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Study on Unlocking the Potential of the Fourth Industrial Revolution in Africa

Country case: Morocco

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Karine Kouassi Lou, Francie Sadeski, Matthieu Lacave

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List of acronyms

4IR	Fourth Industrial Revolution
ADD	Digital Development Agency
AfDB	African Development Bank
AI	Artificial Intelligence
ANRT	National Telecommunications Regulatory Agency
AVR	Augmented and Virtual Reality
CPI	Corruption Perception Index
CNDP	National Commission for the Control of the Protection of Personal Data
DAS	Data Acquisition Systems
DER	Distributed Energy Sources
EESC	Economic, Social and Environmental Council
ETRI	Electronics and Telecommunications Research Institute
EMR	Energy Management System
ESS	Energy Storage System
EV	Electric Vehicles
FDI	Foreign Direct Investment
FTAs	Free Trade Agreements
LNG	Liquefied Natural Gas
LTE	Long Term Evolution
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GMP	Green Morocco Plan
HDI	Human Development Index
IAP	Industrial Acceleration Plan 2014-2020
ICT	Information and Communication Technologies
IEEE3	Institute of Electrical and Electronics Engineers
IIAG	Ibrahim Index of African Governance
IoT	Internet of Things
IP	Intellectual Property
IPR	Intellectual Property Rights
IRESEN	Solar Energy and New Energies Research Institute
IT	Information Technology

NIA	National Information Society Agency
OCP	Office Chérifien des Phosphates
OECD	Organisation for Economic Cooperation and Development
PCP Morocco	Programme for Country Partnership for Morocco
R&D	Research and Development
SECRETS	Sustainable Energy Clusters Realised Through Smart Grids
SME	Small and Medium Sized Enterprise
STEAM	Science, Technology, Engineering, Arts and Mathematics
STEM	Science, Technology, Engineering and Mathematics
UAVs	Unmanned Aerial Vehicles
UM6P	University Mohammed VI Polytechnic
US	United States
WEF	World Economic Forum
WGI	World Bank's Worldwide Governance Indicators
WIPO	World Intellectual Property Organization

1 Introduction

This document is one of the five country case studies drafted in the framework of the Study to Unlock the Potential of the Fourth Industrial Revolution (4IR) in Africa. The overall study aims at i) understanding the preconditions for the adoption of 4IR technologies, challenges and drivers, positive and negative effects; ii) describing the technologies for knowledge dissemination, including domains of application; iii) benchmarking emerging countries; iv) demonstrating applications in Africa; v) in order to conclude on a business case and vi) recommend interventions and vii) design specific ICT components for AfDB projects which will showcase the feasibility of supporting the 4IR in Africa.

This case study thus looks in depth at the potential for the adoption of key 4IR applications with diverse geographical, political, economic, technological and social preconditions:

- It reviews the socioeconomic situation of the country and the implications for technological readiness for the 4IR.
- It assesses the potential for the 4IR to be used in the key economic sectors of the country, i.e. the High Five AfDB priority fields, which are agriculture, energy supply, industry manufacturing, regional integration and well-being (including financial inclusion, smart cities, education and healthcare).
- It concludes on the business case for the 4IR in the country.
- It proposes recommendations at the national level.
- It envisions potential AfDB interventions or projects.

Our team collected data by drawing on existing research and public policy documents and by consulting local stakeholders. This was done either on the telephone, online or in person. One field visit per case study country was organised to allow the team to acquire a deeper understanding of the local conditions and peculiarities and to be able to identify the most relevant use cases. The field visit took place as part of a five-day trip and included face to face meetings with key stakeholders from government, the private sector, researchers and NGOs (about 25 meetings).

The document revolves around eight chapters. It has been enriched and finalised following a workshop with stakeholders that was held in early June 2019.

2 Country presentation

2.1 Economic, socio-demographic and industrial profile

Morocco is currently the 4th largest African economy, with a Gross Domestic Product (GDP, PPP) in 2017 of $121.4 billion[1]. In the Arab world, Morocco has the second largest non-oil GDP, as of 2017, and is considered as one of the most competitive economies in north Africa[2]. The population of Morocco was about 35.2 million in 2017, with over 73.5% being in urban areas[3]. In its report for 2017, the Economic, Social and Environmental Council (EESC) points to the persistence of significant inequalities at regional and territorial level, indicating that the latter are observable both economically and socially. The youthfulness of the Moroccan population is another salient feature. However, the decline in the ratio of young people compared to the total population has been palpable over the years (from 44.4% in 1960 to 37% in 1994, then 27% in 2018). The active population (15-64 years old) represents the preponderant part of the population (67%). Morocco is experiencing an extremely rapid demographic transition driven by a drop in the fertility rate (from 5.9 children per woman in 1980 to 2.3 now) and the improvement in living conditions (life expectancy rose from 59 years old in 1980 to 75 now).[4]

Morocco's economy is relatively liberal and is governed by the law of supply and demand. The Moroccan economy is predominantly service-driven (the main activities are tourism, telecommunications, financial services and transportation). In 2017, the services sector accounted for 57% of GDP, with industry made up of mining, construction and manufacturing accounting for 30%, while agriculture accounted for 13%. The inflation rate is quite low and has not exceeded 2% since 2008. Economic growth averaged 3.5% between 2012 and 2015 but slowed down to 1.8% in 2016 due to a poor agricultural harvest, -which is a major contributing sector to the Moroccan economy[5].

In 2017, Morocco exported $25.6 billion and imported $45.1 billion. The country's imports are mainly composed of oil, machinery, vehicles, plastics and cereals. The country mainly exports electrical machinery, vehicles, fertilisers, clothing, minerals (phosphates), vegetables and fruit. In recent years, Morocco has lost market share for clothing and shoes in particular while facing competition from Asia but managed to expand its market share for fertilisers, passenger vehicles and equipment for the distribution of electricity[6]. Following a decade of policies to support industrial development, the performances of Morocco's new industries (automotive, aeronautical and electronics) have thus effectively diversified the country's export base[7] (see Table *1*).

Table 1: Top 10 exported and imported products, value in 2017, USD thousand

Exports		**Imports**	
Product	Value	Product	Value
Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television ...	4,228,397	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral ...	7,168,685
Vehicles other than railway or tramway rolling stock, and parts and accessories thereof	3,395,412	Machinery, mechanical appliances, nuclear reactors, boilers; parts thereof	4,750,992
Fertilisers	2,583,563	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television ...	4,600,002

[1] https://www.afdb.org/en/countries/north-africa/morocco

[2] WEF 2014-2015

[3] https://www.afdb.org/en/countries/north-africa/morocco

[4] High Commission for Planning (HCP) 2017

[5] AfDB's Country Strategy Paper, Kingdom of Morocco, 2017-2021

[6] Arab States. In: UNESCO Science Report: towards 2030

[7] African Economic Outlook 2017

Articles of apparel and clothing accessories, not knitted or crocheted	2,399,404	Vehicles other than railway or tramway rolling stock, and parts and accessories thereof	4,588, 064
Fish and crustaceans, molluscs and other aquatic invertebrates	1,309,486	Plastics and articles thereof	1,879,311
Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, ...	1,137,458	Cereals	1,392,693
Edible vegetables and certain roots and tubers	1,123,072	Iron and steel	1,263,186
Salt; sulphur; earths and stone; plastering materials, lime and cement	1,080,795	Articles of iron or steel	853,831
Edible fruit and nuts; peel of citrus fruit or melons	917,084	Aircraft, spacecraft and parts thereof	770,609
Articles of apparel and clothing accessories, knitted or crocheted	779,160	Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, ...	752,098

Source: ITC Trade Map

2.2 Broad policy objectives

A series of sectoral plans aimed at ensuring strong, sustainable and wealth-creating economic growth have been put in place by Morocco's public authorities for the period from 2015 to 2020. These plans are part of a dual logic of the modernisation of traditional sectors such as agriculture, fishing and mining and the development of innovative sectors such as renewable energies, logistics, the automotive industry, aeronautics and services with higher added value.

These sectoral plans[8] are:

- In agriculture, the **Green Morocco Plan** sets out a roadmap to revive the sector, a main driver of growth of the national economy. Launched in 2008, this plan aims to develop intensive and modern agriculture and to modernise small-scale farming and to improve the incomes of small-scale farmers.
- In energy, the **Energy Strategy 2030** (launched in 2009 but periodically reviewed) intends to foster the development of renewable energies (expected to account for 52% of national production in 2030, with 2,000 MW of solar energy and 2,000 MW of wind energy), to secure the energy supply in a context of strong growth in energy demand, to control the future costs of energy services in relation to the upward trend in prices of petroleum products and finally to preserve the environment by reducing greenhouse gas emissions. Additionally, the **Development of Liquefied Natural Gas Plan** aims to build the infrastructure needed to receive liquefied natural gas, its regasification, its transportation and its use in power generation and industry. The plan also aims to meet national electricity demand, reduce energy dependence on the outside world and fossil fuels through the rise of renewable energies and the development of local energy resources, as well as to ensure security of supply of energy.
- In industry, the **Industrial Acceleration Plan 2014-2020** develops a new approach based on the establishment of more efficient ecosystems, aiming at the integration of value chains and the consolidation of local relations between large companies and SMEs. The plan is expected to generate more jobs in the sector with a significant increase in the industry's share of GDP. These changes require diversification and enlargement of the industrial fabric as well as a better link between large companies and SMEs. The strategy also sets a goal for creating a more sustained pace of Foreign Direct Investment (FDI) growth, with a public investment fund worth €2 billion. Additionally, the **Development Strategy for the Mining Sector** focuses on developing investment in research

[8] Source : http://www.invest.gov.ma/?Id=8&lang=fr
https://www.men.gov.ma/Fr/Documents/Vision_strateg_CSEF16004fr.pdf

and prospecting, promoting the market to attract national and international investors, updating regulations and enhancing the mining heritage. It provides an implementation path for several structural pillars affecting the entire chain of mining activity: exploration, research, exploitation, recovery and processing of minerals.

- In 2009, the **National Strategy for the Development of Scientific Research to 2025** recommended raising the secondary enrolment rate from 44% to at least 80% and the tertiary enrolment rate for 19–23-year-olds from 12% to over 50% by 2025. As of 2014, unemployment remained high, at over 9% (even though Morocco is one of the five African countries which had an employment rate above 2% in 2018, but there is still invisible underemployment in urban cities[9]) and about 41% of the labour force lacked any qualification. The more recent **Strategic Vision 2015-2030 of the Reform of the Moroccan Education System** aims at setting up a new school, whose principal foundations are: equity and equality of opportunity; quality for all; the promotion of the individual and society.

- Concerning innovation, the **Moroccan Innovation Strategy** was adopted at the country's first National Innovation Summit in June 2009 by the Ministry of Industry, Commerce, Investment and the Digital Economy. It has three main thrusts[10]: i) to develop domestic demand for innovation; ii) to foster public-private linkages; and iii) to introduce innovative funding mechanisms, including Intilak for innovative start-ups and Tatwir for industrial enterprises or consortia, with the aim of generating 1,000 patents and creating 200 innovative start-ups by 2014. In 2011, the Moroccan Club of Innovation was created in partnership with the Moroccan Office of Industrial and Commercial Property in order to foster a network of players in innovation, including researchers, entrepreneurs, students and academics. The government is also encouraging citizen engagement in innovation. One example is the Moroccan Phosphate Office (*Office chérifien des phosphates*), which has invested in a project to develop a smart city, the King Mohammed VI Green City, around Mohammed VI University and located between Casablanca and Marrakesh, at a cost of DH4.7 billion (*circa* $479 million).

- Recent international and government initiatives have addressed the availability of pre-seed and seed funding, notably the setting up of the Innov Invest Fund, which was officially launched in October 2017. The fund is dedicated to support and finance about 300 projects from start-ups and innovative firms for a total investment of approximately DH700 million for five years. So far, of all companies which have benefited from Innov Invest support, 30% operate in the ICT sector and 20% in Greentech, but also agribusiness and industry, which accounted for more than 26% of the financing granted. The fund is operated through 16 accredited partners to provide support services[11] and four Venture Capital (VC) funds [12]. So far six start-ups have been financed at a cost of DH34 million[13].

2.3 ICT policy objectives

Concerning ICT, the government issued a broadband plan (co-financed by the African Development Bank, who provided $30 million) in 2009-2010. Morocco has further developed a cross-sectorial strategy for digitalisation under the leadership of the Ministry of Industry, Commerce, Investment and Digital Economy and a **Digital Morocco 2020** plan was developed, succeeding the Numeric Morocco 2013 plan. The programme consists of $750 million in investments, structured around three pillars and nine initiatives, which aims to i) accelerate the digital transformation of Morocco; ii) reinforce Morocco's positioning as regional digital hub; and iii) remove the eco-systemic barriers, namely, governance and digital skills.

[9] African Economic Outlook, 2018.

[10] Arab States. In: UNESCO Science Report: towards 2030

[11] CE3M, CEED Maroc, Cluster Menara, Enactus, Endeavor, Groupe SOS Maroc (Bidaya), Happy Ventures, H Seven, Kluster CFCIM et Moroccan CISE, APP Editor, Cluster Solaire, Impact Lab, R&D Maroc, Réseau Entreprendre Maroc et Start-up Maroc.

[12] SEAF, Global Nexus, Azur Partenaires, MITC capital

[13] Interview with SEAF Morocco

Box 1: Digital Morocco 2020

PILLAR # 1: DIGITAL TRANSFORMATION OF THE NATIONAL ECONOMY

Initiative 1: e-gov - Digital transformation of the administration to support the transformation of the administration and accelerate the implementation of IT projects, but also to modernise government IT platforms through the development of an IT master plan, the development and reinforcement of common ERP, interoperability of systems and the use of shared data centres.

Key indicators: i) Top three in the MEA region (UN e-gov Index ranking); ii) Operationalisation of Digital Development Agency; iii) +50% of administrative procedures digitalised.

Initiative 2: Bridging the digital gap for the benefit of citizens (connectivity for all, secondary and higher education programmes, public access to Wi-Fi) **and businesses**, particularly MSMEs / regions disadvantaged in terms of connectivity).

