East African Journal of Interdisciplinary Studies
eajis.eanso.org
Volume 7, Issue 1, 2024
Print ISSN: 2707-529X | Online ISSN: 2707-5303
Title DOI: https://doi.org/10.37284/2707-5303

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Innovation and Commercialization Characteristics of Techno-Business Firms in Uganda: An Overview of Firm Processes, Strategies, and Challenges

Ronald Jjagwe[1,2] John Baptist Kirabira[1] & Norbert Mukasa[1]*

[1] Makerere University, P. O. Box 7062. Kampala, Uganda.
[2] Uganda National Council for Science and Technology, P. O. Box 6884. Kampala, Uganda.
*Author for Correspondence Email: jagweron@gmail.com

Article DOI: https://doi.org/10.37284/eajis.7.1.2148

Date Published:
28 August 2024

Keywords:
Characterization, Commercialization, Innovation, Techno-Business Firms, Uganda.

ABSTRACT

The role of techno-business firms in shaping the innovation and commercialization processes in Uganda has been the focus of extensive research and analysis. The objective of this study is to provide a comprehensive understanding of the contributions of techno-business firms to the innovation and commercialization landscape in Uganda. To accomplish this, qualitative and quantitative research methods were employed using interviews and observational approaches. These methods involve gathering evidence, including observations and interviews with techno-business entrepreneurs. By examining the various factors that influence the growth of these firms, such as their approaches to Research and Development (R&D), marketing, and partnerships, this study sheds light on the ways in which techno-business firms drive innovation and commercialization in Uganda. This study indicates that R&D and Intellectual Property (IP) protection are vital components of firms' innovation and commercialization initiatives. The study underscores the importance of grants or subsidies as the primary financing mechanism for firm activities. The study highlights that product or innovation development depends on collaborative agreements, adjustments to current products, and internal idea generation. This study reveals innovation and commercialization disparities and proposes remedies to bridge these gaps. This ultimately fosters transformative growth by enhancing industrial production and strengthening the connections between techno-business firms and the industrial sector.

APA CITATION

Jjagwe, R., Kirabira, J. B. & Mukasa, N. (2024). Innovation and Commercialization Characteristics of Techno-Business Firms in Uganda: An Overview of Firm Processes, Strategies, and Challenges *East African Journal of Interdisciplinary Studies*, *7*(1), 278-296. https://doi.org/10.37284/eajis.7.1.2148.

CHICAGO CITATION

Jjagwe, Ronald, John Baptist Kirabira and Norbert Mukasa. 2024. "Innovation and Commercialization Characteristics of Techno-Business Firms in Uganda: An Overview of Firm Processes, Strategies, and Challenges". *East African Journal of Interdisciplinary Studies* 7 (1), 278-296. https://doi.org/10.37284/eajis.7.1.2148.

HARVARD CITATION

Jjagwe, R., Kirabira, J. B. & Mukasa, N. (2024) "Innovation and Commercialization Characteristics of Techno-Business Firms in Uganda: An Overview of Firm Processes, Strategies, and Challenges", *East African Journal of Interdisciplinary Studies*, 7(1), pp. 278-296. doi: 10.37284/eajis.7.1.2148.

Article DOI: https://doi.org/10.37284/eajis.7.1.2148

IEEE CITATION

R., Jjagwe, J. B., Kirabira & N., Mukasa "Innovation and Commercialization Characteristics of Techno-Business Firms in Uganda: An Overview of Firm Processes, Strategies, and Challenges", *EAJIS*, vol. 7, no. 1, pp. 278-296, Aug. 2024.

MLA CITATION

Jjagwe, Ronald, John Baptist Kirabira & Norbert Mukasa. "Innovation and Commercialization Characteristics of Techno-Business Firms in Uganda: An Overview of Firm Processes, Strategies, and Challenges". *East African Journal of Interdisciplinary Studies*, Vol. 7, no. 1, Aug. 2024, pp. 278-296, doi:10.37284/eajis.7.1.2148.

INTRODUCTION

The development of firm innovation and commercialization processes has a crucial impact on industrialization and economic growth (Min et al., 2020; Butnik-Siverskyi et al., 2024). It enables the transformation of theoretical concepts into practical applications, streamlines work processes and techniques, and enhances access to information and knowledge, ultimately bolstering economic competitiveness. The advancement of techno-business development strategies can also support a shift in product development and value addition by fostering the establishment of new businesses and industries that facilitate the commercialization of new products and processes (Lekashvili & Bitsadze, 2021; Loganathan & Subrahmanya, 2022; Butnik-Siverskyi et al., 2024).

The importance of global trends underscores the necessity for firms to commercialize their innovations to sustain a competitive advantage or to venture into overseas markets. The trend towards accelerated innovation and commercialization not only benefits innovators but also raises the bar for rivals. Successfully commercializing innovations empowers techno-business firms to penetrate existing markets or create new ones, resulting in sustained industrial leadership and long-term viability. Previous research has linked successful commercialization to a firm's resources, human resource practices, top management teams, and the external environment (Min et al., 2020; Gong et al., 2021; Pererva et al., 2024).

The Government of Uganda (GoU) emphasizes technological innovation and commercialization to drive economic growth and sustainable development, as demonstrated by its Science, Technology, Innovation Policy (MFPED, 2012), National Development Plan (NPA, 2020), and National Vision 2040 (NPA, 2007). Understanding the significance of innovation and commercialization is critical to Uganda's economic growth and prosperity. However, the success of policies and strategies in fostering innovation and commercialization hinges on their design and implementation within the context of innovation systems (Mulumba et al., 2017; Wen, 2023).

According to Ecuru et al. (2014), techno-business firms in Uganda primarily engage in incremental and adaptive innovations within the formal manufacturing sector with a focus on in-house development and international collaboration. However, local universities and research organizations do not actively participate in innovation processes, which can enhance their innovation capabilities. The study suggests that despite political will, coordination among stakeholders remains weak, and the role of techno-business firms in driving innovation and commercialization is still emerging.

