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The Challenges of University Knowledge and Technology Transfer on Entrepreneurial and Industrial Innovation: A Case Study of the University of Rwanda

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Abstract

This study aims at investigating the challenges of Knowledge and Technology Transfer (KTT) in support of entrepreneurial and industrial innovation in Rwanda, particularly the University of Rwanda. The Triple Helix Model, which emphasizes university-industry-government collaboration, and the Technology Transfer Process Model are frameworks used to examine the challenges and opportunities associated with knowledge and technology diffusion and commercialization. A quantitative methodology approach (quantitative surveys) was developed to research what works best from a knowledge-translation point KTT mechanism. The results indicate that though some strides have been made, KTT in Rwanda remains demarcated and, above all, deficient in terms of industrial engagement, institutional support, research funding, and scattered application of the policies. The absence of defined collaborative mechanisms has led to poor commercialization and thus weakened the effect of academic research on development in the economy. This study advocates an AI-driven, KTT framework that is policy-wise consistent and features well-structured university-industry partnerships through AI-powered research matchmaking; digital Intellectual property (IP) management and an improved governmental incentive to fill these gaps. According to the recommendations, the establishment of a National Knowledge Transfer Office (NKTO) will be helpful to enhance commercialization grants, industry-academia training programs, and stronger IP protection policies. Therefore, the modification of the knowledge transfer ecosystem towards a more interactive one is to stimulate the rapid commercialization of research and the enhancement of entrepreneurship, as well as giving Rwanda share to innovation-led economic growth.

Introduction

Knowledge and Technology Transfer is the transfer of knowledge, scientific or academic, which includes discoveries, methods, and inventions, towards practical applications and benefits to the society, often including commercialization, partnerships, and public service. This guarantees that research does not only remain in journals or laboratories, but also has an impact in health, agriculture, education, energy, and business sectors. Knowledge transfer could also be defined as a process by which knowledge goes from the

root to where information is imparted and practiced. The core of innovation is in knowledge, which is why open innovation opens the door to knowledge transfer with agents outside the business.

The capacity to convert information through sharing also leads to one level of innovation or another. It is therefore vital to establish an efficient knowledge management system that supports the absorption of knowledge originating from knowledge exchange within and among organizations as Knowledge transfer between academia and business is an essential driver of innovation and economic progress since it eases the commercialization of knowledge (Sung & Gibson, 2000). In a contemporary economy highly based on knowledge, activities in the domain of KTT have been increasingly recognized as engines of creativity for entrepreneurial as well as industrial activity.

It becomes incumbent on the tertiary institutions as the knowledge and research generation institutions to cooperate with the industrial and government organs, to advance technology, promote economic growth and create jobs (Breznitz & Henry, 2016). However, in many of the developing countries such as Rwanda, the transfer of research-based knowledge into market-specific applications has been found to be generally weak, disjointed and poorly funded, partly due to institutional situations prevailing in the country (Ndaruhutse, 2016).

This article is based on a study that seeks to investigate the challenges of KTT in the context of Entrepreneurial innovation in Rwanda Rwanda's approach to technology transfer during the period of 2024 under research is characterized by interventions oriented towards research exploitation with an emphasis on widening and deepening innovation dimensions without many initiatives aimed at harnessing transnational influences and policy objectives (Perez-Guzman et al., 2023). The absence of structured collaboration between the government, higher education institutions and the industry has led to a major flaw by the fact that academic research cannot lead to the improved technological capability as it needs to reach the stage of industrial production in order to do so, thereby restricting the country's development potential to further utilize inventiveness (Twizeyimana, Larsson & Grönlund, 2018). The Triple Helix Model provides a theoretical underpinning to investigate interaction amongst the three parties involved- Universities, industries, and the government- making it more favorable to collaborative innovation system rather than through acculturation programs (Shyiramunda & van den Bersselaar, 2024). This study seeks to address the following research questions:

1. What are the key challenges faced by the University of Rwanda in implementing effective knowledge and technology transfer processes focused on entrepreneurship and innovation?

To address the questions, the quantitative method strategy used therein quantitative survey. The research takes an empirical approach to evaluate how Rwanda can design and execute a strategy towards the fostering of innovation.

Literature Review

Theoretical background

Technology is considered essential for driving innovation, fostering economic and industrial progress, and bringing about social and human development to enhance lives. To achieve the numerous social-economic development imperatives described in Agenda 2063, African nations like Rwanda must establish themselves, acquire and absorb the necessary technologies, and start the process of catching up to their developed counterparts. Domestic and international technology acquisitions and transfers can be vital tools for closing technological gaps and accelerating technological advancements in African nations, as the continent produces only a small portion of the world's research and development output and is largely undeveloped (Abdulai, Lyndon , & Brychan , 2022).

The policy on science technology and innovation (STI) for Rwanda was first made in 2005 with the support of International experts on Science, Technology, and Research Policy, This was a vision for 2020, The Vision 2020 for Rwanda highlighted the crucial role that Science and Technology played in Rwanda's

development, and the Policy document was written to build on the immense work that has been done since 1994 to develop Rwanda, to enhance the Science, Technology, and Research capacity, and to reinforce the development pillars of Vision 2020, across all sectors of the Rwandan economy (Guerrero & David , 2019) In 2015, vision 2020 was developed into Vision 2050, and broad stakeholder consultations and citizen engagement were conducted to define what Rwandan citizens want to see by 2050. Rwanda's education system intends to be market-driven by 2050 linking Rwandans to creative occupations produced in ICT as part of the strategy on STI (Aubert, 2018).