Key indicators: i) Reduce by half the digital gap; ii) 20% of SMEs equipped and connected to the internet.

Initiative 3: Integrated transformation of critical sectors of the economy (PortNet[14], health, ...).

PILLAR # 2: REGIONAL DIGITAL HUB

Initiative 4: Strategic Repositioning Business Process Outsourcing (BPO) on Europe by Encouraging Value-Added Economic Business Models and setting up a promotional offer with specific incentives.

Initiative 5: Digital hub for French-speaking Africa with the development of infrastructure and physical networks and **encouragement of African talent to join Moroccan** firms.

Key indicators: i) Annual growth of offshoring: 5-10%; ii) Number one digital hub in francophone Africa; iii) Number two digital hub in Africa after South Africa

PILLAR # 3: MOROCCO's DIGITAL PLACE

Initiative 6: Acceleration of datacom infrastructure, in particular, access to high and very high broadband and universal access to mobile data.

Initiative 7: Training and skills development in ICT.

Initiative 8: Creation of a digital legal and regulatory framework.

Initiative 9: Emergence of new national technology players.

Key indicators: i) Top three in the MEA region for datacom infrastructure; ii) 30,000 IT professionals trained; iii) Top three in the MEA region for doing IT; iv) 5 Moroccan champion firms in African top 30

Source: Ministry of Industry, Trade, Investment and Digital Economy[15]

A Digital Development Agency (ADD) was announced in 2016 and has recently been set up, following the enacting of a law (September 2017), in order to upgrade the governance and regulation of the digital sector. Its mandate is to execute Morocco's Digital Strategy for government services (generalising e-government to ease users' access), private sector (digitalisation of companies) and citizens' access to social services, medicine and education. The roadmap includes i) upgrading of ICT regulations, ii) setting up a national training programme in digital literacy, iii) upgrading existing technology infrastructure, in particular advanced infrastructure (national data centre, sovereign cloud) and iv) developing digital trust (cybersecurity and data protection)[16].

[14] https://portail.portnet.ma/fr/a-propos

[15] http://www.ires.ma/wp-content/uploads/2017/11/RAPPORT-TRANSFORMATION-NUMERIQUE.pdf

https://www.itu.int/en/ITU-D/Regional-Presence/ArabStates/Documents/events/2016/DigitalTransformation/Pres/Strat%C3%A9gies%20nationales%20pour%20le%20d%C3%A9veloppement%20de%20l%E2%80%99%C3%A9conomie%20num%C3%A9rique%2C%20samia%20chakri.pdf

[16] Interview with ADD and Ministry of Economy and Industry

2.4 Policies specific to 4IR technologies

Innovation in Big Data is driven by the public sector in Morocco.[17] The third pillar of Digital Morocco 2020 targets the development of **Big Data** through investment in datacom infrastructures that are supposed to host and transit data (backbone, broadband, data centres)[18] and the development of local skills and competences.

Hence, even though Morocco seems not to have a specific strategy related to the 4IR *per se*, some major announcements have been made recently by public authorities. In March 2019, a call for research projects in **Artificial Intelligence (AI)** (complete with a budget of DH50 million) was launched by the Ministry of National Education, Vocational Training, Higher Education and Scientific Research in partnership with the Ministry of Industry. This call for research projects[19] includes 11 themes: education and pedagogical approaches; health; agriculture; finance, banking and insurance; energy, water and environment; industry: predictive maintenance; transport and logistics; telecommunications and networks; computer vision; automatic processing of natural languages and smart cities.[20]

Concerning **Blockchain**, the National Telecommunications Regulatory Agency (ANRT) has, via the Soft Centre (its innovation and R&D unit), set up a think tank on the subject, bringing together the centre itself, a private consultancy firm, a start-up active in Blockchain, an incubator and a university. Its mandate is to lead to the creation of a national Blockchain platform and ecosystem as part of an Open Innovation approach aimed at facilitating the creation and deployment of FinTech services and smart contracts for individuals and start-ups[21]. In addition to this project, another important initiative in the Dakhla region aims to produce, thanks to the Sahara wind, 900 megawatts of energy to power data centres for Blockchain-based crypto-currencies such as bitcoin[22].

Concerning **Virtual Reality**, a partnership has been signed between Eon Reality (US), Ben Guerir University, OCP group, INSEAS, Rabat University and the Ministry of Industry, with USAID, to set up a technology training centre for students and workers. Located on Mohammed VI Polytechnic University's campus in Benguerir, the new centre will provide Augmented and Virtual Reality (AVR) technology, solutions and products to Morocco's growing digital transformation of the academic, industrial, and government sectors.

Concerning specific ICT regulations, the National Telecommunications Regulatory Agency (ANRT) is the public institution responsible for regulating the ICT sector in Morocco. Its activities encompass general and market regulation. The country adopted a law on the protection of personal data (Law n°09-08 of 18th February 2009) in 2009. The National Commission for the Control of the Protection of Personal Data (CNDP) was created under this law. The Commission is responsible for verifying that the processing of personal data is lawful, legal and does not infringe on privacy, fundamental rights and freedoms. Morocco also adapted its law to comply with the EU General Data Protection Regulation (GDPR) and has a legal framework for cybersecurity. Additionally, while some technologies require specific regulations to be operated, notably drones and the IoT, to use some frequencies, the ANRT has engaged in setting up regulatory sandboxes for the IoT, notably to support applications in the agriculture sector.

2.5 Level of readiness of the country for the 4IR

Effective government and governance are necessary to create a regulatory environment in which innovations and enterprises can thrive and hence are able to try out new applications of 4IR

[17] https://financenews.press.ma/article/economie/big-data-le-maroc-se-forge-son-propre-modele

[18] http://www.cfcim.org/wp-content/uploads/2017/04/BigData.pdf

[19] the funded projects must address relevant needs, be feasible, and have real socio-economic impacts

[20] https://www.bladi.net/maroc-intelligence-artificielle,54879.html

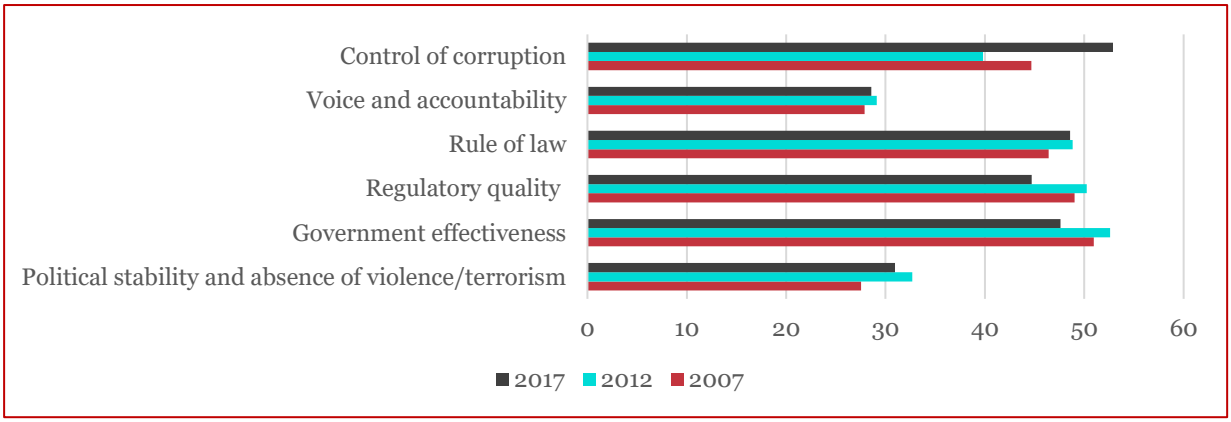
[21] https://www.challenge.ma/startup-numa-casablanca-lance-un-appel-a-candidatures-94772/

[22] https://www.huffpostmaghreb.com/entry/blockchain-le-projet-de-ferme-eolienne-geante-a-dakhla-prend-du-retard-selon-maghreb-confidentiel_mg_5c77efe5e4b0952f89df05b6

technologies. According to the World Bank's Worldwide Governance Indicators (WGI), the main traditional parameters of governance include: (i) Voice and Accountability; (ii) Political Stability and Absence of Violence; (iii) Government Effectiveness; (iv) Regulatory Quality; (v) Rule of Law; and (vi) Control of Corruption. These indicators are important predictors of the overall ability of a country's governance system to support the implementation and absorption of emerging technologies into its innovation eco-system.

The World Bank measures **government effectiveness** every five years. According to the Ibrahim Index of African Governance (IIAG)[23], Morocco has one of the most impressive records in terms of progress over the past decade, moving from 25th out of 54 countries up to 15th. In a period of ten years (2007-2017), the analysis of the World Bank's Worldwide Governance Indicators (WGI)[24] reveals that the rule of law and control of corruption have seen improvements. Political stability and absence of violence/terrorism and voice and accountability remain relatively stable. However, government effectiveness and regulatory quality have decreased.

Figure 1: WGI Morocco's rank- Percentile rank 0 (lowest) to 100 (highest)



Source: World Bank's Worldwide Governance Indicators (WGI) Database

Another index ranking countries according to regulatory quality, amongst other factors, is the **Ease of Doing Business Index**, also compiled by the World Bank. This index measures regulatory performance. Several aspects of the index are particularly relevant in terms of preconditions for 4IR technologies: ease of starting a business, getting electricity and getting credit. On this index, Morocco scores 60 out of 100 compared to 51 for Sub-Saharan Africa[25] and better than India.

Finally, the regulatory quality on paper may deviate from reality on the ground when there is widespread corruption in a country. By its nature, corruption is very hard to measure and to compare internationally. The most ambitious attempt to do so is Transparency International's **Corruption Perception Index**, which is updated annually and attempts to measure the level of corruption in the public sector of countries. In 2018, Morocco received a score of 43/100, ranking a mediocre 73rd out of 180 countries, but equalling South Africa and considerably higher than the score of Nigeria (27) and showing a trend towards improvement.[26] This also points to the potential that technologies such as Blockchain could play in increasing transparency and reducing the scope for corruption.

[23] http://mo.ibrahim.foundation/iiag/

[24] The Worldwide Governance Indicators are available at: www.govindicators.org

[25] http://www.doingbusiness.org/en/data/doing-business-score

[26] https://www.transparency.org/cpi2018

As regards Morocco's *overall* readiness for 4IR technologies, the World Economic Forum (WEF) **Global Competitiveness Index** 2018[27] provides a useful indication as it explicitly considers 4IR readiness in its methodology. Morocco is ranked 75th out of 140 countries here.

Based on the 2018 report on the readiness for the Future of Production by the World Economic Forum, a report which analyses the readiness of countries in terms of future production opportunities, Morocco is still defined as a nascent economy with weak structures of production and drivers of production, ranked in 77th position and 73rd position respectively. The ability to innovate is rated at 2.2 on a scale of ten and therefore requires improvement on a variety of pillars (where most scores average ± 3) to boost innovation, especially R&D expenditure and patent applications.

As the previous sub-section has shown, Morocco has embraced an ambition and policy initiatives aimed at improving the country's capability to innovate and make use of a number of selected, advanced technologies. In the WIPO **Innovation Index** 2018[28] Morocco is ranked 76th out of 124 countries, with a rather mediocre score (31), higher than Nigeria (22) but on a par with South Africa (35). The index is a composite of sub-indices looking at aspects of innovation capability from institutions, human capital, infrastructure, market and business sophistication, to knowledge and technology outputs and creative outputs.

When it comes to **legal and regulatory, institutional and governance preconditions**, of particular importance in Morocco, which already faces stark inequality (estimates of the Gini-coefficient ranging at 0.395)[29], is that the rise of the 4IR does not exacerbate inequality by making large numbers of people unemployed while enriching those with access to advanced technologies.

Another key precondition for developing viable commercial applications for advanced technologies is **strong protection of intellectual property rights (IPR)**. Here, according to the WEF, Morocco is ranked a lowly 97th out of 140 countries.[30] Likewise, government services embracing digitalisation and the opening up of data for use by commercial entities and NGOs to develop new tech-driven solutions is a precondition. A proxy indicator for this can be **e-participation in government** (defined as the use of online services to facilitate the provision of information by governments to citizens), where Morocco was ranked 55/140 in 2018, according to the WEF.[31]

Innovative firms (start-ups or larger companies engaging in innovation) are essential in rolling these out on a larger scale across different economic sectors. **Access to finance** allows such a high-risk undertaking, high-return ventures, including grants, seed funding, equity capital and mainstream debt to scale-up innovations. According to the WEF, Morocco benefits from a rather good financial system and is ranked 44th out of 140 countries. Domestic credit to the private sector by banks reached 63% of GDP in 2017[32]. However, only 29% of Moroccans have a bank account. Mobile money is not developed: Only 1% of the population has a mobile money account[33].

