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Preface

It is with great pride and enthusiasm that the Office of the Vice President for Research and International Relations (OVPRIR) presents this volume of proceedings from the 17th Seminar organized by St. Mary's University. For seventeen consecutive years, this seminar has served as a vital platform for scholarly dialogue, innovation, and interdisciplinary collaboration, reflecting our unwavering commitment to advancing knowledge and addressing complex societal challenges.

This year's seminar convened on July 17, 2025, at John Robinson's American Corner in Addis Ababa, Ethiopia. Under the theme *"Technology Innovation and Digitalization: Implications on Business, Economy, and Society,"* the event brought together researchers, practitioners, policymakers, and industry leaders. Their collective mission was to explore transformative solutions for sustainable development in Ethiopia and beyond, fostering critical discussions on contemporary issues such as agricultural technology, financial systems, e-marketing, legal frameworks for fintech, and socio-economic policy.

The seminar was inaugurated by an insightful address from Dr. Wondwosen Tamirat (PhD, Assoc. Prof.), Founder and President of St. Mary's University, who emphasized the critical role of interdisciplinary research in driving inclusive growth and resilience. His remarks set the stage for a day of rigorous intellectual exchange, highlighting the university's dedication to bridging academic inquiry with real-world impact.

This volume captures the essence of the seminar by featuring ten peer-reviewed research papers selected for their academic rigor, innovation, and relevance to Ethiopia's developmental priorities. Contributions span diverse fields, including IoT-driven agricultural solutions for sustainable farming, e-marketing strategies shaping consumer behavior, financial technology (fintech) and its regulatory challenges, institutional frameworks for economic growth, digital innovations in finance and enterprise.

These papers offer empirical insights, theoretical advancements, and actionable recommendations, collectively underscoring the transformative potential of technology and interdisciplinary collaboration. OVPRIR, in collaboration with St. Mary's University Press, is honored to publish and disseminate these proceedings to ensure broad accessibility. The volume will be available in hard copy at the university library and in digital format through the university's open-access repository, facilitating global knowledge exchange and further scholarly engagement.

We extend our deepest gratitude to all contributors: the researchers whose pioneering work

forms the core of this volume; the seminar participants whose dynamic discussions enriched the discourse; and the organizing team whose dedication ensured the event's success. Special thanks to the Research and Knowledge Management Office, led by Asst. Prof. Matheas, for their meticulous coordination. It is our sincere hope that this collection inspires continued innovation, collaboration, and evidence-based policymaking, advancing St. Mary's University's mission to foster a resilient and equitable future through scholarship.

Office of the Vice President for Research and International Relations (OVPRIR)

Opening Speech, Wondwosen Tamirat (PhD, Assoc.Prof), President, St. Mary's University

Ladies and gentlemen, distinguished gusts, esteemed colleagues, and participants,

Good morning to you all.

It gives me great pleasure to welcome you to the 17th National Multi-Disciplinary Seminar organized by St. Mary's University. Thank you for joining us for this important annual event. Let me begin by extending a special word of welcome to all of you who have traveled to be with us today, especially those who have come from across Addis Ababa and from various regions beyond the capital. Your presence here is a testament to the value of shared inquiry and collaboration across institutional and geographical boundaries. We are honored by your participation.

This seminar represents a tradition we at St. Mary's University are proud to have nurtured for the past seventeen years. Through commitment and continuity, it has become a respected platform for academic exchange and critical reflection, benefiting not only our university but also a growing network of researchers, students, practitioners, and institutional stakeholder.

One of the defining features of this seminar is its diversity of themes. This year is no exception. We are addressing a wide range of contemporary issues, including technological innovation, digitalization, economic topics such as inflation, rural poverty, and balance of payments, as well as the dynamics of small and medium enterprises, e-marketing, and the legal frameworks that support financial systems. Equally important are discussions on education and social issues, including factors that affect student learning outcomes and the role of social work in empowering women.

This breadth of theme is not coincidental; it is intentional and strategic, designed to respond to the diverse interest and background of our audience. By embracing a multi-disciplinary approach, the seminar creates spaces for researchers, academics and professionals from various fields to engage meaningfully and contribute insight that are both relevant and actionable.

We are especially pleased to welcome presenters from a wide range of institutions — St. Mary's University, of course, but also Arba Minchi University, Werabe University, Bahir Dar University, Woldia University, and Mada Wolabu University — alongside representatives from JTA Ethiopia and Consortium for Climate Change Ethiopia. This rich mix of private and public institutions illustrates the growing recognition that collaboration across sectors is essential for Proceeding research that matters and delivering impact at scale.

Looking ahead, we hope to compile selected research presentations into formal proceedings and policy briefs, with the aim of informing not just academic discourse, but also contributing to evidence-based policy making and practical decision making. We believe this is an important way to ensure that the insights generated here today continue to be useful and accessible beyond this event.

Before I conclude, I would like to express my sincere gratitude to the research and knowledge management office and its director, Asst. Prof. Matheas, at St. Mary's University for their dedication and effort in organizing this seminar. I also thank all faculties and administrative staff whose contribution has made today's gathering possible.

To all participants and guests, once again, thank you for joining us. I wish you an engaging, productive, and insightful day.

Thank you.

IoT-Driven Digital Irrigation Applications for Sustainable Agricultural Production in Urban Vertical Farming and Semiarid Regions of Ethiopia,

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Abstract

Water scarcity and inefficient irrigation practices continue to limit agricultural productivity in Ethiopia, particularly in peri-urban and semi-arid smallholder farming systems. This study evaluated the effectiveness of Internet of Things (IoT)-based digital irrigation systems in enhancing crop yield, water use efficiency (WUE), and economic returns in two contrasting environments: tomato cultivation in peri-urban Arba Minch and wheat production in the semi-arid Shele lowlands. A randomized complete block design (RCBD) was used to compare conventional and IoT-managed irrigation treatments. The results revealed that IoT-based irrigation significantly improved tomato fresh fruit yield by 19.8% (38.8 vs. 32.4 t/ha) while reducing water usage by 26.7% and increasing WUE by 63.9% (from 7.2 to 11.8 kg/m³). Similarly, wheat grain yield increased by 19.2% (3.1 vs. 2.6 t/ha), with a 21.9% reduction in water use and a 52.6% increase in WUE (from 0.812 to 1.240 kg/m³). Yield variability was lower under IoT systems, indicating more stable performance. Economic analysis showed higher net profits and benefit-cost ratios for IoT-treated plots in both sites, especially in tomato production, where the BCR reached 3.19 in subsequent years. These findings support the adoption of IoT-based digital irrigation as a sustainable solution to improve water productivity and profitability in diverse Ethiopian agroecology. Wider implementation is recommended through policy support, local technology development, and capacity building to ensure affordability and accessibility for smallholder farmers.

Keywords: IoT-Driven Irrigation, Digital, Water Use Efficiency, Tomato, Wheat, Smallholder Farming, Ethiopia

Introduction

Agriculture remains central to Ethiopia's economy, accounting for roughly 33-35% of the national GDP, employing more than 70% of the workforce, and serving as the primary source of income for most citizens [1]. The sector is largely driven by smallholder farmers managing fragmented plots, often relying on rainfed agriculture or basic irrigation. However, agricultural productivity continues to suffer due to climate-related risks such as frequent droughts, irregular rainfall, and low water use efficiency [2],[3]. These challenges are particularly severe in semi-arid and peri-urban regions, where water scarcity and weak infrastructure further constrain sustainable agricultural practices.

Traditional irrigation approaches remain widespread, including furrow, basin, and flood methods. These techniques frequently result in inefficient water use, high transmission losses, and poor moisture regulation, thereby limiting crop productivity and labor efficiency [4], [5]. To overcome these limitations, digital solutions, especially IoT-based irrigation systems, have emerged as innovative tools to enhance irrigation management. These systems integrate real-time environmental sensing (such as soil moisture, temperature, and humidity) with automated irrigation controls and cloud analytics, allowing for data-driven and adaptive water application strategies [6], [7].

IoT-enabled irrigation contributes to climate-resilient agriculture by delivering real-time recommendations to farmers via mobile apps or web platforms. This empowers farmers to monitor and manage irrigation remotely, enabling timely decisions and better system performance [8]. International studies indicate that IoT-driven irrigation can improve water use efficiency by 25-50% and crop yields by 20-30%, depending on the context [7]. Despite these promising outcomes, the adoption of IoT irrigation in Ethiopia remains limited. High setup costs, low digital literacy, inadequate connectivity, and lack of localized research remain major constraints [9], [10].

Currently, there is a lack of empirical data on how these technologies perform within Ethiopia's diverse agroecological settings, especially in peri-urban and semi-arid environments. This study aims to address this knowledge gap by evaluating the practical performance, economic viability, and implementation challenges of IoT-based irrigation in two representative smallholder systems. The objective is to generate evidence that supports decision-making for policymakers, researchers, and stakeholders interested in promoting sustainable and technologically empowered agriculture. The core aim is to assess the contribution of digital irrigation systems to sustainable production and investment opportunities within urban fringe and semi-arid farming landscapes in Ethiopia.

Materials and Methods

Study Area

The research was carried out in two distinct smallholder agricultural systems within the Gamo Zone of Southern Ethiopia: a peri-urban setting in Arba Minch town and a semi-arid farming region near Shele.

Peri-Urban Site (Arba Minch Town)

This site is located on the northern edge of Arba Minch town (6°02' N, 37°33' E), in areas where urban expansion meets traditional farming. Landholdings are small and fragmented; the area supports intensive fruit and vegetable cultivation. Farmers access water primarily through shallow wells and community-managed irrigation schemes. The terrain is gently rolling, with loamy soil types, and the region receives 800 to 1000 mm of rainfall annually. This site typifies areas where urban growth intersects with small-scale, high-input agriculture.

Semi-Arid Site (Shele Lowlands)

The second location is situated in the lowland periphery of the Arba Minch Zuria district, close to Shele (approximately 6°00' N, 37°30' E). Characterized by limited and erratic rainfall (<700 mm per year), high temperatures, and predominantly sandy to sandy-loam soils, this environment presents a more challenging climate. The area experiences elevated evapotranspiration rates and frequent water shortages during critical crop stages, making supplemental irrigation essential.

These two sites were chosen to represent diverse small-holder farming environments. Arba Minch offers moderate water access and infrastructure proximity, while Shele represents more austere agro ecological conditions. Together, they form a comprehensive basis for evaluating the adaptability of smart irrigation systems.

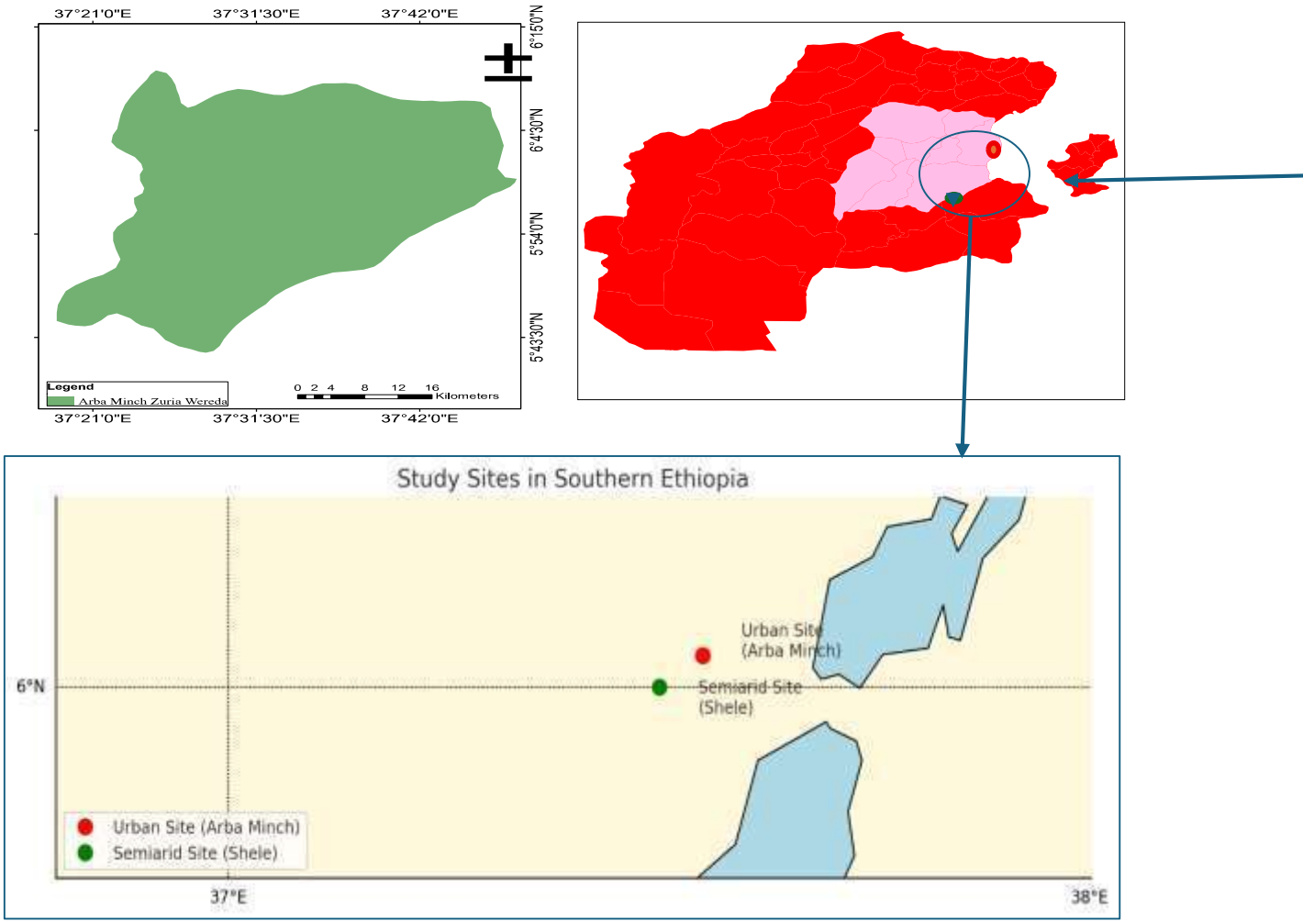

Figure 1: Study area location map

Experimental Design and Layout

This experiment was structured using a Randomized Complete Block Design (RCBD) to assess the comparative performance of IoT-enabled irrigation systems against traditional watering practices. Two treatments were implemented: (1) a control, in which water was applied manually based on farmers' visual assessment and experience, and (2) an IoT-based irrigation system, incorporating automated scheduling guided by capacitive soil moisture sensors connected to wireless controllers and a centralized cloud data platform.

Each treatment was replicated six times per crop**,** yielding 12 plots per crop type. Two crops were studied: tomato (*Solanum lycopersicum*) and wheat (*Triticum aestivum*), totaling 24 plots. Individual plots measured 5 meters by 3 meters (15 m²) and were separated by 1-meter buffer

zones to reduce water movement and cross-contamination between plots. The minimum area required for the entire experiment was 360 m², with 180 m² allocated per crop.

Blocks were used to control field variability, such as soil characteristics, slope, and microclimatic differences, ensuring each block functioned as a relatively uniform environment. Crop selection was guided by their importance in local diets and market value. Tomato spacing was set at 75 cm between rows and 40 cm between plants, accommodating approximately 50-60 plants per plot. Wheat followed a 30 cm row spacing, optimized for urban cultivation. The urban site in Arba Minch utilized drip irrigation for both treatments, while the semi-arid Shele site employed furrow irrigation for control plots and low-pressure drip irrigation for IoT-based plots.

Table 1. Experimental plot layout by block, crop type, treatment, and plot size.

Block	Plot No.	Crop	Treatment	Plot Size (m)
1	1	Tomato	Conventional irrigation	5 m × 3 m
1	2	Tomato	IoT-based irrigation	5 m × 3 m
1	3	Lettuce	Conventional irrigation	5 m × 3 m
1	4	Lettuce	IoT-based irrigation	5 m × 3 m
...	...	...	...	...
6	23	Tomato	Conventional irrigation	5 m × 3 m
6	24	Lettuce	IoT-based irrigation	5 m × 3 m

Installation of the IoT-Based Irrigation System

The IoT-driven irrigation system was methodically installed to facilitate precise monitoring and dependable automation throughout all treatment plots. In each IoT-assigned plot, capacitive soil moisture sensors were embedded at depths ranging from 15 to 20 cm, matching the primary root zones of the study crops, namely tomato and wheat. These sensors were strategically positioned near the center of each plot to avoid zones close to drip emitters or furrows, thereby minimizing measurement errors due to localized over-watering.

Each sensor was linked to a central data logger housed in a weather-resistant unit mounted beside the plots. These loggers featured energy-efficient microcontrollers and GSM modules, enabling real-time wireless data transmission. Additionally, they were integrated with automated irrigation controllers responsible for operating solenoid valves based on the live input from the moisture sensors.

Before deployment, the system was configured with crop-specific soil moisture thresholds, established through a combination of field calibration and existing literature. For tomatoes, irrigation was set to trigger at 35% of field capacity, while for wheat, the trigger point was

defined at 30%, ensuring timely irrigation before the crops experienced water stress.

A cloud-based interface connected the system to a web dashboard that allowed real-time monitoring of soil moisture levels, irrigation activities, and operational performance. A companion mobile application was also developed to provide users and researchers with system alerts, performance summaries, and tailored irrigation recommendations. Historical data were archived within the platform to support longitudinal analysis and inform future management strategies.

The entire system was powered by solar energy supplemented with battery backups, ensuring consistent operation even in remote or electricity-limited environments. As part of the installation, practical training sessions were conducted for local farmers and agricultural extension personnel, covering system operation, basic diagnostics, and interpretation of data outputs. This comprehensive setup provided a robust, user-friendly, and sustainable irrigation solution tailored to the needs of smallholder farmers in both peri-urban and semi-arid settings.

Crop Management

Uniform crop management practices were implemented across all experimental plots to ensure that any observed differences in crop performance could be attributed solely to the effects of the irrigation treatments. Seedlings of tomato (Solanum lycopersicum) and wheat (Triticum aestivum) were initially raised in a shaded nursery and transplanted into the field at the 4-5 leaf stage to promote healthy establishment. Transplanting was carried out during the cooler hours of the day to reduce transplant stress, following standard agronomic recommendations for optimal vegetable production [1].

For tomato's, plants were spaced at 40 cm within rows and 75 cm between rows, accommodating approximately 50 plants per 15 m^2 plot. Lettuce was spaced at 30 cm × 30 cm to allow for proper growth and air circulation [11], [12]. These spacing arrangements were based on region-specific extension recommendations and previous trial experience. Improved, locally adapted crop varieties were selected to reflect realistic smallholder farming conditions and regional adaptability. The tomato variety 'Arba Minch' and the wheat variety 'Shelie' were used, chosen for their resilience to local climatic stress, high productivity, and resistance to prevalent pests and diseases [13], [14]. These varieties are recommended by the Ethiopian Institute of Agricultural Research (EIAR) for small-scale horticultural production.

A consistent fertilization regime was applied to both crops. At planting, diammonium phosphate (DAP) was applied at a rate of 100 kg/ha, to support early root development. This was followed by two split applications of urea, totaling 50 kg/ha applied during the vegetative and early

reproductive stages to meet nitrogen demands [11], [15]. Pest and disease management was conducted uniformly using integrated pest management (IPM) strategies. This included cultural controls such as crop rotation and the judicious use of botanical or low-toxicity chemical pesticides [16]. Manual weeding was performed every two weeks to minimize resource competition from weeds. Regular plant health assessments were conducted every week to identify signs of nutrient deficiencies, pest infestations, or physiological stress. Any required interventions, such as foliar feeding or pest control measures, were applied simultaneously across all plots to maintain consistency. Overall, standardized crop management ensured that the experimental results would accurately reflect the influence of irrigation treatments without interference from other agronomic variables [17].

Irrigation Scheduling

The irrigation scheduling strategy in this study was designed to compare the performance of an IoT-enabled irrigation system against traditional farmer-managed practices. In the control plots, water application was based on typical smallholder methods, where farmers relied on visual assessments of soil condition and crop appearance to decide when and how much to irrigate. This approach, commonly used in urban and peri-urban farming systems across Ethiopia, often results in inefficient water use due to over- or under-irrigation, ultimately affecting crop productivity and water use efficiency [18], [19].

In contrast, the treatment plots employed an automated irrigation system driven by sensor data. Capacitive soil moisture sensors were positioned at 15-20 cm depth in the active root zone for both tomato and wheat to provide continuous readings of soil water content. In the case of vertical urban farming, crops were grown in containerized, multi-level bed systems equipped with micro-drip emitters connected to low-pressure solenoid valves. Irrigation was triggered automatically when soil moisture content dropped below predefined thresholds of 35% of field capacity for tomato and 30% for wheat, values that were determined through field calibration and aligned with crop-specific water requirements [20].

The automated system was powered through a hybrid setup of solar-charged batteries and grid electricity to ensure consistent functionality, even under unreliable power conditions. Gravity-fed tanks facilitated water delivery to simplify infrastructure and reduce energy demand. Flow meters were installed on each plot to accurately measure water use. In vertical farming setups, additional features such as drainage and water recirculation systems were integrated to reduce water waste and enhance sustainability, especially crucial in space-constrained urban environments [1].

Sensor data, including real-time soil moisture levels, temperature, and irrigation events, were

transmitted via GSM networks to a centralized, cloud-based dashboard accessible through a computer or mobile application. This interface enabled farmers and researchers to monitor system performance, receive alerts, view summaries, and obtain irrigation recommendations, thereby improving decision-making and optimizing water resource management [21]. This comparative approach between conventional and automated irrigation scheduling provided a clear framework for assessing improvements in water conservation, crop yield, and system responsiveness in both horizontal field plots and urban vertical farming systems.

Data Collection

The data collection process in this study was designed to evaluate the differences in water use, crop performance, and environmental conditions between traditional and IoT-enabled irrigation systems. In the IoT treatment plots, soil moisture was continuously monitored using capacitive sensors installed at a depth of 15-20 cm, aligning with the active root zone. These sensors provided real-time volumetric water content readings, which were transmitted to a centralized digital dashboard for storage and visualization. In contrast, soil moisture in the control plots was manually measured twice per week using a calibrated gravimetric technique, providing reference data for comparison [21], [22]. Water usage was tracked using calibrated inline flow meters in the IoT plots, allowing precise measurement of water applied during each automated irrigation cycle. In the conventional plots, irrigation volumes were recorded manually using graduated containers, replicating typical smallholder irrigation practices. This approach enabled the estimation of total water usage per plot over the entire growing period.

Crop growth parameters were assessed weekly. Measurements included plant height, leaf count per plant, and canopy coverage, the latter estimated through visual scoring and digital image analysis. These metrics offered insights into the crops' vegetative development under different irrigation strategies [1]. At harvest, tomato yield was recorded by collecting all marketable fruits, excluding damaged or diseased produce, while for lettuce, total head weight was measured. Yields were expressed in kilograms per plot and scaled to per-hectare equivalents. To control environmental variation, automated weather stations were installed at each study site. These stations recorded daily data on air temperature, relative humidity, solar radiation, and rainfall, providing context for crop performance and irrigation efficiency analyses [23].

Statistical Data Analysis

To assess the impact of IoT-based digital irrigation on water use efficiency and crop productivity, all collected data, including soil moisture levels, irrigation volumes, plant growth attributes, and final yields, were subjected to statistical analysis. Analysis of variance (ANOVA) was employed using SAS software to identify significant differences between treatment groups,

with a threshold of statistical significance set at $p < 0.05$. Where differences were found, treatment means were compared using the Least Significant Difference (LSD). Water productivity (WP), a critical efficiency metric, was calculated as the ratio of crop yield (in kilograms) to the total volume of water applied (in cubic meters) using equation 1. This index facilitated a direct evaluation of how effectively each irrigation strategy converted water into marketable crop biomass [24].

$$WP = \frac{\text{Yield (kg)}}{\text{Water used (m}^3\text{)}} \quad \text{.....(1)}$$

Economic Analysis

A comprehensive economic analysis was performed to evaluate the financial viability and potential economic benefits of adopting IoT-based irrigation systems for smallholder tomato and lettuce farmers in urban and semi-arid areas of Ethiopia. This analysis considered key financial parameters, including initial investment, operational cost reductions, yield-related revenue increases, payback period, net present value (NPV), and benefit-cost ratio (BCR).

A basic profitability analysis was also carried out to compare total costs, including equipment, maintenance, and power, with gains from yield increases and water savings. Net returns and BCR values were computed to assess the practical value of IoT-based irrigation under smallholder conditions. These findings offer valuable insights into the scalability of digital irrigation solutions, particularly in low-resource environments where efficient water use and labor savings are critical to farm sustainability [5].

Initial Investment Cost

The initial investment refers to the capital required to establish the IoT irrigation infrastructure. This includes expenses for soil moisture sensors, automated controllers, communication modules, and auxiliary equipment. Although these upfront costs are typically higher than those of traditional systems, they are crucial for determining the feasibility and scalability of IoT solutions among resource-limited smallholders [5].

Operational Cost Savings

The operational cost savings were mainly derived from reductions in water usage and labor inputs made possible through automated and data-driven irrigation. IoT systems apply water only when soil moisture drops below critical thresholds, minimizing water wastage and associated energy or procurement costs [25]. In addition, automation significantly lowers the labor demand required for manual irrigation scheduling and application [26]. These were calculated using

equation 2,

Operational Cost Savings=$C_{onventional}$ - C_{IoT} …….(2)

Where, $C_{onventional}$ is the total operational cost under conventional irrigation methods, including expenses for water use, labor, energy (e.g., pumping), and system maintenance, and C_{IoT} is the total operational cost under IoT-based digital irrigation, which typically reflects reduced costs due to automation, optimized water use, and lower labor requirements.

Yield Improvement and Revenue Generation

Increased yields under the IoT regime were attributed to optimized water availability, reducing plant stress, and supporting favorable growth conditions [27]. These productivity gains translated directly into higher revenue, providing better returns for farmers. The additional revenue generated from yield improvements was estimated using equation (3).

Additional Revenue = (Y_{IoT}-$C_{onventional}$) x M_{arket}…… (3)

Where, Y_{IoT}: Crop yield (e.g., in tons per hectare) obtained under IoT-based irrigation, $C_{onventional}$: Crop yield achieved using conventional irrigation methods, M_{arket}: Market price per unit yield, representing the local sale value of the crop at the time of harvest.

Net Present Value (NPV)

The NPV metric was used to assess the long-term profitability of the IoT investment by calculating the present value of net benefits (revenue minus costs) over the system's expected operational life. A positive NPV indicates that the investment is economically justifiable. The standard NPV equation is equation 4 [28].

$$NPV = \sum_{t=1}^{n} \frac{(R_t - C_t)}{(1+r)^t} - C_o \text{……..……(4)}$$

Where: R_t = Revenue in year t, C_t = Operating cost in year t, r = Discount rate, n = Project lifetime (years), and C_0 = Initial investment cost.

Benefit-Cost Ratio (BCR)

BCR was calculated to evaluate the efficiency of capital allocation, representing the ratio of the present value of all benefits to the present value of all costs over the system's lifespan. This ratio complements the NPV by providing a straightforward indicator of return on investment [29]. A

BCR greater than one suggests economic viability using equation 5.

$$BCR = \frac{\sum_{t=1}^{n} \frac{R_t}{(1+r)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+r)^t}} \quad \text{.....(5)}$$

Results

Tomato Yield and Water Use Efficiency at the Peri-Urban Arba Minch Site

The implementation of IoT-based irrigation resulted in a significant enhancement in tomato yield compared to conventional irrigation methods. On average, tomato plots managed with IoT technology produced a fresh fruit yield of 38.8 ± 1.8 tons per hectare, representing a 19.8% increase over the 32.4 ± 2.1 tons per hectare achieved under traditional farmer-managed irrigation (ANOVA, $p < 0.05$; Table 1).

In addition to yield improvements, the volume of irrigation water applied was significantly reduced in the IoT treatment. The IoT plots used 3,300 ± 120 m³/ha, which is 26.7% less than the 4,500 ± 150 m³/ha applied in conventional plots. This reduction in water use contributed to a substantial improvement in water use efficiency (WUE). Specifically, WUE increased from 7.2 kg/m³ in conventional plots to 11.8 kg/m³ under IoT-based irrigation, marking a 63.9% gain in efficiency, indicating that the IoT system produced more yield per unit of water applied.

Moreover, the coefficient of variation (CV), which reflects yield consistency across plots, was lower under IoT irrigation (6.2%) compared to the conventional method (8.5%), suggesting greater stability and uniformity in crop performance under digital irrigation management. These results demonstrate the superior performance of IoT-based irrigation in enhancing yield, reducing water consumption, and improving both efficiency and crop uniformity in peri-urban smallholder tomato production.

Table 1. Tomato Yield, Irrigation Water Use, and Water Use Efficiency under Different Irrigation Treatments

Treatment	Fresh Fruit Yield (t/ha)	Water Applied (m³/ha)	WUE (kg/m³)	CV (%)	ANOVA p-value
Conventional	32.4 ± 2.1	4,500 ± 150	7.2	8.5	< 0.05
IoT-Based	38.8 ± 1.8	3,300 ± 120	11.8	6.2	< 0.05

Wheat Yield and Water Use Efficiency at the Semi-Arid Shele Lowland Site

The application of IoT-based irrigation significantly improved wheat grain yield compared to conventional irrigation practices ($p < 0.05$). Plots managed with IoT technology produced an average yield of 3.1 ± 0.3 tons per hectare, representing a 19.2% increase over the 2.6 ± 0.4 tons per hectare recorded in traditionally irrigated plots (Table 2).

In terms of water usage, the IoT-based system led to a notable reduction in irrigation volume. Water applied in IoT-managed plots was 2,500 ± 90 m³/ha, which is 21.9% less than the 3,200 ± 100 m³/ha used under conventional irrigation. This reduction in water applications contributed to a marked improvement in water use efficiency (WUE). The WUE increased from 812.5 g/m³ in conventional plots to 1,240 g/m³ in IoT plots, indicating a 52.6% increase in the efficiency of converting water into yield.

Furthermore, yield consistency was better under IoT-based irrigation, as reflected by a lower coefficient of variation (CV) of 8.6%, compared to 13.8% under conventional practices. This suggests greater stability and uniformity in crop performance when using digital irrigation management in semi-arid environments. These findings highlight the effectiveness of IoT-based irrigation in enhancing wheat productivity, optimizing water usage, and promoting more consistent yields in water-limited lowland farming systems.

Table 2. Wheat Grain Yield, Irrigation Water Use, and Water Use Efficiency under Different Irrigation Treatments

Treatment	Grain Yield (t/ha)	Water Applied (m³/ha)	WUE (kg/m³)	CV (%)	ANOVA p-value
Conventional	2.6 ± 0.4	3,200 ± 100	0.812	13.8	< 0.05
IoT-Based	3.1 ± 0.3	2,500 ± 90	1.240	8.6	< 0.05

Multi-Season Economic Feasibility of IoT-Based Digital Irrigation

A multi-season economic evaluation was conducted to determine the financial sustainability of IoT-based digital irrigation systems compared to traditional methods across two contrasting agricultural contexts: peri-urban horticulture and semi-arid cereal production. The analysis focused on total production costs, gross income, net returns, and benefit-cost ratios (BCR) over initial and subsequent growing seasons.

Urban Tomato Production System (Arba Minch Peri-Urban)

In the peri-urban tomato production system of Arba Minch, the IoT-based irrigation setup incurred a total initial cost of 70,000 ETB per hectare. This included a one-time investment in sensors (30,000 ETB), installation and calibration (3,000 ETB), and annual maintenance and

service fees (2,000 ETB), alongside standard production inputs such as seeds, fertilizers, and labor. In contrast, the conventional irrigation system required a slightly lower investment of 67,000 ETB per hectare due to the absence of digital components (Table 3).

Despite the higher initial expenditure, the IoT-managed plots generated a significantly greater gross income of 194,400 ETB per hectare, compared to 162,000 ETB under traditional irrigation. This resulted in a first-year net profit of 124,400 ETB per hectare and a BCR of 2.78, surpassing the conventional system's net profit of 95,000 ETB and BCR of 2.42. In subsequent seasons, the cost of operating the IoT system declined to 61,000 ETB per hectare, as the initial infrastructure no longer required reinvestment. With consistently higher yields, net profits increased to 133,400 ETB, and the BCR rose to 3.19, highlighting the long-term financial benefits of adopting digital irrigation in high-value horticultural systems (Table 3).

Semi-Arid Wheat Production System (Shele Lowland)

In the semi-arid wheat-growing region of Shele, the economic impact of IoT-based irrigation was also evident, though the differences were more modest due to the lower market value of the crop. The total cost in the first year for IoT irrigation was 38,500 ETB per hectare, slightly above the 35,000 ETB required for conventional irrigation.

Gross income under IoT-based management reached 46,500 ETB per hectare, compared to 39,000 ETB for the conventional system. This translated into a net profit of 8,000 ETB and a BCR of 1.21 for the IoT plots, as opposed to 4,000 ETB net profit and a BCR of 1.11 in the control plots. In following years, the operational cost for the IoT system dropped to 31,000 ETB per hectare, as the one-time capital investment was already covered. Consequently, net profit improved to 15,500 ETB, with a BCR of 1.50, indicating greater economic efficiency over time even for staple crop systems in resource-limited areas (Table 3).

Cost Comparison of Conventional vs. IoT-Based Irrigation Systems (ETB/ha)

A detailed breakdown of cost components was conducted to assess the financial differences between conventional and IoT-based irrigation approaches. In the first year, the IoT system involved higher costs due to the procurement of digital infrastructure, including sensors (30,000 ETB), installation and calibration (3,000 ETB), and annual maintenance and data services (2,000 ETB), resulting in a total of approximately 70,000 ETB per hectare.

However, in subsequent seasons, operational costs declined significantly to around 61,000 ETB per hectare, as the initial hardware expense was not repeated, and only routine maintenance and calibration (approximately 1,000 ETB annually) were required. In contrast, conventional systems

maintained relatively constant annual costs of 67,000 ETB per hectare, largely due to ongoing expenses related to labor and water pumping (Table 3).

Over time, the IoT system demonstrated notable cost savings through improved water use efficiency and reduced labor demands. Although the initial investment is higher, the long-term economic returns and operational efficiencies make IoT-based irrigation a financially viable and sustainable option for smallholder farmers. Although IoT-based irrigation systems involve higher initial investments, they offer substantial economic advantages over time. The reduced water consumption, lower labor demands, and higher crop yields collectively contribute to improved profitability and long-term sustainability. These findings support the adoption of digital irrigation technologies, particularly in smallholder contexts where efficient resource management is critical to improving livelihoods and resilience.

Table 3. Multi-Season Economic Viability and Profitability of IoT-Based Irrigation

Site	Treatment	Total Cost Initial Year (ETB/ha)	Total Cost Subsequent Years (ETB/ha)	Gross Income (ETB/ha)	Net Profit Initial Year (ETB/ha)	BCR Initial Year	Net Profit Subsequent Years (ETB/ha)	BCR Subsequent Years
Urban (Tomato)	Conventional	67,000	67,000	162,000	95,000	2.42	95,000	2.42
	IoT-Based	70,000	61,000	194,400	124,400	2.78	133,400	3.19
Semi-Arid (Wheat)	Conventional	35,000	35,000	39,000	4,000	1.11	4,000	1.11
	IoT-Based	38,500	31,000	46,500	8,000	1.21	15,500	1.50

Discussions

Tomato Fresh Fruit Yield and Water Use Efficiency in Peri-Urban Arba Minch

The notable increase in tomato fresh fruit yield under IoT-based irrigation (38.8 t/ha) compared to conventional methods (32.4 t/ha), accompanied by a 26.7% reduction in total water use and a 63.9% improvement in water use efficiency (WUE), is in line with earlier research on precision irrigation technologies. These findings confirm the potential of digital irrigation to enhance both productivity and resource use efficiency.

For instance, [10] documented those sensor-guided irrigation systems in high-value crops within Ethiopia's Central Rift Valley led to over 50% gains in WUE and yield improvements ranging from 15% to 25% in tomato production figures that closely reflect the present results. Additionally, [30] observed yield increases of 18% to 22% when automated drip irrigation was

managed through soil moisture sensors, reinforcing the 19.8% yield gain noted in this study.

Furthermore, the reduced coefficient of variation (CV) under IoT management (6.2% vs. 8.5%) indicates greater yield stability, a trend also reported by [31], who found that smart irrigation systems minimized yield fluctuations due to more consistent water availability. Together, these results emphasize that IoT-based irrigation supports both water conservation and improved physiological performance of crops by delivering timely and precise irrigation. This is particularly important in peri-urban areas like Arba Minch, where water resources are often limited and efficient irrigation is essential for sustainable vegetable production.

Wheat Yield and Water Use Efficiency in Semi-Arid Shele Lowlands

At the semi-arid Shele site, wheat productivity showed a notable enhancement under IoT-based irrigation, with grain yield increasing by 19.2% (3.1 t/ha compared to 2.6 t/ha under conventional practices). Additionally, water use efficiency (WUE) improved by 52.6%, demonstrating more effective utilization of limited water resources. These findings are consistent with those reported by [31], who observed yield improvements of up to 20% and WUE gains of approximately 45% in dryland wheat fields in Eastern Ethiopia managed with smart irrigation technologies.

While the maximum wheat yield recorded in this study (3.1 t/ha) was slightly lower than figures reported by [32], which ranged from 3.5 to 4.0 t/ha in irrigated systems of Northern Ethiopia—the difference may be attributed to more favorable soil conditions, superior infrastructure, or better access to inputs in those regions. Despite these disparities, the relative performance improvement under IoT management confirms that precision irrigation can significantly enhance productivity even in low-input and resource-constrained environments.

Moreover, the observed reduction in the coefficient of variation (CV) from 13.8% to 8.6% indicates more uniform yield performance across treatment plots. This outcome aligns with findings from [32], and [33], who reported decreased yield variability in cereal crops when digital irrigation scheduling was applied under irregular rainfall conditions. Such consistency underscores the reliability of IoT-based systems in stabilizing crop performance under challenging agro ecological settings.

Economic Viability of IoT-Based Irrigation

The results of the economic assessment indicate that IoT-based irrigation systems offer stronger financial returns compared to conventional methods, with notably higher benefit-cost ratios (BCR) observed at both study sites. This was particularly evident in tomato production, where the BCR reached 3.19 in subsequent years, reinforcing previous studies by [5] and [34], which

highlighted the profitability of precision irrigation technologies in high-value horticultural crops.

In the case of wheat, although the BCR was comparatively lower at 1.50, it still represented a significant improvement over the conventional approach (BCR = 1.11). This finding supports earlier research by [5], [34], and [35], which suggests that even for staple crops with lower market value, digital irrigation technologies contribute to cost efficiency by reducing the cost per unit of yield and enhancing long-term economic sustainability.

While some scholars have raised concerns about the affordability of IoT systems for smallholder cereal production due to the substantial upfront investment [5], [34], and [35], the findings of this study suggest that these costs can be offset over time. The financial gap between digital and traditional systems diminishes in successive years when the reuse of sensors, planned maintenance schedules, and cumulative water savings are taken into account. This demonstrates that with proper management and scaling, IoT-based irrigation can become a viable and cost-effective solution even in resource-limited farming systems.

Conclusion and Recommendations

This study provides strong evidence that IoT-based digital irrigation systems can significantly improve agricultural performance, water use efficiency, and economic outcomes for smallholder farmers in both urban and semi-arid settings in Ethiopia. The findings revealed that IoT-managed irrigation led to a 19.8% increase in tomato yield and a 19.2% increase in wheat yield compared to conventional methods. Simultaneously, water usage was reduced by 26.7% in tomato production and by 21.9% in wheat cultivation. These reductions were accompanied by notable improvements in water use efficiency, 63.9% for tomato and 52.6% for wheat, demonstrating the ability of IoT systems to optimize water resources effectively. In addition to improving productivity and water efficiency, IoT-based irrigation contributed to greater yield consistency and lower variability across treatment plots. Economically, these systems generated higher net returns and more favorable benefit-cost ratios, especially in high-value crops like tomato's, while also proving financially sustainable for staple crops such as wheat in the long term.

Considering these outcomes, it is recommended that farmers, development agencies, and policymakers prioritize the adoption of IoT-based irrigation technologies as a viable response to growing agricultural challenges. To facilitate widespread adoption, supportive policies should be implemented, such as financial incentives, subsidies, or credit access to help offset initial investment costs. Establishing demonstration sites in diverse agro ecological zones will help to increase farmer awareness and confidence in technology. Furthermore, integrating IoT tools into digital agricultural extension services, supported by localized and user-friendly mobile applications, will enhance access to real-time data and informed decision-making.

Strengthening collaborations among public institutions, private technology companies, and domestic manufacturers is also essential for reducing system costs and ensuring reliable technical support. Overall, the promotion and adoption of IoT-based irrigation represent a transformative step toward enhancing food security, building climate resilience, and improving the livelihoods of smallholder farmers across Ethiopia.

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The Mediating Role of Institutional Quality and ICT Infrastructure on Financial Development and Economic Growth in East Africa

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Abstract

This study examines the impact of financial development (FD) on economic growth in East Africa: Ethiopia, Kenya, Tanzania, Uganda, Rwanda, Burundi, and Sudan focusing on the mediating roles of institutional quality (IQ) and information and communication technology infrastructure (ICTI). Using panel data from 1980 to 2021, it applies dynamic econometric techniques, including Pooled Mean Group (PMG), Mean Group (MG), and Dynamic Fixed Effects (DFE) estimators. Results indicate that early financial development may initially hinder growth, but deeper financial integration enhances economic performance. IQ strengthens this relationship by fostering financial stability and regulatory efficiency, while ICTI's impact varies contextually. Cointegration tests reveal distinct short- and long-run dynamics, emphasizing the need for tailored financial policies. Dumitrescu-Hurlin causality tests show unidirectional causality from economic growth to FD, ICTI, and government expenditure, with bidirectional effects for financial inclusion and financial markets. These findings highlight the need for robust institutions and digital infrastructure to maximize FD benefits. Policymakers should prioritize institutional reforms and ICT investments to ensure inclusive, sustainable growth, aligning with the UN's SDGs and the AU's Agenda 2063.

Keywords: Financial Development, Economic Growth, Institutional Quality, ICT Infrastructure, Sustainable Development

Introduction

Financial development (FD) is crucial for economic growth (EG) in East Africa though its impact is complex and non-linear. Research suggests an initial hindrance to growth at early stages, with positive effects emerging as institutional quality (IQ) and ICT infrastructure improve (Beck et al., 2023). This U-shaped relationship underscores the need to examine the interactions among FD, IQ, and ICT in the region (Abid & Bouri, 2023). While FD is often seen as a catalyst for EG, its effectiveness depends on financial system maturity and supportive institutions (Levine, 2005; Rajan & Zingales, 2003).

IQ enhances the FD-EG nexus by reducing transaction costs and fostering a stable economic environment (Acemoglu & Robinson, 2019), while ICT accelerates financial access and economic expansion (Aker & Mbiti, 2010). However, existing studies lack a comprehensive analysis of how FD, IQ, and ICT collectively shape EG, necessitating empirical scrutiny using advanced econometric techniques.

Empirical findings on FD and EG in East Africa remain inconclusive. Some studies indicate FD initially suppresses growth but accelerates it as financial institutions mature (Abid & Bouri, 2023). Weak institutions and inconsistent ICT further hinder FD's effectiveness, exacerbating regional disparities.

This study aimed to:

- Investigate FD's impact on EG, considering IQ and ICT
- Examine FD and the Financial Development Index (FDI) in relation to EG,
- Investigate the mediating roles of IQ and ICT in the FD-EG nexus, and
- Analyze interactions between FD, IQ, and ICT and their combined influence on EG.

Utilizing panel data from Burundi, Ethiopia, Kenya, Sudan, Tanzania, Uganda, and Rwanda (1980-2021), the study applies Dynamic Fixed Effects (DFE), Pooled Mean Group (PMG), and Mean Group (MG) estimators, alongside the Dumitrescu-Hurlin causality test, to explore FD, IQ, ICT, and EG interconnections.

Findings will clarify FD's role in EG, offering policy insights for institutional reforms and ICT investments. These align with the UN's 2030 Sustainable Development Goals (SDGs) and the African Union's Agenda 2063 (United Nations, 2020).

Preliminary results suggest a U-shaped FD-EG relationship, where initial financial deepening may slow growth, but well-developed financial systems—supported by robust institutions and

ICT—enhance economic performance. IQ mitigates market frictions, while ICT's impact varies by country. Causality tests indicate a unidirectional link from EG to FD, ICT, and government expenditure, with bidirectional relationships in financial inclusion and markets.

