 2010; Spielman et al., 2011).

Additionally, two control factors—educational background and gender—were included to address possible socio-demographic influences on innovation engagement (Doss & Morris, 2001; Ragasa, 2012). The modeling process occurred in two phases based on data gathered from 160 participants within Ethiopia's agro-industrial sector. First, the measurement model was evaluated to confirm construct reliability and validity, employing composite reliability (CR), average variance extracted (AVE), and outer loadings (Hair et al., 2019). Second, the structural model was examined using bootstrapping methods to determine the significance and magnitude of the hypothesized paths among constructs. The measurement model's validity was evaluated using Average Variance Extracted (AVE), Composite Reliability (CR) and Cronbach's alpha are detailed in Table 17. All multi-item constructs met the recommended thresholds (AVE > 0.5, CR > 0.7, Cronbach's alpha > 0.7), confirming reliability and convergent validity (Hair et al., 2017). Single-item constructs (education and gender) achieved perfect scores (1.000) as control variables. Innovation reached an AVE of 0.563, a CR of 0.794, and a Cronbach's alpha of 0.711; institutions obtained scores of 0.530, 0.816, and 0.729, respectively. Networking recorded values of 0.543, 0.780, and 0.805; policy noted scores of 0.505, 0.753, and 0.705; and technology showed values of 0.575, 0.747, and 0.757.

Table 17. Summary of quality criteria.

Construct	AVE	CR	Cr-α
Education	1.000	1.000	1.000
Gender	1.000	1.000	1.000
Innovation	0.563	0.794	0.711
Institution	0.530	0.816	0.729
network	0.543	0.780	0.805
Policy	0.505	0.753	0.705
Technology	0.575	0.747	0.757
Threshold	0.500	0.700	0.700

Note: AVE = Average Variance Extracted; CR = Composite Reliability; Cr-α = Cronbach's alpha.

Table 18 below confirms the measurement model's robustness, with all multi-item constructs exceeding minimum validity thresholds. Innovation's AVE (0.563) and CR (0.794) indicate that its indicators (e.g., product and process innovation adoption) reliably capture the construct. At the same time, networking's high Cronbach's alpha (0.805) reflects strong internal consistency, likely due to the coherence of collaboration-related items (Hair et al., 2017). Policy's slightly lower AVE (0.505) is still acceptable, suggesting a diverse set of policy indicators (e.g., incentives, regulations) that collectively represent the construct.

Factor loadings for each indicator were assessed to ensure indicator reliability, with all loadings significant at $p < 0.01$, as shown in Table 16. Innovation indicators included Innv_2

(0.739), Innv_3 (0.740), and Innv_4 (0.770), reflecting aspects like new product development and process improvements, as also confirmed under the quantitative descriptive statistics of this session. Institutional indicators (inst_1 to inst_6) ranged from 0.535 to 0.748, with inst_4 (0.748) indicating strong representation of institutional support mechanisms (e.g., funding or training). Networking indicators (net_1 to net_3) ranged from 0.679 to 0.765, policy indicators (polcy_2, polcy_4, polcy_5) from 0.655 to 0.745, and technology indicators (tech_1 to tech_6) from 0.504 to 0.686. The lower

Loading for tech_1 (0.504) was retained due to its theoretical importance in representing basic technological adoption (Sami et al., 2021).

Table 18. Outer loadings (Mean, STDEV, T-values, p-values).

Measurement indicators	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T-Statistics (|O/STDEV|)	*p*-Values
Innv_2 <- Innovation	0.739	0.738	0.048	15.380	0.000 ***
innv_3 <- Innovation	0.740	0.737	0.051	14.569	0.000 ***
Innv_4 <- Innovation	0.770	0.769	0.045	17.140	0.000 ***
inst_1 <- Institution	0.545	0.546	0.062	8.720	0.000 ***
inst_2 <- Institution	0.535	0.529	0.084	6.401	0.000 ***
inst_3 <- institution	0.718	0.718	0.051	14.062	0.000 ***
inst_4 <- institution	0.748	0.749	0.051	14.679	0.000 ***
inst_5 <- institution	0.730	0.727	0.055	13.240	0.000 ***
inst_6 <- institution	0.624	0.622	0.076	8.169	0.000 ***
net_1 <- network	0.765	0.765	0.043	17.637	0.000 ***
net_2 <- network	0.763	0.764	0.042	17.978	0.000 ***
net_3 <- network	0.679	0.675	0.065	10.398	0.000 ***
polcy_2 <- Policy	0.745	0.744	0.052	14.226	0.000 ***
polcy_4 <- Policy	0.729	0.726	0.061	11.979	0.000 ***
polcy_5 <- Policy	0.655	0.653	0.071	9.280	0.000 ***
tech_1 <- Technology	0.504	0.485	0.183	2.756	0.006 ***
tech_2 <- Technology	0.626	0.606	0.152	4.113	0.000 ***
tech_4 <- Technology	0.685	0.677	0.092	7.480	0.000 ***
tech_5 <- Technology	0.686	0.676	0.113	6.082	0.000 ***
tech_6 <- Technology	0.536	0.526	0.138	3.893	0.000 ***

*** $p < 0.01$

Source: Author's calculation based on survey data (2024).

As shown in Table 18 above, the concept of innovation is most strongly represented by the indicator Innv_4, which has a standardized factor loading of 0.770. This suggests that this item effectively captures respondents' engagement with novel agricultural practices. Similarly, the constructs of institutional support and networking are well represented by inst_4 (loading = 0.748) and net_1 (loading = 0.765), respectively, emphasizing their conceptual alignment with key innovation drivers. In contrast, while conceptually important, technology shows a relatively weaker loading on tech_1 (0.504), indicating variability in technological uptake among respondents. However, given its statistically significant contribution to the model ($p = 0.006$), retaining this indicator is methodologically justified, consistent with the criteria outlined by Hair et al. (2019).

In Table 19 below, the structural model results further reveal significant positive effects of institutions ($\beta = 0.555$, $t = 0.067$, $p < 0.001$), networking ($\beta = 0.352$, $t = 4.438$, $p < 0.001$), and policy ($\beta = 0.209$, $t = 2.347$, $p = 0.019$) on the innovation construct. Notably, technology's direct influence on innovation was statistically non-significant ($\beta = 0.098$, $t = 1.223$, $p = 0.221$), suggesting that its impact may be mediated or dependent on enabling contexts. Institutions also significantly shaped networking ($\beta = 0.555$, $t = 8.334$, $p < 0.001$, $R^2 = 0.65$) and technology adoption ($\beta = 0.384$, $t = 2.895$, $p = 0.004$, $R^2 = 0.45$), while policy exerted a meaningful influence on technology ($\beta = 0.280$, $t = 2.914$, $p = 0.004$).

Regarding control variables, neither education ($\beta = 0.050$, $t = 1.899$, $p = 0.058$) nor gender ($\beta = -0.046$, $t = 0.699$, $p = 0.485$) showed statistically significant direct effects on innovation. However, education accounted for 50% of the variance in innovation ($R^2 = 0.50$), highlighting its contextual significance despite the lack of statistical strength. The effect size calculations revealed a medium effect for education ($f^2 = 0.25$) and a relatively strong impact of networking on innovation ($f^2 = 0.35$). Additionally, the predictive relevance ($Q^2 = 0.35$) of the innovation construct confirms the model's effectiveness for out-of-sample predictions, further enhancing its empirical validity (Hair et al., 2017; Henseler et al., 2015).

Table 19. Final results ((Path coefficients, Mean, STDEV, T-values, p-values, R^2, Effect Size (f^2), and (Q^2)).

Relationship	Original Sample (O) (β)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	*p*-Values	R^2	f^2	Q^2
Education -> Innovation	0.050	0.050	0.027	1.899	0.058 *	0.5	0.25	0.35
Gender -> Innovation	−0.046	−0.043	0.066	0.699	0.485*	NA	NA	NA
Institution -> Network	0.555	0.552	0.067	8.334	0.000 ***	0.65	0.45	0.45
Institution -> Technology	0.384	0.371	0.132	2.895	0.004 ***	0.45	0.35	0.4
Network -> Innovation	0.352	0.351	0.079	4.438	0.000 ***	0.55	0.35	0.4
Policy -> Innovation	0.209	0.209	0.089	2.347	0.019 **	0.40	0.20	0.30
Policy -> Technology	0.280	0.270	0.096	2.914	0.004 ***	NA	NA	NA
Technology -> Innovation	0.098	0.094	0.080	1.223	0.221	NA	NA	NA

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; N/A is used where these metrics do not apply.

Source: Author's calculation based on survey data (2024).

Table 20 below highlights networking as the strongest direct driver of innovation ($\beta = 0.352$, $f^2 = 0.35$), suggesting that collaboration among IAIP stakeholders such as farmers, processors, and researchers significantly boosts innovation adoption, as also claimed in Granstrand and Holgersson (2020). Institutions ($\beta = 0.555$, $f^2 = 0.45$) and policy ($\beta = 0.209$, $f^2 = 0.20$) again play substantial roles, with institutions fostering both networking ($\beta = 0.352$, $R^2 = 0.55$) and technology use [($\beta = 0.384$, $R^2 = 0.45$ as of Enaifoghe (2021)]. Technology's non-significant direct effect ($\beta = 0.098$, $p = 0.221$) indicates it may not independently drive innovation without institutional or policy support, consistent with Bessant (2003).

The moderate R^2 for innovation (0.50) suggests that while these factors explain half the variance, other unmodeled variables (e.g., market demand) may also contribute. The high Q^2 values (e.g., 0.40 for networking) confirm the model's predictive power beyond the sample (Ringle et al., 2020).

Correlation analysis was conducted to explore inter-construct relationships, with results presented in Table 20. Significant positive correlations were found between networking and innovation ($R^2 = 0.55$, $p < 0.01$); institutions and innovation ($R^2 = 0.55$, $p < 0.01$); policy and innovation ($R^2 = 0.40$, $p < 0.01$), while the correlation with technology was not valid.

Overall, the results strongly support Hypothesis H_3 [of the overarching hypothesis], particularly regarding institutional support, networking, and policy influence on innovation. However, the effect of technology was found to be statistically non-significant.

Table 20. Total direct effects ((Mean, STDEV, T-values, p-values, R^2, Effect Size (f^2), and (Q^2)).

Relationship	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	p-Values	R^2	f^2	Q^2
Education -> Innovation	0.050	0.050	0.027	1.899	0.058 *	0.50	0.25	0.35
Gender -> Innovation	−0.046	−0.043	0.066	0.699	0.485	NA	NA	NA
Institution -> Innovation	0.233	0.230	0.058	4.002	0.000 ***	0.55	0.30	0.40
Institution -> Network	0.555	0.552	0.067	8.334	0.000 ***	0.65	0.45	0.45
Institution -> Technology	0.384	0.371	0.132	2.895	0.004 ***	0.45	0.35	0.40
Network -> Innovation	0.352	0.351	0.079	4.438	0.000 ***	0.55	0.35	0.40
Policy -> Innovation	0.236	0.235	0.086	2.756	0.006 ***	0.40	0.20	0.30
Policy -> Technology	0.280	0.270	0.096	2.914	0.004 ***	NA	NA	NA
Technology -> Innovation	0.098	0.094	0.080	1.223	0.221	NA	NA	NA

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; N/A is used where these metrics do not apply.

Source: Author's calculation based on survey data (2024).

Indirect effects were analyzed, with institution → network → innovation showing a significant path ($\beta = 0.195$, $t = 3.770$, $p < 0.001$), while technology-mediated paths (e.g., policy → technology → innovation, $\beta = 0.027$, $p = 0.268$) were not significant, as shown in Table 21.

Table 21. Indirect Effects

Total	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	p-Values	R^2	f^2	Q^2
Institution -> Innovation	0.233	0.230	0.058	4.002	0.000 ***	0.55	0.30	0.40
Policy -> Innovation	0.027	0.026	0.025	1.107	0.268	NA	NA	NA
Specific								
Institution -> Network -> Innovation	0.195	0.194	0.052	3.770	0.000 ***	0.55	0.35	0.4
Policy -> Technology -> Innovation	0.027	0.026	0.025	1.107	0.268	NA	NA	NA
Institution -> Technology -> Innovation	0.038	0.036	0.034	1.107	0.268	NA	NA	NA

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; N/A is used where these metrics do not apply.

Source: Author's calculation based on survey data (2024).

Table 21 underscores networking's role as a mediator, amplifying institutional support's impact on innovation ($\beta = 0.195$, $p < 0.001$), consistent with the SIS framework's emphasis on systemic interactions (Edquist, 2011).

The non-significant technology-mediated paths suggest that technology serves more as a tool facilitated by institutions and policy rather than as a standalone driver, reinforcing Bessant's (2003) argument that technology's effectiveness depends on its ecosystem.

Model fit was assessed using multiple indices, as shown in Table 22. The following indices confirmed an excellent fit: SRMR = 0.035 (below 0.08), RMSEA = 0.058 (below 0.06), CFI = 0.975 (above 0.95), TLI = 0.973 (above 0.95), and NFI = 0.970 (above 0.90), meeting Hu and Bentler's (1999) criteria.

Table 22 confirms the structural model's robustness, with all fit indices surpassing stringent thresholds. This demonstrates that the model accurately represents the data and supports the reliability of the findings (Hair et al., 2017).

Table 22. Model Fit Indexes

Model Fit Index	Value
SRMR (Standardized Root Mean Square Residual)	0.035
RMSEA (Root Mean Square Error of Approximation	0.058
CFI (Comparative Fit Index)	0.975
TLI (Tucker-Lewis Index)	0.973
NFI (Normed Fit Index)	0.970

Source: Author's calculation based on survey data (2024).

Table 22 validates the structural model's robustness, with all fit indices exceeding stringent thresholds. This indicates that the model accurately represents the data and supports the reliability of the findings (Hair et al., 2017).

Hypothesis testing confirmed three of four hypotheses: H_1 (institutional support drives innovation, $\beta = 0.233$, $p < 0.001$), H_2 (networking drives innovation, $\beta = 0.352$, $p < 0.001$), and H_3 (policy drives innovation, $\beta = 0.209$, $p = 0.019$) were supported, while H_4 (technology drives innovation, $\beta = 0.098$, $p = 0.221$) was not. These results align with the SIS framework, which posits that innovation emerges from systemic interactions among institutions, policies, and networks rather than isolated technological inputs (Fagerberg, 2005). For Ethiopia's IAIPs to become engines of competitive agricultural transformation, policy and institutional investments must be accompanied by efforts to stimulate systemic actor engagement and contextualized technology integration.

4.4.3 Qualitative Insights

Qualitative data from Focus Group Discussions (FGDs) with 24 participants (12 from each IAIP) and Key Informant Interviews (KIIs) with 10 experts (5 from each IAIP) provided deeper context, identifying four key themes: innovation and sustainability, climate resilience, circular economy, and challenges and opportunities. Thematic analysis was conducted using NVivo software, coding responses into these categories to complement the quantitative findings.

