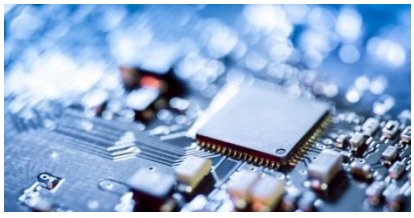
Task Force on the Fourth Industrial Revolution

"4IR as an Enabler of Green and Inclusive Industrialisation"

Final Report

August 2022



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Executive Summary

The Fourth Industrial Revolution (4IR) and its technologies present unprecedented opportunities for Namibia to improve its economy. The emerging Green Hydrogen economy in Namibia under the Harambee Prosperity Plan II can serve as a catalyst for Namibia to accelerate its adoption, use, creation and application of 4IR technologies. However, as the results of this report demonstrate, the enormous benefits of 4IR will prosper Namibia only with significant national policy changes per the recommendations below.

An eight-member Task Force on the Fourth Industrial Revolution was appointed on 1 July 2021 serving until 30 June 2022 to determine Namibia's readiness for leveraging the Fourth Industrial Revolution.

The Task Force reviewed the following thematic areas:

1) Infrastructure and National Data
2) Future of Work, Capacity-Building, Labour Force Skills
3) Industry, MSMEs, Start-Ups and investment
4) Policy, Legislation and Governance
5) Research and Development, and
6) Core 4IR Technologies

The Task Force assessed the current situation by conducting desk reviews and stakeholder engagements. The initial findings then informed the development and application of a Change Readiness Assessment (CRA) Framework for 4IR consisting of three layers that provided a basis for international benchmarking, comparison with other countries, and contextualisation to Namibia's realities. The three layers consisted of 1) "Preconditions" for 4IR, 2) the World Economic Forum's (WEF) "Readiness for the Future of Production" framework and 3) "Broader applications of 4IR". A Namibia 4IR Conference and Expo provided for a national dialogue that further informed the country assessment.

The Task Force consulted over 160 stakeholder organisations and more than 660 individuals, excluding conference attendees of about 400. The online survey for the Country 4IR Readiness Assessment had 514 responses.

A significant contribution of this report is the Country 4IR Readiness Assessment Framework (CRA) online survey that was conducted and analysed during the assessment period. This instrument was used in addition to the different sources of data such as stakeholder focus groups and interviews, secondary data and the Conference and Expo. The CRA survey received a total of 514 responses, including 319 respondents from Namibian companies and 195 respondents from a broader set of organisations.

The Country 4IR Readiness Assessment Framework consisted of three layers: Preconditions for the 4IR, the World Economic Forum's Future of Production instrument and Broader

Applications for the 4IR. The Preconditions and “Application domains for 4IR” sections were contextualised to Namibia.

Preconditions for the 4IR in Namibia are rooted in strong infrastructure, education and a dynamic innovation system; centred around the needs of industry; and manifest in improved living conditions for the majority of the population.

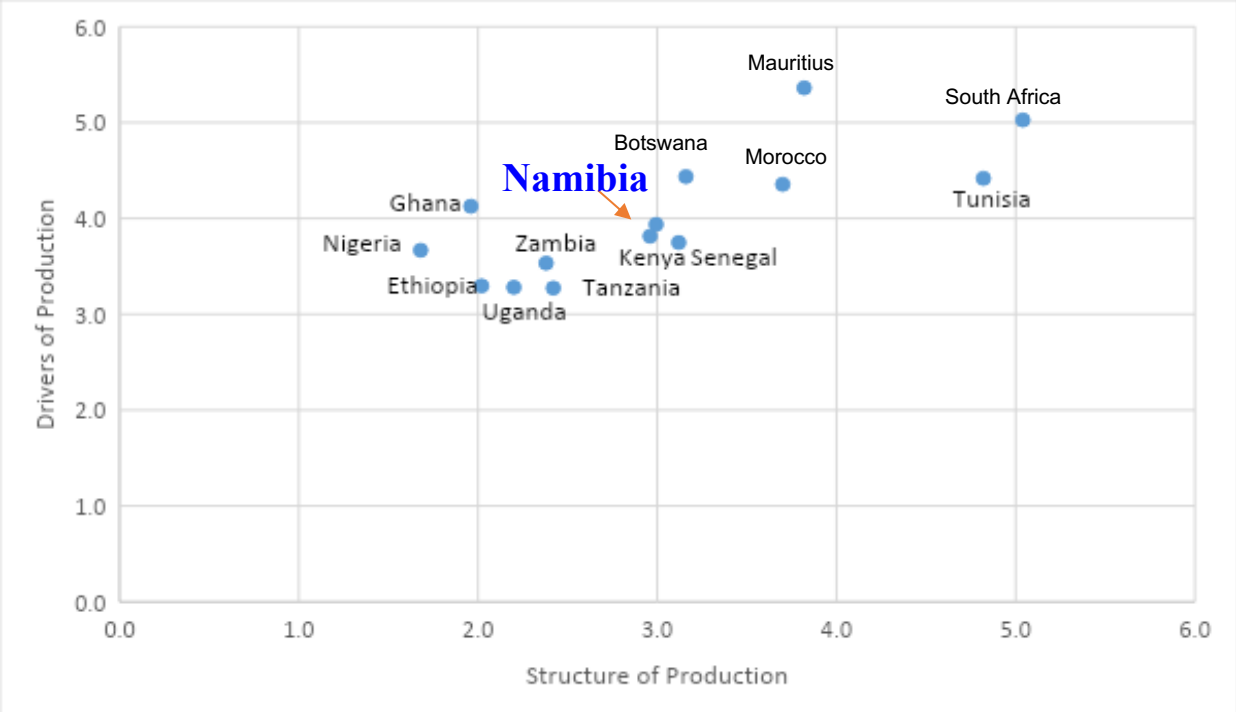
The 4IR depends upon critical physical infrastructure networks, including transport (road, rail, waterways, airports); energy (electricity, fuel supply); water (supply, wastewater treatment); and solid waste (collection, treatment, disposal). 4IR also depends upon digital infrastructure (internet connectivity, data centres, etc.). The relationship between 4IR technologies and infrastructure is interdependent since adequate infrastructure is a precondition for 4IR, but 4IR technologies can also contribute to the modernisation of infrastructure processes, which brings huge opportunities for innovation.

Namibia performs relatively well in physical infrastructure, as compared to peer countries in the region. While 56% of the total population has access to electricity, there are vast differences in urban and rural electrification, with about two-thirds of rural population lacking access to electricity. Although Namibia does not score lowest in the region, improvements are needed in electricity provision.

Education is a central and prerequisite ingredient for the 4IR. The automation and adoption of advanced digital technologies in all parts of society and the economy is already creating pressures to develop educational offerings in complex fields, including artificial intelligence, advanced robotics, biotechnology, new materials and autonomous vehicles. The debates around the type of knowledge and skills that will be needed in the future are also rich in the existing literature, because they highlight the importance of subjects such as science, technology, engineering, the arts and mathematics (STEAM) and ICT skills, as well as soft skills related to problem-solving, collaborative working, together with critical and creative thinking. Educational statistics for Namibia in comparison with other countries indicate the critical importance of investing in education if Namibia seeks to reap the benefits of 4IR. Although Namibia does not score lowest in the region for investment and enrolment into tertiary education, it does score lowest for ICT graduates, which are essential for 4IR. This is corroborated by the findings that quality of mathematics and science education are below average. Availability of scientists, technologists and engineers as well as availability of advanced digital skills are lowest among the African countries assessed. Moreover, 4IR technologies are also changing the way education and teaching are imparted. The assessment further shows that the Namibian style of teaching needs to change and that the quality of vocational training is considered below average. Therefore, an education reform across all layers is necessary to provide for the future of work and the 4IR, from basic education to tertiary education and lifelong learning. There are inadequate opportunities for upskilling and reskilling of unemployed youth. However, the 4IR presents multiple opportunities for youth innovation and business in digital solutions, as the survey showed that most innovations and business improvements were in the digital technologies.

The CRA included the standard World Economic Forum (WEF)'s Future of Production (FOP) assessment where Namibia was scored for the first time. This FOP contains two capabilities and serves as a comparison tool with other countries while pointing out areas for improvement. The FOP capabilities score for Namibia is 3.0 out of 10 for the Structure of Production and a 3.9 out of 10 for the Drivers of Production. The assessment score classified Namibia as a "nascent country" along with all Africa countries assessed, where such countries are considered to be least ready for the Future of Production. Although Namibia is placed below South Africa, Botswana, Mauritius, Morocco and Tunisia, it scored higher than Zambia, Kenya, Nigeria, Ethiopia, Tanzania, Uganda and Senegal. It is important to note that all other countries were assessed according to their 2018 data vs Namibia's 2022 data. Each FOP capability score has individually scored components.

Structure of Production		**3.0**
Driver	**Weight**	**Score**
Complexity	60%	3.9
Scale	40%	1.6
Drivers of Production		**3.9**
Driver	**Weight**	**Score**
Technology and Innovation	20%	3.9
Human Capital	20%	3.6
Global Trade & Investment	20%	3.3
Institutional Framework	20%	5.3
Demand Environment	15%	4.0
Sustainable Resources	5%	2.5



The Nascent Archetype with Namibia's scores

The Structures of Production score means that Namibia's production base may still be small and simple, similar to many countries within Sub-Saharan Africa. Thus, Namibia is likely to find it difficult to expand into advanced manufacturing, because it may still be trying to develop its industrial base. The components used to measure the Structure of Production are the Economic Complexity Index (Complexity = 3.9) and the Manufacturing Value Added (Scale = 1.6). Economic complexity is a measure of a country's productive capabilities that is formulated indirectly by looking at the mix of sophisticated products that it exports. Therefore, Namibia should expand its productive capabilities from resource-based activities within the primary sector to the manufacturing and services sector, to manufacture and export more complex and advanced goods and services. This expansion will allow it to move towards a far better ECI.

The Scale indicator, a measure of Manufacturing Value Added (MVA), is the net output of the manufacturing sector, estimated after adding up all the outputs and subtracting the intermediate inputs. MVA is often used as a proxy for industrialisation. MVA accounts for about 11% of the GDP in Namibia, which has been in decline for the past 15 years or so. It is, however, still higher than in other countries in the region.

The six Drivers of Production represent factors and conditions necessary to capitalise on emerging technologies and transform production systems. Namibia's performance is mixed in terms of the Drivers of Production (3.9/10). The Technology and Innovation driver remains a challenge for Namibia, with government procurement of advanced technology and commitment to cybersecurity ranked lowest.

Human Capital for the 4IR was rated lowest of the African countries assessed and especially in advanced digital skills such as coding. The quality of mathematics and science education was perceived higher than in South Africa and Tanzania but still inadequate for the 4IR. The availability of scientists, technologists, engineers and researchers were also rated lowest in the region of African countries assessed. Global Trade & Investment is one of the lowest ranked drivers of production for Namibia at 3.3 owing to trade barriers. The components of global trade are trade, investments and infrastructure.

The institutional framework driver has the highest scores among the Drivers of Production (5.3/10), and this assesses how effectively government institutions, rules and regulations contribute towards shepherding technological development, novel businesses and advanced manufacturing. Three elements were scored: *future orientation of government*, *rule of law* and *corruption perceptions*. The *future orientation of government* was rated lowest in the region due to the policy and regulatory framework to support the 4IR that is considered inadequate. Government is perceived as particularly slow and inadequate to support digital businesses. Higher scores are attributed to *rule of law* and the *corruption perception,* which are each perceived third among African countries assessed.

Namibia ranked also relatively well on the demand environment, particularly due to a relatively sophisticated consumer base, reasonably spread corporate activity and a market size that is comparable to other peer African countries.

In addition to the inadequate skills base and legislative framework to support the 4IR, the CRA assessment further indicated critical barriers to the adoption of advanced digital technologies: (a) Lack of capital or funds for investment, (b) Lack of knowledge about possible applications of the 4IR technology, (c) Lack of skills for using the technology, (d) Inadequate power or ICT infrastructure and (e) Difficulty integrating the technology into the organisation's processes. These are key areas in which policy interventions could assist more widespread adoption of 4IR technologies in Namibia.

The CRA also assessed the "Application domains for 4IR" and identified information technology, education and energy, followed by the financial sector, media and communications, advanced manufacturing, health and agriculture. Mining, the public sector, fisheries and the informal economy were some of the other sectors in which respondents saw opportunities for 4IR technologies to accelerate Namibia's development and economic growth. Preconditions for the 4IR in Namibia are considered to be rooted in strong infrastructure, education and a dynamic innovation system; centred around the needs of industry; and manifested in improved living conditions for the majority of the population.

A key question facing Namibia is how to ensure that the transition towards a low-carbon and more environmentally sustainable future can be supported and accelerated by the 4IR. There are also fears that digital inequalities can cause poorer communities to become poorer, and that the Gini coefficient (a measure of wealth inequality) could become even higher. These two issues should be addressed in the recommended National Consolidated 4IR Strategy and National AI Institute where innovation, research and development of 4IR technologies will be carried out.

The recommendations from this assessment have implications and benefits for the private sector, public sector, academia and general public. The private sector can potentially benefit if trade barriers were reduced, and a more conducive environment were developed for businesses to adapt to the 4IR. Some of these considerations include addressing the e-commerce barriers; easing doing business through enhanced e-government service provision; introducing more tax incentives; improving the availability and quality of skills; reviewing immigration policies to capture scarce and specialist skills; prioritising the country's cybersecurity framework; increasing support to businesses, MSMEs (micro, small and medium enterprises) and tech entrepreneurs for pivoting to 4IR; revising policies and legislation; improving 4IR infrastructure. The AI Institute and improved data availability and sharing can foster innovation and R&D support to improve products, services and market access using 4IR technologies.

The public sector can potentially benefit from the recommendations made. A consolidated 4IR strategy and 4IR Commission will assist with coordination, which is one of the biggest pain points, as well as oversight of 4IR technology development, implementation monitoring and evaluation. Potential solutions are offered for resource mobilisation: foreign direct investment; domestic private sector and public sector financing of skills development and infrastructure; and attracting more investments for 4IR into the country. The National Data Centre, especially if designed to be a green data centre powered by green energy, and the AI Institute will go a long way in ensuring localised data ownership and data availability while facilitating data

sharing and security. The AI Institute could potentially assist in developing a new service industry such as developing 4IR platforms, products, services for government, the private sector and international organizations. The two entities can also support the new Green Hydrogen economy.

Implications for educational institutions span basic education, vocational, higher education and lifelong learning. These recommendations also include suggested solutions, such as provision of advanced digital skills and qualifications, innovation platforms, internship and apprenticeship funding as well as participating in development of R&D infrastructure and capacity. The assessment also makes recommendations for a change in teaching methods, delivery modes, content, teacher training and school infrastructure to teach a 4IR-ready workforce. Consideration should also be given to making ICT skills as promotional subjects while introducing coding in primary school. Furthermore, specific recommendations focus on providing upskilling and reskilling as well as business opportunities for unemployed youth.

The general public can benefit from all recommendations if implemented. These recommendations address e-government service provision; improved ICT and power infrastructure; lower cost of data and devices; access to upskilling and reskilling programmes for unemployed youth; a paid national internship programme; improved education; digital innovation; and entrepreneurship development facilitated by a conducive legislative framework. Such a framework would include increased access to a global market through e-commerce, payment gateways and forex, as well as consideration for responsible and ethical AI development. Furthermore, the general public might also benefit from free online training programmes facilitated by lower data and device costs and more financing support for digital innovations.

In conclusion, Namibia needs to significantly improve its education system; increase technology investment; increase global trade and investment; and refresh its legislative framework for 4IR. These are contained in a set of 13 recommendations below. A common fear expressed among stakeholders is that the report's recommendations will not be implemented. However, the Task Force strived for an inclusive approach during its consultations, creating data-driven implementable recommendations whilst considering the limited government budgets and how these 4IR recommendations can complement the developing green hydrogen initiatives and other pressing national needs.

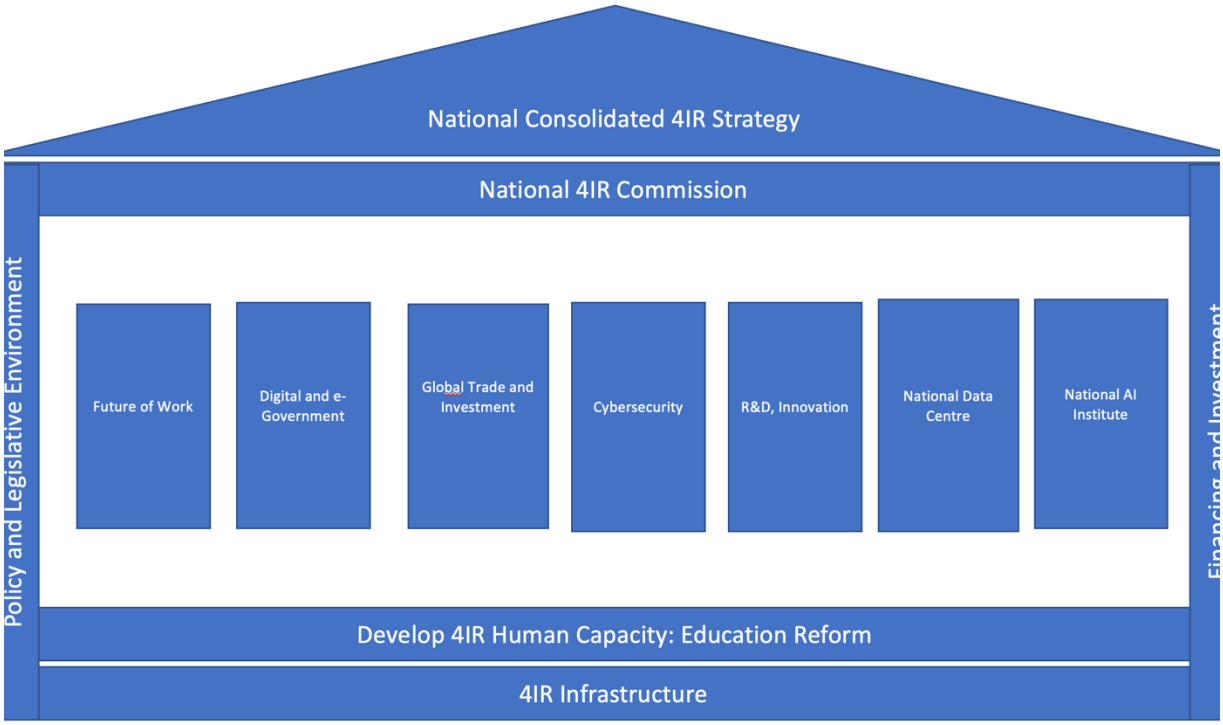
The 4IR Task Force puts forward the following final recommendations (details under Section 10):

Action:	**Proposed Owner:**
1. Appoint a National 4IR Commission (to develop national 4IR strategy and oversee cross-sectoral implementation)	**Office of the President**
2. Develop and implement a consolidated National Consolidated 4IR Strategy (to provide an overarching direction and multi-sectoral planning)	**4IR Commission, OPM, NPC, MICT**

3. Develop 4IR Human Capacity: Education Reform (to close the 4IR skills gap and enhance employment)	**MEAC, MHETI, MSY**
4. Establish a National Data Centre (to be positioned as a national and critical asset)	**OPM, NSA**
5. Conduct a comprehensive policy and legislative review for 4IR (legislative review toolkit for use in review and formulation of assessing outdated, obsolete laws and gaps)	**MOJ, National Assembly**
6. Accelerate 4IR Infrastructure developments (build on ongoing efforts, expand ICT network coverage and access, and operationalise a Special Purpose Vehicle entity to deliver ICT infrastructure and services)	**NPC, MICT**
7. Set a National Roadmap for the Future of Work (accelerate the finalisation of the countrywide skills audit and reform immigration policies and processes accordingly and proactively)	**MLIREC, NPC, MHAI, MIT**
8. Prioritise and develop a Framework for Cybersecurity (to elevate cybersecurity to the highest priority for funding, skills and legislation)	**NPC, OPM, MICT, CRAN**
9. Mobilise Financial Resources for 4IR Development (additional funding such as FDI, private sector and government funding for adequate ICT budgetary provisions)	**NIPDB, MIT, MOF, NPC**
10. Improve the global trade environment (reduction of barriers to e-commerce trade should be an area of particular focus)	**NIPDB, MIT, MOF, NPC**
11. Develop robust e-government services to support 4IR (to create a comprehensive assessment of e-government and digital economy needs and draw up an intervention plan along with funding proposals)	**OPM**
12. Strengthen the 4IR Research and Development capability (R&D government expenditure should be increased with funding support from the private sector and international funders)	**MHETI, NCRST**
13. Establish a National AI Institute (to support 4IR adoption and develop ethical AI applications for private sector, government, academia and civil society)	**OPM, MHETI, NCRST, MICT**

The extensive data collected and hours of data analysis for this report have yielded a highly valuable asset that describes a roadmap for Namibia's future within 4IR. By encouraging all relevant stakeholders to adopt the recommendations of this report, Namibians can pave the way to a much brighter technological future for Namibia.

The 4IR Taskforce graphical depiction of interacting report elements



Acronyms and Definitions

3-D	Three dimensional
4IR	Fourth Industrial Revolution
AI	Artificial Intelligence
AR	Augmented Reality
BIPA	Business and Intellectual Property Authority
CCI	Culture and Creative Industry
CPS	Cyber-Physical System
CRA	Country Readiness Assessment Framework
CRAN	Communications Regulatory Authority of Namibia
ECI	Economic Complexity Index
HESS	High Energy Stereoscopic System
HPC	High Performance Computing
HPPII	Harambee Prosperity Plan II
ICT	Information and Communication Technologies
IIoT	Industrial Internet of Things
IoT	Internet of Things
METF	Ministry of Environment, Tourism and Forestry
MHAI	Ministry of Home Affairs and Immigration
MHETI	Ministry of Higher Education, Technology and Innovation
MICT	Ministry of Information and Communication Technology
MIT	Ministry of Industrialization and Trade
MLIREC	Ministry of Labour, Industrial Relations and Employment Creation
MODVA	Ministry of Defence and Veteran Affairs
MOOCs	Massive Open Online Courses
MSME	Micro, Small and Medium Enterprises
MTC	Mobile Telecommunications Company
NAMRA	Namibia Revenue Agency
NDP	National Development Plan
NRI	Network Readiness Index
NSA	Namibia Statistics Agency
NTA	Namibia Training Authority
OMA	Offices, Ministries and Agencies
OPM	Office of Prime Minister
TN mobile	Telecom Namibia Mobile
TVWS	Television White Spaces
UNFPA	United Nations Population Fund
VR	Virtual Reality
WACS	West Africa Cable Subsea

1. Introduction

Namibia embarked on a country readiness assessment for the Fourth Industrial Revolution to determine the readiness to leverage the 4IR technologies and make recommendations towards a coordinated and coherent policy and legislative framework that can enable our country to exploit and harness opportunities presented by the 4IR. Key technological levers are in place; however, they are fragmented across the public and private sectors and civil society. As is apparent from the report's final recommendations, the prosperous benefits of 4IR will arise in Namibia only if significant policy changes occur at a national level. This report serves as a roadmap to those policy changes.

An eight-member task force was appointed by His Excellency President Dr. Hage G. Geingob, serving from 1 July 2021 until 30 June 2022 to carry out this task. The task involved ascertaining the readiness of Namibia's labour force and related infrastructures, so as to exploit and harness the complete potential presented by these technologies and the Future of Work.

To appreciate the rationale for such an assessment, a deeper understanding of the Fourth Industrial Revolution is necessary.

1.1 The Fourth Industrial Revolution

The Fourth Industrial Revolution concept was coined by Klaus Schwab at the World Economic Forum in 2015 followed by his book in 2016. Schwab defined the 4IR as technologies such as AI, blockchain, machine learning, robotics, big data, VR/AR as blurring the lines between the cyber, physical and biological spheres.[1] The 4IR technologies pose many opportunities but also many challenges to all spheres of society and the economy. This is due to the rapid advantages and changes that AI brings, which are facilitated by large data sets, advances in quantum computing and high-performance computing, the Internet-of-Things (IoT), blockchain, deep learning, machine learning, virtual and augmented reality, 3-D printing and advanced robotics.

4IR offers opportunities and challenges to government, private sector, academia and communities. Government requires a paradigm shift in policy and regulatory frameworks, governance, funding, capability building, and infrastructure investment. The private sector can benefit from increased productivity, improved work-life balance, new business and market opportunities in and beyond Namibia. Citizens require enhanced skills, trustworthy digital content, support to participate through digital means and using digital solutions for improved social services delivery.[2]

4IR was preceded by three industrial revolutions in various time periods and these are described as shown in Figure 1.