Technology transfer is not a recent development. Since the establishment of the Journal of Technology Transfer in 1977, which is devoted to worldwide research on technology transfer methods, practice, and management, the issue has captured the attention of policymakers and researchers for almost fifty years, demonstrating its significance. Despite the abundance and diversity of literature, there is still a dearth of study and incomplete knowledge on technology transfer in the African setting. Nonetheless, it is noted that during the past ten years, the technology transfer landscape in Africa has experienced dynamic development and change, propelled by advancements in relevant policy frameworks, swift advancements in technology, and the growth of technology-related industries and markets in African nations (Perez-Guzman et al., 2023)

Knowledge and Technology Transfer as a part of entrepreneurial and industrial innovation

Knowledge transfer could be defined as a process by which knowledge goes from the root to where information is imparted and practiced. The core of innovation is in knowledge, which is why open innovation opens the door to knowledge transfer with agents outside the business. The capacity to convert information through sharing also leads to one level of innovation or another. It is therefore vital to establish an efficient knowledge management system that supports the absorption of knowledge originating from knowledge exchange within and among organizations as Knowledge transfer between academia and business is an essential driver of innovation and economic progress since it eases the commercialization of knowledge

Technology Transfer could also be defined as the "transfer of systematic knowledge for the manufacturing of a product, for the application of a process or the rendering of service and does not extend to the transactions involving the mere sale or mere leasing of commodities. This definition attempts to differentiate transfer of technology from the diffusion of technology" and views technology transfer as a transfer of a system that includes hardware, software, procedures and skills, among others, as a package, rather than as a "product transfer", such as the sale of a tractor. It looks at technology transfer mostly as a transaction between the supplier and consumer of the technology (Sung & Gibson, 2000).

Technical innovation, its application has lately been extended towards public sector innovation, universities, hospitals and even social businesses. There are three forms of knowledge transfer, such as transfer through purchase, transfer through cooperative development initiatives, and transfer through patents. Traditional technology transfer approaches formed by appropriability, diffusion and communication Technology transfer which results in technological innovation is the best transferred and absorbed in the partnership networks or as described in the tiny world of the strategic technological alliance. The traditional point of view regarding technology transfer is restricted in the context of social innovation. Since it relates to creating technology that is based on functional logic which may be executed without any reference to society. Thus, technology transfer primarily refers to the movement of "know-how" in high-tech, technical processes or instruments, methods or materials (Todeva, 2013). When talking about KTT the mode of technology transfer is paramount to this research such as Non-commercial Transfer, Commercial Transfer, and new company generation which refers to the several methods by which expertise or intellectual property is given to a newly formed business, such as a joint venture or start-up, for development. Known as Spin-off.

The challenges and stakeholder gaps among Stakeholders in KTT

However, there is a deficiency in information exchange between academia and industry. Whether a need is identified before or after the process starts, technology should address it. The economic success of technologically complex goods frequently depends more on user acceptability than on technology itself. Technology is a catalyst for innovation, and for more than a decade, it has dominated African policy and stakeholder agendas, including Rwanda. Due to the deficiency in funding, a lack of an entrepreneurial mindset among researchers, and the lack of communication between stakeholders there has always been a gap between universities and industry (OECD, 2019). some challenges were raised some stakeholders.
Firstly, the lack of practical internships with industry where university students are in touch with day-to-day activities of how the industry works to gain practical knowledge.

Secondly, the low access or high requirement criteria to funding and grants for collaborative research and development projects among both universities and industries to engage in joint ventures.
And finally, inadequate development or support for innovation hubs and incubators that provide resources, mentorship, and support for startups and spin-offs emerging from university research.

Theoretical framework

The Triple Helix Model: University-Industry-Government Collaboration

Etzkowitz and Leydesdorff (2000) discuss the Triple Helix as a knowledge transfer process. Focusing on the need for regional innovation ecosystem development, the three major stakeholders – universities, industry, and government must capitalise on the synergies that will result from collaboration. These institutions worked in many different unrelated environments, wherein universities were predominantly centered on academic and research activities, whereas the other centers were meant for purposes of economic development. But following the change in economies towards knowledge economy the scoping between these actors have blurred giving rise to new types of partnerships and institutions, namely hybrid organizations (Breznitz & Henry, 2016).

In this model, universities are not restricted to the production of theoretical knowledge only; they are involved in the commercialization and the process of knowledge transfer to businesses. Similarly, industries turn from pure recipients of academic research knowledge to managers of creativity, while the governmental agencies are concerned with the development of some frameworks, appropriating funds and setting rules for the purpose of entrepreneurship and academic community linkage services. Concerning academic industrial relationships at the universities of Rwanda, there is minimal foundation and structured partnerships are rare on promotion of research for commercial purposes (Nsanzumuhire & Groot , 2020). The Theory of Triple Helix postulates the promotion of an effective partnership in which the government, industry, and university will be able to transfer technology, drive innovation, and wealth creation respectively.

The interconnectedness of the three universities, industry and government in innovation are all related is depicted in the diagram of the Triple Helix Model below (Figure 1).