Under innovation and sustainability, respondents linked innovation to sustainable practices like crop rotation and soil conservation, noting, "Rotating crops keeps the soil fertile and reduces costs" (FGD Participant 2, Bulbula). This aligns with the significant institutional effect ($\beta = 0.233$) and product innovation adoption (66.03%), reinforcing sustainability as an innovation driver (Tadesse, 2020). Climate resilience was evident in the adoption of climate-smart agriculture (CSA), with a respondent stating, "CSA helps us cope with erratic rains and droughts" (KII Respondent 1, Yirgalem), supporting the PLS-SEM findings by illustrating practical applications of innovation.

The circular economy theme highlighted waste management practices, such as "turning fruit peels into compost or biogas" (FGD Participant 5, Bulbula), reflecting a systemic approach to resource use that complements networking's role ($\beta = 0.352$) in fostering collaborative solutions (Belete & Assefa, 2015). Challenges and opportunities included barriers like high input costs (“Fertilizers and seeds are too expensive,” KII Respondent 3, Bulbula) and limited academic collaboration (“We need more research support, but universities are distant,” FGD Participant 7, Yirgalem), which may explain technology’s weak direct effect ($\beta = 0.098$). Opportunities involved government support (“Subsidies could lower costs,” KII Respondent 4, Yirgalem) and foreign-local partnerships (“Foreign firms bring tech we can adapt,” FGD Participant 9, Bulbula), aligning with policy’s influence ($\beta = 0.209$) and suggesting avenues to enhance technology’s impact (Girma, 2020).

The qualitative insights enrich the quantitative results, confirming that institutional support and networking evident in collaborative waste management and CSA adoption are key drivers, as per SIS (Edquist, 2011). The role of policy is reflected in calls for subsidies, while technology’s limited direct effect is contextualized by cost and collaboration barriers, supporting Bessant’s (2003) ecosystem perspective. The findings suggest that strengthening academic ties and reducing input costs could amplify innovation, leveraging the strong networking foundation identified in the PLS-SEM analysis.

Thus, this study’s empirical findings provide compelling evidence on the structural and contextual factors shaping agricultural innovation within Ethiopia’s Integrated Agro-Industrial Parks (IAIPs). Drawing on both quantitative and qualitative analyses, it is evident that innovation in these agro-industrial ecosystems is not driven solely by technological inputs but is instead embedded within broader institutional, policy, and networking frameworks. This aligns with the Sectoral Innovation System (SIS) framework, emphasizing that innovation outcomes emerge from interactions among actors, institutions, and contextual enablers (Edquist, 2011; Fagerberg, 2005).

From the quantitative analysis, product innovation emerged as the most widely adopted form (66.03%), highlighting the agro-industrial sector's focus on tangible outputs such as processed goods and enhanced crop varieties. Process innovations (38.46%) were also present to a moderate extent, while technological and organizational innovations lagged behind, indicating that systemic or strategic innovation processes remain underdeveloped. The relatively low uptake of technology (30.13%) and organizational restructuring (22.64%) may reflect structural constraints such as limited financial resources, insufficient technical capacity, or weak connections with research and academic institutions (Zanello et al., 2016; Bessant, 2003).

Structural Equation Modeling (SEM) revealed that institutional support ($\beta = 0.555$), networking ($\beta = 0.352$), and policy ($\beta = 0.209$) significantly and positively influence innovation. Interestingly, technology had no significant direct effect on innovation ($\beta = 0.098$, $p = 0.221$), reinforcing the notion that technology adoption relies on supportive institutional and policy environments (Bessant, 2003; Lundvall, 2010). The mediating role of networking in the institution–innovation pathway ($\beta = 0.195$, $p < 0.001$) underscores the importance of collaborative ecosystems where farmers, processors, and service providers co-create and diffuse innovative practices. These findings strengthen the SIS argument that innovation is a systemic phenomenon—deeply influenced by interactions among policy actors, institutional structures, and knowledge flows (Spielman et al., 2011; Granstrand & Holgersson, 2020).

From a policy perspective, these insights call for a recalibration of Ethiopia's innovation strategy within the IAIP framework. First, strengthening institutional infrastructures—through targeted capacity building, extension services, and access to finance—is imperative. Institutional effectiveness drives innovation directly and enables technology adoption and stakeholder networking. Second, enhancing policy coherence, particularly regarding subsidies, research incentives, and infrastructure, can facilitate the technological and collaborative aspects of innovation. As the data suggest, policy positively influences technology uptake ($\beta = 0.280$); however, this translation into innovation remains conditional.

Moreover, the weak impact of technology as an independent driver underscores the need for systemic policy support, particularly in addressing barriers such as high input costs and limited access to research outputs. As voiced in the qualitative findings, respondents called for increased academic collaboration, more substantial government subsidies, and support for foreign-local technology partnerships. These demands point toward a need for an integrated innovation policy framework that bridges academia, industry, and government, commonly referred to as the "triple helix" model (Etzkowitz & Leydesdorff, 2000).

For academia, this research opens critical avenues for further exploration. While institutional and networking factors appear pivotal, future research could explore the role of market dynamics, supply chain coordination, and environmental sustainability as complementary or moderating variables. In addition, integrating qualitative insights—such as circular economy practices and climate-smart agriculture—demonstrates the value of a mixed-methods approach in capturing the nuanced realities of innovation systems in agro-industrial settings.

In conclusion, under this sub-thematic study, innovation in Ethiopia's IAIPs is best understood as a multidimensional process shaped by institutional robustness, collaborative networks, and coherent policy frameworks rather than isolated technological investments. As such, both policymakers and academic researchers must embrace a holistic, systems-based view to nurture innovation ecosystems capable of driving inclusive and sustainable agro-industrial transformation.

4.5 Innovation, Product Differentiation, and Trade Policy

4.5.1 Quantitative (PLS-SEM)

4.5.1.1. Measurement Model Evaluation

In Partial Least Squares Structural Equation Modeling (PLS-SEM), the evaluation process begins by assessing the measurement (outer) model following established guidelines to ensure construct reliability, convergent validity, and discriminant validity (Hair et al., 2017; Hair et al., 2019). The first step involves examining the outer loadings of individual indicators. Indicators with low loadings are considered for removal to improve the model's overall fit and reliability.

In this study, most indicator loadings exceeded the recommended threshold of 0.70, indicating strong indicator reliability. The construct "innovation" was initially measured using six items. However, after estimating the initial path model, two items—product innovation (PRI) and innovation awareness (IA)—were excluded because their outer loadings fell below 0.50 (See Table 21 below). According to Hair et al. (2011) and Sarstedt et al. (2022), items with loadings below 0.40 (or in some cases, 0.50) should be eliminated to maintain the validity and reliability of the construct.Similarly, the "product differentiation" construct was initially operationalized through five sub-dimensions comprising several items. Following the model assessment, two items (PD2 and PD8) were retained based on their satisfactory loadings of 0.851 and 0.755, respectively, meeting the minimum indicator reliability criteria.

The construct "trade policy" was initially measured using five sub-dimensions. However, only one item—TPIS2 ("Trade agreements with foreign markets have effectively reduced barriers to international trade for IAIP-based firms")—was retained for further analysis. As such, the final measurement of the trade policy construct relied on this single indicator, following the removal of low-loading items to ensure construct validity and reliability, consistent with established PLS-SEM guidelines (Hair et al., 2017; Hair et al., 2019; Sarstedt et al., 2022). Although this simplification reduced the multidimensional representation of the construct, TPIS2 was retained due to its theoretical relevance and strong outer loading. Furthermore, qualitative findings reinforced its empirical importance, confirming the construct's significance within the broader research model.

Similarly, the construct "global competitiveness" was conceptualized initially through three sub-dimensions: export performance (EP1 and EP2), market positioning (MP1 and MP2), and integration into global value chains (GVC1 and GVC2). Based on the outer loading assessment, EP2 (representing export performance) and MP2 (representing market positioning) were retained for the final model, as the remaining items exhibited insufficient loadings and were removed to uphold construct reliability (Hair et al., 2017; Hair et al., 2019).

Moreover, the convergent validity is assessed through Average Variance Extracted (AVE) and Composite Reliability (CR) to confirm the reliability and validity of the construct. Adequate convergent validity is shown by an AVE of > 0.5, which guarantees that the construct accounts for at least 50% of the variance in its indicators(Hair et al., 2019; Henseler et al., 2015). It is calculated by dividing the number of indicators by the sum of squared outer loadings. The internal consistency of a construct's indicators is assessed by Composite Reliability (CR), which indicates reliability at a threshold of ≥ 0.7(Hair et al., 2011; Hult et al., 2017). Table 23 depicts the indicators retained for further analysis and reliability and validity results. Thus, as depicted in Table 23, CR for the construct innovation was 0.769, with an AVE of 0.559, which meets the thresholds of 0.5 and 0.7 for AVE and CR, respectively. The composite reliability value for the construct product differentiation was 0.785 with an AVE of 0.647, which again meets the thresholds for CR and AVE.

Table 23. Quality criteria for the outer model

Construct	Indicators	Outer loadings	CR	AVE
Innovation	IDS	0.790	0.769	0.559
	OI	0.601		
	PI	0.552		
	TI	0.738		
Product differentiation	PD2	0.851	0.785	0.647
	PD8	0.755		
Trade Policy	TPIS2	1.000		
Global Competitiveness	EP2	0.774	0.820	0.696
	MP2	0.891		

Source: Author's calculation based on survey data (2024).

Note(s): IDS=innovation diffusion strategies, OI=organizational innovation, PI=process innovation, TI=technological innovation, PD2=Quality differentiation(We use advanced production techniques to ensure consistent product quality), PD8= Cultural and Regional Relevance dimension(We incorporate local inputs or flavors to enhance the regional appeal of our products), TPIS2= The infrastructure for customs and border processing is efficient and supports timely exports, EP2= Export Performance, MP2=Market Positioning

The composite reliability and AVE for the construct of global competitiveness were 0.820 and 0.696, respectively. In conclusion, as shown in Table 23, the results indicate that after removing the indicators with low outer loadings, the constructs for Global Competitiveness, Innovation, and Product Differentiation meet the recommended thresholds for reliability and validity. We assessed the discriminant validity using HTMT ratios (Table 24 below) and the Fornell-Larcker criterion (Table 25 below).

Table 24. Heterotrait-Monotrait ratio (HTMT)

Constructs	HTMT Values
Innovation ↔ Global Competitiveness	0.247
Product Differentiation ↔ Global Competitiveness	0.351
Product Differentiation ↔ Innovation	0.509
Trade Policy ↔ Global Competitiveness	0.428
Trade Policy ↔ Innovation	0.241
Trade Policy ↔ Product Differentiation	0.404

Source: Author's calculation based on survey data (2024).

The acceptance value(thresholds) for the Fornell-Larcker criterion is that the square root of the AVE for each construct should be greater than the inter-construct correlations, and for HTMT, the values should be below the threshold of 0.85 (Fornell & Bookstein, 1982; Hair et al., 2019; Henseler et al., 2015).

Table 25. Fornell-Larcker Criterion

Construct	1	2	3	4
Global Competitiveness	*(0.834)*			
Innovation	0.500	*(0.677)*		
Product Differentiation	0.196	0.299	*(0.804)*	
Trade Policy	-0.329	0.209	0.246	*(1.000)*

Source: Author's calculation based on survey data (2024).

Note(s): The italicized figures refer to the square root of the average variance extracted (AVE) for each Construct

As can be seen in Table 25, the square root of the AVE for each construct (italicized figures shown in brackets) are greater than the inter-construct correlations (off-diagonal values), and the HTMT values for all constructs are below the threshold of 0.85, confirming discriminant validity between the constructs used in this study.

4.5.1.2. Structural Model

Once the measurement model was evaluated, our next step in PLS-SEM analysis was to evaluate the structural model(Henseler et al., 2015). In order to assess the structural model, path coefficients (β), effect size, and the statistical significance of direct and indirect effects were examined, emphasizing the study's hypothesized relationships. Figure 10 depicts the relationships between variables and the coefficients of determination (R^2) for endogenous latent variables. As indicated in Figure 10, the coefficients of determination(R^2) for endogenous latent variables ranged from moderate to substantial ones as suggested by Henseler et al.(2009). To evaluate the overall fit of the structural model, we utilized the Standardized Root Mean Square Residual (SRMR), a regularly reported index in PLS-SEM (Afthanorhan et al., 2016; Pavlov et al., 2021; Shi et al., 2018). The threshold for SRMR is generally considered acceptable if the value of SRMR for the estimated model is below 0.08 (Henseler et al., 2015; Hu & Bentler, 1999). In this study, the SRMR value for the estimated model was 0.069, which falls within an acceptable range, demonstrating a good match between the hypothesized model and the data (See Appendix III). This demonstrates that the model accurately captures the relationships between the constructs. The structural model results to evaluate both direct and mediated relationships between the constructs in the hypothesized model (path relationships) and their statistical significance are depicted in Table 26.

Table 26. Structural Model Results

Path	Path Coefficient(β)/Effect	t-value	P-value
Innovation →Product Differentiation	0.299	4.674	0.000***
Product Differentiation →Global Competitiveness	0.058	0.614	0.539
Trade Policy → Global Competitiveness	-0.318	4.887	0.000***
Innovation → Global Competitiveness	0.017	0.552	0.581
Control Variables →Global Competitiveness	0.175	0.878	0.380

*** $p < 0.01$

Source: Author's calculation based on survey data (2024).

As shown in Table 26 and Figure 10, innovation positively and significantly influences product differentiation ($\beta = 0.299$, $p < 0.001$), confirming hypothesis 1[14], which predicted that innovation positively and significantly affects product differentiation. Conversely, the path from product differentiation to global competitiveness ($\beta = 0.058$, $p = 0.539$) was insignificant.

In this case, hypothesis 2, which states that product differentiation positively and significantly affects global competitiveness, was not supported. This may indicate that, in this context, product differentiation strategies alone are not directly contributing to global competitiveness outcomes, possibly due to market conditions or limited product innovation. Similarly, trade policy significantly negatively affected the global competitiveness of IAIPs

[14] Hypothesis H1-H4: The sub-thematic study supplemented the overarching hypothesis H_4 of the dissertation, which states that Innovation (IN), product differentiation (PD), and trade policy frameworks (TP) exert a significant and positive impact on global market competitiveness (GMC) in Ethiopia's agro-industrial sector (Table 4). The rationality assumptions of this overarching hypothesis were drawn from the same table: 'Innovation and product differentiation are key strategic drivers of competitiveness, particularly when supported by coherent trade policies that facilitate international market access (Porter, 1990; UNIDO, 2019).

(β = -0.318, p = 0.000), suggesting that restrictive trade policies may hinder global competitiveness.

