ADVANCING TECHNOLOGY TRANSFER IN MOROCCO

khadija jabri

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Contents

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ABBREVIATIONS AND ACRONYMS

Abbreviation	Original	English
ADD	Agence de Development Digital	Agency of Digital Development
AfDB	The African Development Bank Group	The African Development Bank Group
AI	Artificial Intelligence	Artificial Intelligence
AMTTPA	Accelerated Mining Technology Transfer Platform for Africa	Accelerated Mining Technology Transfer Platform for Africa
ANEAQ	Agence Nationale d'Evaluation et d'Assurance Qualité de l'Enseignement Supérieur et de la Recherche Scientifique	The National Agency for the Evaluation and Quality Assurance of higher education and scientific research
AWS	Amazon Web Services	Amazon Web Services
CDG	Caisse de Dépôt et de Gestion	Central Guarantee Fund
CETIEV	Centre Technique Des Industries Des Equipements pour Véhicules	Technical Centre of Vehicle Equipment Industries
CGEM	Confédération Générale des Entreprises au Maroc	General Confederation of Moroccan Enterprises
CNRST	Centre National pour la Recherche Scientifique et Technique	National Centre for Scientific and Technical Research
CPIRSDT	Comite permanent interministériel pour la Recherche scientifique et le Développement technologique	The Permanent Inter-Ministerial Committee on Scientific Research and Technological Development
CRAT	Centre Régional Africain de Technologie	Regional African Centre of Technology
CSEFRS	Conseil Supérieur de l'Education de la Formation et de la Recherche Scientifique	The Supreme Council for Education, Training, and Scientific Research
DQI	Digital Quality Index	Digital Quality Index
ECOWAS	Economic Community of Western African States	Economic Community of Western African States
EIUI	Entrepreneurial and Innovative University Index	Entrepreneurial and Innovative University Index
EPO	European Patent Office	European Patent Office
ESRI	Education, Scientific Research, and Innovation	Education, Scientific Research, and Innovation
EU	European Union	European Union
EV	Electric Vehicle	Electric Vehicle
FIMME	La Fédération des Industries Métallurgiques, Mécaniques et Electromécaniques	The Federation of Metallurgics, Mecanics, and Electromecanics
FTA	Free Trade Agreement	Free Trade Agreement

FTZ	Free Trade Zone	Free Trade Zone
GDP	Gross Domestic Product	Gross Domestic Product
GEP	Green Energy Park	Green Energy Park
GERD	Gross domestic Expenditure on Research and experimental Development	Gross domestic Expenditure on Research and experimental Development
GII	Global Innovation Index	Global Innovation Index
GIMAS	Le Groupement des Industries Marocaines Aeronautiques et Spatiales	The Group of Moroccan aeronautic and special industries
GIPC	Global Innovation Policy Centre	Global Innovation Policy Centre
ICT	Information and Communication Technology	Information and Communication Technology
IFMIA	Institut de Formation aux Métiers de l'Industrie Automobile	Institut de Formation aux Métiers de l'Industrie Automobile
IPR	Intellectual Property Rights	Intellectual Property Rights
IRESEN	Institut de Recherche en Énergie Solaire et Énergies Nouvelles	Institute for Research in Solar and New Energies
LSBCI	Liner Shipping Bilateral Connectivity Index	Liner Shipping Bilateral Connectivity Index
LSCI	Line Shipping Commodity Index	Line Shipping Commodity Index
MEF	Ministry of Economy and Finance	Ministry of Economy and Finance
MESERFC	Ministère de l'Education Nationale, de l'Enseignement Supérieur, de la Formation des. Cadres et de la Recherche Scientifique	Ministry of National Education, Higher Education, Vocational Training, and Scientific Research
MESRI	Ministère l'Enseignement Supérieur, de la Recherche Scientifique et de l'Innovation	Ministry of Higher Education, Scientific Research, and Innovation
MICEVN	Le Ministère de l'Industrie, du Commerce, du Numérique et de l'Économie Verte	Ministry of Industry, Commerce, Digital and Green Economy
MIT	Massachusetts Institute of Technology	Massachusetts Institute of Technology
MITC	Morocco Information Technology Company	Morocco Information Technology Company
MNF	Maroc Numeric Fund	Morocco Numeric Fund
MNNA	Major non-NATO Ally	Major non-NATO Ally
MOOC	Massive Open Online Course	Massive Open Online Course
MoU	Memorandum of Understanding	Memorandum of Understanding
MRO&U	Maintenance, Repair, Overhaul and Upgrade	Maintenance, Repair, Overhaul and Upgrade
NASA	National Aeronautics and Space Administration	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization	North Atlantic Treaty Organization

NCSR	National Council for Scientific Research	National Council for Scientific Research
NDC	Nationally Determined Contributions	Nationally Determined Contributions
NGO	Non-Governmental Organization	Non-Governmental Organization
NPD	Nouveau Plan de Development	New Development Plan
OCP	Office Chérifien de Phosphate	Office Cherifien of Phosphate
OECD	Organisation for Economic Co-operation and Development	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer	Original Equipment Manufacturer
OMPIC	Office Marocain de la Propriété Industrielle et Commerciale	Moroccan Office of Industrial and Commercial Property
PC/PPUE	Prix de la Compétitivité/ Prix du Partenariat Université- Industrie	Competitivity Prize/ University-Industry Partnership Prize
PME	Petite et Moyenne Entreprise	Small and Medium Enterprise
R&D	Research & Development	Research & Development
R&D Maroc	Association Marocaine de la Recherche et Développement	Moroccan Association for R&D
RMIE	Réseau Maroc Incubation et Essaimage	Moroccan Innovation et Spin-off Network
SABCA	Sociétés Anonyme Belge de Constructions Aéronautiques	Sociétés Anonyme Belge de Constructions Aéronautiques
SABENA	Societé anonyme belge d'Exploitation de la Navigation aérienne	Societé anonyme belge d'Exploitation de la Navigation aérienne
SIPRI	Stockholm International Peace Research Institute	Stockholm International Peace Research Institute
SME	Small and Medium-sized Enterprises	Small and Medium-sized Enterprises
SNRI	Système National de Recherche et Innovation	National System of Research and Innovation
STI	Science Technology and Innovation	Science Technology and Innovation
TDB	Trade and Development Bank	Trade and Development Bank
TT	Technology Transfer	Technology Transfer
TTO	Technology Transfer Office	Technology Transfer Office
UCA	Université Cady Ayyad	University Cady Ayyad
UEMF	Université Euro-Méditerranéenne de Fès	Fez Euro- Mediterranean University
UM5	Université Mohammed V	University Mohammed V
UM6P	Université Mohammed VI Polytechnique	University Mohammed VI Polytechnique

UNCTAD	The United Nations Conference on Trade and Development	The United Nations Conference on Trade and Development
UNESCO	The United Nations Educational, Scientific and Cultural Organization	The United Nations Educational, Scientific and Cultural Organization
VAT	Value-added Tax	Value-added Tax
VR	Virtual Reality	Virtual Reality
WHO	World Health Organization	World Health Organization
WIPO	World Intellectual Property Organization	World Intellectual Property Organization

EXECUTIVE SUMMARY

Morocco has long been known as the “gateway” between Europe and Africa, due to its advantageous geographical location at the crossroads of both seas and continents. By positioning itself as a sought-after location for low-cost labour and international manufacturing activities, the country made significant gains. In recent years, however – by diverging from low-value-added services and goods – Morocco has emerged as a regional leader in the development and deployment of clean energies, signalling a paradigm shift to a more diversified economy.

In support of this goal towards economic diversification, Morocco placed innovation and technology creation at the heart of its economic agenda—for many years—in a strategic bid to transition from a resource-based to a knowledge-based economy. This effort started out with the National Innovation Strategy (2009) before its updated version: the National Strategy for the Development of Scientific Research through 2025. Moreover, the country launched several other initiatives seeking to develop a favourable environment for innovation, while diversifying support for research and promoting technology transfer.

Technology transfer – as the name suggests – refers generally to the practice of transferring technology in its various subtypes, from the originating party to the benefitting party. Furthermore, technology transfer can take several forms; it is called either inward or outward technology transfer when technology is transferred into the entity – or transferred out to another party, respectively. Similarly, ‘intra’ or ‘inter’ technology transfer refers to when the technology is transferred to entities within the same group, or entities not belonging to the same group. In such cases, entities are usually research institutions (universities or research centres), firms, or both.

With this context in mind, technology transfer in Morocco exists in its various forms, with the current dominating narrative suggesting a more focused effort on the university-industry nexus. Indeed, a culminative set of initiatives were taken over the years in a bid to forge links between university and industry. Cities of innovation were created within universities in five regions, with more to follow, and a sizable number of funding initiatives to support innovative projects and start-ups were launched. In February 2022, a National Plan for the Acceleration and Transformation of the Higher Education, Scientific Research and Innovation (ESRI) ecosystem was announced, to work in alignment with the New Development Model of 2021. The plan aims to propel the country along a progressive path forward, with strong innovative capacity and high added value across both academia and science, by overhauling Moroccan universities and improving the financial flow into research and innovation.

Similar to universities, firms are guaranteed to use some form of technology transfer on a daily basis. The limited empirical data on the technology transfer activities at the firm level in Morocco, renders a detailed national assessment and diagnosis challenging. However, in accordance with the general observation that firms in developing countries are more likely be importers of technology than exporters, it can be assumed that inward technology transfer is the most predominant form in Morocco. While there may be exceptions, the lack of supportive examples makes outward technology transfers unlikely to hold significant weight in the country’s technology transfer ecosystem. Overall, technology-based innovation in Morocco is characterised by using a market-pull rather than technology-push strategy. Indeed, Morocco’s most structured and successful technology transfer value chains are found predominately in the mining, phosphate, agronomy, and renewable energies sectors, due to their significance to the national economy.

As reported by several studies, significant progress has been made, backed and confirmed by statistics including the number of international publications, patents filed, and start-ups created. However, several gains are short-lived rather than being sustainable in the long run, and the

technology transfer ecosystem remains riddled with challenges, some more complex than others. At university and public research institutions, bridging the “valley of death” is of particular interest. This entails commercialising and promoting research outputs, which is a growing pain not only due to a lack of resources, but also because researchers’ understanding of the commercial value of their work is inadequate. The lack of absorption capacity from industry, compounded by the difference in culture between academia and their respective industries, appears to be a crucial factor as well.

At the firm-level, challenges are abundant. Taking the automotive industry as an example, the benefits of offshoring for Morocco are numerous, but perhaps the biggest challenge and consequential opportunity lies in the inclusion of local firms in the value chain, which would ensure a seamless technology transfer. Such a challenge becomes more pronounced when labour-intensive offshoring activities limit higher value-added creation and meaningful training and technology transfer. From an investor’s perspective, technology transfer activities should be restricted to a certain extent, in order to preserve their competitive advantage. This would result in a balancing act where Morocco must both seize opportunities to foster the country’s industrialisation, while ensuring technology transfer is occurring through targeted policies and technical assistance to local firms.

