UNITED NATIONS ECONOMIC COMMISSION FOR AFRICA

ADVANCING TECHNOLOGY TRANSFER FOR SUSTAINABLE DEVELOPMENT | RWANDA

Survey Report

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Abbreviations

ACTFA	African Continental Free Trade Area
ADB	Asian Development Bank
AfDB	African Development Bank
BNR	National Bank of Rwanda
BPT	Business, Professional and Technical
GDP	Gross domestic product
GII	Global innovation index
GoR	Government of Rwanda
FDI	Foreign Direct Investment
FPC	Foreign Private Capital
HDI	Human Development Index
IIAG	(Mo) Ibrahim Index of Governance in Africa (IIAG)
ICT	Information and communication technology
ITU	International Telecommunication Union
IPR	Intellectual property rights
MINECOFIN	Ministry of Finance and economic Planning
NCST	National Council for Science and Technology
NIS	National Innovation System(s)
NISR	National Institute of Statistics of Rwanda
OECD	Organisation for Economic Co-operation and Development
PSTA4	Strategic Plan for Agriculture Transformation 4
R&D	Research and development
RAB	Rwanda Agriculture and Animal Resources Development Board
RBC	Rwanda Biomedical Center
RBC-RIDS	Rwanda Biomedical Center - Research Innovation and Data Science Division
SME	Small and Medium-sized Enterprises
SSA	Sub-Saharan Africa
STI	Science, technology and innovation
TT	Technology Transfer (or Transfer of Technology)
UNCTAD	United Nations Conference on Trade and Development
WB	World Bank
WDA	Workforce Development Agency
WIPO	World Intellectual Property Organization
WEF	World Economic Forum

EXECUTIVE SUMMARY

This report presents results from the survey on Rwandan Firms and Research and Technology Organizations (RTOs). The survey was conducted as part of a regional study by the United Nations Economic Commission for Africa (UNECA) on "Advancing Technology Transfer for Sustainable Development" in Africa.

The purpose

The study aims to showcase technology transfer existence, methods and patterns in Rwanda viewed through the context of private firms and RTOs. It provides a narrative developed from the preliminary assessment of various TT practices, as well as institutional and environment settings which are further intended to be used to establish context, distinctions, and relations with the broader (regional) baseline information collected from across the continent.

Methodology

This study sample included 12 senior level participants from the 6 RTOs and 6 firms (including both public and private) that were selected from the areas of Agriculture, Health and Fintech making up 3 priority tech innovation areas identified in relation to Rwanda's Proof of Concept Hub Strategy.

For consistency purposes, the survey adopted the unified questionnaire used across the participating survey countries to collect data. The baseline information presented is the outcome of the analysis of the eight (8) themes around technology transfer: Staff and Budget; Strategy and Management; Technology Acquisition Practices and Sources; Intellectual Property (IP) Ownership, Protection and Commercialization; Regional and International Collaboration; Past Experience and Projected Expectations; Government Incentives; and Motivation and Challenges of TT.

While the quantitative analysis produced useful information, the exploratory nature of the study necessitated further understanding of the survey themes. As such, interviews were conducted at two firms with the intention of extracting extensive information on the TT themes. The two case subjects are among the renowned flagship high-tech companies that reflect Rwanda's ambition to advance its industrial base through technology transfer. They were especially selected to generate ideas and opinions that further contextualize TT in Rwanda whilst also adding different perspectives to the study.

Key Findings and Messages

Analysis of the survey questions provided insight into the TT practices in Rwanda.

The Rwandan innovation system is steadily improving in many aspects including policy environment, infrastructure, information and communication technology (ICT) adoption, human capital development, as well as the overall institutional support and funding systems. However, despite the efforts to improve the innovation ecosystem performance some key elements like technology absorption capacity and transfer still remains weak.

While the surveyed RTOs and firms expressed interest in the broad concept of innovation, there is limited structure, understanding, and interest in the aspect of technology transfer. There is notable evidence in increased knowledge and skills transfer through community outreach, which can serve as a basis for increased partnership and collaboration.

Collaboration between private sector firms and RTOs is very scarce which affects the overall TT prospects. The firms rely heavily on technology acquired from abroad. And although funding for R&D is increasing (mainly through the government), funding for TT activities remains very limited with minimal participation of the private sector.

Although some incentives exist that are geared towards technology acquisition, they are mainly in some specific areas while others are lacking. Furthermore, firms and RTOs are unaware of their existence, and even when they are aware, the process involved may be very tedious and time consuming which affects overall interest.

There are no dedicated Technology Transfer Offices (TTOs). TTOs can play a critical role in championing TT and developing commercial and technical skills.

Establishing information or data on technology transfer is challenging. As such, there are minimal documented success stories showcasing best practices in TT. Admittedly there are a few, like Zipline and Irembo that are good case studies that can provide learning lessons in TT.

The study observed that key aspects of TT like Intellectual property (IP), commercialization, and spin-outs, remain mysterious to the broader audience (including firms, RTOs, and policymakers).

Many renowned countries celebrated for their technology advancement, have benefited from the concept of 'technology reverse engineering' which is widely attributed to fairylike economic transformation or leapfrogging or technology-catchup. Rwanda and the African region need to redesign its technology interests to take advantage of international tech advancements but also utilize existing channels like "Made-in-Rwanda" on the local scene and "African Continental Free Trade Area (ACTFA)" on the continental level to boost TT. There is need to redesign and integrate such potentially transformative initiatives into the public procurement processes.

It is hoped that the information presented in this report provides a general perspective on the functioning of TT in Rwanda, and will be useful not only in informing ongoing innovation discussions, but also in shaping local and regional interventions to boost technology transfer.

1. INTRODUCTION

The United Nations Economic Commission for Africa (ECA) is conducting a study on "Advancing Technology Transfer for Sustainable Development" across eight African countries: Rwanda, Egypt, Ethiopia, Ghana, Kenya, Senegal, South Africa and Zambia. The study was initiated as result of the need to benchmark elements that influence performance of technology transfer across the region.

By learning from practices across the surveyed countries, the study primarily seeks to establish the preferred modes and channels of technology acquisition by African firms and RTOs, the impact of TT, and the effectiveness of government support measures that institutions found to be helpful or encouraged TT both from abroad and within the country.

This report focuses on Rwanda. It begins by providing a brief description of the policy environment and institutional settings that influence TT in Rwanda. This is used to contextualize the approach taken to conduct the survey.

The survey process, presented in section 3, focused on identifying suitable institutions selected from both the public and private sector with the objective of providing all-encompassing perspectives on TT in Rwanda. Importantly, the survey takes a duo perspective of RTOs and firms. This approach is suitable for generating both contrasting and overlapping viewpoints that complement and fulfill the Study objectives in advancing TT advancement.

Section 4 of this report presents the findings of the survey of six RTOs and six Firms. The findings are in presented in a logical format following the key thematic areas established in accordance with the objectives of the Study. The sections also includes information gathered from the interviews conducted with two case subjects to establish extended insight into the thematic areas.

The report concludes with a summary of key take away points and actionable recommendations aimed at enriching ongoing discussions on how to advance technology transfer in Rwanda, and map the lessons learnt to the wider African context.

2. BACKGROUND

2.1. Overview

Rwanda's vision is to become an upper middle-income economy by 2035, and a high-income country by 2050.[1] To achieve these growth ambitions, the Rwandan Government has laid out a list of economic and social goals under the National Strategy for Transformation (NST1).