This supports Hypothesis 3, which states that trade policy significantly affects global competitiveness. The indirect effect of innovation on global competitiveness was minimal (β = 0.017, p = 0.581), indicating that the Innovation construct does not directly drive global competitiveness via product differentiation in this model. Thus, this model did not support hypothesis 4 of the sub-thematic study, which states that product differentiation mediates the relationship between innovation and global competitiveness.

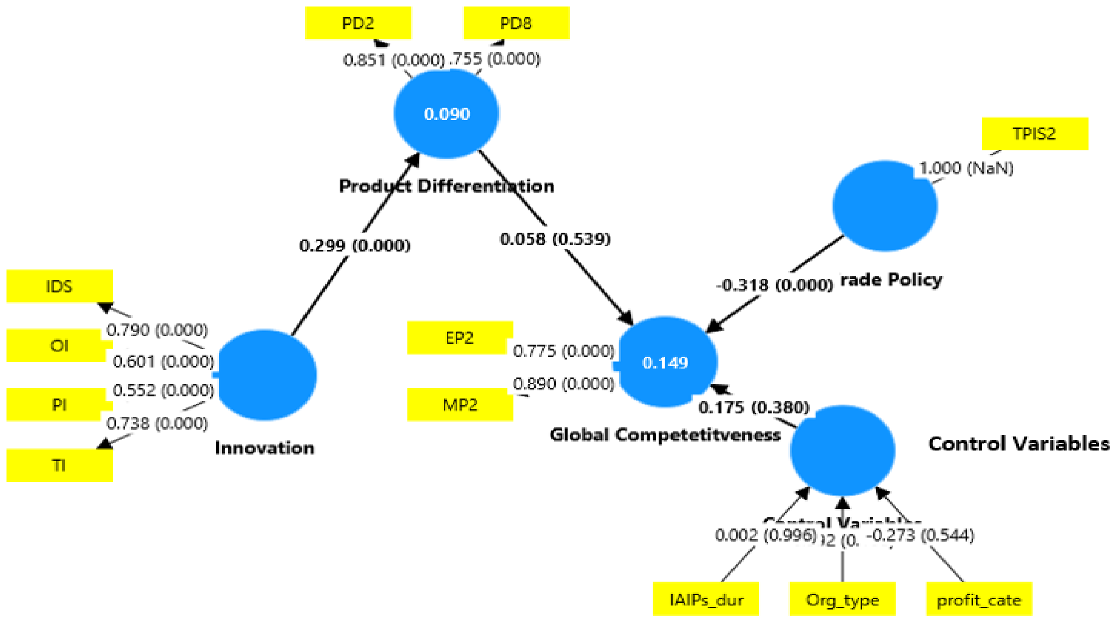


Figure 10. Structural model with path coefficients

Hence, the empirical results provide partial support for Hypothesis H_4 of the overarching hypothesis of the dissertation, as the synthesis of the sub-thematic hypothesis depicts that:

- The pathway from innovation to product differentiation is established, reinforcing the argument that innovation enhances a firm's ability to provide distinctive products.

- However, the data do not support the hypothesis that product differentiation directly contributes to global competitiveness. This may indicate that while firms innovate and differentiate, these efforts do not yet translate into substantial market gains without supporting institutional and market systems.
- The finding that trade policy negatively influences competitiveness challenges the assumed positive role of trade frameworks and highlights the need for policy reform. Instead of enabling international market access, current trade regulations may create barriers undermining firm-level performance in global markets.

These results align with emerging evidence that innovation must be embedded within enabling policy ecosystems and complemented by market intelligence, branding, and logistical capacity to yield competitiveness outcomes (Porter, 1990; UNIDO, 2019).

The partial confirmation of the overarching *Hypothesis* H_4 reveals critical insights for both theory and practice. While innovation fosters product differentiation, these advantages are insufficient for enhancing global market competitiveness in the current Ethiopian agro-industrial context. Moreover, restrictive trade policies in these IAIPs appear to act as bottlenecks rather than facilitators of global competitiveness.

A predictive relevance (Q^2 predict) statistic was used in this study to assess the model's out-of-sample predictive power. This statistic is useful in validating the robustness and applicability of the structural model in real-world scenarios (Ringle et al.,2020; Joseph et al., 2022). Hair & Alamer (2022) suggest that $Q^2 > 0$ indicates predictive relevance. In the current study, the Q^2 predictive analysis suggests that the model exhibits low but positive predictive relevance for most indicators, highlighting the need for additional predictors to enhance out-of-sample predictive accuracy. At the construct level, global competitiveness shows significant predictive relevance, supporting the utility of the PLS-SEM model for practical applications, as seen in Fig. 10.

4.5.2 Qualitative Results

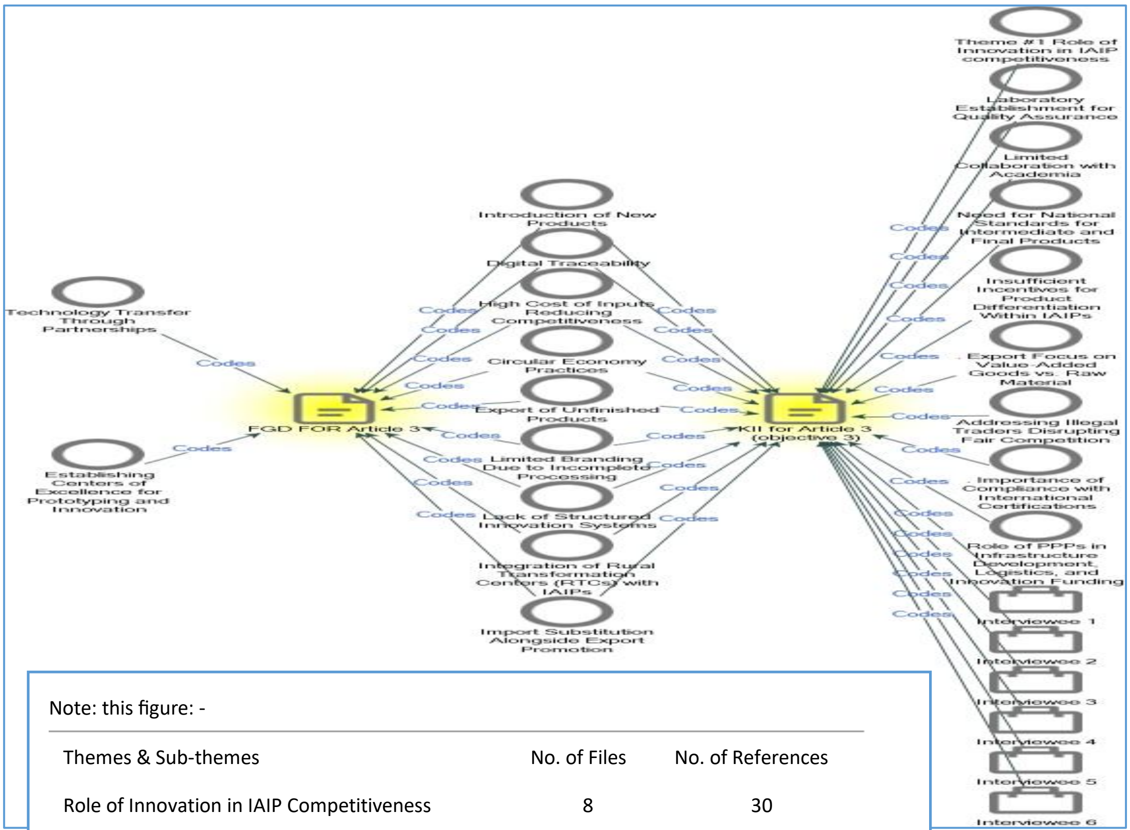
The qualitative findings obtained from the thematic analysis of key informants' interviews and focus group discussions were presented in this section. Three main themes were identified using deductive thematic analysis, including the role of innovation in the completeness of IAIPs, challenges in product differentiation, and the impact of trade policy frameworks. These themes were predetermined or identified deductively in this study to address the core research question: "How do innovations in agro-processing, product differentiation, and trade policy frameworks influence Ethiopia's competitiveness and integration into global value chains through IAIPs?" Using the software NVivo V.15, visualizations such as word clouds, project maps, and hierarchy charts were employed to explore the data and identify patterns. Table 27. depicts the identified themes and the number of files associated with them.

Table 27. List of Codes and No of References

Themes and Sub-themes	No. Files	No. of References
Theme #1 Role of Innovation in IAIP competitiveness		
Circular Economy Practices	2	3
Digital Traceability	2	5
High Cost of Inputs Reducing Competitiveness	2	2
Introduction of New Products	2	9
Laboratory Establishment for Quality Assurance	1	2
Limited Collaboration with Academia	1	1
Technology Transfer Through Partnerships	1	4
Theme #2 Challenges in product differentiation		
Establishing Centers of Excellence for Prototyping and Innovation	1	1
Export of Unfinished Products	2	2
Insufficient Incentives for Product Differentiation Within IAIPs	1	1
Integration of Rural Transformation Centers (RTCs) with IAIPs	2	2
Lack of Structured Innovation Systems	2	3

Themes and Sub-themes	No. Files	No. of References
Limited Branding Due to Incomplete Processing	2	2
Need for National Standards for Intermediate and Final Products	1	3
Theme #3 Impact of trade policy frameworks		
Export Focus on Value-Added Goods vs. Raw Material	1	3
Importance of Compliance with International Certifications	1	2
Addressing Illegal Traders Disrupting Fair Competition	1	2
Import Substitution Alongside Export Promotion	2	2
Role of PPPs in Infrastructure Development, Logistics, and Innovation Funding	1	3

Source: NVivo output based on the Qualitative data (2024)



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Themes & Sub-themes	No. of Files	No. of References
Role of Innovation in IAIP Competitiveness	8	30
Challenges in Product Differentiation	7	12
Impact of Trade Policy Frameworks	5	12

Figure 11. Project map illustrating the interconnections between them 1 and the sub-codes

4.5.2.1 Role of Innovation in IAIP Competitiveness

In order to make Ethiopia's Integrated Agro-Industrial Parks (IAIPs) more globally competitive, innovation is essential. IAIPs seek to revolutionize agricultural production and tackle major competitive issues through value-added processes, collaborative systems, and technology breakthroughs. Three subthemes form the framework of this theme: (1) innovation systems and strategies); (2) technology tools; and (3) Challenges to adopting innovations.

Innovation Systems and Strategies:

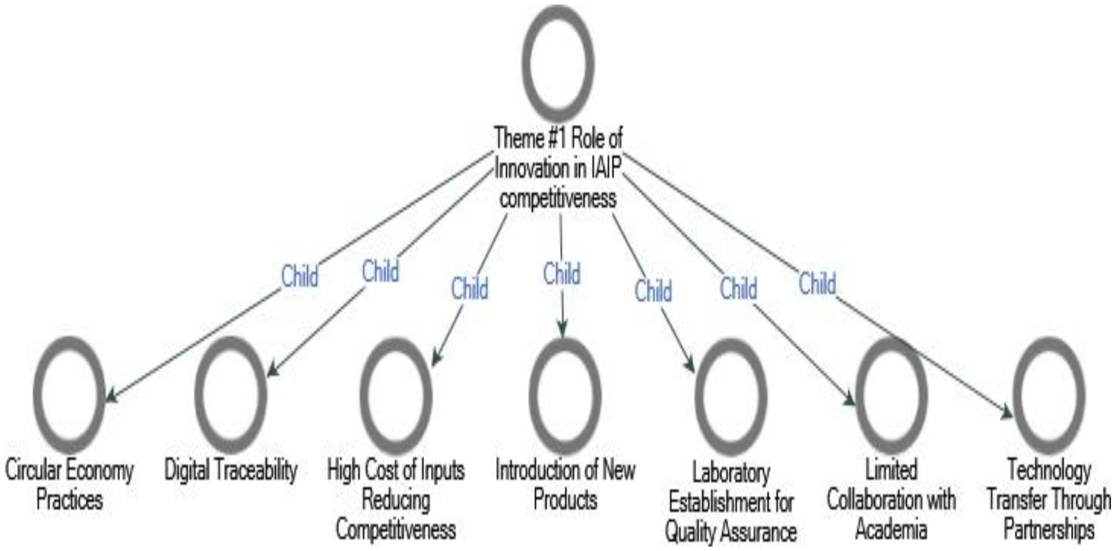

Figure 12. The Role of Innovation in IAIP's Competitiveness

IAIPs' innovation processes and strategies center on launching new products or goods, encouraging circular economy principles, and facilitating technology transfer via collaborations or partnerships.

i. Introduction of New Products

By introducing new agricultural goods into the production system, participants emphasized how successful IAIPs are at promoting product variety. For instance, according to one participant, soybean farming has increased in the Bure IAIP region:

> *"For example, in Bure, soybean is now entering the production system as farmers begin to cultivate and supply it to the park."* (Interviewee 6, KII)

There was another FGD participant who highlighted how integrated agro-industrial parks help innovative products enter local markets:

> *"Due to the IAIPs initiative, a new product (soybeans) was introduced in the region."* (Participant 3, FGD)

By encouraging value addition, integrated agro-industrial parks hope to change Ethiopia's reliance on exporting raw commodities beyond soybeans, as is the case in Bulbula IAIP. One respondent explained this change as follows:

> *"Agricultural products will now pass through the IAIPs for value addition before being exported."* (Interviewee 3, KII)

These results highlight integrated agro-industrial parks' ability to create value-added, globally competitive products and lessen reliance on raw exports.

ii. Circular Economy practices

Practices of the circular economy, which emphasize resource reuse and waste reduction, have been essential to integrated agro-industrial parks plans as explained by participant of FGD:

> *"The next task that has been on plan is the concept of circular economy, where the byproducts from those agro-processing industries become an input for bio-energy development and other products."* (Participant 3, FGD)

Another speaker went into further detail on sustainability programs, emphasizing endeavors to reach zero waste by stating as follows:

> *"The parks will focus on zero waste through initiatives like wastewater recycling and integrating byproducts into other production chains."* (Interviewee 4, KII)

Ethiopia can establish itself as a pioneer in sustainable agro-industrial production by implementing these techniques, which align with international sustainability standards.

iii. Technology Transfer via Partnerships

Cooperation between integrated agro-industrial parks (IAIPs) and local stakeholders, development partners, and research institutes can make technology transfer easier. The second participant of the FGD emphasized the significance of this procedure as:

> *"Technology transfer was considered, through the process, local investors will be created, which in turn avoid the problem of capital outflow and ensure sustainability."* (Participant 2, FGD)

As highlighted by the aforementioned participant, in order to promote ongoing innovation, rural transformation centers have been incorporated into IAIP networks:

> *"The integration of rural transformation centers with IAIPs creates a foundation for sustained technology transfer and innovation."* (Participant 2, FGD)

Moreover, another participant of the FGD strengthened the role of partnership in transferring the technology as follows:

> *Value chain actors, such as input providers and research centers, have developed improved seeds, which are key to innovation systems within integrated agro-industrial parks."* (Participant 1, FGD).