Structure of the report

This report provides a comprehensive diagnosis of the state of technology transfer in Morocco. Building on previous studies and supplementing with findings from interviews with key stakeholders, this study brings forth an updated outlook based on the latest information gathered through these sources.

The report is structured as follows:

- Section 1: provides an overview of the technology transfer ecosystem in Morocco and defines it into its key constituent categories.
- Section 2: examines the technology transfer ecosystem in the country with a sectoral lens.
- Section 3: highlights the key challenges that impede technology transfer in Morocco.
- Section 4: proffers a set of recommendations to help Morocco enhance its technology transfer system.

1.TECHNOLOGY TRANSFER IN MOROCCO- AN OVERVIEW

Morocco has been making real efforts in advancing science, technology, and innovation for over two decades now. The country has strived to make its STI ecosystem more interconnected by forging links between the private and public sector. A few key statistics can describe the STI status in Morocco: Morocco ranked 77th in the 2021 Global Innovation Index, R&D financing represents less than 1% of its GDP, and SCImago ranks Morocco 6th in Africa in terms of scientific publications. Countries with a robust track record in STI generally display the following characteristics: outstanding universities, a higher proportion of population with a higher degree, developed financial support and venture capital, developed university-industry links, an enticing environment for innovation through innovation-friendly regulations and policies, proactive policies and incentives to attract talent, and an overall favourable environment to do business. To this end, Morocco made notable progress in all these sectors through a series of continuous and progressive reforms and initiatives.

Technology transfer is a highly collaborative and interactive process, where various actors such as research institutions, firms, incubators, accelerators, and civil society work in synergy with each other. Technology transfer activities are conducted in Morocco in various forms but two particular observations were at the forefront of this study: firstly, national debate appears to focus mainly on university-industry collaboration, inadvertently discounting the potential that local firms hold, and secondly, R&D activities are clustered in only a few cities, putting other regions at risk of being excluded in the country's innovation and industrialisation efforts.

1.1 Science, technology and innovation: State of play

The World Intellectual Property Organization (WIPO) ranked Morocco 77th out of 132 economies featured in its 2021 Global Innovation Index (GII) report;[1] the GII ranks world economies according to their capabilities for innovation. In accordance with the report, Morocco performed well in innovation outputs, specifically knowledge and technology, but fell short on other metrics such as human capital and research.

For many years, Morocco has expressed its ambition to become a frontrunner in the region in the areas of science, technology, and innovation. Unveiled in spring 2021, the country's New Development Model[2] laid out the steps the government will take to make Morocco a nation of opportunity, entrepreneurship, and innovation. Specific emphasis was placed on the importance of universities' role in building a future-ready "skilled Morocco". A supportive infrastructure is as necessary to create a conducive STI environment as the case of human capital development. Morocco is undoubtedly achieving its plans to improve digital infrastructure. As of January 2021, at least 27.62 million Moroccans (nearly 74% of the population) use the internet, a significant increase from the 25.32 million registered in the same month of the preceding year,[3] thus making Morocco the most advanced market in Africa where internet connectivity is concerned. In 2021, Morocco was ranked 84th globally and 6th in Africa based on the Digital Quality Index (DQI), which measures digital quality in 110 countries based on five criteria: internet affordability, internet quality, electronic infrastructure, electronic security, and electronic government. Similarly, Morocco ranks the 45th country out of 230 countries globally in mobile data affordability.[4]

Cognizant of the role of digital infrastructure in promoting Industry 4.0, the country launched the Agency of Digital Development (ADD) – a strategic public entity placed under the supervision of the ministry in charge of the Digital Economy. The ADD's primary mandate is to act as a digital transformation catalyst, by overseeing the country's digital development strategy and promoting the shift to digital tools across all sectors.

The ADD certainly lived up to its mission in May 2019, when it launched the AL-KHAWARIZMI program. Endowed with a budget of 50 million Moroccan dirhams ($5.6 million), the program aims to promote research and development in Artificial Intelligence (AI) and its application through calls for proposed research. The future of AI cannot be underestimated, and it is instructive to note that Morocco has an active AI research community. For instance, MoroccoAI – a network of Moroccan AI experts – seeks to expand Morocco's AI transformation and promote AI education and research. Similarly, AI Movement, also known as the Moroccan International Centre for Artificial Intelligence, is a centre of excellence of Artificial Intelligence established at Mohammed VI Polytechnique University (UM6P) that aims to foster the emergence of Moroccan expertise in Artificial Intelligence and Data Sciences.

Several studies have extensively examined the STI activity in the country, and it is safe to say that Morocco is paving the way for Industry 4.0. As of Q3 2019, the country boasts 31 Tech Hubs, placing it second in North Africa.[5]

1.2 Technology Transfer definition

Technology transfer is a practice that has generated much discourse over the years, and even more recently in the wake of the COVID-19 pandemic, owing to vaccine access and equity. However, the debate began much earlier in 1961 at the 1084th plenary meeting, when some developing countries requested the Secretary General to commission a study examining the effects of patents, and its legislations in selected under-developed countries. The request also sought to inspect issues surrounding the granting, protection, and use of patents, considering the provisions of existing international conventions and the special needs of developing countries.[6] It subsequently became one of the most discussed areas in the international economic spheres, leading to a range of policies, frameworks, and partnerships at the national, regional, and international levels.

The definition of technology transfer has evolved over the years, varying from one stakeholder to another. For instance, Tech Transfer Central defines technology transfer (or Tech Transfer) in the context of research institutions, as "the process by which new inventions and innovations created in those institutions' labs are translated into products and commercialized."[7] The European Commission defines it as "The process of conveying results stemming from scientific and technological research to the market and to wider society, along with associated skills and procedures, and is such an intrinsic part of the technological innovation process."[8] MIT describes technology transfer as "The movement of knowledge and discoveries to the general public. It can occur through publications, graduating students entering the workforce, presentations at conferences, and research relationships with industry."[9] NASA presents its technology transfer practice as "A programme that ensures that innovations developed for exploration and discovery are broadly available to the public, maximising the benefit to the nation."[10]

In our day-to-day life, there are numerous examples of technology transfer around us. For instance, one of the most notable inventions of 2000s was the smartphone, which has since become the *sine qua non,* of modern society. When it was first unveiled by Steve Jobs in 2007, the iPhone made global headlines. However, its invention is not as simple as it may appear. Indeed, the device had six layers, and each one was the result of painstaking research.[11] Another example is Amazon — the ever popular e-commerce website which started as an online bookstore in 1994, and then expanded into other industries such as consumer electronics, cloud computing and entertainment, before becoming one of the world's most valuable companies[12] and claiming the third spot in the list of the most innovative companies in the world in 2021.[13] The company would later lend its platform to other businesses to sell their products. During this time, it also began offering several businesses the possibility to outsource their computing needs, so that they could sell their own products on Amazon in exchange for a fee which would later lay the foundation of Amazon Web Services (AWS).

These examples demonstrate the true power and potential of technology transfer, and the far reaching economic and societal benefits that can be harnessed in its application. Amazon ushered in the cloud era, while Apple revolutionized the mobile industry.

With the impacts of technology transfer being so potent and profound, it should be emphasised that the process is more complex and cumbersome than it appears. The practice involves various stakeholders, processes, and factors — both scientific and non-scientific — in an overall, detailed process that is gradual and cumulative (see figure 1).

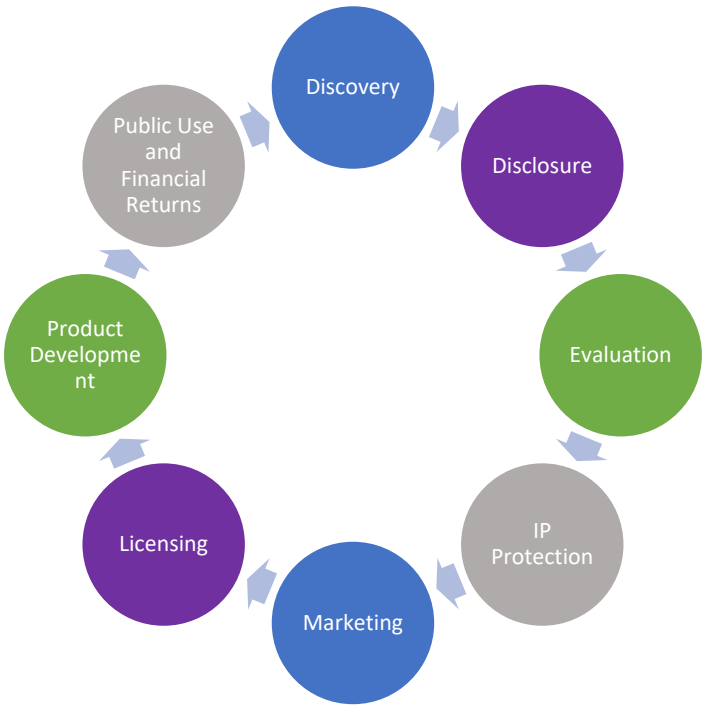

Figure 1: Technology Transfer process
Source: European Commission. Technology Transfer, 2022.

1.3 Intellectual Property in Morocco

In its general set up, technology transfer refers to the process of sharing intellectual property in its various forms with both wider society and individual economic actors. Therefore, protecting inventions originating from universities, research institutions (public or private), firms, and entrepreneurs is integral step to the technology transfer value chain. IP protection offers many benefits, namely helping patent holders to explore different avenues to commercialise their IP by either developing, manufacturing and turning it into a source of revenue, or by licensing or franchising it. It also serves to protect the innovator's product by restricting access to it. Furthermore, it increases chances of cross-border collaboration and allows the exporting of products and services (outward technology transfer).

It is, however, necessary to note that if IP captures an important part in the technology transfer value chain, it is a double-edge sword. Indeed, while weak IPR protection may disincentivise research endeavours and lead to the unintentional spill over of sensitive data by the invention's holder, a strong IPR protection – on the other hand – could lead to insufficient knowledge and technology diffusion, thereby slowing innovation. Thus, it is important to strike the right balance whereby innovation is promoted, and the patent holder's rights are upheld.

In Morocco, The Moroccan Office of Industrial and Commercial Property (OMPIC) is the entity responsible for the protection and promotion of intellectual property. Founded in 2006 and headquartered in the port city of Casablanca with multiple branches across the country, OMPIC is a

public institution with legal status and financial autonomy under the overall supervision of the Ministry of Industry, Trade, Investment, and the Digital Economy.