The NST1 sets the tone for promoting technology transfer as an integral component in Rwanda's quest for industrialization and achieving sustained economic growth. It observes that TT is essential not only in producing basic household goods and low tech products, but also in manufacturing high value goods for export (priority 4).

The need to promote technology transfer is inherently reflected in a number of policy instruments. The National Industrial Policy (2011) stresses the need for increased investment and technology upgrade for Rwandan firms. The Policy observes that Rwanda can solve many problems by adapting and using off-the-shelf technology.

The Made-in-Rwanda Policy (2017) seeks to promote industrialization and attain a structural shift in the export base to high-value goods with the aim of growing exports by 17% annually. The Policy identifies access to modern technology as a major factor in managing the cost of production and ensuring competitiveness of the industrial base.

Central to Rwanda's industrialization drive are the Special Economic Zones (SEZs). The SEZs are the government's strategic initiative to unlock the industrial performance and potential towards export promotion and position Rwanda as a commercial and logistics hub. Currently, the Kigali Special Economic Zone (KSEZ) is the largest SEZ with the highest concentration of both light and heavy manufacturing industries in Rwanda.

The KSEZ hosts over 100 companies including several of the country's high profile industries that specialise in areas like agro-food processing, manufacturing, construction, textile, and pharmaceutical. Furthermore, the KSEZ hosts the Kigali Innovation City (KIC) which is a flagship national program aimed at creating an ecosystem centered on high-tech, innovation and talent development to accelerate Rwanda's transition to a knowledge-based economy.

[1] "Vision 2050" - Ministry of Finance and Economic Planning (MINECOFIN), 2020.

The KIC is strategically positioned in the KSEZ to provide proximity to the industries. The KIC is designed to provide an environment that facilitates acquisition and transfer of skills, knowledge and technology mainly through human capital development, innovation-friendly financing, and technology companies. In line with the orientation to foster industry academia-collaboration, the KIC is home to a number of world-class learning and research institutions like Carnegie Mellon University Africa (CMUA), the African Leadership University (ALU), the Regional Center of Excellence in Biomedical Engineering (CEBE), and the African Institute of Mathematical Sciences (AIMS).

The KIC initiative also forms part of the broader ICT Hub Strategy (2019)[2] that seeks to position Rwanda as a leading regional hub and test bed for technology innovation. According to the Strategy, ICT is instrumental in propelling digital transformation and fostering ICT-driven innovation across seven key sectors: Governance, Agriculture, Education, Health, Finance, Gender and Youth mainstreaming, and Trade and Industry.[3] The Strategy builds on well documented success stories like the Zipline (drone delivery company) and the Mara Phone (Smartphone manufacturing company) that have emboldened the government to pursue a "Proof of Concept (PoC) Hub" strategy. The Strategy is envisioned to attract innovators and technology developers from Africa and the world, and the innovators will be supported to test their technology ideas, concepts or invention, and expand their innovation into other regions and markets.

Even with the multifaceted government interventions and enabling business and industrial environment, Rwanda imports a large share of its technologies from other parts of the world which increases opportunities for TT within its borders. A recent national STI[4] survey (2021) shows that 33% of the surveyed institutions reported to have imported new machinery or equipment. It also shows that 84.8% of the institutions made commitment on investing a portion of their capital in technologies. The report further shows that 38.1% invested up to 5%; 12% invested between 5% and 10%; 7.8% invested between 50% and 75%; and 2.2% invested above 75%. The report also shows low firm level capacity for innovation (25%), low level of technology adoption (11.1%), and moderate level of technology

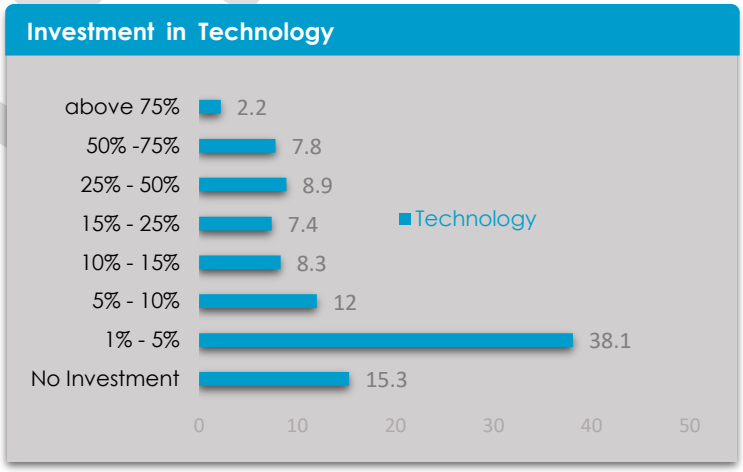

Figure 1. Technology Investment (STI Survey - NCST, 2021)

[2] "ICT Hub Strategy 2024" - Ministry of ICT and Innovation (MINICT), Rwanda, 2019.

[3] "Rwanda ICT Sector Profile", MINICT, Rwanda, 2019.

[4] "Nattional Science, Technology and Innovation (STI) Survey" – National Council for Science and Technology (NCST), 2021

impact (43.6%) of the surveyed institutions. In terms of human resources, the report shows that 30.9% of the full-time employees have university degree, of which 11.26% of full-time employees have a diploma.

Besides the firms in Rwanda are increasingly convinced to acquire technology, a recent Research and Experimental Development (R&D) survey[5] also indicates that research funding, capacity and performance is increasing. Despite the growth patterns, the survey also highlights some gaps and challenges including: low levels of R&D outputs especially in terms of intellectual property (IP), along with limited private sector participation in R&D. The latter affects the potential to develop relevant and appropriate technological solutions, and inevitably limits opportunities for technology transfer.

The government has been attempting to address the gaps in R&D funding. In 2016, it established the National Research and Innovation Fund (NRIF) through which the public funding for research and innovation is channeled. The NRIF offers various grants including providing support for joint R&D between firms and research institutions. And besides NRIF, the government also introduced the Rwanda Innovation Fund that is dedicated to boosting innovation and technology start-ups in funding for new and emerging technologies such as Fintech, Drones, Blockchain, Artificial intelligence (AI), and Robotics. The two funding channels compliment other existing government backed funding like the Business Development Fund (BDF), and the Rwanda Green Fund (FONERWA) which support technology acquisition and transfer.

2.2. Objectives of the Study

The Survey's objective is to provide a basis for benchmarking TT practices in Rwanda, and generate insight into patterns in management, practices, exploitation, and general performance of TT observed through the RTOs and firms.

The specific objectives of the study were to:

- Assess the adequacy of current policy settings and practices that facilitate TT in Rwanda.
- Conduct a survey of firms and RTOs to provide baseline information on the functioning of TT.
- Identify and highlight progress and success stories in TT in Rwanda.
- Derive actionable recommendations to boost TT in Rwanda.

[5] "National R&D Survey 2021" – National Council for Science and Technology (NCST), 2021

3. SURVEY METHODOLOGY

This section provides a description of methods used in identifying relevant information, and gaining insight into the performance technology transfer in Rwanda. It introduces the major elements underpinning the assignment including: desk review, stakeholder engagements, survey design, data collection tools, and administrative considerations.

3.1. Survey Entities

In providing orientation for this study, care was taken to ensure that the methodology and identified case studies are closely aligned to the national development agenda.