These partnerships help the integrated agro-industrial parks to become more competitive by resolving resource inefficiencies and increasing their ability to adopt new technologies.

4.5.2.2 Technological tools

Integrate agro-industrial parks' competitiveness is largely driven by the deployment of innovative technological solutions, such as quality assurance labs and digital traceability systems.

i Digital Traceability

A common topic among participants was the function of digital tools in guaranteeing supply chain transparency and adherence to international standards. One participant of the key informant’s interview clarified this as follows:

> *"Digital tools such as IoT-based quality monitoring systems and AI-driven market analysis can help companies differentiate their products while ensuring they meet global standards."* (Interviewee 7, KII).

As another interviewee highlighted, enhancing traceability has been made possible in large part by using blockchain technology:

> *"The adoption of digital agriculture tools like blockchain ensures supply chain transparency, enhancing competitiveness in global markets."* (Interviewee 7, KII).

The Integrated Agro-Industrial Parks of Ethiopia will be greatly impacted by the use of traceability systems, like Polygon API, which improve adherence to global standards, such as carbon credit tracking and organic certifications. By integrating smallholder farmers into formal supply chains, these solutions empower them, increase competitiveness through sustainability and transparency, and provide market access to high-value, environmentally concerned international markets. As one respondent from the private sector highlighted, “*Traceability systems have been implemented to map farmers and ensure compliance with* *international standards, such as carbon credit tracking. SunVado uses tools like PolygonApp and mobile technologies to ensure traceability of organic avocado oil." (Interviewee 1, KII).* The use of Polygon API tool by one of the private sectors (SunVado) in Yirgalem IAIP positions Ethiopia as a pioneer in using digital agriculture technologies to meet the international demand and sustainability aims, and can be a scalable model or example for other Integrated Agro-Industrial Parks found within a country and abroad.

ii. Laboratory Establishment for Quality assurance

As one respondent highlighted, "*Laboratories supported by international partnerships ensure that products meet national and international standards for export." (Interviewee 6, KII),* in order to guarantee that products meet international export standards, laboratories within IAIPs have become essential. By certifying eco=friendly products these facilities contribute to environmental sustainability as highlighted by another respondent:

> *"Laboratories play a significant role in certifying organic and environmentally friendly products for global markets."* (Interviewee 4, KII).

These facilities strengthen Ethiopia's standing as a trustworthy provider of sustainable, high-quality goods.

4.5.2.3 Challenges to Adopting Innovation

As the respondents highlighted, significant obstacles still exist in spite of advancements in innovation methods and technology adoption. The challenges include the high cost of inputs, which limits the competitiveness of the firms within IAIPs, and limited collaboration with academia.

i. High Cost of Inputs

One of the main challenges to competition that was mentioned by respondents a lot was input costs. For instance, a respondent from the private sector stated:

> *"Sourcing avocados at fair prices is difficult due to illegal traders and brokers, increasing input costs for IAIP processors."* (Interviewee 3, KII).

High input costs, exacerbated by the influence of unauthorized intermediaries, have emerged as a key constraint affecting the competitiveness of Ethiopia's Integrated Agro-Industrial Parks. The inability to procure raw materials affordably increases production expenses and undermines the competitiveness of processors in both local and international markets, as noted by a private sector respondent. An FGD participant also reinforced this view, saying:

> *"High production costs make it challenging to offer competitive prices in international markets."* (Participant 1, FGD).

ii. Limited Collaboration with Academic Institutions

One respondent emphasized the vital need for research and academic collaboration to solve sectoral shortages, pointing out that the limited engagement between academia and Integrated Agro-Industrial Parks poses a fundamental obstacle to encouraging innovation. *"One of the observed challenges is the limited academic engagement and collaboration. There is a significant need for research in this field; however, universities are not participating to the extent that was anticipated."* This lack of involvement limits the creation of innovative solutions and the sharing of information that could improve the operations of the Integrated Agro-Industrial Parks.

Another FGD participant stressed the significance of bridging the gap between Integrated Agro-Industrial Park actors and academia by stating, "*Collaboration with academia is essential to close knowledge gaps and foster innovation in production systems.*" To address the knowledge and resource limitations that the Ethiopian Integrated Agro-Industrial Parks face, it is imperative that academic-industry cooperation be strengthened. These partnerships can close the gap between research and practice by encouraging innovation, enhancing manufacturing methods, and creating context-specific solutions.

iii. Challenges in Product Differentiation

Strategic product differentiation is crucial for achieving global competitiveness in Ethiopia's Integrated Agro-Industrial Parks. However, challenges such as inadequate branding, the export of semi-processed goods, and disorganized innovation mechanisms hinder this goal. Additional barriers include gaps in institutional frameworks and the absence of standardized national guidelines and incentives. Nevertheless, participants noted that strengthening Rural Transformation Centers (RTCs) and establishing centers of excellence could provide opportunities to enhance product differentiation.

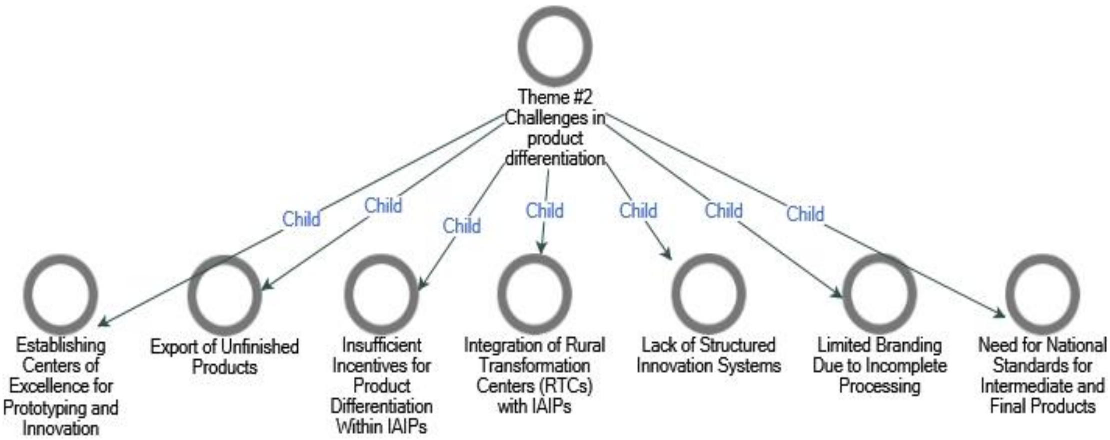

Figure 13. Project Map showing the interconnections b/n Theme 2 and its Sub-themes

4.5.2.4 Barriers to Differentiation of Product

Product diversification has been found to be significantly hampered by the practice of exporting incomplete goods. Participants emphasized Ethiopia's IAIPs' minimal value addition and primary commodities processing to crude forms. As an example, one respondent mentioned:-

> *"For instance, the processed avocado itself is exported to Europe in its crude stage, not refined. After reaching there, firms refine it and give the brand they want. The same applies for protein powder – unfinished one is exported, and foreign firms finish the processing and supply it to the market with varying appearance."* (Participant 1, FGD).

In addition to decreasing profitability, this practice hinders Ethiopia's potential to establish a reputation for producing branded, high-quality goods worldwide. As a respondent from a private agro-processing company clarified:

> *"As a manufacturer of crude avocado oil, our process yields only 5% oil, with the remaining 95% resulting in waste, which adds to the difficulty of maintaining profitability."* (Interviewee 3, KII).

4.5.2.4.1 Limited Branding Due to Incomplete Processing

Many others blamed the lack of branding opportunities for the inability to finish processing locally. One respondent underlined this as:

> *"Currently, the lack of refined and branded products from IAIPs means we miss out on premium market opportunities. Processed avocado oil and other*

products are exported in their unfinished form, and the final branding and marketing happen in other countries." (Interviewee 5, KII)

The ability to process information locally is inseparably linked to branding. As one respondent clarified it as:

> *"Branding comes after all the processes and when the product takes its final type. Because products like crude avocado oil are only semi-processed here, the opportunity for creating a branded, competitive Ethiopian product is missed."* (Participant 1, FGD).

4.5.2.4.2 Lack of Structured Innovation systems

The lack of organized innovation systems was a major obstacle to product differentiation as a respondent from development partners outlined, *"For instance, Bahir Dar University incubation and integration development center is developing numerous products, but only at the innovation stage, and only little has advanced to a company level. They lack a structured system and remain fund-based innovation systems, lacking sustainability."* This gap is exacerbated by the limited academic engagement as noted by another respondent:

> *"There is a significant need for research in this field; however, universities are not participating to the extent that was anticipated. This limits the structured development of innovations that could solve the differentiation challenges in IAIPs."* (Interviewee 2, KII).

4.5.2.4.3. Policy and Institutional Gaps

i. Need for National Standards

One of the main obstacles to attaining product differentiation was found to be the lack of comprehensive national standards, as pointed out by the respondent:

> *"While processed goods can access global markets by adhering to established standards, it is equally important to develop standards for intermediate inputs that cross borders in their raw form."* (Interviewee 5, KII).

To close this gap national initiatives are being made to create standards for new products as highlighted by a respondent from public sector, *"This year (2024), we requested national standards for 32 products, including crude avocado oil and egg yolk powder, among others."*

ii. Insufficient Incentives for Product Differentiation

The absence of financial and policy-driven incentives to support differentiation initiatives was another barrier to product differentiation as raised by the participants. One respondent highlighted:

> *"There are currently no strong financial or policy-driven incentives for firms to focus on differentiated products. Without this support, firms often take a minimal effort approach, limiting their capacity to compete in high-value markets."* (Participant 1, FGD).

Prolonged delays in investment decision-making processes impede progress in innovation and product diversification within Ethiopia's IAIPs. According to one respondent, prolonged time gaps between initial expressions of interest and actual investment decisions discourage firms from pursuing innovative ventures. This lag widens the gap between public and private sector goals and limits IAIPs from functioning as full-fledged centers of value-added production.

iii. Center of Excellence for Prototyping and Innovation

One promising way to deal with the difficulties of product differentiation, as outlined by participants of the FGD, is to establish centers of excellence. A participant explained this as:

> *"There is a new initiative at a planning stage – to realize centers of excellence at each Integrated Agro-Industrial Park center. This will ensure the availability of process instruments that can be used for prototype development."* (Participant 1, FGD).

Centers of excellence and innovation hubs within IAIPs are critical in providing the infrastructure required for enhanced product development processes. A respondent from the public sector noted their significance in supporting firms with prototype development, testing of innovative concepts, and capacity building. These facilities strengthen the IAIP innovation ecosystem by translating conceptual innovations into marketable products, fostering competitiveness in both domestic and export markets.

iv. Integration of RTCs with Integrated Agro-Industrial Parks

Integrating Rural Transformation Centers (RTCs) with IAIPs was emphasized as a strategic approach to enhancing input quality and local farmer productivity. As noted by one participant, locating RTCs within a 100 km radius of each IAIP aligns with a broader vision in which these centers may eventually evolve into full-fledged IAIPs.

> *Each rural RTC within a 100 km radius was integrated with each park, with the long-term aim that those RTCs would become IAIPs themselves.*

This integration plays a significant role in ensuring that raw materials supplied to Integrated Agro-Industrial Parks meet the required quality standards, as another respondent explained:

"Integration with rural transformation centers is crucial because it ensures that raw materials supplied to IAIPs are of the desired quality." (Interviewee 6, KII).

v. Impact of Trade Policy Frameworks

Trade policy frameworks play a critical role in shaping the competitiveness and global integration of Ethiopia's IAIPs. This section explores the alignment of trade regulations with goals such as import substitution, value-added exports, fair competition, and infrastructure support through public-private partnerships. Figure 14 presents a thematic map illustrating these relationships.

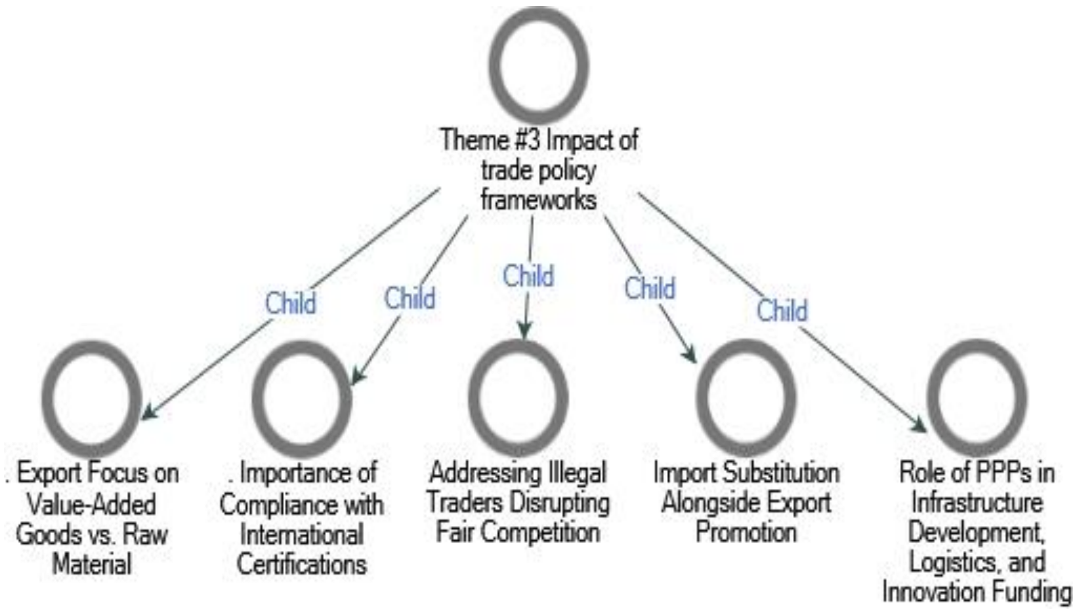

Figure 14. Project map illustrating the interconnection between Theme 3 and its sub-themes

4.5.2.5 Trade Policy Effectiveness

4.5.2.4.1 Export Focused on Value added Product Vs Raw materials

Ethiopia's trade strategies aim to transition from exporting unprocessed raw materials toward promoting the export of processed and value-added goods. IAIPs are envisioned as pivotal instruments in advancing this economic transformation, as emphasized by a public sector informant who said:

> *"IAIPs are believed to transform our economy from a long-standing agriculture-led economy to an industry-led economy. This transformation will significantly impact the country's export system, which has primarily relied on raw materials, by shifting towards processed and semi-processed commodities."*

Ethiopia can increase its export earnings and competitiveness in global markets by implementing such trade policies. One participant clarified how the explicit goal of industrialization policy is to encourage value addition in export commodities:

> *"The industrialization policy clearly aims to facilitate value addition for export commodities. The shift from raw product export to semi-processed or fully processed goods creates opportunities for increased export revenue and greater competitiveness in international markets."* (Interviewee 4, KII)

4.5.2.4.2 Import Substitution alongside Export

The trade policies of Ethiopia's prioritize import substitution to support domestic sectors in addition to export promotion as public sector respondent pointed out:

> *"Unlike previously implemented policies that primarily focused on export promotion, the new policy recognizes the importance of import substitution. By encouraging local production of goods that were traditionally imported, IAIPs are positioned to strengthen domestic industries while simultaneously promoting export-oriented value-added products."* (Interviewee 2, KII).