According to OMPIC's official figures, patent filing in Morocco grew by 167% during the period 2015-2019 with patents of Moroccan origin representing only 7% of the total number (see figure 2).

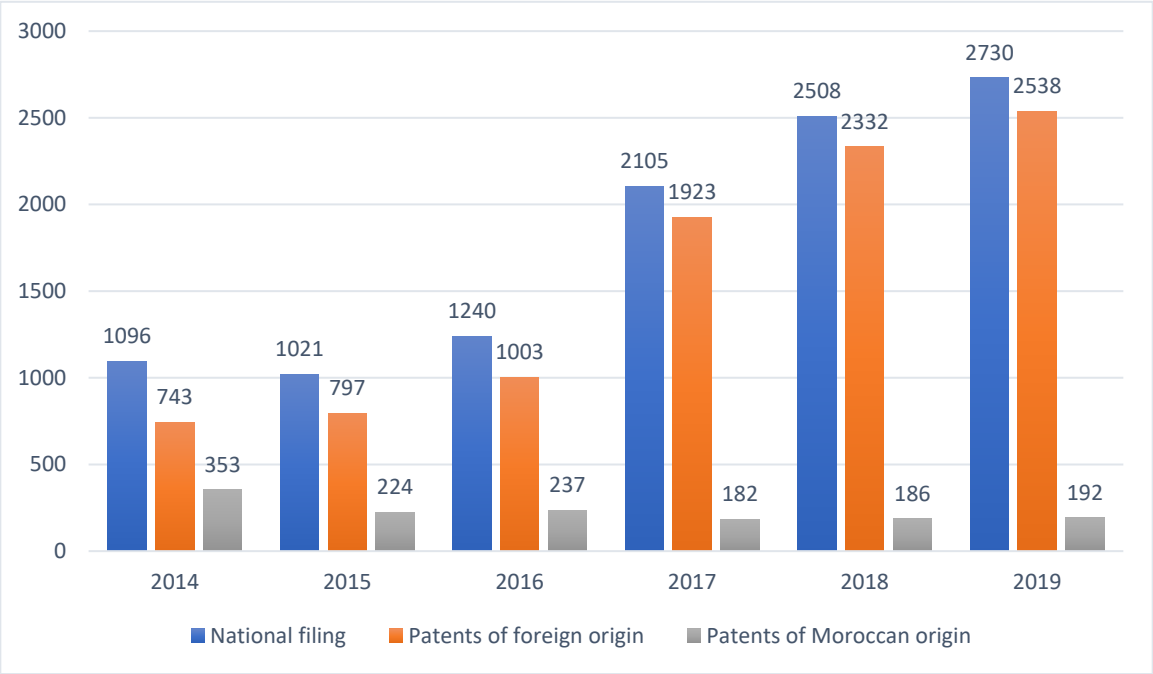

Figure 2: Patent filing evolution in Morocco
Source : OMPIC, Rapport d'analyse du premier quinquennat du système de validation au Maroc 2019, 2020

The patents of foreign origin, on the other hand, grew by 218% over the same period. Perhaps most notably, these statistics are derived directly from the EPO-Morocco validation agreement of European patents in Morocco – effected on March 1st, 2015 – with the chief aim to open Morocco to global markets and therefore strengthen its economic integration. Indeed, the agreement resulted in more simplicity in the process of patents filing for Europeans in particular.

While this result bolstered Morocco's position in the patenting market, there was a decrease in the number of native Moroccans filing between 2015 and 2017 which can be attributed to Law 23-13[14] that was introduced in December 2014. The objective of this law was to modernise and reform the patent filing system, giving it superior alignment with international standards while improving the quality of patents filed. This was made possible by introducing a set of criteria to selectively attract productive investments with high added value thereby reducing counterfeits in the process.

In accordance with OMPIC official figures, the top countries for patent filing during the aforementioned period (2014-2019) have steadily been the United States, France, Germany and Italy respectively, with new countries that do not commonly file patents in Morocco—such as Turkey, China, and Denmark – following suit. It is also worth noting that whilst pharmaceutical groups have consistently been among the top in the list of patent applicants, they are slowly capitulating to companies in the automotive sector. In 2019, there were four groups active in the automotive sector that were in the top 10 list of applicants (see figure 3), putting Morocco on course to become the leading African automaker – a title currently credited to South Africa.

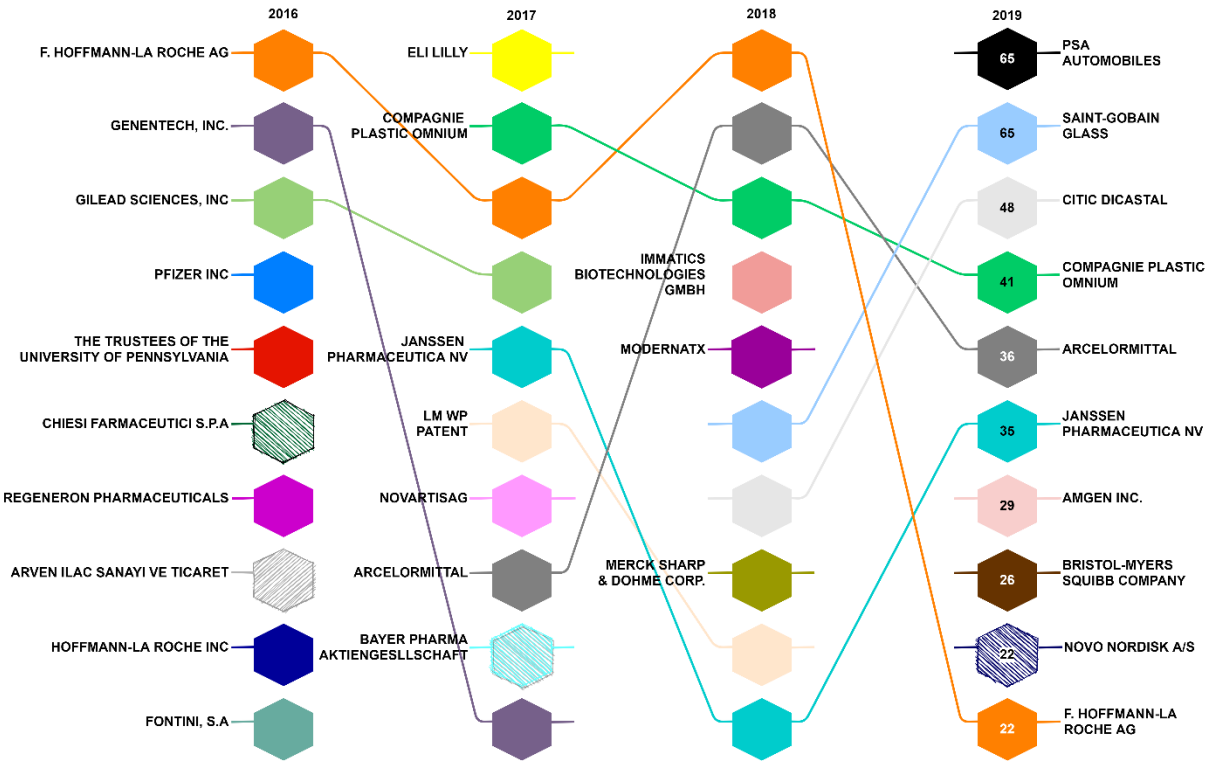

Figure 3: Top patent applicants 2016-2019
Source : OMPIC, Rapport d'analyse du premier quinquennat du système de validation au Maroc 2019, 2020

A number of reforms to fine-tune the patent filing and protection system, have enabled Morocco to achieve international praise. In its annually released IP Index, The US Chamber of Commerce Global Innovation Policy Centre (GIPC) ranked Morocco 22nd out of 53 countries[15] and following this, became the highest performing middle-income economy in the index. The index evaluates IP rights in 53 global economies, from patent and copyright policies to commercialization of IP assets, enforcement, and ratification of International Treaties. The report describes Morocco as having strong protection for patents and related rights — a position that stemmed mainly from the US-Morocco Free Trade Agreement (FTA) and agreements with the EU that have encouraged the country to strengthen its IP environment and associated standards.

Despite this vantage ranking, Morocco's IP environment remains rife with obstacles, mainly around counterfeit. In a recent publication by the OECD, Morocco ranked 16th out of the 25 top provenance countries in counterfeit and pirated goods between 2017-2019[16], topping the list of African countries. Another report by the OECD and the EU's Intellectual Property Office, found that the proliferation of free trade zones is unintentionally boosting counterfeiting as a direct result of the reduced taxes, customs controls, light regulation, and limited oversight.[17]

With heightened vigilance towards these issues, and to meet its international commitments in the fight against counterfeiting and piracy, the country has taken several initiatives such as introducing financial penalties, strengthening border controls, and raising consumer awareness of the dangers of counterfeit products. In recognition of Morocco's efforts in the development of a system of intellectual property that promotes innovation, creativity, and fights counterfeiting – Morocco was unanimously elected in October 2019, as a chair of the World Intellectual Property Organisation (WIPO) General Assembly for the biennium 2020/2021. It has thus become the first Arab country and

the second African country after Nigeria, to preside the General Assembly of the WIPO since its creation in 1967.[18]

1.4 Morocco's Technology Transfer Communities

1.4.1 Universities

Morocco is home to 12 public universities and several private institutions. Private institutions do not play a significant role in technology transfer, unlike public universities. Amongst the most active universities in research and development are the University of Cady Ayyad in Marrakech, Mohammed I University of Oujda, and the Mohammed VI Polytechnique University (UM6P).

- *University Cady Ayyad (UCA)- Marrakesh*

Founded in 1978, University Cady Ayyad has 15 affiliate institutions, 67 labs and 3 research centres across the cities of Marrakesh, Kelaat Sraghna, Safi and Essaouira. Like other universities, UCA's research activities revolve around the thematic areas relevant to the Marrakech-Safi region's socio-economic needs and challenges. In line with its objective to play an active role in its socio-economic and cultural surroundings and strengthen the links between public institutions and elected councils, UCA, in December 2021, signed an agreement with the city council of Marrakech. The agreement provides for the city's local development through actions such as preparing the city action plan for the period 2022-2027 and helping the city of Marrakesh develop its application to UNESCO to join the network of learning cities. [19] UCA was the first Moroccan university to launch a MOOC in 2013.

- *Mohammed I University Oujda (UMP)*

The Mohammed I University of Oujda is a public university located in the eastern region of Morocco, known as the 'Oriental region.' Founded in 1978, it federates 10 higher education institutions, 5 faculties, and 3 specialized schools spread over three cities in the region: Oujda, Nador, and Al-Hoceima. The university focuses on research and the development of the Oriental region through various structures and initiatives aimed at bringing the university closer to its socio-economic environment. The Scimago Institutions ranked UMP as the top Moroccan university in research and innovation in 2021.[20]This ranking was based on scientific research, innovation, societal impact, and other sub-criteria such as the number of studies published on the Scopus database.
UMP is home to a large technology transfer facility named the "Technology Transfer and Expertise" campus (CU2TE) which spreads over a surface of four hectares with several research laboratories, incubators, and firms, thus enabling cross-fertilization of efforts. The CU2TE also serves as a platform for South-South cooperation and a hub for technology transfer between African countries.