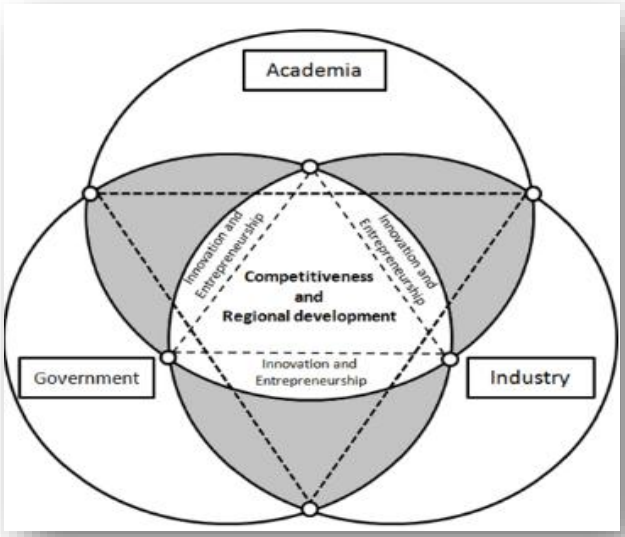

Figure 1: The Triple Helix model showing the interconnectedness between universities, industry, and government
Source: (Farinha & Ferreira, 2013)

The Technology Transfer Process Model: From Linear to Interactive Approaches

The Technology Transfer Process Model helps in demonstrating how knowledge is moved from research institutions to the industrial world. In fact, technology transfer has traditionally been seen as linear, in that knowledge pass from basic research through applied research, development, and finally, commercial application (Mowery & Bhaven, 2005). This single-directional assumption for the flow of knowledge will not facilitate smooth commercialization and will lead to poor commercialization rates mainly because there was no identification of unmet industry needs early in the research (Bozeman , Heather , & Jan , 2015).

Normal models of technology transfer have described it as a pipeline. In fact, the transfer of new technology should be an ongoing process of communication between academia, industry, and policy makers (Cai & Marcelo , 2021). There exists a synergy between industry and academia also in the co-development of research agendas thereby ensuring market-oriented research. To further incentivize regulation, the Government has introduced commercialization grants, tax breaks, and support to startups. By means of acting as intermediaries, technology transfer offices (TTO) are patent registration and licensing agreement facilitators, as well as helping research-industry linkages. In Rwanda, the current technology transfer system has largely been linear in character, thus limiting its potential in the field of industrial innovation. There is no structured engagement from industry; so, research often remains confined to an academic pursuit and not turned into something of commercial value to be explored in the right frontier (Tijssen, & Wong, 2016). The improvement of this situation requires Rwanda to move towards an interactive KTT system in which universities, industry, and government continuously interact to ensure research output commercialisability. Based on literature, a comparison table (Table 1) is presented which sums up the discrepancies between Linear Technology Transfer and Interactive Technology Transfer Models, identifying key variables like the nature and extent of stakeholder engagement, commercialization success rates, and policy intervention.

Table 1: Differences between linear and interactive transfer models		
Key Aspects	**Linear Technology Transfer Model**	**Interactive Technology Transfer Model**
Knowledge Flow	One-way (University to Industry)	Multi-directional (University <-> Industry <-> Government)
Collaboration Type	Minimal, research-driven	Strong, co-created research and innovation
Industry Participation	Limited, occurs at commercialisation stage	Active throughout the research process
Government Involvement	Regulatory role, little proactive involvement	Strategic, provides funding, incentives, and infrastructure
Innovation Efficiency	Lower, due to weak stakeholder interaction	Higher, due to continuous knowledge exchange
Research Commercialization	Misalignment with industry needs	Faster, as industry is involved from the outset
Flexibility in Application	Rigid, follows a set process	Flexible, allows iterative adjustments
Response to Market Needs	Weak, technology may not align with demand	Strong, research is aligned with market demand
Role of Universities	Conducts research independently	Partners with industry for applied research
Role of Industry	Receives knowledge passively	Engages in joint R&D and co-innovation
Policy Support	Weak policy frameworks for academia-industry	Strong policy incentives for commercialization and partnerships

Source: Author's construct

Research Methodology

This section illustrates the research plan, the data collection methods, the sampling, and the approaches to analysis used in the understanding of the assisting and hindering factors of Knowledge and Technology Transfer in Rwanda. Quantitative methodology for research in knowledge translation and transfer at the University of Rwanda provides critical scaffolding in bringing empirical evidence into educational practices and policies (Verduin, Scholte, Rutayisire & Richters, 2010). Quantitative research is distinguished by systematic investigations of numerical data, through a variety of methodologies such as those based on objectivity and generalizability, often using structured instruments such as surveys and experiments to gain data from large sample sizes, thus increasing the reliability of the findings. One might make use of questions as survey instruments or questionnaires to capture numerical data from many participants. Questions are structured to get a specific answer that is quantifiable and analyzed. Research can thus investigate attitudes, behaviors, opinions, and demographics on a broad scale; however, it has its weaknesses in bias due to response and nonresponse.

Research design and data collection methods

Quantitative analyses (surveys and statistical validity) ensure that the findings are bled into the arena of statistical significance so that generalizations may be made and recommendations for policy developed.

Quantitative survey design and structure

The digital survey was sent between August 23, 2024, and September 17, 2024. Participants in the online survey were employers, graduates, and current students from a variety of backgrounds who have KTT for

innovation at the University of Rwanda. Employers were contacted electronically through emails to get their opinions on the KTT and the Rwandan labour market, while students, recent graduates, and young innovators were sent the Google form via a QR code after every brief presentation. Social networking sites and discussion forums run by employers also received it. The study had approximately 150 participants drawn from the different campuses of the University of Rwanda, Entrepreneurial Enterprises, Industry, and a few government bodies. 100 responded to QR and 23 responded with more detailed answers to in their own words (refer to figure 2).