By encouraging local manufacturing, this dual strategy ensures that IAIPs not only help to lessen reliance on imports but also boost Ethiopia's competitiveness internationally by exporting value-added commodities. For example, the reliance on imported materials is reduced due to the development of packaging industries within the Integrated Agro-Industrial Parks, as participants of the FGD highlighted,

Through promoting domestic manufacturing, this dual strategy supports import substitution while strengthening Ethiopia’s export potential. For instance, IAIP-based packaging industries are helping reduce reliance on imports, as highlighted by a participant in the FGD:

"The development of packaging industries within IAIPs aims to replace imported packaging materials with locally produced alternatives, thereby reducing costs and enhancing competitiveness."

4.5.2.6 Regulation of Trade

4.5.2.6.1 Addressing Illegal Traders Disrupting Fair Competition

Multiple respondents stressed that illegal trading activities posed a significant challenge to fair competition within the Integrated Agro-Industrial Parks. The issues, including price instability caused by unregulated brokers and traders, especially for the fresh fruit market, adversely affected the firms within the park. Respondent from the private sector from Yirgalem IAIP shared:

> *"Our primary challenge lies in sourcing avocados at fair prices, largely due to the activities of illegal traders and brokers who dominate the fresh fruit market."* (Interviewee 3, KII).

The negative consequence of illegal traders is not only for private companies but also affects the farmers' income. Thus, stronger regulatory frameworks are necessary to ensure compliance and promote a level playing field, as respondents recommended:

> *"The government should take steps to regulate the market by addressing the issue of illegal traders and ensuring that all participants comply with tax obligations."* (Interviewee 1, KII).

4.5.2.6.2 Importance of Compliance with International Certifications

To access the high-value global markets, compliance with international standards, including ISO certifications and carbon crediting, is critical, as respondents highlighted:

> *"To integrate into the global market, compliance with international certifications like ISO and environmental policies is critical. For instance, we are working on achieving ISO certification and carbon credit compliance to ensure our products meet global environmental and safety standards."* (Interviewee 4, KII).

To meet these standards, traceability systems such as those implemented by SunVado (a private company within Yirgalem IAIP) were highlighted as relevant tools:

> *"SunVado focuses heavily on traceability systems to meet international standards. For example, we have implemented digital mapping of farmers to comply with carbon credit requirements."* (Interviewee 1, KII).

4.5.2.6.3 The role of PPPs in infrastructure development, Innovation finding, and Logistics

Public-private partnerships (PPPs) are pivotal in bridging infrastructure and financing gaps within Integrated Agro-Industrial Parks. Respondents emphasized the importance of clearly defining stakeholder responsibilities and promoting collaborative arrangements to attract and sustain investment by stating: -

> *"Improving public-private partnerships (PPPs) is essential in this context. Clearly defining the roles and responsibilities of each stakeholder will ensure that all parties meet their obligations and promote investments in infrastructure, technology, and logistics to enhance competitiveness."*

Respondents mentioned the establishment of laboratories for quality assurance in IAIPs as exemplary, successful Public-Private initiatives:

> *"Partnerships with development partners and international organizations are helping IAIPs build laboratories, logistics systems, and quality assurance frameworks."* (Interviewee 6, KII)

The public-private partnership driven investments also support funding for innovative activities which enables firms to adopt new technologies and build capacity, which has a positive implication on global competitiveness. This sentiment was highlighted by one participant of FGD as:

> *"Public-private partnerships are key for innovation funding. With proper collaboration, IAIPs can attract investment from anchor firms and development partners who fund technological upgrades, R&D, and capacity building."* (Participant 2, FGD).

Hence, this study underscores the pivotal role of innovation, product differentiation, and trade policy in shaping Ethiopia's global competitiveness and integration into global value chains (GVCs) through Integrated Agro-Industrial Parks (IAIPs). By combining Partial Least Squares Structural Equation Modeling (PLS-SEM) and qualitative insights, the findings highlight the intricate interdependencies among these factors, offering critical direction for policymakers, academia, and private sector actors (Hair et al., 2019; Creswell & Poth, 2018).

Quantitative analysis validated innovation as a significant driver of product differentiation, affirming the foundational link between technological advancement and value addition (Hair et al., 2017). However, the lack of a significant relationship between product differentiation and global competitiveness suggests that value addition alone does not guarantee export performance without supporting institutional and infrastructural systems (Porter, 1990; Dinh et al., 2012). Furthermore, trade policy was found to negatively affect competitiveness, indicating regulatory frictions and policy misalignments that hinder market integration (UNCTAD, 2020).

The qualitative findings added depth by exposing systemic constraints within IAIPs. The continued export of semi-processed products, such as crude avocado oil and protein powder, prevents Ethiopia from capturing high-value markets and building a global brand identity (Gebreeyesus & Sonobe, 2012). Fragmented innovation systems, often reliant on donor funding and lacking structured institutional support, impede the development and commercialization of new products (Spielman et al., 2011). Additionally, minimal academic involvement stifles knowledge exchange and applied research tailored to local agro-processing challenges.

Institutional inefficiencies further inhibit product differentiation. The lack of enforceable national standards for emerging products and the absence of investment incentives limits the capacity of IAIPs to become competitive production nodes within global markets (World Bank, 2020). Despite national policy narratives promoting industrial transformation, execution remains inconsistent and under-resourced (UNIDO, 2019).

However, opportunities for transformation are evident. The creation of Centers of Excellence within IAIPs—designed to support prototyping, product testing, and collaborative research—represents a strategic avenue for fostering innovation (MoTI, 2023). When effectively linked with academic and industry actors, these centers can drive the development of differentiated, high-quality products aligned with global market demands (OECD, 2021). Similarly, integrating Rural Transformation Centers (RTCs) within the IAIP ecosystem improves input quality and supports localized innovation capacity (ATA, 2020).

Trade policy[15] must evolve from passive export orientation to proactive facilitation of competitiveness through enforceable standards, digital traceability, and certification schemes. For example, compliance with ISO and carbon credit frameworks is increasingly vital for access to premium markets (FAO, 2021). Firms like SunVado demonstrate that blockchain-enabled traceability can enhance Ethiopia's alignment with global sustainability protocols and buyer requirements (SunVado, 2023).

Public-private partnerships (PPPs) remain indispensable for addressing infrastructure, financing, and technological upgrading gaps. Delineated stakeholder responsibilities in PPPs

15 Trade policy: in this study context refers to Export Focused on Value added Product Vs Raw materials processing facilitation in Ethiopian IAIPs.

are necessary to ensure sustained innovation, operational efficiency, and investment attraction (Rodrik, 2008; World Economic Forum, 2019).

For academia, this study underscores the imperative of repositioning universities as integral contributors to industrial ecosystems. Strengthening the research-practice interface through co-designed curricula, industry-led research, and innovation hubs is essential for building the human capital and knowledge infrastructure required for global competitiveness.

In conclusion, this sub-thematic study contends that improving Ethiopia's agro-industrial competitiveness via IAIPs necessitates a coordinated approach: institutionalizing innovation systems, offering structural assistance for product differentiation, and aligning trade policies with competitiveness goals. By fostering cohesive multi-stakeholder engagement, IAIPs have the potential to transform into pivotal centers within Ethiopia's global value chains.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study evaluated the role of Sectoral Innovation Systems (SIS) in enhancing Ethiopia's agro-industrial competitiveness and integration into global value chains (GVCs), specifically focusing on the performance and institutional dynamics of Integrated Agro-Industrial Parks (IAIPs). Utilizing a mixed-methods approach, including Partial Least Squares Structural Equation Modeling (PLS-SEM) for the analysis of survey data and thematic analysis based on data from Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs), the study provided empirical and conceptual insights into how innovation, governance, and trade policy interact within emerging agro-industrial ecosystems.

In line with the first objective, the study analyzed governance and institutional frameworks within Ethiopia's IAIPs, finding that fragmented institutional coordination, regulatory inconsistencies, and limited academia–industry partnerships significantly constrain innovation ecosystems. Weak governance undermines the effective functioning of IAIPs and hinders their potential to serve as competitive platforms in GVCs.

The research for the second objective indicates that sustainability, innovation, and market integration are interconnected through reinforcing mechanisms. Nevertheless, the existing implementation of IAIPs does not align these dimensions with global standards. Issues like inadequate traceability systems, insufficient enforcement of sustainability protocols, and restricted access to premium markets obstruct the parks' roles in promoting inclusive and sustainable agro-industrial development.

Regarding the third objective, the study has identified several key drivers of agricultural innovation, particularly the roles of digital technologies, institutional support mechanisms, and localized Centers of Excellence. These elements are essential for enhancing technological capability, strengthening rural–urban value chains, and promoting context-specific innovations. However, the diffusion of such innovations remains uneven due to infrastructure gaps and inadequate policy incentives.

Aligned with the fourth objective, the study examined the relationship between innovation, product differentiation, and trade policy. While innovation significantly influenced product differentiation, the latter did not translate into enhanced global competitiveness without enabling infrastructure, quality assurance mechanisms, and favorable trade policies. The current trade policy framework—characterized by regulatory rigidity, poor standard enforcement, and lack of export support—was identified as a binding constraint on Ethiopia's agro-industrial upgrading efforts.

Theoretically, this research contributes to the SIS literature by illustrating the importance of governance quality and policy coherence as mediating variables in low-income, agrarian-industrial transitions. It extends the framework by emphasizing that innovation system performance is contingent not only on actor networks and knowledge flows but also on institutional alignment and regulatory support.

In conclusion, while Ethiopia's IAIPs demonstrate latent potential to drive structural and inclusive transformation, unlocking this potential requires shifting from fragmented, project-based initiatives to coherent, system-wide innovation strategies. Robust governance reforms, increased private-sector engagement, and stronger linkages among research, industry, and government must support these efforts. Restructuring trade policy to enhance competitiveness is essential for positioning IAIPs as dynamic nodes in global agro-industrial value chains. This study provides an integrated foundation for policy design, institutional reform, and further research into innovation-driven development in similar emerging contexts.

Indeed, this dissertation fulfills its established objectives and provides novel conceptual and theoretical insights into agro-industrial innovation systems and global value chain (GVC) integration, particularly in low-income countries. By recognizing the complex and systemic nature of agro-industrial competitiveness, the study proposes five interrelated analytical frameworks that enhance existing theoretical models and offer practical guidance for future research, data-informed policymaking, and real-world applications, as delineated below.

1) Agro-Innovation Constellation Model (AICM): This study introduces the Agro-Innovation Constellation Model (AICM) as a conceptual framework to address the systemic fragmentation characterizing Ethiopia's agro-industrial landscape. AICM integrates five critical components—sectoral innovation systems (SIS), global value chain (GVC) governance, trade policy, sustainability, and local institutional capabilities such as rural transformation centers and cooperatives—into a unified system. By emphasizing institutional alignment, actor coordination, and capability-building, AICM provides a holistic approach to understanding and operationalizing innovation-driven agro-industrial upgrading.
2) Business Innovation Clinic Framework for IAIPs: This dissertation envisions the Business Innovation Clinic as a proactive platform inspired by health systems and enterprise support models, which is integrated into Integrated Agro-Industrial Parks (IAIPs). As a co-innovation hub, it provides customized advisory services—including business diagnostics, marketing, technology adoption, certification, and financial readiness—to SMEs, cooperatives, and start-ups. Jointly managed by academic institutions, government entities, and private-sector partners, these clinics facilitate real-time feedback that fosters continuous learning and adaptive policy design within IAIPs.
3) Integrated Agro-Innovation Readiness Index (IAIRI): This research proposes the Integrated Agro-Innovation Readiness Index (IAIRI) to assess the systemic preparedness of IAIPs for global competitiveness. This multidimensional index evaluates IAIP performance across five pillars: institutional coordination, innovation infrastructure, value chain integration, sustainability practices, and GVC

compliance. The IAIRI serves as a diagnostic tool and a policy instrument, guiding investment decisions, performance monitoring, and reform prioritization in Ethiopia and similar emerging economies.

4) Innovation–Regulatory Coherence as a Missing Link: While innovation is frequently assessed in terms of technology and the spread of knowledge, this study highlights regulatory coherence as a significant yet often overlooked factor affecting innovation results. The proposed construct of innovation–regulatory coherence stresses the need for a coordinated alignment between innovation policy and the regulations that support trade, quality, and sustainability. Without this alignment, even the most promising innovations struggle to achieve meaningful competitive advantages or enable access to global markets.

5) Triple-Helix + PPP Governance Nexus: This research expands on the traditional Triple-Helix model, which focuses on collaboration between universities, industry, and government, by introducing a hybrid governance model. This new model integrates Public–Private Partnerships (PPPs) and subnational institutional actors, such as cooperatives and regional governments. The Triple-Helix + PPP Nexus highlights the governance complexities within Ethiopia's federal system and seeks to promote distributed leadership, context-sensitive innovation, and collaborative industrial policymaking in IAIPs.

The five conceptual contributions collectively highlight a crucial transition: shifting from fragmented, project-based agro-industrial interventions to a cohesive, system-oriented innovation policy framework. Each suggested model aids in creating a comprehensive analytical framework that can guide the development of innovation policies, institutional reform initiatives, and strategic investment plans. This study establishes a flexible knowledge foundation by synthesizing insights from Sectoral Innovation Systems (SIS) theory, global value chain (GVC) governance, sustainability challenges, and advancements in innovation infrastructure, grounding this in empirical research from Ethiopia. It provides actionable insights for other low- and middle-income nations seeking agro-industrial transformation and enhanced global competitiveness in an increasingly complex, innovation-driven global market.

5.2 Recommendations

1) Policy-Level Recommendations

- Institutionalize the Agro-Innovation Constellation Model (AICM) at the national level to coordinate innovation, trade policy[16] Sustainability practice targets[17]and institutional capacity-building across agro-industrial strategies.
- Establish the Integrated Agro-Innovation Readiness Index (IAIRI) as a comprehensive tool for diagnosing and monitoring the performance of IAIPs and RTCs. The IAIRI must assess spatial, institutional, and operational readiness alongside the developmental effect of agro-industrial systems in various regions. This index will guide evidence-based investment decisions by generating comparative benchmarks, enhancing coordination among institutions, and promoting continuous policy learning and accountability within the rural transformation framework.
- Strengthen innovation–regulatory coherence by aligning innovation policy with trade, certification, and quality infrastructure systems. Regulatory reform should

[16] Trade Policy: Redesign trade policies to support competitiveness by enforcing international standards (e.g., ISO, Codex), enabling digital traceability, and prioritizing high-value, export-ready agro-products in exceptional cases for the country's integrated agro-industrial parks.