- *University Mohammed VI Polytechnique (UM6P)*

Located in the Mohammed VI Green City, UM6P has steadily become the leading Moroccan institution in applied research and innovation since its official inauguration in 2017; focusing not only on areas of interest to the Moroccan economy such as renewable energies, mining, and agriculture but also on Africa as a whole.

Since its inauguration, the university has forged partnerships with the distinguished universities Columbia Business School, MIT, and McGill University. UM6P's ultimate goal is to become an African centre of excellence to propel the continent into new frontiers of business and human development, and they have already made a significant start by housing Africa's most powerful supercomputer with the support of the University of Cambridge, Dell and Intel.[21] UM6P's programs are designed around Africa's top priority areas known as the High 5s: light up and power Africa, feed, industrialize, integrate, and improve the quality of life for the people of Africa.[22] To date, there have been seventeen research labs dedicated to those areas.

UM6P has a Technology Transfer Office (TTO) mandated to manage the transfer of technology, protect, promote and valorise the intellectual property developed in the university's labs. This includes ensuring a successful transfer of invention and discovery to industry. For that purpose, the TTO is equipped with two platforms:

- The TechCell: A platform for accelerated transfer of chemical technologies and processes having a maturity level superior to TRL3.
- The Accelerated Mining Technology Transfer Platform for Africa (AMTTPA): A technology transfer acceleration platform for Africa in the mining sector. AMTTPA seeks to advance the mining sector in Africa by creating living labs and developing executive education courses dedicated to the sector.

Overall, universities remain the top Moroccan patent applicants at both the national and international level.[23] Three Moroccan universities in particular are among the PCT top applicants (see table below). The Patent Cooperation Treaty (PCT) is a system that assists applicants in securing international patent protection for their inventions.

Applicant	2018	2019	2020
Universite Internationale de Rabat	9	9	8
Universite Sidi Mohamed Ben Abdellah Fes		2	3
OCP	2	3	2
Universite Mohammed VI Polytechnique			2
Atlas Olive Oils SARL			1
Consulting Antonini			1
Ecole Superieure des Industries du Textile et de l'habillement (ESITH)	1	1	1
Enviroass SARL			1
Imaplast			1
Maroc Conteneurs Internationales			1

Top Moroccan PCT applicants from 2018 to 2020
Source: WIPO, Statistical Country Profiles, 2021

Despite universities registering the highest number of filed patents, their inventions are rarely commercialised. The most notable examples of Technology Transfer Offices (TTOs) in the country were highlighted in this section, but such structures remain scarce. However, foundations were laid in the first quarter of 2022 to set up TTOs in a number of Moroccan universities with the support of OMPIC which will assist in defining the business and governance model of developed structures.

1.4.2 Research Centres

There are several research centres in Morocco. Some are embedded in universities, while others are standalone research centres belonging to ministries, government agencies, and corporations. Research activities are focussed on sectors of priority such as mining, renewable energies, agronomy, phosphate, and digital technologies.
An example of one of these centres is the Institute for Research into Solar and New Energies (IRESEN). Created in 2011, IRESEN is responsible for identifying research priorities and projects aligned with the country's national energy policy objectives. It also operates both as a funding agency that organizes competitive calls for R&D and innovation projects, and a research organization that

sets up applied R&D platforms to access to research and innovation infrastructure, such as the Green Energy Park and Smart Buildings Park.

IRESEN is a strategic entity that plays a significant role in the energy mix strategy in Morocco, and is present throughout the green energy value chain via two fronts:

- Infrastructure: Through a network of research platforms dedicated to green energy.
- Support entity: By financing research projects, providing access to expertise, administrative and logistical support for equipment acquisition, supporting scientific conferences participation, offering grants and scholarships to PhD students.

The institute includes a network of six platforms focused on research and innovation in clean energy:

- *Green Energy Park:* A test, research, and learning platform focused on solar energy. The initiative is a collaboration between IRESEN and UM6P.
- *Agro energy TIC valley:* A platform dedicated to research and development in bioenergy, agri-tech, and the food-water-energy nexus with a focus on introducing renewable energies in the agricultural and agri-food sectors by exploiting advancements in digital technology.
- *Water energy nexus:* A platform dedicated to research and development in marine energy, water treatment and desalination.
- *Green and Smart building Park:* A learning, research, and test platform focused on green buildings, energy efficiency, and smart network fields.
- *GEP-Maroc Cote D'Ivoire (GEPMCI):* A collaboration with l'Institut National Polytechnique Félix Houphouët Boigny (INP-HB) in Yamoussoukro, Côte d'Ivoire. The platform complements the Green Energy Park by integrating solar thermic and photovoltaic energies.
- *Green H2A:* A Green hydrogen & applications park and a research platform focused on the industrial deployment of green hydrogen applications in Morocco.

IRESEN has a network of 14 labs across the country hosted by various Moroccan universities, three of which can be found at the University of Cady Ayyad: the production of thermic energy lab, the electric mobility lab, and the batteries testing lab. Several public entities chair IRESEN, including the Ministries of Economy and Finance, Higher Education, Research and Innovation, and the Energy Transition and Sustainable Development ministry, reiterating the strategic value of the institute to Morocco's commitment to green energy.

1.4.3 Incubators

Incubation in Morocco started at the beginning of the year 2000, specifically in universities prompted by Law 01/00 regarding the organisation of higher education. The law mandated universities to create incubators to support innovative start-ups.[24]

Incubators are structures that support entrepreneurs in building their young companies through a range of services such as physical infrastructure, mentorship, access to financing, and extended networking opportunities.

To meet the needs of the start-ups in Morocco, several incubators were launched by both the private and public sectors. Examples of incubators in Morocco include: the U-Founders incubator by the UM6P, Impact Lab, Technopark incubator Casablanca, and Al Akhawayn university incubator. It is worth noting that private incubators are important in the innovation ecosystem in Morocco, playing a pivotal role in supporting start-ups. However, it cannot be said with confidence whether they are significant in the technology transfer value chain.

The university of Hassan 1st of Settat, which houses of one the country's largest incubators, offers a framework in which patents are commercialised. As part of this framework, the university's PhD students are offered the opportunity to develop and commercialise their patents with the financial, technical, and administrative support of the incubator. As of 2022, seven successful start-ups emerged as a result of this incubation model:

Company name	Description	Number of patents
Biodome	Specialised in organic waste recovery through the production of compost and biogas.	5
Easy Control:	Remote management device for farms.	1
Central Solar:	Device for solar pumping.	1
Mastery	Design and implementation of innovative geolocation solutions	1
Endo Smart	Endoscopy adapter via smartphone	1
Handbook	Virtual collaborative learning platform for middle and high schoolers	1
CosmeSolutions	R&D in dermocosmetics	1

Hassan 1er incubator's start-ups that commercialised their patents
Source: University Hassan 1er

Morocco incubation and Spin-off Network (RMIE) is the initiative of reference when it comes to incubators in Morocco. Indeed, RMIE supports the setup, development and promotion of university incubators. As of 2019, seventeen university incubators are members of the RMIE—only five of whom are actually operational.[25] This low figure is due to a number of factors such as lack of financial and industrial support, and the ambiguity surrounding the legal status of start-ups.

1.4.4 Firms

According to a 2019 study by the Moroccan Higher Planning Commission[26], firms in Morocco are clustered in the cities of Casablanca and Tangiers which jointly host 63% of the total number of companies in Morocco. MSMEs represent 93% of firms in the country, with two thirds operating in the tertiary sector and less than 10% in the industrial sector. The industrial export sector is substantially dominated by large companies, who account for 60% of the sector's exports.

There are no exact figures on the number of multinational companies in Morocco, however, IT, pharmaceuticals, automotive, and aerospace heavy weights including IBM, Microsoft, Intel, Dell, Roche, Renault, Safran, Airbus, and Boeing operate through subsidiaries and joint ventures with local companies.

There are a number of entities that ensure favourable conditions for business and development are provided, and promote capacity building programmes for the private sector. Examples of these entities include:

- *Confederation Generale des Entreprises au Maroc (CGEM)* : Created in 1947 and headquartered in Casablanca, the General Confederation of Moroccan enterprises is the main representative of enterprises in the country, counting over 90 000 member companies[27], and serves as an intermediary between the private sector and the public sector

and institutional organisations. It regularly commissions and finances studies to better inform the direction and efficacity of national policies and promotes research and innovation by exploring and leveraging collaboration between firms and universities.

- *Le Groupement des Industries Marocaines Aeronautiques et Spatiales (GIMAS) :* Founded in the early years of 2000 and headquartered in Casablanca, The Group of Moroccan Aeronautic and Special Industries (GIMAS) counted 125 members in 2019.[28] Among its objectives is to consolidate and reinforce the competitivity of the aerospace Moroccan industry, represent the best interests of the industry with national and international organisms, and ensure the integration of an R&D in the national aerospace strategy through partnerships with universities and research centres.
- *La Fédération des Industries Métallurgiques, Mécaniques et Electromécaniques (FIMME) :* Founded in 1951 and headquartered in Casablanca, the Federation of Metallurgics, Mecanics, and Electromecanics (FIMME) has 1600 members.[29] Among its top priorities is to develop the technological capacities of its members through collective capacity building programmes and source development opportunities from abroad.

To accelerate national innovation, Morocco has increased its efforts to facilitate the creation of start-ups through the introduction of various financing and support mechanisms:

- *Innov Invest fund***:** launched in 2017, this programme was a critical turning point for entrepreneurs in Morocco. It was established by Morocco Guarantee and SME Finance Corp (CCG) and supported by the Moroccan Government, the World Bank, and the European Union to enhance the access to finance for SMEs and start-ups, and make Morocco a regional hub for innovative entrepreneurs. [30] As of 2020, about 200 projects benefited from funding, totalling a sum of 100 million dirhams (about $1million). [31]
- *Innov'Act programme:* A programme launched by MESRSI and R&D Maroc (Moroccan Association for R&D) to promote the activities of R&D and dynamize innovation in the national production sector.
- *Programme INTILAK:* This programme is dedicated to innovative start-ups having at least two years of activity in an innovative project or R&D promotion. The programme finances up to 90% of the expenses of the project, not exceeding one million Moroccan dirhams (about $100,800.00).
- *The Moroccan Innovation and Spin-off Network (RMIE):* Founded in 2002, RMIE is managed by CNRST and aims to promote innovation, start-ups creation, and the transfer of knowledge between university and industry.
- *Maroc Numeric Fund (MNF):* Launched in 2010, the MNF is a venture capital fund focused primarily on tech start-ups. It is a public-private investment fund whose leading investors are: AttijariWafa bank, Banque Centrale Populaire, BMCE bank, Morocco Information Technology Company (MITC) which is the management company of Moroccan Technoparks, and Central Guarantee Fund (CDG).
- *Programme Tatwir:* This programme offers a customised blended and integrated offer of investment, innovation support, and technical advisory. It specifically targets MSMEs actives in the sectors of green growth, industrial innovation and Industry 4.0. Three programmes are offered: Tatwir green growth, Tatwir start-ups, Tatwir automotive integration.
- *PTR instrument:* The PTR instrument is dedicated to projects of innovation and technological development undertaken by firms, consortiums or groups of enterprises and covers the expenses of such projects up to 75% not exceeding 100 000 dirhams ($10,000).