Another precondition relates to **infrastructure**. This concerns the **availability of broadband and mobile internet**. Morocco is ranked first on the African continent in terms of infrastructure quality, according to the Global Competitiveness Index - WEF 2017-2018. Indeed, there are currently almost six fixed lines per 100 people (supply), which is beyond the continent average (three lines/100 people). In line with that, there are sparse broadband services that serve few portions of individuals (in 2017, four fixed broadband subscriptions/100 people (demand))[34]. By contrast, mobile connectivity is widespread

[27] http://www3.weforum.org/docs/GCR2018/05FullReport/TheGlobalCompetitivenessReport2018.pdf

[28] https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2018.pdf

[29] https://data.worldbank.org/indicator/SI.POV.GINI?locations=MA

[30] http://www3.weforum.org/docs/GCR2018/05FullReport/TheGlobalCompetitivenessReport2018.pdf

[31] http://www3.weforum.org/docs/GCR2018/05FullReport/TheGlobalCompetitivenessReport2018.pdf

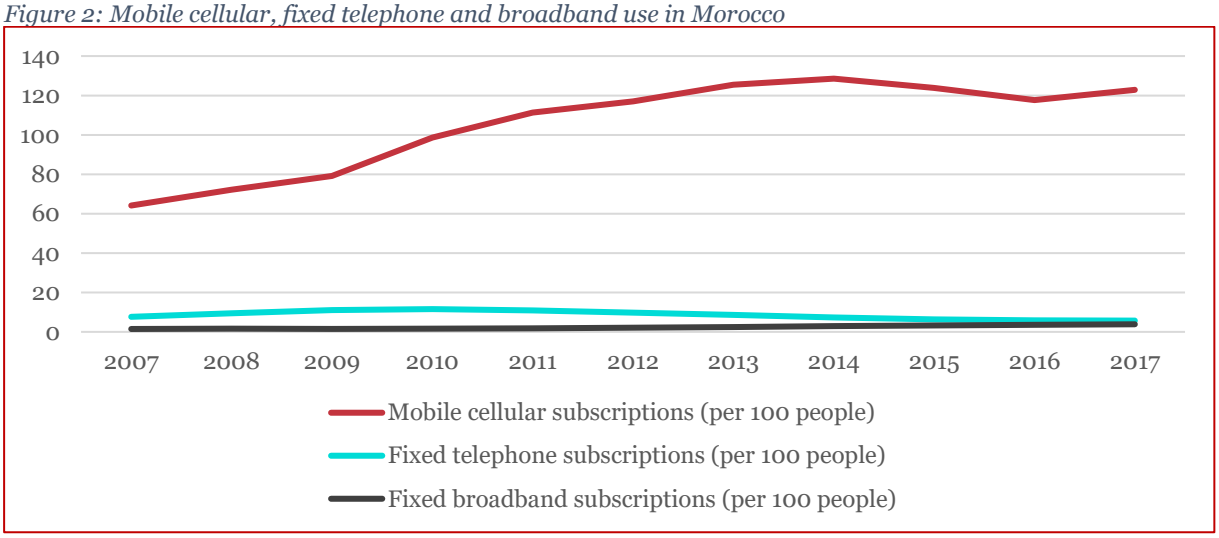
[32] Ministry of Economy and Finance, Morocco

[33] World Bank FINDEX data

[34] World Development Indicators https://data.worldbank.org/

(in 2017, there were 123 mobile cellular subscriptions/100 people) (see Figure 2). In addition, the number of secure internet servers is quickly increasing, rising from two per 1 million people in 2010 to 294 in 2018. Consequently, the proportion of Moroccans using the internet rose from 22% of the population in 2007 to 62% in 2017.[35] Morocco is also the first African country which launched pilot 5G connectivity.

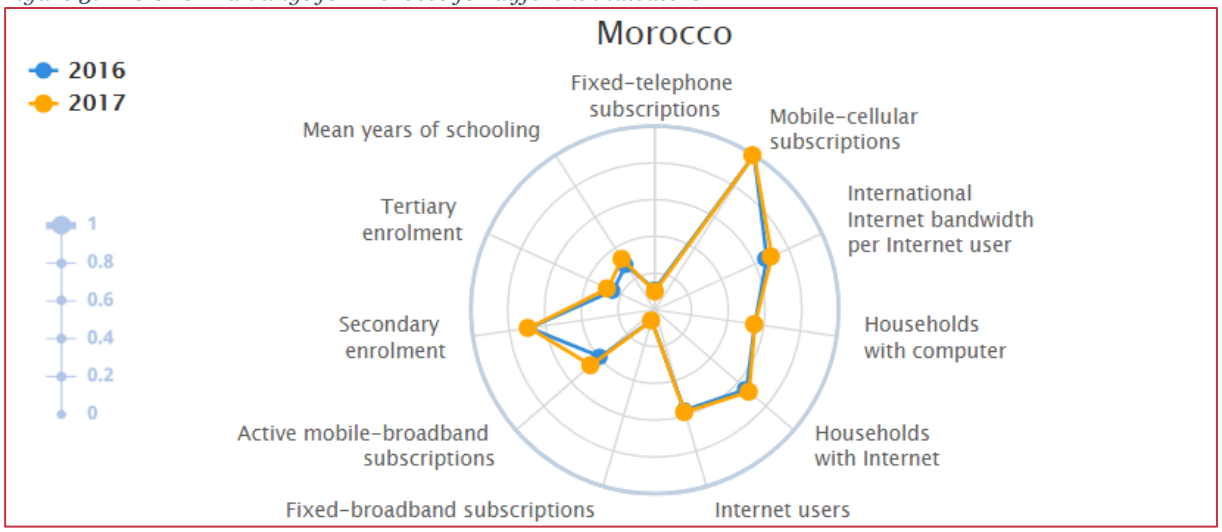
Figure 2: Mobile cellular, fixed telephone and broadband use in Morocco



Source: World Development Indicators

Based on the ITU's ICT development index, Morocco is ranked in 100th position, falling two places from its ranking in 2016. The figure below shows the indices for different parameters in Morocco.

Figure 3: ITU's ICT rankings for Morocco for different indicators



Source: ITU

[35] Op. Cit.

Another infrastructure precondition concerns the **availability and use of data** across the country. From 2017 to 2018, the use of data has jumped to 39.2%[36], higher than the International Data Corporation's forecast.

Advanced technologies can only find applications adapted to local needs in countries with a strong **innovation ecosystem and culture**. A complete ecosystem chain from coworking spaces to start-up incubators with financial incentives and an accelerator (La Factory) to link start-ups to corporates, connected to the financial system, has developed late in Morocco. Morocco has a strong tech ecosystem, and according to a GSMA report on ecosystem accelerators in Africa, amongst the 442 in Africa, Morocco has 22[37]. The country has one technopark in Casablanca (inaugurated in 2001), which opened an extension in Rabat in 2012, then Tangiers in 2015. Other extensions have been planned, notably one in Agadir in 2019. A technopark hosts all innovation ecosystem chain stakeholders: individual innovators; start-ups and small and medium-sized companies specialising in information and communication technologies (ICTs), 'green' technologies and cultural industries; as well as labelled support structures. A thousand companies have been accompanied so far and 300 hosted. Technologies developed and exploited by these companies include mobile applications, cloud computing, Big Data, and for about the last three years, the IoT, AI and Blockchain, demonstrating that the private sector has an increasing interest in these technologies[38]. Concerning open innovation, La Factory shows excellent results (90% of orders six months into the programme) and aims at **developing a specific AI lab[39]**. Innovation is also dependent on both the state and private sector investing substantially in research and development (R&D). **R&D expenditure** as a share of GDP amounted to 0.7% in Morocco in 2018, ranking the country 51/140 according to the World Economic Forum.[40] Multi-stakeholder collaboration is quite low (ranked 102/140) and hampers the potential for technology transfer within the ecosystem (from universities to the private sector).

As regards **human capital and skills development**, Morocco has a low overall ICT literacy rate by comparison with other countries in the world, even if it is one of the highest in Africa. Less than 50% of youth and adults demonstrate basic ICT skills, less than 20% can effectively create a presentation or use basic arithmetic in a spreadsheet. Only 5% can write a computer programme[41]. With the Digital Programme, Morocco is aiming to position itself as a strategic hub in the Middle East and North Africa by becoming one of the top performing countries and an attractive destination for outsourcing services. While facing an exodus of its ICT skilled force to developed countries where financial conditions are better, it notably plans to provide digital literacy programmes and train over 39,000 ICT professionals by 2020[42]. The Morocco Federation of ICT and offshoring Technologies (APEBI) has launched two measures to i) favour integration of foreign competencies in ICT and ii) convert scientific bachelor's degrees into IT degrees with a nine-month training programme. The higher education system, with its ten engineering schools (ENSAM, ENI, ENIM, Hassan II University, INSA, AIAI, Agritech etc.), produces engineers that are globally competitive and so they tend not to stay in Morocco or on the continent[43].

The following chapters analyse, in depth, the markets and applications by the main sectors in the country

[36] https://www.jeuneafrique.com/736968/economie/le-marche-local-booste-les-performance-de-maroc-telecom/

[37] https://www.gsma.com/mobilefordevelopment/blog-2/africa-a-look-at-the-442-active-tech-hubs-of-the-continent/

[38] Interview with Technopark

[39] Interview with La Factory

[40] http://www3.weforum.org/docs/GCR2018/05FullReport/TheGlobalCompetitivenessReport2018.pdf

[41] UNESCO

[42] Interview with APEBI

[43] Interview with APEBI and Polytech Casablanca

3 Agriculture

Current utilisation level of the main 4IR technologies[44]

Artificial Intelligence	Big Data analytics	Blockchain	Drones	3D printing	IoT

Potential use in the future

Artificial Intelligence	Big Data analytics	Blockchain	Drones	3D printing	IoT

Legend: Red: not many / few examples; Orange: nascent / some examples; Green: good potential /numerous examples

3.1 Presentation

Agriculture is a primary sector which plays an important economic and social role in Morocco. There are close to five million people engaged in agriculture, with close to two million being women[45]. Morocco produces grains (chiefly wheat, barley, and corn), crops, fruit, vegetables, etc. The agricultural productivity index (which measures the relative level of aggregate volume of agricultural production for each year by comparison with the base period of 2004-2006) of Morocco has been constantly increasing and stood at 149, up from 130 in 2006[46]. The country exports citrus fruits and early vegetables to the European market; its wine industry is developed, and the production of commercial crops (cotton, sugar cane, sugar beets and sunflowers) is expanding[47]. The country imports cereals.

In the last ten years, the agricultural sector achieved a sustained and less erratic growth in its added value, with an average annual growth rate of 6% over the 2008-2017 period, attesting to the good behaviour of crops, particularly the cereals as well as livestock (red meat and white meat) and arboriculture (citrus and olives)[48]. Agriculture remains a very strategic sector for Morocco and, in 2015, it accounted for up to 15% of the Moroccan economy[49].

Recently, the global context put the importance of public policies for agriculture back to centre stage. In 2000, the international food markets were stretched, and food prices increased. This situation had an impact on Morocco while its food security was relying on international imports. Agriculture is thus seen as leverage for the national economic independence, stability and development of Morocco, as attested by the **Green Morocco Plan** (GMP) implemented since 2008, an ambitious yet grounded roadmap to develop intensive and modern agriculture and modernise small-scale farming and improve the incomes of small-scale farmers. The issues relating to the GMP are the economic development of the country, the

[44] Based on use cases identified and interviews conducted

[45] AfDB

[46] idem

[47] https://www.britannica.com/place/Morocco/Economy

[48] Ministry of Economy and Finance, Dashboard of the economy, January 2019

[49] AfDB Country Strategy Paper, Kingdom of Morocco.

reduction of poverty and retention of the large rural population. The plan has mobilised considerable amounts of public investment and is structured around two pillars. The first is to develop large economic poles based on high value-added crops, largely oriented to export, with strong private investment complemented by public aid to generate foreign currencies. The second seeks to develop, in a way that builds solidarity among farmers, small-scale farming that is more oriented towards the internal market and is able to maintain populations in rural areas with improved incomes, concentrating certain actions in the most disadvantaged regions (mountains, Saharan areas etc.) whilst taking into consideration the preservation of natural resources. In 2015, the budget devoted to agriculture and sea fishing amounted to €950 million (4.1% of the national budget). The budget more than quadrupled from 2008 to 2015[50].

The Ministry of Agriculture has made digitalisation one of the key priority areas for the development of the agricultural sector, endowing it with a dedicated team and budget. At the level of the central department of the ministry, 30 engineers are currently assigned to digitalisation and are responsible for the implementation of digital solutions targeting primarily small-scale farmers who constitute about 90% of all farmers in the country. In terms of budget, digitalisation is endowed with DH30 million. Savings of DH400 million were gained in the programme to attenuate the effects of drought by relying on digitalisation[51]. Digitalisation encompasses the use of satellites, drones and Artificial Intelligence to provide smallholder farmers with information to support efficiency and accuracy, thus developing resilience in the face of droughts and floods.

In September 2018, Morocco hosted the first **Agritech forum** in the country to promote technologies applied to promising agricultural sectors, in particular arboriculture, horticulture, field crops, market gardening, viticulture, livestock breeding and fishing. These technologies were in particular satellite imagery, the IoT, unmanned aerial vehicles (UAVs), software, robots, intelligent machines but also the analysis of crop profitability (the relationship between income and expenditure). Applications range from irrigation management to spray drones to soil analysis tools matching needs to plant disease control to new resilient cropping methods.

Since its launch, the Green Morocco Plan has contributed to accelerating the structural transformation of the Moroccan agricultural sector. This strategy is about to meet the challenge of strengthening the resilience of the agricultural sector, strengthening value chains and improving the productivity of the cereals sector.
In fact, the Green Morocco Plan helped increase both public and private investment in agriculture. Public investment in the sector has tripled since 2008, from DH3.1 billion to DH9.9 billion in 2016.

3.2 Rationale for supporting the adoption of 4IR technologies

3.2.1 Potential applications and impacts

With a semi-arid climate, it is difficult to be sure of good rainfall and Morocco's GDP varies depending on the weather. The danger of drought is ever present. Especially at risk are the cereal-growing lowlands, which are subject to considerable variation in annual precipitation. On average, drought occurs in Morocco every third year, creating volatility in agricultural production, which is the main constraint for expansion in the sector. In this context, the use of 4IR technologies is of interest and can help to achieve the objectives of the Green Morocco Plan.

The adoption of technology in agriculture can have a promising impact on productivity and thus contribute to increasing the revenue of rural farmers and to increasing the agricultural value-added. Additionally, while climate change is a real threat to Morocco's agriculture, technologies could help mitigate some of the effects.

The IoT, Big Data and Artificial Intelligence can transform farming by allowing smart and precise agriculture, which yield more productivity and profitability. Likewise, Big Data and Artificial

[50] Ministry of Economy and Finance, Dashboard of the economy, January 2019

[51] https://lematin.ma/journal/2018/quentreprend-maroc-transformation-digitale-agriculture/302975.html

Intelligence (AI) can help farmers gain access to complex information that can inform farming decisions. Blockchain can improve traceability, increase producers' earnings and secure contracts and transactions. Through instant data gathering and processing, drones offer various applications in agriculture in the following ways, which are currently being used by farmers globally: soil and field analyses, crop spraying, irrigation, crop health assessment and livestock monitoring.

However, 4IR technologies can have an impact on the workforce. A recent study by the Ministry of Economy signalled that 83% of the total agriculture jobs could be automated.