[17] Sustainability practices: Introduce policy incentives for sustainable practices such as renewable energy, water-efficient technologies, and circular economy models within IAIPs.

prioritize export readiness, traceability[18], and market access for high-value agro-industrial products.

2) Agro-Industrial Stakeholder Actions

- Implement Business Innovation Clinics in each IAIP to offer real-time diagnostics, innovation advisory services, certification support, and SME upgrading. These clinics should act as collaborative platforms managed by park authorities, industry stakeholders, and service providers.
- Develop Centers of Excellence and RTCs: Invest in infrastructure and capacity building for product testing, incubation, and research within IAIPs and RTCs, facilitating rural innovation and value chain integration.
- Promote Branding and Market Access: Create national branding initiatives and invest in logistics, certification, and packaging systems that meet international standards.
- Strengthen Supply Chains: Encourage cooperative procurement models and input price stabilization mechanisms to reduce cost barriers and improve input quality.

3) Academic and Research Community

- Adopt a Triple-Helix + PPP governance framework to formalize collaboration among universities, private firms, government agencies, and local institutional actors (e.g., RTCs, cooperatives). This participatory governance model should guide curriculum development, technology transfer, and IAIP policy experimentation.

[18] Develop digital governance platforms and clarify institutional mandates to foster accountability and adaptive decision-making. Strengthen multi-stakeholder coordination across the public and private sectors.

- Forge Academia–Industry Linkages**:** Co-develop curricula, conduct applied research, and embed innovation labs within IAIPs to improve the practical relevance of academic output.
- Establish Innovation Hubs: Establish university-based research hubs focusing on traceability, sustainability, food safety, and technology transfer.
- Encourage Knowledge Co-Production: Promote student-industry projects, fellowships, and joint ventures that align academic research with real-world agro-industrial challenges.

4) Future Research Directions

- Longitudinal Impact Studies: Conduct time-series evaluations to assess the long-term effects of IAIP initiatives on competitiveness, sustainability, and inclusivity.
- Explore Digital Agriculture: Study the adoption and impact of digital tools such as precision farming, IoT sensors, and blockchain traceability on value chain efficiency.
- Consumer Perception Studies: Analyze international consumer attitudes toward Ethiopian agro-products to refine differentiation and branding strategies.
- Governance Innovation Models: Investigate experimental policy approaches (e.g., regulatory sandboxes) to test governance models in different regional and institutional contexts.

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7. APPENDICES

I: Data Collection Tools

A. DATA COLLECTION TOOLS FOR STAKEHOLDERS (FARMER, PUBLIC, FARMS, RESEARCH) HEEDS DATA.

PART I: SURVEY QUESTIONNAIRE

CODE (To be filled by researcher): ______________IAIP Name: ________________________

Introduction

Dear Respondents,

Thank you for taking the time to participate in this questionnaire. This survey is part of a PhD Dissertation titled as *"Enhancing Ethiopia's Agro-Industrial Competitiveness: The Role of Sectoral Innovation Systems and Integrated Agro-Industrial Parks in Global Value Chain Integration"* ***by Mr. Efa Muleta Boru***.

The general objective of this study is to assess the role of sectoral innovation systems (SIS) on Ethiopia's agro-industrial competitiveness, focusing on exploring how these systems promote the country's integration into global value chains through integrated agro-industrial parks. And specifically, 1. To analyze the governance and institutional frameworks in Ethiopian IAIPs, focusing on enhancing innovation ecosystems and facilitating multi-stakeholder coordination to improve global market competitiveness; 2. To identify and analyze the key drivers of agricultural innovation within Ethiopia's Integrated Agro-Industrial Parks 3. To assess the impact of Innovation, Product Differentiation, and Trade Policy on Ethiopia's Agro-Industrial Competitiveness and Global Value Chain Integration through IAIPs; and 4. To examine the interlinkages between sustainability, innovation, market integration, and global value chain governance in Ethiopia's Agro-Industrial Parks.

Thus, your participation is vital in better understanding the institutional and governance frameworks that enhance Ethiopia's agro-industrial competitiveness. The survey has five main sessions as below *[General Demographic Information; Governance and Institutional Frameworks; Drivers of Agricultural Innovation in Ethiopia's IAIPs; Sustainability, Innovation, and Global Market Integration of Ethiopia IAIPs; and Innovation, Product Differentiation, and Trade Policy in Ethiopia's IAIPs]* should take approximately 50 minutes to complete. All responses will remain confidential and are only for academic research purposes.

Thank you for your cooperation and contribution to this important research!

General Instructions: Please mark your answer by ticking the appropriate choice and feel free to share your thoughts in the blank spaces provided**.**

Section I: Demographic Information (3 Questions)

1. Type of Stakeholder:
   - Farmer
   - Public Sector (Government)
   - Firm/Agro-Processor
   - Non-Public (NGOs, etc.)
   - Research/Academia
2. Years of Experience in the Agro-Industrial Sector:
   - 0-5 years
   - 6-10 years
   - 11-15 years
   - 16+ years
3. Role in the Agro-Industrial Sector:
   - Management
   - Research
   - Policy Maker
   - Operational/Field Work

✓ *Please rate the following statements of [II-V] tables based on your experience and knowledge, using the scale below:*

1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

II. Governance and Institutional Frameworks in Ethiopia's IAIPs

Table: Survey Questionnaire for the Analysis of Governance and Institutional Frameworks in Ethiopia's IAIPs

Construct	*Code*	*Statements (Survey Questions)*	*1*	*2*	*3*	*4*	*5*
Institutional Framework (IF)	IF1	The Ethiopian government provides adequate financial support for innovation in Integrated Agro-Industrial Parks (IAIPs).	☐	☐	☐	☐	☐
	IF2	The cost of technology in IAIPs is manageable for most firms/agro-processors.	☐	☐	☐	☐	☐

Construct	*Code*	*Statements (Survey Questions)*	*1*	*2*	*3*	*4*	*5*
	IF3	There is sufficient access to skilled labor within the IAIPs to meet the needs of agro-industrial enterprises.	☐	☐	☐	☐	☐
	IF4	The infrastructure within IAIPs is well-developed and accessible to all stakeholders.	☐	☐	☐	☐	☐
	IF5	Supportive government policies are in place to encourage innovation in IAIPs.	☐	☐	☐	☐	☐
	IF6	There is a favorable environment for the acceptance and adoption of new technologies within IAIPs.	☐	☐	☐	☐	☐
Section 2: Innovation Ecosystem (IE)	IE7	Research and Development (R&D) facilities are easily accessible within or near IAIPs.	☐	☐	☐	☐	☐
	IE8	There are sufficient collaborations between universities and firms/agro-processors to support innovation in IAIPs.	☐	☐	☐	☐	☐
	EI9	Firms within IAIPs are actively involved in process innovation (e.g., improving production methods).	☐	☐	☐	☐	☐
	EI10	10.Technology innovation is a priority for firms within IAIPs.	☐	☐	☐	☐	☐
	EI11	Innovation diffusion strategies are in place to ensure the rapid spread of new technologies across the agro-industrial sector.	☐	☐	☐	☐	☐
	EI12	Partnerships with other organizations, such as research institutions or private firms, are common in IAIPs.	☐	☐	☐	☐	☐
Section 3: Stakeholder Coordination (SC)	SC13	Effective public-private partnerships (PPPs) are in place to foster innovation and industrial development within IAIPs.	☐	☐	☐	☐	☐
	SC14	There are regular platforms for multi-stakeholder engagement to discuss issues and solutions related to agro-industrial growth.	☐	☐	☐	☐	☐
	SC15	Stakeholder collaboration is actively encouraged in designing and implementing innovation policies in IAIPs.	☐	☐	☐	☐	☐

Construct	*Code*	*Statements (Survey Questions)*	*1*	*2*	*3*	*4*	*5*
	SC16	Government agencies work closely with private firms to develop policies that enhance innovation in IAIPs.	☐	☐	☐	☐	☐
	SC17	The coordination between stakeholders (public, private, non-public) is efficient in achieving shared goals for agro-industrial competitiveness.	☐	☐	☐	☐	☐
Section 4: Global Competitiveness (GC)	GC18	Ethiopia's agro-industrial products are competitive in global markets.	☐	☐	☐	☐	☐
	GC19	The level of international competition faced by firms in IAIPs is increasing.	☐	☐	☐	☐	☐
	GC20	The percentage of agro-industrial products from IAIPs exported to international markets is growing.	☐	☐	☐	☐	☐
	GC21	The quality of products from IAIPs is consistently improving.	☐	☐	☐	☐	☐
	GC22	The productivity of firms/agro-processors within IAIPs has increased in recent years.	☐	☐	☐	☐	☐
	GC23	Ethiopia's agro-industrial policies support firms in IAIPs to compete in international markets.	☐	☐	☐	☐	☐
Section 5: Exogenous Variables (OE)	OE24	There is adequate support from international trade policies to facilitate the integration of Ethiopian IAIPs into global value chains.	☐	☐	☐	☐	☐
	OE25	Market integration (local and regional) is increasing within Ethiopia's agro-industrial sector.	☐	☐	☐	☐	☐
	OE26	Sustainability practices (e.g., environmental, social) are being adopted by firms in IAIPs to improve competitiveness.	☐	☐	☐	☐	☐
	OE27	The role of innovation in product differentiation is significant in enhancing Ethiopia's global market position.	☐	☐	☐	☐	☐
	OE28	Trade policy reforms have positively impacted the growth of firms within IAIPs.	☐	☐	☐	☐	☐
Note:	You can adda any text information additionally under each statement if need be						

III. Sustainability, Innovation, and Global Market Integration of Ethiopia IAIPs

Construct	*Code*	*Statements (Survey Questions)*	*1*	*2*	*3*	*4*	*5*
Sustainability Practices (SP)	SP29	Our IAIP applies crop rotation and soil health improvement techniques.	□	□	□	□	□
	SP30	Climate-smart agricultural techniques are actively implemented in our IAIP.	□	□	□	□	□
	SP31	We manage water resources efficiently to ensure long-term sustainability.	□	□	□	□	□
	SP32	Sustainable farming methods are standard in our production operations.	□	□	□	□	□
	SP33	Soil conservation practices are enforced consistently across the IAIP.	□	□	□	□	□
	SP36	Our IAIP has adopted renewable energy sources for production and processing.	□	□	□	□	□
Innovation (IN)	IN37	New or improved agricultural products (e.g., seeds, processed foods) have been developed recently.	□	□	□	□	□
	IN38	We continuously enhance production through new or upgraded processes.	□	□	□	□	□
	IN39	Digital and precision agriculture technologies are widely utilized.	□	□	□	□	□
	IN40	We have implemented organizational or managerial innovations to improve operations.	□	□	□	□	□
	IN41	Innovation hubs and collaborative R&D centers are operational within or around our IAIP.	□	□	□	□	□
	IN42	Staff and stakeholders are aware of innovation trends and practices.	□	□	□	□	□
Market Integration (MK)	MI43	Government or institutional support mechanisms for market integration are available and effective.	□	□	□	□	□
	MI44	Our IAIP actively transacts with regional and international buyers.	□	□	□	□	□
	MI45	The existing market channels efficiently link producers to target markets.	□	□	□	□	□

Construct	*Code*	*Statements (Survey Questions)*	*1*	*2*	*3*	*4*	*5*
	MI46	Our products are competitive in global markets based on quality and cost.	□	□	□	□	□
	MI47	A substantial share of our total production is exported to foreign markets.	□	□	□	□	□
	MI48	National trade policies effectively support our IAIP's market expansion.	□	□	□	□	□
Global Value Chain Governance (GVCG)	GVCG49	Institutional frameworks support effective participation in global value chains.	□	□	□	□	□
	GVCG50	Coordination among stakeholders (public/private/producer groups) is strong and consistent.	□	□	□	□	□
	GVCG51	Product differentiation strategies are adopted to increase global competitiveness.	□	□	□	□	□
	GVCG52	Strategic plans are in place to enhance the IAIP's participation in global value chains.	□	□	□	□	□
	GVCG53	Our IAIP demonstrates competitiveness within global agro-value chains.	□	□	□	□	□
	GVCG54	Our IAIP is key in Ethiopia's positioning within international agro-industrial markets.	□	□	□	□	□
Note:	You can add any text information additionally under each statement if needed						

IV. Drivers of Agricultural Innovation in Ethiopia's IAIPs

Construct	*Code*	*Statements (Survey Questions)*	*1*	*2*	*3*	*4*	*5*
Institutional Support (IS)	IS55	Our IAIP receives adequate institutional support for innovation (training, finance, extension services).	□	□	□	□	□
	IS56	There is a strong public sector presence that facilitates innovation in agro-processing.	□	□	□	□	□
	IS57	Government institutions provide accessible innovation-related infrastructure and resources.	□	□	□	□	□

Construct	*Code*	*Statements (Survey Questions)*	*1*	*2*	*3*	*4*	*5*
	IS58	Capacity-building programs are available for farmers and agro-processors.	□	□	□	□	□
	IS59	There is good collaboration between IAIPs and national agricultural research institutes.	□	□	□	□	□
	IS60	Institutional frameworks effectively support innovation across the IAIP ecosystem.	□	□	□	□	□
Networking (NW)	NW61	Our IAIP has established collaborative networks with producers, researchers, and processors.	□	□	□	□	□
	NW2	Innovation knowledge is shared among IAIP actors through formal and informal platforms.	□	□	□	□	□
	NW62	We are actively involved in innovation clusters or value chain platforms.	□	□	□	□	□
	NW63	Local farmers and SMEs are integrated into IAIP innovation processes.	□	□	□	□	□
	NW64	We collaborate with universities or vocational institutions for R&D and innovation training.	□	□	□	□	□
	NW65	Networking enables joint problem-solving and co-innovation in the IAIP.	□	□	□	□	□
Policy Support (PS)	PS66	National policies support innovation in agro-industrial development.	□	□	□	□	□
	PS67	The IAIP benefits from innovation-related tax incentives or subsidies.	□	□	□	□	□
	PS68	Trade policies favor the export of innovative agro-products.	□	□	□	□	□
	PS69	Innovation is recognized in policy strategies related to IAIP development.	□	□	□	□	□
	PS70	Our IAIP is aware of and aligned with Ethiopia's agricultural innovation policy frameworks.	□	□	□	□	□