The question was divided into 5 sections starting with Demographic Questions to Contribution of KTT to Entrepreneurship and Innovation. Some sample questions include:

1. How effective has KTT contributed to the development of entrepreneurial skills in your community?
2. Are there opportunities you see for improving the commercialization of research outputs?
3. How accessible are the Knowledge technology transfer resources provided by the Universities in Rwanda?
4. What recommendations would you make to policymakers to enhance the effectiveness of knowledge and technology transfer in Rwanda?

More questions are in the Appendix.

Data Analysis Methods

Quantitative Data Analysis: thematic coding was used to extract recurring patterns in enablers, critical success factors, and barriers. Quantitative Data Analysis The descriptive statistics involved frequency analysis of the responses provided to the survey. Mean Test ranks the key KTT enablers and barriers depending on the ordering of preferences by different stakeholders.

Ethical Considerations

The ethical principles of research were adhered to in this study. These include informed consent, that is participant information on the objectives and purposes of the research, as well as their willingness to participate. Confidentiality, that is personal information is anonymized, and responses are stored securely. Voluntary Participation is assured and that the respondents have the right to withdraw at any time.

Results and Discussions

This is the result of this study that gives a discussion on the current state of knowledge and technology transfer (KTT) in Rwanda, barriers to effective KTT, and what could have possibly worked for strengthening research commercialization and innovation. The interpretation of the results was based on survey responses and focus groups. Tables and figures will be used wherever necessary to summarize key trends and to make comparisons.

Descriptive Statistics

A survey conducted with university researchers, industry representatives, and policymakers assessed key aspects of Rwanda's knowledge transfer ecosystem. The findings, summarized in figure 3 and Table 2. show that only 32% of respondents believe university research aligns with industry needs, while only 27% report the existence of structured collaboration frameworks. The low percentage of Technology Transfer Offices (TTOs) and industry participation further highlights Rwanda's challenges in linking academic research with commercial applications.

Table 2: Perception of knowledge transfer effectiveness					
Aspect	**% Agreeing**	**% Disagreeing**	**95% CI Lower**	**95% CI Upper**	**$\chi 2$ (p-value)**
Research Alignment with Industry	32	68	23.8	40.2	14.2 (<0.01)
Structured Collaboration Exists	27	73	19.2	34.8	9.8 (<0.05)
Active TTOs Present	18	82	11.2	24.8	6.5 (0.09)

Perception of KTT Challenges by stakeholder by percentage

As illustrated within the confines of Figure 2, how such stakeholder group constituents as Academia, Industry, and Government perceive the challenges associated with Knowledge and Technology Transfer (KTT) are presented with a specific percentage for each group who found the areas below as challenging: Research Alignment (Blue), Collaboration (Orange), TTO Presence (Green). Government: Sensitization brings in moderate levels of challenges (around 78% total). Industry: Sensitization carries around less than 60% to 65% total perception on overall challenges with the lowest overall starker challenges. Academia: Carries the highest overall perception of challenges (about 85% total). In all three groups, there is consensus that Collaboration and TTO Presence are common challenges, but Academia is particularly concerned with Research Alignment, because that implies poor connection between academic research and practical or commercial applications. These areas could therefore be addressed to improve KTT effectiveness across sectors.

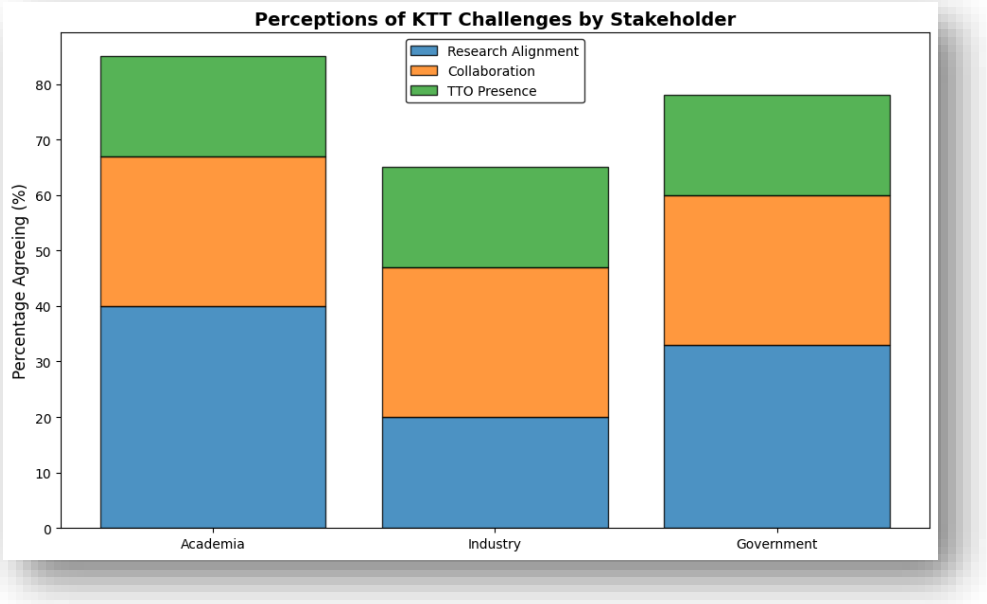

Figure 2: Perception of KTT Challenges by stakeholder by percentage

Stakeholder agreement with 95% confidence intervals

"Stakeholder Agreement With 95% Confident Intervals" provides the percentage of stakeholders who have agreed on three statements on Knowledge and Technology Transfer (KTT) and their respective 95 percent confidence intervals showing the level of uncertainty or variation in responses. From this chart, appearing to perform worse are stakeholders in KTT structures among which skepticism and little confidence about their current standing can be observed, especially whereby TTO activity and formal collaboration mechanisms are concerned. Research alignment is slightly better regarded; however, with generally low percentages, there remains an opportunity for improvement.