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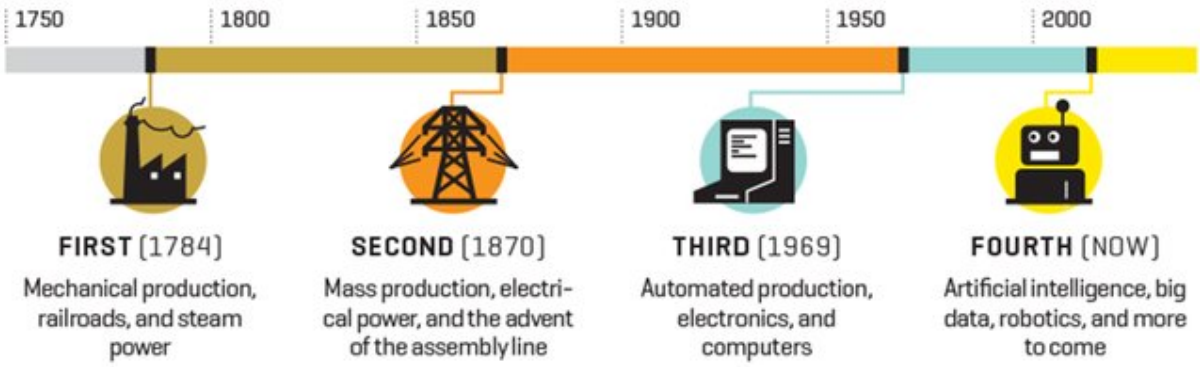
[1] *Klaus Schwab. 2016. The Fourth Industrial Revolution. World Economic Forum*

[2] *Adapted from https://asean.org/wp-content/uploads/2021/10/6.-Consolidated-Strategy-on-the-4IR-for-ASEAN.pdf*

Figure 1: The Four Industrial Revolutions[3]



The First Industrial Revolution occurred from around 1784 and was characterised by steam power and waterpower for production, the use of steam engines and machinery for production in Britain. The Second Industrial Revolution started around 1870 where electrical power replaced steam power and assembly lines were introduced for mass production. The rise of digital technologies around 1969 caused a digital revolution due to automation and digitisation because of the proliferation of electronics and computers, the invention of the internet and the discovery of nuclear energy. Mobile internet especially fuelled the Third Industrial Revolution. Thus, in the Third Industrial Revolution, digital transformation was already a goal. The Fourth Industrial Revolution was coined by Klaus Schwab as noted above but developed also from Germany's Industry 4.0 where ICT was used to optimise manufacturing. This was fuelled with rapid advances in quantum computing for increased processing speeds and the availability of large datasets, which made unsupervised artificial intelligence possible and blurred the lines between physical, cyber and biological systems. Applications and technologies include, among many others: AI, virtual and augmented reality, big data, 3-D printing, autonomous cars, virtual smart assistants, blockchain, cloud computing, robotics and humanoids, and gene editing,

Namibian citizens might not realise it yet, but they are already connected to a hyper-connected world with 13.8 billion[4] connected devices in our workplaces, homes, entertainment and educational institutions. Smartphones are already powered by essential 4IR technologies such as AI, Internet-of-Things (IoT), advanced data analytics and blockchain technology,[5] which run in the background of their apps.

4IR is thus not optional for countries to decide whether they are in the Fourth or Third Industrial Revolution. Citizens and industries are connected to this hyper-connected world and use

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[3] *Source: Demandbase, 2017 DOI: 10.18531/Studia.Mundi.2018.05.01.68-78*

[4] *https://www.statista.com/statistics/1101442/iot-number-of-connected-devices-worldwide/*

[5] *https://www.pwc.com.au/digitalpulse/4ir-survey-pros-and-cons.html*

technologies such as smartphones. Prerequisites for 4IR include electricity, electronics, internet connectivity and devices, and digital technology developers to harness the power of 4IR technologies.

4IR can bring about many positive changes such as advanced and smart manufacturing, automation and smart cities, 3-D printing technologies that can print anything from houses to human organs, genome editing to cure diseases or biological defects, autonomous vehicles, drones, transformation of economies, and data-driven insights and forecasting. Hyper-connectivity means that large amounts of data are fed to global datasets, which in turn are used to benefit AI. On the other hand, hyper-connectivity also brings concerns about cybersecurity, ethical and privacy concerns. The 4IR could not only potentially deepen the digital divide at global scale, and in Namibia between regions, but also increase existing gender inequalities and racial bias, as well as deepen job insecurity and income and wealth disparities.

The Fourth Industrial Revolution is almost at the exit stage, as AI has become a black box and brought unprecedented and unexpected consequences. Increasingly it is recognised that humans need to be placed in the centre to control AI and thus, the Fifth Industrial Revolution is beckoning. For the purposes of this country assessment, however, the focus remains on 4IR and the fine balancing act to use it to Namibia's advantage and mitigate the negative effects.

1.2 AI: Dominant technology for 4IR

There is often confusion about *why* Artificial Intelligence (AI) is shown as the dominant supporting digital technology for the Fourth Industrial Revolution (4IR). It is crucial to simplify 4IR in basic terms first to bring light to this prominence. 4IR in basic terms is about smart (*intelligent*) working using *digital technologies* to harness *creative* value chains. First, let us define technology. There is a distinction between digital technology and technology in general terms.

Technology is a broad concept that refers to the use and knowledge of tools and techniques for using these tools and skills to improve our ability to control and quickly adapt to the environment. Tools here can be used in *the sense of the physical device*. Thus, for instance, a bicycle can be classified as a technology because it is a machine that also makes transportation more efficient, whereas digital technology refers to the *electronic* tools, systems, devices and resources that generate, store or process data.

Data is a precursor to intelligent working, for example, in a smart factory. To intelligently network, a massive amount of data is required (big data). To ensure intelligent networking of the ecosystem, all components must be connected. This is where the concept of cyber-physical systems (CPSs), e.g. the technology that controls a power plant, and the supporting digital technologies for 4IR such as high-performance computing (HPC), Internet of Things (IoT), Industrial Internet of Things (IIoT), online security (cybersecurity and blockchain technologies), autonomous robotics and many more are mentioned. CPS is required to allow the different physical objects, virtual objects, and humans to work smartly. With the

abovementioned analogy established, it becomes implicit that all those supporting technologies should be in place to achieve Artificial Intelligence (AI).

2. Background and Context

The Task Force was supported by a dedicated secretariat, comprised of the Presidential Advisor for Youth and Enterprise Development, and a Project Manager who joined the Task Force in February 2022. The Task Force drew expertise and resources from within Government Offices, Ministries and Agencies. The Presidential Advisor, Ms Daisry Mathias, served as Ex-Officio member on the Task Force.

The Task Force was supported by one official each from:

- Ministry of Information, Communication and Technology (MICT)
- Ministry of Labour, Industrial Relations and Employment Creation (MLIREC)
- Office of the Prime Minister (OPM)

The Task Force was further supported with pro-bono research support from:

- University of Namibia (UNAM)
- Namibia University of Science and Technology (NUST)
- University of Johannesburg (UJ)

3. Purpose and Scope of the Assessment

The mandate of the Task Force was that the 4IR Task Force should conduct a "Namibia 4IR Country Assessment" that would include recommendations on distinct thematic areas. The Task Force divided the work into six workstreams, each chaired by a Task Force member. The Chairperson and Presidential Advisor on Youth Matters and Enterprise Development served as *ex-officio* member on all workstreams.

Workstreams

Workstream 1: 4IR infrastructure and National Data: Assess the existing national hard and soft 4IR infrastructure network including energy networks, identify gaps and make recommendations towards integrating 4IR infrastructures into a coherent and comprehensive national network, unlocking connectivity and efficiencies. Make recommendations towards a national data repository to ensure secure, available and consolidated data that will enable innovation and the delivery of e-governance services. Make recommendations towards bolstering cybersecurity frameworks.

Workstream 2: Future of Work, Labour Force Reskilling and Human Capacity Development: Ascertain Namibia's digital labour profile, workforce reskilling requirements and partnership models between the public and private sector to realise workforce reskilling, lifelong learning and multi-disciplinary training. Assess impact of Artificial Intelligence on labour force dynamics and the Future of Work. It should further inform the formulation of the National Human Resource Development strategy and implementation plan on the Skills of the

Future. The Task Force should also examine demographic and technological trends that will affect the jobs landscape and recommend measures to prepare Namibian workers for the future of work. Alignment to the existing institutions responsible for Digital and Artificial Intelligence policy and attendant implementation plans should be ensured. Conduct analysis of human capacity development ecosystems and make recommendations on human capital investments in Artificial Intelligence, blockchain and disruptive technologies; identify leverage points that can be accelerated by 4IR to link potential employees to productive and decent work; recommend the requisite skills and blended curricula.

Workstream 3: Industry, MSMEs, Startups and Investments: Identify emerging trends presented by the 4IR and identify future industries of 4IR technologies requiring targeted support (e.g. manufacturing support; economic incentives; targeted import substitution, targeted MSME support for 4IR businesses) towards employment creation, inclusive growth and shared prosperity.

Workstream 4: Policy and Regulatory Environment and Governance: Conduct a rigorous analysis of existing policies and the regulatory environment to identify requisite levers, gaps and bottlenecks in related national, technological, and institutional infrastructure that undermine digital transformation (e.g. structural and bureaucratic). Recommend policy approaches, strategies and reforms towards a coordinated and more coherent national 4IR framework. Make recommendations on necessary public service reforms towards SMART Governance.

Workstream 5: Research & Development: Identify priority areas for research, development and innovation.

Workstream 6: Core 4IR Technologies: Assess the use, capacity and development of core technologies such as AI, blockchain, big data, robotics, 3-D printing, etc. in the country as well as future requirements and mechanisms to rapidly improve the development and deployment of such technologies.

Figure 2 illustrates the divisions of the six workstreams and their respective sponsors.

Outcomes

Two reports were to be submitted. The initial report was submitted in November 2021 and this document forms the final report, which includes the Country Readiness Assessment and Survey. A *Namibia 4IR Conference and Expo* was hosted on 7-8 June 2022.

Figure 2: Workstreams and Sponsors

4. Methodology

This 4IR assessment readiness report aims to highlight the country's current state/position and offer recommendations to reposition the country to harness the benefits of 4IR.

A mixed method research methodology was used, comprising both qualitative and quantitative methods. These methods consisted of:

1. Focus groups (stakeholder engagements) and semi-structured interviews
2. The Country Readiness Assessment (CRA), including a national online survey
3. Inputs from the Namibia 4IR Conference and Expo

Reviews of trusted third-party secondary data were also conducted, and public opinions expressed via media such as social media platforms, radio and television were also considered.

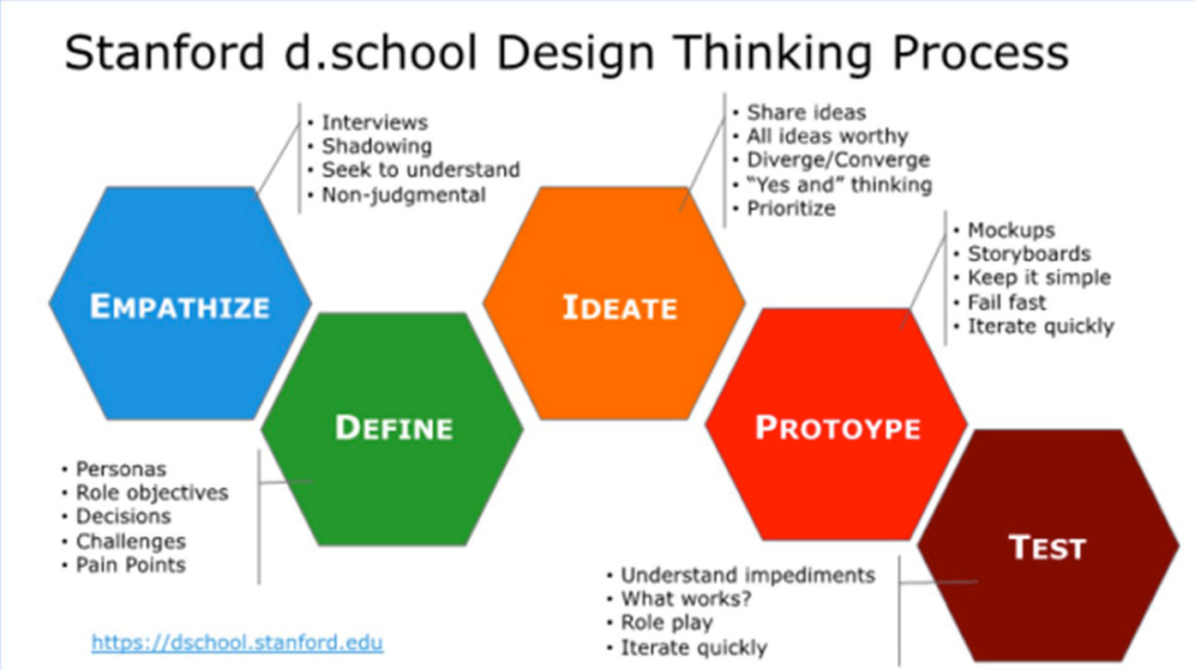
Stakeholder Engagements: Focus Groups and Interviews

The initial phase of the study was overlaid with a Design Thinking approach to understand and define the problem space. Early stakeholder engagements in the form of focus groups were conducted with different stakeholders clustered by sector, function or a specific problem. High-level engagements in the form of focus groups with key Ministers, the National Council and National Assembly were also conducted to inform of sectoral stakeholder sessions and capture their own activities and concerns. Semi-structured interviews were conducted either with individuals or organisations to understand pertinent issues raised during early stakeholder engagements or picked up during the 4IR Readiness survey. Further stakeholder

engagements were held after the initial report and during data collection for the 4IR Readiness survey.

The Design Thinking approach (see Figure 3) has five distinct iterative approaches. During the first *empathy* stage, stakeholders are engaged in a variety of methods such as focus groups (stakeholder engagements) and interviews, then during the *define* stage the stakeholder feedback is analysed and augmented with observations and literature sources to define the pain points or problem. The *ideate* phase is to share ideas, diverge/categorise ideas and facilitate dialogues as in this case. Here pertinent issues raised were explored with the affected stakeholders to find alternative solutions. The *prototype* phase is to find solutions and benchmark against other countries whilst the final phase is to *test* the gap analysis, 4IR readiness assessment scores and recommendations in the form of *stakeholder validation.* Given that this is an iterative process, constant and iterative stakeholder engagement is necessary.

Figure 3: The Design Thinking Process



Source: Stanford University

Stakeholder engagement sessions were conducted for each workstream as per each workstream's critical stakeholder maps.

Country Readiness Assessment (CRA) Framework: Online Survey

The overall 4IR Country Readiness Assessment was supported by an online survey with data collected from 514 respondents, including 319 respondents from Namibian companies and 195 respondents from a broader set of stakeholders.

The CRA framework provided a common assessment framework with the main aims as: (1) providing a basis for international benchmarking and comparisons of Namibia's data with other countries' data, and (2) contextualise the assessment to the realities of Namibia. Although the full report on the CRA framework analysis is included in Chapter 7, the framework and layers of analysis are extracted from the report below.

This assessment framework had three layers of analysis as depicted in Figure 4:

1. The first layer holds the **Preconditions** or fundamental prerequisites for widespread adoption of 4IR digital technologies. These preconditions include infrastructure, education and functional innovation systems.
2. The second layer assessed the readiness of industry based on the World Economic Forum (WEF) **Readiness for the Future of Production** (FOP) comprising two components: the structure of production and the drivers of production. The 2018 WEF FOP framework, in collaboration with A.T. Kearney,[6] provides a score per country that serves as a benchmarking framework and dataset to (a) assess key levers and factors required to transform production systems, (b) assist decision-makers to assess the degree to which their country is ready and positioned to shape and benefit from the shifting nature of production, (c) catalyse public-private sector dialogue, and (d) inform the development of joint actions and modern industrial strategies.
3. A third layer explored the **Broader 4IR Applications**. For developing countries that are currently users rather than producers of 4IR technologies, the applications beyond advanced manufacturing are particularly important, especially in the areas that directly affect the developmental goals of the country, such as food production/agriculture and other resource-based activities, energy, health, education, and public sector delivery. In the 4IR, intelligent technologies could be the key to unlocking solutions to some of the country's most deep-seated problems, as well as achieving its aspirations in terms of economic growth, and industrial development.

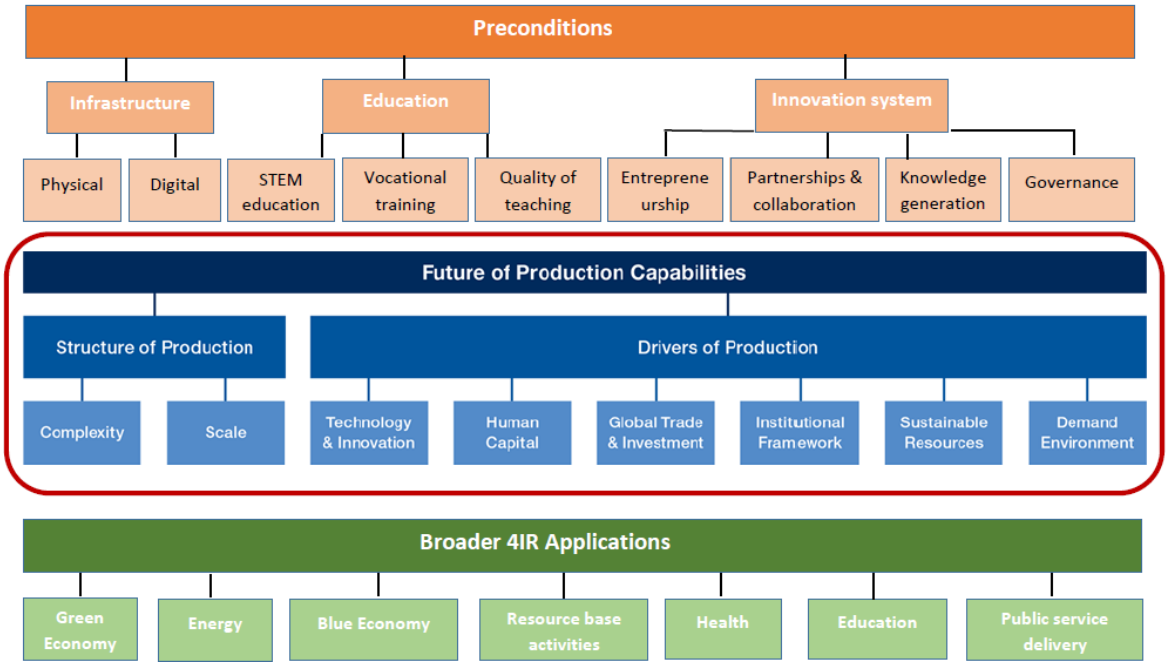
This framework encapsulates the three layers that are considered central to the unfolding of the 4IR in Namibia as rooted in strong infrastructure, education and a dynamic innovation system; centred around the needs of industry; and manifest in improved livelihood conditions for the majority of the population through the broader application of 4IR technologies beyond industry.

The research questions that the CRA framework aimed to answer were:

1. Does Namibia have the preconditions for the 4IR?
2. Does Namibia have the necessary capabilities for the Future of Production?
3. Does Namibia have the potential to apply 4IR more broadly?

[6] *Schulz et al., 2018; Olaitan et al., 2021*

Figure 4: 4IR Readiness Assessment Framework for Namibia



Namibia 4IR Conference and Expo

The Task Force organised the Namibia 4IR Conference and Expo on 7-8 June 2022 to serve as centre for national dialogue on 4IR and allow the public to provide more input to the assessment. The conference allowed the workstreams to receive feedback on the critical issues per thematic area. The conference was attended by about 400 delegates consisting of the President, the Vice President, the Prime Minister, Ministers, Deputy Ministers, Executive Directors of Government Offices/Ministries/Agencies, public and private sector organisations, academia, non-governmental organisations, civil society especially youth representatives, and invited international panellists. The preliminary results from the country CRA assessment were shared and workstreams shared their preliminary work. Each workstream sponsor made a presentation on their preliminary work and had expert panellists as respondents and an open Question-and-Answer session. Each workstream session had a rapporteur who captured main outcomes, which formed part of the conference outcomes. The Expo showcased 4IR innovations of organisations and entrepreneurs. The events were livestreamed on national televisions and various social media platforms such as Facebook and YouTube. Several media activities like televised panel discussions, radio and television one-on-one interviews took place during and after the conference and expo.

This report is structured into different sections to present 1) the current situation analysis as captured through the stakeholder engagements, 2) CRA analysis based on the national survey, 3) workstream reports, and 4) final recommendations.

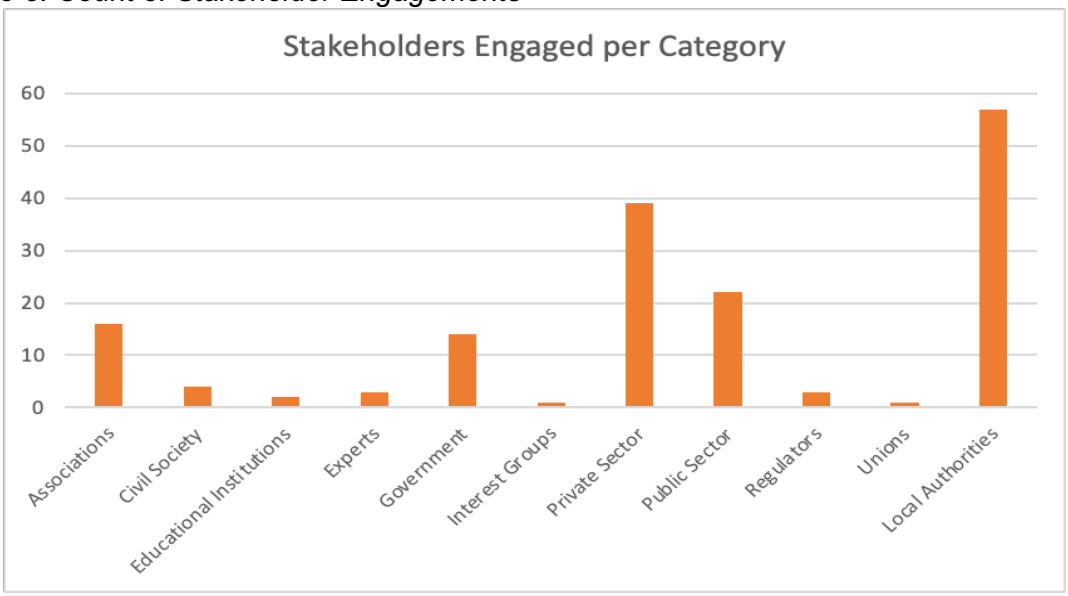
5. Stakeholder Management

A stakeholder mapping exercise took place early in the process. Each workstream identified critical stakeholders and particular topics to be discussed. Such stakeholder engagement sessions were conducted as focus groups or interviews in hybrid mode, i.e. in person and also virtually from 14 September 2021 until 21 October 2021 and again from January 2022 until July 2022. The general stakeholder sessions took place mostly at State House with a few taking place in different venues, but high-level engagements with Ministers, National Assembly and National Council took place at their offices except for the Namibia Intelligence Agency session which took place at State House. Specific facilitated dialogue sessions with individual or multiple stakeholders took place at The Lemon Tree. The latter sessions focused on specific issues. Stakeholder engagements were either requested by particular stakeholders or organised by the Task Force.

Early stakeholder engagement sessions as focus groups and interviews probed the problem space and informed the current situational analysis, the theme ("4IR as enabler for green and inclusive industrialisation"), and the development of the CRA Framework survey question design. These insights were augmented and triangulated with the 4IR Readiness survey, secondary data reviews, additional stakeholder engagements and outcomes of the Namibia 4IR Conference and Expo.

Stakeholders were defined in the various workstreams whilst some stakeholders reached out to the Task Force. There were over 160 stakeholder organisations and about 660 individuals consulted, excluding the Namibia 4IR Conference and Expo attendees of about 400. Figure 5 groups stakeholders by category.

Figure 5: Count of Stakeholder Engagements



The stakeholder engagement sessions informed the Task Force of key pain points and opportunities facing different sectors. Where ambiguity existed on specific industry related issues, facilitated dialogues among key stakeholders were convened.

High-level engagement sessions with key Ministers and their management, the National Council, the National Assembly's Standing Committee on ICT and Innovation, the Association of Regional Councils Congress (ARC), the Association of Local Authorities (ALAN) and Namibia Investment Promotion Board (NIPDB), served to inform them of sectoral stakeholder pain points, solicit support for the proposed recommendations and captured their pertinent issues. A detailed list of stakeholders engaged is attached to this report.

6. Situational Analysis

Overview

Namibia is a country of 824,292 km² and has a population of 2.56 million, with 51.5% women vs 48.5% men in January 2021.[7] Namibia is classified as an upper-middle-income country due to its political stability and sound economic management.[8] The country has a youthful population with the majority aged 15-24 with a high youth unemployment rate of 37.82% in 2019 and projected to 50.30% for 2021 according to UNFPA.[9] The overall unemployment rate was 20.35% in 2020.[10] Namibia, like elsewhere in Africa, can take advantage of its youthful population and ideally skill and drive technology innovations and entrepreneurship for the Fourth Industrial Revolution.

Vision 2030 highlighted the important role that Information and Communication Technologies (ICTs) play in the economic development of the country. Over the years, the short-term National Development Plans (NDPs) have prioritised ICTs as an enabler for development. NDP 4 (2013/2017) positioned ICTs to have "adequate ICT infrastructure in place to facilitate economic development and competitiveness through innovation, research and development" and consequently the NDP 5 (2017/2022) targeted to achieve "universal access to information, affordable communication, technology infrastructure and service by the year 2022".[11]

For the purposes of this report, the following definition of ICT is adopted from UNESCO:[12]

Information and communication technologies (ICT) is defined as a diverse set of technological tools and resources used to transmit, store, create, share or exchange information. These technological tools and resources include computers, the Internet (websites, blogs and emails), live broadcasting technologies (radio, television and webcasting), recorded broadcasting technologies (podcasting, audio and video players, and storage devices) and telephony (fixed or mobile, satellite, visio/video conferencing, etc.).'