1.4.5 Civil Society

In national innovation systems, the role of civil society tends to be underestimated and, in some instances, overlooked, especially in developing countries where government is seen as the main catalyst for change. In the context of technology transfer in Africa, civil society is mostly seen as a contributor at the grassroot level through sensitization and capacity building activities.

In Morocco, civil society has had a small place in the national innovation system for over two decades. Its main role is to promote innovation and R&D, and serve as an interface between government, industry, and society to ensure a continuous collaboration and exchange of ideas among the actors of the national innovation ecosystem. Three particular entities stand out:

- The *Moroccan Association for Research & Development* (AMDRS): Created in 2013 to promote, support, develop and commercialise scientific research in Morocco. Some note-worthy examples of the activities of the AMDRS include the creation of the African Prize for the best scientific article on solutions for health problems in Africa in 2018, and the organization of a training course on how to write scientific articles in 2019.
- *INJAZ al Maghrib :* Created in 2007, INJAZ al Maghrib is a non-profit organization that connects Moroccan youth to the private sector, with the end goal of creating a generation of future entrepreneurs. The organization champions the "learning by doing" approach by mobilizing its extended network of volunteers of business executives to deliver customized programs in a number of Moroccan institutions.
- *Moroccan Centre for Innovation and Social Entrepreneurship (MCISE):* Founded in 2012 by a group of social change enthusiasts, the centre is a not-for-profit organization whose mission is to find innovative solutions to social problems in Morocco through the support and mentoring of local social entrepreneurs. The MCISE has a strong presence in the social entrepreneurship ecosystem in Morocco, and strong international ties which led to the centre becoming a fellow of the prestigious Ashoka network in 2017.

1.5 Institutional arrangement and governance

Despite having no single, unified strategy for science, technology, and innovation, Morocco has three different plans[32] that contain elements of an STI strategy: the Morocco Innovation Initiative, the Moroccan National Strategy for the Development of Scientific Research through 2025, and the Moroccan Vision for Education 2015-2030, all of which are designed to work in tandem around the country's scientific and technological research priorities:

- Health, environment, and quality of life
- Agriculture, fishing, and water
- Natural resources and renewable energies
- Aeronautic and automobile industry, transport, logistics, and advanced technologies
- Education and learning
- Human sciences and contemporary challenges of the Moroccan society

Research institutions in Morocco are under the responsibility of the state with the exception of a few private institutions. Several entities and bodies are involved in the development and priority setting of STI R&D policies in the country, including legislation, evaluation, and funding:

- *The Supreme Council for Education, Training, and Scientific Research* (CSEFRS) is an independent and consultative body instituted through Article 168 of the constitution. Its primary purpose is advocating on all matters relevant to education, training, and research. It brings together a large group of expert stakeholders from government institutions, civil

society, and teachers' unions to discuss and participate in efforts relating to education, training, and research.

- *The Permanent Inter-Ministerial Committee on Scientific Research and Technological Development (CPIRSDT)* is chaired by the Prime Minister, and its mission is to coordinate R&D activities across government. It is supported by the CSEFRS.
- *The Hassan-II Academy of Science and Technology* is also under the responsibility of the Prime Minister, and contributes to the promotion of scientific research, sets the general orientations for scientific and technological development, funds scientific and technical research programs, evaluates research programs, and oversees the integration of scientific and technical research in national and international collaborative activities and socio-economic development. Its capacity to mobilize the national and international scientific communities, coupled with its financial standing, funding, and institutional positioning, makes the institution important in the orientation and promotion of scientific research activities.
- The *National Centre for Scientific and Technical Research (CNRST)* coordinates research programs among universities and scientific institutions. CNRST is also responsible for establishing and maintaining connections and collaborative programs with research institutions in foreign countries.
- The *National Agency for the Evaluation and Quality Assurance of Higher Education and Scientific Research* (ANEAQ) was created pursuant to Law 01.00 on higher education organization and its reform. Its main objective is to improve and ensure the quality, competitiveness, and diversity of training, promote scientific research, and adapt the educational system to suit the market's needs.

The figure below illustrates the key players in the Moroccan technology transfer ecosystem; their functions, and their collaborative and hierarchical relationships.

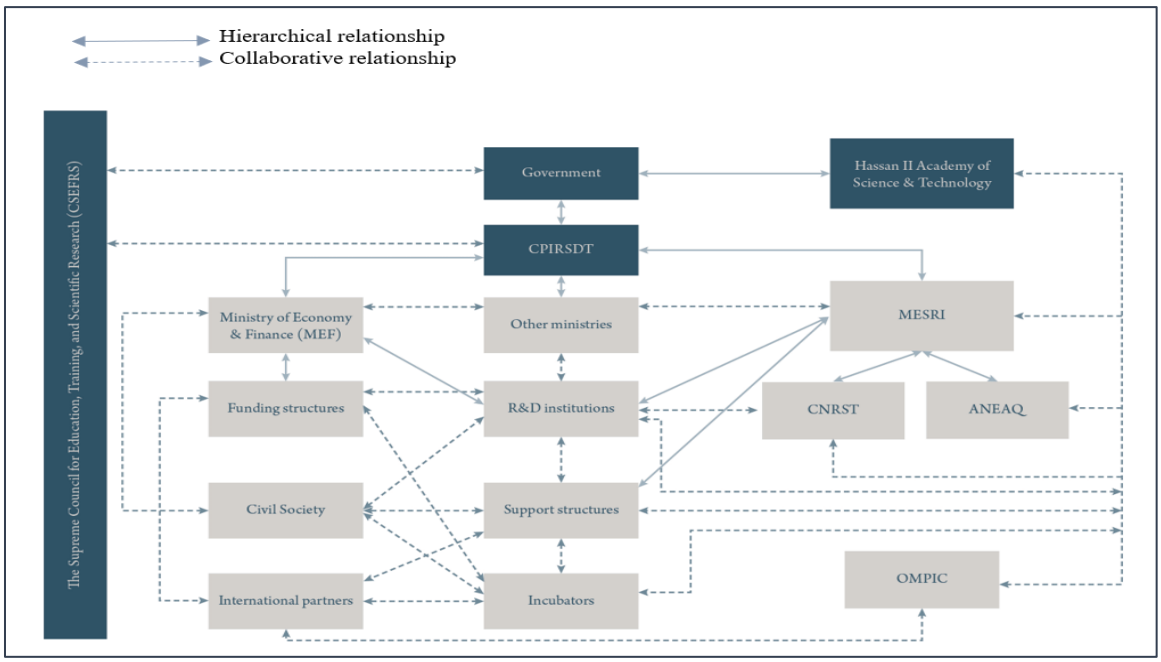

Figure 4: Technology Transfer governance in Morocco
Source: Own elaboration

It should be noted that the role of certain entities is evolving. For instance, OMPIC is set to play a more significant role in the commercialisation of research products. In 2022, it signed several agreements with Moroccan universities to help establish their technology transfer offices.

1.6 R&D funding

In 2017, Morocco invested 0.8% of its GDP in R&D, a considerable increase from the 0.34% spent in 2016, but still low compared to the 2.3% recorded in OECD countries. [33]

The latest available statistics on budgetary allocation among entities involved in R&D put institutions of higher education as the top receivers accounting for about 45% of the total budget, followed by public research institutions with 23%, with the remainder allocated to the private sector and international co-operation (see figure 5). These numbers reiterate Morocco's focus on universities to play a greater role in the technology transfer ecosystem.

Firms on the other hand, allocate significantly less funds to R&D activities. According to the Moroccan Higher Planning Commission,[34] only 6% of Moroccan firms engaged in R&D activities in 2019, with that sample being primarily large companies. It has also been noted that companies that don't invest in R&D activities cite lack of financial resources as the main obstacle.

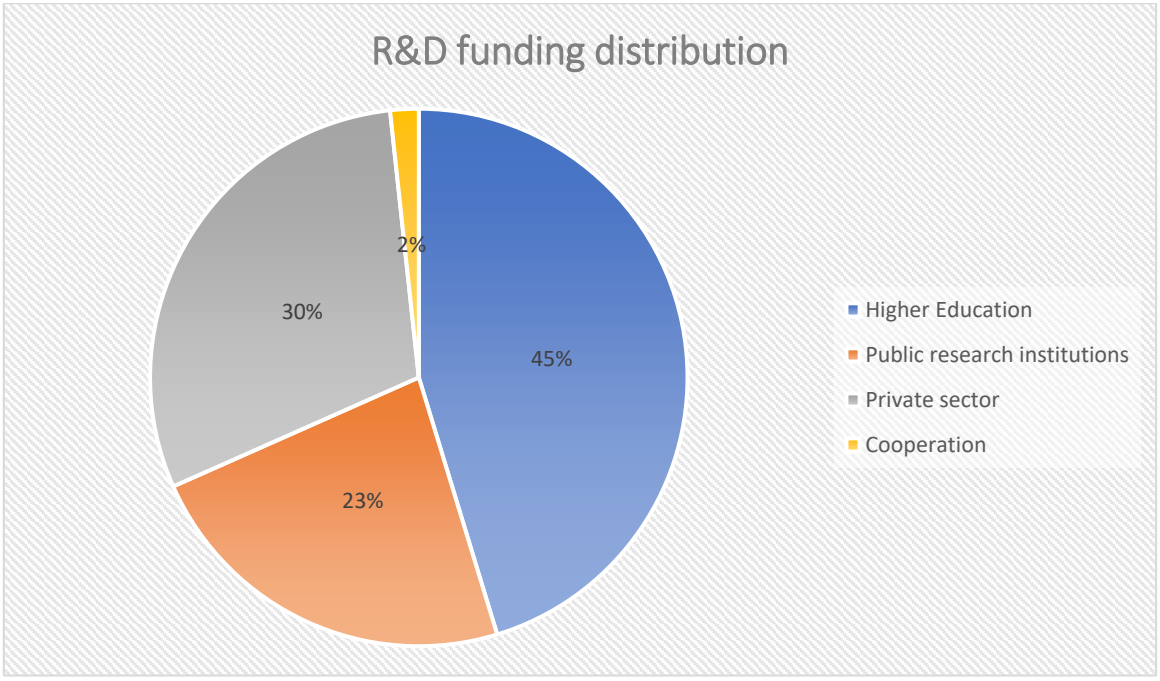

Figure 5: R&D funding distribution, 2010.
Source: Hassan II Academy of Science & Technology, Développer la recherche scientifique et l'innovation pour gagner la bataille de la compétitivité, 2012.