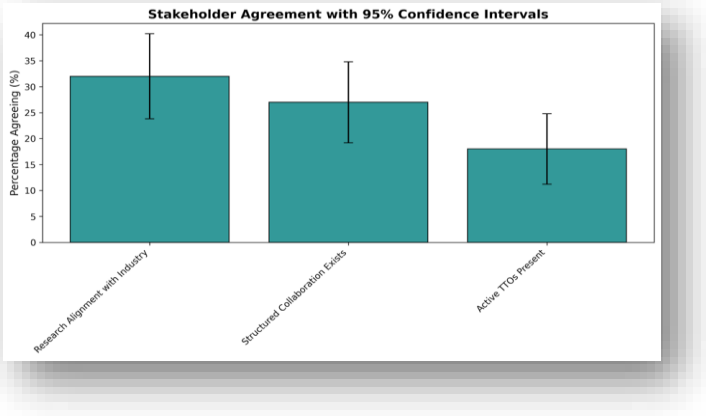

Figure 3: Stakeholder agreement with 95% confidence intervals

Distribution of funding availability scores by stakeholder

Different stakeholder groups perceive the availability of KTT funding differently, be it Academia, Industry, or Government. It is also mentioned in the indexes which matter, wherein this index shows the distributions of funding scores by stakeholders. This distribution indicates skewed perceptions of funding which may jeopardize stakeholder engagement in KTT. The perceived lack of funding in the industrial sector may call for specific policies or incentives to enhance participation in knowledge transfer and technology transfer.

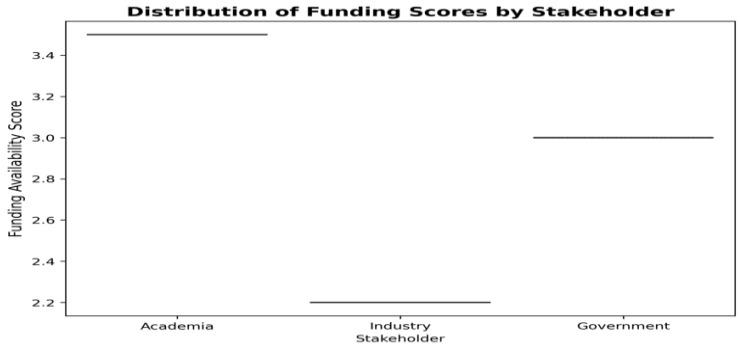

Figure 4: Distribution of funding availability scores by stakeholder

Funding Availability vs. Collaboration

"Funding Availability vs. Collaboration" is a 2-D scatter plot that envisages the above-mentioned scope between the availability of funds and collaboration scores of other stakeholders – one of which is Academic, the other Industry, and lastly Government. The chart shows that improving availability of resources will enhance collaboration, especially for less funded stakeholders like industry and government. However, the relationship is not absolute; the other possible factors are policy, institutional support, or trust.

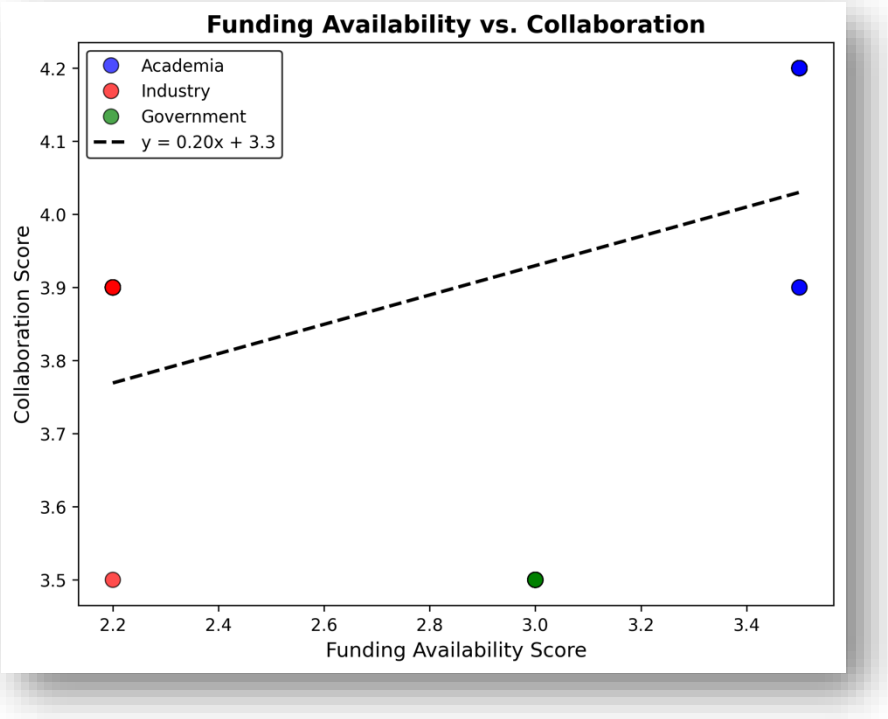

Figure 5: Funding availability vs collaboration score

Description of participants based on gender, age and occupation

This is a summarizing survey response related to demographics and professional backgrounds of participants as the survey focuses on areas like education, career development, or tech adoption.