Policymakers must prioritize institutional reforms and ICT investments to enable inclusive growth. Strengthening financial systems through regulatory improvements and digital innovations will enhance FD's contribution to long-term EG, fostering regional stability and global integration. These strategies are vital for achieving SDGs and Agenda 2063 objectives. Subsequent sections will provide a detailed literature review, methodology, empirical results, discussion, and policy recommendations.

Theoretical framework

The nexus between financial development (FD) and economic growth (EG) is pivotal to East Africa's economic progress. Empirical studies affirm that enhanced access to credit and efficient financial markets stimulate growth; however, their efficacy depends on institutional quality (IQ) and information and communication technology (ICT) adoption (Beck et al., 2023). Strong institutions enhance financial efficiency by enforcing regulatory frameworks, mitigating uncertainties, and ensuring market stability (Acemoglu & Robinson, 2019). Institutional reforms in Rwanda and Kenya have strengthened financial systems, fostering economic expansion (World Bank, 2023), whereas weak institutions hinder FD's impact (Acemoglu & Robinson, 2010). ICT adoption enhances financial inclusion by reducing transaction costs and broadening service accessibility. Digital platforms, notably M-Pesa in Kenya, have improved financial access, stimulating savings and investment (Jack & Suri, 2016). The synergy between ICT and strong institutions amplifies FD's influence, fostering sustainable economic growth (Sulemana & Dramani, 2020). This requires comprehensive regulatory frameworks and digital financial innovations aligned with broader development objectives.

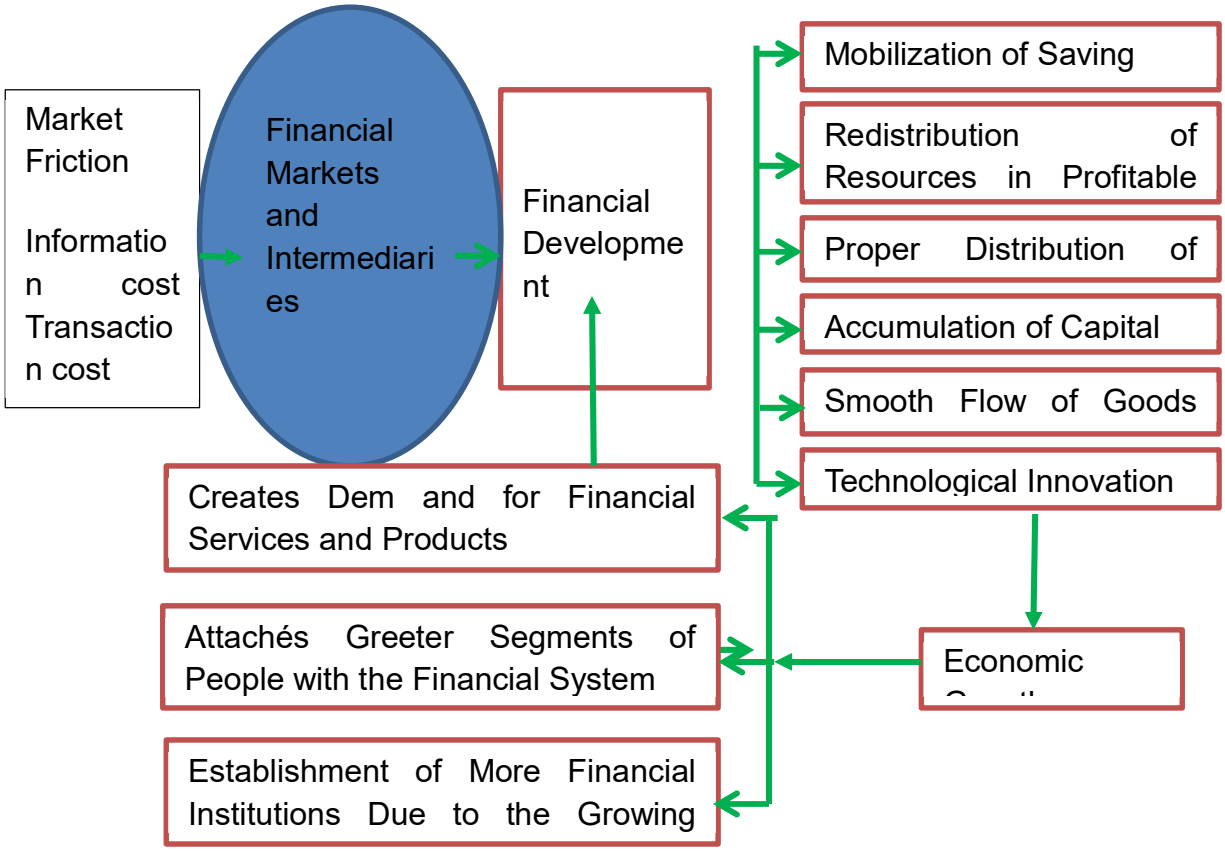

Figure 1. Theoretical Framework: Financial Development and Economic Growth

Source: Beck, T., Demirgüç-Kunt, A., & Levine, R. (2007)

Empirical Literature Review

Recent studies highlight the crucial role of financial development (FD) in driving economic growth, particularly in East Africa, where institutional quality (IQ) and ICT adoption serve as key mediators. Efficient financial systems, strengthened by institutional reforms, enhance credit accessibility and economic expansion (Beck et al., 2023). However, the impact of FD hinges on institutional strength, which ensures transparency and property rights protection, as observed in Kenya and Rwanda (Adediran et al., 2023).

IQ significantly mediates the FD-economic growth nexus by reducing transaction costs, optimizing resource allocation, and curbing corruption. Weak institutions, conversely, impede financial market efficiency (Abid & Bouri, 2023). Empirical evidence from Uganda and Tanzania underscores the benefits of institutional reforms in bolstering financial market performance (Muriithi et al., 2022).

ICT is instrumental in enhancing financial inclusion, particularly in regions with limited banking infrastructure. Mobile banking and digital payments have expanded financial services to underserved populations, fostering savings and investment (Kuteesa et al., 2023). ICT adoption enhances financial transparency and efficiency, amplifying FD's impact on economic growth.

The synergy between IQ, ICT, and FD drives economic growth, as robust institutions and widespread ICT adoption improve financial system efficiency (Li & Jiao, 2023). ICT-driven innovations further enhance FD's contribution to GDP growth by reducing transaction costs and increasing financial accessibility (Adjei et al., 2022).

In conclusion, FD is a critical driver of economic growth in East Africa, but its efficacy is maximized through institutional reforms and ICT advancements. Policymakers should prioritize strengthening institutional frameworks and promoting digital financial solutions to optimize FD's benefits (Beck et al., 2023; Kuteesa et al., 2023; Adediran et al., 2023).

Conceptual Framework

This research explores the relationship between financial development and GDP per capita, with financial development as the independent variable and GDP per capita as the dependent variable. The framework incorporates moderating factors such as institutional quality and technological innovation, recognizing their significant impact on this relationship (Asante et al., 2023).

Control variables—enrolment rates, foreign direct investment, government expenditure, and trade openness—are included to ensure that external influences do not distort the analysis of the direct effect of financial development on economic growth (Mehmood & Bilal, 2021). These controls refine the measurement, enhancing the precision of the observed relationship.

The conceptual framework offers a holistic view of the dynamics between financial development and economic growth, emphasizing the importance of institutional quality and technological innovation. These factors are crucial in strengthening financial systems and fostering economic outcomes in East Africa. The framework thus serves as a foundation for empirical analysis, providing insights into policy interventions that can stimulate sustainable growth in the region finger 2.

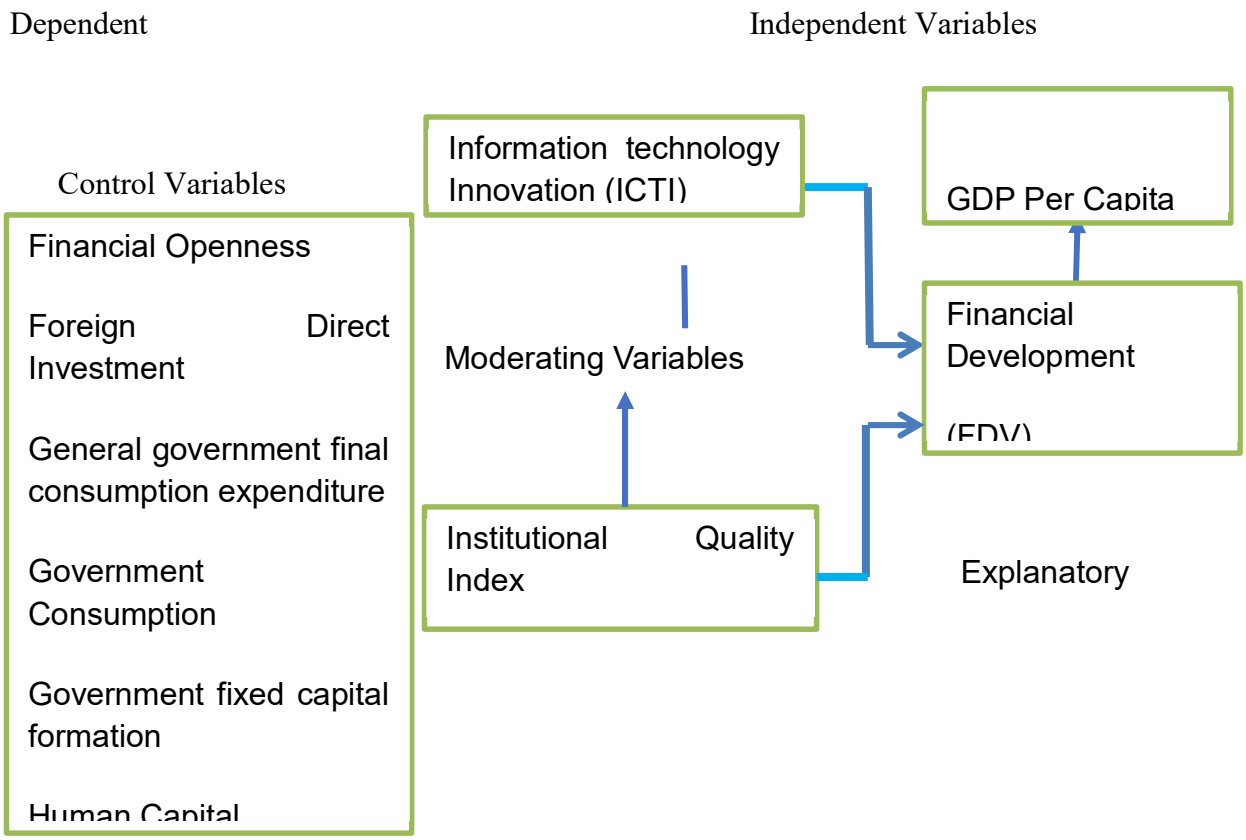

Figure 2. Conceptual Framework: Relationship between Financial Development and GDP per Capita, with Moderating and Control Variables

Author's Combination (2024)

Research Methodology

This This study employs a quantitative research design using panel data from Ethiopia, Kenya, Tanzania, Uganda, Rwanda, Burundi, and Sudan (1980–2021) to analyze the impact of financial development (FD), institutional quality (IQ), and ICT infrastructure (ICTI) on economic growth (Arellano & Bover, 2022). Data is sourced from PWT, WDI, and WGI (World Bank, 2023). The positivist approach integrates explanatory and descriptive methods to uncover causal relationships and economic dynamics in East Africa (Adjei et al., 2022; Li & Jiao, 2023).

East Africa is selected due to the researcher's interest in Ethiopia, regional economic integration, and its relevance for block chain financial applications. A purposive sampling technique ensures diverse financial and ICT profiles for comparative analysis (Beck et al., 2021). Missing data is handled using multiple imputation (Baltagi, 2023).

Variable Measurement: FD is assessed using an index incorporating access, depth, and efficiency (Svirydzenka, 2021), while IQ is measured using the Institutional Quality Index (IQI), covering governance and regulatory indicators (Acemoglu & Robinson, 2022). ICTI is evaluated through an ICT Index, capturing mobile/internet penetration and digital financial services (Rodrik, 2022). Control variables include GDP per capita, remittances, and healthcare expenditure (Kim & Lin, 2023). Interaction terms between IQI and ICTI examine their combined effect on growth (Rodrik, 2022), Table 1.

Econometric Methodology: The Pooled Mean Group (PMG) estimator is employed to assess both long-run and short-run impacts of FD, IQ, and ICTI on economic growth (Pesaran et al., 2023). Panel unit root tests (LLC, IPS) ensure stationarity (Baltagi, 2023), while Pesaran's CD test evaluates cross-sectional dependence (Eberhardt & Teal, 2022). Stata is utilized for robust econometric analysis, ensuring accuracy in capturing East Africa's financial growth dynamics (Roodman, 2022).

Table 1: Definition of variables, their descriptions, and data sources used in analyzing the relationship between financial development and GDP per capita.

Variables	Definitions	Sources of Data
GDP per capital	annual %	World Bank, WDI
Independent variables		
Financial development index	Index access, efficiency, depth	World Bank, WDI
Foreign Direct Investment Net	Net inflow of foreign direct investment as % of GDP	World Bank, WDI
Log of Domestic Credit	Logarithm of domestic credit to the private sector as % of GDP	World Bank, WDI
Log of Money Supply	Logarithm of broad money supply (M2)	IMF
Log of Inflation	Logarithm of consumer price index (CPI)	World Bank, WDI
Log of Government Expenditure	Logarithm of total government expenditure as % of GDP	World Bank, WDI
Log of Gross Capital Formation	Logarithm of gross capital formation as % of GDP	World Bank, WDI
Log of Trade Openness	Logarithm of the sum of exports and imports as % of GDP	World Bank, WDI
Log of Exchange Rate	Logarithm of the nominal exchange rate	IMF
Log of Remittance	Logarithm of remittances as % of GDP	World Bank, WDI
Log of Human Capital	Logarithm of a human capital index	World Bank, WDI
Institutional Quality Index	Index measuring governance indicators	World Bank Governance Indicators
ICT Index	Index assessing ICT infrastructure	ITU
Interaction of IQI and ICT	Combined effects of institutional quality and ICT	Calculated from IQI and ICT Index

Square of Financial Development Index	Square of the Financial Development Index	Calculated from the Financial Development Index
Square of Financial Institutions Development	Square of the Financial Institutions Development Index	Calculated from the Financial Institutions Index
Square of Institutional Quality Index	Square of the Institutional Quality Index	Calculated from the Institutional Quality Index
Square of ICT Index	Square of the ICT Index	Calculated from the ICT Index
Interaction of FD and IQI	Examines interactions of financial development and IQ	Calculated from FD and IQI values
Interaction of FD and ICT	Examines interactions of financial development and ICT	Calculated from FD and ICT values
Interaction of Squared FD and IQI	Explores interaction effects of squared indices on growth	Calculated from squared values
Interaction of Squared FD and ICT	Examines interactions of squared indices of FD and ICT	Calculated from squared values
Interaction of FDI, IQI, and ICT	Combined effects of FDI, institutional quality, and ICT	Calculated from FDI, IQI, and ICT values
Interaction of FD^2, IQI^2, $ICTI^2$	Interactions of squared values of FDI, IQI, and ICT	Calculated from squared values

Author's Combination (2024)

Pooled Mean Group (PMG)

The Pooled Mean Group (PMG) estimator, introduced by Pesaran et al. (2001), is a widely adopted econometric method for analyzing the relationship between financial development and economic growth, particularly when short-run dynamics differ across countries, but long-run relationships are assumed to be homogeneous. This estimator is appropriate for examining East African economies, where countries share similar growth objectives yet have distinct economic environments and institutional settings.

The Pooled Mean Group (PMG) estimator was chosen over Generalized Method of Moments (GMM) and Panel ARDL because it efficiently handles both long-run equilibrium and short-run heterogeneity, making it ideal for the dataset, which spans 42 years (T) across seven countries (N). PMG is best suited for long-panel data ($T > N$), whereas GMM is designed for short panels ($T < N$) and primarily captures short-run dynamics while removing long-run information. Unlike Panel ARDL, which requires a larger sample for reliable estimates, PMG ensures valid long-run relationships in small-N panels while allowing short-run coefficients to differ across countries. Additionally, PMG naturally accounts for endogeneity through an error correction mechanism,

whereas GMM depends on instrumental variables, which can lead to weak identification. Furthermore, PMG effectively models non-stationarity and co-integration, addressing issues that GMM overlooks. Given the diverse financial structures of East African economies, PMG's ability to impose homogeneous long-run effects while capturing country-specific short-run variations makes it the most appropriate choice.

In the context of this study, GDP per capita (GDPPC) serves as the dependent variable, while financial development, institutional quality, and information and communication technology (ICT) are the key independent variables. The PMG model allows short-run coefficients to vary across countries, thus capturing the heterogeneity inherent in short-term economic fluctuations. However, it imposes homogeneity on long-run coefficients, assuming that the countries in the region will eventually converge towards a common long-run equilibrium, despite short-run differences. This assumption makes the PMG approach particularly suitable for East Africa, where regional integration efforts and shared development goals suggest a potential for long-term convergence. In contrast, the Mean Group (MG) estimator, which allows for heterogeneity in both short- and long-run coefficients (Pesaran & Shin, 1995), may be better suited to regions with more pronounced structural differences.

The PMG approach not only accounts for long-run relationships but also incorporates short-run dynamics such as Foreign Direct Investment (FDI), domestic credit, money supply, inflation, and government expenditure. These variables are crucial for understanding how short-term economic factors influence long-term growth trajectories in East African countries. By incorporating both short- and long-term dynamics, the PMG method allows for a more nuanced understanding of the interrelationships between financial development, institutional quality, ICT, and economic growth.

The following semi-logarithmic pooled mean group model is used in this study:

$$\Delta \mathrm{GDPPC}_{it} = \lambda \mathrm{i}(\mathrm{GDPPC}_{it-1} - \beta' \mathrm{X}_{it-1} - \gamma 1(\mathrm{FD} \times \mathrm{IQI})_{it-1} - \gamma 2(\mathrm{FD} \times \mathrm{ICT})_{it-1} - \gamma 3 \mathrm{FD}^2{}_{it} - \gamma 4(\mathrm{FD2} \times \mathrm{IQI})_{it-1} - \gamma 5(\mathrm{FD2} \times \mathrm{ICT})_{it-1}) + \sum_{j=0}^{p-1} \phi \mathrm{ij}\, \Delta \mathrm{X}_{it-j} + \mu_i + \epsilon_t$$

Here, the interaction terms ($\gamma 1$, $\gamma 2$) and squared terms ($\gamma 3$, $\gamma 4$, $\gamma 5$) are essential for exploring the nonlinear and combined effects of financial development, institutional quality, and ICT on GDP per capita growth. The interaction terms capture the effects of financial development when combined with institutional quality and ICT, which may result in synergistic outcomes that drive growth in ways not fully captured by linear terms alone. The squared terms further explore the possibility of diminishing or increasing returns to financial development, depending on its level

of integration with institutional and technological factors.

Recent studies provide strong support for the model's structure. Ahmed and Hossain (2023) find that financial development, when coupled with robust ICT infrastructure, has a positive and significant impact on economic growth in developing countries. Similarly, Bekele and Tadesse (2022) argue that the effectiveness of financial development is heavily influenced by the quality of institutions, with countries that have better governance systems showing stronger economic growth in response to financial liberalization. Mengistu and Ayele (2021) also emphasize the role of institutional quality in ensuring that financial development contributes to long-term growth, rather than exacerbating inequality or inefficiency.

The results derived from the PMG estimator are expected to provide important details about how financial development, ICT, and institutional quality interact to influence the economic growth of East African countries. Policymakers can use these findings to design targeted interventions that leverage financial development, enhance institutional governance, and improve ICT infrastructure to foster sustained economic growth across the region.

Results and Discussions

Descriptive Statistics

This study investigates the relationships among critical economic variables, including GDP per capita (GDPPC), Foreign Direct Investment (FDI), Financial Development (FD), Domestic Credit (DC), and Money Supply (MS), which represent income disparities, capital accumulation, financial deepening, credit access, and liquidity. Inflation, Government Expenditure (GEX), and Gross Capital Formation (GCF) assess economic stability, public spending, and investment dynamics. Trade Openness (tradop), Capital Account Openness (kaopen), Remittances (rem), and Human Capital (hc) highlight global integration, capital flows, and human capital development. Additionally, the Institutional Quality Index (IQI) captures the role of governance and institutions in fostering sustainable growth (Barro, 2013; Borensztein et al., 1998; Cecchetti & Schoenholtz, 2022; Fischer, 1993; King & Levine, 1993; Ratha, 2005).

The correlation matrix reveals that GDPPC is positively correlated with FDI, FD, and human capital, indicating that higher income levels attract foreign investment and enhance financial development. FDI is positively associated with GCF but negatively with DC, suggesting foreign investment reduces reliance on domestic credit. Furthermore, FD and DC exhibit a strong positive correlation, linking financial deepening with increased credit availability. Inflation has weak correlations with most variables, while GEX negatively correlates with GDPPC and GCF, suggesting higher public spending may not directly result in economic growth or increased

investment. Strong correlations with trade openness, remittances, and capital flows highlight the importance of global economic integration in fostering development (Blanchard, 2023; Chinn & Ito, 2006; Edwards, 2023; Levine & Zervos, 2023; Rodrik, 2023; Sachs & Warner, 2022).

Econometric Analysis

This study applies advanced econometric methods to analyze the relationship between financial development and economic growth, addressing cross-sectional dependence, stationarity, and long-term relationships to ensure robust findings.

Cross-Sectional Dependence

This is examined using the Breusch-Pagan LM test, the Pesaran scaled LM test, and the Pesaran CD test. The results indicate weak dependence among the variables, with Breusch-Pagan (30.9977, p = 0.0737), Pesaran scaled LM (1.5427, p = 0.1229), and Pesaran CD (1.8581, p = 0.0632) suggesting slight correlation (Pesaran, 2021; Breusch & Pagan, 2020). Driscoll-Kraay standard errors are used to adjust for heteroskedasticity and autocorrelation, ensuring robust estimates.

Table 2: Cross-Sectional Dependency Test Results

Test	Statistic	d.f.	p-value
Breusch-Pagan LM	30.9977	21	0.0737
Pesaran Scaled LM	1.5427	-	0.1229
Pesaran CD	1.8581	-	0.0632

Source: Own computation (2024)

Panel Unit Root Tests

Stationarity is tested using the Levin-Lin-Chu and Im-Pesaran-Shin tests. Results indicate that logGDPPC, logDC, and logMS are non-stationary at levels but become stationary after first differencing (I(1)), consistent with economic theory. Conversely, login is stationary at I(0), supporting mean reversion (Baltagi, 2021; Engle & Granger, 1987).

Table 3: Panel Unit Root Test Results Using Levin-Lin-Chu and Im-Pesaran-Shin Methods

Variable	Statistic (I(0))	p-value (I(0))	Statistic (I(1))	p-value (I(1))
logGDPPC	0.295	0.2280	-5.455	0.000
logDC	-1.171	0.867	-6.676	0.000
logMS	-1.151	0.869	-5.866	0.000
loginf	-3.661	0.000	-4.938	0.000
logGEX	-2.247	0.023	-2.001	0.022
logGCF	-1.622	0.334	-9.998	0.000
logtradop	-1.496	0.499	-8.685	0.000
logexr	-2.325	0.022	-2.023	0.022
logrem	-2.137	0.033	-1.834	0.033
Loghc	-1.560	0.415	-4.008	0.000
FD	-7.2424	0.000	-10.7534	0.000

Source:

Own computation (2024)

Cointegration Test

Long-term relationships among financial development, economic growth, and institutional factors are examined using the Pedroni and Kao cointegration tests. Both the Phillips-Perron and Augmented Dickey-Fuller statistics reject the null hypothesis of no cointegration at the 5% significance level, suggesting a significant long-term equilibrium relationship (Pedroni, 2004; Apergis & Payne, 2023).

Table 4: Kao Cointegration Test Results Indicating a Long-Term Equilibrium Relationship

Statistic	Value	p-value
Modified Dickey-Fuller t-statistic	-3.8527	0.0001
Dickey-Fuller t-statistic	-2.3487	0.0094
Augmented Dickey-Fuller t-statistic	-1.7291	0.0419
Unadjusted Modified Dickey-Fuller t-statistic	3.7936	0.0001
Unadjusted Dickey-Fuller t-statistic	-2.3314	0.0099

Source:

Own computation (2024)

Heteroskedasticity and Serial Correlation Tests

The Breusch-Pagan/Cook-Weisberg test confirms no heteroskedasticity ($\chi^2 = 2.12$, $p = 0.1449$), while the Wooldridge test detects first-order serial correlation, addressed by using panel-corrected standard errors (PCSE) (Breusch & Pagan, 1979; White, 1980).

Table 5: Heteroskedasticity and Serial Correlation Test Results for logGDPPC

Test	Variable	Null Hypothesis	Test Statistic (chi^2)	p-value
Breusch-Pagan/Cook-Weisberg	logGDPPC	Constant Variance (H_0)	2.12	0.1449

Source: Own computation (2024)

This econometric analysis provides compelling evidence of the significant relationship between financial development and economic growth. The stationarity tests indicate most variables are integrated of order one, and cointegration tests reveal a stable long-term relationship. Addressing cross-sectional dependence, heteroskedasticity, and serial correlation enhances the robustness of the results, offering valuable insights for policymakers aiming to leverage financial development as a tool for sustainable economic growth.

Bottom of Form

Discussions of Findings

Financial Development and Economic Growth in East Africa: Unraveling a U-Shaped Relationship

The analysis shows a U-shaped relationship between financial development (FD) and economic growth in East Africa, where growth stagnates initially but accelerates as financial development deepens (Aybar & Joyce, 2019). In the long run, FD positively impacts growth, with the Pooled Mean Group (PMG) model revealing a significant positive coefficient for FD^2, supporting financial deepening theory (César et al., 2022). However, the Mean Group (MG) and Dynamic Fixed Effects (DFE) models show mixed results, underscoring the complexity of this relationship (Table 6).

In the short term, FD exhibits moderate positive effects on economic growth, consistent with studies on developing economies (Mitra, 2020). The rise of financial technology, such as mobile banking and mobile money, has greatly enhanced financial inclusion in East Africa, boosting economic activity through accessible services like real-time price information and electronic transactions. The error correction term (ECT) indicates slow adjustment to long-term equilibrium aftershocks, pointing to inefficiencies and weak governance in the region, which hinder financial development's positive effects (Mitra, 2020). Policy implications include focusing on improving financial service access and expanding credit, particularly early in development.

Table 6. Financial Development and Economic Growth in East Africa

Dependent variable logGDPPC	PMG Coefficient	p-value	MG Coefficient	p-value	DFE Coefficient	p-value
Long -run coefficient						
L. FD2	138.491	0.003*	-21.68135	0.565	237.836	0.810
ECT	-0.004	0.785	-0.036467	0.092***	0.004	0.805
Short -run coefficient						
ΔFD2	5.732	0.081 ***	5.986757	0.071***	3.582	0.029 *
No. of observations	287					

Source: Own computation (2024), *p < 0.01 (1% significance level), ** p < 0.05 (5% significance level), *** p < 0.1 (10% significance level)

U-Shaped Relationship between Financial Development and Economic Growth: The Mediating Influence of Institutional Quality and ICT

The study highlights a U-shaped relationship between financial development (FD) and economic growth (EG), with significant effects observed in the Pooled Mean Group (PMG) model (L1. FD^2 = 2.799, p = 0.020), but not in the Mean Group (MG) and Dynamic Fixed Effects (DFE) models. This variation emphasizes the role of institutional quality (IQI) and information and communication technology (ICT) in mediating this relationship (Acemoglu et al., 2021). The PMG model shows a strong positive impact of IQI on EG (L1. IQI = 0.129, p < 0.001), indicating that stronger institutions promote financial efficiency and reduce rent-seeking behavior, but this effect is not consistently replicated in other models (Bai et al., 2022) (Table 7).

ICT, while promising as a driver of FD and economic growth, shows mixed results. The PMG model suggests a non-significant relationship between ICT and EG, which is consistent with studies that highlight barriers like insufficient digital literacy and infrastructure (Kim & Lin, 2022). Sharma et al. (2023) argue that ICT can facilitate financial intermediation, but its success hinges on improving human capital and digital inclusion.

The study also finds slow adjustment in the financial sector (EC = -0.077, p = 0.438), highlighting concerns about the pace of financial reforms. This finding aligns with Molla et al. (2022), who suggest that integrating education and infrastructure with financial liberalization can enhance economic convergence. Additionally, Sassi et al. (2023) caution that relying on aggregated indicators may obscure sectoral and regional disparities, urging the use of more granular data for better insights. Given these methodological inconsistencies, policymakers should approach the U-shaped hypothesis carefully. The effectiveness of FD on EG depends on institutional quality and ICT infrastructure readiness, emphasizing the need for targeted reforms.

Future research should explore disaggregated indicators and additional mediating factors like education and energy access (Adeniyi et al., 2021).

In conclusion, this study underscores the complex relationship between FD and EG, emphasizing the critical roles of institutional quality and ICT. Future empirical studies should refine econometric models to account for regional and sectoral differences, enabling more effective policy recommendations.

Table 7. U-Shaped Relationship between FD and EG: Mediating Roles of Institutional Quality and ICT

Dependent variable logGDPPC	PMG		MG		DFE	
D.logGDPPC	Coef.	P>z	Coef.	P>z	Coef.	P>z
__ec						
FD2						
L1.	2.799	0.020*	31.84	0.76	-144.629	0.295
L3.	1.942	0.118	-18.12	-0.77	-5.05015	0.928
IQI						
L1.	0.129	0.000*	-0.08	-0.21	-0.22169	0.711
L2.	-0.011	0.707	-0.13	-0.44	0.247103	0.658
ICTI						
L1.	0.016	0.171	-0.26	-1.25	0.544027	0.49
L2.	0.000	0.960	0.31	1.75	0.003338	0.994
SR						
__ec	-0.077	0.438	-0.09	-0.63	0.015128	0.28
FD2						
D1.	0.691	0.462	2.96	1.88	1.012646	0.301
IQI						
D1.	0.011	0.195	0.01	0.73	0.004019	0.541
ICTI	-0.003	0.691	-0.01	-0.81	0.002254	0.673
_cons	0.564	0.394	0.58	0.63	-0.10228	0.273

Source: Own computation (2024)

*p < 0.01 (1% significance level), ** p < 0.05 (5% significance level), *** p < 0.1 (10% significance level)

U-Shaped Relationship between FD and EG: Interaction with ICTI and Institutional Quality

The relationship between financial development (FD) and economic growth (EG) is complex and nonlinear, with recent studies emphasizing the roles of institutional quality and ICT infrastructure in shaping this dynamic. In the long term, financial development follows a U-shaped curve, with its positive impact on economic growth intensifying as financial systems mature. This is supported by a significant positive coefficient for FD^2, highlighting the key role of financial systems in capital allocation, investment stimulation, and transaction cost reduction (Beck et al., 2021). However, as economies reach a certain level of development, the positive effects of financial development may diminish, as indicated by the diminishing returns captured by the squared term (Rajan & Zingales, 1998). The interaction between financial development and institutional quality further enhances growth, with robust governance structures amplifying the positive impact of financial development on economic growth (Laeven & Levine, 2008). Nonetheless, the influence of institutional quality on financial development is context-dependent, as seen in the negative coefficient for FD^2IQI in the MG model (Table 8).

In the short run, financial development remains an important driver of economic growth, although its effect is weaker compared to the long run. The coefficient for FD^2 indicates a continued positive impact on growth, but with a more muted effect (King & Levine, 1993). The interaction between financial development and ICT infrastructure, however, shows a negative coefficient, suggesting that in the short term, ICT infrastructure may inhibit the growth-enhancing effects of financial development. This could be due to a lack of effective integration between the financial sector and ICT, which may cause inefficiencies (Gisselquist, 2017). Over time, as ICT infrastructure matures and becomes more integrated with financial systems, its positive effects on economic growth are likely to become more pronounced.

These findings offer valuable policy insights for achieving the Sustainable Development Goals (SDGs) and the African Union's Agenda 2063. Both institutional quality and ICT infrastructure are critical for maximizing the economic benefits of financial development. Policymakers should focus on improving the quality and efficiency of financial services rather than simply expanding financial systems (Beck et al., 2021). Strengthening institutional frameworks to ensure transparency, accountability, and financial inclusion is essential (La Porta et al., 2021). Governments should also adopt strategies for ICT development that ensure the effective integration of digital infrastructure with financial systems (World Bank, 2022). Continuous monitoring and evaluation of financial sector reforms will enable timely adjustments, ensuring that financial systems continue to support sustainable economic growth (Pesaran et al., 2001). In conclusion, achieving sustainable economic growth requires a comprehensive approach that considers the long-term effects of financial development, complemented by strong institutions and robust ICT infrastructure.

Table 8. U-Shaped Relationship between FD and EG: Interaction with ICTI and Institutional Quality

Dependent variable	PMG		MG		DFE	
logGDPPC						
logGDPPC	Coef.	P>z	Coef.	P>z	Coef.	P>z
Long run						
FD2						
L1.	481.761	0.000*	-4.147	0.220	-1.481	0.252
FD2IQI						
L1.	1.893	0.050*	-0.285	0.897	0.458	0.365
FD2ICTI						
L1.	-49.065	0.000*	1.835	0.229	0.000	
F2Q2ICT2						
L1.	0.872	0.789	-0.086	0.526	0.000	
Short run						
Error correction	0.747	0.000*	0.729	0.000*	0.999	0.000*
FD2	363.115	0.000*	-1.436	0.660	0.665	0.496
FD2IQI	1.080	0.206	1.478	0.020*	0.778	0.042
FD2ICTI	-36.731	0.000**	0.526	0.686	0.645	0.101
F2Q2ICT2	0.556	0.002	0.580	0.398	-0.016	0.175
FD2						
D1.	-360.20	0.000*	4.405	0.121	0.000	
FD2IQI	0.349	0.317	1.478	0.020*	0.778	0.042*
FD2ICTI						
D1.	37.500	0.000*	0.087	0.927	-0.205	0.613
F2Q2ICT2						
D1.	-0.710	0.001*	-0.609	0.184	0.004	0.746
FD2						
L2.	-1.309	0.556	-0.985	0.562	-0.818	0.434
FD2IQI						
L2.	0.478	0.682	0.387	0.748	-0.360	0.402
FD2ICTI						
L2.	-0.418	0.774	-0.010	0.995	-0.824	0.048*
F2Q2ICT2						
L2.	-0.151	0.617	0.222	0.310	0.023	0.104
_cons	1.626	0.073*	1.742	0.041*	0.009	0.918

Source: Own computation (2024), *p < 0.01 (1% significance level),** p < 0.05 (5% significance level),*** p < 0.1 (10% significance level)

Causality test

The Pairwise Dumitrescu-Hurlin Panel Causality Test (Table 9) reveals complex interrelationships among financial development, economic growth, ICT, and institutional quality in East Africa. The Zbar statistics at significance levels of 1%, 5%, and 10% confirm these linkages. A significant causality from economic growth (logGDPPC) to squared financial development (FD^2) is found at the 1% level (Zbar.stat = 1.637, p-value = 0.0001), suggesting a nonlinear relationship: financial development initially fosters growth, but its marginal effect diminishes beyond a threshold, aligning with the findings of Beck et al. (2000). The absence of causality from FD^2 to logGDPPC (p-value = 0.233) supports the finance-growth paradox (Rajan & Zingales, 2003), indicating that further financial expansion does not yield additional growth benefits, underlining the need for cautious financial sector management to avoid instability.

Economic growth also has a robust causal relationship with ICT development (logGDPPC → ICTI), with a Zbar.stat of 4.709 (p-value = 0.0000), confirming the role of ICT in driving economic performance by enhancing financial inclusion and market efficiency (Aker & Mbiti, 2010). The second lag of economic growth (L2 logGDPPC) significantly influences ICT development (Zbar.stat = 2.728, p-value = 0.0064), reinforcing the importance of past economic performance for future ICT infrastructure, which in turn boosts economic growth (Schwab, 2016). This feedback loop is particularly relevant for East Africa, where digital banking and mobile money are transforming the financial landscape (Mbiti & Weil, 2011).

The causality from economic growth to financial institutions (FI) and financial markets (FM) is marginally significant at the 10% level (Zbar.stats = 1.872 and 1.890, p-values = 0.0612 and 0.0587), suggesting that growth fosters the expansion of these sectors, essential for financial inclusion and further economic development (Honohan, 2004). However, these effects are weaker compared to those observed with ICT, emphasizing that institutional and regulatory frameworks are crucial for optimizing financial system performance.

Policy implications are clear: the connections between economic growth, ICT, and financial institutions underscore the need for strategic investments in ICT infrastructure and financial reforms to sustain growth. Additionally, the nonlinear relationship between financial development and growth indicates that financial sector deepening should be carefully managed to prevent overextension. Policymakers should focus on digital finance initiatives and ensure financial system resilience, in line with SDGs Goal 8 on inclusive economic growth and Goal 9 on resilient infrastructure (UN, 2015).

In conclusion, the Pairwise Dumitrescu-Hurlin Panel Causality Test highlights intricate relationships among financial development, economic growth, ICT, and institutional quality in

East Africa. Targeted policies balancing financial expansion with sustainability, prioritizing ICT development, and implementing institutional reforms are essential for aligning economic growth with the SDG and Agenda 2063.

Table 9. Pairwise Dumitrescu Hurlin Panel Causality Test

Direction	Zbar.stat	Prob
L. logGDPPC ⇒FD2	1.637	0.0001*
FD2⇒ logGDPPC	1.194	0.233
logGDPPC ⇒FD	1.410	0.1585)
L 2. logGDPPC ⇒FD2	1.637	0.1016***
logGDPPC⇒ ICTI	4.709	0.0000*
logGDPPC ⇒GEX	3.435	0.0006*
L2. logGDPPC⇒ ICTI	2.728	0.0064*
L2. ICTI ⇒ L2. logGDPPC	3.208	0.0013*
logGDPPC ⇒FI	1.872	0.0612***
FI ⇒ logGDPPC	1.1240	0.261
logGDPPC ⇒FM	1.890	0.0587***
FM ⇒LogGDPPC	1.3475	0.178

Source: Own computation (2024)

Note: The superscripts ***, ** and * denote the statistical significance at 1%, 5% and 10% levels, respectively

Summary, Conclusions, and Policy Implications

This study investigates the dynamic relationship between financial development (FD) and economic growth (EG) in East Africa, emphasizing the mediating roles of institutional quality (IQ) and information and communication technology (ICT). Empirical findings reveal a U-shaped relationship, suggesting that financial development alone does not guarantee economic progress unless complemented by strong governance and ICT penetration. Initially, FD may lead to inefficiencies due to weak institutions and regulatory gaps; however, as governance improves and ICT adoption increases, FD fosters growth (Beck & Levine, 2023). Institutional quality enhances financial efficiency by reducing transaction costs and improving investor confidence, ensuring optimal capital allocation (Acemoglu & Robinson, 2022). Furthermore, ICT-driven financial inclusion expands access to banking services, particularly through mobile technology, reinforcing financial deepening and economic stability (Kuteesa et al., 2023). Panel causality tests confirm bidirectional causality between FD and EG, indicating that financial sector expansion stimulates economic growth, which in turn strengthens financial markets and technological advancements. These findings necessitate a holistic policy framework integrating

financial, institutional, and technological strategies.

Conclusions

Findings underscore that FD's impact on EG is contingent upon governance structures and digital financial services. Without sound institutions and technological advancements, FD may lead to resource misallocation, speculative activities, and financial instability. However, when complemented by robust institutions and ICT, FD emerges as a catalyst for sustainable economic transformation. Thus, East African economies must adopt a multi-dimensional approach, incorporating institutional reforms, FinTech innovations, and regional cooperation to optimize FD's contribution to economic prosperity.

Policy Recommendations

To enhance financial development's effectiveness in fostering economic growth, a synergistic policy framework is required, integrating regulatory, technological, and economic strategies.

1. Strengthening Institutional Quality and Financial Governance

- Enhance regulatory frameworks to promote transparency, reduce market inefficiencies, and mitigate financial mismanagement (World Bank, 2023).
- Implement anti-corruption measures to strengthen public confidence in financial institutions and improve capital market efficiency.
- Develop financial dispute resolution mechanisms to prevent systemic risks and ensure a stable investment climate.

2. Leveraging ICT for Financial Inclusion and Efficiency

- Expand mobile banking and digital payment systems to bridge financial access gaps, particularly in rural areas (IMF, 2023).
- Increase broadband penetration to facilitate digital transactions and financial literacy programs, ensuring the widespread use of FinTech solutions (Kuteesa et al., 2023).
- Encourage the adoption of blockchain technology for secure, transparent financial transactions, reducing fraud risks and enhancing market efficiency.

3. Enhancing Regional Financial Integration

- Harmonize banking regulations across East African economies to enable seamless cross-border transactions and financial market stability.

- Develop regional investment frameworks to attract intra-African capital flows and enhance economic resilience (UNECA, 2023).
- Establish interconnected stock exchanges to improve market liquidity and promote diversified investment opportunities.

4. Promoting Inclusive Financial Policies

- Expand microfinance initiatives to support SMEs and informal sector enterprises, ensuring broad-based economic growth (Beck et al., 2022).
- Implement gender-responsive financial policies to enhance women's participation in formal banking and entrepreneurship.
- Provide incentives for FinTech startups to foster financial innovation and competition, improving service delivery and cost efficiency.

5. Developing a Resilient and Sustainable Financial Ecosystem

- Establish macro prudential regulations to mitigate financial instability and systemic crises (BIS, 2023).
- Promote green finance by integrating environmental, social, and governance (ESG) criteria into financial decision-making.
- Institutionalize long-term financial education programs to enhance savings culture and investment literacy among the population.

Future Research Directions

Further research should explore sector-specific FD impacts, comparing East Africa's financial trajectory with other emerging markets. Additionally, examining the role of financial regulation in preventing speculative bubbles and ensuring sustainable economic growth is essential. Future studies could also integrate artificial intelligence in financial analytics, providing insights into predictive modeling and financial risk assessment.

This study provides robust empirical evidence that financial development's impact on economic growth in East Africa is contingent upon institutional quality and ICT advancement. Policymakers must adopt a synergistic, multi-sectoral approach that aligns financial governance with technological transformation and regional integration. By implementing these strategies, East African economies can harness financial development as a sustainable driver of inclusive and long-term economic growth. Declarations: No funding was received for this study. Clinical trial number: not applicable. Ethics, Consent to Participate, and Consent to Publish declarations: not applicable.

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The Effect of E-Marketing on Consumer Purchase Intention: The Case of *Anbessa* Beer

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Abstract

This study examined how E-marketing practices influence the purchase intentions of Anbessa beer consumers. Using a quantitative approach, 384 questionnaires were distributed, yielding 376 valid responses. Descriptive statistics assessed respondent demographics, while multiple linear regression evaluated the effects of five independent variables—influencer marketing, mobile marketing, email marketing, social media marketing, and search engine optimization—on purchase intention, analyzed through the Statistical Package for Social Science (SPSS). The results showed that all eMarketing practices significantly enhanced purchase intention, with influencer marketing, social media marketing, and search engine optimization having the strongest impacts. Mobile marketing had a weak effect, and email marketing showed a negative but non-significant impact. Consequently, Anbessa beer should focus on improving influencer marketing, social media marketing, and search engine optimization to boost consumer purchase intentions. Although mobile marketing's effect was weak, it still warrants attention for potential enhancements. Email marketing should be reevaluated and possibly integrated with more effective strategies to better meet consumer expectations and improve overall marketing performance. These findings offer valuable insights for marketing managers, guiding them in refining eMarketing strategies to enhance consumer engagement and purchase intentions. The significant positive impacts of influencer marketing, social media marketing, and search engine optimization underscore their effectiveness in driving consumer behavior, highlighting the need to leverage these channels for increased brand visibility. The weak performance of mobile marketing indicates opportunities for improvement, while the negative impact of email marketing suggests a misalignment with consumer preferences. By reassessing and integrating email marketing with more successful strategies, Anbessa beer can better align its eMarketing efforts with consumer needs. Overall, this study provides clear guidance for marketing managers to refine strategies that drive consumer engagement and purchase intention, ultimately enhancing Anbessa beer's success in a competitive market.

Keywords: Email Marketing, Influencer Marketing, Mobile Marketing, Social Media Marketing, Search Engine Optimization, and Purchase Intention

Introduction

In the era of globalisation, where for search of information, services and goods are available at our palms and desks; marketing discipline comes to the first row in feeding information to the information seeker with tailored and compelling content for the information seeker to arrive at an informed decision. As the role of marketing is to inform, attract, educate, excite, and persuade people to buy information, services, or products, it aims to allure the perceptions of people in favour of the brand and its offering, with the goal of getting them to make a purchase and continue to make purchases in the future and to become return customers.