Techno-business firms typically face intense competition and must develop suitable business models to effectively commercialize new products and realize their economic potential (Hussen & Çokgezen, 2020; Jian & Hongxia, 2023). In emerging economies, technological entrepreneurship is fostered through connections between major technology firms and small enterprises, which contribute to industrial growth (Usman et al., 2024). A firm with specialized technological capabilities may choose to commercialize its products alone or adopt a hybrid strategy depending on factors such as competition and financial position (Mukhtar et al., 2021). Research has shown that open innovation business models are positively associated with successful technology commercialization, suggesting that being open can lead to shorter

Article DOI: https://doi.org/10.37284/eajis.7.1.2148

development times and a larger proportion of sales from new products (Kolade et al., 2021).

Techno-business enterprises in Uganda have considerable influence on the country's innovation landscape by contributing to incremental and adaptive innovations. This study aims to provide a comprehensive understanding of the contributions of techno-business firms to the innovation and commercialization landscape in Uganda. The potential of these firms has not been fully realized because of inadequate engagement with research institutions and an underdeveloped commercialization ecosystem. To address this issue, it is essential to fortify collaboration among firms, universities, and policy mechanisms to facilitate technology transfer and entrepreneurship. Noya and Taneo (2023) emphasized the importance of strengthening these interactions to enhance innovation output. Additionally, improved interactions with knowledge-intensive services, as highlighted by Kiefer et al. (2019), are crucial for fostering innovation in these firms.

Literature review

Towards innovation and commercialization framework development

Uganda has directed its efforts towards the development of a framework for innovation and commercialization, and recent initiatives have demonstrated the potential for cultivating scientific and technological capacity that could influence local innovation (Bowman, 2019). The Millennium Science Initiative (MSI), the involvement of universities such as Makerere and Mbarara, and the establishment of incubators suggest developing infrastructure to support innovation. Nevertheless, the absence of a coordinated mechanism for science, technology, and innovation (STI) policy stakeholders continues to be a hurdle (Guimón, 2013).

While Uganda has taken measures to encourage innovation, such as obtaining exemptions from the Trade Related Aspects of Intellectual Property Rights (TRIPS) system, the country's pharmaceutical sector has begun to establish partnerships that foster innovation, indicating a shift towards higher-tech products such as diagnostics (Kapiriri et al., 2020). In contrast, broader issues relate to the commercialization of intellectual property rights (IPRs), and the need for legal and institutional support for innovation has been identified (Nahikiriza, 2023). Additionally, increased investment in Research and Development (R&D) and the implementation of policy measures to stimulate the commercialization of R&D are prerequisites (Hogan et al., 2022).

Countries around the world are increasingly recognizing the significance of innovation in driving economic growth and creating value. Consequently, many governments are revamping their innovation systems to remain competitive. In 2009, the Ugandan government introduced a comprehensive Science, Technology, and Innovation (STI) Policy to provide institutional and infrastructural support to produce goods and services as part of the country's development plan (MFPED, 2009). This initiative, when combined with other government efforts, university undertakings, industry contributions, and the participation of development partners, serves as a starting point for the formulation of more extensive and inclusive innovation policies and strategies in the country and surrounding areas.

Although Uganda has taken steps to promote STI through initiatives such as MSI, there is a need for better coordination and a cohesive policy framework to fully utilize these efforts in product innovation (Guimón, 2013). The experiences of other countries and the importance of legal frameworks can provide valuable insights for Uganda to enhance its innovation and commercialization efforts (Min et al., 2020; Butnik-Siverskyi et al., 2024). To strengthen these efforts, R&D investment is crucial for Uganda's growth.

Innovation and commercialization policy framework

The Ugandan policy framework for innovation and commercialization is intricate and encompasses diverse sectors and stakeholders.

Article DOI: https://doi.org/10.37284/eajis.7.1.2148

The government of Uganda has recognized the importance of STI in addressing challenges and promoting economic growth. Initiatives such as MSI and the participation of universities such as Makerere and Mbarara demonstrate the government's commitment to fostering innovation (Guimón, 2013). Furthermore, the growth of biotechnology and biosciences in Uganda is contingent upon government support for STI, which includes establishing a national science funding facility, promoting private sector commercialization of bioscience innovations, and enhancing institutional governance systems (Onapa et al., 2018, Nahikiriza, 2023).

The formation of policies for innovation and commercialization is significantly impacted by various sector policies and legislative acts, including the National Industrialization Policy of 2008, the National Agricultural Research Act of 2005, and the Uganda National Health Research Act of 2011. These policies are rooted in constitutional provisions that mandate the state to promote science and technology. Policies, such as the National Science, Technology, and Innovation Policy of 2009 and the National Biotechnology and Biosafety Policy of 2008, have provided a comprehensive framework for investment in research and innovation. However, it is essential to ensure that these policies are supported by clear implementation plans, and that they possess the capacity necessary for effective execution.

However, challenges exist in coordinating STI policies among stakeholders and commercializing university research. Despite the government's demonstrated political will for STI development, as evidenced by its investment in initiatives such as MSI, a more effective mechanism for policy coordination and stronger technology development and commercialization at universities is necessary (Nahikiriza, 2023). Moreover, the broader context of innovation and commercialization policy frameworks highlights the importance of collaboration among the government, industry, and academia (Noya & Taneo, 2023). Uganda has been actively working on developing its innovation and commercialization policy framework with significant government investment and initiatives aimed at bolstering its STI capacity. Despite these efforts, challenges remain in effectively coordinating policies and enhancing commercialization.

Financing innovation and commercialization

Funding for innovation and commercialization in Uganda is mostly provided by international or foreign agencies, the government, and not the private sector. Unlike middle- and high-income countries, where private investment is the primary source of innovation and commercialization, the private sector in Uganda is not yet capable of making significant investments in R&D (Sithole, 2020). Additionally, the scarcity of venture capitalists to support the commercialization of research results implies that the government has the largest responsibility for financing research and innovation in Uganda. Although R&D spending as a percentage of the Gross Domestic Product (GDP) has varied over the past five years, ranging between 0.2% and 0.5%, most of these funds come from abroad (UNCST, 2016). This level of spending falls short of the recommended minimum of one percent of GDP for R&D by the African Union (African Union Commission, 2014).