Based on the narrative introduced in the previous sections, this Study was structured to align with the current Proof of Concept (PoC) Hub strategy which identifies three (3) focus sectors (Agriculture, Health and Financial Services) under which nine (9) priority technology innovation domains were selected based on Rwanda's competitive advantages, overall potential, and the need to attain the envisaged transformational prospects outlined in Rwanda's Vision 2050.

In accordance to the Terms of Reference, the target audience for the survey was based on two groups: Firms and RTOs. Although the total population of firms and RTO's can be readily established, the exploratory nature of the Survey renders it impractical to collect data from the entire population considering the challenge of time, accessibility, availability, and budget constraints.

The sample size consisted of 12 senior officials each representing an individual firm or RTO. Care was taken to include both private and public sector organisations. The surveyed entities include 4 higher education institutions, 2 public sector research establishments and 6 private firms. The selected entities were carefully chosen to include public and private entities to provide perspectives from multiple angles within the topic of technology transfer in a Rwandan context.

The study also includes interviews conducted at two flagship high-tech companies (herein referred to as Case A and Case B) that reflect Rwanda's ambition to advance its industrial base through technology transfer. The information gathered from the two case studies were especially selected to generate ideas and opinions that further contextualize TT in Rwanda whilst also adding different perspectives to the study.

3.2. Study Design

Given the nature of the study, both qualitative and quantitative methods were adopted to establish baseline information on TT practices, which in turn would be used to develop appropriate recommendations towards improving TT in Rwanda.

3.3. Data Collection Methods and Tools

A combination of methods was used to obtain the required information including; desk-based review, consultative meetings, internet search of existing resource documents and secondary data. The data collection process also involved a survey and two case studies.

3.3.1. Desk Review

Review of documents started at the inception stage (and continued throughout the assignment of the consultancy services) to enable the consultant enrich their understanding of the assignment as well as the academia, political and socio-economic context of technology transfer in Rwanda. However, the search of literature produced very limited published reports specifically on technology transfer in Rwanda. Most of the technology transfer information can be indirectly interpreted from institutional reports, policies and strategic documents.

3.3.2. Data Collection Tools

Data collection tools were established to guide the data collection process. These tools include:

a) Questionnaire

This being a perception-based study, the use of questionnaires was considered to be appropriate for undertaking the assignment. To facilitate uniformity of the questionnaires across the surveyed countries, the client provided two sets of questionnaires that were each used to collect detailed information form the firms and RTOs, respectively. The questionnaire structure comprised of twelve sections:

Questionnaire Sections

RTOs	FIRMs
1. Details of the Respondent and Institution	1. Details of the Respondent and Institution
2. R&D Personnel	2. Firm Personnel, Subsidiaries & Export Status
3. R&D Funding	3. R&D Budget
4. TT Strategy and Management	4. TT Strategy and Management
5. Technology Collaborative Partnership	5. Technology Collaborative Partnership
6. Technology Licensing and IP Ownership	6. Technology Licensing and IP Ownership
7. BPT Services	7. BPT Services
8. Capital Goods	8. Capital Goods
9. Use of Open-Source Technologies	9. Use of Open-Source Technologies
10. Geographical Spread of TT Partners	10. Geographical Spread of TT Partners
11. Comparison of TT performance (past/projected)	11. Comparison of TT performance
12. Incentives, Motivation & Challenges	12. Incentives, Motivation & Challenges

Figure 2. Sections of the RTO and Firm Questionnaires

Both questionnaires were designed to capture the entity's technology transfer related activities in terms of strategy, management, partnership, licensing, support services, use of open source technologies, past performance (3 years) and projections (3 years), access to government incentives, and finally looks at the motivation, challenges and comparison with peers, with some distinctions as observed in the figure 2 above.

b) Case Study

Additional information was collected through interactive face-to-face interviews with two senior management officials at the two selected firms. The interviews provided more detailed opinions about TT aspects. The process used a semi-structured interview process that deepened the discussions of institutional perspectives in relation to technology transfer.

3.4. Response Rate & Administrative Considerations

The survey targeted 12 institutions including 6 RTOs and 6 private firms, and all responded. However, it is notable that TT is still not well formalized. This can be attributed to the limited response patterns. In some case the respondents we were unable to report on some data due to scarcity (or it was unavailable), and in some cases respondents were not at liberty to disclose specific information including financial expenditure or budget related details. As such, some results could not be interpreted in a meaningful manner as mentioned in the next section. Therefore, an extended investigation was needed to deepen understanding of the survey thematic areas. This was achieved through semi-structured interviews at two identified case studies. The case studies helped to reveal additional aspects that affect technology transfer especially in the private firms.

4. SURVEY FINDINGS

This section presents the key findings from the survey on technology transfer (TT) in selected RTOs and firms in Rwanda. The findings are presented in a logical format according to the key thematic areas assessed to address the objectives of the assessment.

5.1. Details of Respondent Institutions

The respondent institutions include Universities, Public R&D Institutions, and private firms. The figure 3 shows each respondent institution's year of establishment and area of focus.

Basic Information of Respondent Institutions

Institution	Year	Ownership	Main Business and Tech Area
Firm-A	2017	Private (International)	Fintech company focusing on data based lending
Firm-B	2015	Private (Local)	Technology company specializing in delivering mobility solutions
Firm-C	2015	Public-Private	Builds and operates the government digital service portal
Firm-D	2014	Private (International)	Drone Logisitics, Warehousing and Fulfilment, Supply Chain optimization
Firm-E	2019	Private (Local)	Agribusiness, Postharvest Processing Technology
Firm-F	2006	Private (International)	Agribusiness and Rice milling , packaging, and seed development
RTO-A	2010	Public	Agricultural Research
RTO-B	2020	Public	Health Research Innovation and Data Science
RTO-C	2012	Public (International)	Public Health
RTO-D	2013	Public	Technology Innovation and Entrepreneurship incubation
RTO-E	2017	Public	Biodiversity science, Biodiversity Informatics, Climate Adaptation, Climate Smart Agriculture
RTO-F	2013	Public	Agriculture, Forestry, Nature Conservation, Animal Sciences, Veterinary Medicine

Figure 3. Respondent Institutions

Of the 6 surveyed RTOs, three are in the Kigali City, with one (each) in the Northern, Southern, and Eastern provinces respectively. Of the RTOs, only 1 is private (RTO-C) and a branch of a university in another country, the others are public institutions with three being branches of a parent institution in Rwanda, and the others are fully independent government agencies (RTO-A and RTO-B). Of the 6 firms, 3 of them (Firm-A, Firm-D and Firm-F) are internationally owned, 2 (Firm-B and Firm-E) are locally owned, and 1 (Firm-C) is a public-private ownership.

5.2. TT Staff and Budget

The sections 2 (staff) and 3 (R&D budget) aimed to identify the number of staff, the level of qualification of the staff as well as the budget available to undertake R&D in general and TT activities in particular.

Firms: The six surveyed firms have a total of 643 staff. Four have operations in other countries with some having multiple subsidiaries, and only one firm (Firm-E) exports abroad. In terms of R&D performance, 4 firms collectively had a research budget of $500,000, and only 1 firm has a dedicated team for handling TT issues. However, none of the firms is listed on the stock market. Notably also, although some firms provided information on Ownership, Occupational category, Gender Groups, and Education Qualification, the aggregated data could not be compiled to derive a coherent statistic.