In recent times, due to the increase in online users, classic marketing has breached new boundaries through the extension of its tentacles in the internet area, and businesses are increasingly relying on e-marketing to support their marketing efforts. This is due to its paramount importance; it holds in today's business landscape for several reasons. E-marketing allows businesses to reach a global audience at a fraction of the cost of traditional marketing methods. It offers a level of personalization and customer engagement that is unparalleled, enabling brands to build stronger relationships with their audience. The digital nature of e-marketing is also allowing for real-time analytics and data-driven insights, helping businesses to adapt and optimize their strategies swiftly. In addition, when it is executed properly, the ROI, or return on investment, can be greater than more traditional marketing strategies.

In the past decades, e-marketing has become a vital component in an organization's overall marketing strategy. It allows companies to tailor messages to reach a specific audience, making it possible to market directly to people who are likely to be interested in their product. However, for organizations to succeed, they must find effective ways to spread the word about their products and services, and that's never been more challenging than today. Consumers face more choices from more providers, all clamouring for their attention. Deploying the right approach and using the right type of e-marketing platforms is one way to stand out from the crowd.

E-marketing is still developing in Ethiopia, with limited research on its impact on consumer purchase intention. Recently, the beer industry has experienced significant growth, attracting new competitors. This surge in competition, along with the ban on Above the Line advertising (TV, radio, OOH) for alcoholic beverages in May 2019, has led the beer sector to embrace e-marketing for brand communication. The researcher noted effective e-marketing practices among different breweries, prompting the focus on this industry. This study examines *Anbessa* beer to understand how e-marketing strategies—such as email marketing, influencer marketing, mobile marketing, social media marketing, and search engine optimization—affect consumer purchase intention.

Materials and Methods

According to Creswell (2013), quantitative research yields data that can be transformed into pertinent statistics, aiding in evaluating issues, extrapolating results from larger samples, and assessing attitudes, beliefs, behaviors, and specified criteria. In this study, the researcher has examined the relationship between e-marketing and purchase intention. A quantitative research approach was used to objectively analyze how various variables interact, employing a hybrid design that combines explanatory and descriptive research to assess e-marketing's impact on consumer purchase intention.

Explanatory research identified cause-and-effect relationships, while descriptive research detailed the characteristics of the population under study, addressing the how, what, when, and where of the research question.

As per Saunders and Lewis (2012), 'population' is defined as the complete set of group members. The target population comprised *Anbessa* beer consumers aged 21 and older who drink beer at least once a week, reside in Addis Ababa, possess Android or iOS devices, are educated, have at least one active social media account, and spend a minimum of thirty minutes daily online.

As the population size of *Anbessa* beer consumers was unknown, Cochran's formula was utilized to determine the necessary sample size, ensuring a desired level of precision based on the estimated proportion of the attribute, confidence level, and margin of error.

According to Saunders & Lewis (2012), probability sampling, often referred to as representative sampling, is commonly used in survey research to make inferences about a population and address research questions. By using probability sampling, researchers can generate statistically representative findings at a lower cost than data collection for the entire population. Hence, in this research, probability sampling was employed to ensure each population member had a known, non-zero chance of selection.

Lundahl & Skärvad (1992) claim that data can be categorized into primary and secondary data. Primary data is collected by the researcher specifically to address the research objective, while secondary data is pre-existing, collected for a different purpose by another individual. As per Kombo and Tromp (2006), primary data is obtained through questionnaires with structured, close-ended questions. Accordingly, in this research, primary data were collected through structured questionnaires targeting *Anbessa* beer consumers, while secondary data were derived from existing resources. The questionnaires included multiple-choice questions for descriptive analysis and a five-point Likert scale ranging from Strongly Agree (5) to Strongly Disagree (1) for explanatory analysis.

A pilot study assessed the questionnaire's clarity, leading to subsequent revisions based on feedback before distribution.

Both descriptive and inferential statistics were utilized to summarize population characteristics and analyze data. Descriptive statistics included mean, standard deviation, frequency percentages, and bar charts, while inferential statistics such as correlation and multiple linear regressions tested hypotheses and research objectives. The multiple linear regression model estimating the effect of e-marketing on purchase intention was specified as:

$$CPI = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

Where,

CPI = Consumer Purchase Intention derived from e-marketing in the beer industry

α = Constant

β = Coefficient of estimate

X_1= Search engine optimization

X_2 = Social media marketing

X_3 = Email marketing

X_4 = Mobile marketing

X_5 = Influencer marketing and

ε = the error term

As the objective of this study aimed at predicting the impact of e-marketing on *Anbessa* beer's purchase intention, correlation and multiple regressions were used to analyze data using SPSS.

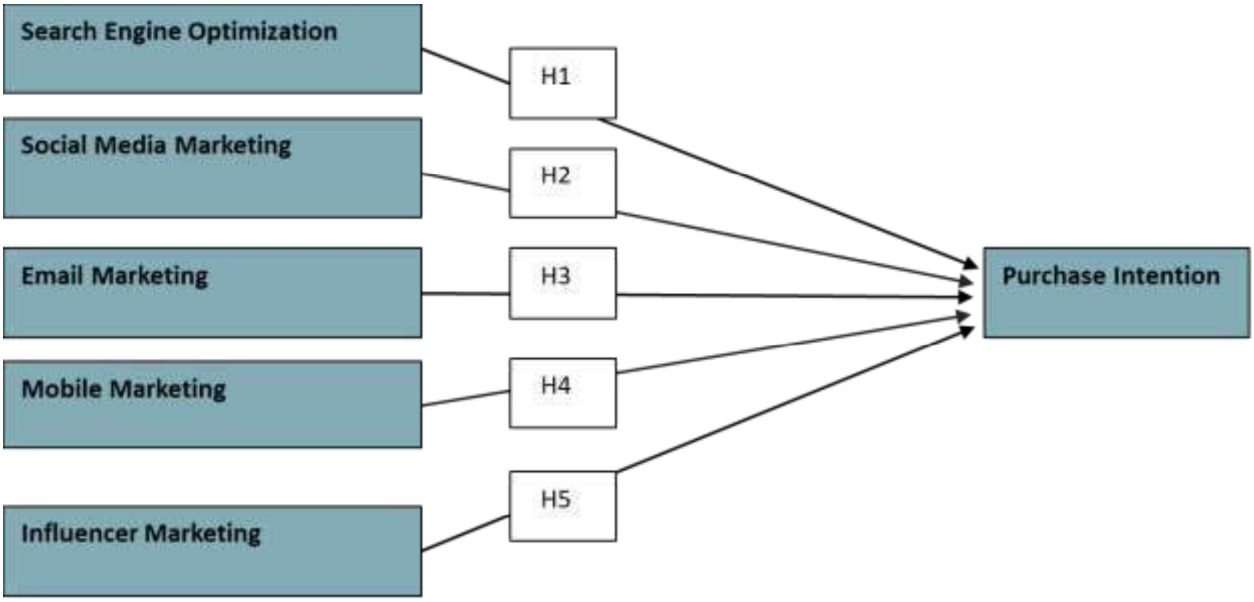
The validity of a measure is its ability to measure what it is meant to measure. There are various types of validity: content validity, criterion-related validity, construct validity, and face validity. Like other measures, a questionnaire needs to be valid to be effective; it must measure its intended purpose. Content validity, construct validity, and criterion-related validity are relevant to questionnaires (Rogers, 1995). In this research, the gathered information was evaluated for content validity, and strategies to ensure the validity and reliability of the measurement instruments included informing respondents about the study's significance, selecting model

variables based on theories and empirical evidence, conducting content and technical reviews, and utilizing expert feedback along with pilot tests.

According to Joppe (2000), reliability pertains to the consistency of results over time and their accuracy in representing the entire study population. If a study's results can be replicated using a similar methodology, the research instrument is considered reliable. Yin (2003) further explains that reliability involves the absence of random error, allowing subsequent researchers to reach the same conclusions if they were to conduct the study in the same manner again. Cronbach's alpha, the most popular test of consistency reliability, is a measure used to assess the reliability, or internal consistency, of a set of scale or test items. In other words, the reliability of any given measurement refers to the extent to which it is a consistent measure of a concept, and Cronbach's alpha is one way of measuring the strength of that consistency (Goforth, 2015). Cronbach's alpha, a measure of internal consistency reliability, was employed to assess the questionnaire's reliability, with a benchmark of 0.7 for adequate consistency. A pilot sample test was conducted, and items with Cronbach's alpha values of 0.7 or higher were retained.

To develop the conceptual framework, the Hierarchy of Effects theory and the Uses and Gratification theory were analyzed concerning the influence of eMarketing on consumer purchase intention. Integrating these theories offers new insights and enhances the understanding of E-marketing's effect. The Uses and Gratification theory uncovers consumers' gratification-seeking beliefs and motives related to E-marketing. Conversely, the Hierarchy of Effects theory establishes a firm basis for assessing consumers' behavioral intentions post-exposure to E-marketing messages. Accordingly, five independent variables were developed as presented in the below figure. The conceptual framework was structured with the independent variables "Search Engine Optimization," "Social Media Marketing," "Email Marketing," "Mobile Marketing," and "Influencer Marketing," while the dependent variable "Purchase Intention" was identified in the study. Hence, this study has utilized the model depicted in Figure I below.

Figure 1: Conceptual Model



Source: Own Compilation (2024)

Research Hypothesis

Search Engine Optimization: Search engine optimization is the science of improving a website to increase its visibility on search engine results pages when people search for products or services (Ramos and Cota, 2009). Several empirical studies highlight the effectiveness of search engines. According to Chan et al. (2011), consumers acquired through paid searches tend to make more purchases and exhibit a higher customer lifetime value compared to those gained through other online or offline channels. Furthermore, Dinner et al. (2014) found that paid search advertising outperforms offline advertising.

H1: Search engine optimization has a positive and significant effect on E-marketing on consumer purchase intention.

Social Media Marketing: Social media marketing is a type of digital marketing that uses social media platforms to promote a brand and offerings to an ideal customer (Baluch & Main, 2025). Forbes (2013) notes that social media influences purchasing behavior across all products and services. Consumers' decisions can be shaped by quality, brand, advertising, or pricing. The study found that customers tend to buy low-cost or high-cost items based on recommendations from their social media contacts. Additionally, commercial advertising on social media impacts both brand perceptions and purchasing intentions (Yang, 2012).

H2: Social media marketing has a positive and significant effect on E-marketing on consumer

purchase intention.

Email Marketing: Email marketing is a form of digital marketing that refers to the use of email to attract, engage, and communicate with potential and existing customers (AMA, 2024). Hartemo (2016) observes that customers now anticipate regular email communication with businesses, a trend influenced by advancing technology. Chaffey et al. (2009) highlight the importance of email marketing for organizations aiming to enhance customer relationships, utilizing a permission-based model that lets clients opt in to receive emails (Davis et al., 2010). Nonetheless, differentiating between solicited and unsolicited emails continues to pose a challenge.

H3: Email marketing has a positive and significant effect on eMarketing on consumer purchase intention.

Mobile Marketing: Mobile marketing refers to the practice of promoting products and services through the use of mobile devices like smartphones and tablets (Bhasin, 2024). Mobile marketing is gaining traction among retailers, enhancing customer acceptance and delivering strong returns on investment (Kleijnen & Dickinger, 2008). It enables retailers to collect detailed consumer behavior data, making data management essential in retail (Verhoef et al., 2010). Shankar et al. (2010) highlight that mobile marketing transforms the retail landscape from consumers visiting stores to retailers engaging with them via mobile devices anytime, anywhere.

Nysveen et al. (2005) found that mobile channels improve brand satisfaction and marketing effectiveness in both direct and indirect customer interactions, as well as traditional channel usage. Retailers send periodic messages to customers who opt in for marketing communications, often incorporating static images or videos to promote new products or special offers. Successful mobile advertising depends on persuading consumers to opt in, using concise text, and ensuring message relevance (Blum and McClellan, 2006).

H4: Mobile marketing has a positive and significant effect on E-marketing on consumer purchase intention.

Influencer Marketing: Influencer marketing is a collaboration between popular social media users and brands to promote brands' products or services (2023). Chen et al. (2024) studied the effects of influencer marketing on consumer purchase intentions related to light and healthy eating. Their findings indicate that influencer credibility, professionalism, and live- streaming sales significantly boost consumers' willingness to buy, demonstrating the positive impact of influencer marketing on E-marketing and enhancing consumer purchase intention.

H5: Influencer marketing has a positive and significant effect on E-marketing on consumer

purchase intention.

Approval for the study was sought from St. Mary's University School of Business, Department of Marketing Management, and formal consent was obtained from participants before data collection. Respondents' rights were protected by anonymizing their information; ensuring participation was voluntary, and clearly communicating the research's purpose.

Results and Discussions

Descriptive Analysis

The mean value reflects the average response of a sample population to a specific question, calculated by summing all individual responses and dividing by their number. A higher mean signifies a more favorable perception or greater agreement among respondents, while a lower mean suggests the opposite (Hassan, 2024). Standard deviation, as noted by Rumsey (2023), measures the average distance of each data point from the mean. A smaller standard deviation indicates that the data points cluster closely around the mean, showing less variability, while a larger standard deviation indicates a wider spread from the mean, demonstrating greater variability.

The table below presents descriptive statistics for five independent variables: Search Engine Optimization (SEO), Social Media Marketing (SMM), Email Marketing (EM), Mobile Marketing (MM), Influencer Marketing (IM), and the dependent variable Purchase Intention (PI).

Table 1: Descriptive Statistics

Descriptive Statistics			
	N	Mean	Std. Deviation
SEO	376	8.83	2.731
SMM	376	14.17	3.224
EM	376	9.05	3.089
MM	376	9.08	3.046
IM	376	13.24	3.448
PI	376	13.49	3.436

Source: Survey result, 2024

For Search Engine Optimization (SEO), the mean score is 8.83. Social Media Marketing (SMM) has the highest mean score among all variables at 14.17. Email Marketing (EM) has a mean

score of 9.05, while Mobile Marketing (MM) has a mean score of 9.08. Influencer Marketing (IM) has a mean score of 13.24. The mean score for Purchase Intention (PI) is 13.49. The standard deviation measures the variability or dispersion of scores around the mean. For SEO, the standard deviation is 2.731, indicating moderate variability in responses. SMM has a standard deviation of 3.224, indicating higher variability compared to other variables. The standard deviation for EM is 3.089, and for MM, it is 3.046. IM has the highest standard deviation at 3.448, suggesting considerable variability in responses. The standard deviation for PI is 3.436.

From the data, Social Media Marketing (SMM) and Influencer Marketing (IM) have the highest mean scores, suggesting these practices are perceived more favorably or used more frequently by respondents. The high standard deviation values for SMM, IM, and PI indicate a broader range of responses, reflecting diverse perceptions or experiences among respondents regarding these marketing practices and their impact on purchase intention.

Correlation Analyses

Correlation analysis is a statistical method for evaluating the strength of relationships between two quantitative variables. To study the connections among influencer marketing, mobile marketing, email marketing, social media marketing, search engine optimization, and purchase intention, Pearson's correlation coefficient is used to measure the degree of linear association between these variables. Pearson's coefficient, as described by Malhotra et al. (2007), ranges from -1.0 to +1.0 and indicates the strength and direction of the association between two variables. A correlation between 0 and 1 shows a positive relationship, while 0 indicates no relationship. A value of 1 reflects a perfect positive relationship, -1 denotes a perfect negative relationship, and values between -1 and 0 signify a negative relationship. Results below ±0.61 are considered to indicate a low strength of relationship (Hanuman et al., 2011).

The below table presents the results of the correlation analysis between the independent (influencer marketing, mobile marketing, email marketing, social media marketing, search engine optimization) and dependent variable (purchase intention). The table provided shows linear and positive correlation coefficients ranging from weak to strong.

Table 2: Pearson Correlation Analyses

		PI	IM	MM	EM	SMM	SEO
PI	Pearson Correlation	1	.70**	.32**	.28**	.64**	.51**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	376	376	376	376	376	376
IM	Pearson Correlation	.70**	1	.36**	.31**	.62**	.39**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	376	376	376	376	376	376
MM	Pearson Correlation	.32**	.36**	1	.93**	.28**	.50**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	376	376	376	376	376	376
EM	Pearson Correlation	.28**	.31**	.93**	1	.25**	.50**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	376	376	376	376	376	376
SMM	Pearson Correlation	.64**	.62**	.28**	.25**	1	.34**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	376	376	376	376	376	376
SEO	Pearson Correlation	.51**	.39**	.50**	.50**	.34**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	376	376	376	376	376	376
**. Correlation is significant at the 0.01 level (2-tailed).							

Source: Survey result, 2024

Table 2 demonstrates significant positive correlations: Influencer marketing and purchase intention ($r = .70$, $p < 0.01$), mobile marketing and purchase intention ($r = .32$, $p < 0.01$), email marketing and purchase intention ($r = .28$, $p < 0.01$), social media marketing and purchase intention ($r = .64$, $p < 0.01$), and search engine optimization ($r = .51$, $p < 0.01$), all statistically significant at the 99% confidence level. Notably, the correlation between influencer marketing and purchase intention is the strongest among these variables.

Regression Analyses

Regression analysis was conducted to determine the independent variable with the greatest and least impact on the dependent variable, as well as to assess the influence among the independent variables.

Multi-Collinearity Test

Multi-Collinearity occurs when independent variables in a regression model are correlated, which poses a problem since these variables should ideally be independent. Multi-collinearity can affect regression models with one or more predictors. Perfect multi-collinearity occurs when the correlation coefficient, r, is exactly +1 or -1.

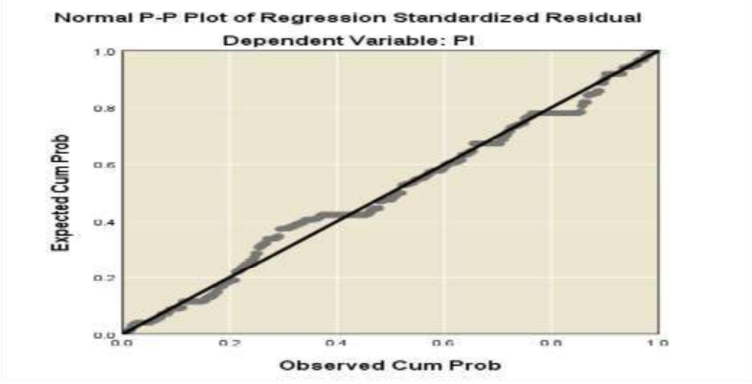
Table 3: Correlation between each variable

	IM	MM	EM	SMM	SEO
MM	.36	1			
EM	.31	.93	1		
SMM	.62	.28	.25	1	
SEO	.39	.50	.50	.34	1

Source: Survey result, 2024

Linearity Test

The assumption of linearity between the dependent and independent variables can be tested by generating a scatter plot of x vs. y. This visual representation helps to reveal whether the points appear to align along a straight line, indicating a linear relationship and confirming the assumption. Figure 2: Normal P-P Plot of Purchase Intention

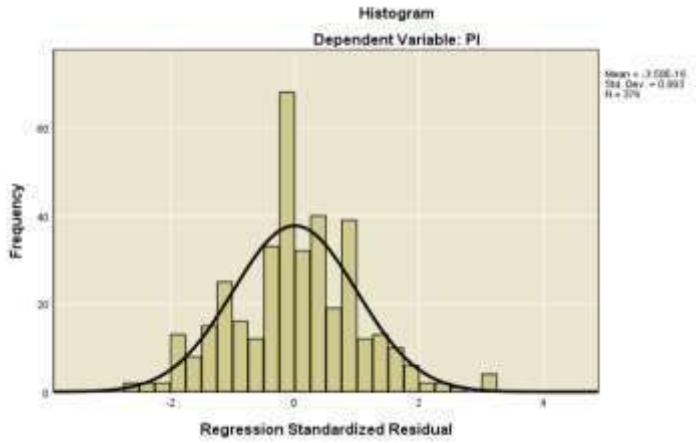


Source: Survey result, 2024

Normality Test

Normal distribution is essential for linear regression analysis. A Q-Q plot effectively evaluates this assumption by showing if the residuals are normally distributed. Additionally, skewness and kurtosis are checked, usually falling within ±1. The following table demonstrates that this study satisfies the normality assumption.

Figure 3: Normal Distribution Curve

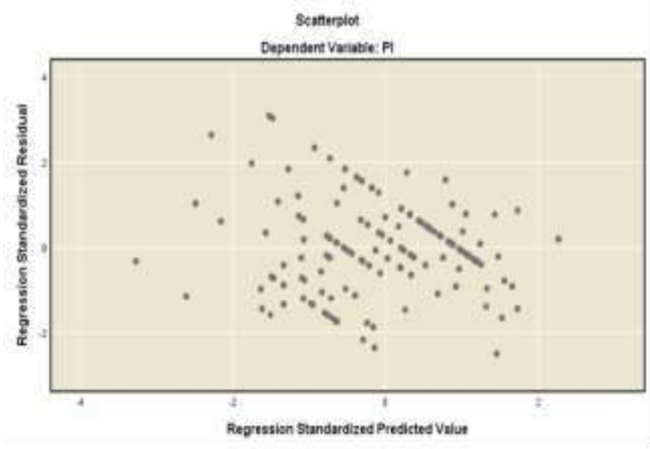


Source: Survey result, 2024

Homoscedastic Test

A key assumption of linear regression is that the residuals have constant variance across all levels of x, known as homoscedasticity. To detect heteroscedasticity, a straightforward approach is to create a scatter plot of fitted values versus residuals after fitting the regression line to the data.

Figure 4: Scattered plot



Source: Survey result, 2024

Multiple Regression Analysis

Regression analysis was conducted to evaluate the impact of eMarketing on consumer purchase intention for *Anbessa* Beer. The model incorporates all variables: influencer marketing, email marketing, search engine optimization, social media marketing, and mobile marketing. The findings of the regression analysis are summarized in the table below.

Table 4: Regression Model Summary

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.783[a]	.613	.607	2.153	.969
a. Predictors: (Constant), IM, EM, SEO, SMM, MM					
b. Dependent Variable: PI					

Source: Survey result, 2024, marketing and mobile marketing.

As shown in table XXIV, the value of R square was 0.613. This value tells how much of the variance within the dependent variable purchase intention is clarified by the model. It shows the percentage of the response variable between the value of 0 and 100%. This summary is utilized to recognize the effect of eMarketing on consumer purchase intention of *Anbessa* Beer. As it is shown within the table, R squared is 0.613 and adjusted R squared is 0.607 proposing that that

61% variation in the dependent variable is clarified by the independent variables utilized in the model. This implies that 61% of the variation in purchase intention is influenced by influencer marketing; email marketing, search engine optimization, and social media. The Durbin Watson (DW) statistic shows for autocorrelation within the residuals from a statistical regression analysis. The DW statistics always have a value between 0 and 4. A value of 2 implies that there's no autocorrelation identified within the sample, whereas values from 0 to less than 2 show positive autocorrelation and values from 2 to 4 show negative autocorrelation. For this model the Durbin Watson was 0.969, which is within the acceptable suggested range, and so the model is fit and appropriate in predicting the effect of E-marketing on purchase intention.

Hypothesis Result

Table 5: Hypothesis Result

Hypothesis Formulated	Beta Value	Significance	Relationship	Result
H_1: Search engine optimization has a positive and significant effect on purchase intention of *Anbessa* beer consumers.	**.28**	**.000**	Positive	Supported
H_2: Social media marketing has a positive and significant effect on purchase intention of *Anbessa* beer consumers.	**.29**	**.000**	Positive	Supported
H_3: Email marketing has a positive and significant effect on purchase intention of *Anbessa* beer consumers.	**-.08**	**.386**	Negative	Not Supported
H_4: Mobile marketing has a positive and significant effect on purchase intention of Anbessa beer consumers.	**.01**	**.885**	Positive	Not Supported
H_5: Influencer marketing has a positive and significant effect on purchase intention of *Anbessa* beer consumers.	**.43**	**.000**	Positive	Supported

Source: Survey result, 2024

Discussions

H_1: The beta value is 0.28 at a 99% confidence interval ($p<0.01$), indicating a significant positive relationship between search engine optimization and consumer purchase intention. This suggests that effective SEO strategies enhance the likelihood of consumers purchasing *Anbessa* beer. The hypothesis is supported, showing that improved SEO practices can lead to better E-marketing outcomes and increased consumer purchase intentions.

H_2: The beta value is 0.29 at a 99% confidence interval ($p<0.01$), indicating a significant positive relationship between social media marketing (SMM) and consumer on the purchase intention.

This suggests that effective SMM strategies enhance the likelihood of purchasing *Anbessa* beer, supporting the hypothesis that SMM significantly influences consumer buying decisions. Therefore, investing in social media marketing is crucial for improving brand visibility, engaging potential customers, and ultimately boosting *Anbessa* beer sales.

H_3: Based on the result, the beta value is -0.08 at a 99% confidence interval ($p<0.01$), and this shows a negative relationship. The results show no positive and significant relationship between search engine optimization and consumer purchase intention. Instead, the findings indicate a significant negative effect of SEO on E-marketing and on the purchase intention for *Anbessa* beer. This means that the current SEO strategies may be negatively impacting the likelihood of consumers purchasing *Anbessa* beer. The hypothesis that proposed a positive and significant effect is therefore rejected, highlighting the need for re-evaluating and improving SEO practices to better support E-marketing and consumer purchase intentions.

H_4: The beta value is 0.01 at a 99% confidence interval ($p<0.01$), indicating a positive but insignificant relationship between mobile marketing and consumer on the purchase intention. This implies that current mobile marketing efforts do not significantly drive consumers to purchase *Anbessa* beer, leading to the rejection of the hypothesis, which expected a significant effect. This finding highlights the need to reevaluate mobile marketing strategies to better influence consumer purchase intentions for *Anbessa* beer.

H_5: The beta value of 0.43 at a 99% confidence interval ($p<0.01$) indicates a significant positive relationship between influencer marketing and consumer on the purchase intention. This implies that effective influencer marketing strategies increase the likelihood of consumers purchasing *Anbessa* beer. The support for the hypothesis highlights the crucial role of influencer marketing in driving consumer purchase intentions, emphasizing the need to invest in such strategies to enhance brand visibility, engage potential customers, and ultimately boost sales for *Anbessa* beer.

In summary, the findings emphasize the importance of optimizing E-marketing strategies to enhance consumer purchase intentions. While SEO and SMM show significant positive effects, mobile marketing requires further optimization, and influencer marketing stands out as a highly effective approach. These insights can guide marketing managers in refining their strategies to achieve better E-marketing outcomes and increased consumer engagement.

Conclusion

Research findings indicate that among five independent variables, three significantly and positively influence consumers' purchase intention for *Anbessa* beer, while one has a positive but insignificant effect, and another has a negative yet insignificant effect. Influencer marketing has

the greatest impact on purchase intention, whereas email marketing shows no effect, and mobile marketing has the least effect.

The results suggest that 61% of the variance in consumers' purchase intentions is explained by social media marketing, influencer marketing, search engine optimization, email marketing, and mobile marketing. The remaining 39% of variance is attributed to other factors that the organization should consider when evaluating E-marketing. Furthermore, the analysis highlights the importance of understanding the underlying mechanisms by which these marketing strategies influence consumer behavior. Specifically, the interaction between influencer marketing and social media platforms creates a powerful synergy that can effectively enhance brand visibility and consumer trust. This aligns with existing literature that emphasizes the role of credibility and relatability in driving purchase intentions through endorsements from trusted figures.

Moreover, while email marketing did not show a significant effect in this study, it may still play a role in customer retention and information dissemination, particularly for repeat customers. Organizations might want to rethink their approach to email marketing by tailoring content to better meet consumer expectations or by integrating it with other strategies, such as personalized offers linked to influencer campaigns.

Mobile marketing, despite its limited impact in this research, remains a critical channel, especially with the increasing reliance on mobile devices for shopping and communication. Companies are encouraged to innovate within this space, perhaps by leveraging location-based services or enhancing user experience through streamlined mobile applications.

The investigation's findings and recommendations seek to improve the organization's E--marketing strategies and address the factors affecting *Anbessa* beer consumers' purchase intentions.

Given that influencer marketing has the greatest impact on purchase intention; it is recommended to continue investing in partnerships with influencers who resonate with the target audience. This can enhance brand visibility and consumer trust.

Utilize the synergy between influencer marketing and social media platforms to create engaging and relatable content that drives purchase intentions. This aligns with existing literature emphasizing the role of credibility and reliability in driving purchase intentions through endorsements from trusted figures.

Use targeted advertising on social media platforms to reach specific demographics and increase the effectiveness of marketing efforts.

Focus on creating high-quality, relevant content that improves search engine rankings and drives organic traffic to the website.

Use email marketing to retain existing customers by providing valuable information, updates, and exclusive deals. Although email marketing did not show a significant effect in this study, it may still play a role in customer retention and information dissemination, particularly for repeat customers.

Leverage location-based services to provide personalized offers and promotions to customers based on their geographic location. Despite its limited impact in this research, mobile marketing remains a critical channel, especially with the increasing reliance on mobile devices for shopping and communication.

In light of the findings, it is crucial for *Anbessa* beer to continually evaluate their E-marketing strategies and to remain agile in adapting to emerging trends and consumer preferences. Additionally, further research should delve into the 39% of variance unexplained by the variables examined here. This could include investigating demographic factors, cultural influences, or economic conditions that could affect purchase intention and exploring untapped marketing avenues that might resonate with their target audience. By doing so, the organization can develop a more holistic marketing strategy that not only drives immediate sales but also fosters long-term customer loyalty and brand equity.

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Legal space for the creation and Operation of Fintech in Ethiopia

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Abstract

The digital economy is reshaping the global financial system, driving the transformation and development of financial technology irreversibly. Fintech, which combines such technology and financial services, has revolutionized how businesses can run. The use of such tools has been steadily increasing in Ethiopia in the last few years and is expected to grow fast. The country's financial regulator, the National Bank of Ethiopia, is amending a decade-old payment system law, allowing foreign investors to set up business in this country. The delicate nature of financial systems imperatively requires legal and regulatory systems to regulate fintech creation and operations. Yet activities related to fintech are inadequately addressed by the current law in place. The legal or regulatory response is unclear due to the novelty of the products, services, and players. Because of these fragmented and inconsistent regulatory environments, examining Ethiopia's legal landscape and regulatory frameworks for fintech has become critical. This article, dedicated to such an end, analyzes the legal regime for the creation and operation of fintech under the National Bank of Ethiopia regulatory framework. The investigation employed a mixed research methodology with dominant qualitative data generating tools. The evidence from the investigation shows that the Ethiopian law in place today does not include technology assessments for fintech. Additionally, current regulations on fintech are insufficient because they do not address consumer protection and maintaining consumer trust procedures. Accordingly, the evidence suggests that lawmakers create a comprehensive regulatory framework to manage fintech and pave the way for a healthy development of financial technology.

Key Terms: Fintech, Finance, Regulatory Framework, Technology

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Introduction

Over the last two decades or so, the world economy has undergone a thorough modernization and digitalization across sectors. The enabling tools for such transformations are a package of financial technologies widely termed as fintech. This set of tools combines the use of technology, innovation, and automation to improve financial services. The tools are increasingly recognized as key enablers for financial sectors, enabling more efficient and competitive financial markets worldwide.[2] In a more unprecedented magnitude, digital fintech tools are allowing access for financial services to unbanked areas in emerging economies. As such, they permit customers to access financial services at an affordable price, increase convenience, improve financial inclusion, and boost productivity gains.[3] Such rapid advances in technology are changing the landscape of the financial sector with more products continually added to the developing system.

Fintech, as a recent concept, has no agreeable definition. For financial practices experts such as Varga,- it refers to companies that develop financial services and products by relying much on intense information technology[4]. Schueffel, a scholar who reviewed more than 200 articles in the scholarly discourse,[5] defined this concept as a new financial industry that uses technology to improve economic activities. Apart from individual scholars and practitioners, institutions define the concept in terms of its role in institutional operation and transformation. To this end, the Financial Stability Board (FSB)[6], describes it as "… financial innovation made possible by technology that could lead to new business models, applications, processes, or products that would significantly affect financial markets and institutions as well as the provision of financial

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[2]Boeddu,Gian Luciano and Chien,Jennifer, Consumer Risks in *Fintech* : New Manifestations of Consumer Risks and Emerging Regulatory Approaches : Policy Research Paper (English). Finance, Competitiveness and Innovation Global Practice Washington, D.C. : World Bank Group (2023) ,available at http://documents.worldbank.org/curated/en/515771621921739154/Consumer-Risks-in-*Fintech*-New-Manifestations-of-Consumer-Risks-and-Emerging-Regulatory-Approaches-Policy-Research-Paper last accessed on 23,January 2023.

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[4] Varga, D. '*Fintech*, the new era of financial services', Budapest Management Review, (November, 2017), p.12.

[5] Schueffel, P. Taming the beast: a scientific definition of *Fintech*. Journal of Innovation Management, Vol 4, No 4, (2016), p.32.

[6] The Financial Stability Board is an international body that monitors and makes recommendations about the global financial system. It was established after the G20 London summit in April 2009 as a successor to the Financial Stability Forum.

services."[7]Although there are some differences in the scope and perspectives of the definitions for this concept, there are three common core elements that underlie its essence: new technology, finance, innovation, and efficiency.

The three elements take the center stage in the definitions, signifying that there is a symbiotic relationship between technological revolutions and business practices, including the legal operations of institutions. Experience shows that some technological innovations lead to the modification of business practices, resulting in changes in the law. But the pace of these changes varies. Legal systems may need time to reflect on the implications of progressive technological changes and develop a consistent, predictable, and flexible response to new challenges.

The National Bank of Ethiopia, which regulats the country's financial system, has undergone tremendous changes in the last decade or so. Among others, it is amending a payment system law that has been in force for ten years. The new law is meant to allow foreign and domestic investors to establish businesses in Ethiopia as providers of digital financial services.[8] It will pave the way for fintech to contribute to the growth of Ethiopia's economic and financial environment. Until recently, the payment services sector in Ethiopia was exclusively reserved for two types of financial institutions: banks and microfinance institutions. The major shift from such market players happened recently with the recognition of nonbank digital financial service providers (fintech).

The regulatory framework for fintech is poorly defined worldwide.[9] Also, the Ethiopian jurisdiction has no well-regulated laws covering fintech in general. There are only sporadic laws, yet not concise enough to regulate the specific area of Fintech.

This gap in the law is so clear that it requires the formulation of sound regulatory systems that regulate the fintech creation and operation. Moreover, due to the novelty of the products, services, players, and the sporadic legal/regulatory response are not always clear. As a result, courts may risk making inconsistent rulings, and swing towards approaches that may not always

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[7] Johannes Ehrentraud, &Denise Garcia, Policy responses to fintech: a cross-country overview, Financial Stability Institute, FSI Insights on policy implementation No 23, (January, 2020), p.6. available at https://www.bis.org/fsi/publ/insights23.pdf last accessed January 26.

[8] Hawi Dadhi .Why Ethiopian local fintech are worried, (2022), available at https://qz.com/africa/2175298/why-ethiopias-local-*Fintech*s-are-worried last accessed on February 4, 2023.

[9] Matthias Lehmann. Global rules for a global market place? Regulation and supervision of *Fintech* providers, Boston university international law journal vol. 38, No, 1, (2020), p. 142.

be the most appropriate option given the context of a specific jurisdiction.[10] Thus, ensuring a level playing field between regulated financial institutions and fintech players and amongst them remains a challenge.

Against this background, financial services are among the most heavily regulated sectors in the world. Not surprisingly, regulation has emerged as governments' first concern as Fintech companies take off. As technology is integrated into financial services processes, regulatory problems for such companies have multiplied. In some instances, the issues are a function of technology. In others, they reflect the tech industry's impatience to disrupt finance.[11]

Looking into the service providers, one could find highly emerging Fintech organizations to provide financial services in Ethiopia. Some of them could be privately owned or owned by the government; it could also be independently providing financial services or fintech with other financial organizations. These irregularities of regulation could constrain fintech provider customers, and this in turn might open a space for an individual to infringe on users' interests.

Against this backdrop, this article examines the Ethiopian legal regime in terms of its potential to regulate the creation and operation of fintech. The study employed mixed doctrinal and empirical methodology to explore governing rules and the practical regulatory framework.

Overview of Fintech in General

Meaning of Fintech

The supply of financial services is being challenged by a new industry called Financial Technology (fintech), which combines cutting-edge technology and innovation to improve financial operations.[12] Fintech uses technology creatively to build and provide financial services and solutions. As such, fintech often addresses every facet of the connection between a bank and its customers and develops cost-effective, more convenient, and generally more effective digital

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[10] Financial Stability Implications from fintech, Supervisory and Regulatory Issues that Merit Authorities' (Jan. 23,2023)available at https://www.fsb.org/wp-content/uploads/R270617.pdf last accessed on February23.2023.

[11] The *Fintech* Industry: Definition, Landscape, and Companies,(Jan.25,2023)available at https://academy.apiary.id/blog/the-*Fintech*-industry-definition-landscape-and-companies.last accessed on Feb ruary 23,2023.

[12] Silva, L. A., Financial inclusion in the age of *Fintech*: a paradigm shift. Fourth FSI-GPFI conference on standard-setting bodies and innovative financial inclusion: implications of *Fintech* and other regulatory and supervisory Developments, Switzerland: Basel. (2018), p. 4.

substitutes. It has developed into a platform that connects banks with essential service providers like utilities, telecom, transit, card programs, shops, healthcare, and education, among others.[13]

Since internet technology began to penetrate the financial market, all financial fields involving computer technology, such as blockchain technology, cloud computing technology, digital information technology, and network communication technology, have been called financial technology. Fintech refers to any digital service a consumer uses to manage their money, including online banking, payments, investing, savings, budgeting, and borrowing[14]. Fintech businesses can offer more creative and customer-focused business models. In contrast to traditional financial services, which came under urgent pressure to revisit their business models and change their strategies to be more competitive, these disruptive businesses are steadily gaining market share and profitability.[15]

In Ethiopia, any business that seeks to become a digital financial service provider has two options. Either it can become a payment instrument issuer (electronic money issuer) or a payment system operator. Payment instrument issuers are digital wallet operators or digital banks obliged to guarantee their customers' electronic deposits with a guarantee deposit in one of the commercial banks of Ethiopia. This is an obligatory requirement to safeguard financial stability if they go bankrupt. According to Licensing and Authorization of Payment Instrument Issuers Directive No. ONPS/01/2020 Article 6(1), a payment instrument issuer may be allowed to provide the following services:[16]

Cash-in and cash-out.

Local money transfers, including domestic remittances, load to the card or bank account, and transfer to the card or bank account.

Domestic payments, including purchases from physical merchants and bill payments.

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[13] Mehrotra, A. Financial Inclusion through *Fintech* – A Case of lost focus. International Conference on Automation, Computational and Technology Management (ICACTM), Dubai, UAE. (2019), p. 5.

[14] Liudmila Zavolokina, & Mateusz dolata, The *Fintech* phenomenon: antecedents of financial innovation perceived by the popular press. (2016), P.16. Available at https://jfin-swufe.springeropen.com/ articles/10.1186/ s40854-016-0036-7 last accessed on February 25.2023.

[15] Nicoletti, B. The Future of *Fintech*. Rome, Italy: Palgrave Studies in Financial Services Technology, (2017), Available at https://link.springer.com/book/10.1007/978-3-319-51415-4 last accessed on 26, February 2023.

[16] Licensing and Authorization of Payment Instrument Issuers, Directive No. ONPS/01l2020,article 6(1)

Over-the-counter transactions, and

Inward international remittances.

A customer of a payment instrument issuer has a daily transaction limit (5,000 ETB) and deposit limit (30,000 ETB).[17] Its services are expected to cater to small-value retail transactions and peer-to-peer sending for the market. The newly introduced Tele Birr mobile service is licensed under this category. In addition, all bank wallet services, such as Coop Pay, CBE Birr, and Amole, fall into this category. As per Article 6 (2),[18] based on written approval of the National Bank, a licensed payment instrument issuer under the full responsibility of and written outsourcing agreement with a regulated financial institution and pension funds may be allowed to provide micro-saving products, micro-credit products, micro-insurance products, or pension products.

On the other hand, payment system operators are fintech companies that focus on payments between consumers and merchants. A payment system operator cannot perform cash in/out; it is expected to provide interoperable and interconnected payment services between buyers and sellers with its market-facing products. Such an operator is expected to collect the buyer's account information digitally through a mobile or a web as a customer touchpoint. Then the initiated payment will be sent to the national payment switch for clearing and settlement of payment transactions[19].

According to national bank Directive ONPS/02/2020 on licensing and authorization of payment systems operators, a comprehensive application must be submitted as one of the following by anyone seeking to operate payment systems:[20]

national switch operator

a switch operator

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[17] Licensing and Authorization of Payment Instrument Issuers, Directive (amendment) No. ONPS/06/2022,article 2

[18] Id., supra note 17, article 6(2).

[19] Nurhassen mensur, Digital technologies and competitive strategies of commercial banks and *Fintech* in Ethiopia, Ethio- *Fintech* weekly article by yene financial technology, (October 2021).p.4.

[20] Licensing and authorization of payment system operators, Directive no ONPS/02/2020, article 4(3).

an automated teller machine operator

a point-of-sale machine operator

Payment gateway operator.

Upon submitting an application, both payment instrument issuers and payment system operators will become direct participants within the Ethiopian national payment system, which puts them on equal footing with any bank in Ethiopia when initiating, processing, and settling payments.

Fintech Developments

The evolution of finance has been influenced by technical advancement for centuries. Over the past few years, we've seen an increase in automation, specialization, and decentralization. In contrast, financial institutions have discovered ever-more-sophisticated and effective ways of leveraging enormous amounts of customer and firm data.[21] These are going through a significant shift due to the rapid development and adoption of new technology. Globally, fintech emerged and flourished at the fastest intensity[22].

As an evolutionary background, fintech has three phases over the last 150 years. [23]. The first stage is known as 'fintech 1.0,' between 1886 and 1987. In this stage, correspondent banking was established, and the financial institutions globally became interconnected. The second stage, known as fintech 2.0,' occurred from 1987 to 2008; this stage witnessed the development of the traditional financial sector in which the digitization of banks occured.[24] Also, this stage witnessed innovative financial products like Automated Teller Machines (ATM) and the adoption of stock exchanges, central clearinghouses, and international correspondent banking. The present stage is titled ' fintech 3.0 (from 2008 onwards). [12] This stage plays most to the evolution of new companies offering technology-enabled financial services and traditional institutions seeking to meet evolutionary trends in financial innovation.

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[21] *Fintech* and Financial Services, D. H.-G. *Fintech*, and Financial Services. IMF. (2017).

[22] The History and Evolution of the fintech industry, The C2FO team,(January.23,2022) ,available at https://c2fo.com/resources/finance-and-lending/the-history-of-*Fintech*-how-has-the-industry-evolved/ last accessed on February 27,2023).

[23] Douglas Arner, &Jànos Barberis. 'The Evolution of *Fintech*: A New Post-Crisis Paradigm?' University of Hong Kong Faculty of Law Research Paper. (2015), p.23.

[24] Id.

The Ethiopian baking practice more or less passed through these stages. As soon as Ethiopia officially replaced the Bank of Abyssinia in 1931, our country's financial sector expanded shortly after Emperor Haile Selassie assumed power. It was a very new phenomenon in comparison to other jurisdictions. With this, fintech's emergence is also a relatively recent trend. Although there isn't a fully developed fintech industry in Ethiopia, commercial banks have incorporated fintech into their operations. Examples include online payment systems, payment transfers, automated teller machines, digital lending, and other financial services banks offer through fintech. The first ATM was unveiled by the Commercial Bank of Ethiopia in 2001.[25]

M-BIRR plans to launch a mobile banking service in Ethiopia in early 2013 as financial technology with the view to allow people to carry out fundamental financial transactions from their mobile phones, such as sending and receiving money, paying bills, receiving salaries and other government or non-governmental benefits, and repaying loans.[26] Belcash of the Netherlands also introduces Hello Cash. Banks and microfinance organizations in Ethiopia offer Hello Cash, a mobile money service.[27] With this platform's help, consumers can make deposits, withdrawals, transfers, and payments using mobile devices. The previous ten years have seen the introduction of several platforms for financial services, including Chapa, Coop Pay, Amole Mobile, Tele Birr, CBE-Birr, etc.