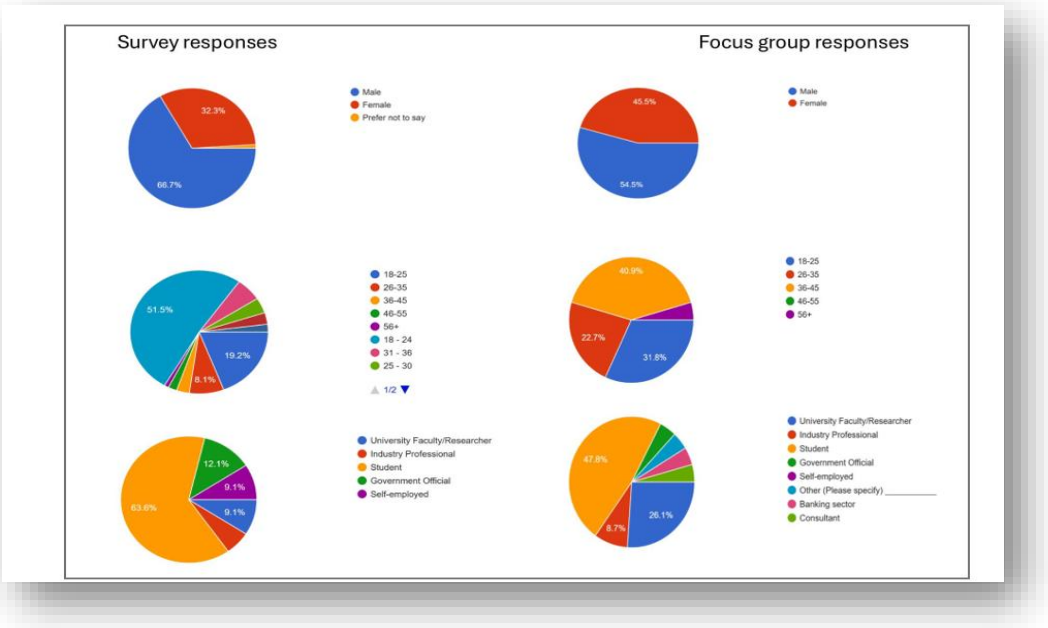

Figure 7: Description of participants based on gender, age and occupation

Correlation matrix of KTT challenges

The color intensity and numerical values display the intensity and direction of linear relationships between variables in this matrix. The scale on the right side illustrates the values of the correlation, which goes as follows: +1: Perfect positive correlation,0: No correlation, -1: Perfect negative correlation. It is indeed true that funding somewhat dictates the collaborative efforts under a knowledge and technology transfer umbrella. While relevant, industry engagement has less strong connections with either collaboration or funding, possibly implying the prominence of other factors-such as policy or institutional culture-in its making.

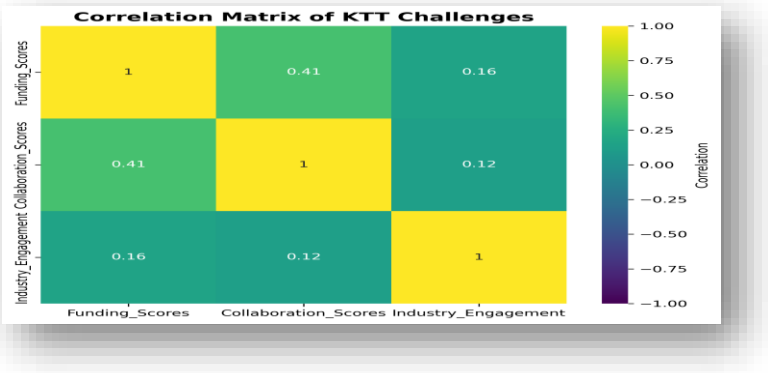

Figure 8: Correlation matrix of KTT challenges

The study has without doubt demonstrated that the University of Rwanda has successfully incorporated innovation into its programs with GRID and UNIPOD. Several interlinked challenges were found in the study, which effectively block KTT at the University of Rwanda, especially in entrepreneurship and innovation. The major challenges affecting KTT, as confirmed by the quantitative data collected, are inadequate funds, weak collaboration structures, lack of engagement with industries, and non-existence of active TTOs.

1. Inadequate Funding for Research and Innovation Activities

Funding emerged as the most critical barrier to effective KTT. As shown in the correlation matrix and stakeholder responses, low funding scores were moderately correlated with weak collaboration structures ($r = 0.41$). The distribution of funding scores indicated that academia rated funding availability higher (mean ≈ 3.5), whereas industry rated it significantly lower (mean ≈ 2.2). This suggests a mismatch in perceptions and potentially uneven access to funding sources, particularly for applied research with commercial potential. The scarcity of dedicated funding for innovation and entrepreneurship activities reduces the university's capacity to support spin-offs, prototyping, and patenting.