3.2.2 Current use cases and level of technology take-up

Most of the current applications of 4IR technologies in agriculture use **drones, Big Data analytics and the IoT as well as Artificial Intelligence. There are strong linkages between those technologies[52].** Drones are used to intelligently map plots, follow the evolution of plants and collect technical data in order to make better use of nutrients, optimise the consumption of fertiliser and predict the weather more precisely. The analysis of this data is based on Big Data, the aim being to make a diagnosis of the plants and to take the necessary actions, for example to bring the right dose of fertiliser to the right place at the right time. Finally, decisions are made via AI algorithms. The **IoT** is making its debut with very recent complete and integrated applications at scale, which also deal with data analytics. **3D printing** seems to have very few applications in agriculture in Morocco, as does **Blockchain**[53].

The technology providers are international start-ups either partnering with local firms or investing alone. There are also academic (Moroccan universities)/corporate (big national corporations) partnerships to develop projects and research potential applications. The public sector is also supplying technology services even if the investment in agri-tech seems low.

The demand is driven by large companies in the sector. Technologies are not widespread among small farmers, mainly because of the cost. However, some associations of producers are investing to develop smart farming solutions, notably the Moroccan Association of Producers and Exporters of Fruit and Vegetables, which invested in IoT solutions. There are also interesting use cases by financial service providers (insurance companies) as detailed in the following paragraphs.

Here are some initiatives which illustrate these trends:

- The **French start-up Airinov**, which began its expansion in Morocco with an exclusive partnership with **Etafat, a Moroccan company specialising**, among other things, in topography and which includes among its customers the Agricultural Domains, Nador West, Casa Transport, OCP etc. Among the services offered by the company, "the overflight of farms for a fertilization modulated according to the needs of the vegetation and according to the cultures". The drones, using sophisticated sensors, proceed to the diagnosis of the vegetation without contact thanks to the overflights operated by the company Etafat. It transmits this data to Airinov, which is responsible for transforming it into agronomic advice via certified algorithms. Mapping advice is delivered to the customer within 48 hours on average. It optimises inputs and improves yields through the optimal use of fertilisers[54].

- The **insurance company MAMDA** also initiated, in 2017, a pilot project for the assessment of claims on parcels using drones. The objective of this technology is to identify agricultural areas affected by climate events and to have an overview of plots for damage assessment and compensation to farmers in considerably shorter time frames. The insurer, in partnership with an agricultural reinsurance company, has teamed up with companies specialising in the use of drones

[52] https://www.maghrebemergent.info/la-big-data-au-service-de-l-agriculture-arrive-au-maroc/

http://www.agrimaroc.ma/bengrir-big-data/

https://www.challenge.ma/agriculture-2-0-lagriculture-connectee-95900/

[53] No example of applications could be identified through desk research or during the field visit.

[54] https://www.challenge.ma/agriculture-2-0-lagriculture-connectee-95900/

in the agricultural world and who develop airship drones from a mobile console made available to experts. Images captured by the drones are analysed by a dedicated application and can determine the vegetative state of crops and an estimate of yield. Thus, the data collected will enable farmers to improve the yields of their farms and optimise investments in terms of inputs (advice on dosing, fertilisation, identification of treatment areas). All advice and information are transmitted via smartphone to farmers with, in the short term, the amount of compensation that they will receive[55].

- **The Office Chérifien des Phosphates (OCP)** has **developed, with the University Mohammed VI Polytechnic (UM6P), a business unit called Agri Edge**. **The platform transforms agricultural data into decision-making information for farmers**. Agri Edge offers farmers three services: reasoned fertilisation, precision irrigation and integrated pest management. Access to the service is free for small-scale farmers while large-scale farmers pay for it. The business unit has completed the proof of concept stage for reasoned fertilisation and precision irrigation applications and is currently in the industrialisation phase. In addition, Agri Edge is working on **the use of smartphones to diagnose agricultural diseases**. This project is under development at the UM6P. Moreover, all these solutions will be popularised during the second edition of Agri Analytics Days, to be held on April 23rd, 24th and 25th 2019 in Morocco. This meeting of the agricultural ecosystem, organised by this university and the OCP, will deal with, in particular, the theme of precision agriculture.
- The Moroccan company **Visio-Green Africa**, a subsidiary of the French company Visio-Green, **launched in 2018 a complete Internet of Things (IoT) system** for the first time in Morocco. The goal is to have a smart irrigation system to give farmers the ability to manage their plantation remotely in a very simple way and to collect/stock various data to manage plantations more efficiently. The first project was carried out with the Moroccan Association of Producers and Exporters of Fruit and Vegetables.

Box 2: Agri Edge

In Morocco, the company OCP (phosphate producer and transformer, fertiliser) has entered into a public-private partnership with the University Mohammed VI Polytechnic (UM6P) to create a new venture called Agri Edge. The business unit has been created by the OCP and incubated at the UM6P.

Agri Edge is a platform related to agriculture precision. It analyses agricultural data to guide farmers in their decision-making. The platform offers farmers three services: fertilisation, precision irrigation and integrated pest management.

The team of Agri Edge is composed of agronomists and experts in precision agriculture.

Agri Edge has developed an irrigation control system that reduces production costs for the farmer, optimises the amount of water used for irrigation and, on a large scale, reduces water stress on groundwater.

Sensors directly implanted in the selected plots make it possible to record key data, which are then transcribed on the application available on the customer's telephone. The farmer therefore has access to real time information and can quickly make the right decisions with the support of the Agri Edge team's recommendations. These include, among other things: the place, time and duration of irrigation required.

A pilot test showed that the system put in place helps to save 15% of water. Agri Edge's objective is to reach 30% of water saving in the medium term.

Access to the service is free for small-scale farmers while large-scale farmers pay to have the service. Having reached the stage of theoretical development, this business unit also completed the testing phase for fertilisation and precision irrigation. Currently, the project is in the scaling up phase.

[55] https://www.challenge.ma/agriculture-2-0-lagriculture-connectee-95900/

Source: Technopolis Group (2019), Morocco country case

3.3 Drivers and challenges for the adoption of 4IR technologies

The key enablers for technology take-up are assessed as follows.

- **Systems governance and regulations**. The government has developed a plan and engaged funding to support the private sector and small-scale farmers. In Morocco, the use of drones, both for professionals and amateurs, is hampered by legal restrictions. The country has decided to limit the import and use of them by subjecting them to authorisations (order of 23 February 2015). It is mainly the security risk that has been put forward by the Moroccan authorities. The device is classified in the same category as explosives. It should be noted that the import of any flying machine (drone or model airplane) into Morocco, whether powered by a motor or remote control, is subject to an import license being obtained beforehand. Certain administrations, companies or public bodies may be authorised for specific professional needs (production of films, shows etc.) to import flying machines. Each use must, however, be the subject of a specific authorisation from the local authority[56].
- **Innovation ecosystem**. Morocco can rely on a relatively well-developed research and innovation ecosystem compared to other African countries. Major investments supporting research have been recently announced in AI. There are already strong existing partnerships between academia and the private sector to develop projects.
- **Knowledge and skills**. On the demand side, the sector is dominated by a rural population who do not necessarily have the required skills to manipulate and effectively use complex technologies, which provides an avenue for 4IR services. On the supply side, Morocco has the potential to develop local adaptations of the technologies in agriculture due to the research sector and the growing interest in Masters courses related to 4IR technologies. If these efforts are supported in the long run, Morocco has the potential to be a leading country in the use and development of applications on the continent.
- **Finance**. Technologies may be expensive for small-scale farmers to acquire. However, the government is heavily investing in agriculture through the Green Morocco Plan by already providing subsidies to the private sector and supporting small-scale farmers.

4 Energy

Current utilisation level of the main 4IR technologies

Artificial Intelligence	Big Data analytics	Blockchain	Drones	3D printing	IoT

Potential use in the future

Artificial Intelligence	Big Data analytics	Blockchain	Drones	3D printing	IoT

[56] https://www.challenge.ma/agriculture-2-0-lagriculture-connectee-95900/

Legend: Red: not many / few examples; Orange: nascent / some examples; Green: good potential /numerous examples

4.1 Presentation

The energy sector, which includes electricity, gas, oil and renewable energies such as solar, wind and hydropower, accounted for 2.2% of the country's GDP over the period from 2008 to 2017. It directly employed more than 44,700 people in 2016, 0.4% of the active employed population. The energy sector in Morocco is dominated by fossil fuels, mainly imported. They cover 88.8% of the country's primary energy consumption. Renewable energy contributes 9% and electricity imports 2.2%. Morocco has abolished subsidies on fossil fuels in the field of transport and electricity. On the other hand, the abolition of those subsidies on gas and petroleum products is proving to be a real challenge. Transport is one of the sectors in which improving energy efficiency and halting the increase in energy demand remains difficult. As far as renewable energy is concerned, the prospects are very promising and this can be seen thanks to natural potential (a wind potential estimated at 25,000 MW, of which 6,000 MW will be achievable by 2030; with the solar potential already well installed with a sunshine estimated at 3,000 hours / year and 5 KWh / m2 / day of irradiation; for hydropower an availability of nearly 200 exploitable sites) and highly developed energy infrastructure and a legislative and institutional framework conducive to accelerating the implementation of development projects[57]. Morocco is the world's 13th most attractive country for renewable energies, according to the Renewable Energy Country Attractiveness Index (EY, October 2016)[58].

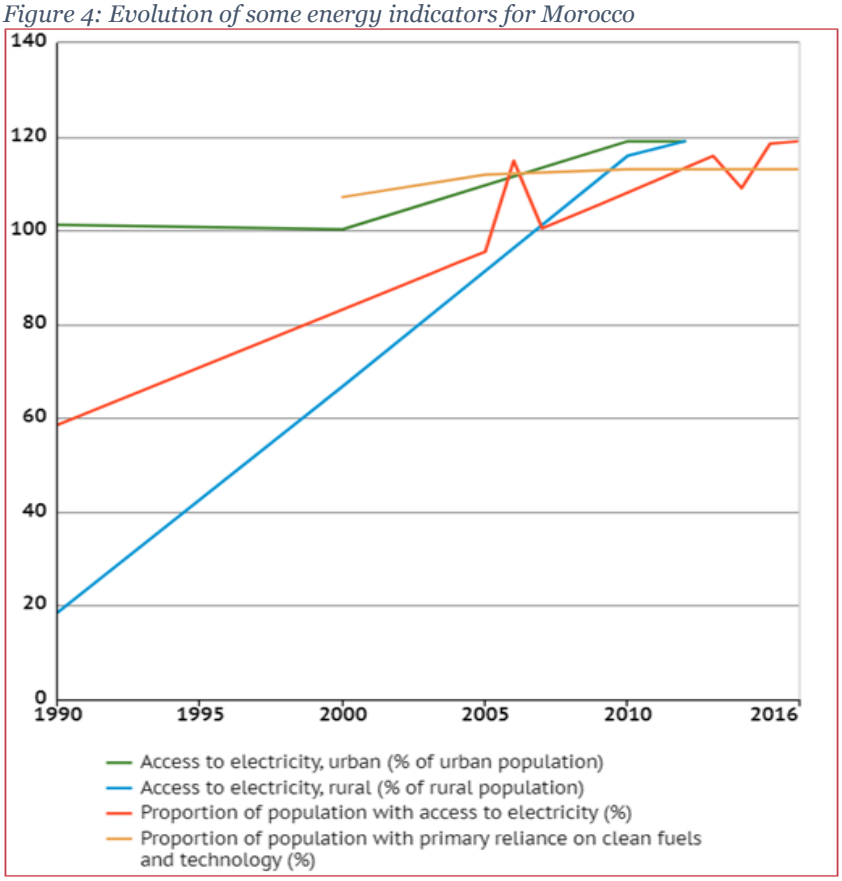
Nearly the entire Moroccan population has access to electricity and the production of electricity from solar, wind, tide, wave and other sources has increased considerably from 2010[59]. The figure below gives more insight on the power generation potential of Morocco.

[57] Ministry of Economy and Finance, Dashboard of the economy, January 2019

[58] Op.Cit.

[59] http://dataportal.opendataforafrica.org/nbyenxf/afdb-socio-economic-database-1960-2020#

Figure 4: Evolution of some energy indicators for Morocco



Source: http://dataportal.opendataforafrica.org

Morocco is gradually transforming its energy system. The National Office of Electricity and Drinking Water (ONEE) of Morocco launched, in 1995, a programme of rural electrification which allowed, in twenty years, for access to electricity for the whole population.

Morocco developed, in 2009, an **Energy Strategy 2030**. It aims to foster the development of renewable energies (52% of national production by 2030) in order to secure the energy supply in a context of strong growth in energy demand, to control the future costs of energy services in relation to the upward trend in the prices of petroleum products and finally to preserve the environment by reducing greenhouse gas emissions. The Moroccan legal and institutional framework structures the development of renewable energies through two laws (n ° 13-09 and n ° 58-15) which liberalise the production of electricity from renewable energies and offer the possibility to sell the renewable energies surplus produced at ONEE. This legislative framework favours private initiatives and investments[60].

Consistently with this ambition, Morocco has developed different instruments and schemes to support its national energy strategy implementation: the Energy Investments Company, which is the financial arm of the State; the Energy Development Fund, which has resources equivalent to $1 billion; the Macharii Effinergie Investment Loan (carried by Attijariwafa Bank) is intended for SMEs and large industrial companies; the Imtiaz and Moussanada SME support programmes, which are supported by the Hassan II Fund. In addition, the French Development Agency, the German bank KfW, the European

[60] https://www.huffpostmaghreb.com/meryem-benkirane/transition-energetique-maroc-sur-chemin-smart-grids_b_15358884.html

Investment Bank, the World Bank and the African Development Bank also provide financial support. Morocco will invest more than $40 billion in the energy sector by 2030[61].

In addition, several programmes and partnerships related to R&D, innovation and higher education will help to structure the renewable energy and sustainable development sectors. For example, the **Solar Energy and New Energies Research Institute (IRESEN)** is carrying out several research projects[62]. IRESEN also signed a partnership agreement, during the UN Climate Change Conference of the Parties meeting called COP22, with one of the operational branches of the European Institute of Innovation and Technology, **KIC InnoEnergy**, with the aim of encouraging innovation in the Euro-Mediterranean region.