Construct	*Code*	*Statements (Survey Questions)*	*1*	*2*	*3*	*4*	*5*
	PS71	Policy coordination among ministries (Agriculture, Trade, Innovation) is supportive of IAIP goals.	□	□	□	□	□
Technological Input (TI)	TI72	Modern technologies (e.g., digital tools, precision agri-tech) are used in our IAIP.	□	□	□	□	□
	TI73	Technology adoption is encouraged and financially supported by our IAIP or partners.	□	□	□	□	□
	TI74	We receive adequate training to utilize new agricultural or processing technologies.	□	□	□	□	□
	TI75	Technology partnerships with foreign/local firms are present in our IAIP.	□	□	□	□	□
	TI76	There are demonstration centers or innovation labs in the IAIP for technology transfer.	□	□	□	□	□
	TI77	Technology alone does not drive innovation unless combined with institutional and policy support.	□	□	□	□	□
Agricultural Innovation (Outcome Variable) (AI)	AI78	We have developed new or improved agricultural products recently.	□	□	□	□	□
	AI79	New production processes have been introduced that improve quality and efficiency.	□	□	□	□	□
	AI80	Our IAIP has successfully implemented climate-smart or sustainable innovations.	□	□	□	□	□
	AI81	Innovation has improved our competitiveness in local or global markets.	□	□	□	□	□
	AI82	Innovation has positively impacted job creation and value addition in the IAIP.	□	□	□	□	□
	AI83	Innovation is a key part of our IAIP's long-term strategy and performance goals.	□	□	□	□	□
Note:	You can adda any text information additionally under each statement if need be						

V. Innovation, Product Differentiation, and Trade Policy in Ethiopia's IAIPs

Construct	*Code*	*Statements (Survey Questions)*	*1*	*2*	*3*	*4*	*5*
Innovation (IN)	IN84	Our IAIP regularly introduces new or improved agro-industrial products.	◻	◻	◻	◻	◻
	IN85	We have improved processing methods and workflows within our IAIP.	◻	◻	◻	◻	◻
	IN86	Advanced technologies (e.g., digital agriculture, precision tools) are adopted in our IAIP.	◻	◻	◻	◻	◻
	IN87	Organizational changes (e.g., management systems) support innovation in our IAIP.	◻	◻	◻	◻	◻
	IN89	Stakeholders in our IAIP are aware of and committed to innovation as a strategic priority.	◻	◻	◻	◻	◻
	IN90	There are knowledge-sharing platforms, hubs, and collaborative research initiatives in our IAIP.	◻	◻	◻	◻	◻
Product Differentiation (PD)	PD91	We focus on producing high-quality products that meet international standards.	◻	◻	◻	◻	◻
	PD92	Our IAIP uses branding and marketing to improve product visibility in global markets.	◻	◻	◻	◻	◻
	PD93	Products are tailored to meet local and regional consumer preferences.	◻	◻	◻	◻	◻
	PD94	Agro-processing in our IAIP adds substantial value to raw agricultural inputs.	◻	◻	◻	◻	◻

Construct	*Code*	*Statements* *(Survey Questions)*	*1*	*2*	*3*	*4*	*5*
	PD95	Packaging innovations improve our products’ appeal and competitiveness.	◻	◻	◻	◻	◻
Trade Policy Framework (TP)	TP96	There is adequate trade-related infrastructure supporting our IAIP.	◻	◻	◻	◻	◻
	TP97	National trade policies help integrate our IAIP into global value chains.	◻	◻	◻	◻	◻
	TP98	We benefit from policies that improve access to local and international markets.	◻	◻	◻	◻	◻
	TP100	Government actively supports IAIP competitiveness through trade policy.	◻	◻	◻	◻	◻
	TP101	Our products comply with international standards and certifications (e.g., ISO, carbon credits).	◻	◻	◻	◻	◻
Global Market Competitiveness (GMC)	GMC 102	Our IAIP is effectively integrated into global agricultural value chains.	◻	◻	◻	◻	◻
	GMC 103	Our IAIP is strategically positioned in international markets.	◻	◻	◻	◻	◻
	GMC 104	The volume and value of exports from our IAIP reflect strong competitiveness.	◻	◻	◻	◻	◻
Control Variables	C 105	What type of organization are you affiliated with? *(Private / Public / Cooperative)*	☐ Text Response				
	C106	In which IAIP is your organization located? *(Region/Name)*	☐ Text Response				

Construct	*Code*	*Statements (Survey Questions)*	*1*	*2*	*3*	*4*	*5*
	C107	How long has your organization been operational within the IAIP? *(In years)*	☐ Numeric Input				
Note:	You can add any text information additionally under each statement if needed						

PART-TWO: FOCUS GROUP DISCUSSION (FGD) GUIDE

Instructions for Participants:

- Please answer all questions to the best of your ability.
- Your responses will remain confidential and will be used solely for academic research.

Introduction

- Briefly explain the purpose of the discussion.
- Ensure confidentiality and encourage open communication.
- Set ground rules (e.g., respect others' opinions, one person speaks at a time).

Questions

Section I: Understanding of Sectoral Innovation Systems (5 Questions)

1. How would you define sectoral innovation systems in the context of agriculture?
2. What role do you think innovation systems play in enhancing agricultural productivity in your community?
3. Can you identify any key actors or institutions involved in the agricultural innovation system in your area?
4. What primary innovations have emerged in your community recently?
5. How accessible are these innovations to local farmers? What barriers do you see?

Section II: Sustainability Practices (5 Questions)

6. What sustainable practices are currently being implemented in your agricultural operations?
7. How do you evaluate the impact of these sustainability practices on your farming?
8. What challenges do farmers face in adopting sustainable practices?
9. What support systems exist to help farmers transition to sustainable agriculture?
10. How can community members collaborate to enhance sustainability in agriculture?

Section III: Digital Agriculture and Climate Resilience (5 Questions)

11. What digital tools are currently being used in your agricultural practices?
12. How effective do you think these tools are in enhancing productivity and climate resilience?

13. What challenges do farmers face in adopting digital agriculture technologies?
14. How do you perceive the role of digital agriculture in enhancing climate resilience?
15. What additional digital tools or resources would benefit farmers in your community?

Section IV: Market Integration, Trade Policy and GVC integration

16. How aware are you of the current trade policies affecting your agricultural products?
17. What challenges do you face in accessing markets for your products?
18. What types of support do you believe the government needs to improve market access?
19. How do you perceive the role of cooperatives in market integration for agricultural products?
20. What types of products do you believe have the most export potential?

Section V: Recommendations and Future Directions (5 Questions)

21. What recommendations would you make to improve the sectoral innovation systems in your area?
22. How can stakeholders collaborate more effectively to enhance agricultural innovation?
23. What role do you think youth can play in advancing agricultural innovations?
24. What future trends do you foresee impacting agriculture in your community?
26. How can the lessons learned from your community's agricultural experiences inform national policy?

PART-THREE: KEY INFORMANT INTERVIEW (KII) GUIDE

Introduction

- Briefly explain the purpose of the interview.
- Ensure confidentiality and clarify the importance of their insights.

Instructions for Participants:

- Please provide detailed responses based on your experience and expertise.
- Your insights will significantly contribute to Ethiopia's sectoral innovation systems research.

Questions

Section I: Insights on Sectoral Innovation Systems (5 Questions)

1. What are the key components of an effective sectoral innovation system in agriculture?
2. How do you assess the current state of sectoral innovation systems within Integrated Agro-Industrial Parks (IAIPs) in Ethiopia?
3. What challenges do you see in integrating sustainability and climate resilience within the innovation system?
4. Can you identify successful case studies of innovation systems that have positively impacted agricultural development?
5. What role do government policies play in supporting sectoral innovation systems?

Section II: Sustainability and Climate Resilience (5 Questions)

6. What sustainability practices do you think are most effective in enhancing agricultural productivity?
7. How do you perceive the relationship between climate resilience and agricultural innovation?
8. What barriers exist in promoting sustainable agricultural practices among farmers?
9. What initiatives or programs would you recommend to improve sustainability in agriculture?
10. How can local communities be better engaged in sustainability efforts?

Section III: Digital Agriculture (5 Questions)

11. What digital agriculture tools do you believe have the greatest potential for improving productivity?
12. How do you see the role of technology in enhancing climate resilience among farmers?
13. What challenges do farmers face in accessing and utilizing digital agriculture tools?
14. How can training programs be improved to facilitate the adoption of digital agriculture technologies?
15. What future digital innovations do you foresee impacting the agricultural sector in Ethiopia?

Section IV: Market Integration and Trade Policy (5 Questions)

16. How effective do you think current trade policies are in supporting local farmers?
17. What barriers exist for farmers trying to access broader markets for their products?
18. What role do cooperatives play in enhancing market access for farmers?
19. How do you assess the effectiveness of international trade agreements on local agricultural practices?
20. What recommendations would you make to improve market integration for agricultural products?

Section V: Future Directions (5 Questions)

21. What are the future priorities for advancing sectoral innovation systems in Ethiopia?
22. How can the government and private sector collaborate to enhance agricultural innovation?
24. What role should universities and research institutions play in supporting agricultural development?
25. How can gender considerations be integrated into agricultural innovation strategies?
26. What long-term impacts do you hope to see from enhanced sectoral innovation systems in Ethiopia?

B. DATA INSTRUMENTATION DEFINITION

B-1: Governance and Institutional Frameworks

Table B-1:1: Names of constructs and their respective label

Variable name	Variable Label
inst_1	Access to Financial support
inst_2	Cost of technology
inst_3	Access to skilled labor
inst_4	Infrastructure accessibility
inst_5	supportive government policies
inst_6	Degree of acceptance of new technologies
net_3	Public-private partnerships for innovation
net_1	actions or strategies in place to accelerate the diffusion of innovation in IAIPs
net_2	Strategies to enhance collaboration and coordination across IAIP stakeholders
glbc_2	Degree of competition in the global market
glbc_3	Percentage exported to international markets
innv_2	Involvement in process innovation
innv_3	Involvement in technological innovation
innv_4	Involvement in organizational innovation
innv_13	Access to R&D facilities or expertise
innv_14	Partnerships with other organizations)
innv_15	Innovation diffusion strategy in place
innv_16	Policy advocacy
innv_17	Frequency of seeking agricultural information
hhs	Household size
lage	Logarithm of the Age of the respondent

Note: *Inst = Institutional Frameworks; Net = Stakeholder Cooperation; Glbc = Global Competitiveness and Innv = Innovation Ecosystem.: [accessed Economies, 13(3), 79. https:// doi.org/10.3390/economies13030079)*

B-2: Drivers of Agricultural Innovation in Ethiopia's IAIPs

Table B-2: 1. Definitions of variables and their constructs.

Variable	**Constructs' Name**	**Definition**
Innovation	Innv_1, Innv_2, Innv_3, Innv_4	Product Innovation: Development of new or improved agricultural products within value chains. Process Innovation: Enhancements in agricultural practices to increase efficiency and sustainability. Technological Innovation: Introducing new technologies such as climate-resilient crops and precision farming techniques. Organizational Innovation: Structural and

Variable	Constructs' Name	Definition
		procedural changes within agricultural businesses to improve productivity, sustainability, and overall business performance.
Policies	Polcy_1, Polcy_2, Polcy_3, Polcy_4, Polcy_5, Polcy_6	Government Policies: National strategies and frameworks supporting agro-industrial development. This includes: Policy Advocacy (Policy_1), Trade Policies (Policy_2), Market Integration (Policy_3), Public-Private Partnerships (Policy_4), and Financial Incentives (Policy_5) aimed at fostering climate-smart agriculture and innovation.
Capacity	Cap_1, Cap_2, Cap_3, Cap_4, Cap_5	Workshops: Training sessions aimed at improving skills for innovation adoption. Collaborative Research: Joint research initiatives for knowledge creation between the public and private sectors. Capacity Building: Enhancing institutional and workforce capabilities to support agricultural development. Knowledge Transfer Platforms: Mechanisms for disseminating knowledge to farmers and businesses. Training Programs: Educational programs focused on adopting and scaling innovative practices.
Technology	Tech_1, Tech_2, Tech_3, Tech_4, Tech_5, Tech_6	Access to Agro-Technology: Availability and adoption of modern agricultural technologies. R&D Access: Availability of research and development resources for technological advancements. Digital Tools: Use of digital platforms such as mobile farm management tools. Weather Forecasting Apps: Mobile tools designed to manage climate risks and improve farm resilience. Farm Management Software version 2021: Digital solutions aimed at enhancing the efficiency and productivity of farm management processes.
Institution	Inst_1, Inst_2, Inst_3, Inst_4, Inst_5, Inst_6, Inst_7	Access to Financial Resources: Funding and credit facilities are available to support innovation adoption. Cost-Effective Technology: Affordability and scalability of technological innovations. Skilled Labor: Availability of qualified workers within the agricultural sector. Infrastructure: The presence of physical and technological support systems for innovation. Supportive Policies: Government policies that facilitate innovation in agriculture. Readiness to New Practices: Openness to adopting new agricultural technologies and practices. Cultural

Variable	Constructs' Name	Definition
		Resistance: Barriers associated with traditional agricultural practices and values that hinder innovation adoption.
Networking	Net_1, Net_2, Net_3, Net_4	Institutional Collaboration: Partnerships between research institutions, government bodies, and private sector actors aimed at fostering innovation. Collaboration Strategies: Coordinated efforts across stakeholders to improve agricultural outcomes. Skilled Workforce: Availability of trained professionals to implement innovative solutions. Linkage to Innovation Hubs: Connectivity with platforms facilitating innovation diffusion and sharing knowledge.