2. Weak University–Industry Collaboration

Survey data indicated that fewer than 30% of respondents agreed that structured collaboration mechanisms exist between the University of Rwanda and industry. This was reinforced by the low correlation between collaboration and industry engagement scores ($r = 0.12$), indicating fragmented interactions. The university lacks formalized platforms such as industry liaison offices, innovation hubs, and co-creation spaces that are essential for sustaining long-term partnerships.

3. Low Industry Engagement in Research and Innovation

Despite the potential benefits of university–industry partnerships, industry stakeholders reported limited engagement in KTT initiatives. Only 18% agreed that active TTOs are present at the university, and their funding and collaboration scores were also among the lowest. This weak engagement reflects a broader systemic issue in aligning academic outputs with market needs, possibly due to a lack of communication channels, trust, or incentives for industry partners.

4. Institutional and Structural Barriers

Interviews and qualitative feedback revealed internal barriers such as bureaucratic procedures, limited commercialization skills among academic staff, and unclear intellectual property (IP) policies. These structural constraints hinder the university's ability to efficiently manage and transfer innovations. Furthermore, the absence of a dedicated and well-resourced TTO was consistently cited as a missing institutional link between research and market application.

Discussions

Knowledge and technology transfer (KTT) in Rwanda has been found to be mostly linear with little industry participation, poor institutional backing and poor policy making within the country. Although Rwanda initiated various ways to promote innovation, absence of structured collaboration mechanisms negatively affects research commercialization and influences the rate of impact on the economy (Nsanzumuhire & Groot, 2020). It stands in accordance with the concept of Triple Helix that stresses the necessity for collaboration of universities, industry and government in the driving of innovation (Breznitz & Henry, 2016). Whatever, in Rwanda universities pay more focus on knowledge generation as opposed to commercialization, industries engage poorly with research partnerships, and government policies do not have adequate mechanisms for implementation (Tijssen & Wong, 2016).

The model for Technology Transfer Process provides clarity to understanding why KTT in Rwanda is just one-sided as far as flow of research from the academic to the industrial side, with minimal feedback loops (Mowery & Bhaven, 2005). Because of the absence of TTOs and well-structured funding mechanisms,

the rate of commercialization is quite low unlike the currently interactive ecosystems for knowledge transfer where universities and industries co-design the research agenda (Bozeman , Heather , & Jan , 2015). The traditional linear KTT system in Rwanda could be converted into an interactive one by strengthening partnerships and research institutes through structured research programs and commercialization grants.

A comparison with the best practice will hence provide more scope for improvements in KTT in Rwanda. In Singapore, AI-based research matchmaking platforms link researchers with prospective industry partners to improve commercialization success. These companies are created to support the development of startups in science, technology, and innovation, and expansion of their market potentialities to different parts of the country (Borowiecki, Guimon, Paunov & Planes-Satorra, 2019). The systems of intellectual property (IP) protection in Kenya, based on blockchain, then had a stronger commercialization of research by securing innovations generated from universities (Malpass, 2022).

The study gave the opinion that Rwanda could benefit from similar ways, particularly through AI-powered research matchmaking, structured technology incubators, and improved IP frameworks. Absence of structured university-industry interaction in Rwanda has equally contributed to weak commercialization outcomes. Often, industry executives do not know of university research, while researchers do not know market needs (MINEDUC, 2020). This AI-driven matchmaking platform allows for real-time collaboration, thereby ensuring that academic research meets the requirements of industry. Also, weak frameworks for IP protection inhibit commercialization, as researchers have few incentives to patent or commercialize inventions. A digital IP management system along the lines of the blockchain model in Kenya would be an improvement on research security and draw in industry investments.

Not only do institutional barriers limit KTT effectiveness, but policy fragmentation also poses blockades in KTT. Not having a National Knowledge Transfer Office (NKTO) eliminated significant efficiencies in funding allocations and weak monitoring in research outcomes (Yegros-Yegros & Tijssen, 2016). The establishment of an NKTO under the Ministry of Education or the Ministry of Trade and Industry could harmonize research commercialization, grant funding as well as research and policy implementation. It can also initiate industry-academic training programs that could integrate academic research with market application, strengthening innovation-driven entrepreneurship.

It proposes an AI-based policy framework for knowledge, transfer technology and KTT induction in Rwanda. In this study, a systematic collaboration of industry and academia was brought together with an AI research matchmaking mechanism, e-management of IP and better government incentives. When those strategies be implemented, they will assist Rwanda in accelerating research commercialization, promoting entrepreneurship, and strengthening its innovation ecosystem while conforming to the measures of best practice worldwide. If adopted, these recommendations could assist Rwanda in its transition to a knowledge-based economy, hence increasing its competitiveness on the global stage of innovation.

A proposed AI-driven knowledge and Technology transfer framework

This study addresses the challenges of knowledge and technology transfer on entrepreneurship and innovation by proposing an AI-driven system that enhances university-industry-government collaboration, facilitates efficient knowledge transfer, and accelerates economic transformation. Rwanda's Vision 2050 Rwanda envisages a utopian future where every Rwandan is guaranteed a high standard of living by the year 2050. To this effect, environment and climate change will be examined with consideration of primary areas like food security and quality nutritional issues, universal access to water and modern

sanitation, affordable, reliable, and clean energy, and climate-resilient and environmentally friendly modern settlements. ICT is renowned as playing a pivotal role in Rwanda metamorphosis to a knowledge-based economy, (Perez-Guzman et al., 2023) National Strategy for Transformation (NST1) emphasize the need for science, technology, and innovation as key drivers of economic development. The proposed AI-driven KTT model directly addresses these challenges that hinder knowledge and Technology Transfer by automating research-industry matching, optimizing funding allocation, and enhancing intellectual property (IP) management. The AI-driven Knowledge and Technology Transfer (KTT) model is particularly important for Rwanda due to its strategic vision for becoming a knowledge-based economy and a hub for science, technology, and innovation (STI) (Upstill & Symington, 2002). Rwanda has made significant progress in higher education and research, but the commercialization of academic research and its alignment with industry needs remain major challenges. This proposed model (see figure) is also relevant for other African universities.