Governance and implementation of ICT are split across at least three Ministries and one regulator, with each OMA responsible for its own ICT infrastructure. Namibia has established a dedicated Ministry of ICT in 2008. However, the Office of Prime Minister is responsible for ICT in the public sector, while the Ministry of Higher Education, Technology and Innovation is also responsible for Technology including ICT, and Innovation, as the name implies. CRAN regulates the telecommunications sector.

The ICT infrastructure sector is relatively developed and has more prospects for growth and improvement to drive rapid technological transformation, with specific considerations for

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[7] *https://datareportal.com/reports/digital-2021-namibia*

[8] *Bobek, Moritz & Horvat, 2020;*

[9] *https://neweralive.na/posts/youth-unemployment-expected-to-reach-50*

[10] *ILO, 2020*

[11] *AU, 2014 "Launching of Internet Exchange Point in Namibia" https://au.int/sw/node/27258*

[12] *https://learningportal.iiep.unesco.org/en/glossary/information-and-communication-technologies-ICT*

unconnected communities to be treated as a high priority. The sector's performance, including investments and development, is largely driven by profit interest with little to no specific targets for infrastructure development in the perceived economically viable areas.

According to the World Internet Stats, in December 2020 unique internet users in Namibia were 1,347,418 of the Namibian population of an estimated 2,587,344 representing 52.1% and 792,000 are Facebook subscribers.[13]

The country has three dominant mobile operators (MTC, Paratus and Telecom) providing mobile network coverage in the country as in the table below.

Table 1: Mobile Broadband Coverage in Namibia

Mobile Broadband Coverage (land)	Type of Access
97%	2G
78%	3G
42.5%	4G

The country has a coverage of 24,856 km through fibre optic cables connecting major towns through a fibre point of presence. With one Point of Presence (PoP) for access to the public service information, the fibre cables have also been extended to four bordering countries, Botswana, South Africa, Zambia and Angola, according to information from the Ministry of ICT. The transition from analogue to digital television services also increases the ability to use TV White Spaces (TVWS) to reach remote areas.

In collaboration with the African Union Commission through the African Internet Exchange System (AXIS) Initiative, Namibia became one of the African countries owning an Internet Exchange Point (IXP) in 2014,[14] and to date 5[15] Internet Service Providers (ISPs) are members of the exchange point. However, the IXP has faced challenges in the past related to the ageing of the equipment.
An overview of subsea cables connecting the West Coast of Africa to Europe:[16]

- WACS (West Africa Cable System – Namibia has a landing point)
- Google's Equiano (Namibia has a landing point since 3 July 2022)
- ACE (Africa Coast to Europe – Namibia landing point planned according METF[17])
- MainOne
- SAT-3/WASC
- 2Africa (backed by Meta, under construction but no Namibia landing point planned)

[13] *https://www.internetworldstats.com/stats1.htm*
[14] *https://www.telecom.na/media-centre/212-internet-exchange-point-launched-in-windhoek*
[15] *https://bgpview.io/ix/337*
[16] *https://www.submarinenetworks.com/euro-africa*
[17] *http://eia.met.gov.na/web/projects/614*

- HARP (under construction)

Figure 6: African Undersea Cables as of July 2020

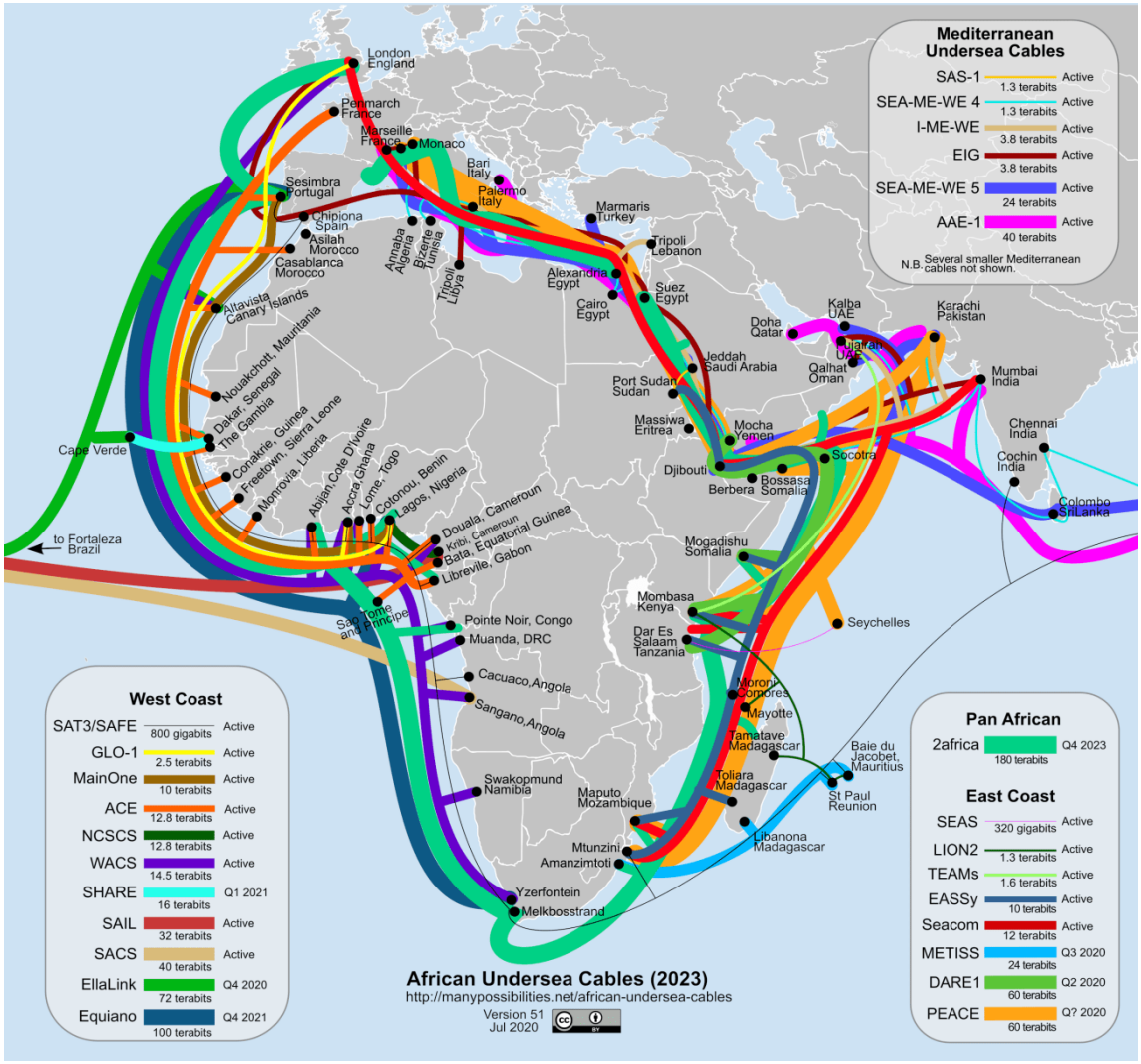


Figure 7: ACE subsea cable with a landing point under construction for Namibia

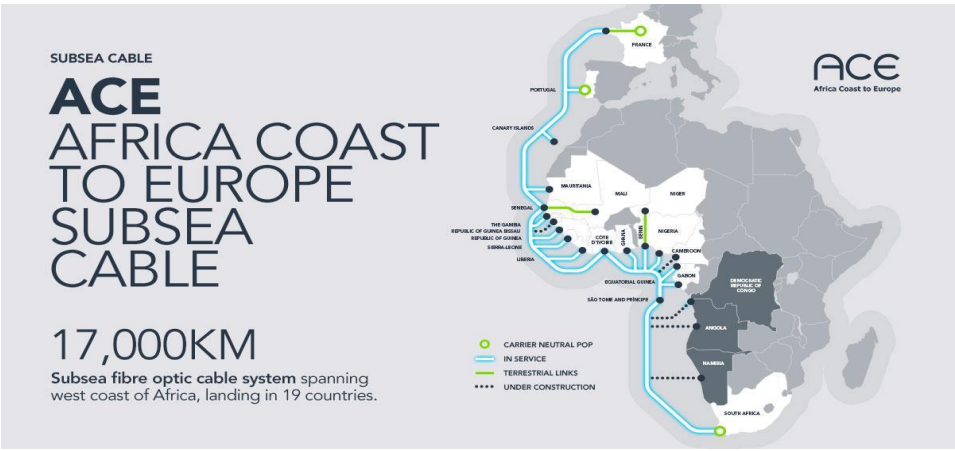
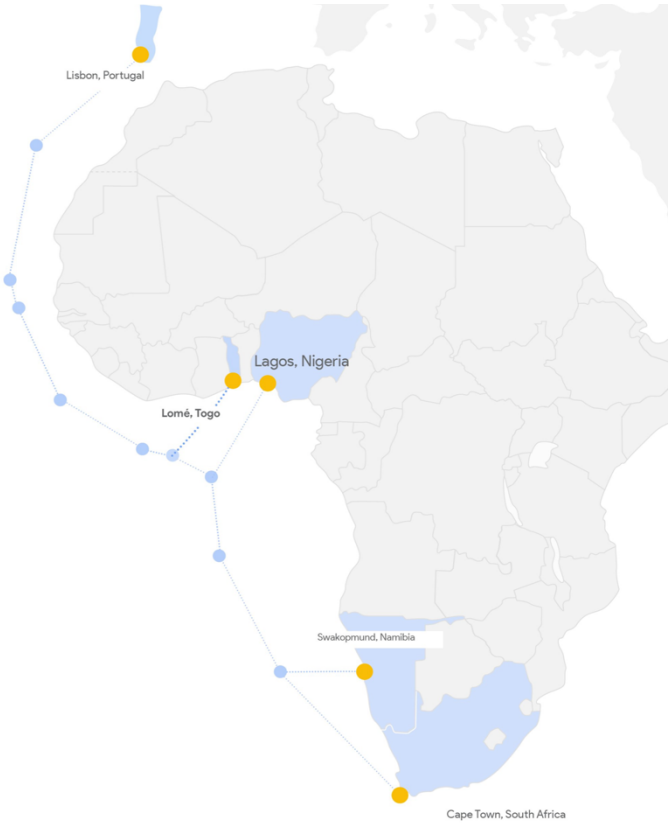


Figure 8: Equiano cable route[18] with Paratus and Telecom as partners[19]



In 2011, the country landed its first connections to the West Africa Cable System (WACS), benefiting Telecom Namibia. In 2012, mobile network operator Mobile Telecommunication Limited (MTC) announced connectivity to the West African Cable System (WACS) via Cape Town by consortium means. In 2021, Paratus and Telecom Namibia announced a signing of an agreement for a landing point for Google's Equiano subsea cable which subsequently landed in Namibia on 3 July 2022. The Africa Coast to Europe subsea cable (ACE) also has a landing point being constructed in Namibia. The Equiano and ACE subsea cable will provide Namibia with the necessary redundancy and provide for increased bandwidth for 4IR applications.

Overall SWOT Analysis

A SWOT analysis was compiled from secondary data sources and stakeholder engagements. The global ranking profile of Namibia also informs the SWOT analysis.

Strengths	**Weaknesses**
● Relatively stable telecommunications	● Lack of coordination resulting in silos, fragmentation across data, infrastructure, governance and operational

[18] Image from https://www.datacenterdynamics.com/en/news/googles-equiano-cable-lands-in-togo/

[19] https://techcentral.co.za/googles-equiano-cable-lands-in-namibia/212818/

backbone with fibre, mobile towers, fixed broadband, grid online, WACs and Equiano landing cable ● 97% mobile broadband coverage (incl. 2G, 3G, 4G) ● Mobile connections are 2.94 million and represents 114.6% of the total population ● 51% internet penetration of total population ● Stable and uninterrupted electricity supply for the electrified areas ● WACs and Equiano subsea cables landing point in Namibia ● Facebook users are at 31.2% of the total population ● Political will ● Infrastructure upgrades were developed in certain sectors during the COVID era ● Universities can teach online since 2020 ● A number of revised bills are already developed and the Electronic Transactions Act is enacted. ● Gender equality rating is good ● Introduction of Fintech regulatory sandboxes for both banked and unbanked sectors (BON and NAMFISA)	structures, sectoral policy and legislative processes ● No national data centre ● National Data is fragmented, outdated and inaccurate with no interoperability standards ● Outdated statistical data of which most dates back to 2018 or earlier ● Fragmented ICT systems and platforms ● Hesitancy on infrastructure sharing ● Telecommunications operators are not coordinated ● Incoherent policy and legislative framework ● Outdated and obsolete legislation ● Lack of fundamental Cybercrimes Act or Data Protection Act ● Long and cumbersome legislative processes ● High youth unemployment ● Bureaucratic processes ● Ease of doing business rating not good ● Ineffective visa and work permit regime ● Public Service infrastructure outdated ● International Payment cashouts presents to a barrier to international online businesses and entrepreneurs ● Cybersecurity risk rating high ● E-commerce rating low ● Many healthcare facilities not connected to internet and/or electricity ● 1300 schools are not connected to internet ● Low budget allocation for ICT projects and infrastructure ● Low investment climate for Culture Creative Industry including ICT ● Jobs mismatch with graduates from higher education sector ● Outdated jobs classification and job requirements ● Low specialised 4IR digital technologies skills ● Inadequate education in manufacturing and 4IR technology skills. ● Inadequate link between the industry needs and education ● Risk averse financial sector for startups ● High engineers' unemployment and closure of Namibian engineering firms plus inadequate holistic education framework ● R&D capacity and investment low ● Low use and development of 4IR digital solutions ● Lack of a national digital strategy, 4IR Strategy or AI Strategy

Threats	Opportunities
● Potential investors go to neighbouring countries or elsewhere due to a skills shortage, enabling infrastructure and enabling legislation ● ICANN Country top level domain name	● Green Hydrogen presents an opportunity to improve not only the energy and water availability, but also contribute in developing key 4IR skills and capability ● Google's Equiano subsea cable with a landing point in Namibia with Paratus and Telecom as partners might result in better bandwidth offerings ● Regulatory sandboxes present an opportunity to overcome the policy and legislative hurdles especially for 4IR tech startups ● Youthful population presents an opportunity for accelerating 4IR adoption and capacity development

In summary, the major weaknesses highlighted are the lack of coordination for data governance, infrastructure, policy and legislative responsibilities, structures, shortage of specialised digital technology skills, an incoherent policy framework with legislative barriers and its lengthy processes, lack of investment in ICT, lack of infrastructure sharing, ageing national infrastructure and cybersecurity.

Stakeholder sessions did, however, prove that opportunities exist to address many of the weaknesses and willingness to find solutions jointly across sectors. The next sections on the CRA analysis and workstream reports inform the final recommendations.

Namibia's Global Indexes Profile

A global index is a single index that maps to many underlying metrics. The multi-criteria approach and the assessment methodologies relating to global competitiveness have been dynamically adjusted over recent years to reflect the global economy's current globalisation trends. In pursuant of becoming an industrialised country by 2030, it is essential to assess Namibia's stance and position on the global indexes as this informs how competitive the country is.

These indexes (see Table 2) can be used to provide the overall global competitiveness of Namibia within the scope of significant impact areas of the 4IR. Furthermore, with the 4IR widely changing economies using modern technologies, assessing how competitive the national innovation and the information communication technology are can greatly benefit decision making and planning. The indices augment the findings and ranking of Namibia's 4IR readiness according to the CRA Framework analysis in this report.

Table 2: Selected global indexes for Namibia

Index	Position (score where available)	Year
Global Competitiveness Index	94/140	2019

Global Innovation Index[20]	100/132 (24.3 points)	2021
Global Startup Index[21]	91/100 (2nd in Southern Africa)	2022
Ease of Doing Business[22]	104/190 (61.4)	2020
Environmental Performance Index	104/180	2020
ICT Performance Index (ICT PI)	103/134	2020
ICT PI subpillar: Network Readiness Index	103/134	2020
ICT PI subpillar: Technology	93/134	2020
ICT PI subpillar: People	98/134	2020
ICT PI subpillar: Governance	105/134	2020
ICT PI subpillar: Impact	105/134	2020
Cybersecurity Index	123/134	2020
Logistics Performance Index[23]	80/167 (2.73/5)	2018
SDG Index	13/52	2020
Ease of doing business	104/190	2020
Huawei Competitiveness Index [24] (Broadband, Cloud, AI and IoT)	74/79	2020
Huawei Competitiveness Index (Mobile Speed)	116th	2020
Huawei Global Connectivity Index (Fixed Broadband Speed)	141	2020
Network Readiness Index[25]	103/134	2020
Digital Quality of Life (DQL) Index[26]	100/110 (Africa: 13/18)	2021

The first few indexes in the table show that Namibia is not performing well on the competitiveness and innovativeness indexes and the ICT Performance Index. However, Namibia moved up 8 spots on the 2022 Global Startup Index to 91/100 and is ranked second in Southern Africa, which is good news. The Ease of Doing Business index (see Figure 9) shows weak performances in starting a business, registering property and cross border trading. Cross border trading concerns were raised multiple times in Stakeholder Engagement

[20] *https://www.theglobaleconomy.com/Namibia/GII_Index/*

[21] *https://www.startupblink.com/accelerators/namibia*

[22] *https://www.doingbusiness.org/content/dam/doingBusiness/pdf/db2020/DB20-FS-SSA.pdf*

[23] *https://lpi.worldbank.org/international/scorecard/radar/254/C/NAM/2016/C/BWA/2016?sort=asc&order=LPI%20Score#datatable*

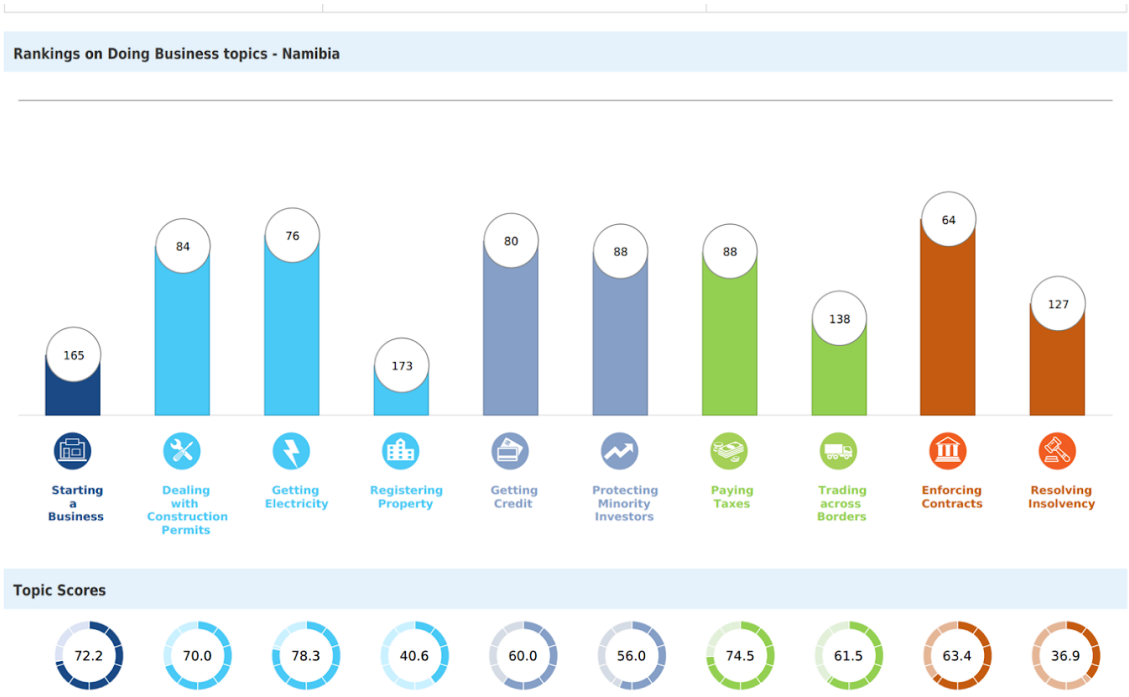
[24] *https://www.huawei.com/minisite/gci/en/country-profile-na.html*

[25] *https://networkreadinessindex.org/countries/namibia/*

[26] *https://surfshark.com/dql2021?country=NA*

sessions from especially the Culture and Creative Industry (CCI). Online sales on international platforms like PayPal, YouTube, Google Play and Apple Store are difficult to cash out in Namibia. Therefore, such tech and CCI entrepreneurs have to travel to South Africa and open bank accounts in that country to be able to cash out their earnings. This also means that the earnings are recorded as South African earnings. The sector reported to be hard hit by COVID due to lockdowns preventing travel to South Africa to cash out earnings. The Task Force held facilitated dialogues to resolve the matter with several stakeholders concerned with exchange control such as Bank of Namibia, Payments Association of Namibia, Namclear, Bankers Association as well as majority of commercial banks. However, no positive results can be reported yet.

Figure 9: Topic Scores on Ease of Doing Business Index[27]



The Huawei Global Connectivity Index of 2020 assessed Broadband, Cloud, AI and IoT as technology enablers, and it ranked Namibia at 74/79 with a score of 28 out of 120. Furthermore, the Index ranked Namibia 116th in the world for mobile speeds and 141st for fixed broadband speeds. Among the low ranked items are Namibia's software developers, R&D expenditure, cybersecurity awareness, internet participation, mobile and fixed broadband affordability, as well as investments in ICT, telecom and cloud. Some of the highly ranked items include Namibia's smartphone penetration and mobile broadband subscriptions as well as its potential to have ICT influence new business models, AI potential, IoT potential and IT

[27] *https://www.doingbusiness.org/content/dam/doingBusiness/country/n/namibia/NAM-LITE.pdf*

Workforce potential. This index corresponds with the analysis obtained from stakeholder feedback.

The global Digital Quality of Life Index (DQL) is a study of 110 countries and covers about 90% of the global population. The index is based on an evaluation of five pillars: internet affordability, internet quality, electronic infrastructure, electronic security and electronic government. Namibia is ranked for the first time and Namibia's best indicators are broadband speed growth (19/110), mobile speed growth (47/110), and broadband internet affordability (62/110). Namibia's worst indicators are that cybersecurity is lowest (108/110), while broadband speed (102/110), mobile speed (99/110) and electronic infrastructure (96/110) are very low. The index further shows that electronic government (90/110) and online services (92/100) are also areas of concern.

One very relevant global index is the Network Readiness Index (NRI), depicted in Figure 10, and Figure 11 that assesses several ICT metrics. Namibia ranks 103rd out of the 134 economies and is well below the expected NRI score of an upper-middle-income economy.