Addressing the financing of innovation and commercialization in Uganda is a multifaceted issue that necessitates the coordination of various stakeholders and mechanisms. The government has demonstrated strong dedication to advancing STI through initiatives such as MSI and fostering collaboration between industry and research institutions (Guimón, 2013). Despite these efforts, Uganda's innovation system is still in its nascent stage, characterized by limited technological development and commercialization.

Uganda's infrastructure development has played a significant role in its progress. Although these arrangements exist, they are generally thought to be beneficial for Uganda's development, provided they adhere to international standards and yield positive development outcomes (Ogwang & Vanclay, 2021). This infrastructure can indirectly promote the commercialization of innovations by

Article DOI: https://doi.org/10.37284/eajis.7.1.2148

improving accessibility and connectivity. Crowdfunding, a novel financing model, has emerged in East Africa and Uganda. Although non-financial return models are more prevalent, equity- and loan-based crowdfunding are gaining traction. It is essential to pay regulatory attention to Fintech models to maximize their potential benefits while mitigating risks (Yin & Chang, 2021; Moon, 2022). This finding suggests an opportunity for innovative financing mechanisms to support Ugandan entrepreneurs.

The MSI was a substantial financial investment in R&D and innovation that received a total of USD 3.35 million from the Government of Uganda (GOU) and an additional United States Dollars (USD) 30 million from the International Development Association. This initiative, which ran from fiscal years 2006/2007 to 2012/2013, aimed to promote science- and technology-driven economic growth by training qualified scientists and engineers and conducting high-quality research (Guimón, 2013). The project allocated approximately USD 23 million to research grants (46%), undergraduate science and engineering curriculum development (53%), and cooperative projects with the private sector (1%) across various fields including engineering and technology (36%), medical and health sciences (28%), agriculture (19%), crosscutting themes (11%), and natural sciences (6%).

The remaining funds were allocated to increase the institutional capacity of the Uganda Industrial Research Institute (UIRI) by five million US dollars as well as to finance outreach programs, policy studies, monitoring, and evaluation. The UNCST was responsible for overseeing the implementation of the MSI project, while an independent Technical Committee comprising members from both Uganda and other countries supervised the grant selection and supervision. A total of 44 grants were awarded to multidisciplinary teams over three years, with 12 projects awarded in 2007, 15 in 2008, and 12 in 2009. These grants were given to postgraduate students at both master's (57 students) and PhD (31 students) levels, who were integrated into the projects. The overall progress of the MSI project has been deemed satisfactory (Crawford et al., 2006; Guimón, 2013) with significant outcomes in terms of research, curriculum development, science outreach, and institutional strengthening.

Uganda's efforts to encourage innovation and commercialization are supported by various measures, such as political initiatives, international partnerships, infrastructural advancements (Nahikiriza, 2023), and cutting-edge financial technologies, such as crowdfunding (Ogwang & Vanclay, 2021). Despite facing challenges such as the need for stronger technology development and commercialization, Uganda is steadily creating a favorable environment for innovation. To ensure continuous progress, it is essential to continue formulating policies that promote innovation, encourage public-private partnerships, and utilize innovative financing methods while adhering to international standards and best practices.

Protecting intellectual property

Uganda boasts a comprehensive legal framework for intellectual property, which encompasses the Patents Act, Copyright and Neighboring Rights Act, and Trademarks Act. These laws do not differentiate between IP ownership by individuals and organizations and allow for joint ownership. As a result, individual scientists in Uganda can claim sole ownership of IPRs unless stipulated otherwise in a contract with their employer, such as a university, or if the organization's bye-laws and policies indicate otherwise. However, many scientists and innovators in Uganda are unaware of existing IP laws, and numerous universities and research organizations, excluding Makerere University, lack effective internal policies for Intellectual Property (IP) management. Historically, Uganda has fallen behind other countries in terms of safeguarding its IP. According to data from the Global Innovation Index (GII) (Dutta et al., 2022), Uganda filed only 39 patents since 2000, significantly fewer than Kenya's 452 patents in South Africa's 22,040 patents. To tackle this issue, the UNCST and Uganda Registration Services Bureau (URSB) joined forces and launched IP seminars to raise IP

Article DOI: https://doi.org/10.37284/eajis.7.1.2148

awareness among researchers, entrepreneurs, and scientists.

The importance of IP rights in fostering innovation and competitiveness has been recognized worldwide (Tahir et al., 2022). However, protecting IP in the digital age presents challenges for Uganda given the global nature of the Internet (Ma, 2020). Blockchain technology can be used for IP protection (Zinych, 2021) and innovative strategies employed by foreign firms in emerging economies with weak IP enforcement (Ziebermayr, 2021) can be considered for implementation in Uganda. Scholars have highlighted various aspects of IP protection including legal frameworks (Tahir et al., 2022), technological solutions (Zinych, 2021), and strategic management (Ziebermayr, 2021). These insights suggest that an integrated approach to IP protection incorporating legal, technological, and strategic elements may be effective.

The national IP policy (MOJCA, 2019) devised by the Ministry of Justice and Constitutional Affairs and the URSB focuses on Uganda's TRIPS obligations. This policy spurs innovation, safeguards intellectual property rights, and fosters creativity, all of which are vital components of a robust IP system. Although IP protection is crucial in an effective IP regime, it is not the only one. Innovators must also consider other strategic options, such as investment and licensing, as well as the structure and functions of the innovation system to optimize the value of their IP assets (Pererva et al., 2024).

Scholars have emphasized the complexity of enforcing intellectual property rights and stressed the need for a comprehensive strategy that integrates robust legal frameworks, innovative technologies, and strategic management practices (Ma, 2020; Zinych, 2021; Tahir et al., 2022). It is essential for Uganda to adapt these principles to its local context, taking into consideration the country's unique legal, economic, and technological environment, to effectively protect intellectual property rights.

Method

Study design and approach

Both qualitative and quantitative research methodologies were employed through data acquisition through interviews and observational techniques. Diverse forms of evidence were obtained through interviews and direct observations of the selected techno-business entrepreneurs. To ensure the dependability and credibility of the study, a rigorous procedure was followed, in accordance with Plotz (2020).