Another key milestone in developing payment system operators in Ethiopia was the establishment of the Ethiopian e-Payment and Settlement System. Three banks, namely, Nib International Bank S.C., Awash International Bank S.C., and United Bank S.C., linked their ATM networks into a single network known as a "premier switch solution" for the first time in February 2009 to facilitate the country's electronic payment system.[28] Later, three additional banks joined this network: Birhan International Bank, Addis International Bank, and Cooperative Bank of Oromia. Although developing a shared system began in 2009, it wasn't operational until

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[25] Gardachew Worku, Electronic -Banking in Ethiopia- Practices, Opportunities and Challenges, Journal of internet Banking and commerce (2010), p. 5. available on https://www.icommercecentral.com/open-access/electronicbanking-in-ethiopia-practices-opportunities-and-challenges-1-8.php?aid=38390 last accessed on February 26,2023

[26] M-Birr national mobile money service, Ethiopia, InclusiveBusiness.net (Jan. 16, 2023) available on https://www.inclusivebusiness.net/IB-Universe/ib-companies/m-birr-national-mobile-money-service-ethiopia, last accessed on February, 27, 2023.

[27] Payment platform in Ethiopia, (Jan 16, 2023) available at research proposal.docx> last accessed February 28, 2023.

[28] Tajebe Getaneh Enyew, Shared Automated Teller Machine (ATM) Network in Ethiopia: Appraisal of the Competition Concerns, Bahir Dar University Journal of Law, Vol.9, and No.2 (June 2019), p. 233.

July 5, 2012. Following the realization of this shared system, a customer of one member bank may use the ATMs of any other member bank, regardless of whose bank he currently uses.[29] Even though the country's first shared network was the premier switch solution due to the NBE's national payment project, all commercial banks, the NBE, and the Ethiopian Bankers Association banded together in 2011 to establish the ETHS-switch national shared ATM network. This nationwide payment system has also been combined with Premier Switch Solution.[30] The eths-switch payment system is a centralized electronic payment system that facilitates secure and efficient electronic fund transfer, clearing, and settlement of financial transactions. Lastly, companies such as chapa, Arif Pay, Santim Pay, Addis Pay etc., join this sector. Now it has become the backbone for various payment system operators and enables interoperability between financial institutions and service providers.

Need for Regulation of Fintech

The fintech regulatory framework aims to take care of specific areas. These areas include possible regulatory mechanisms for the beginning (innovation) of the fintech industry, regulation of cybercrime and fraud, consumer protection and data protection, regulation of the creation of the fintech industry, and regulation of the operation. Regulating bank fintech can be justified on several grounds. Yet the major one is to maximize benefits to financial institutions and the overall macroeconomic health of the nation fintech introduces a lot of possibilities of making the financial markets accessible to the public and serving as a tool to generate income. The availability of investing, getting personal or company loans, obtaining mortgages, and even buying insurance has increased because of fintech [31]. To leverage such demands as a means of ensuring growth in the industry and the economy, regulatory bodies must govern fintech to maximize their benefits.

One of the elements covered by fintech regulatory frameworks is the innovation of fintech startups. According to fintech [32], fintech startups are beginner companies that provide financial services. This fintech policy establishes a specialized environment for innovation, company development, and testing new ideas in a safe and controlled setting. It does this by deploying a

[29] Id.

[30] Id.

[31] *Fintech* and its Role in the Future of Financial Services,(2018),available on https://center-forward.org/wp-content/uploads/2018/02/*Fintech*-3.pdf,last accessed on March 29,2023.

[32] Henner Gimpel, Daniel Rau &Maximilian Roglinger, Understanding *Fintech* start-ups–a taxonomy of consumer-oriented service offerings, FIM Research Centre, University of Augsburg, (2018), p. 247.

regulatory sandbox[33]. To create a specialized setting for testing new ideas and conducting business development in a safe and regulated environment[34].

Fintech companies handle sensitive financial information and conduct transactions on behalf of consumers. Without proper regulation, there is a risk of fraud, data breaches, and other unlawful activities that can harm consumers. Regulation ensures that fintech companies have adequate safeguards in place to protect consumer interests. Fraud also includes depriving another person or an institution of a benefit to which they are legally entitled. fintech fraud may manifest as identity theft, hacking, and deep fakes.[35] They ensured that fintech companies had adequate procedures to prevent these illegal activities.

Another area that required regulation in the fintech era is data protection. Fintech companies collect and process vast amounts of consumer personal and financial data. The law can help protect consumer privacy and ensure that fintech companies handle and store this data responsibly, minimizing the risk of data breaches or unauthorized access. Data protection mainly involves defending sensitive information from loss, compromise, or corruption[36]. Customer protection guards consumers of financial services against subpar goods and dishonest, fraudulent corporate practices[37]. For the connection between fintech companies and their users, consumer protection must exist to run well. Additionally, it helps the customer feel secure and granted.

It is essential to balance regulation and innovation in the fintech sector. While regulation is necessary to mitigate risks, protect consumers, and maintain financial stability, it should not stifle innovation or hinder the industry's growth. Therefore, a flexible and adaptive regulatory approach is needed to address such unique fintech challenges and opportunities.

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[33] RBI regulatory sandbox: How this *Fintech* uses block chain for cross-border pay,(2018) available at

https://www.livemint.com/companies/start-ups/rbi-regulatory-sandbox-how-this-*Fintech*-uses-blockchain-for-cross-border-pay-11631690871141.html , last accessed on March 6, 2023.

[34] Id.

[35]Edlyn Cardoza, 9 types of fraud the *Fintech* industry needs to beware of in 2022,(2022),available at https://ibsintelligence.com/ibsi-news/9-types-of-fraud-the-*Fintech*-industry-needs-to-beware-of-in-2022/ accessed on July 26 ,2023

[36] What is data protection, (2021) available at <https://www.techtarget.com/ searchdat abackup/ definition/data-protection last accessed on June 21, 2023.

[37] Consumer protection laws, (2021), available at https://www.law.cornell.edu/wex/consumer_protection_laws last accessed on July 2, 2023.

The Global Experience in Regulating Fintech

The global experience in regulating fintech is characteristically dynamic and an evolving one. As technology continues to disrupt and transform the financial industry, regulators worldwide have been working to strike a balance between promoting innovation and protecting consumers and the financial system's stability. Countries and regions have taken varied approaches to regulate fintech based on their unique circumstances, priorities, and regulatory frameworks.

The USA, India, and Kenya are jurisdictions with the richest experience in relation to fintech connected to payments and digital lending. This review draws insights from the reservoir of best practices in these jurisdictions.

United States of America (USA)

The United States of America (USA) has been actively involved in regulating the fintech sector over the past decades. The regulatory landscape for fintech in the USA is a complex mix of federal and state regulations, varying depending on the type of fintech activity being conducted.

A single central entity in the United States does not mandate the payment criteria and improvements for the entire industry[38]. Different payment systems and service providers are governed by several laws, rules, and regulations that help ensure end users' protection. Federal and state agencies create rules to carry out the laws that the U.S. Congress and state legislatures approve[39]. Operators, providers, and rule-making bodies for payment systems also establish specific rules and agreements. However, depending on the types of payment services they offer fintech companies are required to comply with various laws, rules, and money transmission licensing requirements in each of the 50 states[40].

Fintech providers typically do not offer the same range of products and services as financial institutions, and they may not be subject to the same types of regulation. The Consumer Credit and Protection Act[41], in particular, governs online lending in the United States. Banks and

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[38] Payment system in USA,(2023),available at https://fasterpaymentstaskforce.org/payment-landscape/payments-in-the-u-s/ last accessed July 21, 2023.

[39] Id.

[40] Id.

[41] *Fintech* laws and regulation 2021 in USA, (2022), available at https://www.globallegalinsights.com/practice-areas last accessed July 2, 2023.

fintech institutions may conduct loans offered via fintech. The majority of pertinent legislation in the USA is consumer protection laws[42]. The Consumer Financial Protection Bureau (CFPB) oversees consumer protection and fair lending practices. It has been actively monitoring and taking enforcement actions against fintech companies that violate consumer protection laws.

The USA has also seen the emergence of regulatory sandboxes, which are controlled environments where fintech companies can test their products and services under the supervision of regulators. These sandboxes allow companies to innovate and experiment with their offerings while ensuring consumer protection.

Overall, the regulatory environment for fintech in the USA is evolving and adapting to keep up with technological advancements. The federal and state governments are working to balance encouraging innovation and protecting consumers, ensuring that the fintech industry can thrive while maintaining regulatory oversight.

India

India has made significant progress in regulating the fintech industry in recent years. The country has recognized the potential of fintech to promote financial inclusion, increase transparency, and accelerate economic growth.

The Reserve Bank of India (RBI) introduced the concept of regulatory sandboxes in 2016 to enable fintech startups to test their innovative solutions in a controlled environment.[43] The objective is to allow these startups to experiment with new technologies, products, or services without being subjected to the full burden of regulatory compliance.

Fintech institutions may offer in-bank and out-bank payment services when using fintech. India has recognized both[44]modalities. Fintech as a whole and payment via fintech in particular have

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[42] Samuel Girma, the legal and regulation crypto currency in Ethiopia, Thesis Submitted in Partial fulfilment of the Requirements of LL.M Degree in Business Law(2011) , p. 20.

[43] RBI regulatory sandbox is shaping the future of Indian banking,(2022) ,available at https://www.finextra.com/blogposting/22907/rbi-regulatory-sandbox-is-shaping-the-future-of-indian-banking last accessed on July 2, 2023

[44]Payment system in India, available at https://www.rbi.org.in/scripts/PaymentSystems_UM.aspx last accessed at July 2, 2023.

no complete and unified regulatory document[45]. According to the Payment and Settlement System Act of India 2007, master directions on issuing and operating prepaid payment instruments are among the regulations of payments in India, which primarily focus on the beginning of payment provider entities[46]. Payment service providers must be licensed and registered upon commencement and starting up.

In India, digital lending is a recent phenomenon. Different lending models are possible with digital lending; the most popular ones are person-to-person, business-to-business, person-to-business, and business-to-person[47]. Lender exposure criteria and aggregate borrowing limits have been prescribed and regulated by regulations and guidelines since 2017[48].

As fintech services gain prominence, protecting consumers from potential risks and fraudulent activities becomes critical. Accordingly, the RBI has adopted a customer-centric approach, emphasizing the need for data privacy, cybersecurity, and dispute-resolution mechanisms.[49] The regulations focus on safeguarding customer interests and promoting fair practices by fintech players.

Kenya

Kenya has been a pioneer in east Africa and Africa in fintech provision for mostly unbanked populations for decades. Hence, it causes an increased rate to the number of populations in the country's financial inclusions, for it is easy and fast to be accessed with lesser costs than traditional banks' lending services.[50] In recent years, Kenya has emerged as a leader in fintech innovation, particularly in mobile money services. The country's most notable fintech success

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[45] *Fintech* laws and regulation in India,(2021),available at https://www.globallegalinsights.com/practice-areas last accessed at July 2, 2023

[46] Id.

[47] Reserve bank of India, Report of the Working Group on Digital Lending including Lending through Online platforms and Mobile Apps (2012), p. 25.

[48] Id.

[49] Das flags concerns on digital lending including usurious rates, data privacy issues,(2022),available at https://www.thehindu.com/business/das-flags-concerns-on-digital-lending-including-usurious-rates-data-privacy-issues/article65914787.ece last accessed at July 3,2023.

[50] Kenya and Its *Fintech* Ecosystem in 2022, available at https://the*Fintech*times.com/kenya-and-its-*Fintech*-ecosystem-in-2022/ last accessed at July 2, 2023.

story is M-Pesa, a mobile phone-based money transfer and microfinance service.[51]

The central bank of Kenya introduced a regulatory sandbox framework. This enables fintech startups to test their innovations in a controlled environment, allowing them to experiment and refine their products or services before full-scale deployment. Kenya has also enacted data protection laws, such as the Data Protection Act, to safeguard the privacy and security of individuals' personal data. Fintech companies are required to comply with these to protect consumer information. The central bank of Kenya has put in specific regulations to supervise and monitor mobile services, including money laundering consumer protection measures[52]. This has helped institutions promote financial inclusion and access to financial services for a large segment of the population.

The Central Bank of Kenya must grant authorization as Payment Service Providers to fintech businesses working in Kenya's payments sector[53]. The National Payment Systems Act (NPSA) and the National Payments Systems Regulations (NPSR), which are currently in effect, govern the beginning and operation of payments made available by fintech [54]. In contrast, CBK has the authority to regulate and license digital credit service providers, including banks[55]. Digital lending and payment through fintech are recognized and regulated within the empire, but cryptocurrencies are not recognized as legal cash in Kenya.

The company Act is one of the relevant legislations applicable to Kenyan digital lending service-providing legal frameworks starting from stipulating minimum establishment requirements for service, providing companies, passing through their operations, to providing legal grounds for their dissolutions.[56]

Kenya's approach to regulating fintech has aimed to leverage technology to drive financial

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[51] Id.

[52] Rodgers Musamali, Bhavish Jugurnath, &Jackson Maalu,*Fintech*, in Kenya: a policy and regulatory perspective journal of smart economic growth, vol. 8, no.1,(2023), p. 36.

[53] Id.

[54] Id.

[55] Central Bank of Kenya Act, Chapter 491 of the Laws of Kenya (as amended by the Central Bank of Kenya (Amendment) Act.

[56] The Kenya Companies, Act No. 17 of 2015.

inclusion, encourage innovation, protect consumers, and maintain financial stability. The country's success in fostering a thriving fintech ecosystem makes it a regional leader and an example for other countries to follow.[57]

Fintech Regulatory Approaches

Fintech may be governed and regulated in various ways, with sub-sectors occasionally determining the possible approach. Four regulatory approaches, namely, wait and see/hands off, test and learn/case-by-case forbearance, structured experimental/innovative approach, and regulatory laws and reforms, are widely in use today. This paper discusses the features and potentialities of these approaches for the desired end .

Wait-and-See

This approach is characterized by institutional actions of observing and monitoring innovation trend(s) from afar before intervening where and when necessary. Over time, however, as regulators gain capacity in innovation and technology and start to adopt it by licensed entities over time, policymakers may incrementally change regulations.[58] A wait-and-see approach has commonly emerged when there is regulatory ambiguity on whether an activity falls under the remit of a particular institution. Alternatively, this approach has offered regulatory forbearance to allow innovations to develop unhindered under situations where there is a need to further build regulator capacity before issuing a response. Still, in other instances, depending on its application, it also includes a do-nothing response, which involves the use of soft laws. Many jurisdictions have applied this approach when there is a collective need to better understand the technology and its possible application in the financial market[59].

Test-and-Learn

This approach involves the creation of a custom framework for each business case, allowing it to

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[57] *Fintech* in Kenya: Towards an enhanced policy and regulatory framework,(2022),available at https://www.thecityuk.com/our-work/*Fintech*-in-kenya-towards-an-enhanced-policy-and-regulatory-framework/ last accessed at July 2,2023.

[58] World bank, How Regulators Respond to *Fintech* Evaluating the Different Approaches—Sandboxes and Beyond pdf, *Fintech* Note ,No 5 ,(2020), p. 10.avalable at https:// documents1.worldbank.org/curated/es/579101587660589857/pdf/How-Regulators-Respond-To-*Fintech*-Evaluating-the-Different-Approaches-Sandboxes-and-Beyond.pdf last accessed at Jan.20.2023.

[59] Id.

function in a live environment (often with a no objection letter from the regulators). However, the scope of supervision, oversight, and safeguard measures varies across jurisdictions. Policymakers have sometimes followed a light touch without close supervision. In others, policymakers follow more extensive frameworks on a case-by-case basis that involves stringent supervisory attention and oversight.[60]

Innovation Facilitators

Innovative approaches involve top-down moves, unlike the learning and test approach. Further, they tend to be more resource intensive than the other approaches. Their use characteristically involves several regulators setting up new units requiring staff with specialized skill sets[61]. Such an operation constitutes a point of contact or a structured framework environment to promote innovation and experimentation. This may take such forms as Innovation Hubs/ Offices, Accelerators, and Regulatory Sandboxes as different types of facilitators.[62]

Regulatory Laws & Reforms

Regulatory law reforms refer to introducing new laws or licenses that are both overarching and product specific in response to innovative firms or business models. In some cases, countries use new laws to expand their mandate, to build capacity, or to raise awareness over accountability while supporting the development of more discreet, secondary reforms and amendments to frameworks. One or more of such moves might eventually lead to regulatory reforms.[63] The National Bank of Ethiopia (NBE) is responsible for issuing licenses and regulating the activities of fintech companies in the country. The government periodically reviews its policies and regulations related to fintech to ensure recent relevance of the technological products. Fintech companies are also required to obtain relevant licenses and to comply with regulations in place in the country. Ethiopia adopted this regulatory approach to support and regulate the growth of the

[60]How regulator respond to fintech, available at https://www.wdronline.worldbank.org/bitstream/handle/10986/33698/How-Regulators-Respond-To-*Fintech*-Evaluating-the-Different-Approaches-Sandboxes-and-Beyond.txt?sequence=6 last accessed on January 16, 2023.

[61] Policy challenges and approaches to innovative fintech, available at https://www.itu.int/hub/2021/06/policy-challenges- and-approaches-to-innovative-*Fintech*/ > last accessed on, January 18, 2023.

[62]World bank, How Regulators Respond to *Fintech* Evaluating the Different Approaches Sandboxes and Beyond ,(2021) p.10 available at https://www.wdronline.worldbank.org/bitstream/handle/10986/33698/How-Regulators-Respond-To-Fintech-Evaluating-the-Different-Approaches-Sandboxes-and-Beyond.txt?sequence=6 ,last accessed Jan.20.2023.

[63] Id.

fintech sector. It is particularly taking a proactive regulatory approach, striking a balance between supporting fintech innovation and ensuring consumer protection and financial stability. These regulatory approaches aim to foster a thriving fintech ecosystem and contribute to the country's economic growth and financial inclusion goals.

Ethiopian Legislation Documents Relevant to Fintech: An Overview

Policy and strategies related to fintech

Governments are inherently in constant move to devise mechanisms that best regulate and benefit their financial systems. Such moves may be policy actions that the government decides to take[64] or a strategic move with a comprehensive plan or a method of doing multiple policy activities. A closer look into the Ethiopian macro strategic documents or financial policies shows that there are only limited policies or strategies relevant to fintech in the country. Those documents include the national digital strategy, national digital payments, the NBE monetary policy framework, and national information and communication technology policies and strategy.

The Federal Democratic Republic of Ethiopia formulated the national Digital Ethiopia 2025-A Strategy for Inclusive Prosperity in Ethiopia.[65] This new fourth industrial revolution (4IR) is advancing across the globe at an unprecedented rate, and Ethiopia proactively embraces it to ensure societal benefit from these technological tools and to cultivate innovation among the youth, who should get ready for a different future world[66]. From the strategy, sectors and institutions can design and/or align action plans to create inclusive prosperity leveraging technology that will catalyze the realization of Ethiopia's broader development vision: job creation, forex generation, and becoming a middle-income country.

While such vision is set out in the strategic documents, Ethiopia's digital economy is still in its infancy, with few private firms providing online services and some government-driven initiatives to go digital. To scale up the capacity of the system, vision, the proposed digital strategy is committed to achieving the following key goals: proposing an inclusive digital economy that

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[64] Public polices, available at, https://www.civiced.org/project-citizen/what-is-public-policy , last accessed on Jan.18, 2023.

[65] Ethiopian Digital strategy, 2020, available at (https://mirror.explodie.org/Ethiopia%20Digital%20Strategy%202020.pdf ,last accessed on February 2,2023.

[66]Digital Ethiopia 2025 – Summary digital Ethiopia ,available at https://mint.gov.et/wpcontent/uploads/2022/01/Summary_of_Digital_Strategy_Final_English1.pdf ,last accessed on February 5,2023,

accelerates the realization of a broader development vision; becoming a visionary umbrella from which sectors and institutions design action-oriented strategies; highlighting the need for urgency, mobilizing stakeholders that enable an inclusive digital economy, and coordinating and strengthening current initiatives under the most strategic and pragmatic path possible.

In addition to this, National Digital Payments Strategy (NDPS) for 2021-2024 is another package that the National Bank of Ethiopia has prepared. This strategic plan, which constitutes 32 action plans, will support a cash-lite and a financially accessible economy, which aim to create a secure, competitive, efficient, innovative, and responsible payment ecosystem[67]. Compared to preceding financial products, this approach is unique and thorough for digital payments, incorporating positive international experiences.

By providing incentives, NDPS encourages fintech[68]. The goal of the incentives is to launch fintechand consumer protection. In addition, NDPS advises enacting strict consumer protection legislation to foster/increase customer confidence and trust by promoting security, safety, and transparency[69]. Complaint resolution mechanisms are essential for consumer protection and trust-building[70].

Ethiopian Financial Inclusion is also another strategy dedicated to the same end. By assessing the current financial exclusions and developing strong frameworks to hasten the planned financial inclusion, the 2017 national financial inclusion strategy aims to accelerate the nation's overall economy. Numerous regional studies suggest that, despite the current progressive financial development, the Ethiopian financial service provisions are full of gaps or exclusions.[71] For instance, a 2014 poll by the index found that 56% of individual citizens did not owe any money but instead saved, borrowed, and used informal measures to protect themselves against hazards.

Several plans with priority activities to overcome related barriers to financial inclusion are prepared as part of implementing the national financial inclusion strategy. Therefore, it is believed that the primary strategic areas to be concentrated on are strengthening financial and

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[67] NBE's strategy, National Digital payment strategy (NDPS) (2021-2024), p. 19.

[68] National strategy for digital payments (NDPS) Strategy for 2021 to 2024, p. 37.

[69] Id, page 51

[70] Id.

[71] Financial inclusion strategy, 2017, NBE, available at https://nbebank.com/wp-content/uploads/pdf/useful-links/ethiopian-national-financial-Inclusion-strategy.pdf. , last accessed on Febuarary.23, 2023.

other infrastructure, ensuring the supply of an adequate range of suitable products, services, and access points, developing a strong financial consumer protection framework, and improving financial capability.

Banking Business Proclamation

In Ethiopia, proclamation number 592/2008 and its successor, 1159/2019, govern the banking industry. In the traditional sense, banking business refers to financial transactions involving a company that offers business loans, credit, payment, currency exchange, savings accounts, and checking accounts[72]. Saving and receiving money, lending money for investments, purchasing and selling gold, sending money to domestic and international banks, dealing with bonds, agency banking, and digital financial services are all examples of financial transactions.[73]

Articles 2(2) (f) and 2(21) of the Banking (Amendment) Proclamation define digital financial services as a service offered by fintech. The legislative provisions mentioned financial services such as payments, remittances[74], and digitally accessed insurance services as major fintech services.[75] Yet other financial services categories, such as digital loans and financial exchanges carried out by fintech, are left out of this classification. From the wording of this provision, it seems that the list of the subcategory of digital financial services is non-exhaustive.

Additional definitions of digital financial services include those for payments, remittances, and insurance that can be accessed and provided online[76]. Digital credit is not listed among the digital financial services in these provisions. Through a close reading of the provisions, one may observe that the legislature alludes to a non-exhaustive list by including phrases like other financial services. Yet equally, anyone would argue that the Directive of Digital Financial Service, which has not yet been implemented, might remedy the gap[77]. The stipulations in the

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[72]Business banking, available at https://www.investopedia.com/terms/b/business-banking.asp, last accessed on 23 February 25,2023.

[73] Business banking proclamation, proclamation No. 592, Federal Negarit Gazeta,Year 14, No 57, (hereinafter referred to as banking business proclamation), Art. 2(2, a-f),

[74] Banking business (amendment) proclamation, No. 1159, Federal Negarit Gazeta,Year 25, No 88, (hereinafter referred to as Banking(amendment) proclamation), Art. 2(1, f &g.

[75] Banking business (amendment) proclamation 1159/2019 Art. 2/21.

[76] Banking business Proclamation no 1159/2019, Article 2(21),

[77] Id, Art 58.

directive suggest that Ethiopia lacks a legal basis for introducing digital credit independently by fintech or banks.

National Payment System Proclamation

Ethiopia issued the first national payment system proclamation in 2011 after recognizing the importance of the national payment system in ensuring the efficiency, effectiveness, and financial stability of the nation's overall economic growth. The proclamation also demanded that guidelines for creating, administering, and controlling the national payment system be provided[78]. A national payment system is a collection of fintechor conventional payment systems, processes, regulations, and technology[79].

The law allows citizens to operate a firm as payment instrument issuers and payment system operators under their respective directive.[80] Foreign nationals are also allowed to engage in a payment instrument issuer and payment system operator business or establish a subsidiary[81]. In addition, the Directive stipulates that anyone other than financial institutions must first get an NBE license to operate a payment instrument or payment system operator. Infringing some of these obligations, there is a tendency among financial institutions to assume that NBE has already granted them a permit to offer banking services. However, according to the law, they may only utilize the payment system for the services associated with their regular financial transactions[82]

Apart from the issue of permits, the proclamation covers rules that apply to the payment made in the conventional bank and fintech. Yet the regulatory provisions, the writer believes, are not strong enough to meet the needs of customers . For example, the user's growing confidence in payment methods and services offered by financial institutions, notably fintech, is not adequately reflected in the regulatory rules. Trust must be there for economies, societies, and financial markets to be robust. Payment providers must adhere to data protection and privacy laws to safeguard customer information. They need to implement strong security measures and

[78] National Payment System Proclamation, No. 718, Federal Negarit Gazeta**,**Year 17, No 84, the Preamble (hereinafter referred to as National Payment System Proclamation).

[79] National Payment System Proclamation, Proclamation No. 718, Art. 2(16, a-e).

[80] National payment system (amendment) proclamation, no.1282/2023, Art.6 (8).

[81] The National payment system (amendment) proclamation no.1282/2023 Art. 6(8) and Art .6(7)

[82] Id., Art. 20.

encryption protocols to protect financial data from unauthorized access or breaches, but this issue is not well regulated in this proclamation[83]. There are no strict requirements for starting a payment provider, particularly for fintech, and there is no provision in the proclamation for harmonizing international payment system laws.

Consumers will be reluctant to use the services if the industry is not trusted; this would, in turn, harm the industry and the national economy by limiting the amount of cash available for investment and productivity.[84] The National Payment System Proclamation lays out many rules for the Ethiopian payment system. Yet the payment service providers who carry out their activities using these rules may not have sufficient security measures to protect users' personal and financial information, leaving them vulnerable to data breaches and fraud. Inadequate governance can also result in poor dispute resolution processes, making it difficult for users to recover their funds in cases of unauthorized transactions or other payment-related issues.

A single provision could not control users' transaction security, nevertheless. The proclamation's Articles 20/1/ and /2/ specify the process for handling complaints. Yet the stipulations cannot adequately address users' concerns over security issues because the course of addressing complaints ironically comes into play once the issue has been resolved.

The National Payment System Proclamation's Article 7/4 specifies the startup requirements for fintech payment platforms. These requirements include the system's proposal, technological specifications, security procedures, clearing and netting procedures, management and integrity experience, consumer interest, and policy implications[85]. The regulatory sandbox is a framework that allows innovators, startups, and financial technology (fintech) companies to test their products, services, or business models in a controlled environment under the supervision of regulatory authorities[86]. Sandboxes allow financial institutions and fintech firms to test out novel financial goods or services in a real-world setting, but only for a limited time and in a specific location. The objective is to foster innovation, promote competition, and ensure consumer protection in emerging sectors or new technologies. Yet despite the global popularity of and key

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[83] Ronald J. Colombo, The Role of Trust in Financial Regulation the Role of Trust in Financial Regulation, Villanova University Charles Widger School of Law,(2020), p. 26,

[84] C V.D. Cruijsena,J.D.Haanb & R.Roerinka, Trust in financial institutions: A survey, University of Groningen, The Netherlands, (2020), p. 27.

[85] National payment system proclamation no 718/2011 Art. 7/4, a-h.

[86] Attery,A,M.Lesher & C.Lomax The role of sandboxes in promoting flexibility and innovation in the digital age, going digital tookili policy not, No2. (2020), p.36.

role of regulatory sandboxes, no framework for the use of such tools has been established in Ethiopia.

Moreover, the innovation hub exam should also be added to the list of requirements before the launch of fintech platforms.[87] The innovation hub exam is a formal assessment conducted by regulatory authorities to determine the eligibility and suitability of fintech companies and innovators to participate in a regulatory sandbox. These requirements are crucial to guarantee quality and system caliber for fintech startups. However, they are not included in the prerequisites.

Ethiopia has no specific sandbox and innovation hub regulatory framework for fintech. While the National Bank of Ethiopia has conducted a pilot test, this test does not constitute a full-fledged sandbox and innovation hub.[88] Its primary purpose is to grant licenses for fintech businesses rather than providing a comprehensive sandbox environment[89]. Furthermore, it is worth mentioning that Ethiopia's Information Network Security Agency (INSA) primarily focuses on testing security issues related to fintech and not on establishing a comprehensive sandbox and innovation hub, as is the case in some other countries[90]. No dedicated institution or regulatory body has the expertise and infrastructure to oversee such a hub. Thus, Ethiopia lacks both practical implementation and a regulatory framework for a sandbox and innovation hub.

The Cooperative Bank of Oromia is the first financial institution to introduce an online credit system called "MICHU." It is a digital lending platform for micro, small, and medium-sized businesses platform[91]. The platform evaluates SMEs' risk and growth potential, so lenders can decide whether to issue loans based on risk assessment outcomes. Cooperative Bank of Oromia launched this platform as a bank for the first time without needing a sandbox on this brand-new platform[92].

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[87] Radostina Patarni, Sandboxes and Innovation Hubs for *Fintech* Impact on innovation, financial stability and supervisory convergence, European parliament committee, (2020), p. 33.

[88] Interview with Solomon Damxewu, NBE Director, payment and settlement system (July 5,2023)

[89] Id

[90] Id

[91] MICHU Uncollateralized Lending Platform, coop bank of Oromia available at https://coopbankoromia.com.et/michu/, last accessed on January 21, 2023.

[92] Interview with Abdi Fekede, Director, Digital products, and services. (March 8,2023)

Lastly, the proclamation cannot regulate digital credit in the form of digital assets or crypto assets. No online credit is permitted on a block chain platform in the form of cryptocurrency[93] within our jurisdiction since NBE circulars prohibit digital assets. Additionally, this results in a lack of regulatory capacity to control various digital credit forms, including businessperson, person-to-person, business-to-business, and person-to-business credits. This inadequacy leads to the mistreatment of consumer complaints, abuse of consumer interests, and mistrust.

Prevention and Suppression of Money Laundering and Financing of Terrorism Proclamation

The Ethiopian legislature passed the Prevention and Suppression of Money Laundering and Financing of Terrorism Proclamation to protect national security, to stabilize financial markets, and to boost the effectiveness of financial institutions[94]. The major goal of anti-money laundering laws is to authorize and assist competent institutions in discovering and reporting suspicious conduct, including crimes that serve as a foundation for money laundering and terrorist financing[95].

Money laundering appeals to criminals in fintech because it is made easier for them by the rise in transaction initiation in these systems, unlimited money flow, and anonymous accounts.[96] While the legislative moves on preventing and combating money laundering and terrorism financing are encouraging, they appear to place little emphasis on digital financial services and instead emphasize traditional financial services. Fintech is currently updating itself continually at the fastest rate. Given this pace of developments and sophistications in fintech, it is imperative to have a more advanced anti-money laundering regulatory framework at all levels of financial

[93] Crypto-asset could be defined as a form of digital currency based on a network that is distributed across a large number of computers. It is a virtual currency formulated to function as a medium of exchange like dollar, euro, and birr. A digital currency in which transactions are verified and records maintained by a decentralized system using cryptography, rather than by a centralized authority. The main plat form deployed to establish decentralized crypto-asset is that block chain. Block chain is an online decentralized ledger technology that registers transactions between two parties connected in a peep-to-peer ("P2P") network.

[94] Prevention and Suppression of Money Laundering and Financing of Terrorism Proclamation, proclamation No. 780, Federal Negarit Gazeta**,** year 19, No 21, the preamble, (hereinafter referred to as Prevention and Suppression of Money Laundering and Financing of Terrorism Proclamation).

[95] Anti-money laundering law (AML), Rule and Guidance, available at https://www.finra.org/rules-guidance/key-topics/aml , last accessed on January. 19,2023.

[96] Anti-Money Laundering Guidance for *Fintech*, available at https://sanctionscanner.com/blog/anti-money-laundering-guidance-for-*Fintech*-167, last accessed on January 30,2023.

system operations. As such, more legislative moves are required to balance the fintech industry's development and the control of criminal activity such as money laundering and support for terrorism.

Referring to the proclamation's clauses, one could conclude that the definition of funds and property does not expressly cover fintech payments and digital lending.[97] According to Article 2/9 of the proclamation, financial institutions include insurance companies, microfinance organizations, postal savings institutions, and money transfer institutions. Fintech and digital financial services are not expressly included in this proclamation.[98]

National Bank Directives Regulating Fintech

Licensing and Authorizations of Payment Instrument Issuers

To promote the safety and efficiency of the payment system by establishing clear and enabling regulatory requirements and protecting the interests of the users– in addition to mitigating associated risks and maintaining reliability[99]–the NBE issued D**irective No. ONPS/01/2020** as per the provisions of the National Payment System Proclamation[100] and the Amendment Banking Business Proclamation[101]. According to the Directive, a person who holds a license from NBE and issues tangible or intangible instruments such as cards, checks, and e-money that allow a person to make payments or transfer funds is referred to as a payment instrument issuer[102]. This Directive ensures that fintech companies comply with relevant legislation and uphold consumer protection standards.

The payment instrument issuer may be permitted to offer standard banking services like cash-in and cash-out, local money transfers like domestic remittances, loading to the card or bank account, transferring to the card or bank account, domestic payments like purchases from

[97] Prevention and Suppression of Money Laundering and Financing of Terrorism Proclamation 780, Art. 2(5).

[98] Id, Art. 2(9)

[99] NBE issues directive To licence ,Authorize payment instrument issuer-National Bank, available at https://nbe.gov.et/nbe-issues-directive-to-license-authorize-payment-instrument-issuers-2/ .last accessed on Feb1,2023.

[100] National Payment System Proclamation number. 718/2011, Art. 4(2, a) and 37(2).

[101] The amendment of banking business proclamation number.1159/2019, Art.58.

[102] The Licensing and Authorization of Payment Instrument Issuers Directive No. ONPS/01l2020. Art.2 (19).

merchants, bill payments, over-the-counter transactions, and inward international remittance services based on requests made and written approval by the NBE.[103] A licensed payment instrument issuer with full accountability and a written outsourcing agreement with regulated financial institutions and pension funds may also be permitted to offer micro-savings, micro-credit, micro-insurance products, and pension products with the written consent of the NBE.[104]

Laws in Ethiopia prohibit providing digital credit services independently by fintech. Such activities require a written outsourcing agreement with a regulated financial institution[105]. However, it is also important to examine the potential consequences of these restrictions. Digital credit services have the potential to bridge the gap in financial inclusion. Moreover, digital credit services can contribute to economic growth by enabling entrepreneurs and small businesses to access capital for expansion and investment. Another point to consider is the innovation and competition that fintechs bring to the market. By restricting their ability to provide digital credit services, there could be a dampening effect on innovation and consumer choice[106]. Also, regulations that are too stringent and inflexible may discourage fintechs from operating in the country altogether. This could hinder the growth and development of the fintech ecosystem.

Like the previous proclamation, no sandbox and innovation hub requirement is required as tests for the payment instrument issuer provider [107]. Fintech companies must put in place measures to protect customers' interests and ensure fair treatment. This may include providing clear and transparent information about fees, charges, and terms and conditions and addressing customer complaints and disputes. Fintech companies must comply with ongoing obligations, such as reporting requirements, maintenance of appropriate risk management systems, and ensuring the protection of consumer funds.[108] Yet all sets of issues are not well regulated under this Directive.

Disagreements and grievances are part of every economic transaction. Require substantive legislation to address those disagreements and complaints; no rule or legal clause currently deals

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[103] Id., Art, 6(2).

[104] Id., Art, 6(1).

[105] Id., Art, 6(2).

[106] Interview with Gelata Abate, Innovation hub director of cooperative bank Oromia, (March 09.2023)

[107] Licensing and authorization of payment system operators, Directive no ONPS/02/2020. Art, 4, 4.6, a-i.

[108] What is regulation in fintech? Available at https://www.idnow.io/*Fintech*/what-is-*Fintech*-regulation/ last accessed on July 3.2023.

with disputes and grievances brought up by digital credit platforms. Additionally, because digital credit operates differently than traditional loans, applying other pertinent laws to address disputes and complaints is challenging and confusing. In other words, the service providers decide everything, including who gets the loan, how much is borrowed, when it is due, how long it will take to pay it back, and the contract terms.

The international payment system is essential and facilitates international trade and remittance. Digital payments made through fintech are more convenient[109] than other mechanisms. Yet for national security reasons, direct payment conducted in a digital manner is restricted. All payments are like the traditional banking system; they need the presence and physical conduct of the customer at the bank. Different payment platforms for international payment need no physical presence and are made online through normal electronic devices. For instance, PayPal, Venom, and eBay are among the online global payment platforms. Globally, there is a digital platform for remittance and exchange of foreign currency[110]. However, the Ethiopian jurisdiction has no direct online payment system for national security purposes[111]. Moreover, those platforms are nonexistent due to the absence of a regulatory framework for such international payment. Even though building a regulatory capacity to oversee a sophisticated payment system can be time-consuming, waiting indefinitely to acquire regulatory capacity might not be a viable approach. International transactions and cross-border payments are becoming increasingly common in today's interconnected world. The absence of a direct online international payment system could slow down or restrict economic growth, hinder cross-border trade, and potentially disadvantage businesses or individuals who rely on global transactions[112]. It is important to find a balanced approach in this situation.

Licensing and Authorizations of Payment System Operators

The second directive affecting fintech is ONPS/02/2020, which deals with the licensing and authorization of payment system operators. It specifies the criteria, procedures, and documents required for obtaining a license, such as company registration, financial statements, a business plan, and proof of technical capability. As one can observe from its name, the primary focus of

[109] The report of United Nations Capital Development Fund (UNCDF) in collaboration with NBE, Ethiopia remittance review; assessment of payment and financial markets infrastructures, (2020) ,p. 6.

[110] Guid; how to get started as a payment system operator in Ethiopia, available at, https://shega.co/post/guide-how-to-get-started-as-a-payment-system-operator-in-ethiopia/, last accessed on Febuarary.3.2023.

[111] Interview with Muluken Mirehetu, NBE legal expert. (February 25,2023)

[112] Solomon, Id supra note 89

this directive is the payment system. It specifies the criteria, procedures, and documents required for obtaining a license, such as company registration, financial statements, a business plan, and proof of technical capability.

The Directive stipulated that anyone other than financial institutions must first get an NBE license to operate a payment instrument. They are considering that NBE has already granted them a license to offer banking services. However, they may only utilize the payment system for their own services associated with their regular financial transactions.[113]

A payment system operator is defined under the Directive as a licensed financial institution by the NBE that owns, operates, and administers a payment system[114], a system that is used to settle the transfer of funds/financial transactions (the system includes the institutions, the people, the rules and procedures, standards, and the technology that make the financial transaction possible) upon authorization by the NBE. The directive at hand allows only Ethiopian nationals and foreign nationals of Ethiopian origin to engage in the payment system. It also provides that the applicant for provision should be established as a company, where the ownership should be vested in Ethiopian nationals and foreign nationals of Ethiopian origin.

Further, the Directive prohibits payment system operators from engaging in other business activities. On the other hand, an entity or person engaged in business activity and interested in the payment system operators' business must form a separate company exclusively engaged in payment system operation, fulfilling the requirements provided under the Directive. The National Payment system operator, Ethswitch, is also established under this Directive to facilitate the overall interoperability between financial transactions in the country. The private payment system operators are also invited to join Ethswitch upon fulfilling the prerequisites stipulated under this Directive.

As such, the directive covers five categories of licenses: the National Switch Operator Payment Switches, ATM Operators, POS Operators, and Online Payment Gateway Operators' services.[115] A company can apply for one or multiple licenses, as the need arises. At the same time, the regulation prohibits a payment system operator from engaging in other business activities,

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[113] Payment System Operators Directive No. ONPS/02l2020. Art. 20.

[114] Payment System Operators Directive No. ONPS/02l2020. Art. 2(34).

[115] Licensing and authorization of payment system operators Directive no ONPS/02/2020.Art. 4(3).

including payment instrument issuer business such as mobile money[116].

Financial Consumer Protection

A new directive or sectorial legislation was issued to regulate the protection of financial consumers under directive 01/2020. This bylaw was enacted based on Article 57 of the amended banking business proclamation that stipulates national banks issue directives with minimum conditions for consumer protection.[117]

The directive, which is special due to its inclusiveness, applies to all financial institutions and financial services[118]. As such, it targets all financial institution consumers. Accordingly, digital lending service consumers (borrowers) are entitled to exercise rights provided under the Directive at hand, including the right to access accurate and appropriate information about the lending service they are requested for, including the interest rate, terms, and conditions of the agreement, protection against misuses of their personal data, fair and dignified treatment, easy, speedy, and accessible dispute resolution mechanisms, etc.

General principles such as fair treatment, transparency and disclosure, suitability, data protection (confidentiality), complaint handling, and dispute resolution are generally regulated under this directive. To this effect, Article 2.11 of the Directive defines digital financial service by stating what it is and listing the categories. Payment, remittance, and insurance are from the list provided by the Directive. From this, we could conclude that digital crediting is not included under the definition; In addition, the Directive focuses on traditional bank services. So, legal protection given to consumers of digital finance is minimal. Legal protection given to the fintech consumer by this directive is minimal. Comparatively, payment- related fintech is slightly regulated.

Conclusion

Fintech has become a popular catch-all for technology-enabled financial solutions. A customer uses every digital financial service to manage their finances, including online banking, payments,

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[116]African *Fintech* state of the industry, African *Fintech* summit, Is an Ethiopia Market Map from the Africa *Fintech* State of the Industry Report,(2020), available at https://africa*Fintech*summit.com/wpcontent/uploads/2021/08/AFTS_StateoftheIndustry_2020_final.pdf last accessed on Febuarary.12,2023.

[117] Amendment of banking business proclamation Number 1159/2019, Art .57.

[118] Financial consumer protection Directive, Directive, No FCP/01/2020, the Preamble

investing, and borrowing money. Digital payment, lending, and money are possible components.

National Digital Ethiopia 2025, the Ethiopian Financial Inclusion Strategy, and NDPS are all taken from an evaluated legislative document. Ethiopian-related fintech policies are incomplete and lack specific provisions for fintech. In the meantime, NDPS appears to be a recent and comprehensive fintech law about payments. However, NDPS is insufficient on its own to address all fintech categories.

To set minimum requirements and prerequisites for providers to launch the service, the current regulatory environment for fintech is insufficient. The fintech regulator's regulations do not cover the listing criteria, particularly technology assessments. These technological trials could be innovation center trials or sandbox trials for regulations. The lack of an innovation hub and sandbox impacts user interest. However, neither in law nor in practice are there now any technology tests.

Fintech also needs a thorough document that governs matters connected to safety, security, consumer protection, and the duties of regulatory agencies by focusing primarily on payment-related fintech. Assess the regulatory perimeter and update it on a timely basis. Regulators need to have a proactive framework that responds to fast changes in the fintech space and regularly implement or contribute to a process to review the regulatory perimeter.

Banking business (amendment) Articles 2(1) (f) and 2(2) of Proclamation No. 1159/2019 demonstrate that banks' use of digital financing, or fintech, is solely permitted for payment, remittance, and insurance. Clause must be changed to consider online lending. NBE will outline different startup requirements and prerequisites for various bank fintechtypes. Proclamation 718/2018 and its amendment proclamation 1282/2023, Directive NO FIS/01/2012, Directive NO ONPS/2/2020, and other legislation should manage digital financial services in a special way that increases consumer confidence to uphold and sustain consumer trust.

Finally, digital credit is a subcategory of fintech. Ethiopian laws forbid fintechcompanies from offering independent digital credit services and demand a signed outsourcing arrangement with a licensed financial institution. This might hamper expansion and development of the ecosystem for fintech in the country.

In addition to allowing digital credit by fintech in Ethiopia, various types of digital lending, including person-to-person, person-to-business, business-to-business, and business-to-person lending need to be given due consideration and be governed by different legislations. Therefore, due to the multiple gaps in the pertinent laws, Ethiopia's regulatory environment for fintechis not adequately regulated and needs an enabling comprehensive law.