Figure 10: Network Readiness Index Rating of Namibia's Overall Performance

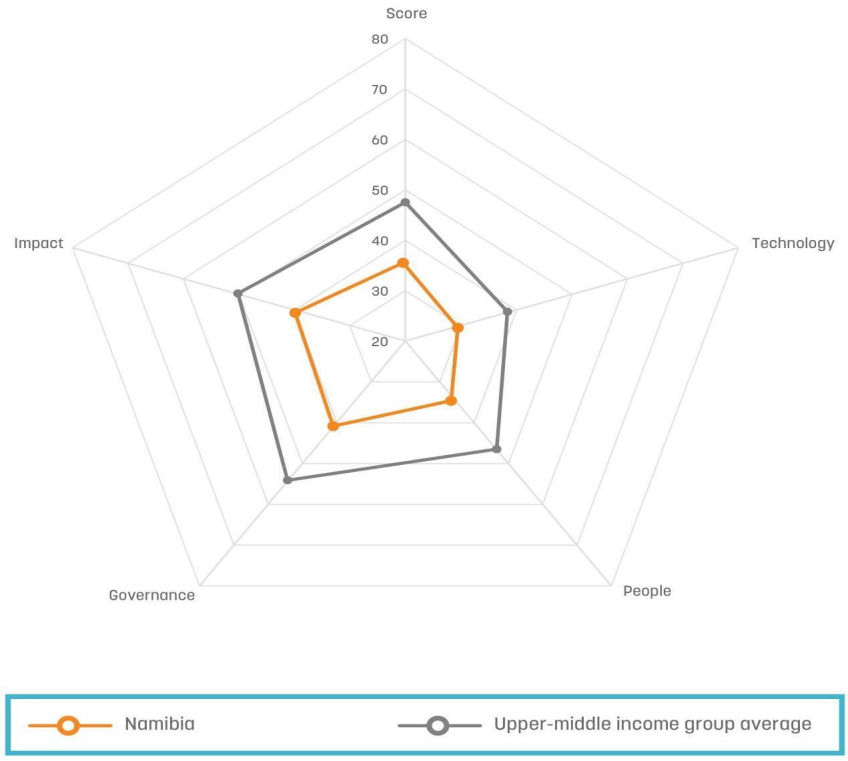


Figure 11: Network Readiness Index for Namibia across four pillars

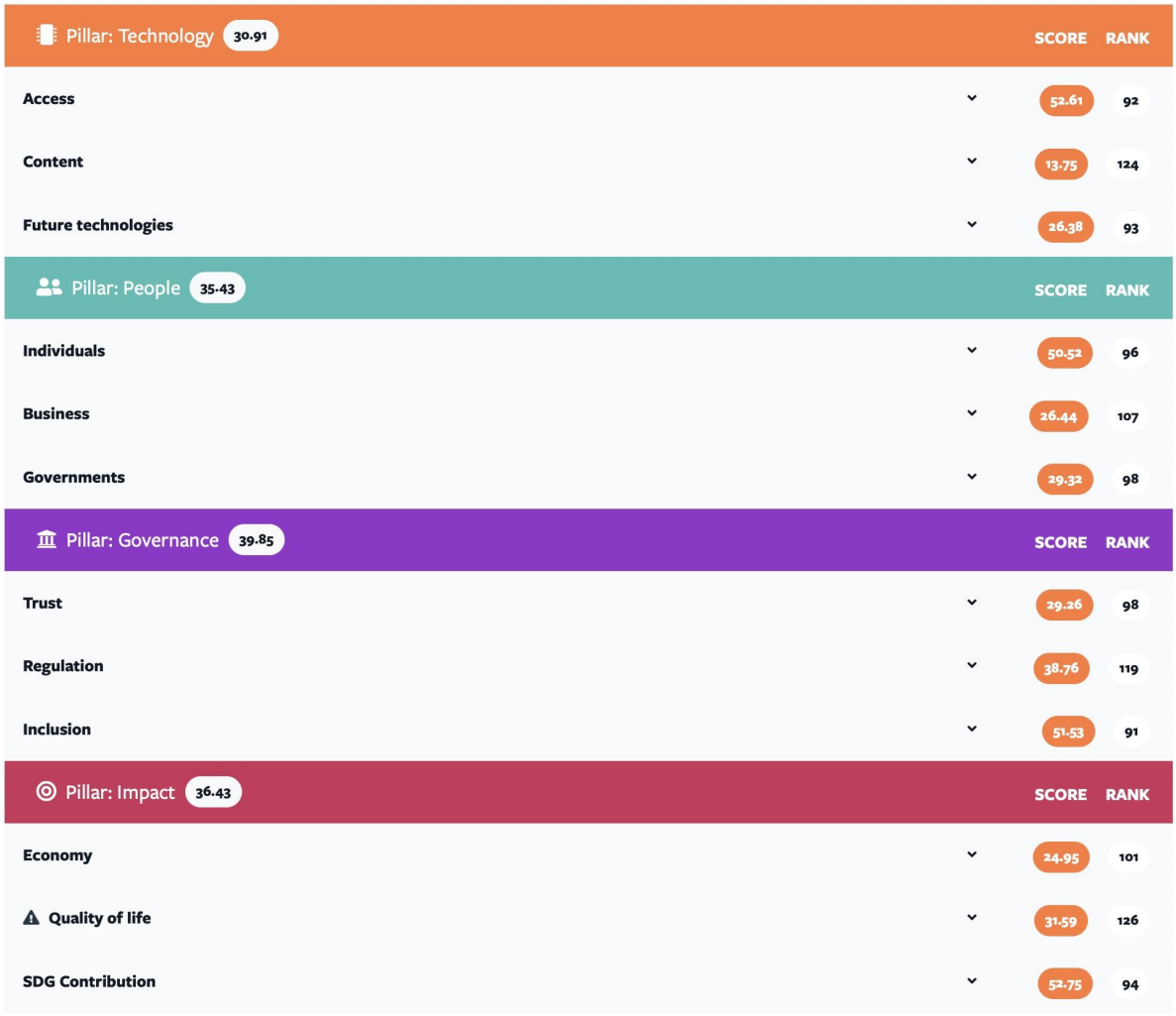


Table 3 below shows the specific indicators of concern or achievement for Namibia and its ranking according to the Network Readiness Index.

Table 3: Network Readiness Index top-ranked and bottom-ranked indicators of Namibia[28]

Strongest Indicators	Rank	Weakest Indicators	Rank
SDG 5: Gender equality	11	Medium and high-tech industry	107
Online access to financial account	35	4G mobile network coverage	110

[28] *Source: Dutta, S. & Lanvin, B. 2020b. Network Readiness Index 2020 Namibia. The NRI 2020 model.*

SDG 7: Affordable and Clean Energy	35	Happiness	112
Active Mobile-broadband subscriptions	42	Fixed-broadband subscriptions	113
Handset prices	60	Healthy life expectancy at birth	113
Internet domain registrations	62	International Internet bandwidth	114
Adult literacy rate	63	Income inequality	120
Rural gap in use of digital payments	65	Cybersecurity	123
R&D expenditure by governments and higher education	67	High-tech exports	123
Internet shopping	67	e-commerce legislation	131

Thus, more work needs to be done in this area to raise the network readiness to correspond with the other upper-middle-income economies. Namibia's weakest indicators include e-commerce legislation, cybersecurity, and high-tech exports. As of 2020 out of 134 economies, Namibia ranks 123 in cybersecurity and high-tech exports and 131 in e-commerce legislation.

These indexes provide an indication to the Task Force for more in-depth analysis to determine the readiness gaps and subsequent recommendations. The indexes further all confirm weaknesses as cybersecurity, e-commerce, legislation and governance, e-government, people (skills), network readiness and bandwidth. The Task Force therefore needs to pay particular attention to these issues.

7. Country 4IR Readiness Assessment Framework

7.1 Positioning the Fourth Industrial Revolution in the context of Namibia

The Fourth Industrial Revolution (4IR), also called Industry 4.0, introduced by the World Economic Forum (WEF) in 2015, builds upon the growing and widespread availability of digital technologies resulting from the third industrial revolution, also referred to as digital transformation. Under the 4IR, the fusion of the cyber, physical and biological spheres, supported by advanced digital technologies such as artificial intelligence (AI), cloud computing, robotics, 3-D printing, and the Internet of Things (IoT), among others, will bring fundamental changes to the way we produce, work and relate to one another.

For the past two decades, information and communication technologies (ICTs) have profoundly transformed the way in which Africa's societies and economies work, and they illustrate the potential for what some people refer to as "leapfrogging". It can be said that Africa is amid an ongoing digital transformation – although it is a late adopter and starts from a much smaller base than other regions.

While African countries are generally behind the rest of the world in terms of digitalisation, the gap is quickly closing. According to the International Monetary Fund, internet penetration in Sub-Saharan Africa has grown tenfold since the early 2000s, compared with a threefold increase in the rest of the world.[29] The adoption of mobile phones in Africa has been quite exceptional over the past 15 years and has grown faster than in any other region of the world. Currently, in a continent of 1.2 billion people, there are over 800 million mobile phone subscriptions.[30] The rapid reduction in the cost of smartphone devices is also accelerating the number of subscribers to smartphone connections. The number of tech hubs within the continent has doubled in recent years, reaching more than 744 in 2021.[31] Africa is also a forerunner in mobile money, accounting for over 70% of the world's $1 trillion mobile money market.[32]

From financial services to manufacturing, energy and agriculture, digital technologies are being leveraged to deliver greater access and move Africa closer to achieving its developmental aspirations.

However, this practice is not without challenges. Deficiencies in infrastructure, skills and the digital divide, pose limitations to its progress. Africa has the lowest global percentage of its population using the internet (33% as compared to 61% in Asia and the Pacific, and a 57% average in developing countries). The digital divide particularly affects women – only 24% of women are using the Internet versus 35% of men[29]. Digital access in remote and poorer areas, as well as by informal enterprises, is also a challenge. There are growing digital divides

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[29] https://www.imf.org/en/News/Articles/2020/06/15/na061520-digitalizing-sub-saharan-africa-hopes-and-hurdles

[30] *International Telecommunications Union (ITU) (2021). Measuring digital development Facts and figures 2021. Geneva: Switzerland: ITU Publications.*

[31] *UNESCO Science Report (USR) (2021). The race against time for smarter development. Paris: France: UNESCO Publishing*

[32] *GSMA (2022). State of the Industry Report on Mobile Money. Available at: https://bit.ly/3pybayh*
Harvard Growth Lab (2019). Country and Product Complexity Rankings. Available on https://atlas.cid.harvard.edu/rankings

between more affluent, urban, literate and better educated households with electricity, and low-income households without electricity. This challenge raises questions about the importance of considering inclusion as central to the process of digital transformation and the subsequent move towards the 4IR.

What are the dynamics and prospects for the 4IR in Namibia?

Namibia has a relatively small open economy, with close ties to the Southern African Development Community (SADC). It is entirely dependent upon imports for its fuel needs, and a net importer of manufactured products and capital goods given its small manufacturing base.[33] New business opportunities have been identified in certain services such as tourism. The country has a good transport infrastructure and significant mineral resources. It is heavily reliant on the agricultural sector – which employs 22% of the country's labour force (World Bank Development Indicators, 2019). Namibia battles with persistent severe challenges of unemployment (particularly amongst the youth), as well as income inequality. These trials have been exacerbated by the COVID-19 pandemic. The country comprises what is often referred to as a "dual economy": a relatively small modern sector co-existing with a large informal economy.

Namibia is particularly vulnerable to the effects of climate change, which have been especially visible in the form of droughts in recent years. It is also heavily reliant upon energy imports; with most of its electricity coming from neighbouring countries and mainly produced from non-renewables such as coal. The country, therefore, has expressed a desire to tackle climate change by establishing a green economy as a key driver of economic recovery. This strategy includes generating renewable energy products such as green fuels, green electricity, and green gas, along with other green co-products (green animal feed and green polymers, etc.) for both local and export purposes. In this context, Namibia has ambitious plans to develop its green and blue (ocean-based) economies as articulated under the economic advancement pillar of the Harambee Prosperity Plan II covering the period 2021-2025.[34]

Industrialisation is a central goal for the Namibian government and is seen as a driver of sustainable wealth and job creation. Namibia's industrial ambition is articulated in Vision 2030,[35] which envisions the country becoming a high-income industrialised nation by the year 2030. The country's current fifth National Development Plan (NDP5) 2017/18–2021/2022[36] focuses on industrialisation through the four integrated pillars of economic progression, social transformation, environmental sustainability, and good governance.

The quest to embrace digital transformation and the 4IR must be seen in the context of Namibia's aspirations and specific challenges. Countries need to make decisions about the 4IR that speak to their own national socio-economic trajectory and policy strategy. Given Namibia's commitment to tackle its persistent challenges related to social inequalities, and its

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[33] *Namibia Statistics Agency (2019). Annual Trade Statistics Bulletin, 2019*

[34] *Available at: http://hppii.gov.na/wp-content/uploads/2021/03/HPP2.pdf*

[35] *Available at: https://www.npc.gov.na/national-plans/vision-2030/*

[36] *Available at: https://www.npc.gov.na/national-plans/national-plans-ndp-5/*

need to move towards a more industrialised and environmentally sustainable future, the 4IR in Namibia is here seen as an ***enabler of green and inclusive industrialisation.***

7.2 Patterns of adoption of 4IR technologies in Namibia

Countries and companies worldwide have been conducting 4IR/Industry 4.0 readiness assessments since 2015 to determine what national or organisational policies need to change to take full advantage of the 4IR transformation. This report presents data on Namibia's 4IR readiness based upon a novel survey implemented across a range of organisations in Namibia during June–July 2022 (referred to as the 2022 Namibian 4IR survey in the rest of the report).[37] The survey received a total of 514 responses, including 319 from Namibian companies (116 complete and 203 partial responses) and 195 responses from a broader set of organisations, such as government agencies, education and training institutions, trade associations and international development organisations (76 complete and 119 partial responses).[38]

This section provides an overview of the respondents' attitudes, awareness, and patterns of adoption of technologies broadly, and 4IR technologies in particular.

7.2.1 Attitudes, awareness, and approaches to technology adoption in Namibia

The COVID-19 pandemic has had a clear impact upon the way in which organisations approach new technologies in Namibia. In industry, 62% of firms reported having increased their investment in digital technologies, as well as their overall adoption of new technologies, while half of them have increased their strategic approach towards new technologies, as well as their strategic partnerships focused on technology – see Table 4 below. This increase has been even more pronounced in organisations outside industry, such as education and government institutions, which have moved many of their services and activities online; around 80% of the organisations outside industry reported an increased strategic approach towards new technologies, as well as boosting their adoption of new technologies.

Table 4: COVID-19's impact on the approach to new technologies

	Industry			Non-industry organisations		
	Increase	No change	Decrease	Increase	No change	Decrease
Strategic approach towards new technologies	57%	20%	23%	80%	13%	7%
Actual adoption of new technologies	62%	25%	13%	76%	17%	7%

[37] *The design of the survey was led by the DSI/NRF/Newton Fund Trilateral Research Chair in Transformative Innovation, the 4th Industrial Revolution and Sustainable Development (UJ-TRCTI), at the College of Business and Economics, University of Johannesburg, with inputs and feedback from researchers at the University of Namibia (UNAM). The implementation of the survey was led by UNAM and the Namibia Presidential Task Force on the 4th Industrial Revolution.*

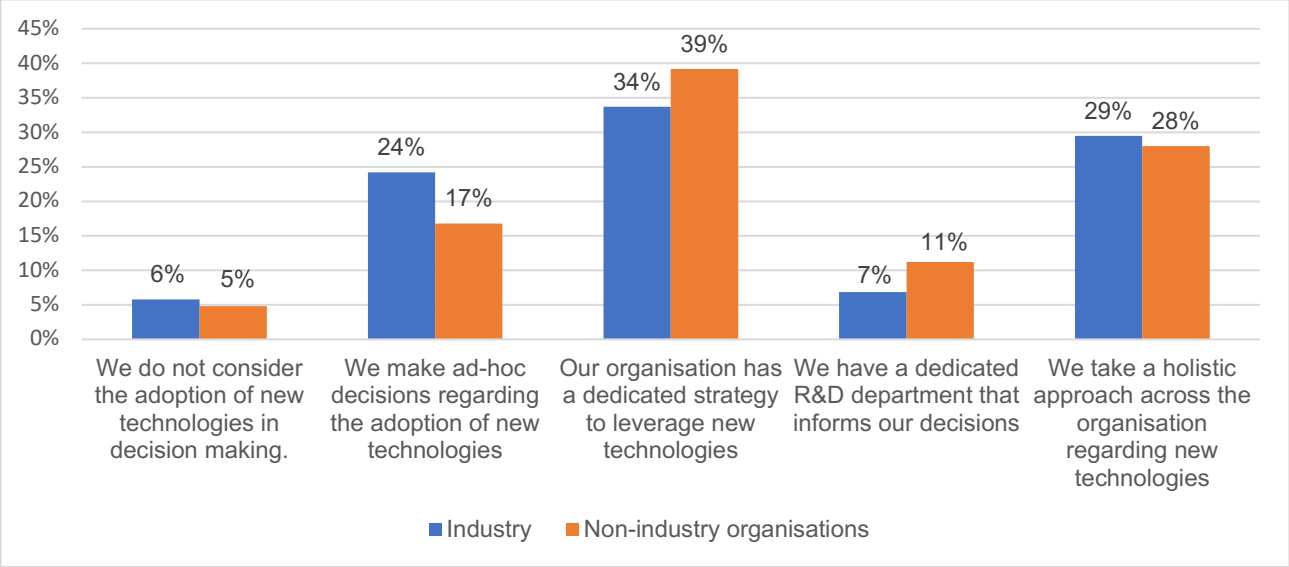
[38] *Complete responses were supplemented with available partial responses in specific questions.*

Investment in digital technologies	62%	29%	9%	69%	23%	8%
Using an R&D approach towards leveraging digital technologies	43%	49%	8%	51%	40%	9%
Strategic partnerships focused on technology	50%	41%	9%	61%	34%	5%

Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 185), Non-industry organisations (n = 124). Values over 60% are highlighted in yellow.

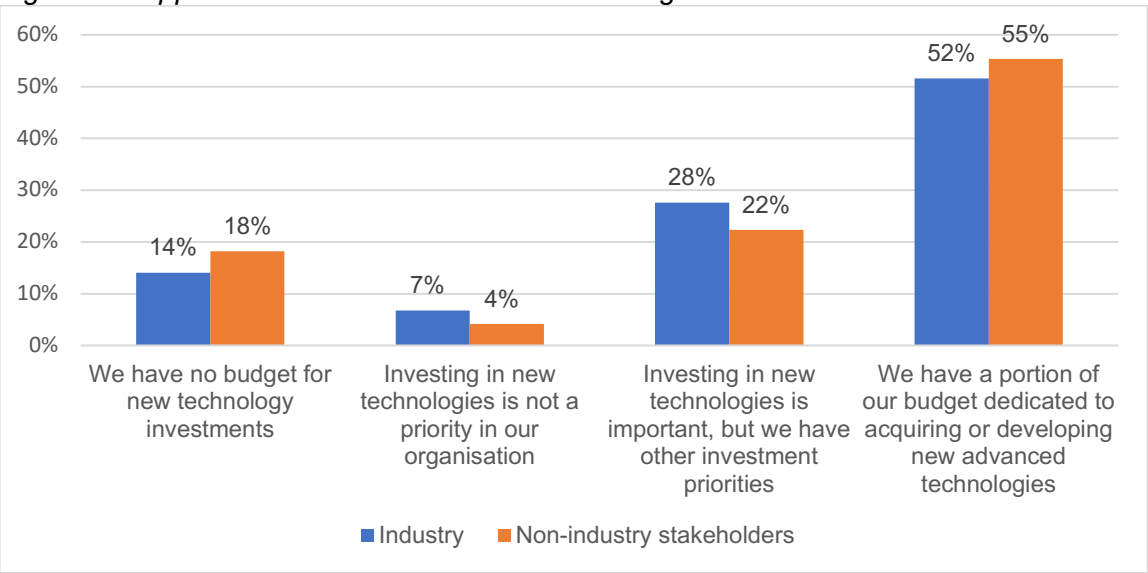
Figure 12 below shows that about one third of respondents from industry and a quarter from other organisations either do not consider the adoption of new technologies in decision making or make ad-hoc decisions. Another third of all respondents seems to have in place a strategic approach to new technologies (34% of industry respondents and 39% of non-industry organisations reported having a dedicated strategy to leverage new technologies). Only 7% of respondents in industry and 11% of respondents outside industry report having a dedicated R&D department informing their investment decisions about new technologies. Despite this finding, Figure 13 below shows that over half of the respondents reported having a dedicated budget to acquire or develop more advanced technologies. However, about a quarter of the industry respondents indicated that "while investing in new technologies is important, they have other investment priorities".

Figure 12: Approach to decision-making about new technologies



Notes: Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 190), Non-industry organisations (n = 125).

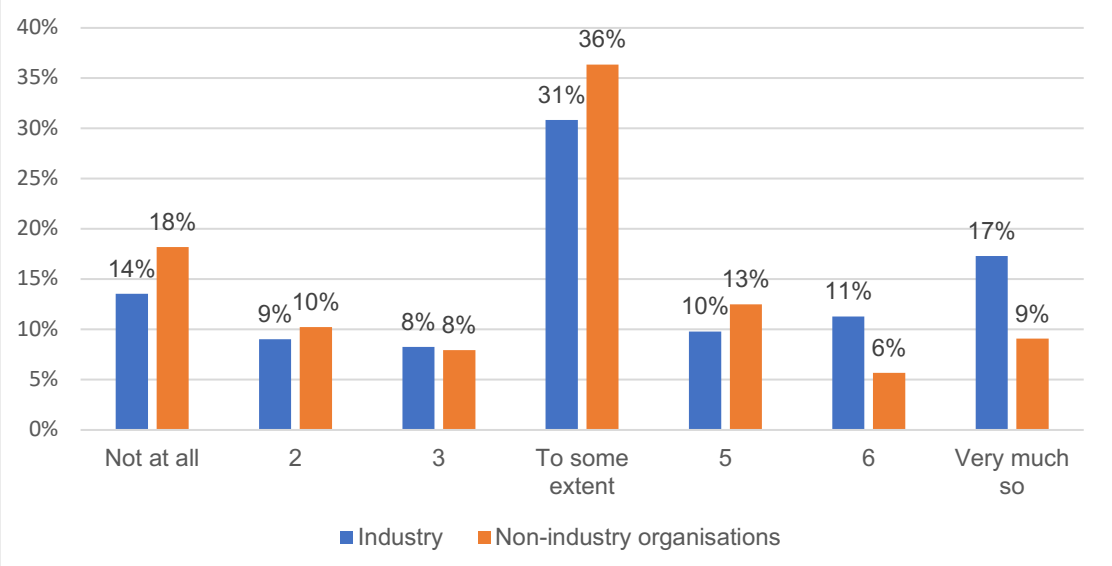
Figure 13: Approach to investment in new technologies



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 192), Non-industry organisations (n = 121). Values may not add exactly to 100% due to rounding.

Figure 14 below suggests that about a third of the responding organisations in Namibia tend to be risk-averse in embracing disruptive ideas (those who answered 1 to 3 to "*Does your organisation embrace risky or disruptive ideas?"*), while another third does embrace risky or disruptive ideas "to some extent". This practice is particularly visible in organisations outside industry. While risk-aversion is an advantageous strategy that provides stability, the 4IR requires the institutional capability to embrace disruptive change while maintaining transparency and efficiency.

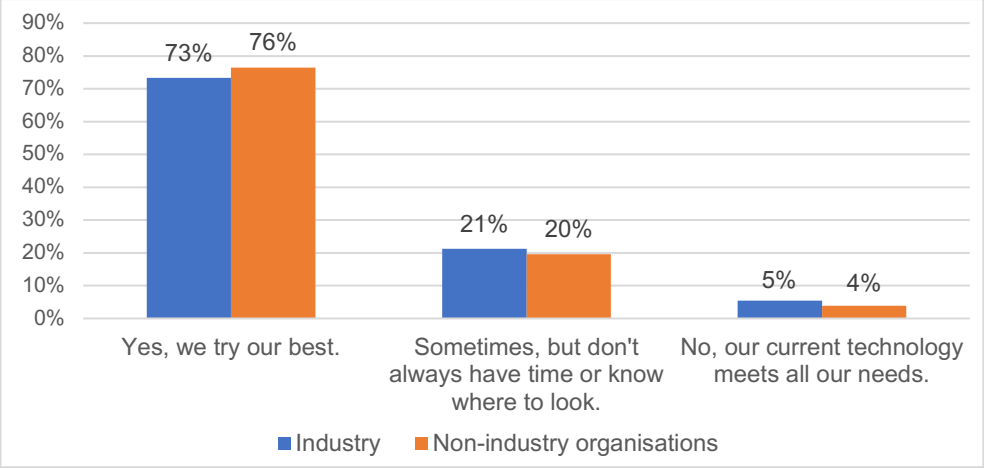
Figure 14: Does your organisation embrace risky or disruptive ideas?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 133), Non-industry organisations (n = 88). Values may not add exactly to 100% due to rounding.

Despite the attitude to risk expressed by respondents, awareness is a central ingredient for new technology adoption. In this respect, most organisations (both within and outside industry) report trying their best to remain aware of the latest technological trends in their sector/trade (Figure 15 below). A fifth of the respondents indicated that while they are interested, they do not always have the time to keep abreast of the latest technological trends.

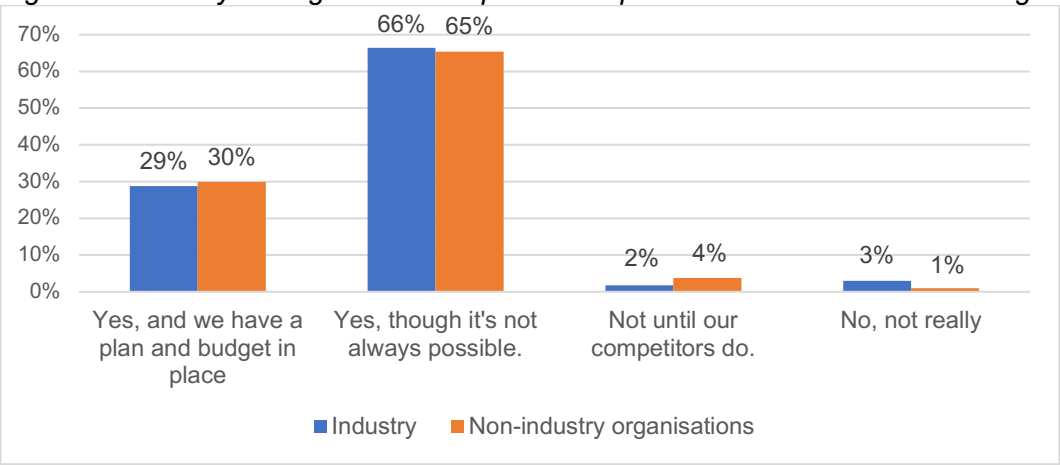
Figure 15: Would you say that your organisation is aware of the latest technological trends in your sector?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 133), Non-industry organisations (n = 88). Values may not add exactly to 100% due to rounding.

Despite a widespread interest to remain abreast of the latest technological trends, only a third of the respondents reported having an actual plan and a budget in place to adopt the latest technologies (Figure 16 below). The majority (65%) admitted that it is not always possible to do so.

Figure 16: Does your organisation aspire to adopt the latest available technologies?