Study population

A total of 55 techno-business entrepreneurs were selected based on purposive sampling to participate in the study. The inclusion criteria involved participants with a thorough understanding of the innovation and commercialization landscape in Uganda. The selected participants were actively involved in the innovation and commercialization processes within their firms and had a strong background in the firm's R&D activities. These individuals were chosen for their valuable insights and ability to provide detailed accounts of the commercialization process within their respective firms. This careful selection process ensured that the insights provided by participants were relevant and valuable.

Data collection

The research project was initiated in 2023, during which the principal investigator was responsible for distributing questionnaires to the participants. Furthermore, online questionnaires were available to those who preferred to complete them independently. The data collected for this study were obtained through interviews and observations of innovation and commercialization patterns. Observations were conducted to understand the dynamics and contextual elements of techno-business enterprises. Interviews were held with techno-business entrepreneurs to gain insights into innovation and commercialization procedures within firms. This method allows researchers to examine real-life situations and gain a deeper understanding of firm-level innovation and commercialization. This approach

Article DOI: https://doi.org/10.37284/eajis.7.1.2148

is highly relevant to empirical studies based on observations or experiences, as stated by Mihas (2019) and Lester et al. (2020).

Data analysis

The questionnaires were thoroughly examined for completeness and consistency to ensure accuracy of the collected data. The data were then entered into Microsoft Excel, organized, and meticulously cleaned before analysis using the Statistical Package for Social Scientists (SPSS) 26.0.

A content analysis tool that involves the coding and categorization of qualitative data was utilized (Mihas, 2019; Lester et al., 2020). The researcher thoroughly read the documents and analyzed them to identify the factors, stakeholders, and contexts that drive innovation in the ecosystem. The results of each phase were combined and used to develop the different codes. Next, the codes were collated and grouped by phase and themes were assigned to each code. Finally, the themes were summarized to produce the results of the study. To gain further insight into the innovation and commercialization processes within firms, an explanation-building procedure is employed in the cross-case analysis (Plotz, 2020). The synthesized data were then organized into chronologically arranged matrices, which were used to draw conclusions.

Results and Discussion

Descriptive characteristics of the firms' innovation and commercialization processes

This involved presenting a thorough overview of the firms' approach and execution of innovation and commercialization plans and strategies.

Table 1: Descriptive characteristics of the firms' innovation and commercialization processes

Firm interactions (n=55)	Percent (%)
Activities relevant to the firms' innovation and commercialization efforts	
Research and development	24.6
Engineering, design, and other creative works	6.9
Marketing and brand equity	13.7
Intellectual property protection	17.7
Employee training	16.5
Software and database development	4.8
Acquisition or lease of tangible assets	4.4
Innovation management	10.5
Others	0.8
Funding sources for the firms' innovation and commercialization activities	
Own funds (retained profits or income from asset disposal)	21.7
Transfers from affiliated firms (holding, subsidiary, or associated companies located in the domestic country or abroad)	4.3
Customer orders (procurement contracts from domestic or foreign governments or international organizations)	10.1
Shareholder loans	3.6
Debt funding from commercial loans	4.3
Loans from government	2.2
Loans from international organizations	2.9
Equity from private equity or venture capital firms	2.9
Grants or subsidies from domestic or foreign governments, NGOs, CSOs	43.5
Others	4.3
Firm strategies to influence the markets for its products	
Upgrade goods or services	10.9
Expand the range of goods or services	15.0
Create new markets	13.2
Enter new markets or adapt existing products to new markets	12.4
Increase or maintain market share	7.5
Increase the reputation, brand awareness, or visibility of goods or services	16.2
Comply with market regulations	11.7
Adopt standards and accreditation	12.8
Others	0.4

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Firms' innovation and commercialization activities

The research adhered to Section 4.2, page 87 of the Oslo Manual (OECD/Eurostat, 2018) and analyzed the influence of innovation and commercialization efforts on product improvement, IP creation, market differentiation, new opportunity discovery, and collaboration facilitation. By investing in these initiatives, firms can enhance their competitive edge, promote growth, and achieve sustained market success (Avenyo et al., 2021; Hussen & Çokgezen, 2022).

Many firms reported that R&D is a critical aspect of their innovation and commercialization efforts, with 24.6% of respondents indicating this to be the case (Table 1). R&D is crucial for driving innovation within a firm by conducting systematic research, experimentation, and inventing new products, processes, and services (Crowley & McCann, 2018; Saka-Helmhout et al., 2020). R&D investment enables firms to remain competitive, adapt to market changes, and develop innovative solutions to meet customer needs.

This study found that approximately 18% of the surveyed firms granted exclusive rights to their ideas through IP-related activities. Firms can maintain a competitive advantage and generate revenue by protecting their ideas, technologies, and brand identity through IP protection (Rajapathirana & Hui, 2018; Kesselring et al., 2023). This research highlights the importance of investing in R&D and safeguarding IP rights to promote innovation and commercialization among businesses.

Approximately 16.5% of the firms surveyed engaged in collaborative staff training with academic institutions, research organizations, and other firms (Table 1). This collaboration can lead to knowledge exchange, access to specialized skills, and an expanded research scope (Abbas et al., 2018; Zhu et al., 2020). By joining forces, firms can reduce costs, share expertise, and accelerate the research and commercialization process.

This study reveals that a substantial proportion of firms (13.7%) invested in marketing and branding efforts to develop unique and differentiated products or services that satisfy customer needs and provide superior value. In doing so, businesses can attract more customers, build brand loyalty, and expand their market share.

The survey results show that many firms engaged in innovation management (10.5%), engineering design (6.9%), and software development (4.8%) to enhance their products, processes, and efficiency. Through continuous development, firms can identify areas for improvement and create new products or services to meet the changing market needs and improve their competitiveness (Barasa et al., 2017; Hussen & Çokgezen, 2022). Such activities are essential for firms to remain competitive and to offer better products and services. Continuous development is necessary to remain competitive and to offer better products and services.

The study indicated that only a small proportion (4.4%) of the firms engaged in acquiring or leasing tangible assets. These activities may lead to new market opportunities and offer various options. By exploring new technologies and emerging trends, firms may discover untapped or specialized markets, as per Crowley and McCann (2018) and Avenyo et al. (2021). Learning about customer preferences, behavior, and future demands through market research helps firms leverage emerging trends and expand their businesses.