RTOs: The 6 RTOs reported a total of 1741 personnel of which 15% are R&D staff. Three institutions provided information on the total R&D budget allocation over $1.5m with over 80% being from RTO-A. It also has the highest number of R&D staff with 190 (72%), with the rest being from RTO-F (48), RTO-B (15) and RTO-D (12). Two RTOs (RTO-C and RTO-E) do not have R&D Staff.

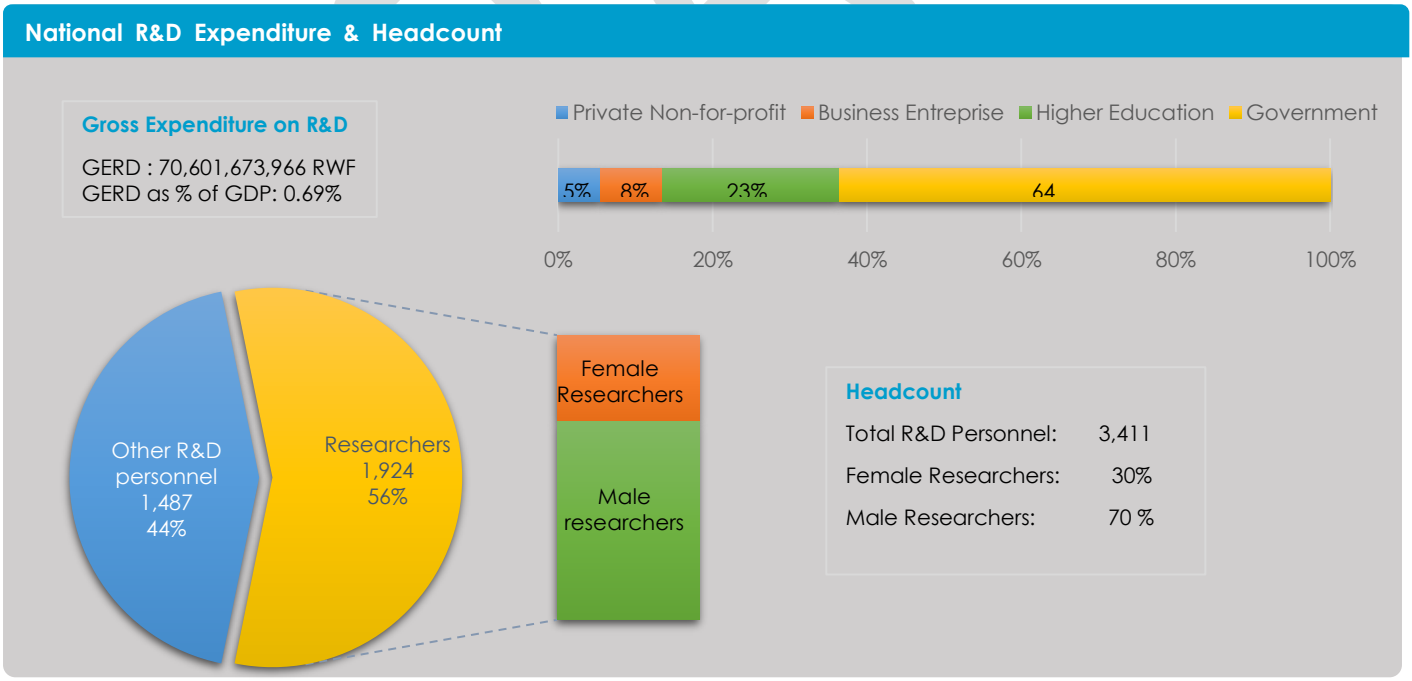

Figure 4. Indicators of R&D Expenditure and Headcount (National R&D Survey 2021)

As with the National R&D survey, the government is the main source of funding for R&D activities. Three of the surveyed RTO's generally received the highest portion of their R&D funding from government (up to 40%) and donors - funding from abroad (up to 40%), and own funds (up to 20%). Only RTO-F received some funding from industry.

In terms of R&D personnel, due to the scarcity of responses it was not possible to report quantitatively on both the gender ratios and education qualifications of the R&D personnel. It is notable however that the ratio of male to female is consistent with the national R&D gender ratios with approx. 70% being male and 30% being female. The education qualifications vary – the majority have Bachelors or Masters or PhDs degrees'.

5.3. TT Strategy and Management

This section provides results on existence of a framework and/or an established TT function both within the firms and the RTOs.

Summary of TT Settings in Firms

Survey Element	Firm-A	Firm-B	Firm-C	Firm-D	Firm-E	Firm-F
Has formalized TT guidelines	×	Yes	×	Yes	×	×
Has a dedicated team / unit for handling TT issues	×	×	×	Yes	×	×
Number of full-time employees in the team / unit	×	×	×	NA	×	×
Total budget for TT activities (US$)	×	×	×	NA	×	×
Has an M&E system in place for TT activities	×	×	×	×	×	×
TT outputs are considered for performance appraisal	×	Yes	×	Yes	×	×
Regularly conduct satisfaction survey on TT partners	×	Yes	×	NA	×	×
Allocates a budget to develop tech partnerships	×	Yes	Yes	Yes	×	×
Amount (USD) Allocated (for tech partnerships)	×	50,000	100,000	NA	×	×
Have tech development & acquisition partnerships	×	Yes	×	NA	Yes	×

Figure 5. Summary of TT settings in the surveyed Firms

Of the six firms, two have formalized TT guidelines covering areas intra-firm TT, inward and outward TT and commercialization, and both firms include TT outputs as a performance appraisal criterion of R&D staff of the firm, although it is only one firm that has a dedicated team handling TT activities, and only one firm regularly conducts satisfaction survey on TT partners. Three firms allocate a budget to developing technology partnerships, although none indicated the overall amount (budget) for TT activities.

Although one of the firms indicated existence of a dedicated team handling TT activities, it neither provided information on the number of staff nor the amount it dedicated budget for TT activities. Furthermore, none of the firms have a TT monitoring and evaluation (M&E) system.

Of the six RTOs, only two have a formalised TT strategy. The strategy is established in the Strategic Plan and the Innovation and Intellectual Property Policy of the two institutions, respectively. Four RTOs have a dedicated team for handling TT issues.

Summary of TT Settings in RTOs

Survey Element	RTO-A	RTO-B	MKUR	UR-CIE	UR-CoEB	UR-CAVM
Has formalized TT guidelines	Yes	×	Yes	Yes	×	Yes
Has a dedicated team / unit for handling TT issues	Yes	×	Yes	Yes	×	Yes
Number of full-time employees in the team / unit	110	×	2	2	×	1
Total budget for TT activities (US$)	3,000,000	×	×	10,000	×	20,000
Has an M&E system in place for TT activities	Yes	×	×	Yes	Yes	×
TT outputs are considered for performance appraisal	Yes	Yes	×	Yes	Yes	Yes
Regularly conduct satisfaction survey on TT partners	Yes	×	×	×	×	×
Allocates a budget to develop tech partnerships	×	×	×	Yes	×	×
Amount (USD) Allocated (for tech partnerships)	×	×	×	5,000	×	×
Have tech development & acquisition partnerships	Yes	Yes	Yes	Yes	Yes	x

Figure 6. Summary of TT settings in the surveyed RTOs

5.4. Technology Acquisition Practices and Sources

Of the surveyed firms, the majority acquire technology through cooperation with foreign experts or consultants, while three of the firms acquired technology through licence agreement and two firms acquired technology through technical assistance, two through import of equipment or machinery or software, and one each through purchasing a patent or trademark, and joint venturing. None of the firms has had a spin-out businesses as a result of TT development and acquisition. Also, two firms acquired technology licences (licenced-in) in 2020 that are in use presently, of which two new products (attributed to the licence) were developed. The licences were acquired mainly from 'External firms in other countries', while notably no technology was acquired from either the public sector enterprises or higher education institutions or through intra-firm licencing, both within and outside the country, respectively.