Deep Learning Based Stance Detection on Grand Ethiopian Renaissance Dam for Amharic, Arabic, and English

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Abstract

Nowadays, the internet has made Amharic, Arabic, and English texts widely available online. Therefore, a large number of discourses about the Grand Ethiopian Renaissance Dam have taken place in Arabic, Amharic, and English. However, due to differences in context, morphology, and character representation, existing models created for distinct languages cannot be applied to multilingual languages like English, Arabic, and Amharic. In this study, we examine the stance classification problem for texts related to the Grand Ethiopian Renaissance Dam using stance classes, namely support, opposition, and neutrality, and target classes, namely Ethiopia, Egypt, the Grand Ethiopian Renaissance Dam, and neutrality. Our model simultaneously performs both target and stance categorization tasks. To develop these models in this study, we have collected 731,856 newly unannotated texts from selected channels, and we have used 13,561 labeled datasets to build the model for the Amharic, Arabic, and English languages. The dataset collected for this research includes social media posts and official statements to represent views expressed from various platforms, namely Twitter, YouTube, and Facebook, using Twitter API, YouTube API, and Face pager. In this work, various natural language processing tasks, such as text preprocessing, which includes text cleaning, normalization, tokenization, and removal of stop words, are performed. Lastly, we compare the performance of our stance models, and the CNN model achieves a high accuracy of 92.4%. On the other hand, our target classification result achieves an excellent accuracy rate of 93.7% for texts using BiLSTM.

Keywords: Stance classification, Multilingual, Deep learning, GERD

Introduction

The Ethiopian government announced its plan to construct the GERD, leading to rising political tensions between the downstream countries (Egypt and Sudan) and the upstream countries; the two groups dispute the right to the Nile waters

[1] [2]. As a result, many debates have taken place between Ethiopia and the downstream countries, held in a common global language with the help of the internet. Furthermore, all parties involved also try to set their diplomatic discourses to maintain their interests. Notably, social media users share their attitudes and feelings on various topics related to GERD. We would also learn more about user stances toward the target entities by mining comments, tweets, and postings on social media networks.

In the digital age, online platforms serve as an important arena for referendum formation and spread. GERD has produced a huge, multilingual corpus of lessons, incorporating Arabic, Amharic, and English in other languages [3]. The task of automatically determining the stance classification, the author's perspective (support, opposition, or neutrality) towards a specific subject, is necessary to understand public stance. However, the linguistic complexity and cultural variations inherent in Arabic and Amharic present significant challenges for traditional NLP techniques.

The goal of stance detection is to be able to identify automatically the position of an author with respect to a specified target—either for, against, or neutral—without manual annotation [4]. Social media sites like Facebook and Twitter are frequently used as platforms for individuals to share their thoughts toward specific targets [5]. The target can be a person, a group, an occasion, a cause, or a piece of legislation. Cross-linguistic analysis is required to gain a comprehensive knowledge of oral speech. Those include models that can analyze and comprehend texts from many languages concurrently. The capacity to appropriately define stance in Arabic, Amharic, and English will shed light on various approaches and potential disputes around the dam [6].

Deep learning has revolutionized various areas of artificial intelligence, including natural language processing [7] [8]. Its ability to learn hierarchical representations and capture relationships makes it well suited for tasks such as stance classification. By taking advantage of deep learning architecture, the purpose of this research is to develop strong models that can effectively handle linguistic complications of GERD-related text [9].

This research aims to develop and evaluate the deep learning models designed to correctly determine the stances related to GERD within Arabic, Amharic, and English language datasets. The expected results of this study include the creation of a valuable multilingual dataset, the development of effective stance classification models, and a deep understanding of public stances

around GERD. This research will contribute to the advancement of multilingual NLPs and provide valuable tools to analyze and monitor public sentiment on important geopolitical issues.

Related Works

In previous works, various studies of stance classification, both in local languages and other languages using deep learning techniques are discussed. The current state of the art on stance classification clearly defines what the gaps are in Amharic, Arabic, and English stance classification. We have done an extensive review of different studies. Moreover, related works are opinion mining work done on English and other languages. In [10], they sought to investigate and compare the performance of transformer-based models in Arabic stance identification. They created transformer-based models for Arabic SD, which was used in a case study on Covid-19 vaccination with Arabic Twitter data and the Ar CovidVac AraBERT dataset. The stance identification system determines whether the author agrees, disagrees, or has a neutral attitude about the provided target. This work addressed posture identification in Arabic tweets by developing and comparing four transformers: Araelectra, MARBERT, AraBERT, and Qarib. The results indicated that the AraBERT model learned better than the other three models, with a 70% F1 score, followed by the Qarib model with a 68% F1 score. One disadvantage of this work is the unbalanced dataset and the scarcity of annotated datasets of SD in Arabic. As a result, the authors investigated the models to understand and interpret the data before making suggestions for the best performance models for the stance identification job. The researcher proposes experimenting with huge datasets and investigating the impact of dataset size on the performance of various transformers. Another research area for expanding and improving this work is to test the algorithms on non-COVID-19 case studies utilizing Twitter data on general or hot topics in social media.

The study [11] introduces XLNet-THAN, a target-specific hierarchical attention model based on the XLNet pre-training model. The attention mechanism and topic embedding are used to derive the semantic structure of the document. This work creates an annotated Chinese document-level stance identification data set to address a gap in the field of Chinese lengthy text stance recognition. This study collects pertinent self-media opinion articles using keywords such as "genetically modified food," "feminism," and "Chinese medicine." In the future, they will perform an in-depth study on how to more precisely extract the author's attitude toward the discussion subject, as well as explore including the article discussion target's extended knowledge information in the stance recognition task.

In [12], difficulties are examined by introducing a new multilingual dataset for posture identification in Twitter in Catalan and Spanish, with the goal of simplifying research on stance detection in multilingual and cross-lingual contexts. The dataset is annotated with a stance on

one topic: Catalonia's independence. They use the new corpus to test a variety of supervised algorithms, including linear classifiers and deep learning methods. Comparing their new corpus to the TW-1O dataset demonstrates the advantages and promise of a well-balanced corpus for multilingual and cross-lingual research on stance identification. Finally, they provide fresh, cutting-edge results on the TW-10 dataset for both Catalan and Spanish. They demonstrate that the technology used to create the Catalonia Independence Corpus produces high- quality annotated data without the need to manually annotate each tweet. Their experimental results validate these findings since the tested systems behave consistently across languages. The findings also reveal that the fastText linear classifier outperforms SVM and RNN techniques on both datasets. These findings are comparable to those obtained for English using the SemEval 2016 data, in which linear classifiers remain competitive with and surpass newer deep learning algorithms.

Besides, [13] employs a deep learning–based stance classification model for Amharic text. They created a multitask Amharic stance classification model with deep learning algorithms that learns sentiment, target, and stance classification tasks simultaneously. The datasets are acquired from several social media networks, specifically Twitter, Facebook, and YouTube, using web scraping techniques. They achieved an F1-score of 86% for subject identification, 65% for posture classification, and 50% for sentiment classification using their multi-tasking model. They did, however, recommend that their model be expanded with a larger dataset and that new relevant targets be investigated after being trained with a limited dataset.

PROPOSED METHOD

The components of the proposed stance classification model for Amharic, Arabic, and English languages are explained in this section. To evaluate and classify stance text, the proposed model includes four basic modules: data collection and preprocessing, data representation, classification module, and evaluation module. The basic tasks or modules we used to predict the category label of raw stance text are described in Figure 1. The description and function of each of the modules shown in Figure 1 are presented as follows.

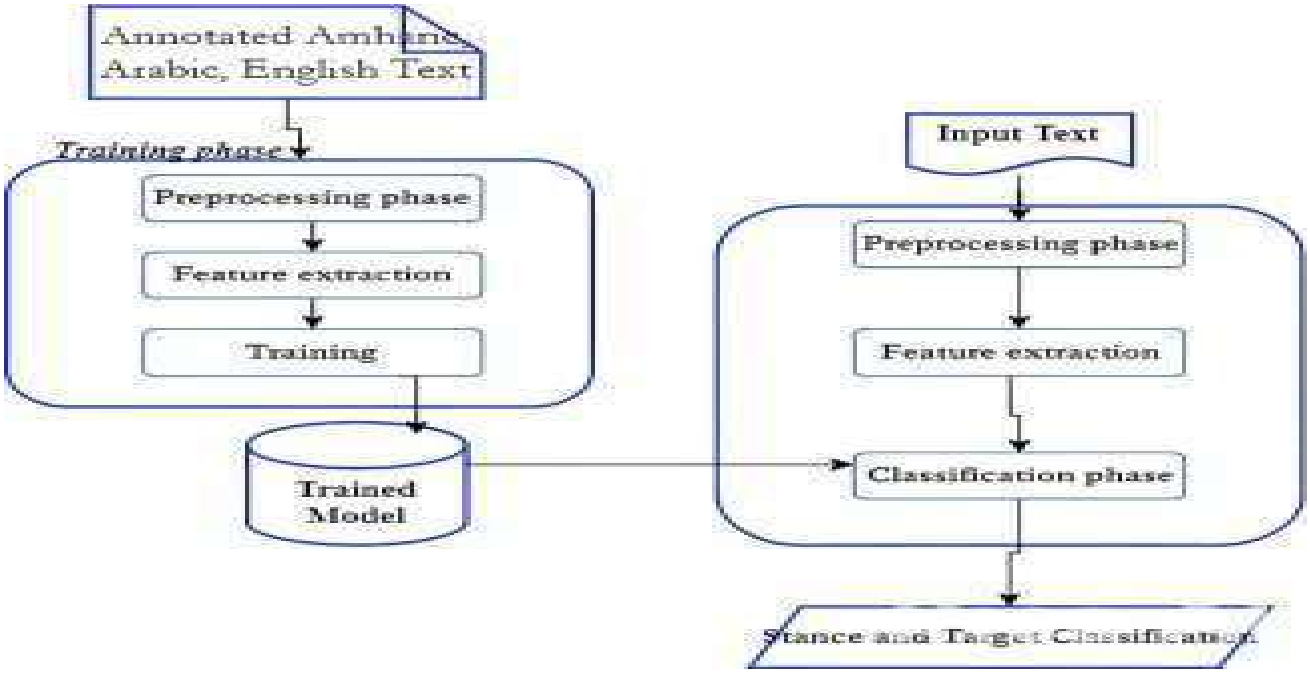


Fig. 1, Proposed Model Development Workflow

A. Data Source Selection

We collected 5020 for Amharic texts, 5100 for Arabic texts, and 5300 for English texts for both the stance class (namely, support, oppose, and neutral) and the target class (namely, Ethiopia, Egypt, GERD, and neutral categories) to train and test the designed deep learning model, since there is no publicly available stance classification corpus. The three stance categories and four target categories are chosen based on the most commonly used stance category related to GERD. Each file is saved with a separate file name within the corresponding category's directory; that is, all texts in the data set are single labeled. In the final step, we combined the dataset into a single CSV file and loaded it into the model for training and testing.

We focus on this research's primary data source on official Facebook, Twitter, and YouTube pages because the terms and conditions of those social media platforms allow people to express their ideas freely. We gather data through the YouTube API and the Twitter API by creating a developer account and scraping using the Face pager software text processing tool.

B. Data preprocessing

The next stage after collecting the dataset is to prepare it for model training and testing. Several

preparation strategies for our dataset were assessed on Amharic, Arabic, and English text corpora using deep learning algorithms in this study. A detailed explanation of each procedure is provided in the next part.

a. Text cleaning: The web-collected texts are unstructured and contain irrelevant data such as letter combinations (e.g., English with Amharic and English with Arabic), special characters, punctuation, and mistakes in formatting like Hamza-Alif (أ) and bare Alif (ا).

The following are the data cleaning and preprocessing steps that are usually applied to Arabic language corpora:

Remove numbers and all English letters from the Amharic and Arabic datasets and newline.

Removes all words containing an underscore, a hashtag sign, and a @ sign from the corpus.

Remove special characters, including symbols and emojis.

Remove repeating character such as ሃሃሃሃ, hahah,

ሓሓሓሓሓሓ

b. Character Normalization: There are several characters in the Amharic writing system that have the same sound, and there is no established guideline for utilizing them in Amharic words. Table 1 demonstrates normalization of Amharic letters that have the same sound but distinct symbolic representations.

Table I. List of consonants used by the study

Canonical form	Characters to be replaced
hä(U)	hä(ሃ፡ኃ፡ኀ፤ሐ፡ሓ)
se(ሰ)	se(ሠ)
ä(አ)	ä(ኣ፡ዐ፡ዓ)
ts'e(ጸ)	ts'e(ፀ)
wu(ዉ)	wu(ዊ)
go(ጎ)	go(ጐ)

For Arabic text normalization, we did not apply the normalization approach since some words might have the same letters but various meanings depending on their placement in the context. In other words, one word may have more than one lexical category [14].

Capitalization enhances human reading and distinguishes words [15]. However, a word's capitalization at the beginning of the sentence is treated the same as the word occurring anywhere in the content with lowercase. For instance, "MANGO," "ManGo," "manGo," and "MAnGo" map to "mango." Therefore, case normalization enables us to establish consistency. For English text normalization, we have been using the normalization approach.

c. Tokenization: Tokenization is more than just separating a text into words; it also removes numerals, language punctuation marks, brackets, hyphens, and any other undesired text components [16]. We eliminated

Amharic and English punctuation signs (፨, ., ;, !, ፤, ፣, ",", etc.),

numerals (፩, ፫, ፪, ፬, ፭, ፮, '፯', '6', '7', '8', '9', etc.), brackets

('(',')'), and hyphens (-) (Endalie & Haile, 2021). Tokenization is a technique for splitting Arabic text into tokens while taking into account changes caused by prefixes and suffixes. It is difficult due to morphological intricacy and clitics [18]. Tokenization of multi-word: employing lexicons, specialized materials, and mathematical models to maintain context and prevent inaccurate segmentation.

d. Stop word elimination: Since our goal is to improve preprocessing performance without impacting stance text classification ability, we built an Amharic stop words list for general usage that comprises all primary stop words and their derived versions. Arabic and English [19] [20] have their own stop words; as an addition to this research, we have evaluated if including stop words impacts the model performance or not.

The fundamental stop words were from earlier released lists. After evaluating and filtering the gathered lists, we generated a new list of around 500 domain-independent stop words [18]. Then, we created their inflected forms using a suggested approach including 123 Arabic clitics.

III. Experimental Results

In this study, we performed a variety of experiments to evaluate the effectiveness of the proposed stance categorization approach. We employed LSTM, BILSTM, and CNN approaches in the experiments we conducted. On these models, we do an experiment using one-hot encoding and Keras features. The settings of model parameters, such as the epoch number, learning rate, and train-test dataset splitting ratio, are constant throughout this experiment. We also assessed the experimental results of all models using several assessment measures, including accuracy, precision, recall, and F1 score.

A. Experimental result of stance detection

Fig. 2shows our model's training and validation accuracy for stance classification. The graph displays the training and validation accuracy of a Bidirectional Long Short-Term Memory (BiLSTM) model over 25 iterations. From the beginning, training and validation accuracy grow exponentially, indicating that the model is learning well from the input. But beyond around 5 epochs, validation accuracy improvement diminishes and later plateaus, although training accuracy continues to rise, albeit at a decreasing rate. The point at which the training and validation accuracy curves diverge shows that the model is getting too specific to the training data and not able to generalize to new data anymore.

In Fig. 3, we can see from the loss graph below that in the first round of epochs, the validation loss and the training loss were high. However, as the epoch round becomes better, the training loss and the validation loss become better too. In the initial epochs, the training loss and the validation loss were 90% and 72%, respectively, but in the final epochs, they were reduced to 0.4% and 20%. The training accuracy and validation accuracy were also better at 54% and 70%, respectively, compared to 98% and 92%, respectively.

Fig. 2. Training and validation accuracy of the stance classification model

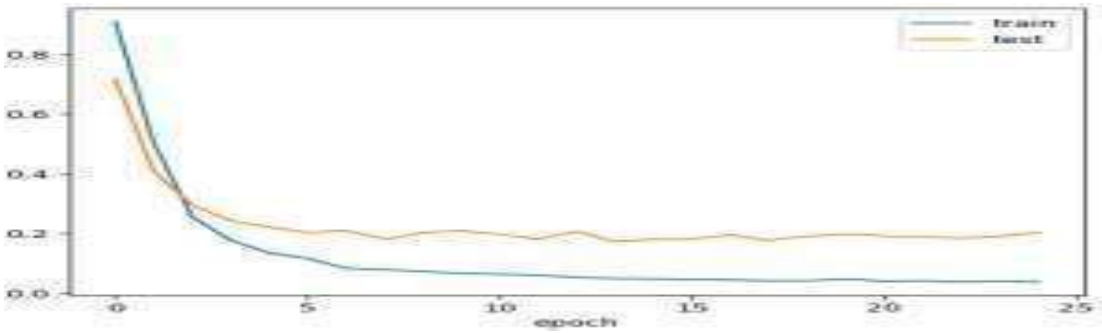
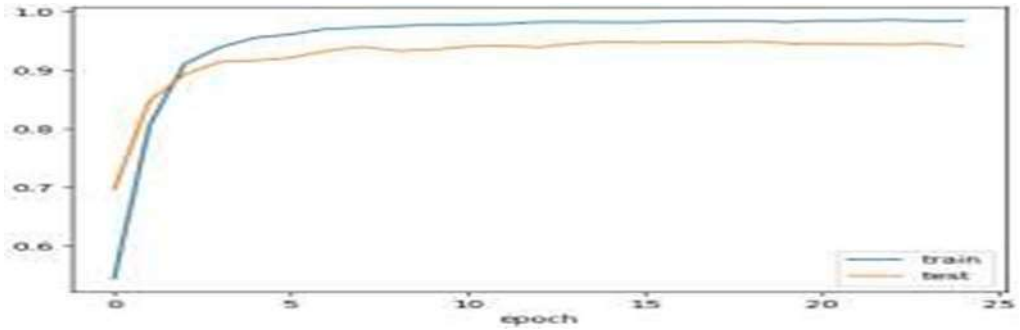


Fig. 3. Training and validation loss of the stance classification model



We present the performance metrics for three classes: 'neutral,' 'oppose,' and 'support.' In terms of actual numbers, the 'neutral' class shows strong performance with a precision of 0.96, a recall of 0.94, and an F1 score of 0.95 on 1146 samples. The 'support' class also shows high performance, with 0.94 precision, a recall of 0.90, and an F1 score of 0.89, from 1143 samples. The 'oppose' class, while still quite well performing, has lower scores than the first two, with a precision of 0.88, recall of 0.90, and an F1 score of 0.89 from 410 samples. Below the per-class metrics is an overall model performance summary.

	precision	recall	f1-score
NEUTRAL	0.96	0.94	0.95
OPPOSE	0.88	0.90	0.89
SUPPORT	0.94	0.95	0.94
accuracy			0.94
macro avg	0.93	0.93	0.93
weighted avg	0.94	0.94	0.94

B. Experimental result of target detection

Fig. 4 below shows the training and validation accuracy for a bidirectional long short-term memory model at 25 times. At first both the training and validation accuracies were increasing rapidly, which indicates that the model is learning correctly from the input data. After about 5 epochs, the rate of improvement in validation accuracy slows down and finally remains the same, although the training accuracy continues to increase slowly. The training and validation accuracy increased from 58.2% to 99.6% and 70.8% to 93.7%, respectively.

In the loss fig. 5, both the training and validation losses show a rapid decline, which shows that the model is effectively learning from the data. However, after about 5 epochs, the rate of drop in

validation loss slows down and finally plateaus, while the loss for training remains the same (the rate being slower).

At the initial epochs, the training and validation loss was 99.6% and 71.8%, respectively, but at the last epochs, it was 0.17% and 0.18%.

Fig. 4. Training and validation accuracy of the target detection model

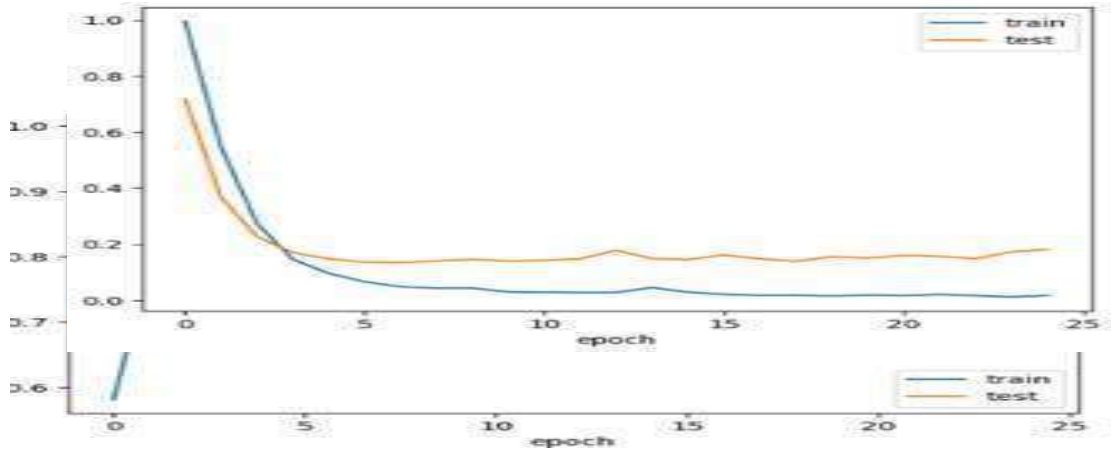


Fig. 5. Training and validation accuracy of the target classification model

We illustrate the performance measure for different classes. The report includes precision, recall, and F1-score for four different categories: EGYPT, ETHIOPIA, GERD, and NEUTRAL. For instance, 'NEUTRAL' has the maximum precision of 0.98, whereas 'EGYPT' has the minimum precision of 0.93. All four classes show high performance with F1 scores ranging from 0.95 to 0.97, which illustrates a good precision and recall balance for each class. These high mean scores suggest that the model is consistently good across all classes, representing good overall performance.

	precision	recall	f1-score
EGYPT	0.93	0.97	0.95
ETHIOPIA	0.95	0.96	0.95
GERD	0.96	0.94	0.95
NEUTRAL	0.98	0.96	0.97
accuracy			0.96
macro avg	0.95	0.96	0.95
weighted avg	0.96	0.96	0.96

IV. DISCUSSION

In this study, we used deep learning models for classifying multilingual stances in Amharic, Arabic, and English social media text comments on GERD. We used 5,020 for Amharic texts, 5,100 for Arabic texts, and 5,300 for English texts for comments and annotations to build the model. The model was tested on 20% of the data and trained on the remaining 80%.

The experimental results show the effectiveness of the proposed model in detecting features of stances and determining the target of the stance along with identified features on the GERD domains. The task is particularly challenging when dealing with diverse languages like Amharic, English, and Arabic, as each language presents unique linguistic features. Deep learning methods, especially neural networks, have proven to be effective for stance classification due to their ability to learn complex patterns in data without explicit feature engineering. However, the challenges posed by the linguistic intricacies of these languages require careful adaptation of models and techniques.

Table II below compares the performance of a stance classification model in Amharic, English, and Arabic using accuracy, precision, and F1score metrics in each of the three language sets: support, oppose, and neutral. An accuracy score is defined as the overall correctness of the predicted statements, while a precision and F1-score are the reported performance for each stance subset. The most precise state is found in oppose and neutral, with 97% in line with support (94%). Since both the methodology and the text are well suited to all languages, the system performed better overall with 92% accuracy in the languages.

Table II. Summary of Stance classification using CNN

Class	**Precision**	**F1-Score**	**Accuracy**
Support	94%	94%	92.4%
Oppose	97%	92%	
Neutral	97%	94%	

As shown in Table III below, it compares the accuracy of a classifier when using three different dialects: Amharic, English, and Arabic. The discrimination task with a special emphasis on target detection related to the GERD includes criteria for accuracy (Acc) and precision (Prec) for each target class (ETH, EGYPT, GERD, and NEUTRAL) and F1 score for each target class. Table III shows the ability of the classifier to correctly categorize the target of texts for those languages.

According to the accuracy and F1score evaluations, the model performs very well for all target categories given in the table. As expected, our model achieves very high precision and F1score

results for every target class observed. In general, the model performs well across all target classes, although accuracy and F1score for some targets differ slightly, suggesting that target identification problems might arise where target differences are evaluated across different languages.

Table III. Summary of Target classification using BiLSTM

Target class	precision	F1-score	Accuracy
ETHIOPIA	92%	91%	93.7%
EGYPT	94%	93%	
GERD	94%	92%	
NEUTRAL	96%	93%	

Conclusion

This research successfully demonstrated the viability and effectiveness of deep learning models for stance classification on the Grand Ethiopian Renaissance Dam in Amharic, Arabic, and English texts. Taking advantage of the power of the nerve network, we were able to automatically identify and classify public stances around this complex geopolitical issue. This study adds to the expanding corpus of research that employs computational tools to comprehend and evaluate sociopolitical discourse in a multilingual context. In this study, we perform different preprocessing steps, such as cleaning the data (removing URLs, numbers, punctuation, and emojis), tokenizing the data, and removing stop words utilized to obtain comments from social media toward the Grand Ethiopian Renaissance Dam. We also used two feature extraction methods, such as one-hot encoding and word2vec. The results of our stance model are compared, and CNN has great accuracy with 92.4% accuracy, CNN has great accuracy with 91% accuracy, and 91.2% using BiLSTM. On the other hand, our target classification result achieves an excellent accuracy rate of 93.7% using BiLSTM, 93% using CNN, and 92% using LSTM for those texts. For future work, we recommend assessing the influence of various current contextualized word embeddings (e.g., GloVe, ELMO, BERT) on the effectiveness of our proposed deep learning model using different languages.

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Iflation Dynamics and Its Determinants in Ethiopia; Time Series Analysis, Ardl and Ecm Approach: The Period 1983-2022

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Abstract

Inflation, one of the basic indicators of macroeconomic instability, affects many other macroeconomic variables, and it weakens the economy if it goes beyond a specified threshold level. The study aims to identify the determinants of inflation in Ethiopia by analyzing 40 years of secondary data from the National Bank of Ethiopia and other sources. Using the ARDL model, the research examines both short-run and long-run factors affecting inflation. In the long run, the findings revealed that variables such as oil price, lagged inflation, and broad money supply have a positive and significant impact on inflation, while real exchange rate and real GDP exhibit a negative impact. Specifically, a 1% increase in lagged inflation, oil price, and broad money supply results in inflation rising by 0.9595%, 0.1537%, and 0.1284%, respectively. Conversely, a 1% increase in real GDP leads to a 0.2288% decrease in inflation. In the short run, a one-unit increase in the lagged consumer price index raises current inflation by 1%, with exchange rate, international oil price, and money supply also showing significant influences on inflation. Moreover, the error correction term estimated at -0.37 is significant at the 5% significance level and has the recommended negative sign. Results confirm that both cost-push and demand-pull factors contribute to inflation in Ethiopia. Based on the findings from this study, it can be recommended that coordination among different governmental economic-policy making institutions is vital. Though it is the choice of a policy on priority between inflation and growth, whatever the government chooses, the coordination among fiscal policy, monetary policy, trade policy, and investment policy is essential to achieve the desired goal.

Keywords: Auto regressive distributive lag (ARDL), Consumer price index (CPI), Cost-push Inflation, Demand Pulls Inflation

Introduction

Ethiopia, as one of the developing countries, has faced a series macroeconomic problems such as a low GDP growth rate, budget deficit, deteriorated balance of payment, and huge debt service since the 1970`s (Getachew Mulat, 2020). Likewise, inflation in Ethiopia has been a burning issue that affects society at large. According to (Durevall, 2010), the largest percentage of inflation accounts for food inflation, and currently food prices are increasing more rapidly in the world in general, and in Ethiopia in particular. High inflation levels contribute to increased uncertainty about future inflation rates, potentially discouraging economic activities. Additionally, inflation leads to decreased export competitiveness, as rising domestic input costs inflate the prices of domestically produced goods in the global market, hampering export growth. (Abeba, 2014). Most importantly, inflation redistributes income from wage earners and fixed-income groups to profit recipients and from creditors to debtors. This in turn increases the number of poor, hence resulting in more inequality (Jhingan, 1997).

One of the key sources of inflationary pressure in Ethiopia is deeply rooted in the government financing of deficits. Data sets from the MoFEC indicate that the average annual financing requirement for the period 1974 -2017 was 8492.971 million Birr. The figures for the period 1974-1990 and for 1991-2017 were 720.279 and 13386.89 million, respectively. In terms of the sources of finance, the annual averages for gross borrowing, external sources, and domestic borrowing for 1974-2017 were 5448.625, 4663.038, and 2140.716 million birr respectively. For 1974-1990 the annual averages were 343.3905, 297.4992 and 396.0675, million birr, respectively, and for 1991-2017 the figures were 8663.032, 7411.711, and 3239.199 (Atnafu, 2020). What it shows that the money injected into the economy in terms of government financing has an increasing trend from time to time and causes prices to be sky-high because the fast increase in money supply was accompanied by the fast-rising inflation.

On the other hand, the major sources of inflation are the nature of investment in the country, the widening of the national deficit and ways of financing it, the inefficiency within government-controlled organizations, the soaring of oil prices, and others (Geda and Tafere, 2008). In contrast, the government argues that the inflation is due to rapid economic expansion that has happened in country. They also indicate that oil prices and an increase in world food prices as the possible sources of the inflation.

Average annual inflation for Ethiopia between 2015 and 2019 was 11.3%; the corresponding figures for low middle-income countries and Sub-Saharan Africa were 3.4% and 4.4%, respectively. Similarly, average inflation for 2018 and 2019 was 14% (Tekleselassie, 2021). In a country where a quarter of the population lives under the poverty line, double-digit inflation puts significant strain on the livelihood of people, particularly on wage earners and the retired section

of the population whose income can rarely cope with inflation rates (Tsegaye, 2021). As can be seen from this discussion, inflation has been rising at an alarming rate for the past seven years; its effects have been devastating for the urban poor and rural population, as their purchasing power has been declining drastically. Although the government has taken measures for price stability, inflation is still rampant in Ethiopia.

The investigation is anticipated to offer the current policy issue in Ethiopia with a consistent, precise, and concrete result-based investigation on the major source of inflation. As long as price stabilization is concerned as one of the pillar targets of the policy plan for the current and the future, this work is expected to dig out the problem and add to the macroeconomic policy formulation process.

Based on the above background information, the objective of the research was to analyze inflation dynamics and its determinants in Ethiopia by using time series data from 1983 – 2022.

Research Methodology

Types and Sources of Data

The time series data of selected macroeconomic variables between 1983 and 2022 were collected from their respective sources so as to make the paper effective in achieving its proposed objectives.

Method of Data Analyses

For the purpose of data analysis, the study employed the inferential method of data analysis. In econometric procedures, first, a unit root test was conducted to check for the stationarity of the time series model using the Augmented Dickey Fuller (ADF) test and the Phillips-Perron (PP) test. The co-integration test was applied using the ARDL bound co-integration approach to examine whether the variables have a long run relationship. The co-integration test serves as a bridge to determine whether to specify both the long-run and short-run model and the latter alone. If bound test of co-integration leads to the conclusion of the presence of a long-run relationship between the variables, both models should be estimated. The coefficients of the long-run model are estimated from the level form of the variables without differencing, but the short-run model (ECM) is derived from the ARDL model by transforming the equation into the re-parameterized form. The long-run information would not be lost in case the coefficient of the error correction term captures evidence of the relationship through its speed of adjustment interpretation. However, the short-run version of the ARDL model is specified if the bound test does not indicate the existence of a long-run relationship (Nkoro and Uko, 2016). Based on the availability of data in the Ethiopian context, some variables are added and some are removed in

the case of this paper. And the model is formulated as follows:

INF = F (EXDBT, Oilprice,M2, RGDP, EXR)

Put in regression form, the inflation function of equation (1) becomes

$INF = \beta_0 + \beta_1 EXDBT + \beta_2 Oilprice + \beta_3 M2 + \beta_4 RGDP + \beta_5 EXR + U_i$

The study adopts a model used to analyze inflation in Ethiopia by Menji (2008) and in Tanzania in 2001 by Laryea and Somalia to study the determinants of inflation. It is meant to mean that inflation (INF) is a function of external debt as a share of GDP (EXDBT), real exchange rate (EXR), money supply growth (M2), real gross domestic product (RGDP), and growth in oil price (Oil price).

Lag selection criteria: In order to carry out ARDL estimation, the choice of lag length is vital. There are various lag length criteria, among them the Akaike information criterion (AIC), the sequential modified LR test statistic with each test at 5%, the final prediction error (FPE), Schwarz information criterion (SC), and the Hannan-Quinn information criterion (HQ). However, each of these has different penalty factors. For the purpose of this study, we therefore limit the selection to the Akaike information criterion (AIC) and Schwarz information criterion (SC).

Diagnostic tests: The model that has been used for testing the long-run relationship and coefficients is further tested with the diagnostic tests of normality, serial autocorrelation, heteroscedasticity and any model misspecifications. The test is carried out to test the robustness of the results from the model.

Measurements and definition of variables

Table 3.*2*: Definition hypothesized variables that determined inflation

Variable			
Name	**Definition**	**Type**	
Dependent variable			
CPI	Inflation measured by the consumer price index	Continuous	
Explanatory variable			**Expected sign**
RER	Real Exchange Rate	Continuous	+
M2	Broad Money Supply	Continuous	+
Oilprice	Gas Oil Price	Continuous	+
XD XD	External Debt	Continuous	+
RGDP	Real Gross Domestic Product	Continuous	-/+

Result and Discussion

This chapter presents the findings of dynamics and determinants of inflation in Ethiopia using both descriptive and econometric analyses.

Descriptive result

Table 1: Descriptive statistics results of variables

	LNCPI	LNEXDBT	LNEXR	LNMS	LNOILPRIC	LNRGDP
Mean	3.906965	22.78944	1.941766	24.25380	3.514592	23.48151
Median	3.612987	22.74419	2.120960	23.91478	3.353998	23.33043
Maximum	5.988084	24.11583	3.553346	29.82007	4.695468	24.99483
Minimum	2.618855	21.33402	0.727549	21.61457	2.507972	20.69386
Std. Dev.	1.012687	0.683665	0.915719	1.938753	0.657647	0.874843
Skewness	0.591297	0.106800	-0.068790	0.699584	0.344768	-0.348723
Kurtosis	2.048780	2.785763	1.802905	3.015004	1.890405	3.949966
Jarque-Bera	3.838918	0.152537	2.419942	3.263158	2.844433	2.314779
Probability	0.146686	0.926567	0.298206	0.195620	0.241179	0.314306
Sum	156.2786	911.5775	77.67064	970.1521	140.5837	939.2605
Sum Sq. Dev.	39.99586	18.22849	32.70312	146.5917	16.86746	29.84866
Observations	40	40	40	40	40	40

Table 1 above shows the descriptive result of variables under consideration in the data set. The result shows the mean value for consumer price index is log3.906965 birr with standard

deviation of log3.612987 with the minimum value birr log2.618855 and maximum value log5.988084 birr, the mean value for exchange rate is 6.386088 with standard deviation of 5.044002 with the minimum value 2.07 and maximum value birr 19.08610 , the mean value of government capital expenditure is 13394.09 million birr with standard deviation of 25962.13 with the minimum value birr 237.6 and the maximum birr 107384.9 value and the mean value of real gross domestic product is 84284.23 million birr with standard deviation of 64116.81 with the minimum value birr 36476.24 and maximum value birr 267038.9 on average per year.

For all the series, the values of means and medians are close to each other, indicating minor symmetry. The maximum and minimum values of the series are also given for each series under the rows maximum and minimum, respectively. The measure of dispersion around the mean in the series is calculated as the standard deviation. Standard deviation is difficult to interpret in absolute terms. However, it can be interpreted in relative terms by comparing the standard deviation for two different distributions, i.e., the distribution with smaller standard deviation exhibits less dispersion, and larger standard deviation shows higher dispersion. Accordingly, in Table 1, log(pop) is a less dispersed series with the value of 0.160567, while log (inv) is the highly dispersed series with a value of 1.658253. The larger the dispersion between the values, the higher the standard deviation that shows greater volatility in investment. Volatility of an investment refers to uncertainty associated with the value of security. However, due to the absence of a security market in Ethiopia. In this case, volatility does not refer to the unpredicted movement of the price of a given value of security but largely refers to the unexpected return of an investment.

Unit root test results

As mentioned in the previous chapter, in studying economic relationships, one of the problems faced is spurious regression. This problem can be solved by checking if the variables are co-integrated so that a long-run relationship exists between them. In co-integration analysis, the first step is to study the order of integration that is determined by unit root tests. In this paper two unit root tests are applied, and their results are discussed below.

ADF test for stationarity

The result of the Augmented Dickey-Fuller (ADF) unit root test is summarized in the table below.

Table 2 ADF Test Results

	Level			First differences			I(d)
Variables	Intercept	Intercept and trend	None	Intercept	Intercept and trend	None	
LNCPI	1.017	-1.57	1.838	-4.417***	-4.899***	0.8922	I(1)
LNEXDBT	-1.4408	-1.5948	1.6726	-5.1845***	-5.113***	5.082***	I(1)
LNEXR	-0.054	-3298	1.8673	-3.605***	-3.6156***	-2.733**	I(1)
LNMS	2.839	2.445	3.997	-3.046***	-3.094***	-3.017***	I(1)
LNOILPRIC	-1.2684	-2.0797	-0.1429	-4.7758***	-4.6715***	-5.8509***	I(1)
LNRGDP	-0.093	-4.6098***	1.414	-7.341***	-7.4086***	-10.195***	I(0)

The ADF unit root test estimated above reveals that LNCPI, LNEXDBT, LNEXR, LNMS and LNOILPRIC have a unit root at first differences. But LNRGDP has a unit root at a level.

Table 3 PP test for stationary

	Level			First differences			I(d)
Variables	Intercept	Intercept and trend	None	Intercept	Intercept and trend	None	
LNCPI	1.6868	-0.8866	5.2497	-4.426***	-4.8522***	-2.7111***	I(1)
LNEXDBT	-1.6567	-1.8790	1.6726	-5.193***	-5.1151***	-5.1047***	I(1)
LNEXR	0.3351	-2.3478	2.9424	-3.485***	-3.5776***	2.7498***	I(1)
LNMS	2.8312	3.5560	3.8488	-3.889***	-4.3869***	-1.4452	I(1)
LNOILPRIC	-1.2684	-2.1272	-0.1189	5.7450***	-5.6394***	-5.8336***	I(1)
LNRGDP	-1.3203	-4.6461***	2.0866	-6.269***	-36.7046***	-12.433***	I(0)

Based on the above result presented in the above table, most of the variables have unit roots at their first differences based on the Phillips-Perron stationary test. According to the result, the null hypothesis is rejected for all of the variables at the level that proves the stationarity of the variables under study. The Phillips-Perron unit root test once again proves that variables under study are stationary at the same order, i.e. I(1) except LNRGDP, which is stationary at a level. Even though the PP unit root test has more power in correcting serial correlation problems, in this case such a problem did not arise and both the ADF and PP unit root tests display similar results, as shown in the above tables.

As a conclusion, the unit root test reveals that some of the variables used in the inflation LNRGDP are stationary I(0) while others are stationary at I(1) in both the ADF and PP unit root tests. In order to continue with the analysis, all variables in the model should be integrated in the

same order. Due to this reason the analysis will continue with the co-integration technique, studying the long-run relationship.

Notes: The sign of *, ** and *** represents the rejection of the null hypothesis of non-stationarity at the 10%, 5% and 1% significance level respectively. The null hypothesis is that the series is non-stationary, or the series has a unit root against the alternative hypothesis that the series is stationary. The Akaike information criterion (AIC) is used to determine the lag length while testing the stationarity of all variables.

Long-Run ARDL Bounds Tests for Co-integration

The stability of the long-run estimates or the existence of the long-run relationship between the dependent and independent variables has been tested by applying the ARDL bound test, by using a maximum of 2 automatic lag-length selections as recommended for yearly data and small sample size (Tsadkan, 2013).

This is done, firstly, by estimating the long-run equation of the model by using the ARDL estimation method with a maximum of 2 lags for both the dependent variable and the regresses

Table 4: **Bound test for cointegration**

F-statistics =7.3424		
Significance	Lower bound I(0)	Upper bound I(1)
10%	2.08	3
5%	2.39	3.38
2.5%	2.7	3.37
1%	3.06	4.15

The decision rule for the bound test is to reject the null hypotheses that no-long run relationship exists if the F statistic is larger than the upper bound at 5% significance level, and to accept the null hypothesis if the F statistic is lower than the lower bound at the 5% significance level and inconclusive about the existence of the long-run relationship if the F statistic lies between the lower and upper bounds.

As we can see from the above table, the F statistic (7.3424) is larger than the upper bound even at the 1% significance level, so we reject the null and we accept the alternative hypothesis of long run relationship. In other expression there is a long-run relationship in the model between the dependent and independent variables.

Long-Run ARDL Model Estimates

Hence, the existence of a long-run co-integration relationship among the variables is confirmed. The next step is running the appropriate ARDL model to find out the long-run coefficients, as reported in table.

Table 5 Estimated Long-Run Coefficients Using the ARDL (1,0,0,0,0,0) Approach

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNCPI(-1)	0.959721	0.124209	7.726634	0.0000
LNEXDBT	0.031283	0.049590	0.630834	0.5326
LNOILPRICE	0.150307	0.049749	3.021335	0.0049
LNM2	0.128432	0.036155	3.552255	0.0012
LNRGDP	-0.228828	0.129120	-1.772214	0.0859
LNEXR	-0.108288	0.060656	-1.785269	0.0837
C	1.486701	2.665227	0.557814	0.5809
R-squared	0.994859	Mean dependent var		3.960420
Adjusted R-squared	0.993895	S.D. dependent var		0.991426
S.E. of regression	0.077466	Akaike info criterion		-2.116810
Sum of squared resid	0.192031	Schwarz criterion		-1.818222
Log likelihood	48.27779	Hannan-Quinn criter.		-2.009679
F-statistic	1032.032	Durbin-Watson stat		2.132740
Prob(F-statistic)	0.000000			

The value of R^2 measures that, out of the total change in the dependent variable, which percent is determined within the model. As the table shows, the value of R^2 is 0.99; it shows that out of the total change in inflation, around 99% is determined by the independent variables included in the model jointly. The Durban-Watson d statistics in this model is 2.1327, which indicates that there is no autocorrelation problem in this model. The F- test for overall significance shows that all variables are statistically significant in the model.

As the long-run estimated result shows in table 5, the lagged value of the consumer price index (LNCPI(-1) has an aggregative or positive effect on inflation in the long-run. Accordingly, a unitary increase in the lag of the consumer price index (LNCPI (-1)) leads to an increase in inflation by 0.9595 %.

According to Frisch (1977), the effects of international inflation on domestic inflation are through several channels for international inflation to be transmitted to domestic economies, including the liquidity effect, price effect, and demand effect. Imported inflation from oil price shock accelerates the growth of domestic inflation in Ethiopia. Accordingly, a one percent increase in the price of gas oil per barrel, put as a proxy by oil price (LNOILPRICE), leads to a

rise in inflation by 0.153 percent and was 1% significant.

This result is similar to the theoretically expected sign and in line with results of other findings;Biresaw (2013) using a Granger causality approach, concluded that gas oil price causes inflation. Since the government terminated subsidizing the gas oil sector in 2007, oil prices have contributed a significant impact to Ethiopian inflation. For instance, using the OLS estimation technique, Menj (2008) concluded gas oil price has been found to be insignificant in influencing inflation. Since the study period was during the subsidization period.

According to Quantity theorists, inflation is always and everywhere a monetary phenomenon. In this study, similarly to the Quantity theorists' idea, broad money supply, represented by money growth (M2) has a positive impact on inflation in the long run at a 1% significance level in Ethiopia. Based on the result presented in the above table, a 1% rise in broad money supply results in a rise in inflation by 0.1284% in the long run. Evidence shows that in the long run, the consequential increase in the money supply causes inflation to move upwards (Sek et al, 2015). Moreover, much evidence supports that expansionary monetary policy can cause demand-pull inflation, which, if combined with cost-push inflation, can threaten macro and social stability.

On the other hand, real gross domestic product (RGDPP) causes inflation in Ethiopia to fall in the long run. This might be due to the decline in demand-pull inflation by the rise in output. Based on the findings of this work, a one percent increase in RGDPP leads to a 0.2288 % decline in inflation in the long run, and it shows that it is significant at a 10% probability level. That means based on this, real gross domestic product is found as a weak determinant of inflation in Ethiopia. This finding is similar to another finding by Khan and (Qasim, 1996).

The other factor that was expected as a major determinant of inflation was exchange rate. But contrary our prior expectation, the real exchange rate (RER) is found to have a weak significant impact on inflation in Ethiopia in the study period. Romer(1993) argues that the choice of the exchange-rate regime is not an important determinant of inflation. According to Loungani (2001), in countries with fixed exchange rates, inflation cannot be caused by exchange rate changes. And since Ethiopia has followed a controlled floating exchange rate regime since 1992 Reuters (2017) it is possible to absorb weak significant impact of exchange rate on inflation in the long run. The weak correlation between the price and the exchange rate might be due to the Ethiopian government's pegging the birr to U.S. the exchange rate regime. Especially in the Derg regime it was fixed at 2.07. All these might have caused the exchange rate not to have a strong significant influence on price in the long run. The result of this work showed as exchange rate increased by one percent inflation increased by 0.1083 % and it was significant at the 10% probability level.