Funding sources for the firms' innovation and commercialization activities

Funding is crucial for innovation and commercialization, as outlined in Section 4.4.4 of the Oslo Manual on page 98 (OECD/Eurostat, 2018). Financial support is necessary to turn theoretical concepts into practical and financially viable solutions that benefit the firm and its stakeholders, as emphasized by Kim et al. (2019) and Saka-Helmhout et al. (2020). According to a survey, 43.5% of firms' financing for innovation and commercialization comes from government

Article DOI: https://doi.org/10.37284/eajis.7.1.2148

grants or subsidies, Non-Governmental Organisations (NGOs), and Civil Society Organisations (CSOs). Firms also use their own profits (21.7%) and client orders (10.1%) as funding sources. Adequate funding allows firms to invest in technology, conduct market research, and validate their innovations, enabling them to understand customer needs, discover market opportunities, and prove commercial viability.

Firm strategies to influence the markets for its products

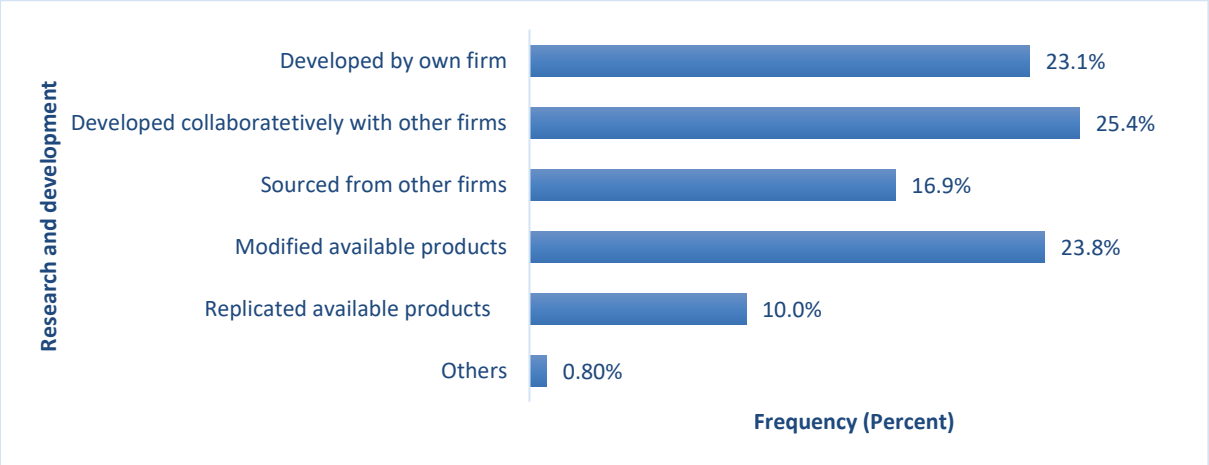
Firms can differentiate their products through unique features, quality, and design, providing a competitive advantage and attracting customers who value these unique features(Saka-Helmhout et al., 2020; Kreiterling, 2023). Research shows that firms use various strategies to influence their product markets, such as enhancing their reputation, expanding their range of goods and services, creating new markets, and complying with market regulations (16.2, 15, 13.2, and 11.4%, respectively). However, increasing or retaining market share (7.5%) is considered the least effective strategy for influencing the market for a firm's products (Table 1).

A firm can opt for a competitive or premium pricing strategy depending on factors such as manufacturing costs, target market, competition, and perceived value. Effective marketing and advertising can boost brand recognition, drive product demand, and shape customer perception. Firms can utilize various channels, such as television, radio, print media, Internet advertising, social media, and influencer marketing to reach their target audience. Additionally, providing excellent customer service can significantly improve the overall customer experience, as reported by Zhu et al. (2020) and (Teixeira et al. (2021). This includes promptly responding to inquiries, effectively managing complaints, and offering personalized assistance.

Firms' product or innovation development activities

This study explores the influence of product innovation development on a company's competitive advantage, customer satisfaction, market expansion, revenue growth, brand image, market adaptation, and talent recruitment, as outlined in section 6.3.2 of the Oslo Manual (OECD/Eurostat, 2018). Allocating resources for product development and commercialization can help firms achieve long-term success in competitive markets (Rajapathirana & Hui, 2018; Saka-Helmhout et al., 2020). As Figure I shows, a significant number of firms reported creating products or innovations through collaborative agreements with other firms (25.4%), modifying existing products (23.8%), or modifying their initial ideas (23.1%).

Figure I: Firms' product or innovation development activities



According to Crowley and McCann (2018), and Hussen and Çokgezen (2022), developing exceptional products can differentiate firms from competitors by providing a competitive edge that

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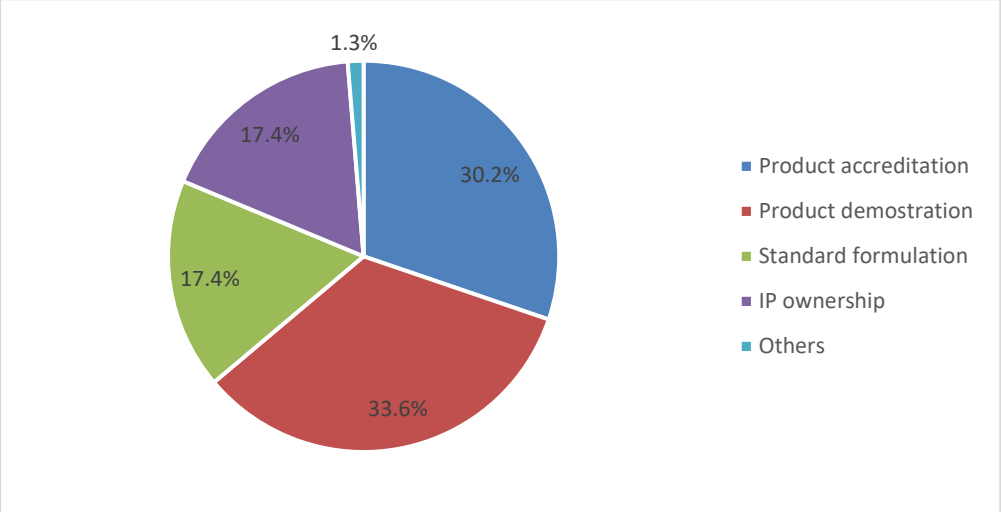
aids in attracting and retaining clients, expanding the market share, and staying ahead of the market. Continuous improvement and innovation that meets or surpasses customer expectations and enhances customer satisfaction are essential. Firms can foster increased customer loyalty and repeat businesses through improved products and services by effectively addressing customer needs. The survey results indicate that firms face issues, such as product duplication (10%) and heavy reliance on external ideas, concepts, and information (16.9%). Product development innovation allows firms to explore new markets and customer segments by creating and commercializing new products.