The figure below shows the mechanisms through which the firms acquired technology.

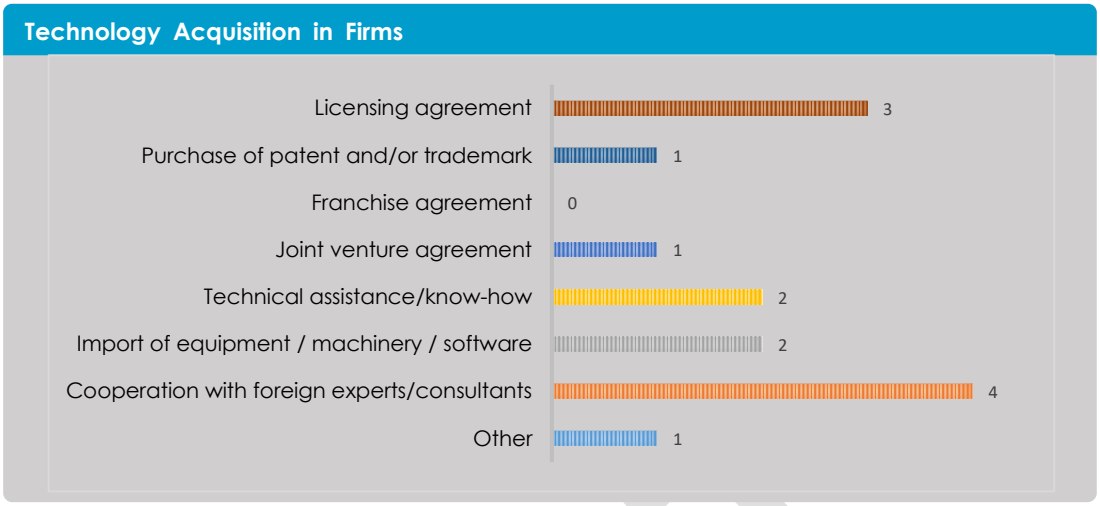

Figure 7. Mechanisms used to acquire technology

No information was provided in relation to the percentage of sales of the new products to total sales in 2020; new production or operation processes introduced in 2020 that are attributed to the licenses acquired; percentage of cost saving with these new processes; and percentage of productivity increase with these new processes.

None of the RTOs provided information in relation to mechanisms of acquiring technologies. However, five institutions provided information regarding partnerships with the private sector, public sector, higher education institutions, and other research institutions as presented in the table below.

Partnerships

with ...	RTO-A	RTO-B	RTO-C	RTO-D	RTO-E	RTO-F
private sector enterprises in the country	3	>5	2	4	1	-
private sector enterprises in other countries	0	>5	3	4	0	-
public sector enterprises in the country	0	3	>5	4	2	-
public sector enterprises in other countries	0	2	5	4	1	-
higher education institutions in the country	0	4	3	4	1	-
higher education institutions in other countries	0	4	3	5	2	-
other research institutions (excl. HEIs) in the country	0	3	3	3	1	-
other research institutions (excl. HEIs) in other countries	0	4	4	4	1	-

Figure 8. Partnerships with private, public and higher education institutions - local & abroad

5.5. IP Ownership, Protection and Commercialization

This section of the survey focused on establishing the forms of Intellectual Property (IP) that were sought (as applied for), acquired and commercialized thereafter by the firms and RTOs.

None of the surveyed firms applied for or acquired a patent, or trademark, as of 2020, and none of the firms expressed that it had granted technology (licenced-out) to other entities in 2020. As such, no licences were issued to external firms, public institutions and higher education institutions both in the country and abroad, and therefore no income was attributed to technology licencing.

In terms of Business, Professional and Technical (BPT) Services; two firms registered payments to BPTS providers that amounted to approximately USD 238,000 with 80% of the amount being paid to external firm in other countries. No payments were made to public or higher education institutions both in and out of the country. Only one firm registered income from BPT services provided to another firm which generated approximately USD 40,000. And since not BPT services were provided to public and higher education institutions, therefore no income was generated from both categories.

Of the 6 RTOs, only one had a spin-off. None of the RTOs (in 2020) acquired a technology license (licence-in) that is actively in use. Likewise, none of the RTOs issued a licence (licence-out) to the Public Sector, Private Sector, or Higher Education Institution, be it in the country or abroad. Accordingly, there was no expenditure or income associated to technology licence acquisition or issuance in 2020 at all the surveyed RTOs. Furthermore, none of the RTO's applied for a patent, and equally none was granted. Notably also, statistics on national IP assets including patents and copyrights could not be established from the national R&D survey (2021). In terms of BPT services, only one institution acquired BPT services from a private sector enterprise in Rwanda, and as well issued services to public sector, private sector and higher education institutions.

Two of the RTOs provided information regarding current expenditure (to acquire) capital goods estimated at USD 3,530,000 including (USD 1,530,000 sourced locally and US$ 2,000,000 sourced from abroad). RTO-A expects to make sales of capital goods both locally (US$ 1,800,000) and abroad (US$ 200,000). However, two RTOs expect an increase in purchase capital goods in the following three years. And none of the RTOs provided information on the budget forecast for the sales of capital goods in the next 3 years.

5.6. Regional and International Collaboration

This section provides details expressed by the firms and RTOs in terms of the proportion of inward and outward TT activities grouped by continent.

FIRMs: Proportion of Inward TT activity partners by Continent

Firm	Africa	Middle East	Europe	Asia	North America	South America	Oceania
Firm-A	0%	0%	0%	0%	20%	0%	0%
Firm-B	40%	0%	0%	0%	60%	0%	0%
Firm-C	0%	0%	0%	100%	0%	0%	0%
Firm-D	-	-	-	-	-	-	-
Firm-E	10%	0%	0%	80%	0%	10%	0%
Firm-F	0%	20%	0%	60%	0%	0%	20%

Table 1. Proportion of Inward TT activities by Firms categorized by Continent (past 3 years)

Table 1 shows that the firms' inward TT activities were with partners from all continents excluding Europe. In terms of outwards TT, only two firms had activities with partners from Africa and North America. One firm provided no information in terms of inwards and outwards TT.

RTOs: Proportion of Inward TT activity partners by Continent

Firm	Africa	Middle East	Europe	Asia	North America	South America	Oceania
RTO-A	40%	10%	10%	20%	20%	0%	0%
RTO-B	-	-	-	-	-	-	-
RTO-C	-	-	-	-	-	-	-
RTO-D	20%	0%	0%	0%	0%	0%	0%
RTO-E	20%	0%	0%	0%	0%	0%	0%
RTO-F	20%	-	20%	-	20%	-	-

Table 2. Proportion of Inward TT activities of RTOs categorized by Continent (past 3 years)

Table 1 shows that inward TT activities of RTOs was mostly with partners in Africa. None had any such activities with partners in South America and Oceania. In terms of outwards TT, only one had activities with partners from all continents excluding Oceania. Two RTOs did not provide information both in terms of inwards and outwards TT.