The country has launched specific solar and wind programmes. For example, one of the largest solar complexes in the world was inaugurated in February 2016 in Ouarzazate (the Noor plant) with a target of a total installed capacity of 580 MW by 2018 and five wind farms. A total capacity of 850 MW should be built between 2017 and 2020[63]. In addition, several innovative projects in the field of smart grids have recently emerged, illustrating Morocco's desire to be proactive and to initiate solutions adapted to the needs of citizens.

Since its launch in 2009, Morocco's energy strategy has made significant progress. The implementation of the renewable energy programme has experienced a sustained acceleration to reach, at the end of 2017, a 34% share of the electricity mix, i.e. an installed capacity of 2,836 MW, of which 180 MW in solar, 887 MW in wind and 1,769 MW in hydraulics. This capacity will, by the end of 2018, be brought to 3,814 MW, including 827 MW in solar power, 1,207 MW in wind power and 1,780 MW in hydroelectric power, an additional capacity of 978 MW[64].

4.2 Rationale for supporting the adoption of 4IR technologies

4.2.1 Potential applications and impacts

4IR technologies can help transform the energy sector by allowing for the development of smart grids and the renewable energy.

Utility companies can be modernised with the help of sensors, smart meters that use sensors to allow remote monitoring of electricity consumption and other **IoT** technology and off-grid, bottom-up energy programmes can benefit from innovative pay-as-you-go schemes linked to IoT-enabled devices. The IoT makes it possible to track material and energy flows to achieve new efficiencies along product value chains. **AI** can be used for predictive infrastructure maintenance. Predictive user behaviour that relies on Machine Learning algorithms can potentially balance consumer demand and utility supply. For example, where power batteries often have difficulties powering homes through the night, AI software can learn the energy needs of a home and adjust the power output in such a way that electricity usage is reduced, for example by dimming lights and TV screens and slowing a fan's motor. **Blockchain** technology can help increase the number of bankable energy projects whilst drones may facilitate grid maintenance, to name a few examples. The potential of **Additive Manufacturing** for modernising the energy sector is more limited by comparison.

[61] Op.Cit.

[62] e.g. IRESEN is managing a research project involving all the Moroccan public universities for the development of a photovoltaic producible mapping application.

[63] https://www.huffpostmaghreb.com/meryem-benkirane/transition-energetique-maroc-sur-chemin-smart-grids_b_15358884.html

[64] Ministry of Economy and Finance, Dashboard of the economy, January 2019

In Morocco, the increase in the share of renewable energies in total electricity production, the development of the decentralised production of electricity within the framework of the law of 13.09, the evolution of electricity uses (air conditioning, heating, electric vehicles, etc.) and the demand of customers, who are increasingly attentive to their consumption, are factors that make the development of smart grids a necessity to meet all these new expectations.

In addition, smart grids constitute a real lever to decrease the loss of electricity (12% of electricity production is currently lost during transportation). Furthermore, smart grids will improve the quality of energy, make maintenance more predictive and reduce the cost of energy. Smart grid solutions will support the sustainable and smart cities of tomorrow, enabling the development of innovative urban services, particularly in the energy and transport sectors. Finally, the development of smart grids could strengthen Morocco's position as an 'energy hub' between Europe, Africa and the Middle East.

4.2.2 Current use cases and level of technology take-up

There are more and more smart grid projects being developed in Morocco. Between ONEE (the National Office of Electricity and Water), which has invested since 2012, and IRESEN (the Moroccan Research institute for solar and new energies), which is building an ecosystem for the development of smart grids and green buildings in Ben Guerir, the number of smart grid projects currently identified in Morocco comes to nearly a dozen[65]. There are also some projects involving start-ups. These smart grid projects use mainly IoT, Big Data and AI.

On the supply side, firms are investing alone but also via academic (Moroccan universities)/corporate (big national corporations) partnerships to develop projects and research potential applications. The demand is driven by large companies in the sector.

The following use cases are worth mentioning:

- ONEE has notably initiated smart metering via a low speed Power-Line Communication (PLC) network. It consists of a fleet of 230 smart posts and prepaid meters connected via the PLC network to data concentrators communicating with a central SMS station (System Management Station) through which data and events are collected: counting, credit recharge, parameterisation and configuration of meters but also the shutdown and restoration of the current at a distance.
- ONEE has also launched a pilot project to test high-speed PLC technology. This project involved installing a pilot site to test high-speed PLC technology for smart-grid applications and various IP services (internet, e-mail, telephony, video, etc.) via MV distribution grids. and BT, depending on the type of zone (urban or rural).
- The Huawei AMI technology pilot project is deployed at three sites with single-phase meters and three-phase meters. The project involves experimenting with the various features offered by Huawei's advanced AMI metering infrastructure, including remote billing, remote management of counters, anomaly detection, etc.
- On Tamesna too, ONEE has a smart grid project in progress. This is a pilot project to adapt the new city's MT/LV substations to remote signalling.

Concerning IRESEN projects:

- The recent opening of the Green & Smart Building Park, which is a testing, training and research platform dedicated to research and development in the field of green buildings, energy efficiency and the integration of renewable energy in buildings. Its objective is to pool resources, federate the efforts of different institutions and local actors in the building sector (research centres, universities,

[65] http://www.leseco.ma/les-cahiers-des-eco/506-green-business/56675-smart-grids-les-experiences-foisonnent-au-maroc.html

development agencies, SMEs etc.) and to encourage research by focusing on human capital in order to achieve the goal set by Morocco, which is to reduce energy consumption in the building sector by 15% by 2030. Concretely, the platform is composed of several laboratories (measuring and testing, characterisation and valuation, smart grid and network management system), a Fablab, a smart campus with twenty houses of 35m² each which will feed a database on the energy performance of various building and insulation materials, a network of electric vehicles and a one hectare test field of three garages where welding, ironwork, carpentry and assembly work will be provided to enable students to build complete or partial installations on a full scale.

- SIEM (Services and Infrastructure for Electric Mobility). Presented for the first time during the inauguration of the Green Energy Park by the King of Morocco last January, this project addresses several challenges: the deployment of a network of charging stations for electric vehicles, the development of an innovative business model for charging services, setting up an information system for collecting and analysing data (GPS, BI, etc.), the socioeconomic impact study on the evolution of the mobility of national electric vehicles, the improvement of the autonomy of electric vehicles and the implementation of innovative charging solutions as well as that of a large-scale electric vehicle network. T
- Through its resource agency, IRESEN also funds several collaborative research and demonstration projects involving national universities and research centres with the participation of their foreign counterparts. The SECRETS (Sustainable Energy Clusters Realised Through Smart Grids) project, led to the establishment of a state-of-the-art smart grid laboratory at the National School of Applied Sciences of Ibn Tofail University Kenitra. This laboratory will be used for capacity building and the development of new models for transmission, management and distribution of electrical energy that can be implemented on a large scale. This project is led by ENSA Kenitra, with the active participation of Hassan II University, the University of Houston, the INESTEC Portuguese Research Centre and AGT Morocco.
- Smart Grid Tahala is an autonomous distribution network using solar energy and a two-way communication system allowing residents from a remote rural area (Ait Ouafqua, 74 km from Tiznit, in the region of Souss-Massa) to benefit from water and electricity free and without cuts. Concretely, this project allowed for the realisation of a significant micro-grid grouping eight buildings: the N'Tahala commune, the women's club, the health centre, the mosque, the communal school, Dar Talib, the Koranic school and Kiada N'Tahala. A solar field has been distributed over the rooftops of the various buildings and several smart meters communicate the data and transmit it over the GPRS network to the control platform for optimised and adapted management of this network. This project is not only technologically interesting through its decentralised network of intelligent and digital distribution of solar energy. It is also interesting because of its social impact. It has enabled 1,500 inhabitants of this rural commune to benefit from free energy and has created a real dynamic in this village by promoting the schooling of children, the development of women and the development of agriculture because the surplus photovoltaic energy is used for pumping water.

Finally, the Moroccan company eLum Energy deploys **AI** software to manage renewable energy (solar energy) distribution. The Moroccan government supports these entrepreneurs and looks for opportunities for future exports to other African countries.[66]

Box 3: eLum Africa

In order to optimise energy consumption, eLum, a Moroccan start-up, installed an integrated system for the management and storage of electrical and solar energy for Bonima-Steri, a factory dedicated to the manufacture of sterile elements for the medical field in the free zone of Tangiers. The energy savings expected reach 15 to 20%.

[66] Jenkins, S. (2017) Morocco capitalises on early lead in renewables. Retrieved from: https://www.ft.com/content/8960096a-1ae0-11e7-a266-12672483791a

The system consists of a set of solar panels and batteries and uses Artificial Intelligence to choose the optimal configuration in terms of power consumption.

Sensors are installed on the machines of the plant and these make it possible to know the evolution of electricity consumption throughout the day and even to foresee it with a margin of error of 95%. A piece of software using AI evaluates this data and launches the recharging of the batteries on the electric network or from the solar panels according to the best sunshine or the best price band.

The system also has another advantage, that of protecting itself from power cuts by drawing from the batteries when the network fails.

Source: (Abjiou, 2017)

4.3 Drivers and challenges specific to energy

- **Systems governance and regulations**. The government has developed a plan and engaged funding to support the private sector under the Morocco Strategy Energy Plan.
- **Infrastructure**. Morocco is endowed with one of the most modern infrastructures in Africa. Morocco therefore has a competitive advantage to attract major players on the supply side and the development of domestic applications.
- **Innovation ecosystem**. R&D in the development of smart grids is also quite developed. Research institutions are dynamic and produce results which are applied. Several research institutions support innovation in energy.
- **Knowledge and skills**. Morocco has a strong knowledge and skills ecosystem to develop smart grid projects.

5 Industrialisation

Current utilisation level of the main 4IR technologies

Artificial Intelligence	Big Data analytics	Blockchain	Drones	3D printing	IoT

Potential use in the future

Artificial Intelligence	Big Data analytics	Blockchain	Drones	3D printing	IoT

Legend: Red: not many / few examples; Orange: nascent / some examples; Green: good potential /numerous examples

5.1 Presentation

Industry as a whole - which includes mining, manufacturing, construction, ICT, logistics and financial services - accounts for about a third of Morocco's GDP.

Manufacturing represented 15.7% of the GDP in 2017 and employed 10.4% of the labour force in 2016. The manufacturing production index (which shows the number of total value-added in the manufacturing production only) of Cameroon has been increasing up to about 143 in 2006 from about

100 in the year 2000[67]. The dominant subsectors are the automobile industry, textile/leather, aeronautics and offshoring[68]:

- The automobile industry is one of pillars of the Moroccan manufacturing sector and represents 40% of export earnings. With production levels reaching more than 375,000 vehicles, Morocco is the second largest vehicle producer in Africa after South Africa. This regional positioning will be strengthened substantially with the entry into production of the PSA plant in 2019, which will initially produce 100,000 vehicles per year and will, in the long term, produce 200,000 vehicles[69].
- The textile/leather sector is the second largest industrial exporter, while the food industry branch comes in third[70].
- The aeronautics branch occupies fourth place in terms of the value of exports, but it is at the top of the sectors that have recorded the biggest increase in exports, with a rise of 20% between 2016 and 2017[71].
- The offshoring sector experienced a steady increase in exports, estimated at 8% on average over the period from 2009 to 2017, rising from DH4.9 billion to DH9.1 billion. This dynamic has been accompanied by sustained job creation, from 27,367 in 2008 to 63,000 jobs in 2016[72].

Concerning construction, it represented 6.3% of the GDP in 2017 and employed 9.8% of the labour force. The real estate sector has begun a decline in recent years, which has been confirmed by a fall of 51% of production since 2011, as well as a drop in new housing. However, some major projects, among them smart cities like "Cité Mohammed VI Tanger Tech"[73], are expected to contribute to the re-launching of the real estate sector[74]. The logistics sector represented 4.3% of GDP and employed 4.6% of the active population[75]. As to the mining sector, this represented 2.3% of GDP in 2017 and employed 0.5% of the labour force in 2016. The sector is dominated by the phosphate industry. Morocco, through the OCP group, has become, over the years, a real global market player in phosphate and derivatives[76].

The booming ICT sector contributed 2.2% of GDP in 2017. The country has more than 46 million subscribers (landline and mobile) and 22 million internet users[77]. According to a report published by the International Data Corporation, the Moroccan IT services market is expected to expand at an average annual growth rate of 10.3% in the coming years and is expected to reach $550 million by 2018.

Morocco has adopted an **Industrial Acceleration Plan 2014-2020 (IAP)**. This plan is a new approach based on the establishment of more efficient ecosystems, aiming at the integration of value chains and the consolidation of local relations between large companies and SMEs. The plan is expected to generate 500,000 jobs in the sector, with a significant increase in the industry's share of GDP[78].

[67] AfDB

[68] Op.cit.

[69] Op. cit.

[70] Op.cit.

[71] Op.cit.

[72] Op. cit.

[73] https://lematin.ma/journal/2017/cite-mohammed-vi-tanger-tech-projet-geant-changera-visage-nord/284631.html

[74] Ministry of Economy and Finance, Dashboard of the economy, January 2019

[75] Op. cit.

[76] Ministry of Economy and Finance, Dashboard of the economy, January 2019

[77] Op. cit.

[78] http://www.mcinet.gov.ma/fr/content/plan-d%E2%80%99acc%C3%A9l%C3%A9ration-industrielle-2014-2020-0

The implementation of the IAP is monitored by an inter-ministerial committee that oversees the implementation of the projects initiated and the implementation of the agreements concluded between the various partners involved[46].

Box 4: Morocco's Industrial Acceleration Plan

To achieve its goals, the Industrial Acceleration Plan (IAP) is based on 10 key measures around the following pillars:

- **Industrial ecosystems for a more integrated industry**

The first block of measures aims to reduce sectoral fragmentation and build a more integrated industry. This project is based on the establishment of industrial ecosystems designed to create a new dynamic and a new relationship between large groups and SMEs. This new kind of collaboration between industry leaders and SMEs aims to make the industry a major job provider, especially for young people, and to put it in a virtuous circle.