Role of standards in the firms' markets and innovation activities

This study examines the role of standards in aiding firms in effectively navigating markets, fostering innovation, improving interoperability, managing risks, and expanding their reach. Firms can increase their growth, competitiveness, collaboration within markets, and innovation activities by adhering to and actively participating in standardization efforts (Avenyo et al., 2021; Kreiterling, 2023). The survey results indicate that 33.6% of the participating firms found standards useful for demonstrating the quality of their goods or innovations, whereas 17.4% considered them necessary to promote the involvement of enterprises in developing industry standards and owning IP rights (Figure II).

Figure II: Role of standards in the firms' markets and innovation activities



Standards are essential for businesses to efficiently market and innovate. They ensure that products, systems, and services work together and establish technological requirements and protocols that allow seamless integration between businesses. By fostering collaboration and reducing redundancy, standards promote innovation and help organizations focus their resources on creating new solutions instead of upgrading existing ones. This leads to faster time-to-market for new products and services.

Firm strategies to position its products on the market

Product positioning evaluates customer perceptions of a firm's offerings relative to its competitors, according to the OECD/Eurostat (2018). This involves highlighting the firm's beliefs, goals, and vision and demonstrating how its products or services address customer needs and enhance their lives. As shown in Figure III, firms employ various techniques to position their products in the market, such as tailoring solutions for specific customers (27.3%), diversifying or expanding product lines (26.1%), strengthening positioning in distinct market segments (23.6%), and developing new business models (22.4%).

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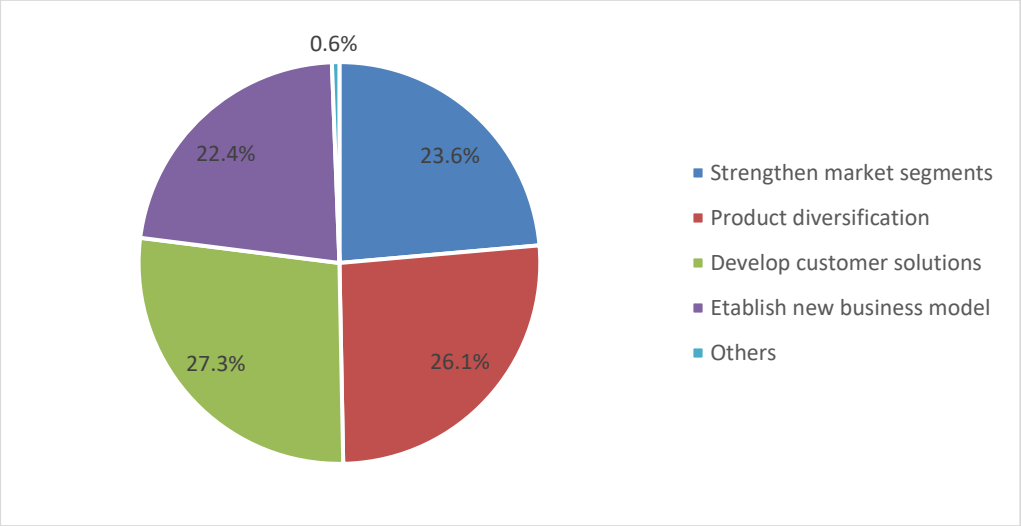
Figure III: Firm strategies to position its products on the market

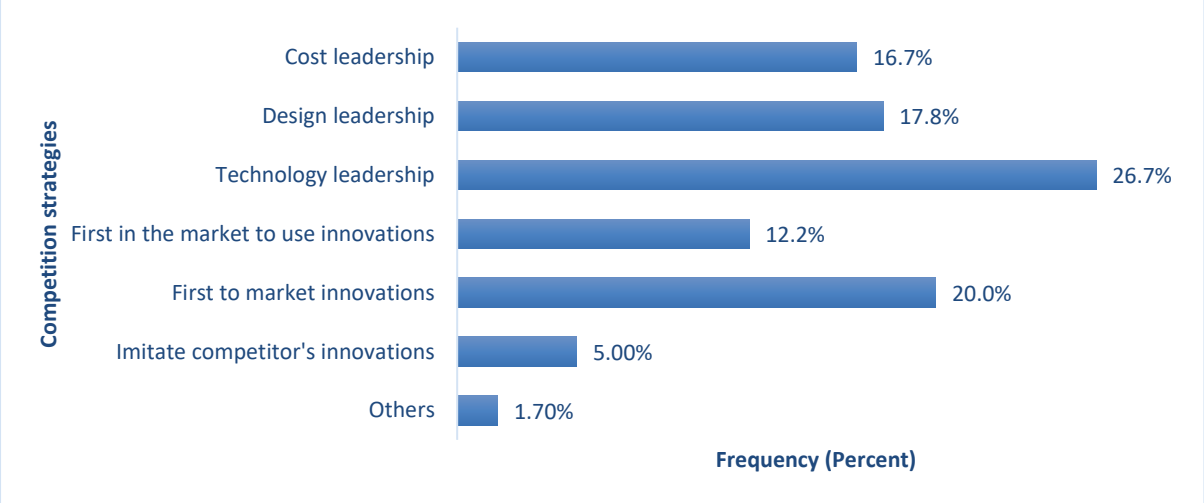


Effective product positioning depends on choosing the right strategy based on the target audience and the competition. A clear and concise marketing message that communicates positioning strategies is essential (Saka-Helmhout et al., 2020; Kreiterling, 2023). It is crucial to ensure consistency across all marketing materials including websites, packaging, and advertising. A combination of online and offline marketing methods, such as social media, websites, print media, television, trade exhibitions, and relationships with influencers and industry leaders, should be used to reach the target audience.