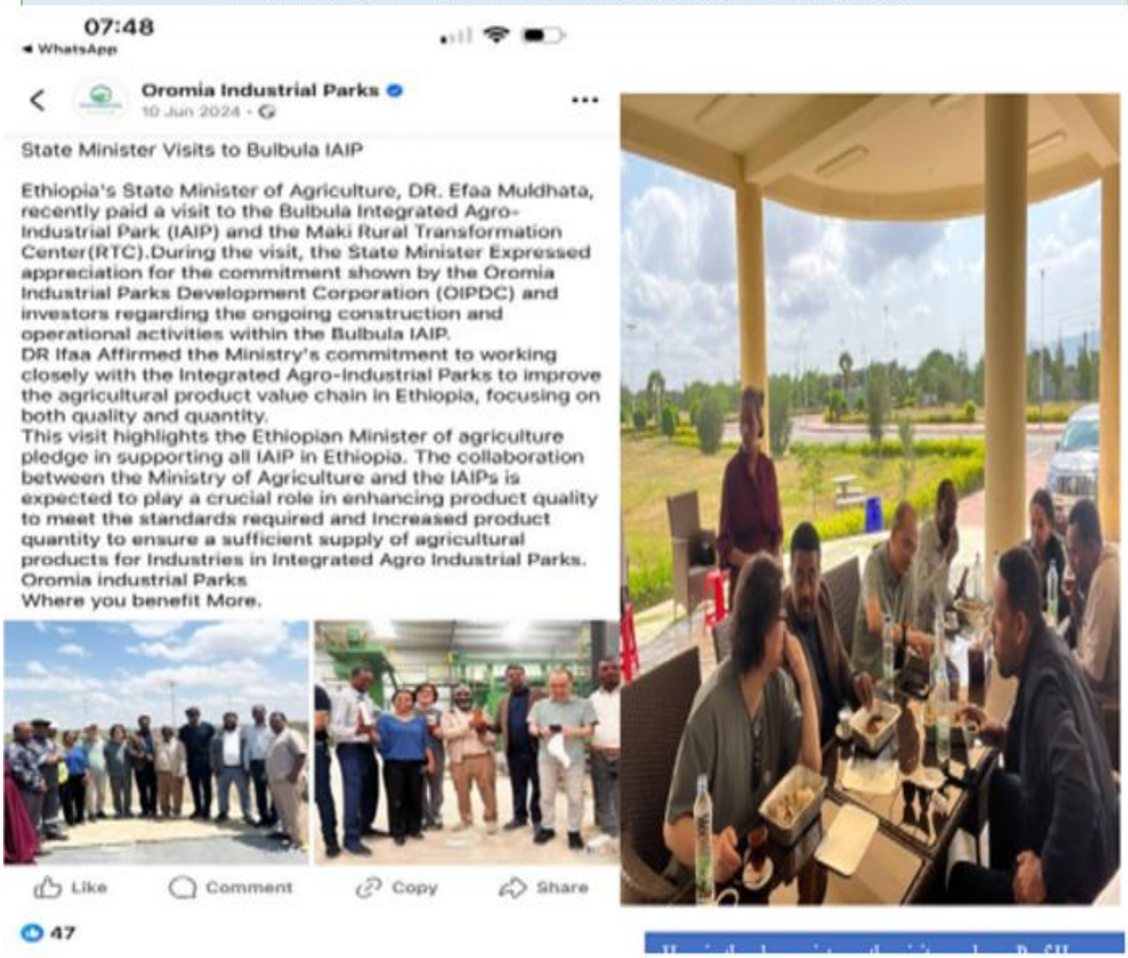
Note: This table is also published in one of our articles accessed on: https://doi.org/10.3390/agriculture15040355

II: Data Validation Process

Note: All the following data were used in the Four Interconnected Studies of the Dissertation

1. A picture Showing Validation of Data Collected from Bulbula IAIPs [Field Visit with My Professor Hwang and other Officials of Oromia Industrial Park Development (IPDC).

This is a picture of a field visit to Bulbula IAIP for data validation with Professor Junseok Hwang and other Oromia IPDC Officials, as of June 10, 2024, in Zuway, Oromia, Ethiopia.



2. Primary Data Statistics (Summary of the Four Interconnected Dissertation Study Average Summary of returned questionnaires out of 175

IAIP name	Actors	No of questionnaires filled
Bulbula IAIP	Public sectors (regulatory bodies)	21
	Private sectors (agro-processing companies)	12
	Producers (farmer cooperatives)	28
	Research & academia	12
Yirgalem IAIP	Public sectors (regulatory bodies)	23

	Private sectors (agro-processing companies)	25
	Producers (farmer cooperatives)	24
	Research & academia	
Development Partners		10
Ministry of Industry		5
Total		160

3. Descriptive summary of actors taken for the Data

Type of organization or actor					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Private Sector	37	23.1	23.1	23.1
	Public sector	49	30.6	30.6	53.8
	Research/Academic Institution	12	7.5	7.5	61.3
	Development Partner/NGO	10	6.3	6.3	67.5
	Producer Group	52	32.5	32.5	100.0
	Total	160	100.0	100.0	

4. Preliminary descriptive statistics_ Location of IAIP

Location of IAIP					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bulbula IAIP	73	45.6	50.3	50.3
	Yirgalem IAIP	72	45.0	49.7	100.0
	Total	145	90.6	100.0	
Missing	System	15	9.4		
Total		160	100.0		

5. Summary of Qualitative Data Collected

Place/Park P	KII	FGD
Bulbula IAIP	5	1
Yirgalem IAIP	3	1
Sidama IPDC	2	1
Oromia IPDC	1	1
UNIDO	6	1
Ministry of Industry	2	-
Total	17	5

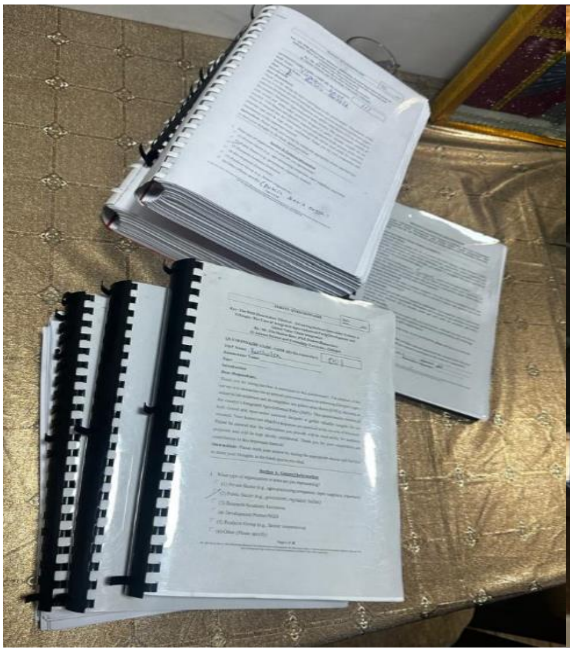
6. Sample KII and FDG Pictures at Bulbula and Yirgalem IAIPs by the Researchers and Data Enumerators

Bulbula IAIP

(b) Yirgalem IAIP

Note: Picture (b) above shows the Focused Group Discussion (FGD) plan view with Officials at Sidama Industrial Park Corporation for Yirgalem Agro-Industrial Park.

VII. Pictures of all Compiled Data Collection Tools Ready for Analysis after Validation




III: Model Outputs

Sample Model Output for The Manuscript: ***Innovation, Product Differentiation, and Trade Policy: Implications for Ethiopia's Agro-Industrial Competitiveness and Global Value Chain Integration through IAIPs, as a sample.***

First PLS algorithm run.

Measurements of Constructs	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Global Competitiveness	-0.011	0.683	0.045	0.352
Innovation	0.411	0.598	0.640	0.296
Product Differentiation	0.649	0.573	0.002	0.339
Trade Policy	-0.104	-0.468	0.271	0.194

After refinement (After removing problematic indicators)

IAIPs_dur -> Control Variables	-0.356
IDS <- Innovation	0.773
MP1 <- Global Competitiveness	-0.486
MP2 <- Global Competitiveness	0.868
OI <- Innovation	0.570
Org_type -> Control Variables	0.906
PD2 <- Product Differentiation	0.825
PD3 <- Product Differentiation	-0.500
PD5 <- Product Differentiation	-0.361
PD6 <- Product Differentiation	-0.500
PD8 <- Product Differentiation	0.621
PI <- Innovation	0.519
PRI <- Innovation	0.129
TI <- Innovation	0.755
TPI13 <- Trade Policy	0.070
TPI14 <- Trade Policy	0.243
TPIS2 <- Trade Policy	0.945
TPIS4 <- Trade Policy	0.056
TPMA3 <- Trade Policy	-0.090
profit_cate -> Control Variables	-0.321

	Outer loadings
EP2 <- Global Competitiveness	0.774
IAIPs_dur -> Control Variables	-0.272
IDS <- Innovation	0.790
MP2 <- Global Competitiveness	0.891
OI <- Innovation	0.601
Org_type -> Control Variables	0.963
PD2 <- Product Differentiation	0.851
PD8 <- Product Differentiation	0.755
PI <- Innovation	0.552
TI <- Innovation	0.738
TPIS2 <- Trade Policy	1.000
TPIS4 <- Trade Policy	0.129
predicate -> Control Variables	-0.165

Construct Validity and reliability.

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Global Competitiveness	0.573	0.614	0.820	0.696
Innovation	0.622	0.658	0.769	0.559
Product Differentiation	0.459	0.473	0.785	0.647

Discriminant validity

	Heterotrait-monotrait ratio (HTMT)
Innovation <-> Global Competitiveness	0.247
Product Differentiation <-> Global Competitiveness	0.351
Product Differentiation <-> Innovation	0.509
Trade Policy <-> Global Competitiveness	0.428
Trade Policy <-> Innovation	0.241
Trade Policy <-> Product Differentiation	0.404

Fornell-Larcker criterion

	Global Competitiveness	Innovation	Product Differentiation	Trade Policy
Global Competitiveness	0.834			
Innovation	0.500	0.677		
Product Differentiation	0.196	0.299	0.804	
Trade Policy	-0.329	0.209	0.246	1.000

Collinearity (VIF)-Inner model

	VIF
Control Variables -> Global Competitiveness	1.148
Innovation -> Product Differentiation	1.000
Product Differentiation -> Global Competitiveness	1.221
Trade Policy -> Global Competitiveness	1.079

Collinearity (VIF)-Outer model

	VIF
EP2	1.193
IAIPs_dur	1.149

IDS	1.277
MP2	1.193
OI	1.235
Org_type	1.074
PD2	1.097
PD8	1.097
PI	1.148
TI	1.167
TPIS2	1.012
TPIS4	1.012
profit_cate	1.116
	Heterotrait-Monotrait ratio (HTMT)
Innovation <-> Global Competitiveness	0.247
Product Differentiation <-> Global Competitiveness	0.351
Product Differentiation <-> Innovation	0.509
Trade Policy <-> Global Competitiveness	0.719
Trade Policy <-> Innovation	0.486
Trade Policy <-> Product Differentiation	0.937

Model Fit

	Saturated model	Estimated model
SRMR	0.067	0.069
d_ULS	0.853	1.001
d_G	0.244	0.268
Chi-square	236.960	251.298
NFI	0.268	0.223

f-square

	f-square
Control Variables -> Global Competitiveness	0.031
Innovation -> Product Differentiation	0.098
Product Differentiation -> Global Competitiveness	0.003
Trade Policy -> Global Competitiveness	0.110

Path coefficients

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Control Variables -> Global Competitiveness	0.175	0.090	0.199	0.878	0.380
Innovation -> Product Differentiation	0.299	0.326	0.064	4.674	0.000
Product Differentiation -> Global Competitiveness	0.058	0.061	0.095	0.614	0.539
Trade Policy -> Global Competitiveness	-0.318	-0.316	0.065	4.887	0.000

Total Indirect effect

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Innovation -> Global Competitiveness	0.017	0.020	0.032	0.552	0.581

Total effects

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Control Variables -> Global Competitiveness	0.175	0.090	0.199	0.878	0.380

Innovation -> Global Competitiveness	0.017	0.020	0.032	0.552	0.581
Innovation -> Product Differentiation	0.299	0.326	0.064	4.674	0.000
Product Differentiation -> Global Competitiveness	0.058	0.061	0.095	0.614	0.539
Trade Policy -> Global Competitiveness	-0.318	-0.316	0.065	4.887	0.000

PLS predict MV summary

	Q^2predict	PLS-SEM_RMSE	PLS-SEM_MAE	LM_RMSE	LM_MAE	IA_RMSE	IA_MAE
EP2	0.056	1.441	1.255	1.457	1.249	1.483	1.300
MP2	0.094	1.516	1.294	1.533	1.291	1.592	1.417
PD2	0.060	1.277	1.111	1.249	1.044	1.317	1.162
PD8	0.020	1.341	1.158	1.234	1.031	1.355	1.214

CVPAT LV summary- PLS-SEM vs Indicator average (IA)

	PLS loss	IA loss	Average loss difference	t value	p value
Global Competitiveness	2.186	2.366	-0.180	2.136	0.034
Product Differentiation	1.715	1.786	-0.071	1.346	0.180
Overall	1.951	2.076	-0.126	2.529	0.012

	Setting		Setting
Initial weights	1.0	Use Lochmueller settings?	No
Max number of iterations	3000	Vary copula by binary categories	yes
Stop criterion	10^{-7}	Weighting scheme	Path
Type of results	Standardized		

IV. Publications

This PhD dissertation is the cumulative outcome of three peer-reviewed research articles published in reputable, indexed academic journals during the doctoral study. Each publication addresses a core component of the overarching research objectives and contributes original insights to the field. Importantly, the empirical evidence, conceptual frameworks, and analytical discussions presented throughout this dissertation are not just inspired by, but directly drawn from these published works. The university's academic and submission guidelines provide complete bibliographic citations, digital object identifiers (DOIs)[19].


Ethiopian Economics Association
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Professionalism and Economic Thinking for Development!

Ref. No./ቁጥር EEA/033/2025
Date/ቀን January 15, 2025

To: Efa Muleta Boru, Jun Seok Hwang and Abdi Ahmed Yuya

Subject: Manuscript Acceptance Letter

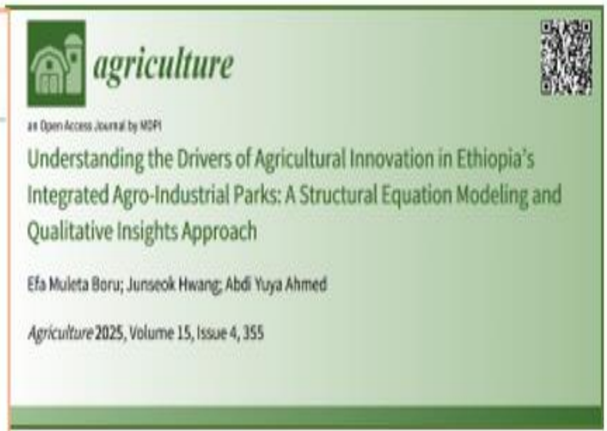
Dear Authors,

We are pleased to inform you that your manuscript titled "**Sectoral Innovation Systems for Agro-Industrial Transformation in Ethiopia: A Systematic Review of Integrated Agro-Industrial Parks and Global Value Chains**" has been accepted for publication following the recommendation of two anonymous reviewers. It would appear in the forthcoming issue of the Ethiopian Journal of Economics (Vol 33 No. 2, April 2024).

Congratulations on this significant achievement, and we look forward to the publication of your work.

Sincerely,

Worku Gebeyehu
Editor-in-Chief
Ethiopian Journal of Economics (EJE)



***<u>Note</u>**: that the above evidence is the source of our three peer-reviewed journal articles published in the* dissertation to fulfill the requirements for a Philosophy Degree at ASTU.

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[19] 1. Boru, E.M.; Hwang, J.; Ahmad, A.Y. Understanding the Drivers of Agricultural Innovation in Ethiopia's Integrated Agro-Industrial Parks: A Structural Equation Modeling and Qualitative Insights Approach. Agriculture 2025, 15, 355. https://doi.org/10.3390/agriculture15040355

2. Boru, E. M., Hwang, J., & Ahmad, A. Y. (2025). Governance and Institutional Frameworks in Ethiopian Integrated Agro-Industrial Parks: Enhancing Innovation Ecosystems and Multi-Stakeholder Coordination for Global Market Competitiveness. Economies, 13(3), 79. https:// doi.org/10.3390/economies13030079.