Given the high number of institutions involved in R&D, it would be assumed that there is a specific entity in charge of R&D overall financing in the country. However, it appears that there is no single body which allocates these fundings. In fact, several funds are emerging to support research in priority sectors to the country, such as mining, agriculture, and clean energy. These funds are administered through tenders or open calls for research and innovation in thematic areas of interest to the funding entity.

It is important to note that despite the number of R&D funding initiatives launched by various entities in the country, CNRST remains the only entity, in line with its mission of being a dynamic actor and R&D facilitator, involved in most initiatives either in the implementation, evaluation, or follow-up stages.

2.TECHNOLOGY TRANSFER SECTORAL ACTIVITIES

Technology transfer in Morocco takes various forms with inward technology transfer being the most dominant.

At the research institution-level, several bi-lateral and multilateral agreements were signed to open Moroccan universities to the world and ensure a continuous flow of knowledge exchange, and to strengthen Moroccan capabilities in sectors of priority. Prominent research centres, such as IRESEN and OCP's R&D centres and their subsidiaries, have multiplied their presence in recent years in a number of Moroccan universities in a bid to accelerate bilateral exchange of knowledge. UM6P plays particularly an important role in the national technology transfer system.

At the firm-level, the high number of multinational companies operating in the country, coupled with low R&D expenditure by Moroccan companies that are primarily MSMEs, strongly suggests that technology transfer activities are led by multinationals' subsidiaries and joint ventures between foreign and local companies.

While sufficient data on detailed technology transfer collaborations between firms in Morocco is overall lacking, it is widely understood that the most structured and successful technology transfer value chains in the country are found in the fields of mining, phosphate, agronomy and renewable energies.

2.1 Renewable energies

As environmental concerns continue to rise, Morocco has pledged 80% renewable energy use by 2050.[35] In line with its vision to achieve a greener economy by 2030, Morocco expanded efforts to mobilise local stakeholders and engage with external partners through numerous partnerships. As an example, Morocco stepped up efforts to establish an Electric Vehicle (EV) industry through a technology transfer agreement with Brazil in August 2021[36], an established Moroccan trading partner. The partnership is a joint effort between INESC P&D Brazil, a non-governmental scientific and technological institution, GEP, Morocco's Green Energy Park research platform, and the Office Cherifien of Phosphate (OCP) Group. Under the agreement, researchers in Brazil will develop the technology, while the Moroccan government will provide funding for the research. The researchers will develop a prototype of the charging equipment in Brazil, and a "twin" will be created in Morocco.

In March 2022, Morocco signed a Memorandum of Understanding (MoU) with Bahrain, to strengthen bilateral cooperation in the sector of renewable energy.[37] The goal of the agreement is to mobilise and enhance each side's expertise and resources to achieve the common goals of development and renewable energies commitments. The focus of the two partners will be on solar energy projects, the development of storage technology and automation, as well as programs to strengthen skills with dedicated training activities and workshops. Similarly, in May 2022, Morocco and Saudi Arabia signed a MoU on the peaceful use of atomic energy. The agreement aims to bring the expertise of the two countries in the field specifically as it pertains to designing, constructing, and operating of a nuclear fuel cycle and waste management. This also includes the areas of engineering and marketing innovative techniques for new generations of nuclear plants.[38]

Another noteworthy example of technology transfer in the energy sector is that of the International University of Rabat (UIR)—a semi-public university. With an average of 40 patents filed annually, the majority of its inventions aim to bring about innovation in the sectors of energy, transport and metrology. To date, the university has transferred four inventions[39] to the energy industry:

- An autonomous solar generator for schools in remote areas.
- A cylindric parabolic solar collector which was transferred to a local company called Taqa pro, a specialist in photovoltaic solar installation.
- A vacuum tube sensor operating at atmospheric pressure.
- A system of heating bitumen storage by high-energy solar panel.

It is unclear whether these inventions were transferred to national or foreign entities, however UIR remains one of the few Moroccan universities focused on technology transfer activities.

2.2 Agriculture

Moroccan society depends a great deal on agriculture. In 2020, the agricultural sector accounted for about 11.7% of Morocco's GDP, behind only the industrial (26.1%) and services (50.8%) sectors.[40]

Agriculture is often referred to as a priority sector in Morocco's development plans. This is partly because of its importance to the national economy. However, it is also because of the pressure Morocco faces to improve efficiency and increase production so that it is better able to cope with the serious challenges posed by both demographic growth and climate change.

The agricultural sector in Morocco has historically relied on traditional practices and skills. However, innovations in pesticides, fertilizers, irrigation systems, biochemistry, and digitization are bringing about promising change. To fully harness these innovations, new skills are required to understand, implement, and monitor and maintain these practices.

With this in mind, Morocco has accordingly taken steps toward understanding and adapting its agricultural sector to emerging circumstances. For instance, the country has launched a new strategic

plan called “The Generation Green 2020-2030”, which replaces and builds upon the achievements of its predecessor “The Green Morocco Plan 2008-2020”. The new plan aims to consolidate existing policies and work in synergy with other national plans, such as the “National Plan for Drinking Water Supply and Irrigation (2020-2027)” and the INTELAKA program, which offers support and funding to Micro, Small, and Medium-sized enterprises (MSMEs). One particularity of the new plan is that it puts emphasis on human capital development and inclusivity by seeking to upskill and reskill Moroccan farmers (with a view to preparing them to adapt to new technologies), promote entrepreneurship in agriculture through financing programs, and support farmers in their transition towards renewable energies and resilient and eco-friendly farming methods.[41]

In terms of technology transfer structures, the *Institut National de la Recherche Agronomique* (INRA) is the leading agricultural research body in the country, with nine scientific departments and ten regional research centres. An autonomous government institution within the Ministry of Agriculture that is responsible for crop and livestock research, the INRA runs programs on genetic improvement, genetic resources conservation, agronomy, machinery, and technology transfer.[42]

Another important research institute is the Mohammed VI Polytechnic University (UM6P), which plays a highly active role in conducting research and driving technological innovation within the agricultural sector. UM6P is not only home to the “Agricultural Innovation and Technology Transfer Centre” but also the OCP Group’s Research and Development (R&D) Centre. The latter is working to develop fertilizers attuned to African crops and soils, as well as to formulate service models that are specially adapted to African farmers and which will ensure they have reliable and affordable access to relevant data and products. [43] Moreover, in 2019, UM6P entered into an international academic partnership with two leading UK agricultural research institutions – Rothamsted Research and Cranfield University – to work jointly on agricultural research projects and set up a doctoral training centre that will support the development of the next generation of Moroccan scientists and engineers.

In January 2021, the university of Ibnou Tofail of Kenitra (UIT) transferred a patent on the production, formulation and recycling of a biofungicide and biostimulant product to the private company Agricultural and Trading Company (ATRACO) SARL.[44] This accomplishment has been described as the first of its kind in Morocco, where successful transfer of technology from university to industry has historically been challenging.

2.3 Biomedicine

The pandemic has put a spotlight on technology transfer and more specifically on home-grown capabilities. After learning hard lessons from the pandemic, many countries, including Morocco, began the race towards vaccine self-sufficiency and sovereignty.

In early 2022, Morocco began the construction of a manufacturing vaccine plant, to implement the SENSYO Pharmatec project – a partnership between the Swedish company Recipharm and a consortium of Moroccan banks and entities – with the ultimate goal of making the country a regional hub for pharmaceutical and vaccine innovation. The $500 million project with investment over a five-year period is set to propel the country into a new era of health science, and will equip the country with the capacity and capability needed for self-sufficiency.

In line with Morocco’s goal towards local manufacturing and industrialisation of medical products and solutions, an agreement was penned between the Moroccan ABA Technology Group and the Moroccan Medical & Biomedical Industrial Cluster (MMI) in December 2021, under the aegis of the Ministry of Industry and Trade.[45] In this partnership, The MMI Cluster will benefit from the ABA Technology Group’s robust and varied expertise across engineering, manufacturing of electronic boards, and embedded software and plastic injection dedicated to the medical sector. This expertise

will be leveraged to provide targeted support to the MMI Cluster through the transfer of technological and industrial know-how in the manufacture of medical devices.

Perhaps another relevant example showcasing instances of technology transfer between two national entities is that of the partnership between UM6P and the Anoual Laboratory – a leading medical Moroccan laboratory based out of the city of Casablanca. The two entities had already been collaborating during the pandemic across several key areas such as the first sequencing of the Sars-Cov-2 genome, and the implementation of an original diagnostic method for Sars-Cov-2 by infrared spectroscopy and machine learning.To further advance their partnership by continuing to play out and mobilise each other's expertise and strengths in advancing development of new diagnostic technologies and medical treatment, UM6P and Anoual laboratory signed a partnership agreement in May 2022.[46] The partnership would help develop several research axes in human genomics and metabolomics and artificial intelligence, paving considerable progress in new diagnostic tools and technologies, as well as medical treatment of certain cancers and metabolic diseases.

2.4 The automotive sector

In 2017, Morocco ranked the highest of other African countries in UNCTAD's Liner Shipping Connectivity Index (LSCI) and the Liner Shipping Bilateral Connectivity Index (LSBCI). These indexes score various countries based on the quality of links, with an emphasis on routes with transhipments. [47] Morocco's scores revealed that the country's best connections include Spain, Belgium, UK, France, Netherlands, and Germany—all leading automotive industry markets—an advantage that the country can leverage to build and develop its automotive industry. Official figures reveal that as of 2019, the country's automotive industry recorded an $8.3 billion in export turnover and a 60% integration rate, created 220 thousand jobs, counted an estimate of 250 companies operating in the automotive industry (as compared only to 35 in 2000), and represented 27% of total Moroccan exports. [48]

Morocco laid the ideal ground for an influx of foreign original equipment manufacturers (OEMs) and their suppliers. This was made possible with a strong value proposition, including Morocco's advantageous location, reliable infrastructure, land, competitive labour costs, and a number of financial incentives and support structures:

- *Free Trade Zones (FTZs):* FTZs have been set up in the cities of Tangiers, Rabat and Kenitra. Companies operating out of these special economic zones enjoy a range of legal and financial benefits, such as income tax and VAT exemption, and access to a range of government services.
- *Institutional support:* Several entities and task forces have been formed to develop, implement, and support Morocco's automotive ecosystem. These include the Directorate of Automotive industries at the Ministry of Industry, Trade, and the Green and Digital Economy (MICEVN); the Moroccan Investment and Export Development Agency, which supports companies with their investment activities in the country; and The Moroccan Automotive Industry and Trade Association (AMICA), which serves as an interface between various stakeholders in the industry both public and private.
- *Training and capacity building:* A network of training and capacity building centre has been established to address the needs of staff operating in the industry. The Automotive Industry Training Institutes (IFMIA) run four training centres, one of which is run by Renault and located in one of Renault's plants.