Firm strategies to counter its competitors

To effectively compete in a market, firms must understand their target audience and unique value propositions, as outlined in Section 8.2, of the Oslo Manual (OECD/Eurostat, 2018). This involves the identification of the target market, customer needs, and pain points. Firms can then develop a positioning strategy that aligns with their market's unique requirements by gaining insight into their customers. The survey revealed that firms use various strategies to compete, such as offering technological leadership (26.7%), first-to-market product or service innovation (20%), design leadership (17.8%), and cost leadership (16.7%). Replicating competitive ideas (5%) and being the first to adopt product advancement in the market (12.2%) were the least effective competitive strategies (Figure IV).

Figure IV: Firm strategies to counter its competitors



Article DOI: https://doi.org/10.37284/eajis.7.1.2148

According to Hussen and Çokgezen (2020), and Avenyo et al. (2021), it is important to use case studies, testimonials, and certifications to demonstrate a firm's expertise, record achievements, and industry knowledge. Additionally, analyzing the strengths and weaknesses of competitors can help identify market gaps and differentiate a firm's products or services. Developing a unique value proposition and effective branding and marketing plans are essential for setting a firm apart from its competitors. This involves creating strong brand identity and consistently communicating key messages across all marketing channels.

Innovation and commercialization challenges encountered by techno-business firms

To comprehend the difficulties that techno-business companies in Uganda are confronted with innovation and commercialization, it is crucial to consider the broader context of startup ecosystems in emerging markets and the challenges that technology-focused startups encounter. Although the resources provided do not specifically refer to the Ugandan context, they offer useful information regarding the common obstacles that can be applied to the Ugandan situation.

Techno-business firms especially those in the technology sector, often grapple with a lack of institutional support, which can impede their growth and hinder their ability to innovate (Bakhtiar et al., 2020; Maulana et al., 2022). Moreover, the rapid pace of technological change, unpredictable customer demand, and market profitability are crucial market contingencies that startups must navigate (Butnik-Siverskyi et al., 2024). These challenges are further compounded by the need for startups to collaborate with innovation ecosystems to support their technological and business model innovations, which may be underdeveloped in emerging markets such as Uganda.

Startup techno-business firms frequently face obstacles when attempting to monetize innovations, particularly when counting external entities within their innovation ecosystems to navigate market uncertainties (Butnik-Siverskyi et al., 2024). In addition to establishing strategic alliances, techno-business enterprises must comprehend regulatory and ethical concerns and consistently adjust to technological advancements and market shifts to achieve success (Maulana et al., 2022).

Techno-business enterprises in Uganda are likely to face challenges, such as those encountered in other emerging markets, including inadequate institutional support, the complexity of navigating rapidly changing technological environments, and the need for developed innovation ecosystems. To overcome these obstacles, strategic planning, the development of innovation ecosystems, and a thorough understanding of the local context are necessary to facilitate the commercialization of technology and the sustainable growth of startups (Maulana et al., 2022; Butnik-Siverskyi et al., 2024; Pererva et al., 2024).

Recommended strategies for improving innovation and commercialization outcomes

To successfully apply strategies to improve innovation and commercialization in techno-business firms in Uganda, it is essential to consider the results and outcomes of various studies focusing on innovation, commercialization, and business performance.

Techno-business firms must prioritize the development of efficient business models that facilitate the commercialization of innovative products, as doing so can greatly enhance their economic potential and value delivery (Kusumawati et al., 2022). Furthermore, the implementation of agile methods can improve the effectiveness of innovation processes, resulting in the prompt and successful commercialization of new technologies (Lages et al., 2023). In addition, it is crucial for corporations to formulate innovation strategies that encompass products, processes, markets, and technological innovation, as studies have shown that these factors positively influence firm performance (Kanyi & Kihara, 2022).

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Moreover, devising technological catch-up strategies and government support programs may enhance a company's capacity for innovation in new product development, which is essential for businesses to remain competitive and meet market expectations (Mukhtar et al., 2021). Additionally, technology-driven business analytics can assist techno business firms in making well-informed decisions that promote growth and provide a competitive advantage (Kumar & Aithal, 2024).

Adopting ambidextrous innovation, which entails reconciling market-driven and driving-market business models, may result in improved organizational performance, as indicated by Kusumawati et al. (2022). Market orientation and innovation have been shown to have a positive relationship with business performance, and it is essential to consider the regulatory influence of the business environment when devising strategies (Giang, 2022). Techno-business enterprises must also adapt to the evolving marketing landscape, particularly the emergence of web-based marketing tactics (Mogull, 2021). Comprehending monetization processes in Internet marketing can assist organizations in transforming target audience behavior into revenue streams, which is crucial for small businesses (Mishra et al., 2024).

Uganda's techno-business enterprises should develop tailored business models, implement agile and innovative strategies, capitalize on government support for new product development, leverage business analytics, balance business model ambidexterity, maintain market orientation, adapt to evolving marketing strategies, and comprehend Internet marketing monetization processes to enhance innovation and commercialization. These strategies are underpinned by empirical evidence that demonstrates their positive impact on firm performance and commercialization (Kanyi & Kihara, 2022; Kusumawati et al., 2022; Lages et al., 2023; Kumar & Aithal, 2024).

Conclusion

Theoretical implications

The consequences of improved innovation and commercialization processes among techno-business enterprises in Uganda can be inferred from the broader context of innovation performance and business model effectiveness in various regions and industries. Research on Ugandan manufacturing companies suggests that although innovative firms, as indicated by computer usage and new machinery purchases, tend to grow faster on average, innovation does not necessarily lead to substantial differences in growth rates compared with non-innovative firms (Bowman, 2019; Onapa et al., 2018). This finding contrasts with the positive correlations between innovation performance and efficiency- and novelty-oriented business models observed in high-tech Chinese service companies (Jian & Hongxia, 2023).