Diagnostic test

For the error correction model, four diagnostic tests are employed to check the problem of serial correlation, misspecification, heteroscedasticity, and non-normal distribution. The Breusch-Godfrey Lagrange multiplier (LM) test is used to check for the problem of serial correlation, the heteroscedasticity test (Breusch-Pagan-Godfrey) is used to verify whether a problem of heteroscedasticity exists and to check if the error terms are normally distributed, and Jarque-Bera (J.B.) normality test is used. Finally, the Ramsey RESET test is employed to see if the model is specified correctly or not. Table 6 below summarizes the results of these diagnostic tests.

Table 6: Results of diagnostic tests

Test	Test Statistic	p-value
Jarque Bera	0.473788	0.789075
Breusch-Godfrey LM	0.7591	0.4763
Breusch-Pagan-Godfrey	1.1193	0.3687
Ramsey RESET	0.02724	0.9784

The normality test for the residual series is undertaken using the Jarque-Bera (J.B.) statistic. The J.B. test from the above table shows that the error terms are normally distributed. This is due to the low t-statistic, which is 0.473788 and the very high p-value, which is equal to 0.789075. But according to Agung (2008), normality tests are usually presented in specific cases and are not for use for any model selected because the statistics used for testing the normal distribution are assumed to have their own specific distribution function. This leads to testing the assumptions of the given specific distribution function, leading to a circular problem. Due to this reason, it is very difficult to give a concrete result for the normal distribution of the residual series using the normality test. The Durbin Watson statistic that detects the serial correlation problem shows that the error correction model does not suffer from the autocorrelation problem. The formal Breusch-Godfrey serial correlation Lagrange Multiplier (LM) test once again confirms that the residual terms in the model are serially independent, with the F-statistic having a value of 0.7591.

The heteroscedasticity test is carried out using the Autoregressive Conditional Heteroscedasticity (ARCH) LM tests. The F-statistics of the test has a value of 1.1193 which shows a statistically insignificant value. From these results, the ARCH LM test strongly suggests that there exists no heteroscedasticity in the residual terms of the model. Hence, the null hypothesis of no heteroscedasticity cannot be rejected, implying that the variance of the error term is constant. Since most of the time the problem of heteroscedasticity is observed in cross-sectional studies rather than in a time series framework, the finding of no heteroscedasticity is not unique.

The last row of the above table shows the result for the specification test using the Ramsey RESET test. The test basically verifies whether the model specified (additive or multiplicative) is correct or not. Accordingly, the RESET test confirms that the multiplicative model is rejected based on the log likelihood ratio of 0.02724 with a p-value of 0.9784. Hence, the data supports the additive model, and therefore the error correction model has no specification error.

In conclusion, the diagnostic tests show that the error correction model does not suffer from non-normality, serial correlation, heteroscedasticity, and misspecification problems. The Jarque-Bera normality test shows normal distribution of the error terms which means that the distribution is normally distributed with zero mean and constant variance. The model is free from serial correlation which means that the error terms are independently distributed or serially independent. In such cases the error that occurs at one time is not correlated with the one that occurs at another time. Though most of the time the problem of heteroscedasticity takes place in a cross-sectional framework, there is still a possibility of its occurrence in time series models that forces us to conduct a heteroscedasticity test in this study. The result in the above table shows that the error correction model does not face a problem of heteroscedasticity, which means the variance of the error term has a constant variance. At last, the Ramsey RESET test shows that the model is specified correctly.

Short-run error correction model

The next step after the acceptance of long-run coefficients of the inflation equation is estimation of the short-run ECM model. As we know, the error correction term (ECM)indicates the speed of adjustment to restore the equilibrium in the dynamic model. It is a one-lagged period residual obtained from the estimated dynamic long-run model. The coefficient of the error correction term indicates how quickly variables converge to equilibrium. Moreover, it should have a negative sign and be statistically significance at a standard significant level (i.e., p-value should be less than 0.05).

Table 7: The Short-Run Error Correction

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.052759	0.025416	2.075783	0.0460
D(LNCPI_1)	1.000000	0.073280	13.64550	0.0000
D(LNEXDBT)	0.099158	0.067445	1.470200	0.1513
D(LNEXR)	0.309620	0.178480	1.734755	0.0924
D(LNOILPRICE)	0.111715	0.057588	1.939913	0.0612
D(LNRGDP)	-0.275812	0.242387	-1.137901	0.2636
D(LNM2)	0.094874	0.042675	2.223161	0.0334
ECT(-1)	-0.370939	0.180659	-2.053252	0.0483
R-squared	0.304465	Mean dependent var		0.086390
Adjusted R-squared	0.174052	S.D. dependent var		0.098852
S.E. of regression	0.089838	Akaike info criterion		-1.820460
Sum of squared resid	0.258270	Schwarz criterion		-1.521872
Log likelihood	42.49897	Hannan-Quinn criter.		-1.713329
F-statistic	2.334628	Durbin-Watson stat		1.931242
Prob(F-statistic)	0.055433			

If the residuals are correlated among them, this correlation is called auto (serial) correlation. one has to look for the pattern of this correlation. Durbin-Watson stat on the regression table is one test, and the other test is by using Bruesch-Godfrey Serial Correlation LM test. The guideline of Durbin-Watson stat is said to be that if the Durbin-Watson stat is near two the residuals are not serially correlated; otherwise, it suffers from serial correlation. In this study presented in the above table, the Durbin-Watson stat is 1.931242 which is close to two.

As shown in the above table, the error correction coefficient estimated at -0.3709 is significant at the 5% significance level and has the recommended negative sign. Moreover, the coefficient of the error term (ECM-1) implies that the deviation from long-run equilibrium level of inflation in the current period is corrected by 37.09% in the next period to bring back equilibrium when there is a shock to a steady-state relationship. The negative values in speed of adjustment indicate the impact of shocks on inflation is declining over time.

As shown in the above table, the lagged value of consumer price index (CPI_1), real exchange rate (EXR), international oil price, and money supplyare the variables that affect inflation in the short run significantly. But their significant level is different. Based on the analysis result presented in the above table, a one percent increase in a lagged value of the consumer price index leads to an increase in inflation by one percent. That means the previous year's value of inflation causes a very high increase in the current year's prices of consumers. The variable is found to be significant at the 1% probability level. Inflation expectation is the other explanatory variable that explains 40% of the short-run variations in the inflation rate. Once again, inflation inertia is a key variable that largely explains changes in the general price level both in the long-run and in the

short-run. In both cases the coefficients of inflation expectation are statistically significant, having p-values less than 0.05 and 0.01 proving the significance at 5% and 1%, respectively.

The other independent variable that affects inflation in the short run was exchange rate. When the exchange rate increases by one percent, it leads to a 0.309 % rise in inflation. The decline in purchasing value of birr due to devaluation against the dollar might have caused this inflation. This variable was significant at 10% probability level. This means the exchange rate has a marginalized effect on inflation in the short-run. In addition, an increase in international oil prices by one percent causes a 0.1117 percent increase in the short run. The variable also significant at 10%. This variable is also has a weak effect on inflation in the short run.

Money supply is the other variable that affects inflation in the short run. According to the result of the analysis presented in the above table, a one percent increase in money supply in the economy cases a 0.0949 % increases in inflation in the short run. The variable was significant at 5%. This shows that money supply has a moderate effect on inflation in the short run.

Conclusion and Recommendation

Conclusion

This work examined the effects of some factors on inflation in Ethiopia by means of co-integration and error correction methods using yearly data for a period of 40 years. To determine the long-run and short-run relationship among the variables, the Autoregressive Distributed Lag (ARDL) model has been applied. Before applying the ARDL model, all the variables are tested for their time series properties (stationarity properties) using the ADF test and PP test. As a result, except for real gross domestic product which was stationary at level, I (0), all variables were stationary at first differences I (1). In addition to this, none of the variables used in this study are I (2).

Next to testing for the time series properties, the model stability test was done by applying the multicollinearity and heteroscedasticity tests. The results revealed no evidence of serial correlation, no functional form problem (the model is correctly specified), the residual is normally distributed, and no evidence of heteroscedasticity problem.

In addition, the study applied the methodological approach called the ARDL model and the method, or the test that is used to check co-integration also known as the bound test approach. As the test result indicated, the bound test (F-statistic) value is found to be larger than the upper bound critical values at a one percent significance level, indicating the existence of a long-run relationship between inflation rate (CPI) and its determinants.

The results of the analysis reveal that in the long run broad money supply, oil price, and lagged consumer price index contributed to raising the consumer price index, while real domestic product and real exchange rates were found to be decreasing factors of consumer price index or inflation. In the short run, the error correction coefficient estimated was -0.3709 and significant at the 5% probability level and has the recommended negative sign. Moreover, the coefficient of the error term (ECM-1) implies that the deviation from long-run equilibrium level of inflation in the current period is corrected by 37.09% in the next period to bring back equilibrium when there is a shock to a steady state-relationship. The negative values in speed of adjustment indicate the impact of shocks on inflation is declining over time.

In the short run analysis, the lagged consumer price index coefficient value is 1, and that means when lagged price index increases by one unit, it leads to an increase in the current inflation by 1%. It was significant at the 1% probability level. The other independent variable that affects price index was the exchange rate. When exchange rate increases by 1%, it leads to a 0.309 % rise in inflation and is significant at 10%. When an international oil price increases by one percent causes a 0.1117% increase of inflation in the short-run and insignificant at 10%. The other independent variable that was affecting inflation significantly was money supply. That means when the money supply increases by one percent in the economy, inflation increases by 0.0949 %, and it was significant at 5%.

In general it can be concluded that the empirical result reveals that inflation in Ethiopia has been affected by different factors that are analyzed in this work. In addition to this, as to my observation, the basic and critical factor for current inflation in the country is the illegal marketing system of consumable commodities. But it still needs further study and making the consumer price stable.

Recommendations

Based on the findings, the researcher would like to give the following recommendation and policy implications.

A constriction of monetary policy is necessary for a reduction of the inflation rate. Since it would be difficult to realize sufficient reduction of inflation only by monetary policy, without impacting economic growth, a reduction of inflation inertia through removal of structural factors is needed. To enhance the central bank's credibility and transparency of monetary policy, it is important to reduce excess money supply. However, a detailed policy prescription requires more rigorous study than this study dealt with on the effect of monetary policy in relation to other factors on price or inflation.

The government will have to pursue a monetary and fiscal policy, which matches with the actual

scenario of real sectors and monetary sectors. It is strongly experienced that further study should be carried out using different sets of variables and appropriate mathematical models to detect the inflation determinants in Ethiopia.

As the exchange rate increases, the price of imported commodities is becoming expensive. Even if devaluating one's own currency may promote export of the country's commodities if that particular country produces an internationally competitive product. But the Ethiopian government devaluates the country's currency. This action causes an increase in the price of the imported commodities and there by the living cost. At the end, the country's currency becomes fully powerless in terms of its purchasing power. So, the government of Ethiopia should stop devaluating the currency to reduce inflation that can be caused by cost-push inflation.

In general, coordination among different governmental economic policy-making institutions is vital. Though it is the choice of a policy on priority between inflation and growth, whatever the government chooses, the coordination among fiscal policy, monetary policy, trade policy and investment policy is essential to achieve the desired goal.

This study can be further conducted by including the market imperfection and illegal marketing agents through the marketing channel. Because currently the major problem in the country is illegal marketing and entering many of the basic commodities into illegal marketing by contrabandists.

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Identifying Critical Factors Affecting Student Learning Outcomes: A Quantitative Study Using RII and Group Index Methodology

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Abstract

In Ethiopia, a significant number of students, particularly from private universities, fail to meet the passing criteria of the university exit examination. This study investigates the underlying factors contributing to this challenge, with a focus on a selected private university. A total of 29 influencing factors were identified through an extensive review of the literature. A structured questionnaire, designed using a five-point Likert scale, was distributed to a randomly selected sample of 194 graduating students, with 188 valid responses collected. The dataset was evaluated for factorability, and exploratory factor analysis (EFA) was performed to reduce and categorize the variables. The analysis resulted in the grouping of the 29 factors into seven distinct components. Subsequently, the group index for each component was computed using the Relative Importance Index (RII) of the items within each factor. The results revealed that Adaptability to Student Abilities had the most substantial impact on students' academic performance (group index = 0.732), followed by Student-Centered Engagement and Responsiveness (0.728) and Learning Environment and Institutional Support (0.722). These findings underscore the critical role of pedagogical effectiveness, active learner engagement, and institutional adaptability in improving student outcomes in exit examinations. The study offers evidence-based insights for private higher education institutions and policymakers aiming to enhance the quality of teaching and learning processes and reduce the high failure rate in national university exit assessments.

Keywords: Group index, Factor analysis, Relative Importance Index, Learning outcome

Chapter One

Introduction

Education is universally recognized as a powerful instrument for building a civilized and progressive society (Chabbott and Ramirez, 2000;Jahantab, 2021) and (Alesina et al., 2021). Countries with well-developed educational systems tend to foster informed, responsible, and productive citizens and are often categorized as developed nations (Meyer, 2001). This relationship underscores the critical role education plays in national development (Lin, 2004;Kruss et al., 2015) and highlights its importance in aligning the youth with the nation's identity (Idris et al., 2012). Accordingly, both public and private educational institutions are entrusted with the responsibility of nurturing a civilized society by equipping students with the essential knowledge, skills, and attitudes needed to contribute meaningfully to their communities (Arshad- Ayaz, 2008).

Among these institutions, higher education establishments, particularly universities and colleges, bear a greater share of the responsibility. They are expected to produce graduates who are not only academically competent but also socially responsible and capable of addressing real-world challenges (Moscardini et al., 2022).

In an effort to enhance the quality of higher education, the Ethiopian Ministry of Education recently introduced standardized entrance examinations for students seeking university admission and exit examinations for graduating students. These measures aim to ensure that only well-prepared individuals enter higher education and that graduates possess the necessary competencies before joining the workforce and society at large.

However, student learning outcomes at the higher education level have come under increasing scrutiny. According to the Ministry of Education (2024), recent university exit examination results reveal that a significant proportion of students failed to meet the minimum passing requirements across both private and public institutions. This alarming trend underscores the urgent need to investigate the underlying factors contributing to poor performance. Motivated by these findings, this study aims to identify the critical factors affecting student learning outcomes using quantitative methodologies, specifically the Relative Importance Index (RII) and Group Index.

Objectives of the study

To systematically identify and categorize the critical factors that influence student learning outcomes in Ethiopian higher education institutions, based on quantitative analysis of exit exam results and stakeholder inputs.

To assess and rank these factors using the Relative Importance Index (RII) and Group Index methodologies, providing an evidence-based prioritization of factors affecting student performance.

To generate actionable recommendations for improving student learning outcomes, informed by the ranking of factors, within the context of national education quality and equity goals.

Literature Review

It is an undeniable fact that enhancing student learning outcomes significantly contributes to the development of a civilized and progressive society. Equipping students with the requisite knowledge, skills, and attitudes necessitates the integration of diverse teaching and learning dimensions. Numerous scholars have undertaken research to identify the key factors influencing these dimensions and have proposed strategic interventions to address the challenges involved.

Conceptualizing Student Learning Outcomes

Student learning outcomes refer to the knowledge, skills, and attitudes that individuals acquire through their educational journey, career development, and life experiences (Brooks et al., 2014). These outcomes also reflect how students internalize and apply the knowledge gained from formal education to real-world contexts. Furthermore, they emphasize what students are capable of demonstrating and performing in practical situations (Chiou, 2020).

Critical Factors Affecting Learning Outcomes

It is widely recognized that higher education institutions bear a fundamental responsibility to equip students with the knowledge, skills, and attitudes essential for both personal growth and societal advancement (Nasrallah, 2014). However, in underdeveloped and developing nations, this mandate is often undermined by a range of systemic challenges. Prominent among these are deficiencies in the teaching–learning environment, the persistence of outdated or ineffective pedagogical approaches, misaligned learning objectives, and inadequate educational infrastructure (Asim et al., 2021). Loyalka et al. (2014) further identified the low quality of training as a critical contributing factor. Similarly, Wu et al. (2014) emphasized the influence of government policy, school administration, the availability and quality of teaching equipment, institutional ethos, leadership and management practices, as well as broader forces such as social change and globalization. Collectively, these factors impede the attainment of desired learning outcomes and obstruct progress toward educational quality, equity, and relevance. Addressing these systemic barriers is essential for cultivating a learning culture that aligns with national development priorities and meets global standards of competency.

Other studies have identified a range of factors that critically influence student learning outcomes. Somerville (2008) highlights six key determinants: the knowledge and experience of campus leaders, the presence of trust and opportunities for collaboration, effective leadership, faculty engagement, clearly defined lesson objectives, and the strategic use of assessment results. Similarly, the study conducted by Asim et al. (2021) identifies five influential factors: assessment strategies, competency-based learning objectives, students' preferred learning styles, proficiency in the English language, and alignment with employment requirements. Furthermore, research by Perez-Perez et al. (2019) reveals that the quality of information, effectiveness of communication, and overall student satisfaction significantly shape learning outcomes.

In developing economies, the factors influencing learning outcomes are generally categorized into two broad domains: digital and traditional instructional factors. Digital learning outcomes are primarily affected by technological limitations and the lack of adequate training for teachers, whereas traditional instructional outcomes are constrained by limited learner engagement and the static nature of information delivery (Purke and Aslan, 2025). In the context of Ethiopia, the study conducted by Faro et al., (2005) identifies three major factors: poor teacher preparation, limited instructional strategies, and poor access to digital resources, all of which significantly influence student learning outcomes.

Quantitative Assessment Methods in Educational Research

The quantitative approach has been acknowledged by scholars for its ability to systematically analyze large datasets and identify statistically significant relationships (Gorard, 2010). Moreover, the quantitative approach facilitates comparative analysis across different variables or groups, thereby enhancing the robustness and generalizability of the research findings (Reale, 2014). Some of the quantitative methods, such as regression analysis, factor analysis, and structural equation modeling, are commonly employed to explore complex variable interactions.

Among these, the Relative Importance Index (RII) has been increasingly adopted for prioritizing factors based on respondent ratings, especially in fields like engineering education and management studies (Holt, 2014). The RII offers a simple yet powerful way to rank items by quantifying the collective judgment of respondents on a Likert scale.

Additionally, the Group Index Methodology, a newer analytical tool, has been proposed to enhance RII results by grouping related variables into components or categories. This approach facilitates a more nuanced understanding of factor clusters affecting student learning, enabling researchers to suggest targeted interventions.

Gaps in the Literature

Despite the wealth of research on factors affecting student learning, two gaps remain prominent. First, few studies have employed both RII and group index methods in combination to systematically identify and rank the most critical factors. Second, there is a limited application of these methods in the context of private universities in Ethiopia, where infrastructural, instructional, and administrative challenges differ significantly from those in public institutions.

This study aims to address these gaps by using RII and group index methodologies to evaluate and rank critical factors affecting student learning outcomes in private higher education institutions in Ethiopia.

The Research Methodology

This section presents the methodological procedures and techniques employed in the study. A quantitative approach was utilized to provide a comprehensive analysis of the research problem.

Study Population

The population of the study includes all undergraduate students enrolled in private universities recognized by the Ministry of Education of Ethiopia. Due to the broad and undefined nature of the target group, the population is considered infinite for sampling purposes. To obtain a manageable and relevant sample, one university was purposively selected. The institution chosen was S Marry University, focusing specifically on its undergraduate programs. The total number of students considered within this context was five thousand four hundred twenty four.

Sample Design and Sampling Technique

As outlined in the population section of the study, a total of five thousand four hundred twenty-four students constituted the population frame. The sample size was calculated using Yamane's formula, with a margin of error set at seven percent, resulting in a sample size of one hundred ninety-seven students.

$$n = \frac{N}{1 + Ne^2} \quad (1)$$

Where n is the sample size, N is the population of the study, and e is the margin of error.

A structured questionnaire was developed based on a five-point Likert scale. The instrument incorporated twenty-nine factors identified through an extensive review of the relevant literature. These factors were refined and reformulated into statements assessing the perceived importance

of their impact on student academic performance.

The questionnaire was administered to the one hundred ninety-seven students selected through a stratified random sampling technique to ensure representation across relevant subgroups. Of the distributed questionnaires, one hundred eighty-eight were returned fully completed, yielding a response rate of approximately ninety-five percent.

Data Analysis

The data analysis process followed a systematic sequence of statistical procedures. First, a reliability analysis was conducted to assess the internal consistency of the questionnaire items and to examine the extent to which responses aligned with the central research problem.

Second, Spearman's rank correlation coefficient was applied to evaluate the degree of agreement or association among responses from students across different academic departments.

Third, exploratory factor analysis was performed to reduce the twenty-nine refined statements into a smaller number of underlying components. Each statement was then categorized under the appropriate component based on factor loadings and conceptual relevance.

Fourth, the Relative Importance Index (RII) was calculated for each factor within the derived components using the prescribed formula, enabling prioritization of the most influential factors.

$$RII = \frac{\sum W}{A * N} \quad \text{---------- (2)}$$

Where ∑W is the sum of all weights given to a factor, A is the highest possible weight, in this case 5, and N is the total number of respondents.

Finally, a group index was computed for each component to quantify its overall significance, again using the specified formula.

$GI = \frac{RI}{n}$ (Where GI is the group index; ∑RII is the sum of the relative importance index of each factor in a given factor group, and n is the number of factors in the group.

Chapter Four

Results and Interpretations

In this section of the study, both secondary and primary data results are presented and interpreted. The secondary data analyzed herein were obtained from the 2024 report published on the official website of the Ethiopian Ministry of Education.

General statistics of private and public institutions

The information presented in Table 1 summarizes the total number of public and private institutions, the total number of candidates, the average pass rate, as well as the highest and lowest pass rates. The results indicate that, on average, public educational institutions significantly outperform private institutions by a considerable margin.

Table 1. The number of institutions, the number of candidates, and passing rates of public and private institutions in Ethiopia

Metric	Public Institutions	Private Institutions
Total Institutions	59	202
Total Candidates	~66,000+	~65,000+
Average Pass Rate (%)	~55%	~23%
Highest Pass Rate (%)	100%	96.67%
Lowest Pass Rate (%)	0%	0%

Distribution by pass rate category

As shown in Table 2, the results obtained from secondary sources were classified into three pass rate categories: high, medium, and low. The number of candidates from public and private institutions was distributed accordingly across these categories. The findings reveal that approximately 90% of private institutions fall within the low pass rate category, compared to about 60% of public institutions.

Table2. Pass rate category and distribution institutions

Pass Rate Band	Public Institutions (No.)	Private Institutions (No.)
High (≥75%)	10	4
Medium (50–74%)	14	8
Low (<50%)	35	190

Institution size and pass rate

As presented in Table 3, the results for institutions with a small number of candidates are somewhat mixed; however, only a few private institutions achieved a high pass rate, while the majority recorded low pass rates. In the case of institutions with a medium number of candidates, public institutions exhibited a pass rate exceeding 50%, whereas private institutions recorded pass rates below 30%. For institutions with a large number of candidates, public educational institutions performed relatively well, while private educational institutions demonstrated considerably lower performance.

Table 3. Institutions candidate size category and pass rate

Size Category	**Trend**
Small (≤500 candidates)	Mixed results: few small institutions score high, but majority has low pass rates.
Medium (501–2000 candidates)	Public institutions in this band often show pass rates 50%+, while private institutions mostly <30%.
Large (>2000 candidates)	Large public universities like AAU, Bahir Dar University perform relatively well (50-75%). Large private institutions (e.g., Rift Valley, Admas) show very low pass rates (<25%).

Group index of public and private institutions

As presented in Table 4, the group index for public educational institutions is approximately 1.41, while that of private educational institutions is about 0.59. This indicates that, on average, the public institution group performs 41% above the mean, whereas the private institution group performs 41% below the mean.

Table 4. Group index of public and private institutions

Group	**Group index (GI)**
Public institutions	55% / 39.1% ≈ 1.41
Private institutions	23% / 39.1% ≈ 0.59

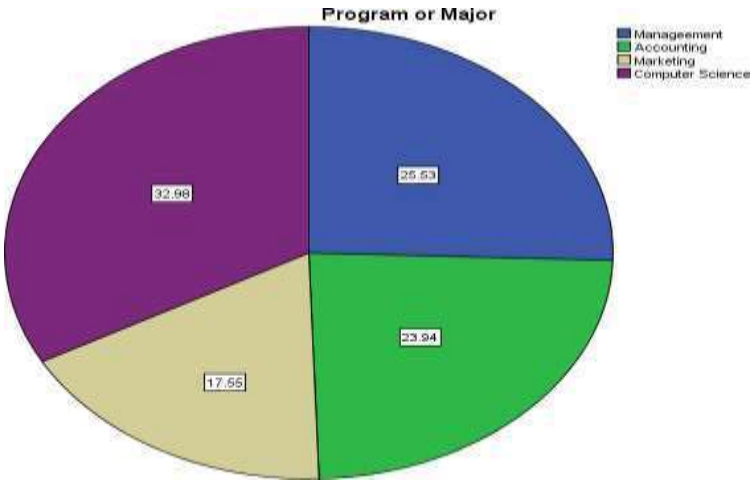
The results presented in Table 1 indicate that the average pass rate for public educational institutions is 55%, while that for private educational institutions is 23%, with the overall mean pass rate standing at approximately 39.1%.

Figure 1. The average pass rate values of public and private institutions and the group mean.

Demographic Information

As presented in figures 2 and 3, the study involved participants from four academic departments: Management, Accounting, Marketing, and Computer Science. Among the total respondents, 32.98% were from the Computer Science department, 25.53% from Management, 23.94% from Accounting, and 17.55% from Marketing. Furthermore, 96.23% of female respondents and 93.9% of male respondents fell within the age range of 21 to 25 years. This indicates that the majority of the participants were between 21 and 25 years of age.

Figure 2. Percentage Distribution of Departments Participating in the Questionnaire Response



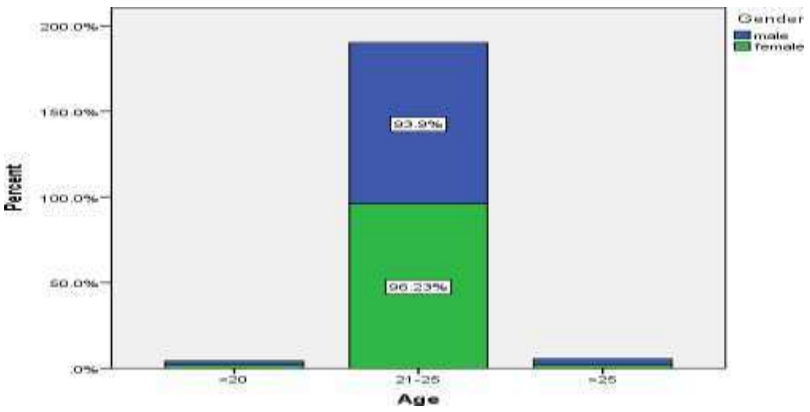


Figure 3. Percentage Distribution of Female and Male Students by Age Group

Reliability test

The results presented in Table 5 illustrate the reliability analysis conducted using SPSS version

20. This analysis aimed to evaluate the internal consistency of the research instrument, ensuring that the items within the questionnaire consistently measure the intended constructs (Bolarinwa, 2015). The computed Cronbach's alpha coefficient was 0.938, which exceeds the commonly accepted threshold of 0.70 and is interpreted as indicating excellent reliability (Noble et al., 2021). This high reliability score confirms that the questionnaire items demonstrate strong internal coherence and that the instrument is suitable for capturing reliable data relevant to the study's objectives.

Table 5. Cronbach's Alpha Value Generated Using SPSS

Reliability Statistics

Cronbach's Alpha	N of Items
.938	29

Spearman's Rank Correlation Test

The Spearman's rank order correlation analysis presented in table 6 was conducted to assess the level of agreement in perceptions across the four academic departments (Schmid and Schmidt, 2007): Management, Accounting, Marketing, and Computer Science, regarding factors influencing student outcomes. The results indicate a statistically significant positive correlation between management and accounting ($\rho = 0.533$, $p = 0.003$), as well as between management and computer science ($\rho = 0.513$, $p = 0.004$), suggesting that these departments share similar

perspectives on the critical factors affecting student performance. Additionally, accounting and computer science also exhibited a significant positive correlation (ρ = 0.500, p = 0.006), reinforcing the consistency of views among these disciplines. The correlation between accounting and marketing (ρ = 0.376, p = 0.044) and between marketing and computer science (ρ = 0.377, p = 0.044) were moderate but statistically significant, indicating partial alignment in perceptions. In contrast, the correlation between marketing and management (ρ = 0.197, p = 0.305) was weak and not statistically significant, highlighting a divergence in viewpoints between these two departments. This divergence may reflect differences in curriculum structure, teaching methodologies, or departmental priorities, which potentially influence how each department perceives challenges and factors affecting student success. The overall pattern of correlations suggests that while most departments share a common understanding of key educational factors, Marketing stands apart, signaling the need for more tailored interventions or strategies that address the unique context and challenges of this department. These findings underscore the importance of considering departmental differences when designing institutional policies or support mechanisms aimed at enhancing student academic outcomes.

Table 6. Spearman's Rank Correlation Coefficients Generated Using SPSS

Correlations

			Management	Accounting	Marketing	Computer
Spearman's rho	Management	Correlation Coefficient	1.000	.533**	.197	.513**
		Sig. (2-tailed)		.003	.305	.004
		N	29	29	29	29
	Accounting	Correlation Coefficient	.533**	1.000	.376*	.500**
		Sig. (2-tailed)	.003		.044	.006
		N	29	29	29	29
	Marketing	Correlation Coefficient	.197	.376*	1.000	.377*
		Sig. (2-tailed)	.305	.044		.044
		N	29	29	29	29
	Computer Science	Correlation Coefficient	.513**	.500**	.377*	1.000
		Sig. (2-tailed)	.004	.006	.044	
		N	29	29	29	29

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Factor Analysis

Factor analysis was conducted primarily to reduce the number of complex factors contributing to students' poor performance in the Ethiopian university exit examination. Before carrying out the reduction process, the suitability of the data was assessed by examining the adequacy of the sample and the presence of multicollinearity using the Kaiser Meyer Olkin measure and Bartlett test of sphericity. As presented in Table 7, the Kaiser Meyer Olkin value was found to be 0.914, which is interpreted as excellent (Vakili, 2018), indicating that the sample was adequate for conducting factor analysis. Furthermore, the Bartlett test of sphericity produced a Chi square value of 2496.637 with a significance level of 0.000. This result confirms that there are statistically significant correlations among the variables (Hadi et al., 2016), supporting the appropriateness of the dataset for factor analysis.

Table 7. Test of Sample Adequacy and Multicollinearity

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.914
Bartlett's Test of Sphericity	Approx. Chi-Square	2496.637
	df	406
	Sig.	.000

Prior to categorizing each factor into its corresponding component, the communalities described in table 8 were examined. Factors with extracted communalities below 0.40 were considered for elimination, as such items are deemed not sufficiently aligned with other items within the same component (Hadi et al., 2016). However, all factors in the analysis demonstrated extracted communalities exceeding the 0.40 threshold, indicating adequate shared variance with the identified components. Consequently, all factors were retained and subsequently grouped into distinct, well-defined components. The number of components was determined based on the **Total Variance Explained** table 9, whereby factors with eigenvalues (λ) greater than or equal to 1.0 were retained in accordance with Kaiser's criterion. The analysis revealed that seven components collectively accounted for 62.6% of the total variance, which is considered satisfactory for social science research.

- The extracted components were conceptually labeled as follows:
- Learning Environment and Institutional Support
- Instructional Flexibility and Inclusion

- Student-Centered Engagement and Responsiveness
- Adaptability to Student Abilities
- Respect for Learner Diversity
- Engagement Through Teaching Style
- Student Empowerment and Ownership, All identified factors were appropriately categorized under these seven components based on their loading patterns and conceptual relevance.

Table 8. Communalities of the Refined Factors

Communalities		
	Initial	Extraction
Ignoring students' varied learning style hinders their academic performance	1.000	.648
Not considering personal learning styles in class activities lead to poor learning outcomes	1.000	.743
Disrespecting cultural and social backgrounds creates a barrier to effective learning	1.000	.476
Lack of awareness of students' strengths and weaknesses negatively impact their learning	1.000	.718
Rigid lesson pace that does not match individual abilities limits students' understanding and performance	1.000	.651
Failure to adapt teaching to diverse learning needs reduces students' engagement and academic success	1.000	.609
Not encouraging student questions and ideas reduces engagement and learning outcomes	1.000	.494
Restricting choice in learning activities diminishes motivation and academic success	1.000	.572
Failing to incorporate real-life contexts in learning activities make the material less relevant and harder to retain	1.000	.574
Lack of work opportunities reduces peer learning and collaborative skill development	1.000	.712
Not involving students in goal setting leads to decreased ownership of learning outcomes	1.000	.596
Absence of a student-centered approach in the curriculum negatively affects motivation and achievement	1.000	.643
Inflexible teaching methods that do not adjust to student understanding undermines learning effectiveness	1.000	.695
Not using diverse tools and media fails to address different learning preferences	1.000	.622
Ignoring students feedback results in ineffective lessons and poor learning outcomes	1.000	.691
Avoiding experimentation with new teaching strategies lead to monotonous and disengaging lessons	1.000	.454
Lack of responsiveness to student input creates a less effective environment	1.000	.672

Table 8 continued

Communalities		
	Initial	Extraction
Failure to adapt teaching methods to diverse student needs leads to disengagement and poor academic results	1.000	.661
Passive participation in the classroom activities limit understanding and retention	1.000	.620
Dull lesson delivery decreases student motivation and academic performance	1.000	.654
Using a limited range of teaching methods reduces comprehension and academic achievement	1.000	.530
Lack of involvement in the learning process lowers motivation and academic results	1.000	.741
Ineffective teaching approaches hinder my academic success	1.000	.503
Limited access to learning resources negatively impacts academic performance	1.000	.736
A poor classroom environment reduces concentration and negatively affects learning outcomes	1.000	.619
Insufficient time and space for classwork hinder effective learning	1.000	.654
Lack of institutional support for modern teaching methods limit students success	1.000	.569
An unsafe or disrespectful environment detracts from learning outcome	1.000	.666
Unavailability of necessary learning materials or facilities impedes academic achievement	1.000	.634

Extraction Method: Principal Component Analysis.

Table 9. Total Variance Explained and Identification of the Seven Components

Total Variance Explained

Components	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.795	37.225	37.225	10.795	37.225	37.225	4.096	14.123	14.123
2	1.451	5.005	42.230	1.451	5.005	42.230	3.043	10.493	24.616
3	1.383	4.770	47.000	1.383	4.770	47.000	2.650	9.137	33.754
4	1.231	4.245	51.246	1.231	4.245	51.246	2.341	8.073	41.826
5	1.197	4.126	55.372	1.197	4.126	55.372	2.154	7.427	49.254
6	1.067	3.680	59.052	1.067	3.680	59.052	2.009	6.927	56.181
7	1.031	3.554	62.606	1.031	3.554	62.606	1.863	6.425	62.606
8	.923	3.184	65.790						
9	.871	3.005	68.795						
10	.819	2.823	71.618						
11	.740	2.553	74.171						
12	.708	2.442	76.612						
13	.647	2.233	78.845						
14	.613	2.112	80.957						
15	.529	1.825	82.783						
16	.514	1.771	84.553						
17	.496	1.709	86.263						
18	.470	1.622	87.885						
19	.457	1.576	89.461						
20	.426	1.470	90.931						
21	.395	1.363	92.294						
22	.366	1.261	93.555						
23	.343	1.182	94.736						
24	.318	1.096	95.832						
25	.292	1.007	96.839						
26	.281	.968	97.807						
27	.238	.822	98.629						
28	.212	.730	99.358						
29	.186	.642	100.000						

Extraction Method: Principal Component Analysis.

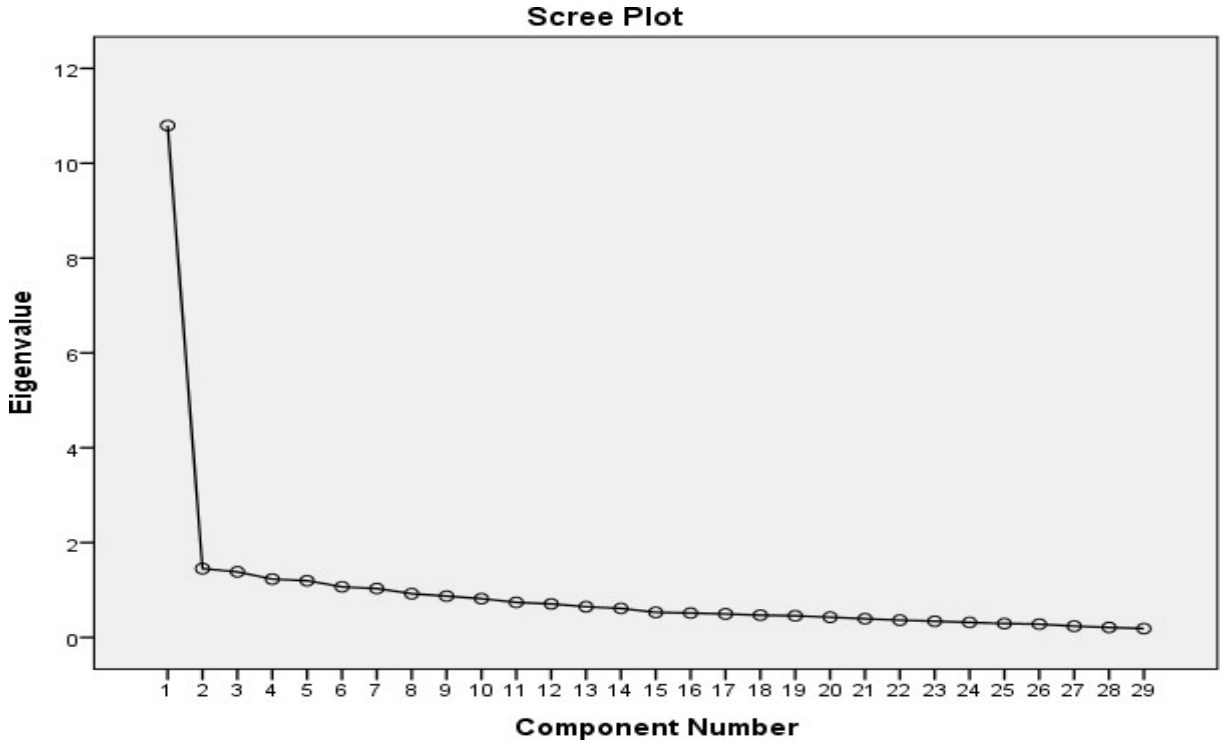


Figure 3. Scree plot showing eigenvalues corresponding to component numbers of the refined factors

The results presented in Table 10 provide a comprehensive summary of the identified components, the refined factors assigned to each component, and the corresponding Relative Importance Index (RII) values calculated for each factor using Equation 2. In addition, the table presents the Group Index values computed using Equation 3, which reflect the overall significance of each component based on the collective importance of its associated factors. This detailed presentation allows for a clear understanding of the relative contribution of individual factors as well as their grouped impact within the broader analytical framework.

Table 10. Component names, refined factors categorized under each component, the computed relative importance index (RII) for each factor, and the group index of each component

No.	Component Names	Factors	RII
1	*Learning Environment and Institutional Support*	Insufficient time and space for classwork hinder effective learning	0.714
		Lack of institutional support for modern teaching methods limits students success	0.694
		Disrespecting cultural and social backgrounds create a barrier to effective learning	0.694
		Unavailability of necessary learning or facilities impedes academic achievement	0.771
		A poor classroom environment reduces concentration and negatively affects learning outcomes	0.746
		Limited access to learning resources negatively impacts academic performance	0.712
		Aggregate	**0.722**
2	*Instructional Flexibility and Inclusion*	Inflexible teaching methods that do not adjust to student understanding undermine learning effectiveness	0.700
		Not using diverse tools and media fails to address different learning preference	0.668
		Ignoring students feedback results in ineffective lessons and poor learning outcomes	0.730
		Not encouraging student questions and ideas reduce engagement and learning outcome	0.696
		Aggregate Index	**0.698**
3	*Student-Centered Engagement and Responsiveness*	Lack of responsiveness to student input creates a less effective environment	0.730
		Failure to adapt teaching to diverse learning needs reduces students' engagement and academic success	0.738
		Lack of involvement in the learning process lowers motivation and academic results	0.700
		Ineffective teaching approaches hinder my academic success	0.746
		Avoiding experimentation with new teaching strategies leads to monotonous and dis- engaging lesson	0.724
		Aggregate Index	**0.728**

Table 10. Continued

No	Component Names	Factors	RII
4	*Adaptability to Student Abilities*	Lack of awareness of students strengths and weaknesses negatively impacts their learning	0.730
		Rigid lesson pace that does not match individual abilities limit students understanding and performance	0.733
		Failure to adapt teaching to diverse learning needs to reduce students' engagement and academic success	0.734
		Aggregate Index	**0.732**
5	*Respect for Learner Diversity*	Ignoring student feedback results in ineffective lessons and poor learning Outcomes	0.730
		Not considering personal learning style in class activities leads to poor learning outcome	0.682
		Disrespecting cultural and social backgrounds creates a barrier to effective learning	0.694
		Restricting choices in learning activities diminishes motivation and academic success	0.694
		Aggregate Index	**0.700**
6	*Engagement through Teaching Style*	Passive participation in classroom activities limits understanding and retention	0.615
		Dull lesson delivery decreases students motivation and academic performance	0.705
		Using a limited range of teaching methods reduces comprehension and academic achievement	0.680
		Lack of involvement in the learning process lowers motivation and academic results	0.700
		Aggregate Index	**0.675**
7	*Student Empowerment and Ownership*	Lack of work opportunities reduces peer learning and collaborative skill development	0.634
		Not involving students in goal setting leads to decreased ownership of learning outcomes	0.681
		Absence of a student-centered approach in the curriculum negatively affects motivation and achievement	0.698
		Aggregate Index	**0.671**

Discussions and Conclusion

Discussion

The findings of this study, derived from the comprehensive analysis of secondary exit exam data provided by the Ministry of Education, reveal significant disparities in student learning outcomes across higher education institutions in Ethiopia. Specifically, the results highlight stark differences between public and private institutions, as well as performance patterns across institution sizes and types.

The most striking observation is the considerable gap in average pass rates between public and private institutions. Public institutions recorded an average pass rate of **55%**, while private institutions averaged only 23%. This disparity is further emphasized by the computed *Group Index* (GI), where public institutions achieved a GI of 1.41, indicating performance approximately 41% higher than the overall mean pass rate. In contrast, private institutions exhibited a GI of 0.59, demonstrating outcomes significantly below the national average.

These results suggest that institutional type is a critical factor influencing student learning outcomes. Public institutions generally benefit from stronger regulatory oversight, more established infrastructures, better-qualified academic staff, and relatively consistent funding from the government. Private institutions, particularly those with low pass rates, may face challenges related to inadequate instructional quality, limited resources, and insufficient academic support systems.

This study was conducted to investigate the major challenges that contribute to students' poor performance in university exit examinations, with a specific emphasis on private universities in Ethiopia. An initial pool of 29 factors was identified through an extensive review of the literature and was subsequently refined into clearly articulated statements that reflect their potential influence. A structured questionnaire, based on a five-point Likert scale, was developed and distributed to 197 respondents selected through stratified random sampling. Of these, 188 valid responses were returned, resulting in a high response rate of approximately 95.6%.

Data analysis was carried out using IBM SPSS Statistics (Version 20). The first step involved conducting a reliability test to assess the internal consistency of the items. The analysis produced a Cronbach's alpha value of .938, which is considered excellent (Noble et al., 2021). Next, Spearman's rank correlation was used to determine the level of agreement among respondents from various academic departments. As indicated in Table 3, there was a weak correlation between the marketing and management departments, while the correlations among other departments were moderate and statistically significant.

Factor analysis was then employed to reduce the 29 identified variables into a smaller number of meaningful components. Before proceeding, the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity were used to assess the suitability of the data. The results indicated that the sample was adequate and the variables were sufficiently intercorrelated to justify the use of factor analysis.

The communalities table was examined to determine the proportion of variance explained by each variable. All variables demonstrated extracted variance values above the accepted threshold of 0.4 and were thus retained for further analysis. The total variance explained table revealed seven components that collectively accounted for approximately 62.6% of the total variance. Each of the 29 refined items was grouped under one of these seven components, and descriptive labels were assigned to reflect the conceptual focus of each category.