As of 2022 the country has four integrated industrial clusters in Casablanca, Rabat, Tangiers, and Kenitra, as well as four specialised training institutes, one of which is run by Renault. Tangiers remains the locale where most of the industry's activity is clustered. The major industrial players operating in Morocco include China's BYD, Renault- Nissan, and PSA Peugeot-Citroen, and key automotive part suppliers include: Japan-based Yazaki, Germany-based Schlemmer, Ireland-based Delphi Technologies, and US-based Lear Corporation.

To manage the growth of the automotive sector in the coming years, Morocco restructured the industry by adopting a new ecosystem approach with the chief objective of ensuring better visibility across the value chain, better organisation, focused support, and above all, promoting greater integration of the sector. The country counts eight specific ecosystems[49]:

- Automotive wiring. Main operators include Delphi, Yazaki, Leoni, Lear, Stahlschmidt and Fujikura.
- Metal pressing. Main operators include Socafix and Gestamp.
- Automotive batteries. Main operators include Electra and Maribat.
- Vehicle interior and seats. Principal operators include SIGIT and Faurecia.
- Heavy goods vehicles and industrial bodywork; Scania Morocco and Irizar are among the main operators.
- Motors transmission (Powertrain); the main operator is Global Mecaplast.
- Renault manufacturing
- Peugeot SA manufacturing

In line with its accelerated strategy to become the world's most competitive automotive hub, Morocco recognises the importance of expanding R&D activities. In support of this aim, the country multiplied efforts to host a number of leading R&D centres in order to catalyse the technical and technological progress of Morocco's automotive sector, and consequently, its technology transfer across the entire automotive value chain. These R&D centres include:

- *The Technical Centre for Vehicle Equipment Industries (CETIEV 2.0):* A centre dedicated to Stellantis (a merger of Fiat Chrysler automobile and Peugeot SA) R&D activities which brings a new expertise to Moroccan R&D. It is comprised of a physical testing facility linked to the activities of automobile development and validation which was previously conducted abroad. It specifically concerns electric, mechatronics, acoustic testing. [50]
- *FEV and UTAC CERAM centre:* A cutting edge development and testing centre born of a joint venture between the German FEV, a leading service provider of vehicle and powertrain development for hardware and software, and the French UTAC CERAM, an independent service provider in all areas of land transport.[51] This centre will help Morocco become autonomous where the homologation of parts and vehicles is concerned.

While the increasing presence of multinational companies in Morocco is setting the country on the path to becoming a global leader in the automotive industry and furthering its industrialisation, it should be noted that the number of Moroccan owned companies in the industry remains concerningly small. Such circumstances call for a refocused strategy, one in which increased government intervention is required to expand the role of Moroccan firms in the national economy. This can be achieved by integrating Moroccan firms into the industry's national value chain by ensuring access to capital and, most importantly, continuous access to learning and transfer of knowledge from the global players operating in the country.

2.5 The defence sector

Over the years, Morocco leveraged its bilateral connections to strengthen its defence sector. According to the Stockholm International Peace Research Institute (SIPRI), Morocco is the third largest arms buyer in Africa for the period extending from 2012 to 2021, just behind Egypt and Algeria – and 25th globally, accounting for 1% of global arms imports for the same period.[52] The United States is the country's top arms supplier, with imports including advanced arms and ammunition.

Beyond imports, Morocco's bilateral and multilateral defence partnership encompasses multiple military exercises, training, counter-terrorism operations, and stabilization participation, by which Morocco can strengthen its military capabilities through human and technical interoperability. The increasingly critical role that Morocco plays in sustaining peace and security in what is considered a highly volatile geostrategic environment granted the country the praise of the international defence community. Today, Morocco is considered a Major non-NATO-ally (MNNA) and is one of the 15 partner countries of NATO's Defence Education Enhancement Programme (DEEP), a programme for defence capacity and institution building.[53]

Amid the ever-evolving international context, Morocco places industrial sovereignty across a number of sectors as a matter of priority. For years, it has expressed its ambition to develop the defence industry, allowing for relief from its heavy dependence on foreign military equipment and arms. To put their proposal into practice, the country enacted Law n° 10-20 in July 2021, relating to security and defence equipment and material, and arms and ammunition.[54] The law serves as a framework to establish an industrial and technological basis for the country's defence industry. The new framework specifically paves the progressive path of establishing private industrial units in the country, thereby offering numerous incentives that would enable foreign investors to choose the country. Such incentives include VAT exemption on sales for public organs in charge of security and defence and a possible derogation from the Moroccan law dictating that setting up a business in the country would require a mostly Moroccan capital. Although the road to achieving this in the defence industry is one that is both long and fraught with challenges, the country nonetheless aims to, slowly and surely, develop its own military industry. Law n° 10-20 represents a pivotal milestone in developing and regulating the industry while incentivising foreign players to establish ties in the country, thereby drawing strategic and economic benefits from it.

Another strategy adopted by Morocco to fortify the defence industry is to leverage existing relationships with key trade partners. For instance, in 2019, Morocco and Brazil signed a deal to share military technology; the agreement focuses on several core areas of research and development, science and technology, logistical support and acquisition of defence products and services.[55] In another example of defence diplomacy, following the normalization agreement between Morocco and the State of Israel in 2020 – and brokered with the US assistance – Morocco and Israel signed in November 2021 a defence memorandum including the exchange of experiences, expertise and technology transfer.[56] Other countries understood to have technology transfer agreements with Morocco in defence and counterterrorism include India, Pakistan, and Turkey.

To duplicate the success of its automotive and aerospace industry exports, Morocco began expressing keenness – as early as 2017 – to become military arms and equipment producing country. Such plans finally began to materialise in April 2022. In what has been labelled a "significant cooperation", Belgian aerospace firms Sabca and Sabena entered into a strategic partnership with Lockheed Martin, an American aerospace, arms, defence, information security, and technology corporation, to build a new military aircraft maintenance facility in Morocco. The partnership includes the construction of a state-of-the-art 15,000 sqm Maintenance, Repair, Overhaul and Upgrade (MRO&U) centre for military aircraft and helicopters at Benslimane Airport.[57] In addition to the new jobs it is expected the create, the added value to the country lies in the fact that such a plant will allow the country to receive the best industrial facility, equipment, training and certification to

support the Royal Moroccan Air Force. Most importantly, however, it serves as a medium for technology transfer and lays the perfect ground for the country to develop its own plants in the future.

2.6 Academia

In December 2021, Morocco celebrated its first anniversary of renewed diplomatic ties with the state of Israel, which forged several bonds across many sectors. The most notable is in that of academia, where a partnership between the University of Jerusalem and UM6P aims to promote academic collaborations between the two universities — from student and academic staff exchanges to joint research and collaborative degrees.[58] In September 2021, UIR and Israel's Ben-Gurion University of the Negev signed a MoU to collaborate on research and education;[59] specifically the two institutions seek to develop a scientific partnership through joint research, teaching, student, and staff mobility.

Similarly, in April 2021, Morocco began the process of its association with the European Programme "Horizon Europe"[60] — the EU's key funding program for research and innovation with a budget of 95.5 billion Euros.[61] By becoming an "Associated country," Moroccan researchers will access the program's call for projects. The program will also encourage and facilitate their rapprochement with the EU Member States, companies, NGOs, and social partners in exploiting research and technology transfer.

In another example of science diplomacy, Morocco signed a memorandum of understanding (MoU) with Hungary[62] in November 2019, to step up academic cooperation and scientific research; the initiative intends to develop joint programs in scientific research and technology transfer in addition to students and teachers exchange programs between the two countries. Similarly, Morocco and Vietnam in December 2021 — celebrating their 60thanniversary of relations — signed a declaration of intent to deepen cooperation opportunities in scientific research and innovation through a raft of measures; including an academic forum every two years, joint research programs, and the exchange of university experiences and mobility of student and researchers.

3. TECHNOLOGY TRANSFER KEY CHALLENGES

Despite the numerous initiatives undertaken by Morocco to promote technology transfer, current efforts remain riddled with challenges. Today, strategic plans are underway to correct the path and solve a number of issues. Some challenges are more complex than others and therefore require both an integrated approach and inter-ministerial cooperation. From the perspective of a research institution, commercialising and promoting research outputs is difficult not only due to lack of resources, but also researchers' lack of understanding regarding the commercial value of their work. Bridging the proverbial “Valley of death” has been difficult due to the industry’s lack of absorption capacity, compounded by the difference in cultures between academia and their respective industries.

At the firm level, start-ups are the backbone of numerous African countries, but do not play a dynamic role in the Moroccan R&D, particularly in technology transfer. This is partly due to stiff legal and fiscal policies and partly due to technology transfer simply not being a priority. For established SMEs, however, Morocco’s offshoring industry represents a key opportunity to explore technology transfer opportunities if the necessary pre-requisites are met, such as continuous access to financing and capacity building programmes to increase chances of integration in the industry.

Overall, the absence of necessary national indicators and a system for tracking, monitoring and evaluation to thoroughly understand technology transfer activities in research institutions and firms, calls into question the validity and efficiency of existing mechanisms and data used to design policies.

3.1 The challenge of brain drain

In an increasingly global world and ever-evolving tectonic market shifts, we see developed countries becoming both importers and exporters of talent. This is translated in the number of foreign expats we see in developed countries, especially in middle eastern countries such as the UAE. According to a Linkedin study[63], more talent is now heading to the Middle-East, Africa, and South Africa, showing an impressive reverse of flow.

As of 2021, Morocco has the highest rate of brain drain in the Middle-East and North African region after Syria[64]. The phenomenon is specifically seen among graduates who often, after completing their studies abroad, decide to stay abroad, where several high-skilled and global talent visas offer the path for residency and citizenship. The bulk of Moroccan engineers are in Europe, specifically in France, a choice that is particularly attractive due to the shared languages and historical links that makes cultural integration easier. However, it should be noted that the Moroccan diaspora can more recently be found in the US, Germany, Canada, and the UK; a slight tilt towards English speaking countries from where they hope to head to the middle east and work for Emirati, Saudi, or Qatari companies.