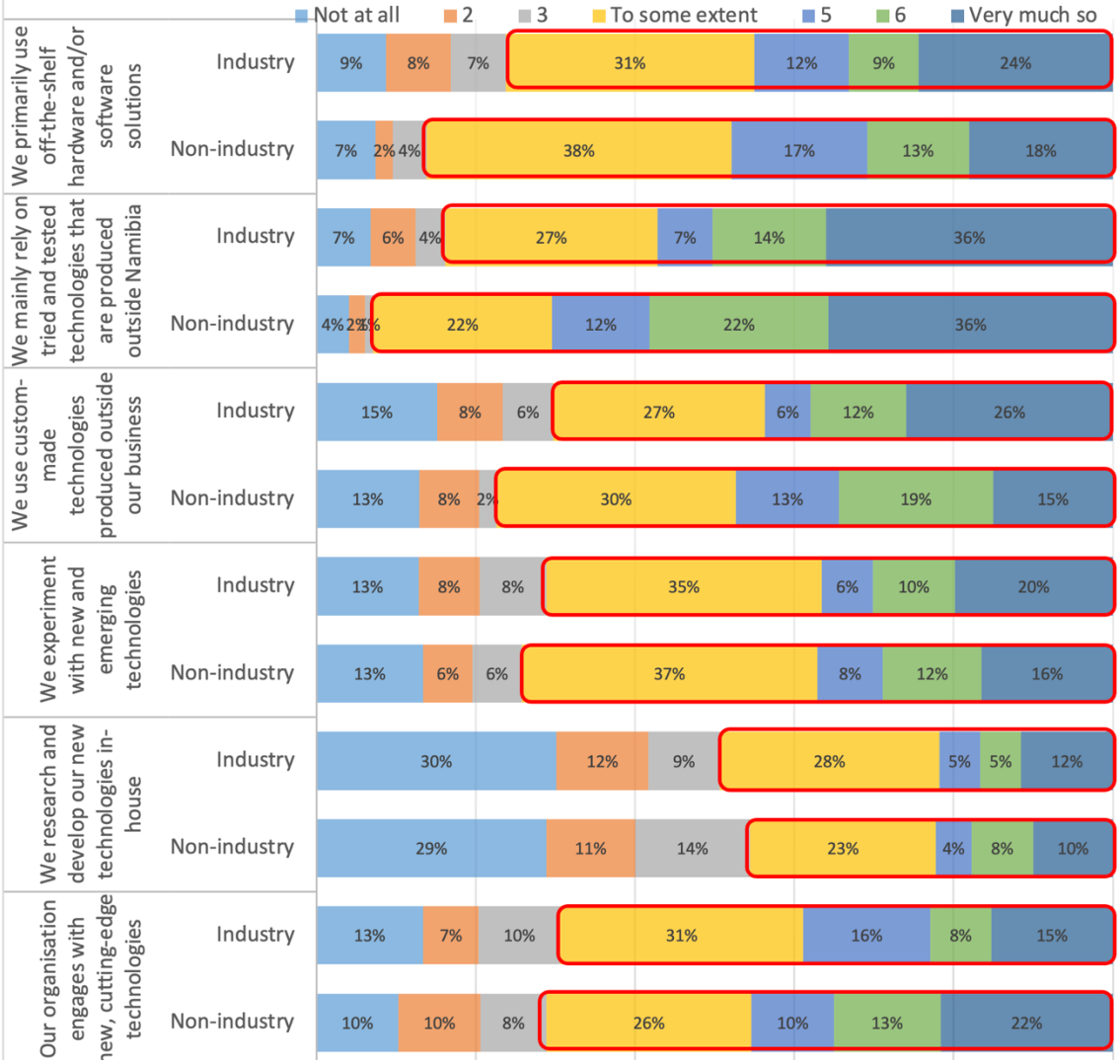


Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 167), Non-industry organisations (n = 107). Values may not add exactly to 100% due to rounding.

7.2.2 Technology profile of organisations in Namibia

Namibia, as it is the case with most developing countries, is a net consumer of technology. Most organisations in Namibia (see Figure 17) primarily use off-the-shelf hardware and/or software solutions, with 76% of industry respondents and 86% outside industry indicating that they use primarily off-the-shelf solutions “to some extent” or “very much so”. Practically all these technologies are described as “tried and tested technologies that are produced outside Namibia”. However, a significant portion of organisations do “research and develop their new technologies in-house” (50% in industry and 45% of broader stakeholders), and nearly three-quarters of the respondents “experiment with new and emerging technologies”. This finding is potentially good news for the development of home-grown technological solutions. Moreover, more than two-thirds of respondents stated that they are “engaging with new, cutting-edge technologies”.

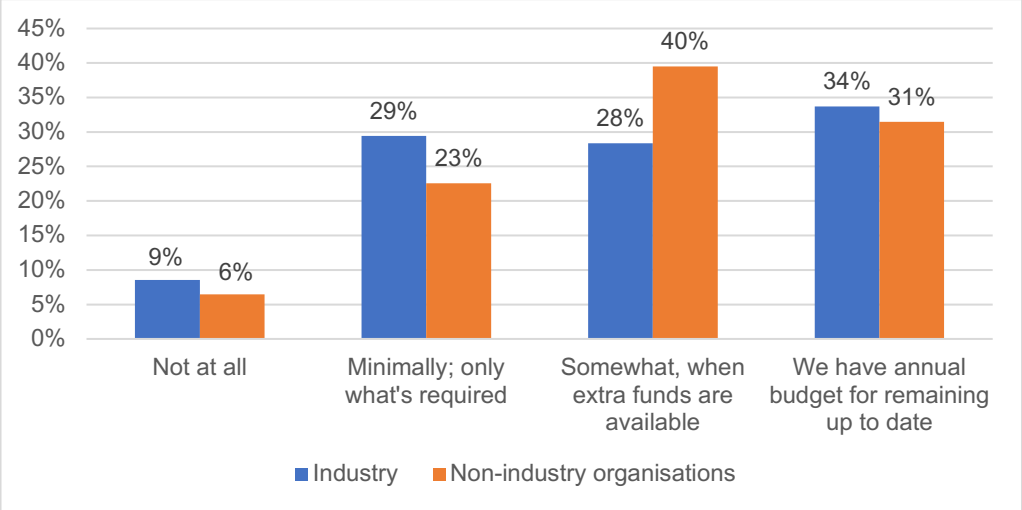
Figure 17: Technology profile of organisations in Namibia.



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 161), Non-industry organisations (n = 98). Values may not add exactly to 100% due to rounding. Red outlines highlight responses of 4-7 (to some extent to very much so).

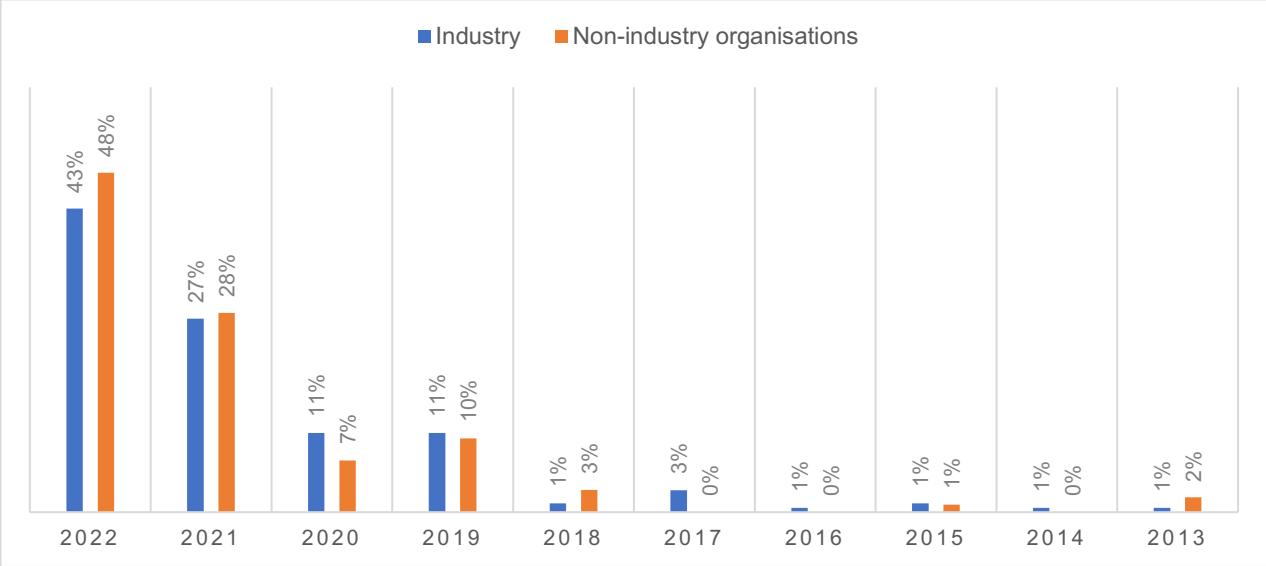
Figure 18 below shows that about one-third of the respondents (both within and outside industry) has an annual budget for technology maintenance and upgrades. However, most of them make these types of investments when they have extra funds available, or only to a minimal extent. These constraints are more visible in organisations outside industry. Despite these results, most organisations reported they had purchased new hardware or software technologies during the last 2-3 years (see Figure 19).

Figure 18: Investments in technology upgrades and maintenance



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 187), Non-industry organisations (n =124). Values may not add exactly to 100% due to rounding.

Figure 19: Last time new hardware or software technologies were purchased



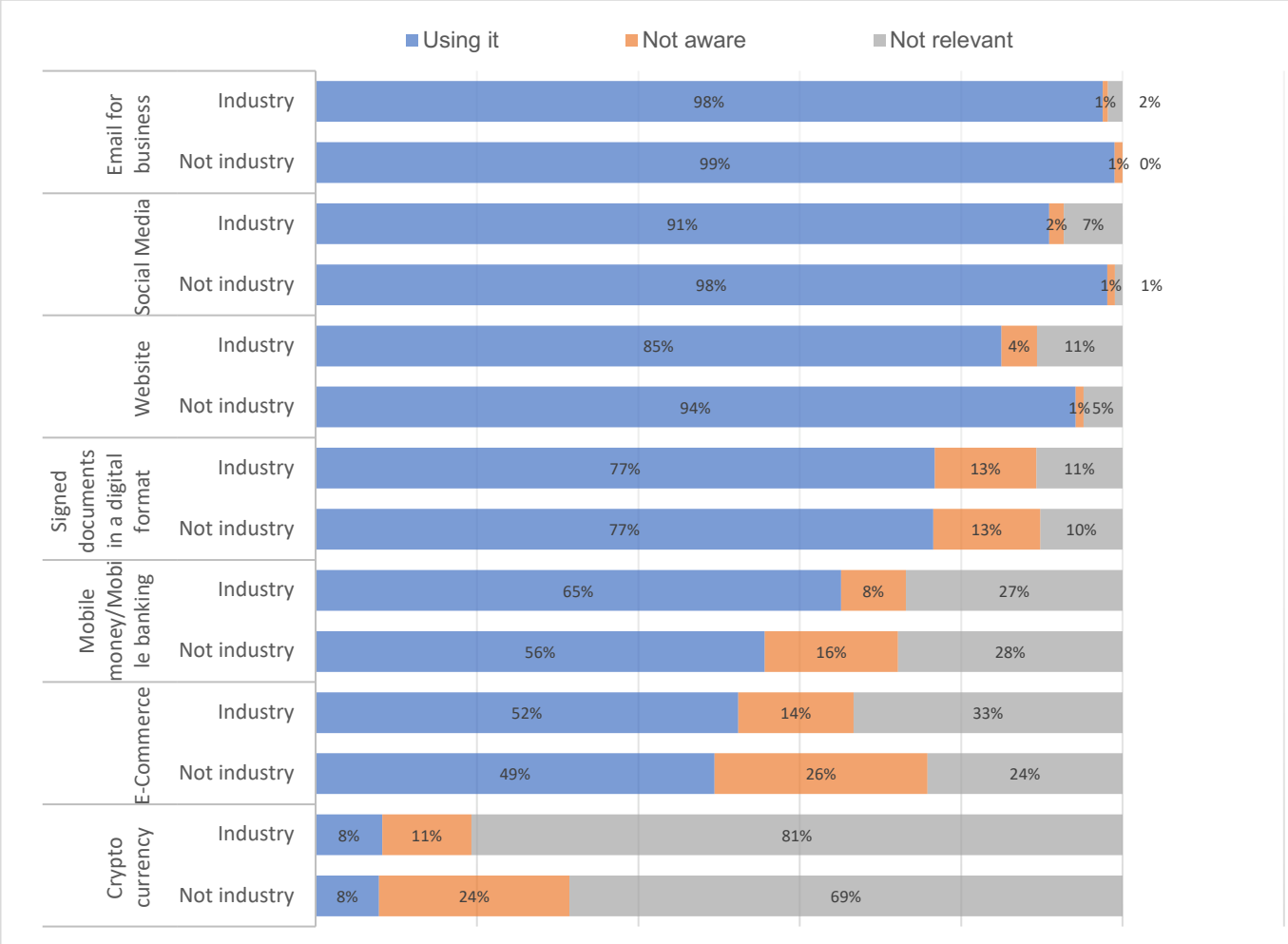
Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 161), Non-industry organisations (n =96). Values may not add exactly to 100% due to rounding.

7.2.3 Digital technology adoption patterns

This section describes the Namibian organisations' adoption patterns of digital technologies, both within and outside industry. It pays particular attention to the advanced digital technologies that are typically associated with the 4IR. It also captures the impact and constraints relating to digital technology adoption as reported by the survey respondents.

Figure 20 below provides an overview of the use of digital technologies in the Namibian system and indicates quite similar patterns between industry and non-industry organisations. Email for business purposes, social media, websites and signed documents in digital formats are widely used, while other digital technologies, such as e-commerce, mobile banking/mobile money and cryptocurrency, are less used.

Figure 20: Use of digital technologies

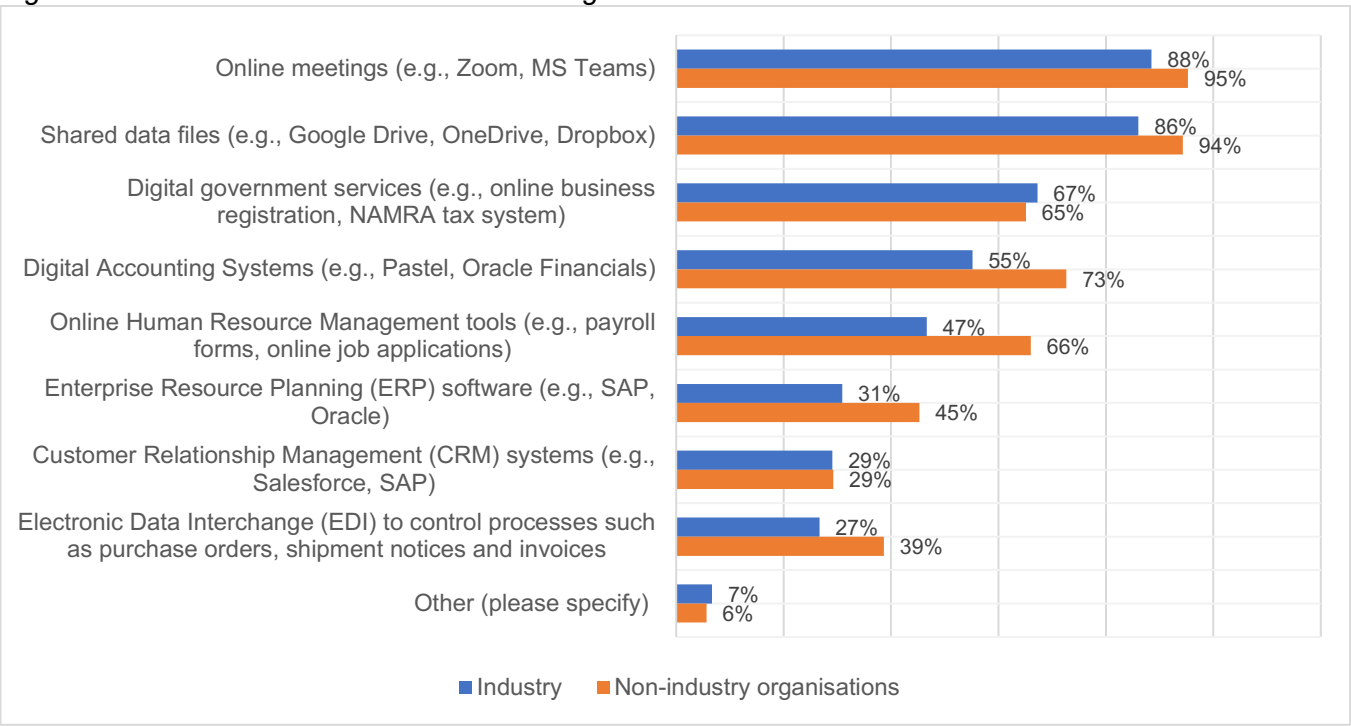


Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Pooled sample (n = 270). Values may not add exactly to 100% due to rounding.

Digital tools are also essential for collaboration across stakeholders within the system, and most organisations both within and outside industry seem to make regular use of online meeting platforms, shared data files and digital government services (Figure 21 below). Digital

accounting systems and online human resource management tools (such as online payroll forms or online job applications) seem to be more commonly used outside industry.

Figure 21: Collaborations or interactions using online tools



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 165), Non-industry (n =106). Values may not add exactly to 100% due to rounding.

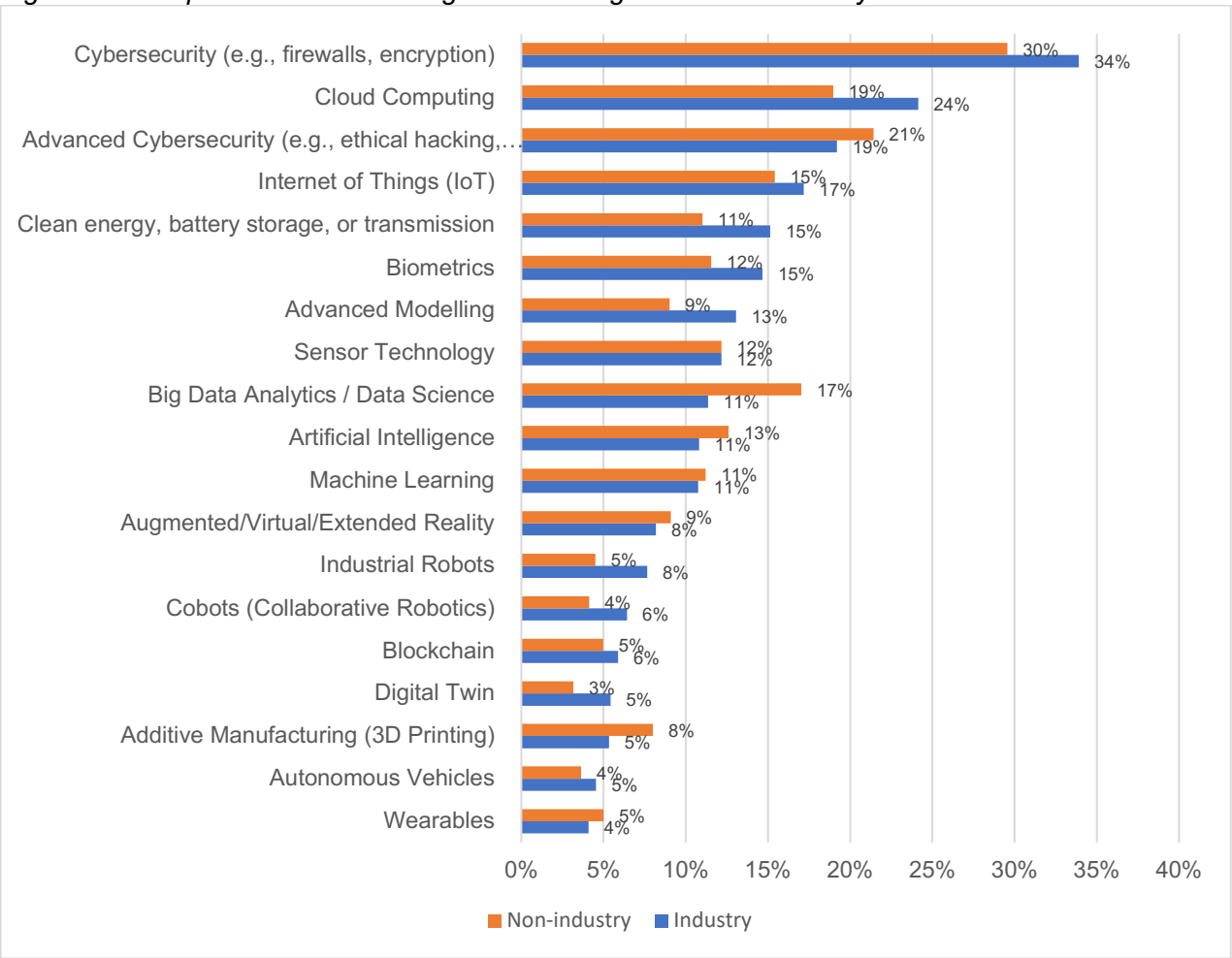
When it comes to advanced digital technologies, Figure 22 below provides an overview of the technologies that are typically associated with the 4IR that have been adopted by organisations in Namibia. The use of these technologies is generally less visible than other, perhaps more accessible, digital technologies. While cybersecurity is used by about a third of all respondents, both in industry as well as by the broader set of stakeholders, advanced cybersecurity involving ethical hacking, content profiler and similar techniques is less common and reported to be used by about 20% of respondents. Cloud computing is used by approximately 25% of the respondents.

The Internet of Things (IoT), clean energy/battery storage/transmission, biometrics and advanced modelling are reportedly used by about 15% of respondents in industry, while their use is less prevalent within non-industry organisations.

Sensor technology, big data analytics/data science, artificial intelligence and machine learning are used by about 10% of the respondents in industry, although big data analytics is slightly more prevalent amongst outside industry organisations.

Other technologies, such as wearables, autonomous vehicles, additive manufacturing (3-D printing), digital twins, blockchain, industrial robots, and augmented/virtual/extended reality, are rarely used across the respondents.

Figure 22: Adoption of advanced digital technologies over the last 3 years



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Pooled sample (n = 232). Values may not add exactly to 100% due to rounding.

Table 5 below provides an overview of the levels of adoption of advanced digital technologies versus the plans to adopt and the suitability of such technologies. Advanced cybersecurity, cloud computing, sensor technology and IoT are the technology most frequently mentioned to be used by the industry respondents. The acquisition and implementation of cybersecurity, machine learning, cloud computing and artificial intelligence are regarded as priorities for industrial companies in Namibia within the coming years. Similar patterns are seen in non-industry organisations, although they display less ambitious plans to adopt 4IR technologies compared to industry. Some technologies such as autonomous vehicles, wearables and industrial robots are described as “not suitable” by most respondents. This perception is an indication of the appetite and the readiness of the Namibian system for specific 4IR technologies.

Table 5: Adoption, plans to adopt and suitability of advanced digital technologies.

	Industry				Non-industry organisations			
	Don't know	Adopted	Plan to adopt	Not suit-able	Don't know	Adopt-ed	Plan to adopt	Not suit-able
Cloud Computing	16%	24%	19%	5%	10%	19%	5%	2%
Big Data Analytics / Data Science	22%	11%	20%	11%	10%	17%	8%	1%
Cybersecurity (e.g., firewalls, encryption)	14%	34%	8%	7%	6%	30%	1%	0%
Advanced Cybersecurity (e.g., ethical hacking, content profilers)	23%	19%	11%	10%	6%	21%	6%	3%
Sensor Technology	25%	12%	13%	15%	14%	12%	5%	4%
Additive Manufacturing (3-D Printing)	21%	5%	14%	24%	15%	8%	5%	8%
Advanced Modelling	26%	13%	10%	17%	15%	9%	7%	3%
Internet of Things (IoT)	21%	17%	17%	9%	11%	15%	7%	3%
Autonomous Vehicles	26%	5%	9%	25%	16%	4%	5%	10%
Machine Learning	23%	11%	20%	11%	12%	11%	8%	4%
Cobots (Collaborative Robotics)	29%	6%	11%	19%	17%	4%	5%	9%
Artificial Intelligence	23%	11%	18%	12%	11%	13%	9%	4%
Augmented/Virtual/Extended Reality	29%	8%	12%	16%	14%	9%	6%	6%
Industrial Robots	27%	8%	8%	21%	15%	5%	5%	11%
Wearables	30%	4%	9%	21%	18%	5%	4%	9%
Biometrics	20%	15%	14%	16%	13%	12%	6%	4%
Blockchain	27%	6%	12%	20%	14%	5%	6%	10%
Digital Twin	33%	5%	10%	17%	19%	3%	5%	7%
Clean energy, battery storage, or transmission	17%	15%	17%	15%	13%	11%	9%	4%

Notes: Highlighted cells show the four largest values in their respective columns.

Reasons given by industrial organisations' respondents for adopting 4IR technologies include (Table 6 below): improve customer experience, increase efficiency, increase productivity of employees, complement the skills available, and gain competitive advantage. Reasons given by outside industry respondents include digitise production/processes, speed financial decisions and greening production process.

Table 6: Why are you adopting or considering adopting these advanced digital technologies?