A focus is put on migration from the informal to the formal sector with the implementation of a complete system of integration of the very small business (TPE), including the creation of the status of auto-entrepreneur, an adapted tax component, as well as social coverage, support and dedicated financing. In order to address the key challenge of matching skills with business needs, the experience of the OCP skills programme[79] will be generalised. To do this, two levers are foreseen: a certified human resources bank and an 'inter-contract pool'.

- **Support tools adapted to industry**

Improving the competitiveness of SMEs is a crucial issue. Therefore, the IAP provides a series of integrated measures to ensure support tailored to the needs of businesses and provides them with a favourable framework for the development of their activities.

In terms of financing, a public industrial investment fund (the Industrial Development Fund - FDI), with a budget of DH20 billion, will allow the industry to consolidate, modernise and develop its capacity to substitute imported products. In parallel with the support of the government, the support of the banking sector is renewed with the launch of the new strategy. An integrated and competitive financing offer is put in place, under a partnership agreement concluded between the government and the banking sector, which is committed to supporting industrial companies (competitive rates, support for restructuring, support for internationalisation, etc.).

In terms of preparation of industrial land, 1,000 hectares will be mobilised for the establishment of rental industrial parks. These industrial parks are in addition to the existing offer in industrial zones and integrated industrial platforms and include a one stop shop, a pool of local jobs, various services and a training facility.

A training offer adapted to the skills needs of the industry is being set up in the framework of the IAP to ensure a better match of this offer to the needs of companies. Direct training aids have also been allocated under the new strategy.

- **Stronger international positioning**

The third block of measures aims to improve the positioning of Morocco internationally. Regarding its situation on foreign markets, support efforts will be concentrated on sectors with strong export potential to improve the competitiveness of Morocco's exportable supply. Close monitoring of Free Trade Agreements (FTAs) under negotiation will be ensured, as well as monitoring of specific compliance with the provisions of existing FTAs. In parallel, the strategy plans to promote foreign investment by introducing a culture of deal-making to open Morocco to the opportunities of the evolution of the international market, for example the announced relocation of 85 million Chinese jobs. For this purpose, a dedicated team has been set up. Finally, the IAP proposes measures to concretise Morocco's African vocation. Privileged relations with African partners are expanding in a mutually beneficial collaboration perspective.

Source: Ministry of Industry, Trade, Investment and Digital Economy

In line with this plan, in March 2019, Morocco and UNIDO signed the **Programme for Country Partnership for Morocco** (PCP Morocco) document; which will support the implementation of the Government's Industrial Acceleration Plan 2014-2020[47]. The PCP rests on a multi-stakeholder

[79] https://www.entreprendre.ma/Le-programme-Skills-pour-encourager-la-performance-aider-les-jeunes-et-soutenir-la-creation-d-entreprises_a5506.html

partnership between development partners, UN agencies, financial institutions and the private sector, under the overall leadership of the government. Through the PCP, UNIDO provides policy advice to the government, delivers multidisciplinary technical assistance focused on selected industrial sectors and areas, and facilitates overall PCP coordination and the convening of partners. PCP Morocco will focus on several priority industrial sectors and areas, namely industrial zones, agro-industry, energy, the circular economy, Industry 4.0 and e-commerce. The programme will also integrate cross-cutting issues such as statistics, gender mainstreaming, partnerships, and south-south and triangular cooperation.

The programme is structured around three areas of intervention: i) **the creation of a smart factory** and the development of partnerships with international agencies to enable rapidly changing sectors (aeronautics, automotive, biomedical, etc.), local industries (textile, agro-industry, etc.), universities, associations and private companies to innovate together in order to improve industrial production; ii) **the establishment of an Industry 4.0 integration platform** for national cooperation and coordination to enable collaboration and partnerships between the various Moroccan organisations responsible for Industry 4.0 and to follow the adoption of technologies and practices of this industry; ii) **the development of skills and curricula in areas related to Industry 4.0**: the focus will be on building a strong and internationally recognised pool of talent in certain subsectors of Industry 4.0 (Additive Manufacturing, robotics, automation, etc.).

5.2 Rationale for supporting the adoption of 4IR technologies

5.2.1 Potential applications and impacts

Morocco has ambitious industrial goals. Hence, incorporated Industry 4.0 is a strategic move for the country which wants to be positioned as being a pioneer in technology and innovation across the continent. If Morocco wants to maintain and enhance its competitive advantage in industry, being up to date with the emerging technologies is paramount. Moroccan authorities are conscious of this fact and are taking action (the orientation of the PCP with UNIDO is an example). The adoption of technology in industrialisation can have a promising impact on productivity and thus contribute to improving revenue and increasing the value-added. However, another issue is to build an Industry 4.0 at a lower cost and without substantially reducing employment[80].

There are diverging views regarding the impact of 4IR within the manufacturing industry. There are legitimate concerns regarding the impact of 4IR within the workforce. On the one hand, it provides improved efficiency and on the other hand there is likely to be employment disruption. Employees must adapt and further develop their skills. On the downside, 4IR technologies can lead to workers losing skills that that technology has replaced.

The full magnitude of the impact of 4IR technologies on the manufacturing market is still to be determined. Employees will need to adapt and re-skill. Applying these technologies in manufacturing processes leads to better quality products (early detection of human error, degradation and defects in the manufacturing process) and consequently leads to safety for consumers and employees. 4IR technologies are expected to lead to optimised operations through the use of technologies like Big Data.

5.2.2 Current use cases and level of technology take-up

The use of 4IR technologies in industry in Morocco is new and at an early stage. **Use cases are more developed in specific sectors with high maturity for certain technologies**: **3D printing for automotive and aeronautics sectors, Big Data analytics for the financial sector**[81]. Morocco is still in a preliminary phase, at least for most industrial companies, in the application of **Artificial**

[80] https://www.huffpostmaghreb.com/entry/le-maroc-et-lonudi-main-dans-la-main-pour-accelerer-lindustrialisation-du-royaume_mg_5c9a0e98e4b0743555a4ff9

[81] https://www.jeuneafrique.com/mag/476366/economie/maroc-thales-senracine-dans-les-hautes-technologies/

Intelligence[82]. The potential of **Blockchain** is being explored by Moroccan industry. Otherwise, no concrete use cases could be identified[83]. The use of the **IoT** is in its infancy. Some use cases in the industry include supply chain management, traffic management, video surveillance and telemetry[84].

The technology providers are large multinationals (for example Thales in 3D printing, IBM in Big Data, Orange in the IoT), but also start-ups. The demand seems to be currently driven by some mature industries (automotive and aeronautics, financial sectors). However, there is a promising trend for further dissemination in other sectors (mainly logistics and transportation, textile industry[85]). 3D printing services are primarily for architectural firms and design offices operating in Morocco. The second target is made up of students from twenty engineering schools as well as the National School of Architecture. The 3D printing industry remains a business of professionals (some industries, engineers' schools) and is limited to the most basic technology, plastic wire.

"Industrie du Maroc Magazine" conducted a survey in 2018 on the prospects and use cases for 4IR technologies. The results revealed that[86] Moroccan companies are very interested in new technologies and companies base their future development strategy on the good management of their data, which is a crucial notion to guarantee cybersecurity, the integrity of an activity, the quality of services or the image of a company. To achieve their growth objectives, companies want to focus on better work organisation by streamlining the internal organisation of the company through management and the mode of governance, by focusing on flexibility, agility and collaborative work while enhancing the sharing of information and customer relationship management. Companies are thus ready to invest in the acquisition of new technologies and wish to develop their know-how in this direction. Companies intend to lead this digital transformation in collaboration with their customers but also with other companies or jointly with universities. However, companies have a number of difficulties that may hinder their transition to Industry 4 .0. The first obstacle identified is the lack of expertise to carry out a digital strategy. Secondly, Moroccan companies are aware that digitalising is a long process that will profoundly change their internal and external organisation. Finally, they suffer from internal difficulties and cultural barriers in terms of resistance to change and the lack of a corporate culture geared towards digital.

3D printing. For years now, Moroccan industry, first and foremost the automotive and aeronautics sectors, has been supplying Additive Manufacturing - sometimes subcontracted in Europe - as a form of rapid prototyping[87]. The Thales Group has opened a 3D printing site for aeronautical and spatial components. The site in which between €15 million and €20 million will be invested already integrates two laser machines - a dozen in the future - and deploys state-of-the-art technologies in Additive Manufacturing. It employs ten engineers who have been trained for almost a year in Europe[88]. Thales has also established links with the International University of Rabat. It hosts three PhD students, including one from the INSA Euro-Mediterranean Fez, a school with an Additive Manufacturing laboratory.

Another example of partnerships between companies and academic world is the one between Dassault Système and ESSTI Rabat. They have joined forces to set up a 3D printing Learning Lab (3DS Learning Lab), the first of its kind in north Africa and the second in Africa, after that of South Africa. The lab

[82] https://www.medias24.com/MAROC/Tech-Medias/186396-Intelligence-artificielle-le-Maroc-est-encore-en-phase-preliminaire.html

[83] https://www.challenge.ma/blockchain-le-maroc-entre-dans-la-course-102794/

[84] https://telquel.ma/2016/05/05/marche-objets-connectes-prise-dabord-les-industriels-au-maroc_1495712/?utm_source=tq&utm_medium=normal_post

[85] https://afrique.latribune.fr/entreprises/les-nouveaux-champions-du-sud/2017-10-31/les-textiliens-marocains-lorgnent-l-industrie-4-0-756310.html

[86] https://industries.ma/industrie-du-maroc-magazine-presente-les-resultats-de-son-etude-sur-les-perspectives-et-lusage-de-lindustrie-4-0-par-les-entreprises-marocaines/

[87] https://www.jeuneafrique.com/mag/476366/economie/maroc-thales-senracine-dans-les-hautes-technologies/

[88] Op. Cit.

targets educational research in cooperation with companies and higher education institutions in many countries, with integration to international networks in India, Korea and France.

Artificial Intelligence. Morocco is still in a preliminary phase, at least for most industrial companies, in the application of Artificial Intelligence[89]. Indeed, the country is still in the data engineering phase. Businesses today are working on data, trying to collect it, digitalise it, facilitate access to it and analyse it. This is the step that precedes the implementation of an Artificial Intelligence system. Access to relevant and quality data is the prerequisite to a successful deployment of Artificial Intelligence in industries and is currently the key issue. Solving it requires redesigning data architectures by installing new systems that will allow better access to data and at the same time facilitating their collection[90]. Not all sectors have the same degree of maturity to accommodate Artificial Intelligence in Morocco. The sectors that best lend themselves to this technology are banking / insurance, telecom operators, retail, part of the industry (automotive industry), agriculture, energy and the public sector (e-gov)[91].

Some applications have already been introduced and are operational in the financial sector (obtaining predictions of customer behaviour) and industry (choosing the combinations of factors that will effectively increase productivity, based on the history of operations)[92]. As for the telecom operators, no programme has been set up, but there are ongoing projects[93]. The Ministry in charge of the Reform of the Administration and the Public Service is working on a project to improve public service by using Artificial Intelligence. The idea is to dematerialise exchanges between administrations, citizens and companies via digital services. In collaboration with the Ministry of Industry, Investment, Trade and Digital Economy, a draft law on digital administration that aims to rethink the way administrative services are delivered is being prepared[94].

Blockchain. Some companies in the financial and transportation sectors (Wafacash, Saham Assurances, as well as several banks, and large public groups such as Tangier Med Port) are reflecting on the possibility of incorporating Blockchain into their processes (internal organisation, client relationship management etc.)[95]. Several seminars and conferences are frequently organised by different professional bodies formed within the various federations and professional associations to raise the awareness of their members about the uses and consequences of this new technology. This is the case, for example, for the APRAM (Professional Association of Shipping Agents, Ship Dealers and Charter Brokers)[96].

Apart from that, there is little concrete application of Blockchain in Morocco. However, experts foresee interesting use cases in various sectors (banking sector, land registry, …).

Experts agree that all Blockchain applications currently available are just the tip of the iceberg. This means that this technology still has immense potential that has not yet been exploited. Admittedly, it is expected to have a bright future but in Morocco this may not be the case, for several more years, according to many experts and specialists, due to the regulatory environment[97].

Big Data. The results of the survey conducted for the 2016 edition of the "MED-IT Skhirat forum" show that companies in Morocco are interested in Big Data projects. However, the transition from intentions

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[89] https://www.medias24.com/MAROC/Tech-Medias/186396-Intelligence-artificielle-le-Maroc-est-encore-en-phase-preliminaire.html

https://lnt.ma/etude-mckinsey-benefices-de-lintelligence-artificielle-maroc/

[90] Op. Cit.

[91] Op. Cit.

[92] Op. Cit.

[93] Op. Cit.

[94] https://fr.allafrica.com/stories/201812140505.html

[95] https://www.challenge.ma/blockchain-le-maroc-entre-dans-la-course-102794/

[96] https://www.challenge.ma/lassociation-des-agents-maritimes-sinteresse-a-la-blockchain-100699/

[97] https://www.challenge.ma/blockchain-le-maroc-entre-dans-la-course-102794/

to acts seems to take a little longer than originally anticipated due to a lack of feedback from previous use cases in the country[98]. Moroccan companies, especially SMEs, are outpaced by the public sector, as the collection, storage and processing of Big Data comes at a prohibitive cost. That said, in Morocco, banks and insurance companies are advanced in this area. As an illustration, data processing has allowed some banks to detect fraud. In addition, some speakers highlighted the many benefits that companies can derive from the free availability of data that can be monetised. The acceleration of the maturity of Big Data in Morocco will pass, among others, via the incubation of start-ups by large groups and the facilitation of the creation of start-ups[99].

IBM inaugurated, in 2014, an innovation centre in Casablanca focusing on the development of entrepreneurship in ICT through the cloud and Big Data. The objective of this centre is to strengthen national technological skills in order to stimulate innovation in Morocco and francophone Africa. The centre focuses on developing solutions that use some of the industry's most recent innovations, including the cloud, Big Data and business analytics. It also develops information IT projects for sectors such as the public sector, banking, finance, telecommunications, commerce, health and transport.[100]

Internet of Things. The use of the **IoT** is in its infancy. Some use cases in the industry include supply chain management, traffic management, video surveillance and telemetry. Experts generally agree that there is huge potential for the application of the IoT in industry[101].