Furthermore, the Relative Importance Index (RII) was calculated for each item using Equation 2, and the Group Index (GI) for each component was determined using Equation 3. The results showed that the component titled Adaptability to Student Abilities ranked highest (GI = .732), followed by Student-Centered Engagement and Responsiveness (GI = .728) and Learning Environment and Institutional Support (GI = .722). These findings suggest that prioritizing these three components may significantly enhance students' academic performance in university exit examinations.

Conclusion

This study aimed to identify the key challenges affecting students' performance in university exit examinations within private universities in Ethiopia. Through rigorous statistical analysis, including factor analysis and the computation of relative importance indices, seven core components were identified as critical determinants. Among these, adaptability to student abilities, student-centered engagement and responsiveness, and learning environment and institutional support emerged as the most influential.

The findings underscore the importance of aligning teaching and assessment strategies with the diverse needs and abilities of students. Institutional policies and classroom practices that prioritize student engagement, individualized support, and conducive learning environments are likely to improve educational outcomes significantly.

While the study provides valuable insights, it is limited to private universities and may not fully capture the dynamics of public institutions. Future research should consider broader samples, longitudinal data, and the integration of qualitative methods to deepen the understanding of factors affecting student performance.

Addressing the identified challenges holistically can contribute to enhancing the quality of teaching and learning, thereby ensuring better academic achievement and institutional accountability in the higher education sector.

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Rural Poverty in Ethiopia: Challenges and Sustainable Pathways for Prosperity

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Abstract

Agriculture remains the backbone of Ethiopia's economy, sustaining livelihoods for the majority of its population and contributing significantly to national GDP. This research abstract presents a comprehensive analysis of the dynamics, challenges, and solutions in agriculture and rural development in Ethiopia, highlighting pathways towards sustainable growth, poverty alleviation, and inclusive rural transformation. Key challenges include lack of proper agricultural extension services, agricultural productivity decline, land tenure systems, rural livelihood strategies, natural resource management practices, and the agricultural policies and interventions. These challenges are exacerbated by population pressure, land tenure insecurity, and the prevalence of subsistence farming practices, which hinder the adoption of modern agricultural technologies and practices. Furthermore, it emphasizes the importance of holistic and integrated approaches to rural development that prioritize sustainability, resilience, and social inclusion. This includes the adoption of participatory and community-driven development strategies, promotion of agroecological farming systems, expansion of rural infrastructure and social services, and strengthening of local governance structures. By addressing structural constraints, promoting innovation, and fostering partnerships between government, civil society, and the private sector, Ethiopia can achieve inclusive and sustainable rural development, thereby improving food security, reducing poverty, and fostering resilient rural economies.

Keywords: *Agriculture, Ethiopia, Sustainable development, Poverty alleviation, Inclusive growth.*

Introduction

Rural development is influenced by various factors, including geography, access to markets, and investment in infrastructure. Agriculture has long been the cornerstone of Ethiopia's economy, especially for the rural community, providing livelihoods for the majority of its population and serving as a significant contributor to the nation's Gross Domestic Product (GDP). Since choices are involved within the agricultural sector both for the sector, as a whole and across subsectors, strong interlinkages exist across subsectors and between agriculture and the rest of the economy. Moreover, agricultural production growth is often constrained by demand in both domestic and export markets, and demand, in turn, depends on income growth both in agriculture and the broader economy. To understand the wide economic impacts of agricultural growth, both urban and rural sectors should be included in this framework (Dorosh & Thurlow, 2012).

Research-based technology together with appropriate domestic and international trade is essential for agricultural growth (Nagy et al., 2020). Therefore, the objective of this research is to study the causes and solutions of rural poverty in Ethiopia.

Natural Resource management

Out of the reviewed papers, six researches (Brück et al., 2023; Chamberlin & Schmidt, 2013; Chesterman et al., 2019; Djillo et al., 2024; Fanta et al., 2024) suggested that effective natural resource management plays a crucial role in alleviating rural poverty.

Soil conservation and Management

Effective soil conservation and management practices are essential for sustainable agriculture in Ethiopia. Implementation of land rehabilitation measures had shown a great relationship with higher crop production and farm income. Studies by Fanta et al. (2024) and Djillo et al. (2024), which were carried out in Southern Ethiopia, identified that the farm distance to home and perception of rehabilitation positively influenced household participation in the community-based land rehabilitation program (CBLRP) in the study area. However, the age of the respondents and access to education positively and ownership of livestock negatively influenced household participation.

Specific trainings tailored for soil conservation are efficient in solving the issue (Chesterman et al., 2019). Youth-based interventions are necessary since the age of households showed a negative relationship with interest in participation in soil conservation programs. And market specialization is recommended at least between livestock and crop production due to the fact that livestock owners preferred the income from their animal production and neglected to participate in soil conservation programs (Fanta et al., 2024).

Site-specific specialized soil conservation trainings mainly targeting the youth are necessary for specialized crop producers in Ethiopia.

Ecosystem service specialization

Ecosystem services are defined as the direct and indirect contributions of ecosystems to human well-being and have an impact on our survival and quality of life. There are four types of ecosystem services: provisioning, regulating, cultural, and supporting services. Provisioning services are characterized by the ability of humans to obtain products from ecosystems, such as food, water, and resources, including wood, oil, genetic resources, and medicines. Regulating services are categorized as any benefit obtained from the natural processes and functioning of ecosystems. Examples include climate regulation, flood regulation and other natural hazard regulation, pollination, water purification, and more. Cultural services include non-material benefits that people can obtain from ecosystems. These include spiritual enrichment, intellectual development, recreation, and aesthetic values. Finally, supporting services are those that relate to habitat functioning themselves, and therefore influence survival. For example, photosynthesis, the water cycle, and nutrient cycles are the basis of ecosystems, which in turn allow us to support ourselves. This type of ecosystem service also goes down to the genetic level, such as the maintenance of viable species gene pools.

Ethiopia's diverse ecosystems provide valuable services, including pollination, water regulation, and soil fertility. Specializing in ecosystem services can create economic opportunities for rural communities while conserving biodiversity and natural resources. A study by Brück et al. (2023) investigated the relationships between ecosystem services specialization, comparative advantage, and tele coupling. The study revealed that ecosystem specialization and tele coupling showed a positive relationship. In addition, Brück et al. (2023) showed that the relationship between comparative advantage and ecosystem specialization grows stronger with altitude. This is because higher altitudes mostly have less forest cover that can give more options to produce more diversified ecosystem service specialization. In this study, wealthier *kebeles* also found to be less specialized. This is because they can “afford” diversity and not only focus on few subsistence crops that are needed for subsistence.

The opportunities and constraints facing Ethiopian *agriculture* are strongly influenced by geographical location. *Ethiopia's* diverse landscape defines certain agricultural production potentials, access to input and output markets, and local population densities, which determine both labor availability and local demand for food. Understanding the geographical expression of *Ethiopia's* agricultural and *rural development* options provides greater information for more locally targeted policy options. These conditions not only vary over space but also change over time as well. New and improved roads, greater telecommunications, improved access to

electricity, and ongoing urban growth continue to lower transaction costs and improve market access. Evolving production opportunities and technologies continue to provide greater flexibility of livelihood decisions within defined biophysical endowments. As *Ethiopia* continues to invest in infrastructure and technology, its agricultural landscape continues to be reshaped and redefined into broader areas of opportunity and growth (Chamberlin & Schmidt, 2013).

Marginal grabens

A graben is a piece of Earth's crust that is shifted downward in comparison to adjacent crust known as "horsts," which are shifted upward. Marginal grabens are rich in water resources, and graben bottoms are suitable for agricultural development as a result of age-old alluvial deposition. In line with a worldwide survey of natural resources, many of the western marginal grabens of the Ethiopian Rift Valley could be agricultural development corridors. Because the population has been growing rapidly, marginal grabens could be used to expand the amount of irrigated agriculture in the country. However, the overutilization of surface and groundwater resources may lead to river basin closures, while inadequate drainage systems have also increased the salt loads in the wetlands and endorheic lakes. In addition, geomorphic processes at the graben bottom, such as gully erosion, hinder agricultural development. Worldwide, proper planning of water and land resources is urgently required to engage in rural development in (semi)closed basins. In fact, wise management practices keep river basins more open to fulfill social and environmental water requirements. However, in the study area, further studies on the water balance, characteristics of debris cones, alluvial fans, soil texture distribution, salinity and irrigation, groundwater inter-basin transfers, and land suitability are needed to support agricultural growth programs (Meaza et al., 2017).

Public administration

Effective public administration also plays an important role in relieving rural poverty, according to (Alemu & Scoones, 2013; Melesse & Awel, 2020; Schmidt & Pearson, 2016; Shumi et al., 2023; and Urquía-Grande & Rubio-Alcocer, 2015)

Resettlement and rural development

Resettlement programs have been implemented in Ethiopia to address land degradation, food insecurity, and poverty in rural areas. However, the success of resettlement schemes depends on careful planning, community participation, and sustainable land management practices. The intraregional resettlement scheme in Ethiopia had brought substantial changes to the livelihood of the resettled communities. It is successful in rescuing human life, improving livelihood assets, and ensuring food security for most of the settlers. Shumi et al. (2023) suggests that urgent attention be given to improving infrastructures and environment conservation for the betterment

of the livelihoods of resettles.

Donation and rural development

Studies (Alemu & Scoones, 2013; Urquía-Grande & Rubio-Alcocer, 2015) support that donations play a crucial role in eradicating rural poverty in Ethiopia. External assistance and donations play a crucial role in supporting rural development initiatives in Ethiopia. The Ethiopian government promotes harmonization and an alignment process of Western donor support through the Ethiopian High Level Forum. Brazil and China are currently not engaged in these coordination platforms, working instead on a bilateral basis. Core activities include experience-sharing in public governance, technical cooperation, and the attraction of private and public investments. In the case of Brazil, the cooperation focuses on renewable energy sector development mainly related to biofuels derived from sugarcane production, whilst in the case of China, cooperation is more focused on infrastructure, agricultural technology, and skill transfer. The approach adopted by *Ethiopia* reflects a commitment to a 'developmental state' approach. This seems to be delivering results in the agricultural sector and beyond (Alemu & Scoones, 2013).

Land Tenure

Land tenure systems play a crucial role in shaping agricultural development outcomes in Ethiopia. Secure land tenure rights are essential for incentivizing long-term investments in land improvement, promoting sustainable land management practices, and ensuring equitable access to land resources. A study by Melesse and Awel (2020) revealed that tenure security positively and significantly affects households' productivity in general and is marginally significant for female-headed households in particular. In case of communal grazing lands, a research (Schmidt & Pearson, 2016) done in the Afar region exposed that loss of communal land due to land privatization weekend traditional institutions and cultural identity in Afar.

Agriculture as a business

Farmers should treat agriculture as a business activity rather than a subsistence activity aiming only to provide a source of food for their households. In order to improve the profitability of agriculture as a business and create wealth even outside of agriculture, researchers (Ayana et al., 2022; Ayenew et al., 2017; Azanaw & Tassew, 2017; Chesterman et al., 2019; Dorosh & Thurlow, 2012; Dowsing & Cardey, 2020; Getnet et al., 2022; Kraaijvanger et al., 2016; Leta et al., 2017; Melaku et al., 2024; Mogues, 2013; Nagy et al., 2020; Owoo & Naudé, 2017; Ozkan et al., 2022; Tesfay, 2023; Woyesa & Kumar, 2021) suggested a number of ideas, such as improvement of agricultural extension services, working on agricultural productivity, and adopting non-farm businesses.

Improvement of Agricultural Extension Services

Access to agricultural extension services is critical for disseminating knowledge, technologies, and best practices to farmers. Strengthening agricultural extension systems can improve farmer productivity, enhance resilience to climate variability, and promote sustainable agricultural practices (Chesterman et al., 2019; Tesfay, 2023). In addition, agricultural extension increases climate resilience of farmers through providing greater access to technologies, markets, information, and credit for investment to adapt their production systems and practices (Ozkan et al., 2022).

While the general truth reveals this fact and agricultural officers believe they are using effective communication, research results (Melaku et al., 2024) show contradictory ideas. A research result by Melaku et al. (2024) shows that eventhough there is an ongoing agricultural extension service in the research area, farmers were unable to implement the required tasks due to lack of agricultural inputs and inaccessibility of extension workers for long periods of time. This shows there is a lack of an appropriate feedback mechanism in planning agricultural extension programs.

In addition, women are also neglected in the agricultural extension services (Azanaw & Tassew, 2017; Mogues, 2013).

Budget issues were also mentioned (Melaku et al., 2024) as causes for fewer contacts between farmers and extension workers. Social learning through social networks by means of communication, observation, collective labor groups, public meetings, socio-cultural events, and group socialization can fill this gap. Informal institutions, such as *iddir*, *debo* and *dado*, also helped farmers learn, adopt, and diffuse technologies (Leta et al., 2017).

Another innovative approach to revolutionize agricultural extension is the participatory research approach. A study by Kraaijvanger et al. (2016) showed that farmers who participated in this research believed that their participation is worthwhile and they acquired new knowledge. Farmers who participated in this research gained yields more than 50% than the control groups. Their confidence in demonstrating specific agricultural practices and discussing with officials to solve neighborhood problems significantly increased. This is supported by Dowsing and Cardey (2020), who suggested that limited access to resources and unpredictable environmental conditions were stifling smallholder farmer innovation and livelihoods. This paper also suggested that service provisions should be better tailored to local conditions, provide greater resource access, and work more closely with farmers. The development and implementation of service provision should involve a wide range of institutions and farmers throughout the process. Local community- and farmer-based organizations are especially important and can work alongside innovative and talented farmers to enable more effective dissemination of information.

Agricultural rural development and service provision should focus greater attention on the views and perspectives of farmers from a range of areas with differing socio-demographic and agro-ecological characteristics for comparative analysis.

Agricultural Productivity

Agriculture is basic to secure growth and development in Ethiopia. It accounts for two-fifths of GDP and three-fourths of merchandise export earnings. Since choices are involved within the agricultural sector both for the sector, as a whole and across subsectors, strong interlinkages exist across subsectors and between agriculture and the rest of the economy. To understand and synergize these linkages, an integrated framework is needed. Moreover, agricultural production growth is often constrained by demand in both domestic and export markets, and demand, in turn, depends on income growth both in agriculture and the broader economy. To understand the economy-wide impacts of agricultural growth, both urban and rural sectors should be included in this framework (Dorosh & Thurlow, 2012).

Agricultural growth is influenced by various factors, including geography, access to markets, and investment in infrastructure. Research-based technology together with appropriate domestic and international trade is essential for agricultural growth (Nagy et al., 2020).

A study by Urquía-Grande and Del-Campo (2017) described women's income, having an animal for transportation, and owning a mobile as positively correlated with willingness to participate in agricultural development projects. As Urquía-Grande and Del-Campo (2017) described an increase in women's monthly income up to $200 has shown a positive relationship with interest in participating in agricultural development projects. However, monthly income exceeding $200 resulted in less interest to participate in agricultural development projects.

Non-farm business

Non-farm activities in rural areas can help in reducing rural poverty (Ayana et al., 2022; Ayenew et al., 2017; Getnet et al., 2022). The proximity of non-farm firms to rural areas can stimulate their own productivity and agricultural growth by providing market opportunities for farmers, facilitating value addition, and promoting rural-urban linkages. Strategic investments in rural infrastructure and agro-industrial development can enhance the competitiveness of rural economies and contribute to poverty reduction (Owoo & Naudé, 2017).

Tourism can be one of the best choices for non-farm activities in rural areas. A study by Woyesa and Kumar (2021) showed that coffee tourism can improve the livelihood of farmers in southwest Ethiopia. This indicates comparative advantages in different parts of the country may support the effort to reduce rural poverty.

Conclusion and recommendations

Natural resource management

Specific trainings tailored for soil conservation are efficient in solving the issue. Youth-based interventions are necessary since the age of households showed a negative relationship with interest in participation in soil conservation programs. And market specialization is recommended at least between livestock and crop production due to the fact that livestock owners preferred the income from their animal production and neglected to participate in soil conservation programs. Site-specific specialized soil conservation trainings mainly targeting the youth are necessary for specialized crop producers in Ethiopia.

Agriculture as a business

There is a lack of appropriate feedback mechanisms in planning agricultural extension programs. In addition, women are also neglected in the agricultural extension services. Social learning through social networks by means of communication, observation, collective labor groups, public meetings, socio-cultural events, and group socialization can fill the gap of budget shortage in agricultural extension programs. Participatory research approaches increase farmers' awareness and confidence in their farming activities and improve their productivity while decreasing direct costs for agricultural extension.

Ecosystem specialization and telecoupling showed a positive relationship. In addition, Brück et al. (2023) showed that the relationship between comparative advantage and ecosystem specialization grows stronger with altitude. As a comparative advantage example, marginal grabens are rich in water resources, and graben bottoms are suitable for agricultural development as a result of age-old alluvial deposition.

Effective public administration

Intra-regional resettlement is successful in rescuing human life, improving livelihood assets, and ensuring food security for most of the settlers.

External assistance and donations play a crucial role in supporting rural development initiatives in Ethiopia.

Non-farm activities in rural areas can help in reducing rural poverty. The proximity of non-farm firms to each other can stimulate their productivity. Secure land tenure rights are essential for incentivizing long-term investments in land improvement, promoting sustainable land management practices, and ensuring equitable access to land resources.

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The Role of Social Work in Empowering Women's Participation as Climate Technology Providers

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Abstract

Women's participation as providers in climate technology remains limited due to structural, financial, and socio-cultural barriers. This study explores the role of social work in empowering women to become active climate technology providers rather than solely end-users. Using a qualitative research approach, it examines how social work facilitates this transition by addressing gender equity, offering capacity-building programs, and advocating for inclusive policies. Through key informant interviews with social workers, women in climate technology, policymakers, and development practitioners, the study identifies effective interventions. Findings highlight that social work promotes access to training, mentorship, financial resources, and networks, enabling women to overcome systemic challenges. Furthermore, social workers play a crucial role in policy advocacy and community engagement, ensuring gender-responsive approaches in the climate technology sector. This research contributes to understanding how social work can drive women's empowerment in sustainable development. Strengthening women's roles as climate technology providers helps bridge the gender gap in climate solutions and fosters inclusive, community-driven innovation.

Keywords: Climate Technology, Women Empowerment, Social Work, Gender Equity, Policy Advocacy, Capacity Building.

Introduction

The effects of climate change are significantly impacting Ethiopia, with droughts, floods, and other climate-related events exacerbating existing social and economic inequalities (USAID, 2016). Women, particularly those aspiring to participate in the climate technology sector, face unique challenges due to entrenched gender roles and societal expectations. Limited access to education and training in science, technology, engineering, and innovation (STEM) fields often restricts their entry into this sector (Federal Democratic Republic of Ethiopia, 2019). Additionally, unpaid care responsibilities and unequal access to productive resources further hinder their ability to engage meaningfully in climate technologies (Federal Democratic Republic of Ethiopia, 2019).

Climate change intensifies these barriers. For instance, resource scarcity caused by environmental degradation increases women's workloads, leaving them with little time or energy to pursue education, training, or employment opportunities in green technologies (Senay Habtezion, Jennifer Baumwoll, et al., 2016). These challenges are compounded by structural inequalities, such as limited access to decision-making processes, financial resources, and supportive networks within the climate technology sector. Such imbalances reduce women's participation and representation, especially in technical and leadership roles (CRGE Facility & Global Green Growth Institute (GGGI), 2020).

Despite these challenges, the climate technology sector presents significant opportunities for women's empowerment. Renewable energy technologies, for example, have the potential to improve livelihoods and reduce burdensome labor. (Emily Folk, 2019). However, women are often positioned as end-users rather than active providers, innovators, or leaders in this space. Addressing this disparity requires targeted interventions to enhance women's representation, address gender-specific barriers, and enable their active participation across all levels of the climate technology value chain (Tucho & Nonhebel, 2017).

Social work plays a critical role in addressing these gaps by empowering women to overcome barriers and engage meaningfully in the climate technology sector. This includes creating platforms for skills development, facilitating access to resources, and advocating for gender-responsive policies that promote equity in the sector. Social workers can act as catalysts for change, ensuring that women are not only included but are also able to thrive as innovators, providers, and leaders in climate technologies (Nyahunda, 2021a).

This paper explores women's participation and representation in climate technologies, identifies the challenges they face, and examines the role of social work in empowering women to navigate and excel in this field. It underscores the importance of dismantling structural barriers, addressing gendered norms, and providing targeted support to amplify women's contributions to climate solutions.

Statement of the Problem

In Ethiopia, women face disproportionate impacts from climate change, yet their active participation in climate technologies and solutions remains limited. While they benefit from innovations like solar water systems and energy-efficient cook stoves, their involvement in the design, implementation, and decision-making processes around these technologies is minimal (Gemechu, 2022). Despite global climate efforts, women's roles in green initiatives remain underrepresented, limiting their empowerment and hindering Ethiopia's overall capacity to implement climate solutions. In a broader context, Ethiopia has seen a steady influx of climate finance, averaging USD 1.7 billion annually for climate-related initiatives, but this only covers 7% of the estimated USD 25.3 billion needed to meet its climate goals (Rajashree Padmanabhi & Chavi Meattle, 2022). A key barrier to progress is the underrepresentation of women in these initiatives, which impacts both their empowerment and the nation's ability to effectively deploy climate projects. This study aims to explore how social work can empower women in climate technologies through strategies like community empowerment, capacity building, and advocacy, enabling them to shift from passive recipients to active contributors and leaders in climate action.

Research Objectives

The main research objective is to explore how social work can empower women's participation in climate technologies in Ethiopia, focusing on their challenges, representation, and the role of community empowerment and advocacy.

The specific objectives are to: identify the challenges that women face in participating in climate technology sectors in Ethiopia, assess the level of women's representation and involvement in the design, implementation, and leadership of climate technology initiatives, and explore how social work strategies, such as community empowerment, capacity building, and advocacy, can enhance women's active participation and leadership in climate technologies.

Research Methodology

The increasing prevalence of women in climate action and technology has significantly impacted the sector, yet gender disparities continue to exist, limiting women's full participation. This research aims to explore how social work can help empower women to become providers of climate technologies in Ethiopia, a sector traditionally dominated by men. Despite various initiatives supporting gender equality, many women still face significant barriers, including limited access to resources, lack of training, and cultural biases that restrict their ability to become leaders in climate technology.

This study employs a qualitative research methodology, specifically using a phenomenological

approach, to explore how social work can empower women to become providers of climate technologies, and not merely end users. The phenomenological methodology allows for an in-depth exploration of the lived experiences of women in this field, focusing on how gender, social work, and climate technology intersect. It is primarily focused on Addis Ababa, Ethiopia, as the key area where climate technology development and gender-focused programs intersect. While Addis Ababa serves as the focal point due to its central role in Ethiopia's climate action initiatives, the study's insights are also relevant to other regions in Ethiopia, especially those with active gender and climate technology programs.

The research is framed within a constructivist paradigm, emphasizing the idea that individuals construct their own understanding of their experiences based on their social and cultural contexts. This perspective allows for a deeper understanding of how women perceive their roles in the climate technology sector and how social work interventions can facilitate their empowerment. It follows a qualitative approach to capture the complexities and nuances of women's roles in the climate technology sector. Through interviews and document analysis, this approach allows for the exploration of participants' experiences, challenges, and insights that quantitative methods would not reveal (Tenny et al., 2024).

The study adopts an exploratory and descriptive research design. The exploratory design is necessary due to the limited research on women's leadership in climate technology and the role of social work in this empowerment. The descriptive design helps to capture the breadth and depth of women's experiences in the sector and the role social work can play in supporting these experiences. It employs purposive sampling, selecting participants who have direct involvement in climate technology and gender inclusion initiatives. These include women technology providers, development organization staff, government representatives, and social workers who are working towards empowering women in the climate technology sector.

The target population includes stakeholders in climate technology, gender inclusion, and social work. Participants are drawn from sectors such as women-led businesses, private companies, development organizations, government ministries, gender associations, and social work professionals. The study focuses on individuals with direct experience in promoting gender equality and climate technology. The sampling frame consists of professionals with expertise in climate technology, gender inclusion, and social work. Participants are selected from a network of experts in these fields who have actively contributed to initiatives empowering women in the climate sector. This ensures that the study includes individuals who can provide valuable insights into the research questions.

The sample size is determined based on the principle of saturation, the point where additional interviews or data collection no longer yield new insights or themes. Saturation ensures that the

sample size is large enough to capture diverse experiences but not excessive to the point of redundancy. The study uses purposive sampling, focusing on individuals who are knowledgeable and actively involved in gender and climate technology initiatives. Participants are selected for their expertise, leadership, and involvement in projects aimed at empowering women and promoting their participation in the climate technology sector.

Data for the study are collected using Key Informant Interviews (KIIs) and document analysis. KIIs involve semi-structured interviews with key stakeholders in the climate technology and gender equality fields. Document analysis includes reviewing policies, research articles, and reports related to women in climate technology to provide additional context to the primary data. KIIs are the main data collection instrument, allowing for in-depth, open-ended discussions with participants. These interviews are designed to explore the perceptions, challenges, and experiences of women leaders in climate technology and the role of social work in facilitating their empowerment.

Document analysis is used to complement the KIIs by providing a broader context. Relevant documents such as policy papers, reports, and research articles are analyzed to assess the state of gender inclusion in climate technology and how social work strategies are being applied to empower women in this sector. The data collection follows a structured procedure. Purposive sampling is used to identify potential participants based on their relevant experience. Initial contact is made via professional networks, followed by scheduling interviews. Interviews are conducted either in person or online, based on participant availability, or are recorded with their consent. The data collected through interviews is transcribed and analyzed to identify recurring themes.

The data are analyzed using thematic analysis, a qualitative data analysis method that identifies key themes, patterns, and categories in the collected data. Thematic analysis involves both deductive and inductive reasoning. Deductive reasoning is used to identify pre-existing themes based on the literature review, while inductive reasoning allows for the emergence of new, unexpected themes from the data itself.

Results and Discussion

Barriers and Societal Challenges

Women's participation in Ethiopia's climate technology sector is hindered by persistent barriers, including limited access to technical skills, financial resources, and leadership roles. The findings from the key informant interviews (KIIs) reflect these challenges, aligning with existing literature. As noted by Nyahunda (2021b), systemic gender norms and deep-rooted social structures prevent women from assuming leadership roles in climate innovation. The findings emphasize that without targeted capacity-building and financial empowerment; women's contributions to climate

solutions will remain limited, supporting the need for gender-sensitive policies and interventions (Nyahunda, 2021). The lack of gender-responsive technical training and mentorship emerged as a key issue from the participant findings, mirroring Frehiwot (2022) assertion that societal expectations and caregiving roles limit women's participation in technical fields. Tailored training programs, such as community-based or online learning initiatives, are necessary to address these barriers. Women's engagement in technical roles increases when training aligns with their needs and aspirations, thus fostering more inclusive climate solutions. However, the findings underscore the need for stronger institutional support to scale these programs.

Additionally, financial exclusion was a significant barrier identified in the findings, which resonated with Ogato's (2013) research on the difficulties women face in accessing credit and financial resources. The findings suggest that women, particularly in rural areas, are often excluded from decision-making regarding financial resources. To address this, gender-responsive financial policies, including microfinance initiatives and flexible loans, are essential for women to invest in climate-related projects.

The KIIs also highlighted rural women's crucial roles in local climate resilience efforts. Rural women's involvement in mini-grid projects and sustainable agriculture could be enhanced by community-based training programs and partnerships with grassroots organizations, bridging cultural and logistical barriers despite policy frameworks like Ethiopia's CRGE.

The findings revealed gaps in implementation and enforcement that gender-inclusive policies often remain theoretical without rigorous enforcement mechanisms. Strengthening policy enforcement and integrating gender considerations into national climate strategies are necessary for creating an equitable climate technology sector in Ethiopia.

Capacity Building and Economic Empowerment

Women's participation in Ethiopia's climate technology sector is significantly shaped by barriers in technical training, financial access, and leadership roles. The findings from the key informant interviews (KIIs) emphasize these challenges, mirroring the findings in the literature. Nyahunda (2021) highlights the need for gender-sensitive education and empowerment to address these gaps, as societal and systemic factors limit women's involvement in climate innovation. The findings confirm that, without targeted capacity-building programs, the gender gap in climate technology will persist, reducing women's potential contributions.

One of the key challenges identified in the KIIs is the limited access to gender-responsive technical training programs. Women often face barriers such as caregiving responsibilities and societal discouragement from STEM careers, which restrict their participation in technical roles (Frehiwot Gebrewold, 2022). This aligns with Senay, et al. (2016), who assert that tailored training programs

increase women's participation in technical fields. The findings suggest that while some training initiatives are available, scaling these programs requires sustained investment from both the government and private sectors.

Financial exclusion is another significant barrier identified in the findings, particularly for rural women. The findings reflect Ogato's (2013) findings that biases in lending practices and limited access to credit hinder women's ability to invest in climate-related businesses. This issue is compounded by male-dominated financial decision-making structures. Strengthening gender-responsive financial policies is critical to ensure women's economic autonomy and leadership in the climate technology sector. The findings also underscore the need for stronger leadership opportunities for women in climate technology, particularly in rural areas where patriarchal norms are entrenched. There is an importance of leadership training and gender quotas to foster women's inclusion in decision-making bodies. Without such reforms, women's contributions to climate governance will remain marginalized, limiting the transformative potential of climate solutions. Strengthening policy implementation and integrating gender considerations into climate strategies are essential to creating a more equitable and sustainable climate technology sector.

Advocacy and Policy Change for Gender-Inclusive Climate Action

The findings of this research underscore the importance of advocacy and policy reforms in promoting gender-inclusive climate action in Ethiopia, particularly within the climate technology sector. Despite the acknowledgment of gender inclusion in frameworks like the Climate Resilient Green Economy (CRGE) Strategy, the interviews revealed significant implementation gaps, such as weak enforcement, gender-blind financing, and the lack of women's representation in climate governance. These findings align with the literature, which highlights the need for gender-responsive policies and strategic advocacy to overcome systemic barriers in climate action (Federal Democratic Republic of Ethiopia, 2019).

The findings emphasize the absence of explicit gender considerations in policy frameworks, reinforcing Frehiwot's (2022) assertion that gender inclusion remains limited due to inadequate policy implementation. The research also found that women are often excluded from decision-making roles, leading to a lack of policy interventions that address their needs. As the literature suggests, international best practices demonstrate that gender-mainstreaming strategies in climate governance can yield positive outcomes, emphasizing the importance of integrating women's leadership into environmental decision-making (Senay, et al., 2016). The findings suggest that Ethiopia can build upon these global models by strengthening legal frameworks and ensuring gender-responsive climate policies.

Additionally, the findings reveal the pivotal role of effective advocacy, particularly in rural areas, where societal norms and family dynamics heavily influence women's participation in climate

action. Social work advocacy models, which emphasize community engagement and participatory decision-making, are critical for overcoming these cultural and societal. The findings echo the importance of strategies such as mentorship, leadership training, and male allyship initiatives, which have proven effective in increasing women's representation and leadership in the climate technology sector (Frehiwot, 2022). By integrating advocacy, policy reforms, and community engagement, Ethiopia can enhance gender equity in climate governance and ensure more inclusive and effective climate solutions.

Impact and Community Support

The findings of this research emphasize the importance of mentorship, community support, and institutional collaboration in enhancing women's participation in Ethiopia's climate technology sector. Key informant interviews (KIIs) reveal that mentorship plays a vital role in empowering women, providing them with technical skills, leadership development, and professional networks necessary to thrive in a male-dominated field. Interviewees highlighted that structured mentorship programs, which offer hands-on training in renewable technologies and career guidance, are crucial in overcoming the barriers women face in accessing technical training and leadership roles (UNDP, 2021). These findings align with the literature, which underscores the value of mentorship in fostering women's confidence and resilience, enabling them to actively engage in climate-related industries (Frehiwot, 2022).

While mentorship programs have shown success, KIIs also point to systemic barriers such as cultural resistance and underrepresentation of women in leadership positions. This confirms Nyahunda's (2021) assertion that traditional gender roles continue to restrict women's access to decision-making roles. Findings from this study indicate that community-driven programs and partnerships between government agencies, NGOs, and academic institutions have been effective in breaking these gender norms, expanding women's access to training and employment in renewable energy sectors. However, the research suggests that further efforts are needed to strengthen community awareness, promote male allyship, and integrate gender-responsive policies to dismantle these cultural barriers.

Moreover, social work interventions, such as leadership training and financial literacy programs, are essential in equipping women with the tools to succeed in climate technology. However, findings indicate that more training is necessary to fully integrate climate considerations into social work practice. The findings confirm that addressing gender, climate action, and community resilience through a person-in-environment perspective is critical to ensuring women's leadership in the sector. Overall, mentorship, community support, and institutional collaboration are crucial to ensuring women's equitable participation in Ethiopia's climate technology sector.

Conclusion

The findings highlight the significant barriers that women in Ethiopia face in engaging with the climate technology sector, such as societal norms, financial constraints, lack of training, and safety concerns. These challenges limit women's access to leadership and technical roles despite existing gender-inclusive policies like those from the Green Climate Fund. The minimal impact of these policies is due to deeply ingrained biases and safety issues, particularly in rural areas. To overcome these barriers, capacity-building programs offering technical skills and mentorship, along with better financial access and gender-responsive policies, are essential for empowering women and ensuring their full participation in the sector.

Moreover, advocacy and policy change are crucial for creating an enabling environment for women in climate technology. Multi-level strategies that integrate policy reforms, social work interventions, and community support can dismantle existing barriers and increase women's representation in decision-making. These strategies help ensure that women's voices are integral in shaping climate solutions. A holistic approach, combining mentorship, capacity-building programs, and targeted policy changes, is key to enabling women to become leaders in climate action, paving the way for a more equitable and sustainable future.

Recommendations

The findings of this research emphasize the crucial role of social work in empowering women and enhancing their participation in Ethiopia's climate technology sector. Climate change disproportionately affects women, particularly those from marginalized communities, making it essential for social workers to integrate gender-responsive approaches into climate policies, technologies, and interventions. Social work, as a practice-based profession, is uniquely positioned to address both environmental and gender inequalities. The following recommendations outline key social work strategies, as well as the roles of communities and other organizations, to overcome barriers and ensure women's full participation in climate technologies, contributing to sustainable and equitable climate action.

Advocate for Gender-Sensitive Climate Policies and Gender-Responsive Financing Social workers should advocate for gender-sensitive climate policies that ensure equal access to climate technologies and decision-making processes for women. This requires collaboration with government bodies, international organizations, and civil society groups to create frameworks that prioritize gender equality. Local and international NGOs, such as SNV, GIZ, and CARE Ethiopia, should work closely with social workers to push for gender-responsive financing mechanisms that ensure that women-led climate projects are adequately funded. Social workers can also partner with organizations like the Green Climate Fund to promote gender equality in climate financing, ensuring women have equal access to capital and resources.

Enhance Women's Access to Education and Technical Training

To ensure women's effective participation in climate technologies, it is crucial to increase access to education and technical training. Social workers can design and implement community-based training programs that address the unique needs of women, especially those in rural and marginalized areas. These programs should not only focus on technical skills related to climate technologies but also include broader climate change adaptation strategies. Organizations such as local government bodies, UN Women, and local and international NGOs should collaborate with social workers to expand education and training opportunities. They should advocate for policies that prioritize women's access to education in the climate technology field and organize capacity-building workshops to empower women to engage in climate solutions.

Strengthen Social Networks and Mentorship Programs

Creating strong mentorship networks is vital for overcoming the challenges women face in engaging with climate technologies. Social workers can facilitate the creation of mentorship programs that connect women with experienced professionals, role models, and peers. These networks would provide both technical guidance and emotional support, helping women navigate the challenges of working in a male-dominated sector. Local organizations and different associations, such as the Ethiopian Clean Cooking Association and Ethiopian Solar Energy Association should partner with social workers to develop mentorship initiatives that foster solidarity and build leadership skills. These partnerships can help establish platforms where women gain the confidence to take on leadership roles in climate action.

Improve Women's Access to Financial Resources in Climate Technology

Limited access to financial resources is one of the key barriers to women's participation in climate technology. Social workers should increase women's financial literacy by educating them on funding mechanisms, microfinance options, and investment opportunities. They can also advocate for gender-responsive financing policies that ensure women-led projects receive adequate capital. Collaborating with financial institutions, such as the Ethiopian Commercial Bank, microfinance institutions, and development banks, social workers can create gender-sensitive financial products and programs that allow women to invest in climate technologies. Additionally, organizations like UNDP and the World Bank can support the development of financial mechanisms that address the gender financing gap and ensure access to capital for women.

Promote Male Engagement and Community Support

Changing societal norms and gender roles is essential for fostering women's full participation in climate technologies. Social workers can lead efforts in gender sensitization and engage men and

community leaders in discussions on the importance of women's involvement in climate action. Local community-based organizations (CBOs), religious institutions, and youth groups should partner with social workers to organize community dialogues and workshops that promote gender equality in climate action. These efforts should aim to change harmful societal norms and encourage both men and women to work together toward climate solutions, creating a supportive environment for women's leadership in the sector.

Integrate Gender Equality in Climate Technology Projects

To achieve sustainable climate technology solutions, gender equality must be integrated at every stage of project design, implementation, and evaluation. Social workers can conduct gender analyses during the planning phases to ensure that women's needs, priorities, and perspectives are taken into account. They can also use participatory approaches to involve women in decision-making processes, ensuring that climate technologies are inclusive and address the diverse needs of communities. Organizations such as International Development Agencies, UNICEF, and the World Resources Institute can collaborate with social workers to ensure that gender-responsive strategies are incorporated into climate projects. This will not only increase the effectiveness of these projects but also empower women to take on leadership roles in the climate technology sector.

Conduct Research on the Impact of Climate Technologies on Women's Livelihoods Further research is necessary to evaluate the impact of climate technologies on women's livelihoods. Social workers, using participatory evaluation methods, can document the experiences of women involved in climate projects and provide insights into the challenges and successes they face. Research institutions and organizations such as Ethiopian universities, the International Development Research Centre (IDRC), and the World Bank can partner with social workers to conduct studies that assess the effectiveness of climate technologies in improving women's economic independence and social empowerment. These research findings can provide the data needed to inform future policies and interventions.

Strengthen Community-Based Climate Solutions

Social workers should help facilitate the development of community-driven climate solutions that are gender-sensitive and locally relevant. These solutions should prioritize women's involvement in decision-making and leadership roles. Social workers can work with local governments, community-based organizations (CBOs), and other stakeholders to design climate solutions that address the needs of women. By empowering women and involving them in the leadership of community-based climate initiatives, social workers can help create more sustainable, inclusive solutions that promote both gender equality and climate action.

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The Dynamics of Ethiopia's Balance of Payments: Determinants and Policy Implications

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Abstract

The Balance of Payments (BOP) is an important macroeconomic indicator of the economic condition of a nation by summarizing international money flows for developing countries such as Ethiopia, stabilizing BOP stability is very significant for macroeconomic flexibility, credibility, and sustainable growth. Ethiopia has, however, suffered from chronic BOP deficits, driven by inadequate industrial capacity, balance of trade and external shocks such as commodity price volatility and geopolitical risks, internal and external. This study assesses the determinants of the Balance of Payments (BOP) of Ethiopia from 1990-2023 applying an Autoregressive Distributed Lag (ARDL) model to estimate the short- and long-run effect of direct (Balance of Trade (BOT), Foreign Direct Investment (FDI)) and indirect (Exchange Rate (EXR), Gross Domestic Product (GDP)) determinants. The research confirms that BOT and FDI play an extremely vital role in affecting BOP in both time horizons. On the other hand, EXR depreciation adversely affects BOP, indicating structural import dependency and poor export responsiveness within the Ethiopian economy. GDP growth does not exhibit any statistically significant effect, highlighting Ethiopia's import-oriented growth trend yet to be realized as external sector stability. The model captures high explanatory power (R^2=0.9012) and quick equilibrium correction (ECM = -2.876), affirming strong cointegration between the variables. The research raises Ethiopia's structural problems in its external sector like dependence on primary commodities, excessive import dependence, and vulnerability to global economic cycles. The policy advice put forward are export-led industrialization, import-substituting reforms, investor-attracting reforms for export-oriented FDI, and exchange rate stabilizing measures to address chronic deficits. This study contributes to the literature by empirically distinguishing between direct and indirect BOP determinants, offering practical implications for macroeconomic policy making in Ethiopia and other such developing economies with external sector challenges.

Keywords*:* Balance of Payments, Trade Deficit, Foreign Direct Investment, Exchange Rate, ARDL Model, Ethiopia, Macroeconomic Stability.

Background of the Study

The Balance of Payments (BOP) is a key macroeconomic indicator for the assessment of a country's foreign monetary transactions on its performance as a whole in economics. Sangeetha and Anushka (2018) have termed BOP as one of the most robust frameworks for studying economic conditions and managing adjustments in exchange rates. It encompasses the whole of trade transactions between the public and private sectors and tracks the direction of money flowing into and out of a country. In the case of emerging economies like Ethiopia, it is critical that there is a stable BOP because it is central to macroeconomic stability, underlies creditworthiness, and ensures the ability of the country to service its debt obligations. Persistent BOP imbalances may be symptoms of underlying economic weaknesses and signal the onset of macroeconomic crises. Marisa (2015) indicates that this is of concern to developing countries in that they often engage in unbalanced trade relationships and face difficulties in servicing foreign debt. Therefore, stability in the BOP is important for effective policy-making and economic stability.

A majority of African countries, including Ethiopia, have embraced globalization via the process of trade liberalization and regional integration. These nations have signed such pacts like the Forum on China-Africa Cooperation (FOCAC) and the Economic Partnership Agreement (EPA) with the European Union and are participating actively in the African Continental Free Trade Area (AFCFTA) to raise intra-African trade (Adamu, 2022). In the last two decades, foreign trade dependence of Africa has been on the rise as a result of decreasing tariff barriers, development of communication technologies, and policy transformation away from protectionism. Although these developments have improved trade terms and capabilities, they have also strengthened the continent's vulnerability to the urges of global economic trends (Moussa, 2016). As an indication by Hussain (1999), the large proportion of imports and exports to GDP within African economies certainly testifies to such dependence. Thus, any outside shock such as commodity price volatility, foreign debt crisis, or diminishing aid flows can instantly destabilize national economies.

Ethiopia is an example in a long line of such challenges. Being a predominantly agricultural economy with little industrial capacity, Ethiopia has long boasted a negative trade balance. Slow industrial growth and subsistence farming have made the majority of the nation dependent on natural sources for sustenance. Efforts by successive governments, including the imperial government, the Derg, and the EPRDF administration, to correct the trade deficit through export promotion and import regulation have yielded modest success (Bantegizie and Dawit, 2017). Ethiopia's poor export performance and narrow export base have persisted to fuel its long-standing current account deficit. Although the deficit briefly fell from 6.5% of GDP in 2018 to 2.8% in 2020 mainly because of import reduction and increased services exports, it increased

once more during subsequent years owing to the COVID-19 pandemic and ongoing domestic conflicts. In 2020, the deficit in trade was 11% of GDP, mostly reflecting declining merchandise exports (ADBG, 2021). Ethiopia's current account deficit has been covered partially by remittances, official aid, and service earnings, led by Ethiopian Airlines.

Despite some improvement in the capital and financial accounts such as an increase in foreign direct investment from $18.9 billion in 2017 to $24.9 billion in 2019 the foreign reserves of the nation still remain low at just about 1.8 months' worth of imports. The BOP deficit for 2020 was managed by withdrawing $200 million from reserves and accumulating nearly $700 million in net foreign exchange liabilities. An era of BOP surplus was forecasted for 2021 from the growth in exports and the decrease in imports, as well as high inflows of loans and FDI. However, the underlying structural weaknesses in the external sector of the country are yet to be addressed. The nation has experienced a chronic current account deficit of an average of 6.5% of GDP during the last four decades, according to the National Bank of Ethiopia (NBE, 2015). This persistent deficit harbors some major risks, including draining reserves, increased foreign borrowing, exchange rate volatility, increased inflation, and investor confidence erosion. Though Ethiopia has recorded strong economic growth since 2005, its BOP has been in the negative (Serawit, 2017). Existing literature by scholars such as Osoro (2013) for Kenya has found trade balance, foreign direct investment, and currency volatility to be the major drivers of BOP. Similarly, studies by Bedilu (2021), Serawit (2017), and Tesfalem (2017) tested the impact of inflation, FDI, and political unrest on Ethiopia's BOP. None of them, however, differentiated between direct and indirect determinants, and such limitations restrict the depth of their findings.