The issue of brain drain is acknowledged and openly debated in Morocco, where retention of local talent is making its place in key strategic plans. Several initiatives were undertaken to address the push and pull factors that lie behind the brain drain in Morocco such as unemployment, inadequate policies, poor entrepreneurial system, lack of incentives, inability of the local economy to absorb and appreciate talent, and much more. Initiatives have also been taken to encourage the return of skilled Moroccans and retain the local talent:

- To curb the outflow of students to France, some prestigious French schools established outposts in Morocco such as l'ESSEC, Centrale, INSA and more, offering the same programs that are taught in France. While this initiative could benefit Moroccan students by offering them a world-class education and a foreign degree in the comfort of their home country, others are yet to be convinced that this option is as enriching as an experience abroad where they are immersed in a multi-cultural environment and are pushed out of their comfort zone.
- Extend a welcoming hand to Moroccans abroad through the FINCOME program: FINCOME, translated from Moroccan Arabic for "where are you", is a programme that aims to mobilize the skills of Moroccans living abroad; this is achieved through a database of qualified Moroccans abroad that are called upon to support research, training and development activities in the country and ensure a continuous flow of knowledge exchange and transfer, either on a perennial or limited basis. This will bridge the gap between Moroccans at home and abroad and strengthen this bond through various bilateral cooperation projects.

Morocco has a devoted a great deal of effort to addressing brain drain, and while some progress has been made, it remains to be seen whether the initiatives will lead to successful and sustainable results. The general sentiment amongst youth is that a move abroad has more to offer than staying home. Whilst opportunities abroad are easily found in some cases due to the local economy's inability to absorb a large amount of talent, there's also a long-held belief that those who emigrated are living a more fulfilling and rewarding life, assuming that such satisfaction is exclusive to travelling and living abroad due to perceptions of a lack of local opportunities. The attraction and encouragement of living, studying, and working abroad is a routine topic of discussion within the rising talents in Morocco. However, Morocco's evolution over recent years appears to be largely ignored in the decision-making process of these prospective talents.

3.2 Lack of funding and incentives

Overall, policy dialogue on technology transfer in Morocco appears to be primarily focused on universities. This could mistakenly convey the idea that universities are supposed to assume a larger role in technology transfer systems, while in fact, the process is highly interactive and requires wide collaboration between different partners, including firms. Notwithstanding this dominating narrative, public research institutions (including universities) and firms face the same challenge which is lack of funds and incentives to engage and invest in R&D activities in a substantive way.

At the university-level, the role and status of the researcher are not well-defined, specifically where research output, ownership and commercialisation are concerned. This not only limits the researcher's scope but also sets them back in the absence of any incentive that would reward them for innovation; it isn't clear whether universities have in place a reward system or research or innovation-related KPI for career advancement. Additionally, it is not clear whether there's a unified research strategy that governs Moroccan universities; the same applies to research budget within universities, it is unclear how the research budget is allocated.

At the industry level, R&D activities inside Moroccan companies remain very limited in the absence of incentives such as tax breaks. Indeed, the majority of firms in Morocco rely on technology sourced from abroad as it is perceived as a strategic choice to cut costs that would have otherwise been incurred by long and heavy investment in R&D activities. With that being said, and looking at the local market overall, the outputs of research & development labs are often too sophisticated for the local industry to absorb them, resulting in what could be perceived as a waste of time and resources or, in the most optimistic scenarios, a long journey to commercialization.

3.3 Cultural difference between university and industry

In addition to the challenges aforementioned, cultural differences between universities and industry present another gap that must be bridged. Indeed, the two operate in two different environments with different sets of rules, missions, and mandates (see table below).

Parameter	Academia	Industry
Research type	Basic research	Applied research
Research Orientation	Curiosity-driven research	Problem-solved driven
Time horizon	Long-term	Short-term
Output	New knowledge	New product
Openness	Publication & Openness	Ownership and Confidentiality
Research strategy	Scientific freedom	Technology roadmaps
Cultural mindset	Sharing	Control
Responsibility	Social responsibilities	Shareholders' responsibilities

Cultural differences between academia and industry.
Source: European Commission, The Open Innovation 2.0 Yearbook, 2015.

The contrasting modes of thinking and operation call for flexibility from both sides. Universities, and more specifically TTOs, must be well equipped with the marketing, commercialisation and execution skills to "speak the language" of the industry.

Industry, on the other hand, must show more willingness to scout, absorb, adopt, and exploit external innovation to complement and improve internal capabilities and consequently, competitivity. The divergence of culture between academia and industry is quite pronounced in Morocco for two reasons. Firstly, the lack of interaction between the two around collaboration is a problem; students find difficulties finding internships in the country because the local economy is not developed enough to absorb emerging talent, especially in STEM. Secondly, the concept of “learning by doing” or industrial placement is non-existent in the country, but MESRI is exploring it as part of its PACTE ESRI 2030.

Bridging this gap in culture is particularly important as universities file the highest number of patents in the country, but rarely succeed in commercialising them, a task that is often assigned to Technology Transfer Offices (TTOs). The most notable examples of TTOs in the country were highlighted in the previous section, but such structures remain scarce and lack the substantial skills, expertise, and means required to play an active role in assisting universities in commercialisation. To address this, foundations were laid in the first quarter of 2022 to set up TTOs in a number of Moroccan universities with the support of OMPIC, which will assist in defining the business and governance model of developed structures.

4.RECOMMENDATIONS

Over the past two decades, Morocco has made significant and impressive progress building its science, technology, and innovation ecosystem. It has also recently announced plans to usher in a new era of home-grown capabilities – for Moroccans, by Moroccans. A transformational programme was announced in early 2022 by the Ministry of Higher Education, Scientific Research, and Innovation. This initiative would overhaul the Moroccan educational system and transform Moroccan universities through the adoption of University 4.0, ready to respond to the new global economy and associated technological trends.

It is still too early to assess the potential of such strategies in tangibly improving Morocco's technology transfer ecosystem; however, an analysis of the current system has unveiled several challenges which require a multi-stakeholder and multidimensional approach. This is in order to improve the existing technology transfer infrastructure and address the internal and external variables that influence the technology transfer value chain in the country. Progress lies first and foremost in the hands of the government, and the key actions at the forefront of any technology transfer strategy are as follows:

Yearly or biennial surveys on national technology transfer systems. A multistakeholder committee should be formed to monitor technology transfer activities. Despite previous plans by MESRI to form such a committee, it has yet to be created. Such a committee would be under the responsibility of several ministries, including MESRI, MIC, and the Ministry of Digital Transition and Administrative Reform. The committee should be mandated to commission yearly or biennial surveys on the technology transfer system in the country, covering both firms and research institutions, creating a national registry for technology transfer activities in the country, and providing policy guidance based on practices observed both at home and abroad.

Create a multitude of educated professionals and entrepreneurs. This goal is two-fold: firstly, it aims to reduce dependability on external resources and capabilities, and grow and strengthen domestic industry; secondly, it aims to grow the capacity to create innovation and support an effective transfer of technologies from the innovation source, to the industry.

Address the human capital flight. Many skilled Moroccans are moving abroad, and this trend has not shown any signs of slowing. Whilst mobility is a human right, devoting significant resources to education becomes counter-productive when the developed talent leaves the country. This problem should be addressed from three angles: improving information access about, to, and from the Moroccan diaspora; understanding their needs; and adopting a multi-stakeholder dialogue approach to design effective strategies to entice and mobilise the Moroccan diaspora to take an active role in the development of the country.

Several options should be explored. This includes enlisting their expertise for short-term missions in the country to rebuild ties with their home-country; multiplying the number of worldwide networks to ensure continuous engagement and funding, which could be led by Moroccan missions abroad; exploring hybrid engagement strategies – physical, virtual, full-time, and part-time – to transfer skills;

and improving access to information on job opportunities in Morocco, starting with Moroccan students who study abroad.

Introduce and enact a start-up bill. Many African countries have enacted start-up bills, including Senegal, Nigeria, Kenya and Tunisia, Rwanda, and Ethiopia. Morocco should begin the dialogue on a framework that defines the relationship between the government and start-ups. A start-up act would encourage the development and growth of start-ups through fiscal and non-fiscal support, while creating a business environment in which government, entrepreneurs, investors, and civil society work together toward a common goal. Subtle debate has emerged in recent years to define the legal status of start-ups in Morocco. Such a bill would not only address this issue but would also consolidate existing laws on start-ups.

Promote the use of the English language in teaching and learning. English is the international language of business and research. In Morocco, Arabic and French remain the official languages across the sectors of academia and business, although a limited number of universities offer English curriculums. Introducing multilingual curriculums could promote research collaboration and improve employment prospects.

Promote industrial placements. Experiential learning, or "learning by doing", is virtually non-existent in the Moroccan academic experience. An industrial placement could offer an extended period of work experience during which university students can take a hands-on approach in applying their learnings in the workplace, and therefore acquire new skills. Such experiences prepare students for the corporate world and allow students understand the commercial value of innovation.

Increase the budget dedicated to research. Although this has been a priority for several years, current funding is still not sufficient for generating the expected added value for the country.

Encourage research contribution and productivity at the university. This starts with allocating sufficient funds for research at the university level and providing appropriate compensation and incentives to research participants. In Morocco, the results of publicly funded research and development belong to the institution at which the research was undertaken, as is the case in most countries. However, there are instances where the institution may not have the resources to exploit the result of an invention. In such cases, it could be beneficial to transfer the IP ownership to researcher.

Encourage the participation of the private sector in R&D activities. Despite the private sector's role in the conception of many national strategies, such as the Moroccan Innovation Strategy, private sector involvement in R&D in Morocco is rare to non-existent. This is often attributed to a lack of incentives. Tax credits and subsidies have generally proven effective in inducing a certain degree of participation of the private sector in R&D, and should be considered here.

Better define the structure and legal status of incubators in Morocco. This specifically applies to university incubators that occupy various positions inside the university, ranging from support services and small structures – to large structures with multiple partners. Modern times call for a unified model across all universities in Morocco, where all incubators operate under the same procedures and standards. Additionally, incubators do not enjoy autonomy vis-a-vis the university; they are highly dependent on the funding and human resources allocated by the university. These

resources are often not enough to sustain the operations of the incubator and take promising ideas off the ground.

Consolidate current initiatives and structures to promote innovation. There are several initiatives and support structures to promote innovation and scientific research; however, they often do not appear to work in synergy. Additionally, programs are often discontinued, which is in part due to the new cabinets after each election cycle. New cabinet members often dismantle their predecessors' programs without fully assessing their merit and efficiency, before announcing new ones.

Instore monitoring and evaluation (M&E) mechanisms for STI activities in Morocco. To simply document, analyse and report on research and technology transfer activities in terms of performance and impact.

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