5.7. Past Experience and Projected Expectations

Table 3 below shows the change in performance of TT activities observed over a period of three (3) years. Firm-B observed that technology provision activities had significantly increased (by over 50%), while its TT activities with own subsidiaries had increased (up to 50%). Likewise, Firm-C observed significant increase in use of open-source technologies, while Firm-F registered an increase in technology acquisition. Firm-A registered no change throughout. None of the firms expressed that TT decreased or significantly decreased over the past three years.

Scale: Significantly Increased (over 50%)
Increased (up to 50%)
No Change (0%)
Decreased (up to - 50%)
Significantly Decreased (Over - 50%)

Firms: Change in TT Activities (past 3 years)

	Firm-A	Firm-B	Firm-C	Firm-F
… technology acquisition activities have	No Change	No Change	No Change	Increased
… technology provision activities have	No Change	Significantly Increased	No Change	No Change
…TT activities with other firms have	No Change	No Change	No Change	No Change
…TT activities with public sector enterprises have	No Change	No Change	No Change	No Change
…TT activities with own subsidiaries have	No Change	Increased	No Change	No Change
…TT activities with universities have	No Change	No Change	No Change	No Change
…use of open-source technologies has	No Change	No Change	Significantly Increased	No Change

Table 3. Change in performance of TT Activities in Firms over last three years

Table 4 below shows the change in TT performance of RTOs over the past three years.

RTOs: Change in TT Activities (past 3 years)

	RTO-A	RTO-D	RTO-E	RTO-F
… technology acquisition activities have	Increased	No Change	No Change	Increased
… technology provision activities have	No Change	No Change	No Change	Increased
…TT activities with private sector enterprises have	Increased	No Change	No Change	Increased
…TT activities with public sector enterprises have	No Change	No Change	No Change	No Change
…TT activities with other research institutions (excl. HEIs) have	No Change	No Change	No Change	Increased
…TT activities with HEIs have	No Change	No Change	No Change	Increased
…intra-institution TT activities have	No Change	No Change	No Change	Increased
…use of open-source technologies has	No Change	No Change	No Change	No Change

Table 4. Grading the change in performance of TT Activities in RTOs over last three years

Table 5 below shows the projected change in performance of TT activities in the Firms for the next three (3) years. AC Group and PesaChoice both project some degree of change in various TT activities, while ICM projects some change in technology acquisition. Irembo projects no change.

Firms: Change in TT Activities (Next 3 years)

	Firm-A	Firm-B	Firm-C	Firm-E
...technology acquisition activities will have	No Change	Significantly Increased	No Change	Increased
...technology provision activities will have	Increased	Significantly Increased	No Change	No Change
...TT activities with other firms will have	Increased	Increased	No Change	No Change
...TT activities with public sector enterprises will have	Increased	Significantly Increased	No Change	No Change
...TT activities with own subsidiaries will have	Increased	Significantly Increased	No Change	No Change
...TT activities with universities will have	No Change	Significantly Increased	No Change	No Change
...intra-firm TT activities will have	Increased	Significantly Increased	No Change	No Change
...use of open-source technologies will have	Increased	Significantly Increased	No Change	No Change

Table 5. Forecasted TT Activities in Firms for the next three years

Table 6 below shows the projected change in performance of TT activities in the RTOs for the next three (3) years. Both RBC and CAVM project wide-ranging changes across the various TT activities, while RAB projects some changes in technology acquisition and provision. CoEB, CIE and MKUR do not forecast any change.

RTOs: Forecasted Change in TT Activities (next 3 years)

	RTO-A	RTO-B	RTO-F
...technology acquisition activities will have	Increased	Significantly Increased	Increased
...technology provision activities will have	Increased	Significantly Increased	Increased
...TT activities with private sector enterprises will have	No Change	Increased	Increased
...TT activities with public sector enterprises will have	No Change	Increased	Increased
...TT activities with other research institutions (excl. HEIs) will have	No Change	Increased	Increased
...TT activities with HEIs will have	No Change	Significantly Increased	Increased
...intra-institution TT activities will have	No Change	Increased	Increased
...use of open-source technologies will have	No Change	No Change	No Change

Table 6. Forecasted TT Activities in RTOs for the next three years

This section of the questionnaire also required for firms and RTOs to express their past and projected performance in acquiring and deploying 'Online sales and digital services' and 'Renewable energy technologies'. The results are presented in the table below.

Scale: 0 - Not at All 1 – Limited 2 – Some 3 - Large 4 - Significant

Firms: Use of Online Sales & Digital Services and Renewable Energy

	Online Sales and Digital services		Renewable Energy Technologies	
Name	**Past 3 years**	**Next 3 years**	**Past 3 years**	**Next 3 years**
Firm-A	Not at All	Some	Not at All	Not at All
Firm-B	Large	Significant	Not at All	Some
Firm-C	Significant	Large	Not at All	-
Firm-E	Large	Not at All	Some	Not at All
Firm-F	Some	Some	Not at All	Limited

Table 8. Firms use of Online Sales and Digital Services and Renewable Energy

RTOs: Use of Online Sales & Digital Services and Renewable Energy

	Online Sales and Digital services		Renewable Energy Technologies	
Name	**Past 3 years**	**Next 3 years**	**Past 3 years**	**Next 3 years**
RTO-A	Limited	Some	Limited	Some
RTO-B	-	-	Limited	Not at All
RTO-C	-	-	-	-
RTO-D	Limited	Limited	Limited	Limited
RTO-E	Not at All	Not at All	Large	Large
RTO-F	Not at All	Not at All	Limited	Limited

Table 7. Firms use of Online Sales and Digital Services and Renewable Energy

5.8. Access of Government Incentives

This section presents the findings of firm and RTO perception of existing incentives put in place to foster technology transfer in Rwanda.

Of the six firms, 4 were not aware of any incentives, and only one was aware of existing government incentives to boost acquisition of technology. The firm has previously applied-for and received tax reduction, and exemption of import duties when acquiring agribusiness machinery. None of the surveyed firms have received Cash grants, Subsidies for investment in resources and assets, and Cost-sharing schemes as a form of government incentive.

Of the six RTOs, 3 were not aware of any incentives, two were aware of existing government incentives, and one conducted searches but register that there is no government incentive. In the past 3 years, only one expressed that they have previously applied-for tax reduction acquired technology licenses, exemption of import duties when acquiring agribusiness machinery, cost-sharing schemes, and subsidies for investment in resources and assets. One RTO received cash grants from the government during that period.

5.9. Motivation and Challenges

Under this section, respondents were requested to select the top five (5) motivations for TT. The figures 9 and 10 below shows the results of TT motivation for Firms and RTOs. From the Firms' chart, 'Earning revenue from the institution's technology' received the highest score (4). Of the RTOs, 'Advanced Human and Institutional Capabilities' received the highest score in terms of motivation. Notably also, RTOs scored highly on the 'Respond to stakeholder request' while none of the firms considered it a motivation.