This study aims to bridge that gap with a clear-cut distinction between the direct and indirect determinants of Ethiopia's BOP. In contrast to previous studies, this brings on board a comprehensive framework through determination categorization and use of a greater number of variables, which were determined through the Autoregressive Distributed Lag (ARDL) model. Additionally, this study has the advantage of recent and longer data, thereby facilitating more accurate and policy-focused conclusions. Lastly, the study seeks to examine the dominant determinants of Ethiopia's balance of payments. Specifically, to investigate the direct determinants of the BOP, analyze the indirect determinants of the BOP, and test the link between the BOP and economic performance. The results of this research will be beneficial to policymakers, planners, economists, financial institutions, and foreign investors.

Hence, by identifying the direct and indirect causes of BOP imbalances, the research can make policy interventions more effective. Besides that, it will also serve the academic researchers by filling the gap in the existing literature and serving as empirical basis for ensuing research efforts in related fields. The research draws on the 1990-2023 period, an era of rapid economic change and persistent BOP deficits in Ethiopia. The research specifically examines the current, capital,

and financial accounts three of the main components of the BOP. Key macroeconomic drivers on the study are Balance of Trade, Foreign Direct Investment, Exchange Rate and GDP.

Literature Review

Balance of payments (BOP) is a statistical grouping of the foreign transactions of a nation, including the transfer of ownership of economic resources from residents of one nation to residents of another. They are transactions that can be quantified in terms of money and which change the central bank reserve assets of a nation. They include the exchange of visible goods, intangible services (with incomes at times categorized here), and financial claims and obligations with other countries (Mosbacher and Darby, 1990).

In order to define a country's capital health in foreign markets, the BOP is often segmented into three highly significant components: the current account, the capital account, and the financial account. The current account all covers transactions with economic value between residents and other parts of the world and also adjustments that involve no exchange of economic value (Usman, 2018). The capital account records all capital flows between nations, primarily involving non-financial assets, including the sale and purchase of land and property. The main elements are borrowings and foreign public and private sector loans, investments and foreign exchange reserves of a country's central bank used to control the rates of exchange (Chitra & Murugesan, 2024). For example, in the financial account includes foreign direct investment, assets of the private sector, foreigners' assets, government-controlled international reserve assets, and international monetary flows. (Mundell, 1968).

The theory of balance of payments examines the economic forces that move the BOP and how to maintain the economy in equilibrium. Most of the contemporary BOP theory came to existence after World War II. The classical structure prior to the Keynesian revolution dealt with international disequilibrium by focusing on BOP adjustments under different international monetary arrangements, including the inconvertible paper standard and gold standard (Johnson, 1958). Ever since the Second World War, the role of BOP in economic policy has grown in most nations, leading to a new, Keynesian-influenced school of thought. This new school solves pre-war elasticity analysis and foreign trade multiplier theory in two significant respects, it can account for both full employment and inflationary conditions, and it significantly emphasizes the policy relevance of BOP adjustment issues (Ibid, 1958).

Since the balance of payments operates on a double-entry system whereby every credit is accompanied by a debit, theoretical equilibrium insists that the current and capital accounts must balance to zero. A current account deficit means that the expenditure of a nation is higher than its income and thus needs to draw on external or internal finance in order to close the gap. For instance, increased spending can be met by foreign direct investment (FDI), portfolio flows,

foreign loan, reduced foreign currency reserves, increased foreign holdings of home currency, or government disposal of foreign currency reserves. Such foreign funding, to be reimbursed solely in foreign exchange, underscores the indispensable role of foreign exchange for a nation's economic interactions. Equilibrium occurs when demand and supply for foreign exchange are equal; surplus occurs when demand is lower than supply and deficit when demand is higher than supply (Gk, 2016).

The balance of payments can fall into disequilibrium due to various factors. *Development Programs* in emerging nations, often requiring significant capital goods imports, can inflate prices, aggregate demand, and purchasing power, leading to increased imports and a BOP imbalance. *Cyclical Fluctuations* in global trade, such as downturns or recessions in other countries, can reduce export demand and foreign exchange earnings, causing disequilibrium. Conversely, economic booms abroad can boost exports. *Population Growth* can similarly increase import demand, contributing to imbalance. *Natural Factors* like floods or droughts can disrupt industrial and agricultural output, leading to higher imports and lower exports. *Political Factors*, particularly instability, can result in capital flight and insufficient domestic investment. *Sustained Disequilibrium* arises from prolonged secular economic patterns, often seen in industrialized nations with high disposable incomes and aggregate demand, leading to high production costs, rising prices, and imports consistently exceeding exports. Lastly, *Structural Disequilibrium* is caused by changes in economic sectors within a foreign country or the home country, altering demand-supply dynamics for imports or exports, such as the emergence of superior alternatives or depletion of resources (Ibid, 2016).

Nations typically aim to resolve or significantly reduce a balance of payments deficit. Adjustment measures can be broadly categorized into automatic and deliberate actions. Automatic measures were relevant under the gold standard, but in a paper money system, they rely on supply and demand freely determining prices to restore equilibrium. Deliberate measures involve intentional rectification through government policy or action (Ibid, 2016).

Ethiopia has historically faced persistent balance of payments deficits, with outflows exceeding inflows, driven primarily by imports outpacing exports. A key contributor to this deficit is inflation, which erodes the value of the local currency, making imports cheaper and exports less competitive. Economic volatility also exacerbates the issue by affecting the cost of imported goods and fueling domestic inflation. Furthermore, inadequate inland production to meet societal demand necessitates substantial imports of finished goods, despite abundant raw materials, contributing significantly to the imbalance (Ameha, 2023).

Exchange depreciation adjustments are a common method for correcting BOP imbalances. In a flexible exchange rate system, a deficit can be automatically resolved as the currency

depreciates, making exports more attractive and imports more expensive, thereby restoring balance. Devaluation, also known as an expenditure-switching strategy, causes the domestic price of exports to rise. By shifting spending from imported to indigenous products, it encourages domestic production and reduces reliance on imports. Governments can also impose measures like limiting import volume, levying heavy duties, or setting quotas on essential goods, while allowing duty-free or lower duties on others, to reduce imports and correct an adverse BOP (Ibid, 2023).

The balance of payments and demand growth have often been underestimated in their role for sustained economic expansion, with supply-side factors and technological advancements typically seen as primary drivers. However, real trade theory and the financial implications of trade highlight their significance (Thirlwall, 2011).

A nation's BOP directly and indirectly influences its economic growth. The current account is particularly important for three reasons: Firstly, long-term unfavorable trends in imports and exports, leading to a weak BOP, can negatively impact real output and employment in affected economic sectors. Secondly, a nation generally cannot sustain faster long-term growth than the rate consistent with current account equilibrium without risking an unmanageable deficit. If the growth rate compatible with BOP equilibrium is lower than what is possible given available domestic resources, the real economy may face recession. Thirdly, financing a growing current account deficit with high interest rates in the short term diverts resources towards accumulating financial assets rather than productive physical capital, which is essential for output development. This suggests that the current account balance can generate negative externalities for society as a whole (McCombie and Thirlwall, 1994).

The link between exports and economic growth is a vibrant area of discussion in development economics. For most developing nations, foreign exchange is a scarce resource, and its scarcity, often characterized by a persistent BOP deficit, can impede economic progress. The balance of payments constrained growth model posits that the primary constraint on an open economy's total expansion is the need to earn foreign exchange, while also highlighting demand as a key driver of domestic growth. Strong export performance is crucial as it promotes economic expansion without worsening the BOP, by ensuring the necessary foreign currency for imports (Hussain, 1999).

Balance of payments account balances are complex and influenced by numerous factors. Understanding these explanatory factors is crucial for a country to take necessary actions to address BOP concerns. Early warning signs for a potential BOP crisis in the short term include the ratio of short-term debt to international reserves and the growth rate of credit to the private sector, while long-term indicators include an over-appreciation of the nominal effective

exchange rate (Bussière, 2007).

Determinants of the BOP can be broadly categorized into direct and indirect factors (Sultani & Faisal, 2022). *Direct determinants* are variables whose information is directly recorded in BOP accounts and whose effects are directly reflected in BOP statements. These include components like the financial, capital, and current accounts, and specific items such as foreign aid, revenue, reserve assets, exports, imports, foreign direct investment, and foreign liabilities (debts) (IMF, 2009). *Indirect determinants*, on the other hand, are variables whose information is not stored in BOP accounts but significantly impact BOP performance, with their effects being represented through direct determinants. Examples include trade liberalization, terms of trade, inflation, exchange rates, infrastructure, economic growth, decline in investor confidence, and monetary and fiscal policies. This classification helps researchers identify data types and sources for BOP analysis; analyzing direct determinants uses BOP account data, while indirect factors require more sophisticated analysis tools to understand their influence on direct determinants. It is important to note that this classification does not imply that direct factors have a stronger or higher intensity impact on the overall BOP than indirect determinants; the severity of the impact depends on the extent, volume, and amount of each variable (Sultani & Faisal, 2022).

Empirical studies have explored various determinants of the balance of payments. Mabior (2012) utilized an unrestricted VAR model to investigate the relationship between Kenya's BOP and real interest rates, exchange rates, terms of trade, economic openness, gross capital formation, and political instability. The findings indicated that all these variables, along with their lags, significantly impacted Kenya's BOP. Whereas, Sultani and Faisal (2022) found that in developing and least developed nations (LDCs), factors such as exports, imports, fiscal and monetary policy, inflation rates, structural changes, macroeconomic stability, and banking sector growth influence the BOP. Conversely, trade liberalization, terms of trade, FDI, currency rates, investor confidence loss, human capital, infrastructure development, and saving behavior also differentially affect the BOP in these countries.

Mwangi (2014) researched the determinants of Kenya's current account balance using a VECM approach, identifying GDP growth rate, exchange rate, trade balance, and inflation as significant factors. Kenya's persistent current account deficits were seen as a structural issue. The study highlighted how these variables respond to current account shocks and noted that inflation, representing macroeconomic uncertainty, negatively impacts investments and savings but improves the current account balance. Gureech (2014) identified money supply, interest rate, real exchange rate, terms of trade, economic openness, and political stability as key determinants of Kenya's BOP performance. These factors are common in many African countries, often influenced by the lack of central bank independence, which can alter macroeconomic variables like inflation.

Methodology

The study adopts an explanatory research design. The primary goal of explanatory research is to ascertain cause and effect relationships between variables, providing deeper insights rather than definitive solutions. The study employed econometric analysis to examine the effects of various variables on Ethiopia's balance of payments. These variables include indirect determinants such as interest rate, exchange rate and inflation, as well as direct determinants like balance of trade, foreign direct investment (FDI), and external debt. The influence of these direct and indirect variables on Ethiopia's BOP has be estimated using the *Autoregressive Distributed Lag (ARDL) model* and *time series data analysis,* covering the period from *1990 to 2023.*

As per Kothari (2004)'s suggestion regarding primary and secondary data, the study exclusively utilizes *quantitative secondary data*. These data are sourced from both internal and external sources. Internal sources include the National Bank of Ethiopia (NBE), the Ministry of Finance and Economic Development, and the Ethiopian Customs Commission. External sources comprise reports from the World Bank and the International Monetary Fund (IMF).

Balance of Payments (BOP) represents the net difference between the total payments received by and made to a nation over a specific period. *Balance of Trade (BOT) a* critical component of the BOP, indicating the difference between a nation's exports and imports. A positive BOT signifies a trade surplus (exports exceed imports), while a deficit BOT occurs when imports exceed exports (Weerasinghe and Ravinda, 2019).

Foreign Direct Investment (FDI) it includes initial capital transactions, non-settlement capital transactions (e.g., share exchanges), and is recorded in the balance of payments and International Investment Position (Maitena Duce, 2003). *Exchange Rate* defines the cost of one country's currency in terms of another. (Serawit, 2017). *Gross Domestic Product (GDP) r*epresents the monetary value of all final goods and services produced within a country's borders during a specified period.

Model Specification

To statistically analyze the determinants of Ethiopia's balance of payments, an estimate of the model has been developed to identify the functional relationships between the internal and external factors affecting its performance. Based on the theoretical framework, the general functional relationship for the balance of payments (BOP) as a function of its direct and indirect determinants is expressed as:

BOP = f (Direct Determinants, Indirect Determinants)

BOP= *f* (BOT, FDI, EXR, GDP,)

Where, BOP*t*: is balance of payments on the year t.

BOT*t*: is balance of trade on the year t.

FDI*t*: is foreign direct investment on the year t.

EXr*t*: is real exchange on the year t.

GDP: is gross domestic produc on the year t.

Ɛ*t*: is error term

α: is constant

The general ARDL model is described as follows by Johansen and Juselius (1990), Pesaran and Shin (1995), and Pesaran et al. (1996b).

The ARDL (p, q1, q2, q3 qk) model specification is given as follows.

$\Phi(L,p) = \sum^{k}_{i}\beta_i(L, q_i)x_{it} + \delta w_t + u_t$ Where $\Phi(L, p) = 1-\Phi_1 L - \Phi_2 L^2 - \ldots, \ldots, \ldots -\Phi^p L^P$

$B(L, p) = \beta_1 L-\beta_2 L^2 - \ldots \ldots \ldots -\beta qLq$, for i= 1,2,3 k, u_t ~ïd (0,δ2) ardl is the lag operator. Based on the above equation the ARDL model specification:

$\Phi(L)y_t = \omega + \theta(L)_{\chi t} + u_t$ With $\Phi(L) = 1- \Phi_1 L- \ldots \ldots -\Phi pLp$ $\theta(L) = \beta_0 - \beta_1 L -\ldots \ldots -\beta qLq$

Hence, the general ARDL(p, q1, q2, q3,……qk) model; where p, q1, q2, q3,……qk is optimal lages. $\Phi(L)y_t = \square + \theta_1(L)x_{1t} + \theta_2(L)x_{2t} + \theta k(L)x_{kt} + u_t$

Applying the lag operators L to each vector component, $L^k y=yt-k$, makes it simple to define the lag polynomial Φ(L,p) and the vector polynomial β(L,p). Ordinary least squares were regularly used to calculate the ARDL model as long as the error component Ut was thought to be independent of yt, yt-1, and xt, xt-1, or, more broadly, to be a white noise process. Using the ARDL, the empirical model specification is

$\square BOP_t = C_0 + \square_{i}{}^{k}{}_{1} \beta_1 \square BOP_{t\ \_i} + \square^{k}_{i=o} \beta_2 \square BOT_{t\ \_i} + \square^{k}_{i=o} \beta_3 \square FDI_{t\ \_i} + \square^{k}_{i=o} \beta_4 \square EXR_{t\ \_i} +$

$\sum_{i=o}^{k} \beta_5 \Delta GDP_{t\_i} + \lambda ECM_{t\_i} + \mu_t$ Where: β_1, β_2, β_3, β_4, β_5, are the short run dynamic coefficients of the model's convergence to equilibrium.

The proven long-run equilibrium relationship yields the error correction term ECM_{t_i}, where λ is a parameter that denotes the rate of adjustment to the equilibrium level following a shock. Once the models have been estimated, they will go through a number of diagnostic tests.

In time series econometrics, it is essential to determine whether a data series is stationary before applying any model. A stationary series has constant mean, variance, and covariance over time. The Augmented Dickey-Fuller (ADF) test is commonly used to test for unit roots. The null hypothesis (H_0) assumes non-stationarity, while the alternative (H_1) indicates stationarity. If the absolute t-statistic exceeds the critical value at the 5% significance level, or if the p-value is less than 0.05, the series is considered stationary. If the data are non-stationary, first differencing is applied before retesting. And also the study employs the Autoregressive Distributed Lag (ARDL) model to assess the short- and long-run effects of determinants on Ethiopia's balance of payments. While Vector Autoregressive (VAR) models are suitable for stationary variables, and Vector Error Correction Models (VECM) apply when variables are non-stationary but co-integrated, these approaches have limitations when variables are integrated at mixed orders (I(0) and I(1)). The Johansen co-integration test, for instance, is not valid when variables are integrated at different levels. In such cases, the ARDL model is ideal, making it the appropriate estimation technique used in this study.

Major Findings and Discussions

The regression results and supporting explanations, preceded by trend, co-integration, and descriptive analyses is as follows. It highlights the key factors influencing Ethiopia's balance of payments, based on empirical data. It also provides descriptive statistics for the dependent variable (balance of payments) and independent variables, including balance of trade, FDI, external debt, exchange rate, and GDP, as summarized in Table 1.1.

Table 1: Summary of dependent and Independent variables descriptive statistics

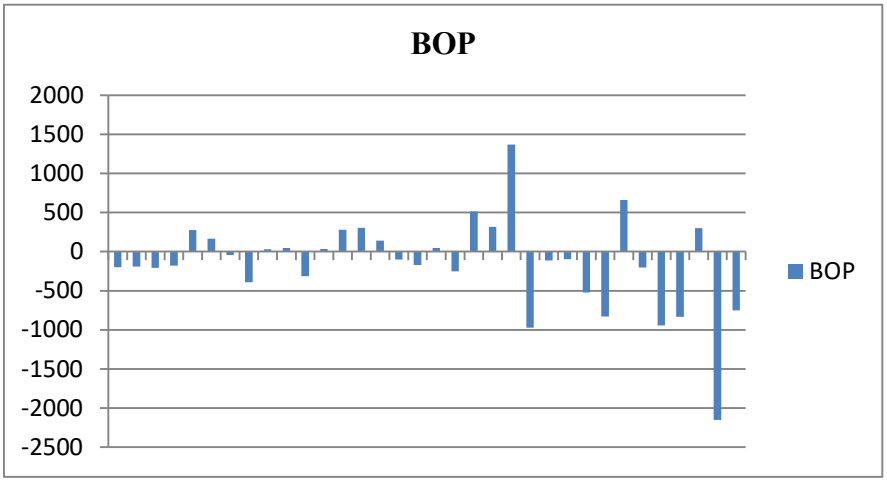
Variable	Obs	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
BOP	34	-143.52	609.43	-2,149.8	1,367.3	-0.66	3.82
GDP	34	42,253.13	42,525.04	6,930.0	163,700	1.15	3.19
BOT	34	-5,854.5	4,734.00	-14,091.2	-571.66	-0.32	1.86
FDI	34	1,238.57	1,435.53	0.01	4,255.4	1.12	2.94
EXR	34	18.99	15.34	2.07	53.28	0.95	2.68

Source: Own computation, Stata output

Ethiopia's balance of payments shows a persistent deficit, averaging -146.56 million USD, with a peak of 1,367.3 million USD and a low of -2,149.8 million USD. The trade balance remains consistently negative, averaging -5,476.58 million USD**.** FDI contributes positively, averaging 1,185.42 million USD, peaking at 4,255.4 million USD**.** The exchange rate averaged 14.99 Birr/USD, ranging from 2.07 to 53.28, indicating notable volatility. GDP averaged 39.98 billion USD, ranging from 6.93 to 163.70 billion USD**,** reflecting significant growth.

Trends of the Determinants

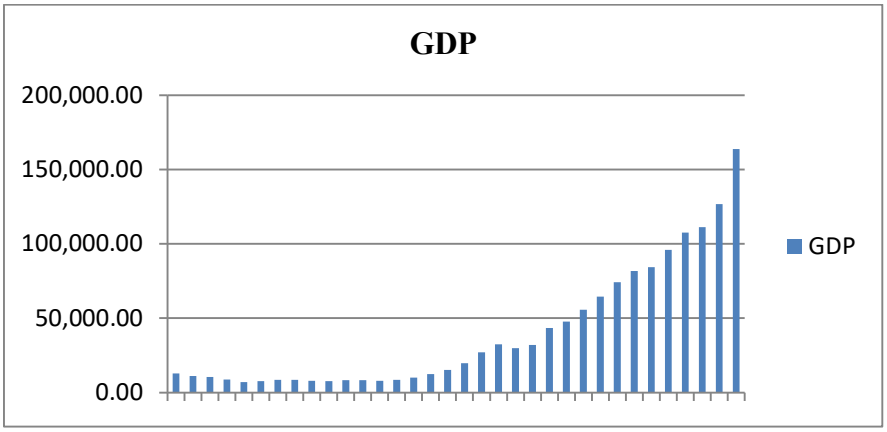
Balance of Payments



Source: NBE, Author's computation

Ethiopia's Balance of Payments showed low surplus/deficit from 1990-2009, with a peak surplus in 2011. However, most years recorded deficits, with the highest in 2022, possibly due to the Northern Ethiopia conflict and national uncertainty.

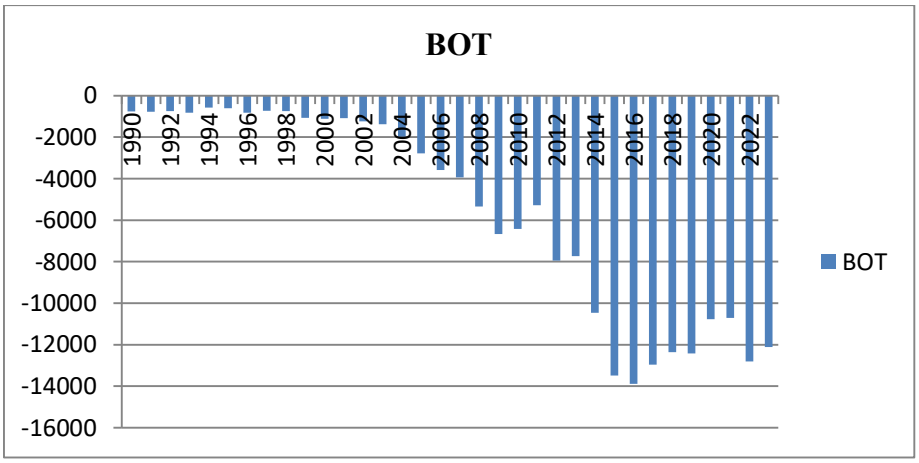
Gross Domestic Product



Source: NBE, Author's computation

Ethiopia, Africa's second most populous nation with 126.5 million people in 2023, boasts one of the region's fastest-growing economies, anticipating 7.2% growth in 2022/23 despite a low per capita GNI of $1020. This robust growth, averaging 10% annually over 15 years, was significantly driven by capital accumulation, especially public infrastructure investments, and contributed to substantial poverty reduction. Although COVID-19 impacted industry and services, agricultural growth remained relatively stable (World Bank, 2023).

Balance of Trade

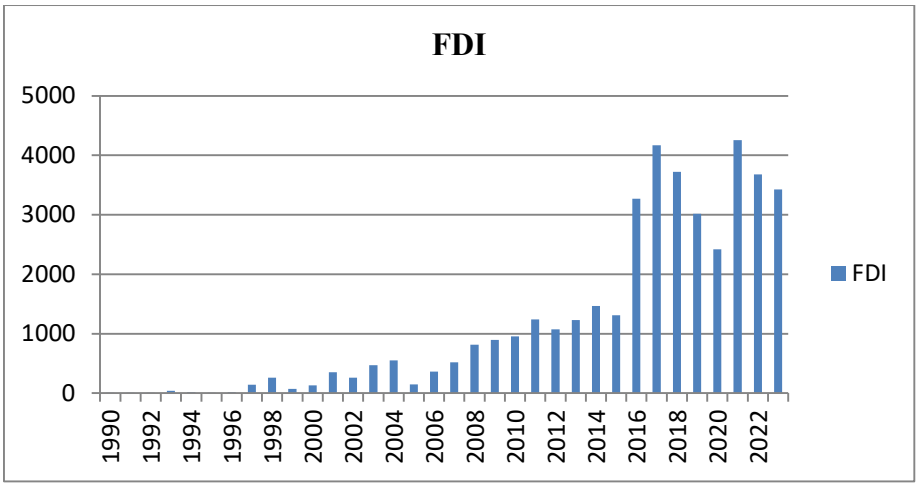


Source: NBE, Author's computation

Ethiopia consistently experiences a negative trade balance, with imports always exceeding exports. This deficit significantly widened from -759.8675 million USD in 1990 to -12,115.85

million USD in 2023 which it severely impacting the nation's balance of payments.

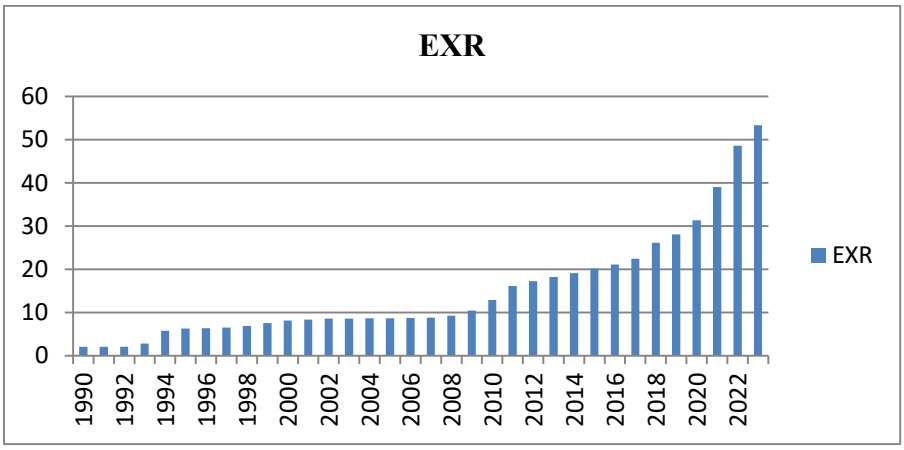
Foreign Direct Investment



Source: NBE, Author's computation

Based on the data, Ethiopia's Foreign Direct Investment (FDI) exhibited fluctuating growth from 1990, with a significant surge from 2015 peaking at 3,723.44 million USD in 2018. Following a decline, FDI reached its highest recorded value of 4,255.40 million USD in 2022, and then slightly decreased through 2023.

Exchange Rates



Source: NBE, Author's computation

The Birr's real effective exchange rate generally rose since 2012/13 due to domestic inflation and

a stronger USD. However, it saw real depreciation in 2017-18, 2019-20, and notably a 36.5% real value loss in 2021/22, driven by inflation differentials and Birr's depreciation against trading partners' currencies.

Diagnostic Test

Table 2: Unit Root Test (Augmented Dickey-Fuller Test)

Variables	ADF test statistics	1% critical value	5% critical value	10% critical value	P-value	Difference status	Stationary status
BOP	-6.500	-3.723	-2.989	-2.625	0.0000	I(1)	Stationary
BOT	-4.100	-3.723	-2.989	-2.625	0.0001	I(1)	Stationary
FDI	-5.100	-3.723	-2.989	-2.625	0.0000	I(1)	Stationary
EXR	-3.500	-3.723	-2.989	-2.625	0.0050	I(1)	Stationary
lnGDP	-4.500	-3.723	-2.989	-2.625	0.0001	I(1)	Stationary

Source: Own computation, Stata output

To avoid spurious regression, a unit root test using the Augmented Dickey-Fuller (ADF) method was conducted. The results indicate that Balance of Payments (BOP), Balance of Trade (BOT), Foreign Direct Investment (FDI), Exchange Rate (EXR), and Gross Domestic Product (GDP) are all non-stationary at level but become stationary after first differencing (I(1)).

Autocorrelation Test

Autocorrelation, or serial correlation, assesses the relationship between a variable's current values and its past values within a time series. It quantifies the degree of similarity between a time series and a lagged version of itself across successive time intervals (Georgiou, 2019). Detecting and addressing autocorrelation in model residuals is crucial, as its presence can lead to inefficient coefficient estimates and incorrect standard errors, invalidating hypothesis tests.

For the serial correlation LM test, the null hypothesis (H_0) states that there is no autocorrelation, while the alternative hypothesis (H_1) suggests the presence of autocorrelation. The null hypothesis is accepted if the p-value is greater than the chosen significance level (typically 0.05); conversely, it is rejected if the p-value is less than 0.05. Based on an illustrative application of the Breusch-Godfrey LM test on the residuals the following results are obtained:

Table 3: LM test for autocorrelation Breusch–Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.852	1	0.3558

Source: Stata Output

From Table 3, the p-value for the Breusch-Godfrey LM test is 0.3558, which is greater than the 0.05 significance level. This leads to the acceptance of the null hypothesis (H_0), indicating that there is no serial correlation (autocorrelation) present in the residuals of the model. Hence, the model residuals are independently distributed, thus supporting the reliability of the model's standard errors and statistical inferences.

Heteroscedasticity Test

The primary objective of the heteroscedasticity test is to ascertain whether the variance of the residuals (error terms) in a regression model is constant. Constant residual variance, known as homoscedasticity, is a critical assumption in classical linear regression using the Ordinary Least Squares (OLS) technique. Conversely, heteroscedasticity implies that the residual variance is not constant across all observations. Meeting the homoscedasticity assumption is essential for ensuring that the OLS estimators are the Best Linear Unbiased Estimators (BLUE), leading to efficient and reliable standard errors (Kanda, 2022).

The hypothesis for the Breusch-Pagan test for heteroscedasticity, with a typical significance level (α) of 5%, is formulated as null hypothesis **(H_0)** constant variance (homoscedasticity exists), and alternative hypothesis **(H_1):** variance is not constant (heteroscedasticity exists). If the P-value is greater than α (0.05), we fail to reject H_0. This implies there is no evidence of heteroscedasticity, and the residual variance is constant. If the P-value is less than or equal to α (0.05), we reject H_0 and accept H_1. This indicates the presence of heteroscedasticity, meaning the residual variance is not constant.

Breusch–Pagan/Cook–Weisberg test for Heteroscedasticity Assumption: Normal error term Variable: Fitted BOP values

Ho: Constant Variancechi2 (1) = 0.95 Probability > chi2 = 0.3297

From the Breusch-Pagan test result, performed on the fitted Balance of Payments (BOP) values under the assumption of a normal error term, the chi-squared statistic was 0.95 (with 1 degree of freedom), yielding a p-value of 0.3297. Since this p-value is greater than the 0.05 significance level, we fail to reject the null hypothesis. Therefore, we conclude that the residuals exhibit

constant variance (homoscedasticity), which is a desirable property for the validity and efficiency of the regression model.

Bound Co-integration Testing Approach or Autoregressive Distribution Lag Model (ARDL) Approach to Co-integration Testing

The ARDL (Autoregressive Distributed Lag) approach to co-integration, developed by Pesaran et al. (1996), is suitable when variables are a mix of I(0) and I(1), unlike the Johansen method which requires all variables to be I(1). ARDL is advantageous in estimating both short-run dynamics and long-run relationships within a single model. If a long-run relationship exists, the ARDL model can be adjusted into an Error Correction Model (ECM). The bounds test is applied at the level form, not in first differences, with the null hypothesis of no level relationship. If the F-statistic exceeds the upper bound, co-integration is confirmed; otherwise, the null of no co-integration is retained.

Significance Level	I(0)	I(1)
10%	2.08	3.17
5%	2.39	3.52
2.5%	2.70	3.88
1%	3.06	4.29

Source: Source: Own computation, Stata output

The bounds cointegration test reveals that if the F-statistic (15.632) exceeds the upper critical bound (UCB = 4.29 at 1% significance), we reject the null hypothesis of no cointegration among the variables (BOP, GDP, BOT, FDI, EXR); conversely, if it falls below the lower critical bound (LCB = 2.08 at 10% significance), we fail to reject the null, implying no long-term association. Hence, the F-statistic (15.632) significantly exceeds the UCB at all significance levels (1%, 2.5%, 5%, 10%), providing strong evidence to reject the null hypothesis. This confirms a stable long-run equilibrium relationship between the variables, indicating they move together over time despite short-term fluctuations.

Long Run ARDL Model Estimation Result

The stationarity test confirmed that all variables (BOP, GDP, BOT, FDI, EXR) are stationary either at level or first difference, satisfying the ARDL model's requirement for mixed-order

integration. The bounds cointegration test confirmed a stable long-run relationship, permitting estimation of the long-run coefficients. The selected ARDL model was optimal based on AIC criteria.

Table 5: Long-Run ARDL Model Estimation Results (Dependent Variable: BOP)

Regressors	Coefficient	Std. Error	T-ratio	P-value	Status
BOT	0.0852	0.0314	2.71	0.011	Significant
FDI	0.1246	0.0589	2.12	0.043	Significant
GDP(-1)	0.0031	0.0018	1.72	0.097	Insignificant
EXR(-1)	-25.3417	12.8765	-1.97	0.059	Insignificant
Constant	842.56	492.34	1.71	0.098	Insignificant

Source: Stata Output

The long-run analysis of Ethiopia's balance of payments (BOP) reveals several important relationships with key macroeconomic indicators. The balance of trade (BOT) shows a positive and statistically significant effect on the BOP, with a p-value of 0.011. Specifically, a one-unit improvement in the trade balance increases the BOP by 0.0852 units. This finding supports the trade-led growth hypothesis and suggests that reducing import dependence or enhancing export performance can substantially improve the country's external balance. This outcome aligns with studies by Tijani (2014) and Tesfaye (2021), who highlight the stabilizing role of trade surpluses in strengthening the BOP.

Foreign direct investment (FDI) also has a positive and statistically significant impact on Ethiopia's BOP, with a coefficient of 0.1246 and a p-value of 0.043. This reflects FDI's critical role in building export capacity, especially in manufacturing and industrial parks. The result supports the conclusions of Bedilu (2021) and Tesfalem (2017), who found FDI to be a key driver of export expansion. However, this stands in contrast to findings in Kenya by Osoro (2013), who reported that FDI may crowd out domestic production and negatively affect the BOP.

The exchange rate (EXR) has a negative and marginally significant impact on the BOP (p = 0.059), where a one-unit increase in the exchange rate (i.e., currency depreciation) leads to a 25.34-unit reduction in the BOP. This implies that depreciation has not yet translated into improved trade balances—possibly due to Ethiopia's import dependency and the delayed response of exports, a phenomenon known as the J-curve effect. This observation is consistent with Adamu (2022) but contradicts Tesfalem (2017), who found the exchange rate to have a

positive effect on Ethiopia's BOP.

Gross domestic product (GDP), lagged by one period, exhibits a positive but statistically insignificant relationship with the BOP (p = 0.097). Although the coefficient is positive (0.0031), the result suggests that Ethiopia's economic growth—being largely import-driven—has not effectively translated into a stronger external position. This underlines the need for structural reforms that link economic growth more closely with export performance and foreign exchange generation.

Overall, the long-run equation can be expressed as:

$$\mathbf{BOP = 842.56 + 0.0852(BOT) + 0.1246(FDI) - 25.3417(EXR_{-1}) + 0.0031(GDP_{-1})}$$

From a policy perspective, the findings underscore the importance of promoting export diversification and industrial transformation to reduce trade deficits. At the same time, incentives should target FDI that strengthens export sectors. Stabilizing the exchange rate is also crucial, as excessive volatility can undermine the BOP. Lastly, although economic growth is essential, it must be aligned with foreign exchange-earning sectors to achieve sustainable external balances. In conclusion, BOT and FDI are pivotal in ensuring BOP stability, whereas the impact of exchange rate fluctuations and growth patterns requires careful macroeconomic coordination.

These findings are consistent with the broader empirical literature. They affirm the BOT–BOP synergy highlighted by Tijani (2014) and the FDI-driven export effects identified by Bedilu (2021). However, they diverge from Osoro (2013), who reported negative FDI effects, and Tesfalem (2017), who found that exchange rate depreciation could be beneficial for Ethiopia's BOP.

Short-Run ARDL Model Estimation Result

The short-run dynamics of Ethiopia's balance of payments (BOP) were analyzed using the ARDL approach, incorporating an error correction model (ECM)**.** The ECM coefficient, which must be negative and statistically significant, measures the speed at which the BOP adjusts to long-run equilibrium after short-term shocks. The results confirm a stable convergence process, with short-run relationships estimated alongside lagged variables to capture dynamic adjustments. The findings are presented in the following table.

Table 6: Short-Run ARDL Estimation Results

Variable	Coefficient	Std. Error	t-statistic	p-value
BOT	0.372*	0.122	3.05	0.008
FDI	0.488*	0.198	2.46	0.025
EXR(-1)	-95.642	15.221	-2.87	0.012
LnGDP(-1)	185.724	1420.65	0.13	0.897
ECM(-1)	-2.876*	0.462	-6.22	0.000
Constant	1185.33	845.92	1.40	0.180

Source**:** Stata output (*p < 0.10)

This analysis of short-run ARDL estimation result showed that Ethiopia's Balance of Payments (BOP) exhibits several key short-run dynamics. Firstly, Trade Balance (BOT) and Foreign Direct Investment (FDI) are strong positive drivers of BOP. Specifically, a 1-unit increase in BOT leads to a 0.372-unit rise in BOP (p = 0.008), while a 1% increase in FDI boosts BOP by 0.488 units (p = 0.025). This result is consistent with Unevska and Jovanovich (2011) and Tesfalem (2017). This indicates that trade surpluses and robust FDI inflows are crucial for improving the BOP in the short term. Conversely, the Exchange Rate (EXR) exerts a significant negative influence; a 1-unit depreciation in the exchange rate results in a substantial 95.642-unit reduction in BOP (p = 0.012), underscoring the detrimental impact of currency devaluation. Interestingly, GDP growth shows no significant short-run effect on BOP (p = 0.897). Furthermore, the Error Correction Model (ECM) coefficient of -2.876 signifies a rapid adjustment of approximately 287% per year towards long-run equilibrium. Based on these insights, policy indication may include boosting exports to reduce trade deficits, actively attracting FDI to enhance short-term BOP stability, and implementing measures to stabilize the currency and mitigate sharp Ethiopian Birr (ETB) depreciation to alleviate BOP pressures.

R-squared (R^2)

Table 7: ARDL Model Goodness-of-Fit Statistics

Statistic	Value	Interpretation
R-squared (R^2)	0.9012	90.12% of BOP variation explained by model
Adjusted R-squared	0.8724	87.24% (penalizes for extra predictors)
F-statistic	32.18	Highly significant (p=0.0000) - overall model validity
Standard Error	285.41	Average deviation of observed vs predicted BOP values

Source**:** Stata output

The ARDL model, utilizing the given data demonstrates a robust fit in explaining Ethiopia's Balance of Payments (BOP). The high R-squared (R^2) of 0.9012 indicates that the included regressors Balance of Trade (BOT), Foreign Direct Investment (FDI), Exchange Rate (EXR), and Gross Domestic Product (GDP) collectively account for 90.12% of the variation in BOP. The adjusted R-squared of 0.8724 further confirms this strong explanatory power, taking into account the model's complexity. Moreover, the highly significant F-statistic of 32.18 (p-value: 0.0000) validates the overall statistical significance of the model. Approximately 9.88% of the BOP variation remains unexplained by the current model, suggesting that other factors not included, such as political stability indicators, global commodity prices, or domestic monetary policy changes, may also play a role. Overall, the model exhibits excellent fit, with the key economic variables successfully explaining over 90% of Ethiopia's BOP variations during the study period. These findings statistically and economically reinforce the primary roles of trade balances, FDI flows, and exchange rates as determinants of BOP. Future research could enhance model completeness by incorporating additional variables like remittance flows or trade policy indices.

Conclusion and Recommendations

The study analyzed the determinants of Ethiopia's Balance of Payments (BOP), employing an Autoregressive Distributed Lag (ARDL) approach with Direct Determinants Balance of Trade (BOT) and Foreign Direct Investment (FDI), and Indirect Determinants Exchange Rate (EXR) and Gross Domestic Product (GDP).

The empirical estimates reveal that Foreign Direct Investment (FDI) and the balance of trade (BOT) exhibits a statistically significant positive impact on Ethiopia's BOP in both short and long run. The results emphasize the significance of high FDI flows and trade surpluses in standing for Ethiopia's external account. Exchange Rate (EXR) depreciation ever has a negative impact on the BOP. Most notably, GDP growth had no significant impact on the BOP over the short or long run, indicating that economic growth in Ethiopia has not yet transferred into adequate growth in exports or overall external sector balance, with heavy dependence on imports.

The ARDL specification employed in this study has strong explanatory power with $R^2 = 0.9012$, which means that the variables utilized in this model explain over 90% of the variation in Ethiopia BOP. Moreover, there was a quick equilibrium correction mechanism (ECM coefficient = -2.876), which is an indicator of the capacity of the economy to restore itself towards long-run equilibrium. This tight fit of the model with the clear statistical significance of BOT, FDI, and EXR confirms them as contributing factor of BOP.

Based on these results, several important policy prescriptions can be identified to remedy

Ethiopia's recurring BOP deficits and achieve long-term sustainable external sector stability. An initial important role is that of an Export-Led Growth Strategy with a concentration on enhanced export competitiveness spurred by planned industrial policy and value-chain orientation. Another, maintaining persistent focus on FDI Attraction by investor-friendly reforms, particularly in export sectors, is needed to support short-term BOP stability. Thirdly, Exchange Rate Management must prefer managed float policies in an effort to smoothen volatility and offset adverse BOP pressures. Finally, Structural Reforms towards minimizing import dependency under import-substitution industrialization are essential to ensure economic growth harmonizes with external sector resilience.

While this research provides insightful empirical evidence for policymakers, it acknowledges some of the shortcomings such as the lack of remittances and global shocks. Future research can make BOP analysis more comprehensive by incorporating these variables and employing more advanced econometric techniques like structural VAR models for enhanced comprehension of shock transmission. Lastly, this research offers a critical foundation for policymakers to develop comprehensive macroeconomic policies to guarantee the long-term health and stability of Ethiopia's external sector.

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Closing Remarks, Ato Tedla Haile, Executive Vice President, St. Mary's University

Invited guests, colleagues, ladies and gentlemen,

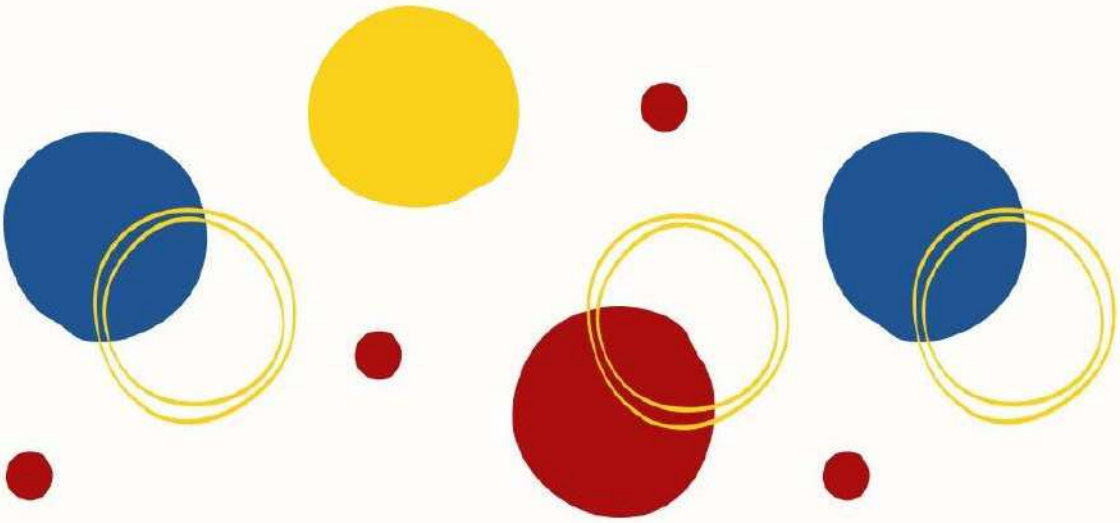
We are now to conclude the daylong seminar after the scholarly discussions on paper presentations from diverse disciplines. This annual event was launched 17 years ago to fill the gaps that were observed in the restricted topics entertained by the flagship conference on higher education, which had already had the student research forum and was followed by the youngest seminar on open and distance learning. As a result, opportunities have been opened for the young and the experienced researchers who might seek a platform for presenting papers.

The scholarly papers presented today covered topics drawn largely from the disciplines of technology, economics, social work, and education. In terms of representations, the event witnessed paper presenters from five universities, other than St. Mary's University and two non-academic entities; thus, the diversity is reflected in thought, topics, professions, and geographic locations. In this regard, through the years, St. Mary's University enduring legacy of commitment to research remains an embodiment of its strength as much as the values it cherishes in teaching and community engagement.

Finally, I thank the paper presenters, whose thought-provoking presentations enlivened the daylong seminar, and you participants, who dedicated your time despite the fact that the rainy morning to attend the event and enrich the discussions by the questions you raised and comments you gave. Gratitude also goes to the chairs, rapporteurs, and master of ceremony. Thanks are due to the US Embassy for allowing us the John Robinson's American Corner facilities. Last but not least, the research and knowledge management teams of St. Mary's University, whose commitment and diligence, have not begun from today's event. For them, it is a whole-year exercise. The responsibility of organizing four annual events and taking up the painstaking job of editing and publishing, in collaboration with St. Mary's University Press rests on their shoulders. I thank them all.

With that, I declare the seminar is closed.

I thank you.



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