Box 5: Thales

The Thales Group for aeronautics has opened a 3D printing site for aeronautical and spatial components, where it is building 3D-printed parts for communication satellites.

Thales will eventually invest between **€**15 million to **€**20 million. The site currently has two laser machines, with up to a dozen expected in the future. Other Additive Manufacturing (AM) techniques are expected to be used at the site in the future. It employs ten engineers, who have been trained for almost a year in Europe.

Thales has also established links with the International University of Rabat. It hosts three PhD students, including one from the INSA Euro-Mediterranean Fez, a school with an Additive Manufacturing laboratory.

Thales hopes to be able to make larger and increasingly complex parts in the future and is working on ways to expand the range of materials that can be used with 3D printing technology.

Source: Technopolis Group (2019), Thales

5.3 Drivers and challenges specific to industrialisation

- **Systems governance and regulations**. Overall the ICT regulations (cybersecurity and data protection, free competition environment) appear as a solid foundation for further ICT and 4IR technologies expansion. Current regulations or lack of appropriate regulations concerning Blockchain or the IoT are rather, as of today, an impediment to the development of technologies in Morocco. Hence the ANRT has opened a work stream on the IoT. The Ministry of Industry is looking at options to allow regulatory sandboxes for the different technologies (AI, IoT) which are inspired from a number of countries (i.e. France, Canada, Switzerland, the UK).

- **Infrastructure**. The Moroccan ICT infrastructure is performing pretty well and appears as a solid basis for offshoring or local production.

- **Innovation ecosystem**. There are necessary improvements to be made in the transfer of knowledge from corporates to start-ups and start-ups to corporates. One bottleneck is the

[98] http://www.med-it.com/Skhirat/pdf/Enquete_BIGDATA.pdf

[99] https://financenews.press.ma/article/economie/big-data-le-maroc-se-forge-son-propre-modele

[100] https://casainvest.ma/fr/casablanca-settat/innovation/le-centre-d%3Finnovation-ibm

[101] https://afrique.latribune.fr/africa-tech/2017-06-08/internet-des-objets-nokia-jette-son-devolu-sur-l-afrique-734190.html
https://cio-mag.com/lindustrie-africaine-a-lheure-de-linternet-des-objets/
https://lnt.ma/orange-appelle-a-creation-dun-ecosysteme-objets-connectes-maroc/

divergence of interest of corporates and public sector as corporates look for commercial gains while the public sector looks for complementarities and structured data.

- **Knowledge and skills**. According to the Ministry of the Economy and the ecosystem, there is a gap in high-tech cutting-edge skills. Additionally, many skilled engineers tend to leave the country for better working conditions abroad. However, according to stakeholders, offshoring has the potential to offer a myriad of opportunities to Moroccan engineers.
- **Finance**. The government Innov Invest financing schemes are solid instruments which would nevertheless need to be reinforced or complemented with other initiatives as the number of high-tech start-ups or projects would increase.

6 Regional integration

Current utilisation level of the main 4IR technologies

Artificial Intelligence	Big Data analytics	Blockchain	Drones	3D printing	IoT

Potential use in the future

Artificial Intelligence	Big Data analytics	Blockchain	Drones	3D printing	IoT

Legend: Red: not many / few examples; Orange: nascent / some examples; Green: good potential /numerous examples

6.1 Presentation

Morocco's regional ambition in Africa is expressed in Morocco's willingness to rejoin the African Union. Following a remarkable diplomatic effort, Morocco rejoined the organisation in 2017. Morocco is also a member of the Arab Maghreb Union (AMU) and of the Community of Sahel-Saharan States (CEN-SAD).

Morocco is developing a policy of rapprochement with the Economic Community of West African States (ECOWAS). Morocco applied to join ECOWAS and in 2017, the organisation agreed, in principle, to integrate Morocco within the organisation. Morocco has also come closer to the Economic and Monetary Community of Central Africa (CEMAC) with the development of a strategic partnership and the establishment of a free trade agreement[102].

Mohammed VI has significantly strengthened Morocco's African ambitions since his coronation. The monarchy has institutionalised the principle of annual visits to several African countries in order to develop close contacts with Heads of State, but also with the economic and political spheres in almost every country. Moroccan economic diplomacy is no longer satisfied with a simple policy of trade agreements but also relies on the creation of economic networks and direct and personal contacts between Moroccan and African economic actors (Daher, 2018).

Moroccan economic diplomacy is a natural part of Morocco's development objectives (Dafir, 2012). This involves systematically opening trade markets, increasing exports to the African region in order to improve the trade balance, especially through trade agreements. It also involves prioritising the standing of Moroccan firms so that they can expand at the international level, using Africa as a base. In order to do so, Morocco has implemented measures to finance trade whilst promoting the diversification of industrial products. Efforts have also been made to improve transport infrastructure, especially in the aerial sector. The other aspect concerns the strengthening of Moroccan foreign investment in Sub-

[102] National Council for Foreign Trade, 2016, Profil économique et commercial régional de la CEMAC, 2016 Edition.

Saharan Africa (Daher, 2018). Some studies have suggested that the development of Moroccan FDI in Sub-Saharan Africa has positive effects on Morocco's GDP (LO, 2016).

Morocco is currently considered to be the second largest investor in Sub-Saharan Africa, with South Africa being the first. Trade in goods and services between Morocco and Sub-Saharan Africa has increased by 15% per year between 1999 and 2016. Despite this spectacular increase, it is important to remember that Sub-Saharan Africa has been a limited economic partner for Morocco, responsible for less than 3% of its trade (Daher, 2018).

According to the Africa Regional Integration Index 2016 (AU, AfDB, & ECA, 2016), Morocco performs fairly well in terms of regional integration. Morocco seems to be performing fairly well in terms of regional integration. However, if it is to integrate further with the rest of the region, the country must perform better with regard to the free movement of persons.

In terms of regional integration, Morocco ranks second in the Arab Maghreb Union (AMU) but seventeenth in the Community of Sahel and Saharan States (CEN-SAD); it also ranks second in AMU and third in CEN-SAD in terms of productive integration, according to the Africa regional integration index produced by ECA[103]. These rankings provide proof of the challenges faced by the country in diversifying its exports toward Sub-Saharan Africa, although it is making efforts to do so.

6.2 Rationale for supporting the adoption of 4IR technologies

6.2.1 Potential applications and impacts

Overall, the current level of Morocco's integration into the regional economy is still fairly low, pointing to great potential for cross-border facilitation and investment through technology when we consider the affirmed political will.

Technologies such as Blockchain may be used in the future to facilitate the finance of cross-border trade which would contribute to regional integration. **Customs administrations and other border agencies can therefore improve their capacity for risk analysis and effectiveness** by using Blockchain, which can ensure data integrity, traceability and transparency, make information on any shipment available in real time and allow data to be collected. **Big Data analytics and AI can help analysts derive powerful insights for risk profiling and management** and therefore prevent customs fraud in Africa. **The IoT** can help **reduce the costs of logistics** and therefore the cost of cross-border trade in Africa, especially when goods are transported by road. In the logistics domain, the IoT can enable companies to easily track driver activities, vehicle location and delivery status. Data collected by sensors can be analysed and help to ensure that more efficient route and delivery planning is done.

Morocco is today the major partner and African investor in ECOWAS. According to the World Investment Report 2016 of the United Nations Conference on Trade and Development (UNCTAD), Morocco invested about $600 million in Africa in 2015. Indeed, several major Moroccan companies operating mainly in the banking, insurance, telecommunications and construction sectors, have extended their activities to west African countries and realise a large part of their turnover and profits from their investments in Africa. 4IR technologies can help accentuate this trend by allowing Moroccan tech start-ups and companies to invest in Africa.

6.2.2 Current use cases and level of technology take-up

There is no evidence of current use cases of emerging technologies in Morocco in fields related to regional integration, namely transport/logistics, customs services and trade finance.

[103] https://www.integrate-africa.org/rankings/country-profiles/morocco/

Morocco is mainly at the awareness-raising stage. For example, the Professional Association of Shipagents and Shipbrokers of Morocco (APRAM) organised, in 2018, a workshop on Blockchain and its involvement in marine transportation[104].

7 Well-being

Current level of utilisation of technologies

Artificial Intelligence	Big Data analytics	Blockchain	Drones	3D printing	IoT

Potential for applications

Artificial Intelligence	Big Data analytics	Blockchain	Drones	3D printing	IoT

Legend: Red: not many / few examples; Orange: nascent / some examples; Green: good potential /numerous examples

7.1 Presentation

This section looks at key policies in the areas/sectors of education, healthcare and smart cities. Rather than providing a comprehensive overview of developments in each of these areas in Morocco, we highlight only the most relevant trends for 4IR take-up.

Smart cities. Morocco aspires to become a pioneer on the continent for the development of smart cities[105]. Since 2015, several smart cities projects have thus been set up in Morocco[106], marking this interest and trend in the country. Aware of the importance of open data in modernising its public and urban space, Morocco has developed several data sharing initiatives, strengthening the link between citizens, associations, companies and public actors.

There are three flagship projects in Morocco:

- The Casablanca Smart City which aims at making the city more attractive and more efficient through its digital transformation;
- The eco-city Zenata, which is one of the first eco-cities labelled in Africa and in emerging countries[107];
- The Green City of Benguerir, a new urban model based on respect for the environment and the promotion of sustainable development[108].

Education. Morocco has implemented major strategies to integrate the use of ICT in education in terms of infrastructure, training and digital resources. The GENIE Programme launched in 2006 and revised in 2009 is the operational dimension of the national strategy of mainstreaming ICT in education. The programme is structured around four pillars: infrastructure (internet coverage in school and universities, computers), training of teachers and administrative staff, development of digital resources and development of ICT usage through awareness raising and by sharing good practices. The programme achieved the following results: 85% of schools have been equipped with a basic digital

[104] https://www.challenge.ma/lassociation-des-agents-maritimes-sinteresse-a-la-blockchain-100699/

[105] https://lematin.ma/journal/2016/smart-cities--quel-positionnement-pour-le-maroc--/248018.html

[106] https://afrique.latribune.fr/think-tank/2017-04-18/le-maroc-pionnier-de-la-smart-city-en-afrique.html

[107] https://afrique.latribune.fr/entreprises/industrie/btp-immobilier/2018-10-19/maroc-l-eco-cite-de-zenata-sort-progressivement-de-terre-794535.html

[108] https://villesdurables.ifdd.francophonie.org/index.php/BENGU%C3%89RIR_:_La_premi%C3%A8re_ville_verte_en_Afrique

environment and 266,000 teachers have been trained in ICT usage in education (Nafidi, et al., 2018). The integration of ICT in education is one of the key measures of the Strategic Plan for the Reform of Education 2015-2030. (High Council of education, training and scientific, 2015)

Health. The Moroccan Ministry of Health identifies e-health as a priority intervention axis in support of the Health Plan 2025. Morocco is committed to investing in innovation and experiments in telemedicine and e-Health solutions. These investments are expected to improve access and equity in healthcare and speed up the path to achieving Universal Healthcare coverage[109]. Morocco has put in place a legal framework to formalise teleconsultation and telemedicine to allow doctors to practise telemedicine as a fully-fledged activity and one that is reimbursed by social welfare organisations[110].

7.2 Rationale for supporting the adoption of 4IR technologies

7.2.1 Potential applications and impacts

Smart cities. While 60% of Moroccan population is urban, this proportion will reach 70% by 2050[111]. By this time, Casablanca, the largest city in Morocco, will have a population of five million inhabitants. The challenge of ensuring quality of life for this population is therefore important. It encompasses meeting the challenges posed by a significant population growth, rapid urban development as well as limited natural and financial resources.

Education. 4IR technologies can be employed to improve education, access to education and training for digital skills. There are some examples of the use of Additive Manufacturing (AM) within education. These mainly consist of cases where higher education institutions use 3D printing laboratories to teach and train young people to use these technologies. For **Artificial Intelligence,** there is the potential for Machine Learning to be used to anticipate job market demand, automate teachers' routine tasks and to personalise learning. AI can also be used to fill skills shortages within the labour market, that is, by carrying out tasks for which the local workforce lacks the appropriate skills. Higher education institutions can use 3D printing laboratories to teach and train young people to use these technologies. **The IoT** has the potential to improve the quality of education and access to education. The large-scale diffusion of mobile communications technology has transformed educational practices, with easier access to educational resources inside and outside schools.

Health. The potential applications of modern 4IR technologies are most apparent within the domains of the IoT, Big Data and Artificial Intelligence. Certain applications have also been identified using drones, Blockchain and Additive Manufacturing although these applications are less evident. **IoT technologies are likely to have a large and positive impact on African healthcare delivery.** For example, hand-held devices can be used to detect if a pharmaceutical product is genuine. Video therapy and remote diagnosis and care can also be enabled by technology, such as by using image recognition to render certain diagnostics automatic. **AI and Big Data** have been becoming steadily more prevalent in healthcare systems, helping to analyse large amounts of data to improve efficiency in both care and access to medical supplies. In particular, AI is starting to be used for surgery, diagnosing diseases, early identification of potential pandemics, imaging diagnostics and remote therapy. AI has also been used to detect health conditions as well as to educate and communicate with patients via mobile phones. The **use of Blockchain in digitalising and sharing medical records** is one of the identified applications of the technology for the healthcare sector. **Another area where Blockchain technology could improve healthcare services is in payments by insurance companies. Medical drones are steadily changing the way that emergency healthcare is provided in Africa**. Indeed, drones have emerged as a good solution to resolve the difficulties and inaccessibility of certain rural areas in terms of the delivery of emergency medical supplies. 3D printing can play a role in healthcare by reducing the costs for prosthetics and samples. Additive Manufacturing (AM) can also play a role in the production of medical equipment and in the testing of diseases.

[109] http://esante.ma/index.php/fr/blog-afrique-et-esante/

[110] Op.cit.

[111] Haut Commissariat au Plan

7.2.2 Current use cases and level of technology take-up

Smart cities. On the supply side, the technology providers are large multinationals (for example IBM in Big Data, Orange in the IoT) but also start-ups. On the demand side, the demand seems to be currently driven by Public Private People Partnerships or municipalities. One interesting use case is the Casablanca Smart City. See Box 6.