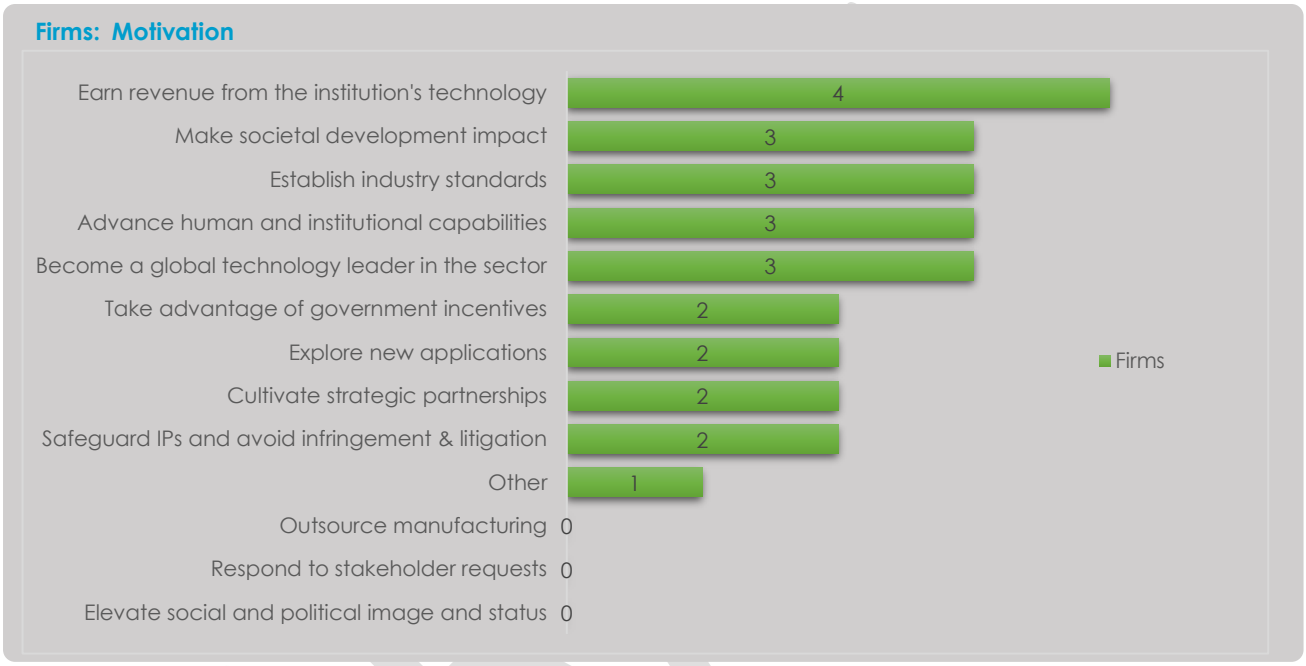

Figure 9. Motivation of Firms to engage in TT Activities

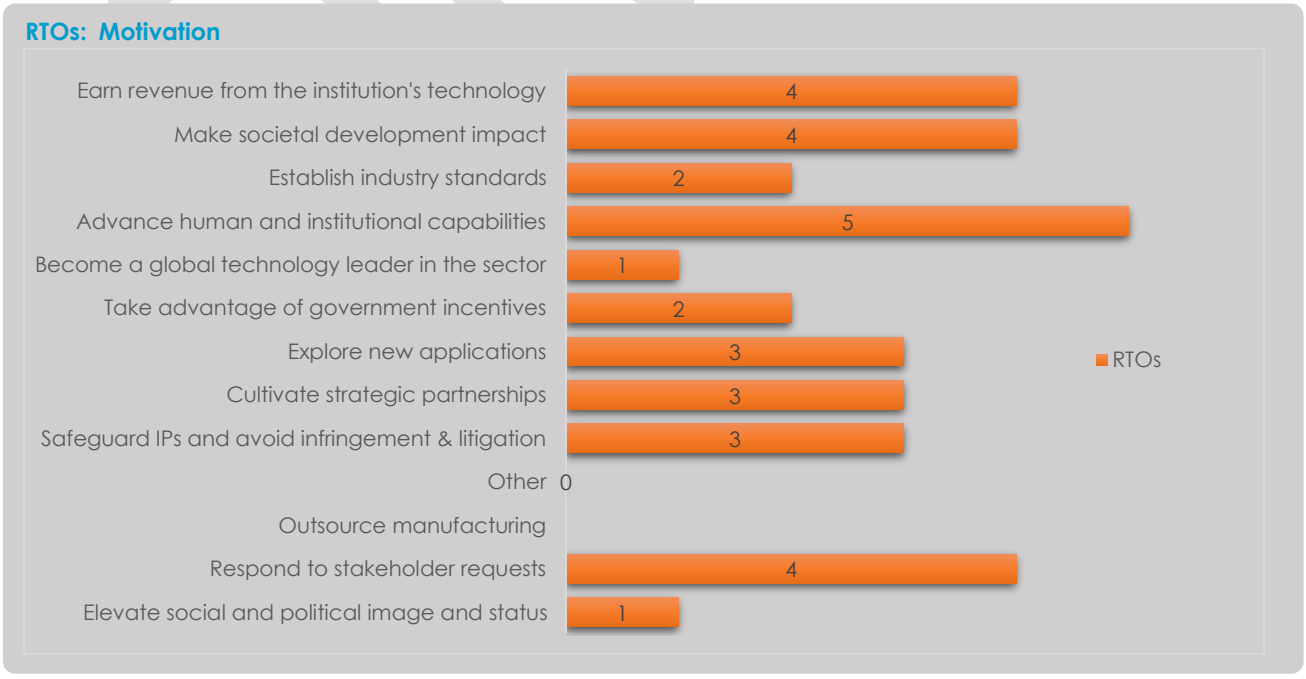

Figure 10. Motivation of RTOs to engage in TT Activities

Figure 11 and 12 below shows the ranking of the perceived challenges of firms and RTOs in conducting TT activities.