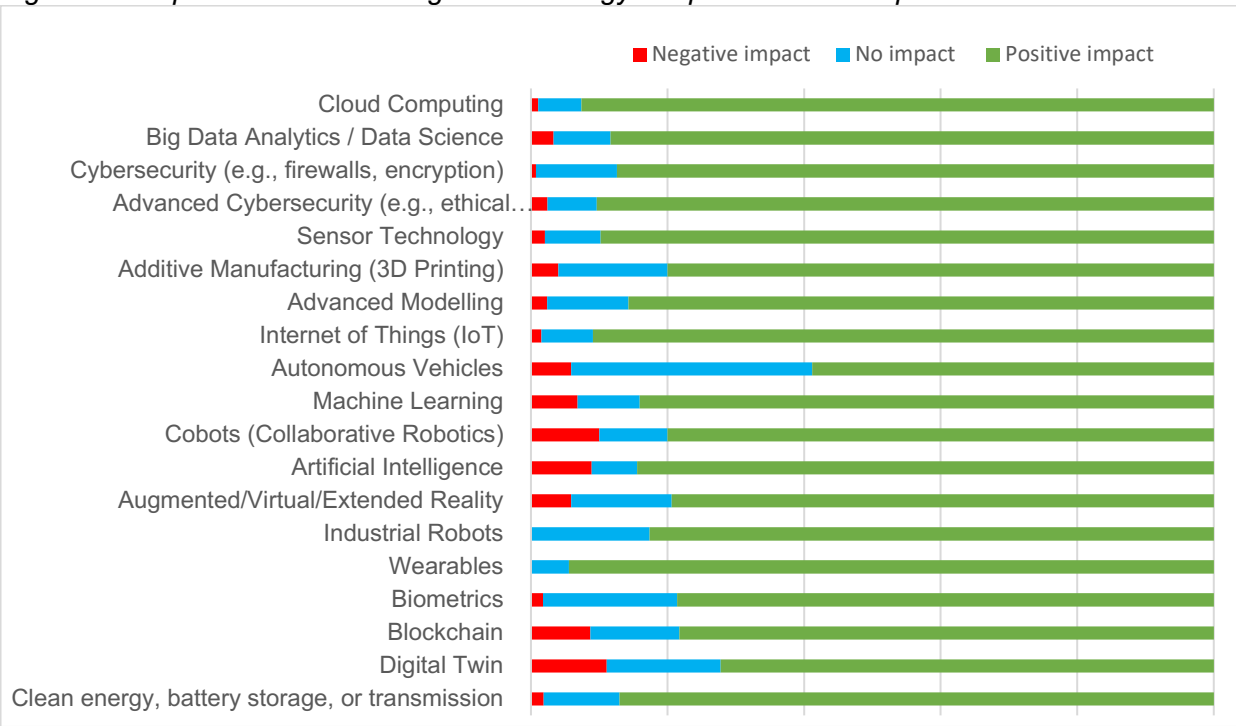
	Industry		Non-industry organisations	
	Currently adopting	Considering adoption	Currently adopting	Considering adoption
Track/manage assets	48%	52%	61%	39%
Eliminate/reduce error	50%	50%	56%	44%
Improve customer experience	69%	31%	71%	29%
Increase efficiency	71%	29%	78%	22%
Increase productivity of employees	68%	32%	76%	24%
Supplement workforce deficits	47%	53%	60%	40%
Complement the skills available in the business	63%	37%	74%	26%
Integrate manufacturing/supply chain	35%	65%		
Automate production	35%	65%		
Digitize production/processes	50%	50%	74%	26%
Increase volume of production	50%	50%		
Speed time to market	58%	42%		
Speed financial decisions	56%	44%	66%	34%
Customise products	55%	45%	62%	38%
My competitors use it	45%	55%	66%	34%
To gain competitive advantage	65%	35%	73%	27%
Determined by the head office	52%	48%	66%	34%
Diversification of production	52%	48%		
Greening our production process	46%	54%	65%	35%

Notes: Highlighted cells show values higher than 65%.

The impact of the adoption of advanced digital technologies is generally positive across the board of technologies, as reported by the respondents (Figure 23 below).

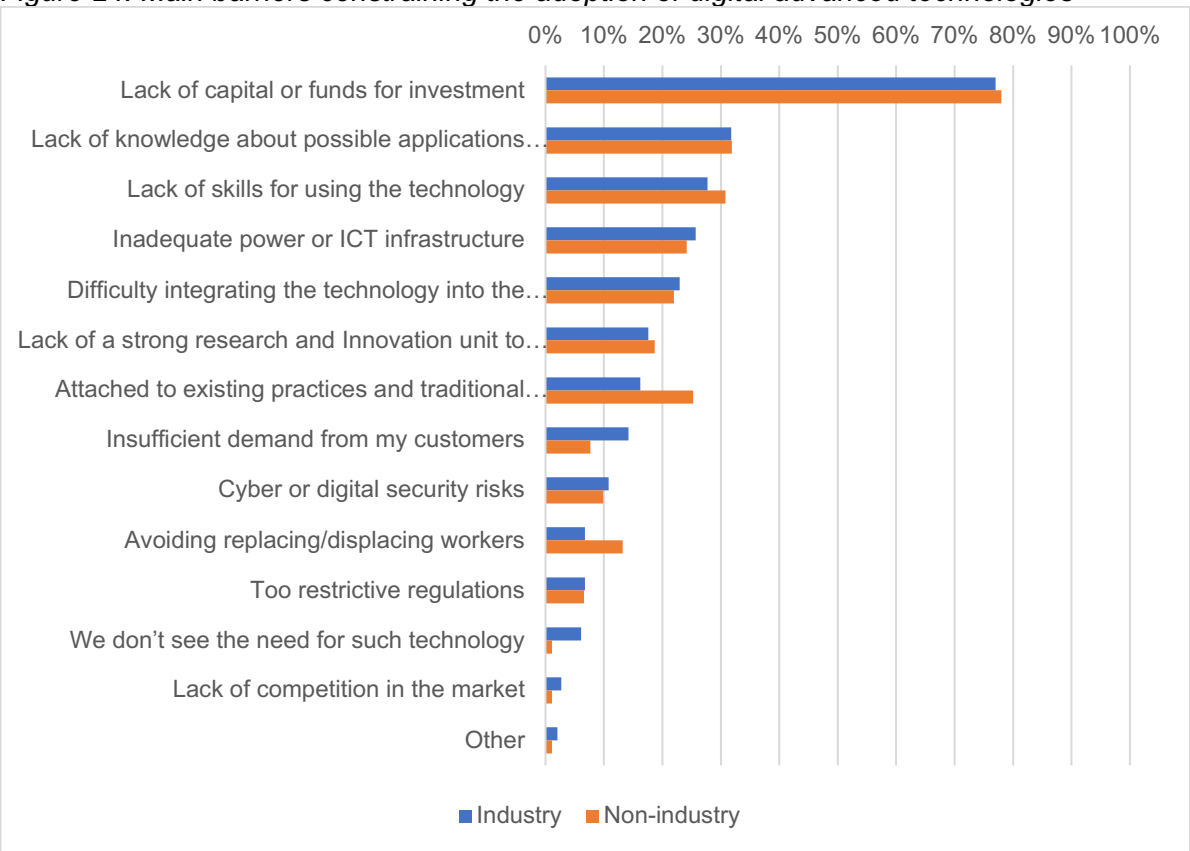
Organisations within Namibia experience critical barriers to the adoption of advanced digital technologies (Figure 24 below). The most prevalent barrier is “Lack of capital or funds for investment” (an average of 77% of the respondents), followed by “Lack of knowledge about possible applications of the technology” (32% of respondents), and “Lack of skills for using the technology” (29% of respondents). “Inadequate power or ICT infrastructure”, and “Difficulty integrating the technology into the organisation’s processes” are also experienced by a considerable portion of the respondents. These barriers provide valuable entry points for policy interventions to support the updating and adoption of 4IR technologies within the Namibian system.

Figure 23: Impact of advanced digital technology adoption on overall performance



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Pooled sample (n = 232).

Figure 24: Main barriers constraining the adoption of digital advanced technologies



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 148), Non-industry (n =91). Values may not add exactly to 100% due to rounding.

7.3 Namibia 4IR Readiness Assessment Framework

Countries globally can gain an understanding of their 4IR readiness levels by using a range of assessment tools. Such tools help measure and map the direction for successful digital transformation. An important part of the process is the use of a common assessment framework that allows countries to: (1) provide a basis for international benchmarking and comparisons of our data with other countries' data, as well as (2) speak to the realities of Namibia.

The assessment framework used in this study has three layers of analysis (Figure 25 below):

1) A first layer capturing the **Preconditions**, or the fundamental ingredients that are needed for widespread adoption of advanced digital technologies. These preconditions are often lacking in developing countries and include: Infrastructure, Education and Functional innovation systems.

2) A second layer (at the centre) assessing the readiness of industry – or the **Readiness for the Future of Production**. This framework was launched in 2018 as a diagnostic tool developed by the World Economic Forum (WEF) in collaboration with A.T. Kearney.[39,40] It was designed as a benchmarking framework and dataset to (a) build awareness of the key levers and factors required to transform production systems, (b) help decision-makers assess the extent to which their country is ready and positioned to shape and benefit from the changing nature of production, (c) catalyse public-private sector dialogue, and (d) inform the development of joint actions and modern industrial strategies.

3) A third layer exploring the **Broader applications of 4IR**. For developing countries that are currently users rather than producers of 4IR technologies, the applications beyond advanced manufacturing are particularly important, especially in the areas that directly affect the developmental goals of the country, such as food production/agriculture and other resource-based activities, energy, health, education and public sector delivery. In the 4IR, intelligent technologies could be the key to unlocking solutions to some of the country's most deep-seated problems, as well as achieving its aspirations in terms of economic growth and industrial development.

The 4IR Readiness Assessment Framework for Namibia encapsulates the **three layers** that are considered central to the unfolding of the 4IR in Namibia – rooted in strong infrastructure, education and a dynamic innovation system; centred around the needs of industry; and manifest in improved living conditions for the majority of the population through the broader application of 4IR technologies beyond industry.

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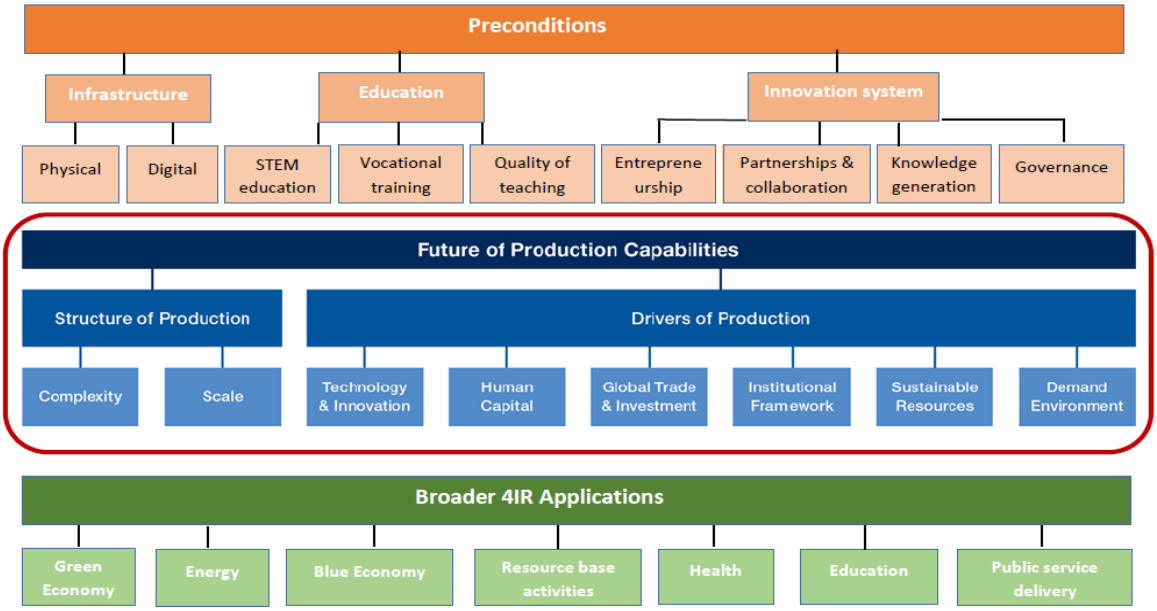
[39] *World Economic Forum (WEF) (2018). Readiness For the Future of Production Report 2018 (https://www.weforum.org/reports/readiness-for-the-future-of-production-report-2018)*

[40] *Olaitan, O.O., Issah, M. & Wayi, N. (2021). A framework to test South Africa's readiness for the fourth industrial revolution. South African Journal of Information Management, 23(1), 1-10.*

Figure 25: 4IR Readiness Assessment Framework for Namibia



Based on this framework this report aims to answer the following questions:
[1] Does Namibia have the preconditions for the 4IR?
[2] Does Namibia have the necessary capabilities for the Future of Production?
[3] Does Namibia have the potential to apply 4IR more broadly?

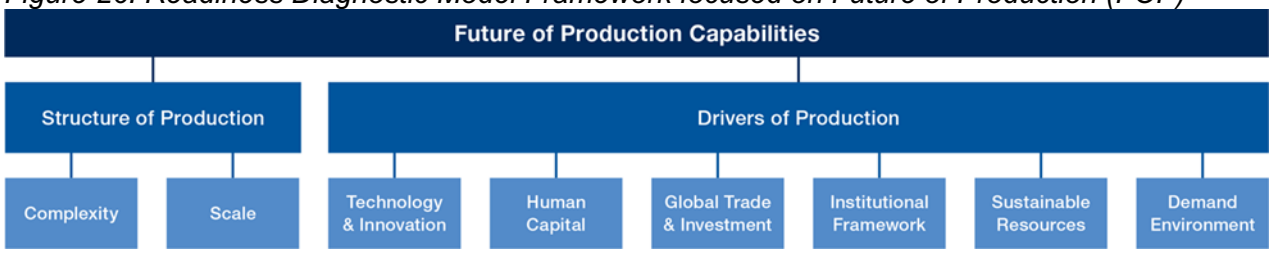
There are strategic reasons for positioning industry at the centre of the framework portrayed in Figure 25 above. Industry is central for the 4IR, given that most 4IR considerations relate to the trends towards automation and data management in manufacturing technologies and processes. In addition, this tried and tested framework allows valuable international comparisons and benchmarking. However, from a developing country perspective it is important to look beyond industry, and to understand the readiness of the whole society for the 4IR and possible applications beyond industry to address some of the most pressing socio-economic and environmental challenges.

The framework for the "Readiness for the Future of Production" was developed through a series of multi-stakeholder consultations that included leading experts in government, international organisations and research institutions.[41] It assesses readiness for the future of production across two different components: 1) the **structure of production**, and 2) the **drivers of production**. The structure of production represents the country's current baseline of production, whilst the drivers of production represent the major enablers and propellers that give a country leverage to employ and capitalise on the 4IR to transform its productive systems

[41] *Olaitan, O.O., Issah, M. & Wayi, N. (2021). A framework to test South Africa's readiness for the fourth industrial revolution. South African Journal of Information Management, 23(1), 1-10.*

(see Figure 26 below). It is argued that countries with large and complex production infrastructures are well placed to take full advantage of the 4IR, as well as to mitigate the uncertainties associated with the 4IR. Similarly, countries that have favourable drivers of production are considered more "ready" because the mix of enablers will allow for the adoption and diffusion of technology to accelerate the transformation of production systems.

Figure 26: Readiness Diagnostic Model Framework focused on Future of Production (FOP)

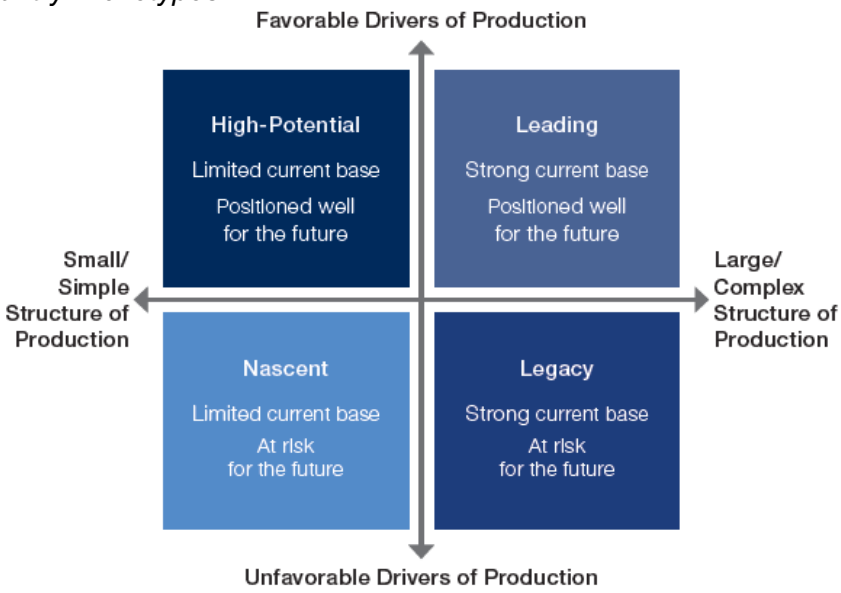


Source: WEF (2018)

The above framework was applied to 100 countries, covering all regions of the world, including 12 countries in Sub-Saharan Africa (Namibia not included). Country inclusion was largely driven by data availability and the significance of production in the selected countries. Using this framework allows for international benchmarking of Namibia in terms of the 4IR, which has not been done before.

Once the scores of the Structure of Production and Drivers of Production are calculated, a country is assigned to one of the four archetypes, through a process in which the ***Drivers of Production*** score is plotted on the y-axis and the ***Structure of Production*** on the X-axis.

Figure 27: Country Archetypes



Source: WEF (2018)

Figure 27 above depicts the four archetypes, namely Nascent, Legacy, High Potential and Leading. The countries classified as Nascent are countries that have small or simple Structures of Production and unfavourable Drivers of Production. This combination means that they are at risk for the future. The WEF's assessment revealed that these countries include South Africa, Brazil, Kenya and Nigeria. In fact, their analysis classified 90% of the countries primarily from the Global South in Africa, Latin America, Middle East and Eurasia, as Nascent[44] and, therefore, least ready for the future of production.

On the contrary, countries that are leading are those with large or complex Structures of Production and favourable Drivers of Production. This combination means they are well positioned for the future. The WEF's assessment revealed that these countries include the United States of America, Japan, Singapore, Germany and China. In other words, these are the countries that are most ready for the future of production, with Japan ranked first in the world.

This study assesses the readiness for the future of production of Namibia, in the context of 4IR. Through this analysis, Namibia will be classified under one of the four archetypes, based upon the Structure of Production and Drivers of Production performance.

7.4 Preconditions for the 4IR

This section examines in detail the first layer of **Preconditions** for the 4IR, as identified in the assessment framework (Figure 25 above): infrastructure (both physical and digital), education, and having a functional innovation system. Many of the results in this section are drawn from external sources that complement the results from the Namibia 4IR Survey. External sources are cited after each table or figure.

7.4.1 Infrastructure

All industrial revolutions have relied upon infrastructure and have resulted in the transformation of infrastructure as much as the transformation of production methods. The 4IR depends upon critical physical infrastructure networks, including transport (road, rail, waterways, airports); energy (electricity, fuel supply); water (supply, wastewater treatment); and solid waste (collection, treatment, disposal). 4IR also depends upon digital infrastructure (internet connectivity, data centres, etc). The relationship between 4IR technologies and infrastructure is interdependent since adequate infrastructure is a precondition for 4IR, but 4IR technologies can also contribute to the modernisation of infrastructure processes, which brings huge opportunities for innovation.

The framework analysis compared Namibia to a list of 18 countries, mostly African. Countries were selected for comparison based upon similarity/dissimilarity of factors such as continental and regional location, population density, advancement of digital technologies within Africa, whilst Estonia, Singapore and Malaysia were included as Namibia based some of its digital systems upon these countries that are quite advanced in 4IR adoption. The following countries were chosen for comparative purposes (Table 7).

Table 7: List of Countries for Data Comparison

	Total Area (km²)	Population	Density
Namibia	825,615	2,587,344	3
Angola	1,246,700	33,933,611	27
Botswana	582,000	2,397,240	4
Ethiopia	1,104,300	117,876,226	104
Ghana	238,533	31,732,128	139
Kenya	580,367	54,985,702	97
Mauritius	2,040	1,266,060	624
Morocco	446,550	37,344,787	84
Nigeria	923,768	211,400,704	232
Rwanda	26,338	13,276,517	538
Senegal	196,722	17,196,308	89
South Africa	1,221,037	60,041,996	49
Tanzania	945,087	61,498,438	69
Uganda	241,550	47,123,533	235
Zambia	752,612	18,920,657	25
Zimbabwe	390,757	15,092,171	39
Estonia	45,227	1,329,254	31
Singapore	710	5,453,566	7692
Malaysia	329,847	32,655,400	102

Source: World Bank Indicators, https://databank.worldbank.org/

7.4.1.1 Physical infrastructure

All innovation requires the mobility of people, ideas and products, which requires good transport infrastructure, especially to empower the youth through mass transport (rail, buses, etc.). Even more importantly, 4IR requires energy and a reliable and affordable electricity supply. Electricity is a catalyst for economic and social development and, therefore, energy provision is a precondition for the 4IR to thrive. The generation of electricity consumes a significant amount of water and, consequently, effective water infrastructure is critical in electricity infrastructure. Data and computing infrastructure are also highly dependent upon energy.

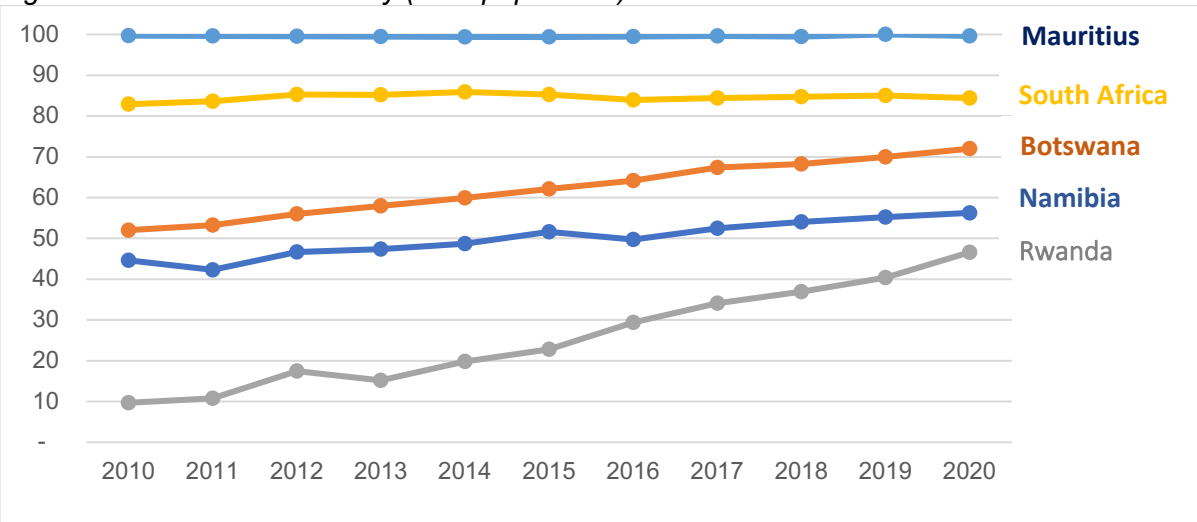
Namibia performs relatively well in physical infrastructure, as compared to peer countries in the region (see Table 8 and Figure 28 below). While 56% of the total population has access to electricity, there are vast differences in urban and rural electrification, with about two-thirds of rural population lacking access to electricity.

Table 8: Infrastructure indicators in Namibia and selected countries – (data from 2012-2020)

	Road transport (km) 2011-18	Rail transport (km) 2019	Air transport, freight (million ton-km) 2020	Access to electricity (% of population) 2020			People using at least basic drinking water services (% population) 2020	People using at least basic sanitation services (% population 2020
				Total	**Urban**	**Rural**		
Namibia	2,628	48,875	1.64	56.3	75	36	84.27	35.26
Angola	2,852	26,000	28.90	46.9	n/a	74	57.17	51.66
Botswana	888	31,747	0.67	72.0	91	26	92.21	80.03
Ethiopia	659	120,171	2,897.13	51.1	93	39	49.62	8.91
Ghana	947	947	0.30	85.9	95	74	85.79	23.70
Kenya	3,819	177,800	113.06	71.4	94	63	61.63	32.70
Mauritius	146	2,428	62.06	99.7	99	100	99.87	96.00
Nigeria	3,798	195,000	0.74	55.4	84	25	77.61	42.72
Rwanda	0	20,986	-	46.6	86	38	60.41	68.83
Senegal	906	4,567	2.57	70.4	95	47	84.91	56.78
South Africa	20,986	750,000	102.39	84.4	89	75	93.89	78.47
Tanzania	4,567	87,581	1.79	39.9	73	22	60.72	31.76
Uganda	1,244	20,544	0.03	42.1	70	33	55.86	19.79
Zambia	3,126	67,671	69.97	44.5	82	14	65.41	31.90
Zimbabwe	3,427	97,267	10.00	52.7	86	37	62.67	35.19
Morocco	2,067	57,300	46.24	100.0	100	100	90.40	87.25
Estonia	2,146	58,412	2,897.13	100.0	100	100	99.59	99.14
Singapore	245	3,500	3,019.93	100.0	100	100	100.00	100.00
Malaysia	-	-	816.75	100.0	100	100	97.10	99.58

Source: World Bank Indicators https://databank.worldbank.org/ and Worlddata.info, https://www.worlddata.info

Figure 28: Access to electricity (% of population) over time



Source: World Bank Indicators https://databank.worldbank.org/

7.4.1.2 Digital infrastructure

Access to advanced digital technologies can be constrained by both physical infrastructure, such as the lack of electricity, and the lack of digital infrastructure. Accelerating digital

connectivity, internet density and broadband penetration are critical, not only for increasing 4IR uptake, but also for reaching and lowering unit costs for under-served people (see Table 9 below).