Box 6: Casablanca Smart City

Casablanca Smart city is a Public Private People Partnership initiative supported by several concrete projects[112]. The city of Casablanca will notably acquire a data platform and services Casa Urban Platform, which will rely on the capabilities of the **Internet of Things** and **Big Data** technologies. The goal is to optimise the acquisition and processing of information to improve the action of the administration and better inform citizens of Casablanca[113]. e-Madina, a cluster organisation set up in 2015, is the implementing body of this project. Its mission is to create and develop a smart city ecosystem to deliver city transformation initiatives using digital technologies. The cluster supports and helps to finance smart city projects for the city of Casablanca[114].

In October 2015, Casablanca was the first African city to join the network of twenty-five smart cities selected by the Institute of Electrical and Electronics Engineers (IEEE3), the largest association of professionals of digital and information technologies in the world. The organisation will support the city of Casablanca in the development of its concept of being an intelligent, social and frugal city[115].

Transformation into a smart city involves developing a network of information at the city level through the collection of data from users via sensors, applications, etc. The city of Casablanca has already initiated the establishment of such a network by inaugurating, in January 2016, an intelligent and optimised CCTV system, including 760 cameras connected by 220 kilometres of optical fibre.

Data platforms like the one developed by the start-up cityzenith make it possible to compile, process and visualise this urban data. The company has developed a city visualisation platform in 5D, adding to the classic 3D the dimension of time, and that of data since the platform makes it possible to aggregate data on the city concerning the environment, security or even infrastructure[116].

Source: Technopolis (2019)

Education. There are very few examples of the use of 4IR technologies in education in Morocco. The scarce use cases identified are still on the verge of digital solutions. For example, the website e-madrassa developed by Inwi is an interactive digital platform which provides digital educational content to primary and secondary students[117]. Education Media Company is a start-up which develops digital platforms dedicated to e-education in Morocco [118].

Health. There are some use cases of 4IR technologies in health in Morocco. Most of the use cases imply Big Data and somehow AI. There is also evidence of the growing use of 3D printing. Below are some interesting use cases:

[112] http://www.e-madina.org/activites/projets/
[113] https://www.medias24.com/casablanca-lancement-plateforme-big-data-594.html
[114] http://www.e-madina.org/presentation/mission-et-objectifs/
[115] https://smartcities.ieee.org/
[116] https://afrique.latribune.fr/think-tank/2017-04-18/le-maroc-pionnier-de-la-smart-city-en-afrique.html
[117] https://www.micromagma.ma/actualites/maroc/item/3058-inwi-lance-une-nouvelle-version-d-e-madrassa.html
[118] http://www.educationmedia.ma/

- PocketDoc is a Moroccan mobile application which provides all the documentation necessary for the therapeutic management of the most serious and frequent pathologies in medicine [119].
- Moldiag is a start-up and the first of its kind in Morocco and Africa, which develops and produces molecular diagnostic kits for the detection and quantification of several diseases such as cancer and infectious diseases. Moldiag's aim is to produce not only reliable and accurate but also very cost-effective molecular tests [120].
- MedTrucks is a start-up which provides healthcare services to the population in 'medical deserts' and therefore allows the population to benefit from healthcare without having to travel a long distance. To do so, MedTrucks has developed, thanks to Big Data and open data, two tools: MedTracking and MedMapping[121]. See Box 8.
- There are also use cases from some hospitals and dentists in the production of prosthetics. For example, the "Clinique des spécialités" in Agadir offers orthopedic surgery using Additive Manufacturing for the production of prosthetics[122].

Box 7: PocketDoc

PocketDoc is a fast and accurate way for physicians to determine the right prescription and dosages for their patients. PocketDoc is a tool for diagnosis and medical prescription for health professionals in general and doctors and medical students in particular. This mobile application offers users quick access to therapeutic management solutions for the most common pathologies, complete and verified prescriptions, a database of medicines, etc.

The platform is a tool that aims to help medical decisions and which allows the user to select pathologies in more than twenty medical specialties, to consult more than 700 complete and verified prescriptions, to access a list of medicines sold in Morocco with their trade name and International Non-proprietary Name (INN) and also to find the usual values of the most requested biological examinations in medicine [123].

Source: Technopolis Group (2019), PocketDoc Maroc

Box 8: MedTrucks

MedTrucks is a start-up which provides healthcare services to populations in 'medical deserts' and therefore allows populations to benefit from healthcare without having to travel a long distance. To do so, MedTrucks has developed, thanks to Big Data and open data, two tools: MedTracking and MedMapping.

MedTracking processes geographical and medical data to quantify the financial and social impact of a medical project on a population. MedMapping is a free access platform that allows patients to geolocate and detect existing hospitals on the internet. It offers an interactive mapping application that allows patients to identify the health centres closest to them. This is a visualisation of several sets of data collected as a result of long-term work, as access to information and data collection in a single place were not easy. In addition, open data sources were not sufficient, exhaustive and most of the time give access to information that is not updated. To compensate for this, MedTrucks organised a citizen participation movement of data collection that makes the citizen an official supplier of data: crowdsourcing.

[119] https://www.welovebuzz.com/ce-jeune-marocain-nous-prouve-que-medecine-et-technologie-ne-font-pas-deux-ce-quil-fait-nous-rend-fiers

[120] https://www.start-up.ma/startup/moldiag/

[121] http://aujourdhui.ma/high-tech/au-maroc-lopen-data-sauve-des-vies

[122] https://www.leconomiste.com/article/981207-impression-3d-medicale-un-centre-pilote-agadir

[123] http://aujourdhui.ma/high-tech/au-maroc-lopen-data-sauve-des-vies

Source: Technopolis Group (2019), MedTrucks Maroc

7.3 Drivers and challenges specific to smart cities

Smart cities. Governance is paramount to the success of smart cities projects. The transformation of Casablanca into a smart city is being slowed down by the lack of clear governance. In fact, while the e-Madina cluster accompanies and feeds many projects, it does not have the role of decision-maker. The multiplicity of actors without effective governance can be a hindrance to the development of the Casablanca Smart City[124].

Education. The Moroccan government has the will to integrate the use of digital and 4IR technologies in education and has invested to support this vision. However, observations in the field and research on the subject reveal that ICT and 4IR technologies are not yet widely used by teachers for educational purposes (Nafidi, et al., 2018). Teachers still need to be supported and trained in using ICT (Nafidi, et al., 2018). On the other hand, the rise of the penetration of smartphones and the internet provide an opportunity to develop e-educational content. The recent and rapid development of e-education start-ups like the Education Media Company show that there is a real potential for the development of 4IR technology use cases in education in Morocco.

Health. One major driver is the political will to foster the development of the use of ICT and 4IR technologies in healthcare in Morocco. However, one major challenge for the development of applications is the availability of quality open data.

8 Overall conclusion for a business case in the country

8.1 Is there a business case for 4IR technologies in Morocco?

The Moroccan government has engaged in policies to tackle 4IR technologies and to be on top of opportunities they present. Morocco is anchored in the liberal open market economy and **missing the 4IR train is therefore not an option**. However, traditional activities and jobs are also threatened by 4IR technologies. For example, offshored calling centres run the risk of being replaced by AI (Google Dupleix technology). Agriculture could lose 85% of its jobs to robotisation. Hence Morocco is facing a dilemma in terms of the risk of non-inclusive growth, while, there is still a remaining gap of 2% to 4% between demographic growth and GDP growth. Morocco has therefore the challenge to create added value. The World Bank has defined the cost of not stepping into the 4IR at a loss of 2% of GDP for Morocco[125].

Undergoing the necessary steps to adopt these technologies turns out to be a geostrategic challenge for Morocco. One of the first steps is to fully engage in ICT take-up by the government sector, the private sector and citizens. The Moroccan government has recently invested in accelerating its digital transformation reform, securing the legal base with a recent broadband regulation and setting up an Action Plan and better governance with the ADD[126].

Morocco has decided to focus its investments on a limited number of sectors and technologies. While acknowledging the threat of spreading its resources and efforts widely, the ADD **focuses on the IoT, AI then eventually Virtual Reality and Big Data** and the Ministry of Industry **is focusing on e-government (likewise Tunisia), agriculture, energy (renewable energies), industry and mobility (smart cities).**

[124] Bearing Point, 2016
[125] Interview Ministry of Economy and Industry Morocco
[126] However, there is not yet a specific Minister in charge of digitalisation (it is under the Ministry of Industry and Economy).

A summary of the markets to be targeted by sector and technology is set out below.

Sectors

Agriculture	Energy	Industrialisation	Smart cities

Technologies

Artificial Intelligence	Big Data analytics	Blockchain	Drones	3D printing	IoT

Legend: Red: not much potential; Orange: nascent potential; Green: good potential

8.2 Overall SWOT

Strengths	**Weaknesses**
A modern ICT infrastructure attracting major players on the supply side and allowing for the development of local applications A well-developed research and innovation ecosystem and strong links between universities and the private sector A strong and well renowned education system Strategic positioning between Europe, the USA and Africa Political stability Major Moroccan firms established in Africa Recent launch of the Innov Invest Fund Creation of the ADD (Digital Development Agency) A successful diaspora A pool of talented and skilled young people Experimentations with regulatory sandboxes	Weakness in technology transfer Brain drain A culture resistant to change at some levels of governance Large scale use cases are embedded in sectors dependent on FDI
Opportunities	**Threats**
Taking African leadership on the 4IR Ecosystem stakeholders are currently federating Acceleration of Open Innovation programmes	Missing the train Losing jobs Non-inclusive growth

9 Recommendations

9.1 Recommendations at the national level

With the challenge of providing jobs to 18 million young people in the next 20 years, Morocco has to find smart solutions which are offered by the ICT sector under the right policy and regulatory conditions. As a key input for other sectors in an increasingly digital economy, the Moroccan ICT sector has the potential to perform far better than it currently does in global rankings. For this to happen, the issue of literacy and affordability needs to be tackled both from the consumption and production perspectives.

To embrace the Fourth Industrial Revolution, Morocco will have to invest in developing new skill sets in line with the technological revolution. There is a need to build a pipeline of future talent that can

embrace the age of emerging technologies. Morocco produces 10,000 engineers per year but there is a complete haemorrhage of them, resulting in a real pressure on these technical profiles. There is a need to increase the number of trained engineers as well as to improve the framework that would make them want to stay. Whilst a skills' upgrading plan has already been developed and has been presented to the parliament and whilst a vocational training plan has also been presented, there is a need for finance for these plans.

Morocco could go a step further by defining a comprehensive strategy for the 4IR, which is consistent with existing strategies (digital, industrial) but which defines its overall ambition for these in five years' time, and tackles the weaknesses in preconditions, proposing specific instruments to support its ambition. The support could be focused on **large corporates** (aeronautics, electronics), which will open the way to smaller initiatives.

While access to finance has been partly resolved, some additional financing is needed for research, demonstration/technology transfer as well as for start-ups.

Concerning regulations, supporting the process of alignment with international standards and setting up regulatory sandboxes is an avenue.

Specific government interventions include:

- designing a 4IR strategy for both the public and private sector;
- adopting open data policies within a well-developed data protection and rights framework; pursuing the use of regulatory sandboxes whenever required and being a driver of innovation;
- incentivising the establishment of national data centres which could eventually serve other countries if the required regulatory framework is in place;
- enhancing current schemes to stimulate R&D in companies by injecting more Venture Capital (VC) into the economy and adapting the fiscal system;
- improving innovation linkages and technology transfer between universities and the private sector;
- acting on the business environment (notably resolving insolvency) to foster innovation and entrepreneurship and issuing a Start Up Act.

9.2 Potential AfDB projects

The following paragraphs are proposals which need to be refined after testing them against the Intervention Framework and following a series of interviews with AfDB staff.

Agriculture

- **Propose finance for the scaling up of agritech initiatives** such as Agri Edge.

Energy

- **Propose finance for scaling up smart grids.**

Industrialisation

- **Support an R&D scheme** i) with competitions on R&D, involving the triple helix of innovation, about each of the technologies to address common/national issues (mission-oriented research); ii) with demonstrators (Factory 4.0) which could have a sub-regional or regional element; platforms that allow manufacturers to show their expertise through concrete achievements and reward people who advance in the use of these technologies and promote them (as the cost of the technology is

quite high); iii) set up better linkages between universities and the private sector, notably to support the transfer of technologies.

- **Propose even more support to innovative firms** i) Proposing services to companies about Business models about 4IR; ii) Financing innovative SMEs or firms and start-ups, additional to Innov invest (setting up an African Y combinator/accelerator).
- **Increase trust in markets** thanks to awareness raising and improving the business environment.

Smart cities

- **Support one or two smart cities initiatives** through to promotion, providing metrics and financing infrastructure.

Crosscutting

- Support the definition of an explicit 4IR strategy and an appropriate policy mix.
- Raise the awareness of the government, private sector and citizens about the technologies to reduce the asymmetry of information.
- Support the alignment of national regulations on cybersecurity and data protection to international standards.
- Propose finance to the Moroccan government in setting up data centres.
- Support training for more highly trained engineers, computer engineers and ensure the right match between market needs and training. This support could be at training of trainer level, with the provision of technical assistance experts on the 4IR technologies.

Appendix A List of stakeholders consulted for this case study

- African Development Bank, Rabat office
- Fédération des Nouvelles technologies de l'Information, des Télécommunications et de l'Off-shoring (APEBI)
- Technopark Casablanca
- ENSEM UH2C
- HighTech Educ
- SEAF Morocco Capital Partners
- Ministry of Industry and Investment, Trade and the Digital Economy
- Digital Development Agency
- High Commission for Planning
- Ministry of Economy and Finance, Studies and Financial Forecasts
- UNIDO Geneva
- Technopark Casablanca
- La Factory
- Digital Economy Commission and NBIC of CGEM
- Orange Morocco
- Telecommunication Regulatory Agency

technopolis |group| France
88 rue La Fayette
75009 Paris
France
T +33 1 49 49 09 20
F +33 1 49 49 09 29
E info.fr@technopolis-group.com
www.technopolis-group.com