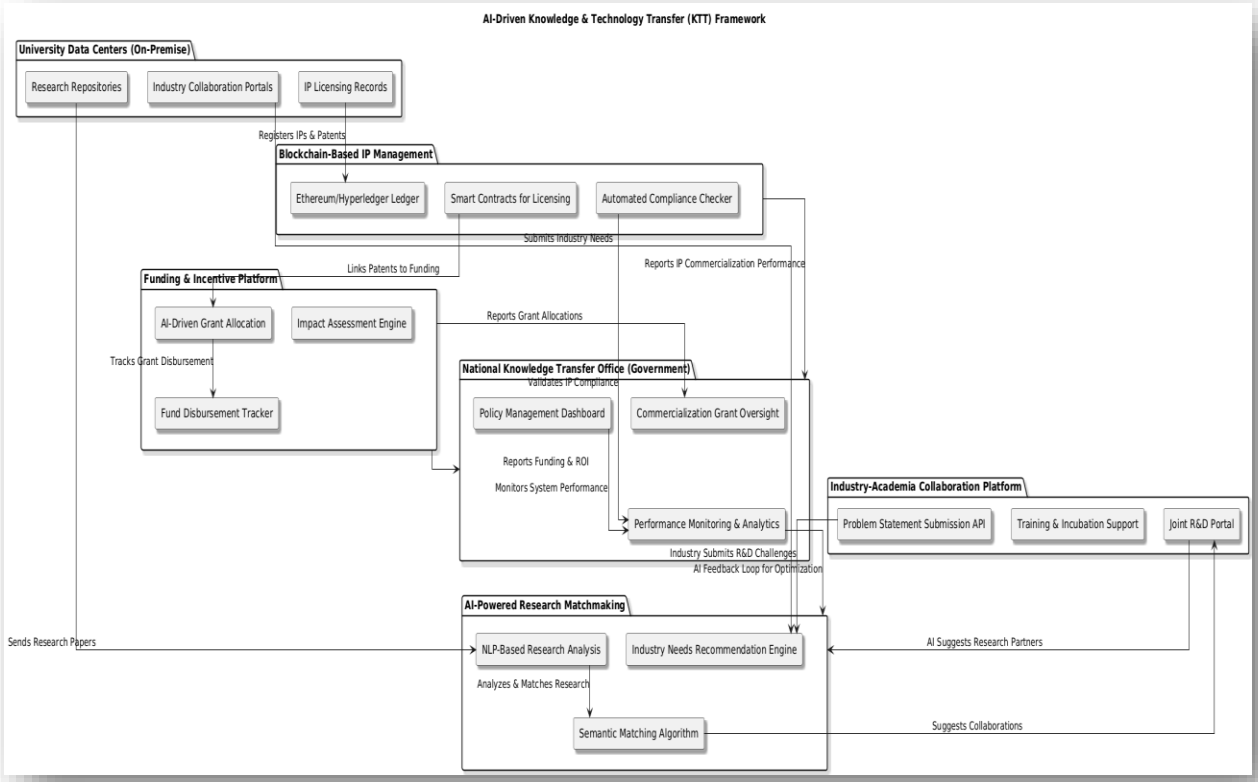

Figure 10: AI-driven framework for efficient knowledge and technology transfer processes to support entrepreneurship and innovation

Conclusions

This study examined the challenges of Knowledge and Technology Transfer (KTT) in Rwanda, focusing on the University of Rwanda. The findings indicate that Rwanda's KTT system remains largely linear, with limited industry engagement, weak institutional support, and fragmented policy implementation, hindering research commercialization and innovation.

Applying the Triple Helix Model and Technology Transfer Process Model, the study highlights the need for structured university-industry-government collaboration to enhance KTT effectiveness. Insights from Singapore, South Korea, and Kenya suggest that AI-powered research matchmaking, technology incubators, and stronger IP protection can improve knowledge transfer outcomes.

To address these gaps, the study proposes an AI-driven, policy-supported KTT framework, emphasizing structured industry partnerships, digital IP management, commercialization grants, and a National Knowledge Transfer Office (NKTO). By adopting these strategies, Rwanda can accelerate research commercialization, foster entrepreneurship, and drive innovation-led economic growth. Future research should explore AI and blockchain integration in KTT and assess scalable knowledge transfer models for developing economies.

Declaration

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Data availability statement

The raw data supporting this research will be made available by the authors, without undue reservation.

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Appendix

1. https://docs.google.com/forms/d/1gyVKAgOadE1LqgZobRrABRTgQscv8KHQRBlpaddRYB4/edit

2. https://docs.google.com/forms/d/1NF15K4Gr8hVSrXQKvH8IqAPxfgiTU7lzzHOe6WNU9d8/edit?fbzx=6985594893931545217