Table 9: Key ICT indicators in Namibia and selected countries – 2020/2021

	ICT regulator has cyber security mandate	Individuals using the internet (% of population)	Mobile cellular subscriptions (per 100 people)	House-holds with a computer (%)	Active mobile broadband (per 100 people)	Fixed broadband subscriptions (per 100 people)
Namibia	yes	41.0	114.06	21	69	2.80
Angola	unknown	36.0	44.56	32	20	0.70
Botswana	yes	41.0	162.84	28	95	11.04
Ethiopia	yes	24.0	38.71	5	20	0.18
Ghana	yes	58.0	130.21	16	85	0.25
Kenya	yes	29.5	114.20	8.8	47	1.25
Mauritius	yes	64.8	150.41	49	98	25.41
Nigeria	no	35.5	99.07	6.4	42	0.03
Rwanda	yes	26.5	81.95	2.5	43	0.14
Senegal	no	42.6	113.95	14	67	0.92
South Africa	yes	70.0	161.80	23	110	2.20
Tanzania	yes	22.0	85.75	3.1	14	1.90
Uganda	unknown	19.9	60.53	3.5	44	0.13
Zambia	yes	19.8	103.92	8.1	56	0.45
Zimbabwe	yes	29.3	88.76	14	59	1.37
Morocco	no	84.1	133.89	64	75	5.70
Estonia	no	89.0	145.17	87	170	31.33
Singapore	yes	92.0	144.35	89	140	25.81
Malaysia	yes	89.5	135.09	78	120	10.38

Source: https://www.itu.int/en/ITU-D/Statistics/Dashboards/Pages/Digital-Development.aspx and World Bank Indicators https://databank.worldbank.org/.

Table 10: Additional ICT indicators in Namibia only – 2022

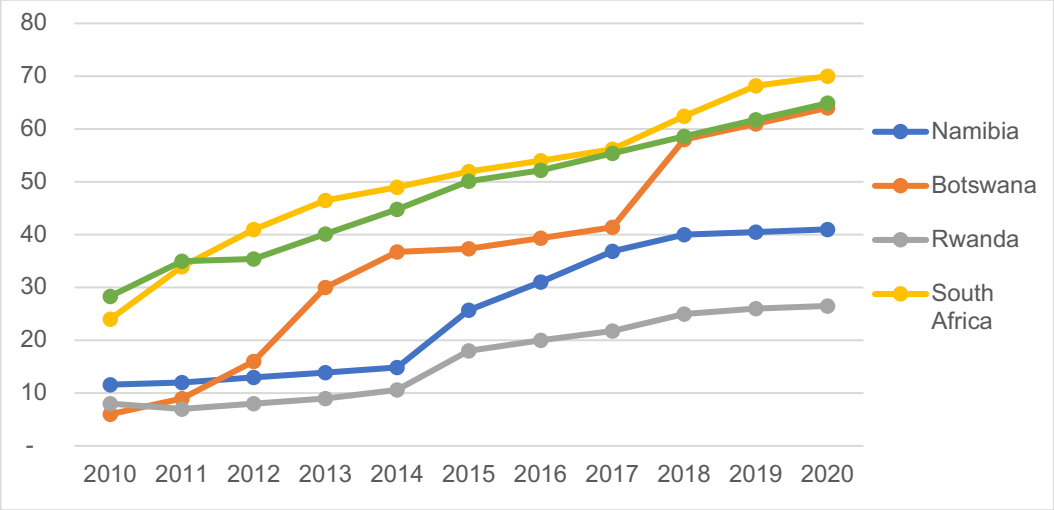
Additional Namibia Indicators	2022	*Comments*
Number of internet users	2,014,511	*Mobile Broadband Subscribers + Fixed Broadband Subscribers*
Number of mobile devices	2,898,001	*Proxy: Number of Mobile subscribers*
Mobile internet coverage	90%	*3G & 4G*
Fixed broadband coverage	92,270	*Fixed broadband subscribers*
Active mobile broadband	1,922,241	*Proxy: Subscribers Mobile Broadband via Mobile*
Cost of data	N$ 14.02/GB	*The cheapest product is Aweh 'O Yeah at N$ 32.00/week or N$ 128/month. Since the request is not clear we are providing the cheapest price for a pre-paid package on a monthly base.*

Source: Communications Regulatory Authority Namibia (CRAN)

Cybercrime has been identified as a high risk in Namibia.[42] The development of cybercrime legislation in Namibia has resulted in an Electronic Transactions Act (No.4 of 2019) that was enacted in November 2019; however, the regulations are still being drafted. The Cybercrime Bill is in the process of being finalised, together with the consolidated National ICT Policy and amendments to the Communications Act. This legislation brings Namibia closer to the regulatory environment for the region, since some peer-countries in SADC have cybercrime legislation in place, such as Botswana, Mauritius, South Africa and Zimbabwe.

Namibia also performs relatively well regarding its percentage of individuals using the internet (41%[43]), which has increased considerably since 2014 (Figure 29). The number of cellular phone subscriptions per 100 people is at the level of countries such as Kenya. Also, 21% of Namibian households have a computer, a figure that is similar to the situation within South Africa.

Figure 29: Individuals using the Internet (% of population)



Source: https://www.itu.int/en/ITU-D/Statistics/Dashboards/Pages/Digital-Development.aspx

The WEF's Networked Readiness Index (NRI) measures the propensity for countries to exploit the opportunities offered by ICTs. In its 2021 Networked Readiness Index (NRI) report, the WEF ranked Namibia 109th out of 134 countries with a score of 35.6 out of 100 (see Table 11 and Figure 30 below). This ranking is down from 103rd in 2020 with a score of 36.1. The NRI is based upon 4 pillars – Technology, People, Governance and Impact. In terms of its relation to the Technology pillar, which is based upon Access, Content and Future Technologies, Namibia was ranked 93rd out of 134 countries with a score of 30 out of 100.

[42] Deloitte (2018) Cyber Security Survey for Namibia: Keeping an eye on what matters, March 2018. Available at: https://bit.ly/3c6MzNK

[43] National data sources show this as 51%

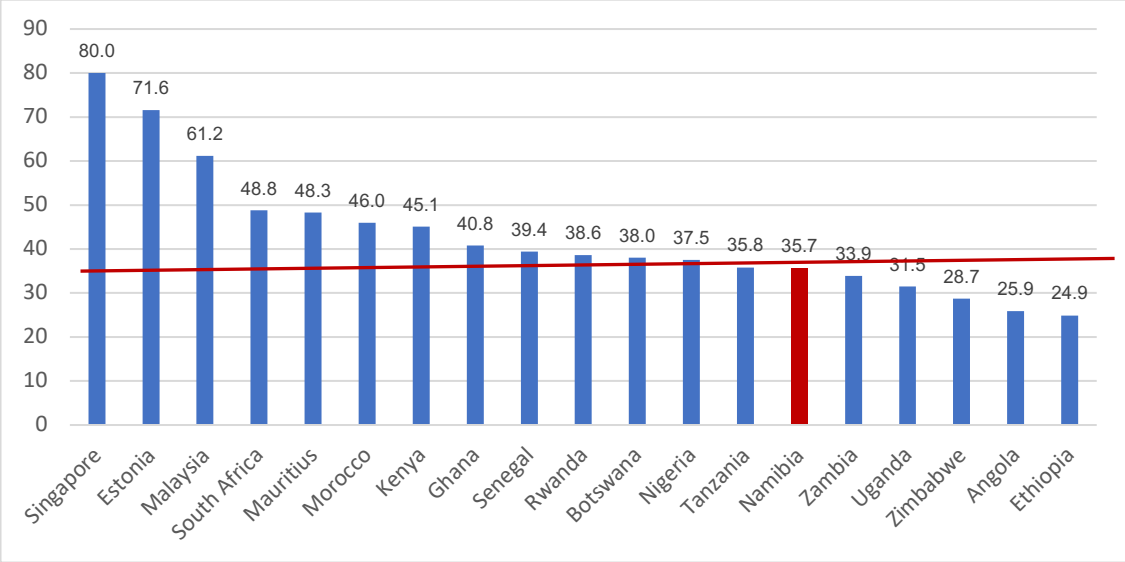
Table 11: Network Readiness Index of Namibia and selected countries, 2021

	NRD Index	2021 Ranking	Technology*	People**	Governance***	Impact****
Namibia	35.6	109	30.9	35.4	39.8	39.4
Angola	25.9	126	19.8	28.4	32.2	23.4
Botswana	38.0	102	36.2	36.2	42.0	37.5
Ethiopia	24.9	127	18.9	19.8	22.6	38.1
Ghana	40.8	96	31.3	36.8	52.4	42.8
Kenya	45.1	84	38.7	43.0	57.2	41.6
Mauritius	48.3	71	40.0	41.7	58.1	53.4
Nigeria	37.5	103	31.9	40.0	39.4	38.7
Rwanda	38.6	101	29.0	34.9	47.5	43.0
Senegal	39.4	99	33.5	32.5	46.9	44.8
South Africa	48.8	70	45.5	46.4	61.2	42.2
Tanzania	35.8	107	29.0	28.0	48.5	37.7
Uganda	31.5	116	22.5	24.8	45.7	32.9
Zambia	33.9	112	25.0	33.9	43.6	33.1
Zimbabwe	28.7	122	25.0	30.3	35.2	24.2
Morocco	46.0	81	43.0	41.5	44.8	54.8
Estonia	71.6	21	62.4	63.6	85.4	74.9
Singapore	80.0	7	75.8	74.7	84.7	84.7
Malaysia	61.2	38	56.0	57.2	68.4	63.3

Source: Portulans Institute (https://portulansinstitute.org/).

Note: [*] Technology: seeks to assess the level of technology that is a sine qua non for a country's participation in the global economy; including measurement of access, content and future technologies. [**] People: measures how people apply ICT at three levels of analysis: individuals, businesses, and governments. [***] Governance: refers to the structures that uphold an integrated network for the safety and security of its users. It includes trust, regulation and inclusion. [****] Impact: assesses the economic, social, and human impact of participation in the network economy across three levels: economy, quality of life and SDG contribution.

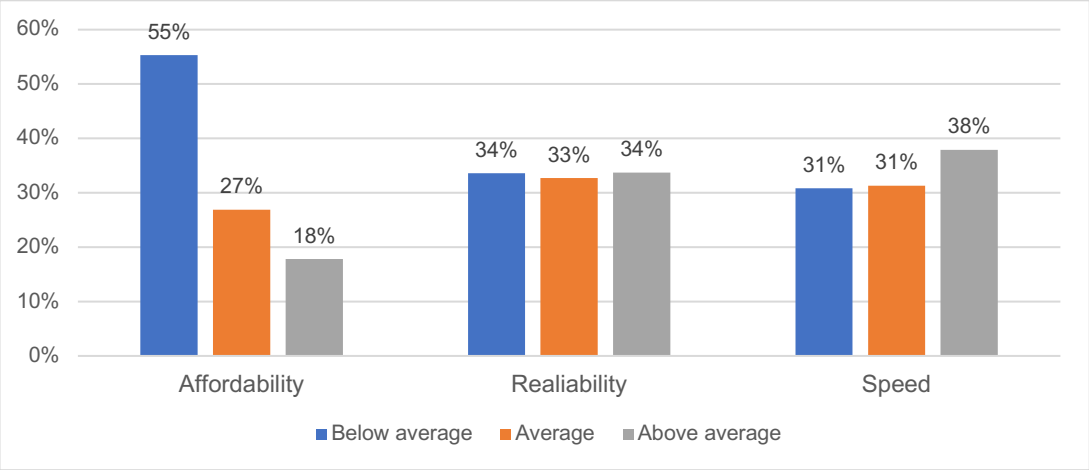
Figure 30: Network Readiness Index



Source: Portulans Institute (https://portulansinstitute.org/).

Through their participation within the 2022 Namibian 4IR online survey, organisations both within and outside industry provided their perceptions about the status of digital infrastructure. Respondents rated internet services largely below the average in terms of affordability but were more positive about its reliability and speed – as indicated in Figure 31 below.

Figure 31: How do you feel about the internet service that is available to you?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 123), Non-industry (n = 85)
Values may not add exactly to 100% due to rounding.

7.4.2 Education and skills

Education is a central ingredient for the 4IR, and one of the three preconditions for 4IR readiness according to our framework. The automation and adoption of advanced digital technologies in all parts of society and the economy is already creating pressures to develop educational offerings in complex fields, including artificial intelligence, advanced robotics, biotechnology, new materials and autonomous vehicles. The debates around the type of knowledge and skills that will be needed in the future are also rich in the existing literature, because they highlight the importance of subjects such as science, technology, engineering, the arts and mathematics (STEAM) and ICT skills, as well as soft skills related to problem-solving, collaborative working, together with critical and creative thinking. Moreover, 4IR technologies are also changing the way education and teaching are imparted.

Educational statistics for Namibia in comparison with other countries (Table 11 above and Table 12 below), as well as the educational trends within Namibia (Table 13 below), indicate the critical importance of investing in education if Namibia seeks to reap the benefits of 4IR. The gaps in the indicators for Namibia in these two tables also expose the importance of capturing internationally comparative data to monitor and benchmark Namibia's educational performance in connection with the 4IR.

Table 12: Educational indicators for Namibia

	Government expenditure on tertiary education as % of GDP (%) (2014-2015)	Gross enrolment ratio for tertiary education (%) 2016-2020 – latest available data)	% of graduates from tertiary education graduating from ICT programmes (%) (2015-2019 – latest available data)
Namibia	1.6	27.8	2.9
Angola	-	9.3	4.7
Botswana	-	25.1	-
Estonia	1.4	70.4	6.7
Ethiopia	2.1	8.1*	-
Ghana	0.8	17.2	3.9
Kenya	0.7	11.5	5.3
Mauritius	0.3	40.6	10.4
Morocco	-	38.5	3.9
Rwanda	0.8	6.2	5.4
Senegal	1.6	13.1	-
Singapore	0.9	88.9	8.6
South Africa	1.1	23.8	3.0
Tanzania	0.7	3.1	3.8
Uganda	0.3	4.8*	-
Zambia	0.5	4.1*	-
Zimbabwe	1.0	10.0*	8.4
Malaysia	0.9	43.1	6.9

*Note: * data older than 2016*

Source: https://databank.worldbank.org/ and NCHE http://www.nche.org.na

Table 13: Educational indicators trends for Namibia

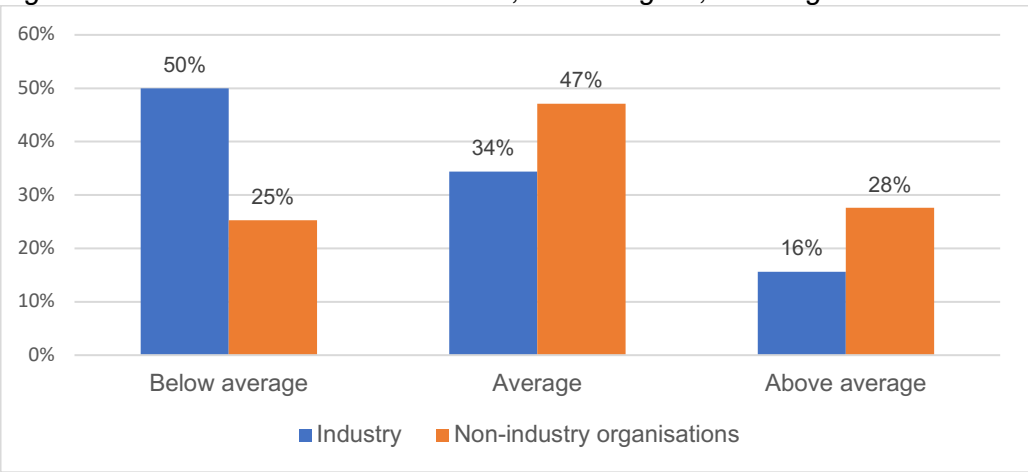
Indicators	2016	2017	2018	2019	2020	Trend
Gross Enrolement Ratio	22.6	22.6	24.6	27.6	27.8	
Enrolment by Offering Type - Distance	27.7	26.6	27.6	26.4	26.3	
Graduates by NQF Field of Learning						
Physical, Mathematics & Computer Science	8.4	7.3	7.0	7.4	5.3	
Manufacturing, Engineering & Technology	2.7	2.8	3.1	2.8	2.0	
Graduates by NQF Qualification Type						
Certificates/Diplomas	24.8	27.5	27.6	30.4	30.5	
Bachelor	16.5	15.8	15.4	16.0	15.6	
Professional Bachelor	27.4	34.8	32.0	32.7	31.2	
Bachelor Honours	14.5	6.3	6.8	5.5	6.1	
Postgraduate Cert/Dipl	1.0	3.3	4.4	2.1	3.4	
Master	1.3	2.6	4.4	3.7	3.0	
Doctoral	0.0	0.2	0.1	0.2	0.6	

Source: http://www.nche.org.na/publications/documents#namibia-higher-education-statistical-yearbook

7.4.2.1 General access to education and skills

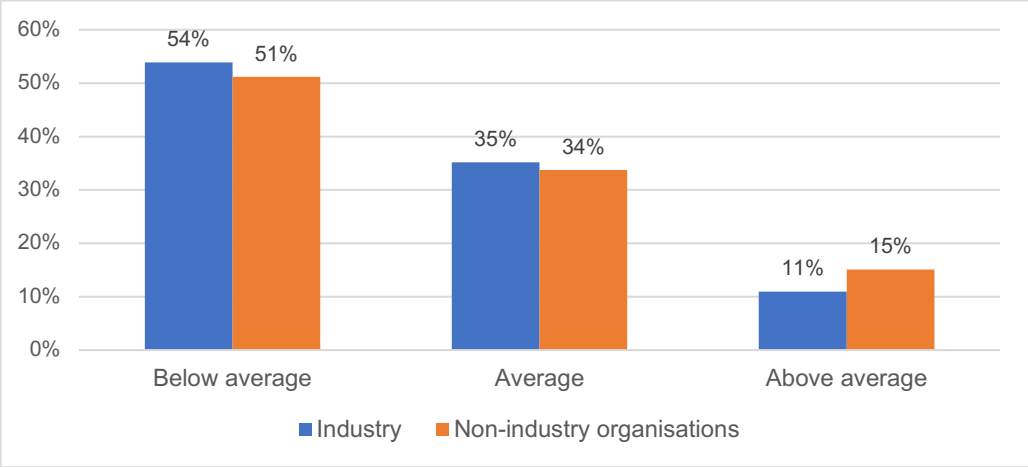
Respondents to the survey generally felt that the availability of scientists, technologists and engineers in Namibia is below average, as well as the availability of high-quality, professional training services in Namibia – see Figures 32 and 33 below. This deficiency is particularly visible in the responses from industry.

Figure 32: To what extent are scientists, technologists, and engineers available in Namibia?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 123), Non-industry (n = 85) Values may not add exactly to 100% due to rounding.

Figure 33: How available are high-quality, professional training services in Namibia?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 128), Non-industry industry (n = 86). Values may not add exactly to 100% due to rounding.

More than 40% of the respondents from organisations in both within and outside industry reported having generally adequate levels of skills for their workforce's needs across the board – from soft skills to technical skills and problem-solving/creative skills (Table 14 below). However, a considerable percentage of respondents within industry indicated that their workforce has "inadequate" levels of skills. The alignment of curricula to current and future skills requirements, requires urgent attention. There appears to be some mismatch between what is required within the various industries and the skills taught or acquired through the education system.

Table 14: Does your workforce have an adequate level of skills for the organisation's needs?

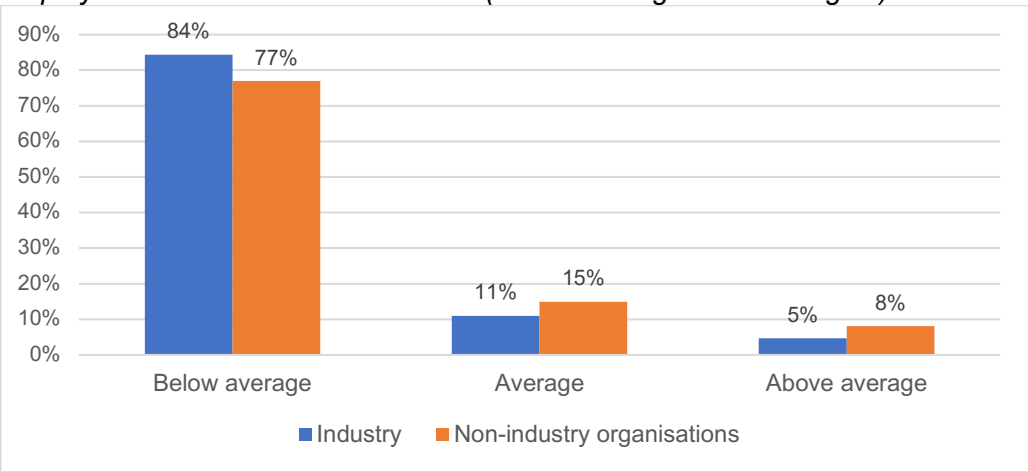
	Inadequate		Adequate		More than adequate		Don't know	
	Industry	Non-industry	Industry	Non-industry	Industry	Non-industry	Industry	Non-industry
Soft skills (communication, networking, team work, leadership)	21%	7%	45%	45%	31%	47%	3%	1%
Marketing skills	25%	15%	51%	44%	21%	37%	3%	4%
Financial knowledge and budgetary skills	24%	9%	48%	48%	24%	39%	3%	4%
Business planning skills	16%	7%	55%	48%	26%	45%	2%	0%
Technical, practical or job-specific skills	19%	8%	42%	38%	37%	52%	2%	2%
Problem-solving / creative skills (i.e., coming up with creative ideas and solutions)	16%	6%	46%	46%	33%	48%	5%	0%

Note: "Adequate" levels are highlighted.

The 4IR poses new challenges to prepare students for the future of work. As jobs are transformed by the technologies of the 4IR, most employees will need to develop new skills or be reskilled. Especially in a context of unemployment and inequality, the reskilling and upskilling of employees is essential to ensure that the 4IR does not result in a wider gap between the "haves" and the "have-nots".

The broad majority of respondents to the 2022 4IR Readiness survey believe that unemployed people in Namibia are insufficiently supported in terms of reskilling and finding new employment in connection with the 4IR (Figure 34 below). Fulfilling the demand for 4IR future skills and the need for upskilling and reskilling will require a shift from "once-off" education towards lifelong learning.

Figure 34: To what extent are unemployed people supported in reskilling and finding new employment in connection to the 4IR (advanced digital technologies)?

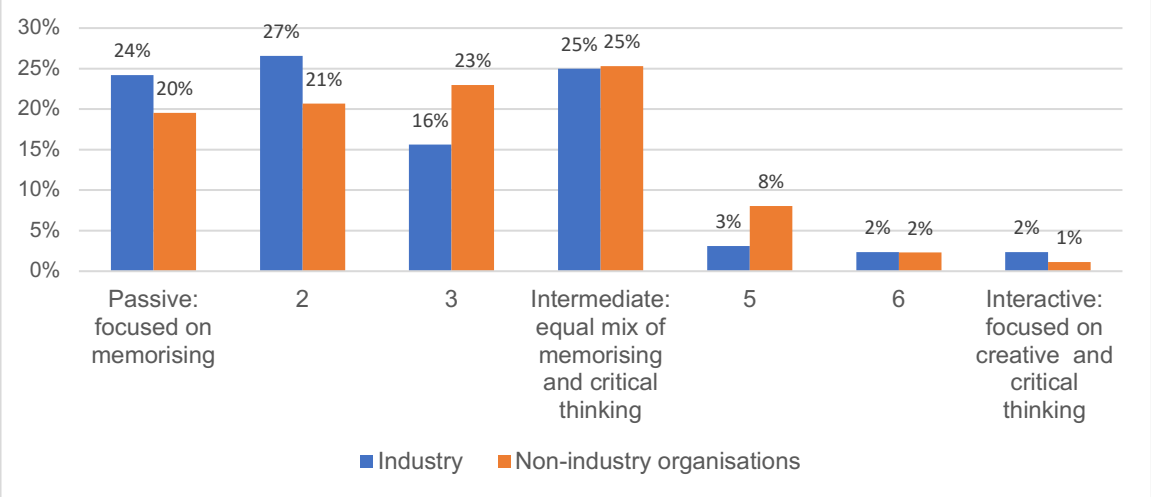


Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 128), Non-industry (n = 87). Values may not add exactly to 100% due to rounding.

7.4.2.2 Quality of teaching

The 4IR requires a new approach to education and teaching that prepares the younger generations for the future of work. In this regard, most respondents from industry perceive the style of teaching in Namibia as not conducive to the 4IR, since it is predominantly based upon memorising and not sufficiently focused on creative and critical thinking (Figure 35 below).

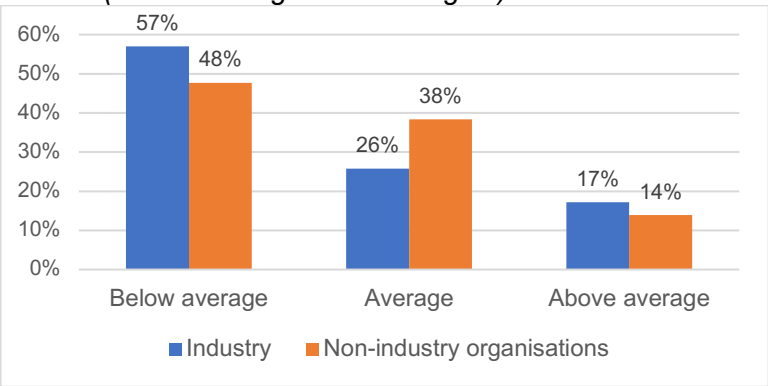
Figure 35: How do you assess the style of teaching in Namibia in connection to the 4IR (advanced digital technologies)?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 127), Non-industry (n = 87). Values may not add exactly to 100% due to rounding.