Previous research has highlighted the importance of business models in managing commercialization and innovation in small technology companies (Maulana et al., 2022). These models serve as guides for operational-level commercialization. Therefore, it is crucial for techno-business companies in Uganda to adopt suitable business models for effective commercialization. Additionally, the initial stages of commercialization heavily depend on financing, as technology-based companies often rely on informal sources, such as venture capital, before receiving formal funding (Yin & Chang, 2021; Moon, 2022).

To enhance the innovation and commercialization processes for techno-business enterprises in Uganda, it is essential to adopt business models that are in sync with their innovation strategies and provide access to suitable financing options. Although it is important to exercise prudence when applying findings from other regions because of contextual differences, the general principles of business model innovation, funding strategies, and the role of technological innovation as a mediator (Yin & Chang, 2021;

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Moon, 2022; Jian & Hongxia, 2023) can offer valuable insights for Ugandan firms.

Policy implications

The effects of policy on fostering innovation and commercialization procedures for techno-business companies in Uganda should consider the current technological innovation situation based on scientific advancements, as well as the broader economic and innovation environment. Uganda has demonstrated a dedication to cultivating science, technology, and innovation (STI), as evidenced by initiatives such as MSI (Guimón, 2013). However, the country still lacks a coordinated mechanism for aligning STI policies among stakeholders, and technology development and commercialization remain underdeveloped.

Considering the negative impact of economic policy uncertainty (EPU) on green technological innovation among non-state-owned and low-tech businesses, as demonstrated by recent research (Zhou et al., 2024), it is crucial for Uganda's policies to focus on reducing EPU and fostering stable conditions that promote innovation. Moreover, the significance of appropriate business models for successful new product commercialization in small technology firms (Maulana et al., 2022) and the need for innovation support services tailored to the commercialization strategies of new technology-based firms (Butnik-Siverskyi et al., 2024) indicate that providing targeted support for business model development and innovation services could be advantageous.

Tax policies and development tax incentives have the potential to promote technology commercialization and foster innovative entrepreneurship, as indicated by Lages et al. (2023). Additionally, incubator policies that support entrepreneurial development and act as intermediaries between university research and industry can enhance the technology commercialization process (Fitria & Hakim, 2022). Consequently, Uganda should consider implementing similar tax incentives and incubator programs to stimulate the growth of its techno-business firms.

To improve the innovation and commercialization processes within techno-business firms in Uganda, it is crucial to focus on establishing a stable economic environment, offering targeted innovation support services, implementing tax incentives for R&D, and establishing effective incubator programs that bridge the gap between research and industry. These measures can foster an ecosystem conducive to the growth of techno-business firms and enhance Uganda's overall innovation capacity, as suggested in various studies (Fitria & Hakim, 2022; Maulana et al., 2022; Butnik-Siverskyi et al., 2024; Zhou et al., 2024).

Ideas for future research

Future research on improving the innovation and commercialization processes of techno-business enterprises in Uganda may benefit from utilizing a multifaceted strategy. Studies have explored the role of knowledge-generating institutions in manufacturing firms' innovation practices, particularly in the food, beverage, chemical, and pharmaceutical sectors (Ecuru et al., 2014). Further research could investigate the obstacles to collaboration and develop frameworks for effective engagement between academia and industry, thus fostering a culture of innovation and trust.

Investigating the harmonization of STI stakeholders in the technology industry and the processes by which they can be improved to foster the development of technological innovations based on scientific research is crucial (Kapiriri et al., 2020). Furthermore, research could examine the impact of initiatives such as MSI on entrepreneurship and industry-academia collaboration.

Research should concentrate on assessing the business models utilized by small technology firms for product launches to identify effective strategies and enhance innovation management (Maulana et al., 2022). Additionally, innovation culture and customer co-creation influence market success in Information and Communication Technology (ICT) companies that provide

Article DOI: https://doi.org/10.37284/eajis.7.1.2148

knowledge intensive business services (Alpraeska, 2022).

Research could delve into the technological catch-up strategies used by governments in emerging economies to develop new product development capabilities within local small and medium-sized enterprises (SMEs) (Mukhtar et al., 2021). It is also crucial to investigate the impact of economic policy uncertainty (EPU) on business development and innovation, with a focus on green technological innovation (Zhou et al., 2024).

Future research could explore alternative financing methods for technology-based businesses, particularly during the initial stages of technology financing, and how this impacts commercialization (Yin & Chang, 2021; Moon, 2022). Additionally, it could examine the development of effective innovation funding mechanisms, particularly in challenging situations, such as martial law (Zaburanna & Yarmolenko, 2022).

Research can assess the external factors that accelerate the growth of innovative startups and technology-based companies with an emphasis on macroeconomic stability and human capital (Jurgelevičius & Kučaidze, 2020). Furthermore, this study investigates the influence of technology-driven business analytics on the quaternary sector and its impact on market trends, consumer behavior, and operational performance (Kumar & Aithal, 2024).

Future research should focus on connecting academia and industry, enhancing the coordination of STI policies, evaluating effective commercialization business models, assessing the influence of government strategies and economic policy uncertainty on innovation, examining financing mechanisms, and exploring the impact of business analytics on innovation. These studies have the potential to offer valuable insights that can strengthen the innovation capabilities and commercialization success of techno-business firms in Uganda (Kapiriri et al., 2020; Alpraeska, 2022; Kumar & Aithal, 2024; Zhou et al., 2024).

Limitations of the study

This study discusses the contributions of techno-business firms to the innovation and commercialization landscape in Uganda. However, a comprehensive analysis of innovation and commercialization requires consideration of a broader innovation ecosystem, including educational and research institutions, examining the specific barriers that impede commercialization and affect business models, and evaluating the influence of absorptive capacity on innovation outcomes.

Declarations

Data availability statement*:* The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Disclosure statement*:* The authors declare no conflicts of interest.

Author contributions: All authors contributed to the writing of the manuscript and read and approved the final manuscript.

Funding: The authors thank Makerere University Research and Innovation Fund (MakRIF) for providing funding for this study. The funding agent was not involved in the study design, collection, analysis, interpretation of the data, or writing of the manuscript.

Acknowledgments: The authors thank all techno-business entrepreneurs who participated in this study.

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