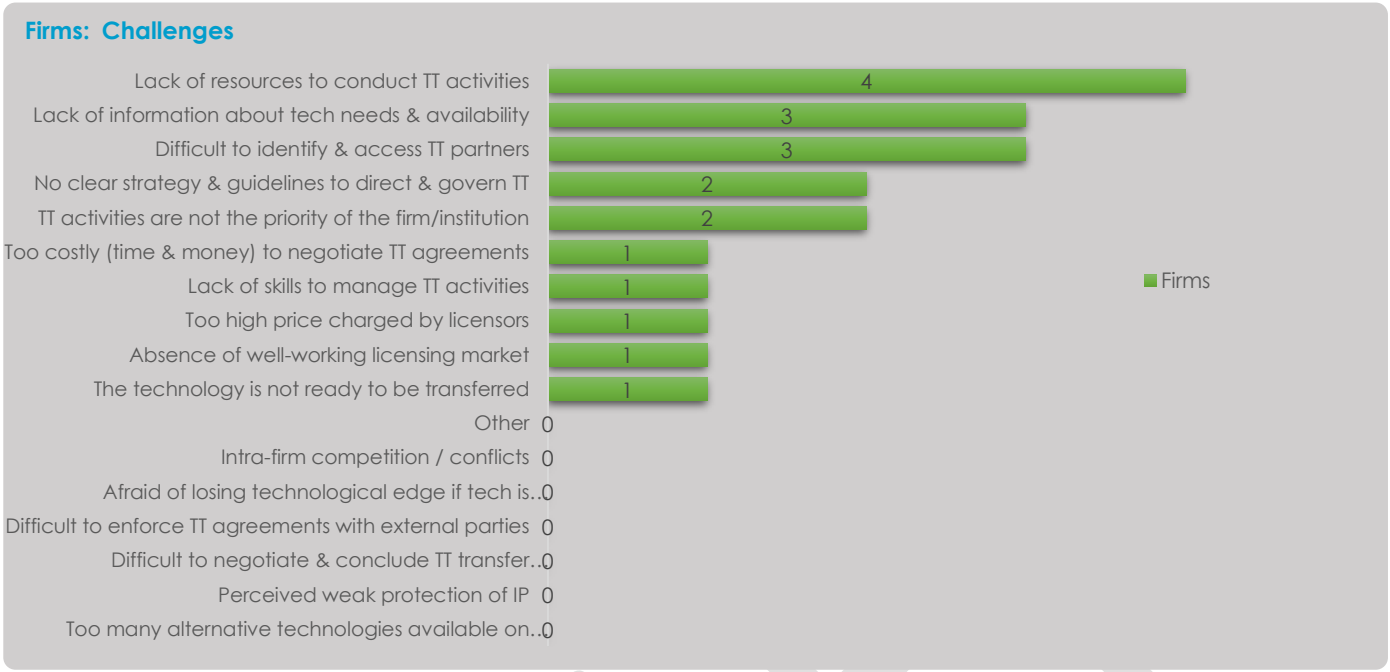

Figure 11. Perceprion of challenges affecting TT activities in firms

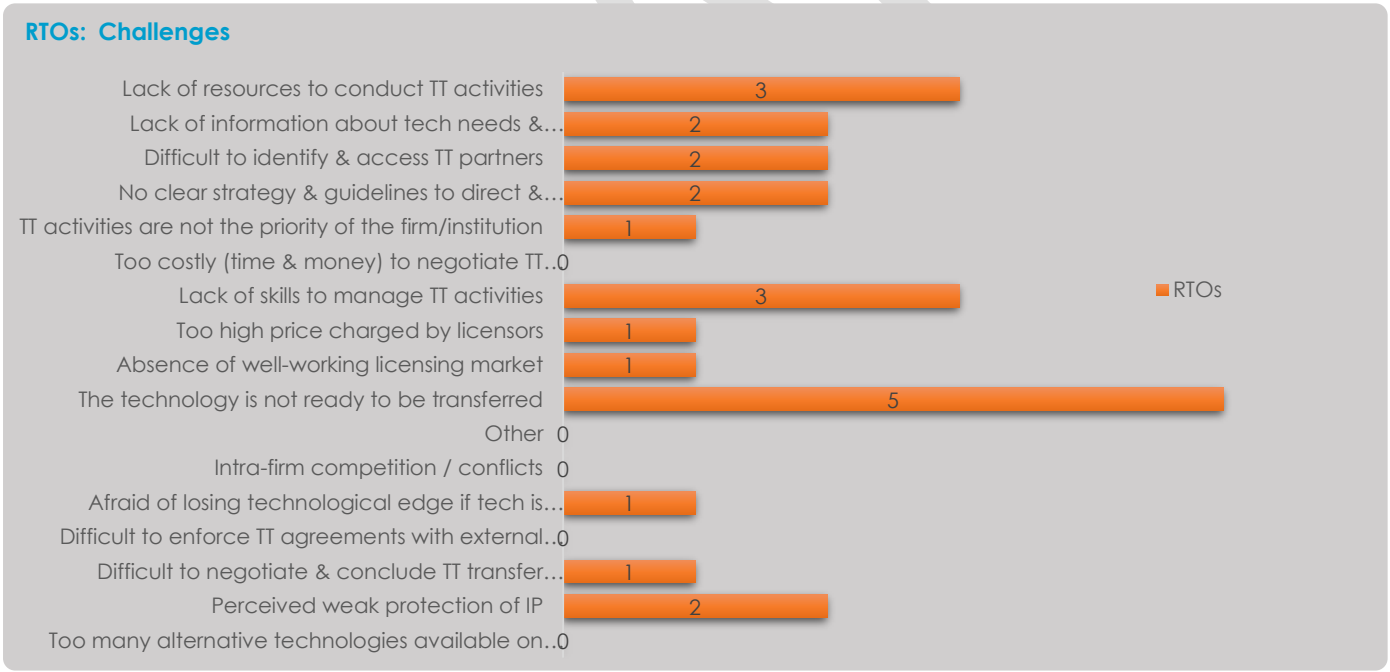

Figure 12. Perceprion of challenges affecting TT activities in RTOs

5.10. Case Studies

In extension to the quantitative survey, two Firms were selected based upon their high profile status and anticipated role in transforming Rwanda's manufacturing landscape. The opinions gathered from the semi-structured interviews provide better understanding of TT activities and complement the quantitative survey. The insight generated from the interview was useful in deriving actionable policy recommendations to further enhance TT in Rwanda and in Africa.

One of the case studies is a subsidiary company of a regional group. The government was instrumental in providing the necessary support to the company during its setup and prototype development. Preliminary success has attracted the attention of the multiple Investors and is in the final phase of a major investment by an investment group that has acquired it.

The company started its operations in 2018 and has over 200 staff of which 62% are female. Besides the permanent staff, the firm also trains technicians from the Rwanda polytechnic in a skills transfer partnership that is supported by the Workforce Development Agency (WDA). The company both produces and assembles parts of products that it has managed to export to over 75 countries within a relatively short period of time.

The second company is also another Flagship initiative that has received support in its establishment given its commercial and social impact prospects. It assembles its units and currently only sells its products on the Rwandan market, although it targets exports in the near future. It also provides an innovative app that has enabled it strengthen its business model. Its swift success has notably led to opening of similar subsidiary in the region.

Details of technology transfer within these two companies is provided below.

CONCLUSIONS AND RECOMMENDATIONS

The Rwandan innovation system is steadily improving in many aspects including policy environment, infrastructure, information and communication technology (ICT) adoption, human capital development, as well as the overall institutional support and funding systems. However, despite the efforts to improve the innovation ecosystem performance some key elements like technology absorption capacity and transfer still remains weak.

While the surveyed RTOs and firms expressed interest in the broad concept of innovation, there is limited structure, understanding, and interest in the aspect of technology transfer. There is notable evidence in increased knowledge and skills transfer through community outreach, which can serve as a basis for increased partnership and collaboration. Collaboration between private sector firms and RTOs is very scarce which affects the overall TT prospects. The firms rely heavily on technology acquired from abroad. And although funding for R&D is increasing (mainly through the government), funding for TT activities remains very limited with minimal participation of the private sector.

Although some incentives exist that are geared towards technology acquisition, they are mainly in some specific areas while others are lacking. Furthermore, firms and RTOs are unaware of their existence, and even when they are aware, the process involved may be very tedious and time consuming which affects overall interest. There are no dedicated Technology Transfer Offices (TTOs). TTOs can play a critical role in championing TT and developing commercial and technical skills.

Establishing information or data on technology transfer is challenging. As such, there are minimal documented success stories showcasing best practices in TT. Admittedly there are a few, like Zipline and Irembo that are good case studies that can provide learning lessons in TT. The study observed that key aspects of TT like Intellectual property (IP), commercialization, and spin-outs, remain mysterious to the broader audience (including firms, RTOs, and policymakers).

It is hoped that the information presented in this report provides a general perspective on the functioning of TT in Rwanda, and will be useful not only in informing ongoing innovation discussions, but also in shaping local and regional interventions to boost technology transfer.

APPENDIX

SURVEY QUESTIONNAIRE

Appendix 1 – Survey questionnaire & Interview Guide

Appendix 2 – Summary survey results

Appendix 3 – Surveyed Institutions