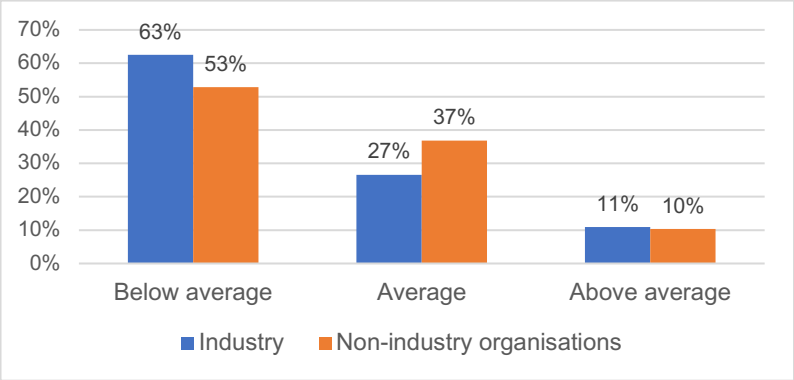
Similarly, the quality of science, maths and digital skills education practices are perceived to be “below average” in connection to the 4IR – see Figures 36, 37 and 38 below.

Figure 36: How do you assess the quality of science education in Namibia in connection to the 4IR (advanced digital technologies)?



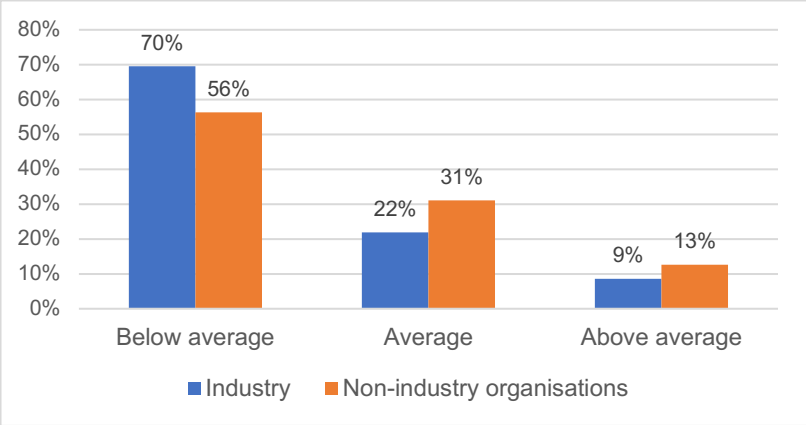
Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 128), Non-industry (n = 86). Values may not add exactly to 100% due to rounding

Figure 37: How do you assess the quality of maths education in Namibia in connection to the 4IR (advanced digital technologies)?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 128), Non-industry (n = 87). Values may not add exactly to 100% due to rounding.

Figure 38: How do you assess the quality of digital skills education in Namibia in connection to the 4IR (advanced digital technologies)?



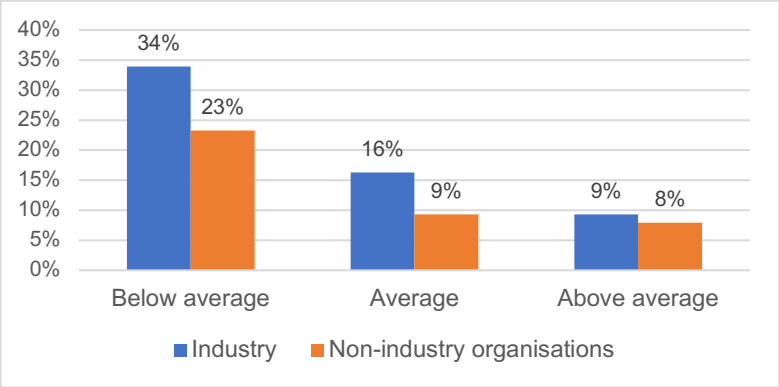
Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 128), Non-industry (n = 87). Values may not add exactly to 100% due to rounding

7.4.2.3 Vocational training

The vocational education system also has to respond to the needs and expectations of the changes brought about by the 4IR and its impact upon the world of work. Successful responses of the vocational system to the demands of the 4IR ought to focus on curriculum development and training of both skilled and highly skilled workers.

The survey results indicate that most respondents do not consider the quality of vocational training to be geared towards the 4IR in Namibia (Figure 39 below).

Figure 39: How do you assess the quality of vocational training in Namibia in connection to the 4IR (advanced digital technologies)?

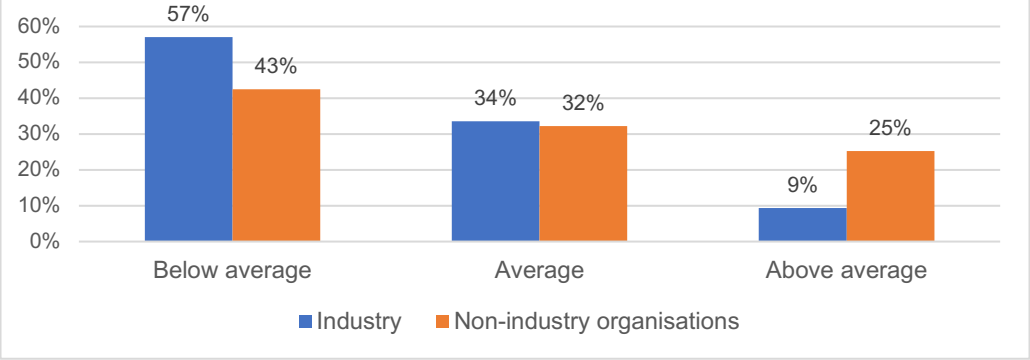


Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 128), Non-industry (n = 87)
Values may not add exactly to 100% due to rounding.

7.4.2.4 Digital skills

Digital skills are central for the adoption of advanced digital technologies. Unfortunately, there seems to be a lack of internationally comparable data on the levels of digital skills amongst the active population of Namibia. However, most respondents to the Namibian 2022 survey perceived digital skills to be generally insufficient in Namibia – see Figure 40 below.

Figure 40: To what extent does the active population possess sufficient digital skills (e.g. computer skills, basic coding, digital reading) in Namibia?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 128), Non-industry (n = 87)
Values may not add exactly to 100% due to rounding.

When the different types of digital skills and the levels of digital skills needed by the workforce within Namibia were considered, respondents generally felt that "basic digital skills" are adequate, while more complex/specialised digital skills (such as coding, software development and advanced cybersecurity) are lacking – see Table 15 below.

Table 15: Does your workforce have an adequate level of the digital skills listed below for your organisation's needs?

	Inadequate		**Adequate**		**More than adequate**		**Don't know**	
	Industry	Non-industry	Industry	Non-industry	Industry	Non-industry	Industry	Non-industry
Instrumental skills for the use of digital technologies [1]	16%	6%	58%	47%	25%	45%	1%	2%
Managing information skills [2]	19%	12%	61%	43%	20%	42%	0%	3%
Digital collaboration and communication skills [3]	15%	8%	55%	38%	28%	52%	2%	2%
Creation of digital content [4]	25%	15%	47%	43%	24%	40%	5%	2%
Basic coding skills [5]	51%	34%	26%	33%	13%	30%	10%	3%
Advanced software development [6]	58%	39%	18%	25%	14%	30%	10%	6%
Hardware and networking [7]	40%	11%	34%	41%	21%	47%	5%	1%
Advanced cybersecurity [8]	54%	24%	23%	34%	13%	37%	11%	5%
Maker technologies [9]	57%	34%	15%	14%	9%	21%	20%	31%

Note: Respondents to the 2022 Namibian 4IR Readiness Survey.

[1] The ability to use basic technologies, electronic devices and software. [2] The ability to find, manage and store digital information and content securely. [3] The ability to communicate, collaborate and share online via different platforms. [4] The ability to create and edit documents, images and other digital contents. [5] E.g., mobile app development, basic programming and other algorithmic knowledge. [6] E.g., full-stack web application development, senior software architecture. [7] E.g., computer maintenance, basic network security, encryption. [8] E.g., ethical hacking, digital forensics, cloud security. [9] E.g., Raspberry pi, Arduino, embedded systems.

Improving digital literacy, especially the development of more specialised skills such as advanced coding, advanced cybersecurity and programming, are essential and have implications for the education and training system within the country. Schools and universities in Namibia will need to increase their efforts to raise the levels of digital skills and integrate digital education within the curriculum from basic to higher education.

7.4.3 Innovation system

As the third element in the preconditions layer of 4IR readiness, the concept of an "innovation system" helps describe the actors and institutions that support and facilitate scientific research,

technological change and the emergence of innovations.[44] A functional innovation system will effectively support the generation, application and dissemination of knowledge, by facilitating the processes of learning. Successful technological learning and innovation within the system emanate from the relationships of collaboration, communication, and interaction among the different actors and institutions within the system.[45]

Table 16: General indicators for Namibia's innovation system

	Entrepreneurship		**Partnerships**	**Knowledge Generation**	
	Time required to start a business	Ease of doing business	Public-private partnerships investment in energy (current US$, thousands)	Patent Applications, residents	Gross Domestic Expenditure on Research and Development (GERD)
Namibia	54	41.00	70,000	8	0.40
Angola	36	36.0	112,000	85	0.03 (2016)
Botswana	48	41	104	2	0.54
Ethiopia	32	24.0	271,000	6	0.62
Ghana	13	58.0	1,533,000	12	0.38
Kenya	23	29.5	98,410	341	0.80
Mauritius	4.5	64.8	69,500	6	0.42
Nigeria	7.2	35.5	40,000	410	0.20
Rwanda	4	26.5	362,000	6	0.75
Senegal	6	42.6	53,900	..	0.57 (2015)
South Africa	40	70.0	826,300	542	0.75 (2019)
Tanzania	29.5	22.0	1,200	1	0.51
Uganda	24	19.9	87,000	13	0.14 (2014)
Zambia	8.5	19.8	336,000	16	n/a
Zimbabwe	27	29.3	65,700	8	n/a
Morocco	9	84.1	1,038,770	250	n/a
Estonia	3.5	89.0	..	21	1.80
Singapore	1.5	92.0	..	1,778	1.89
Malaysia	17.5	89.5	1,331	989	1.00

African Innovation Outlook. https://au.int/sites/default/files/documents/38122-doc-aio_3rd_edition_final_eng_repro.pdf and World Bank Data

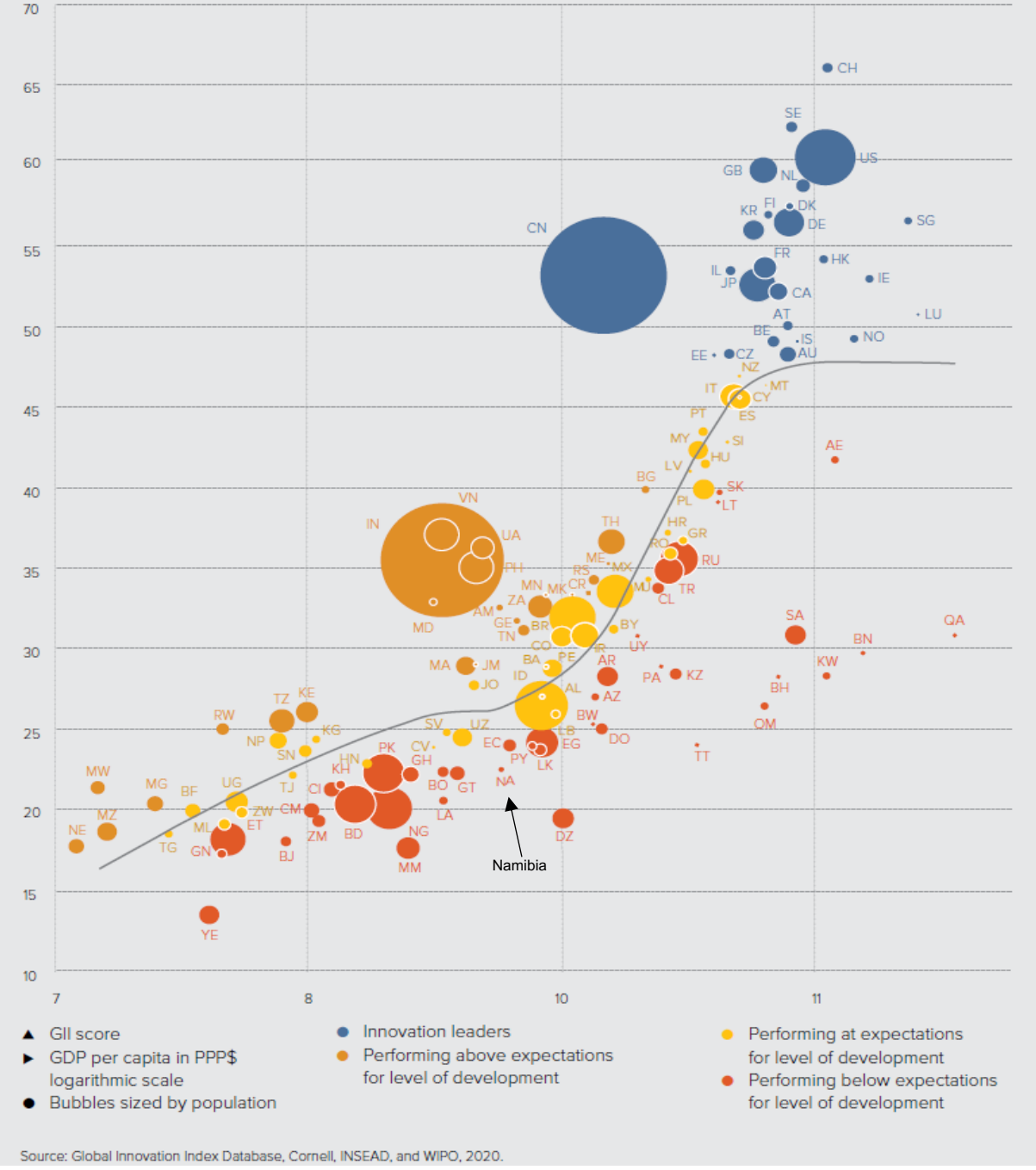
Figure 41 below presents the Global Innovation Index (GII) scores plotted against GDP per capita in natural logs and PPP US$. The trend line gives a signal of the expected innovation performance according to its income level (GDP per capita). Economies performing above the trend line are working better than expected and those below are performing below

[44] *Lundvall, B.Å., Joseph, K.J., Chaminade, C. & Vang, J. (Eds.). (2011). Handbook of innovation systems and developing countries: building domestic capabilities in a global setting. Cheltenham, UK: Edward Elgar Publishing.*

[45] *Kraemer-Mbula, E. & Wamae, W. (Eds.) (2010). Innovation and the Development Agenda, Paris/Ottawa: OECD (Organisation for Economic Co-operation and Development)/IDRC (International Development Research Centre).*

expectation.[46] Relative to its income level, Namibia's overall innovation performance is below what would be expected.

Figure 41: Global Innovation Index (GII) scores and GDP per capita in PPP US$ (bubbles sized by population)

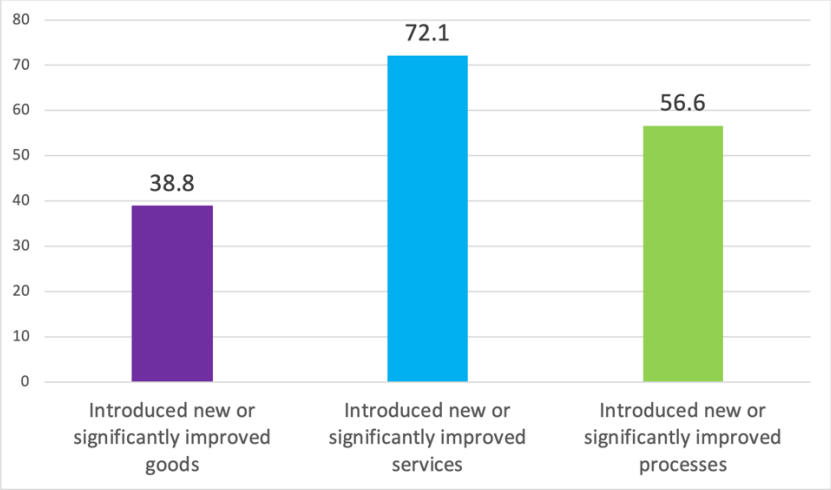


[46] https://news.gtp.gr/2021/10/14/greece-performing-below-expectations-on-innovation/

7.4.3.1 Entrepreneurship and innovation

Central to an innovation system is the support of entrepreneurship, since firms in the private sector are key to the commercial application of knowledge and technological advances. According to the results of the Namibian 2022 4IR survey (Figure 42 below), innovation is prevalent in Namibia − over 70% of the respondents had introduced new or significantly improved services over the past 3 years, 56% had introduced new or significantly improved processes, and 38% new or significantly improved goods.

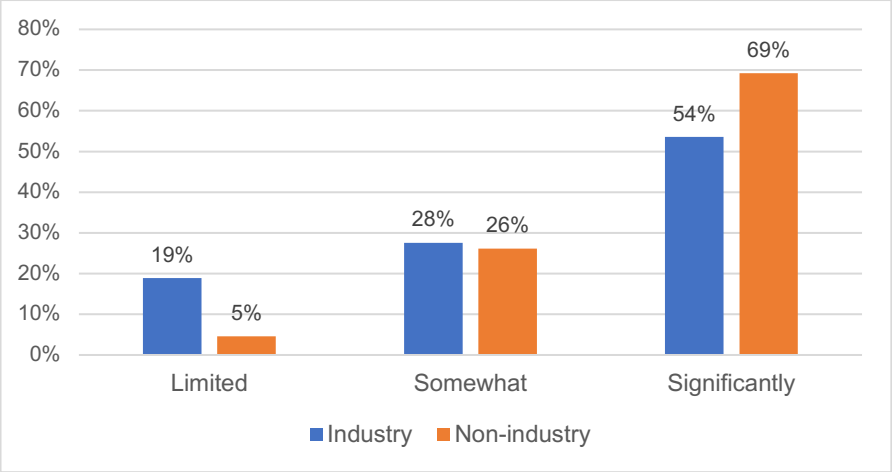
Figure 42: Innovation in Namibia



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Pooled sample.

Moreover, most of those innovations have been facilitated by digital technologies (Figure 43 below), which already serves as an indication of their importance in the productivity and competitiveness of Namibia's industry in current times.

Figure 43: To what extent are innovations in your organisation facilitated by digital technologies?

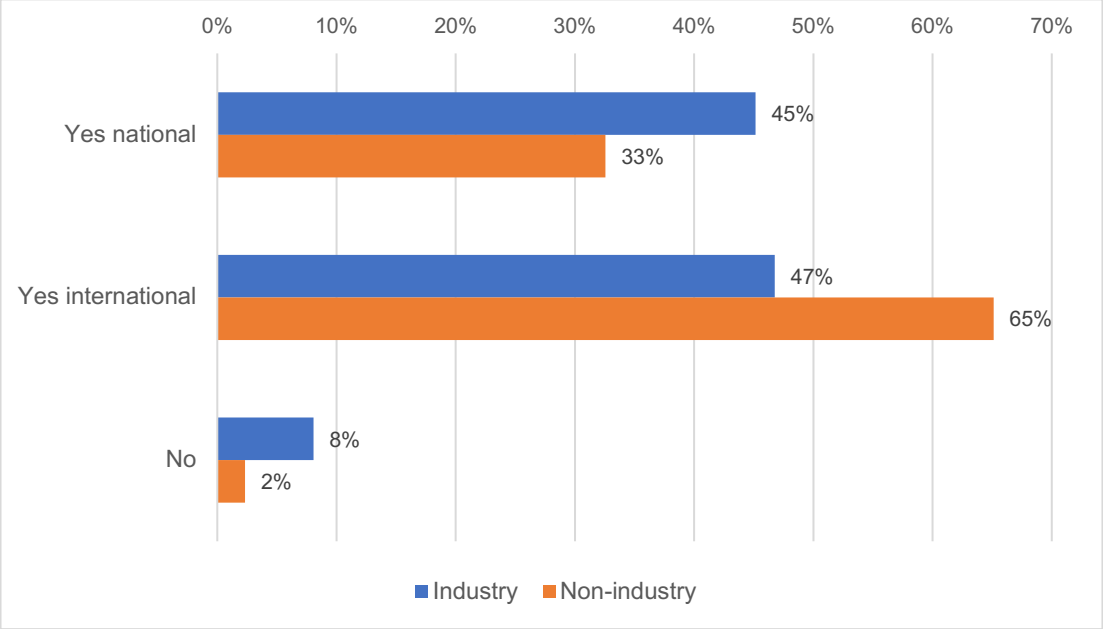


Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 127), Non-industry stakeholders (n = 65). Values may not add exactly to 100% due to rounding.

7.4.4 Partnerships and collaborations

Respondents to the survey indicated high levels of collaboration with other organisations (Figure 44 below), which is a sign that knowledge flows across the innovation system. Most of these collaborations happen with organisations outside Namibia. While international partnerships and alliances are positive and show that the country is part of global value chains, domestic interactions and collaborations should also be nurtured. The "thickness" of the domestic networking "fabric" provides coherence and direction to the national innovation system.

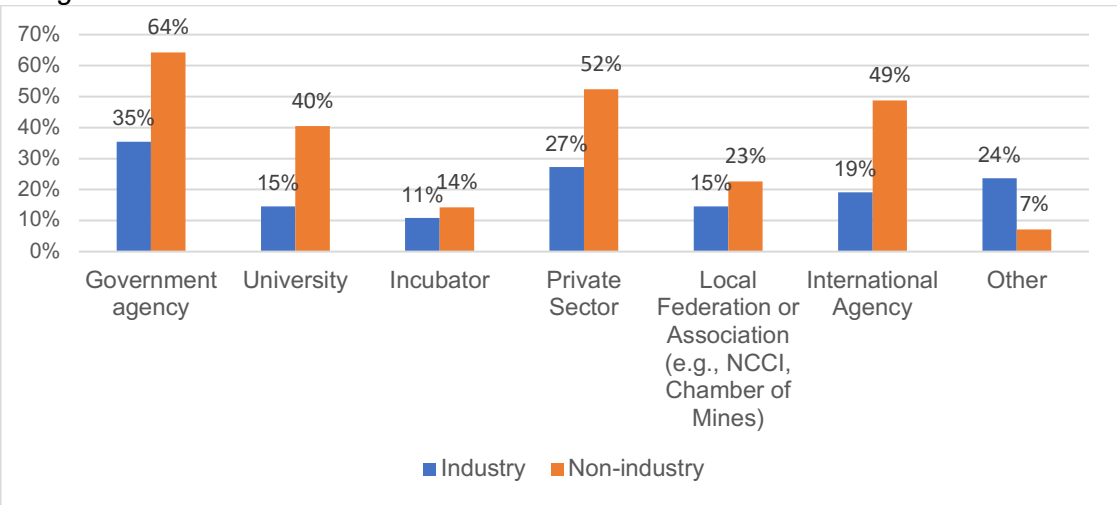
Figure 44: Do you cooperate with other organisations in the same sector/trade as yours?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 124), Non-industry stakeholders (n = 86). Values may not add exactly to 100% due to rounding.

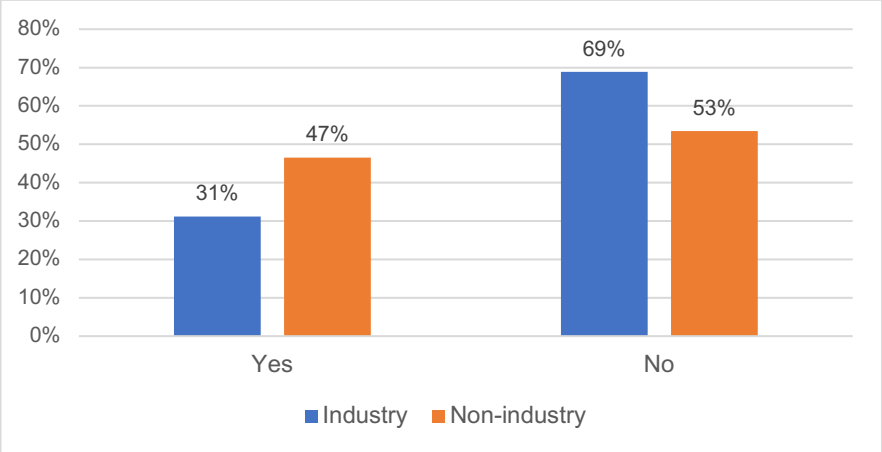
Of industry respondents, 35% reported to have received support from a government agency in Namibia, and limited support from other organisations such as universities, incubators, etc. However, non-industry stakeholders seem to have received more support from the government than the private sector across the board (64% of respondents) – see Figure 45 below. This imbalance is also visible in the non-industry respondents' perception that they do not receive adequate support from recognised institutions (such as government agencies) to develop tech-driven solutions – see Figure 46 below.

Figure 45: Have you received in the past, any type of support for your business from a recognised institution in Namibia?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 110), Non-industry stakeholders (n = 84). Values may not add exactly to 100% due to rounding.

Figure 46: Does your organisation have adequate support to develop tech-driven solutions?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Industry (n = 122), Non-industry (n = 86). Values may not add exactly to 100% due to rounding.

7.4.5 Governance

Respondents to the 2022 Namibian 4IR survey gave their perceptions about the governance of Namibia's innovation system. It is generally perceived that the government should be the main responsible stakeholder to develop the 4IR in Namibia (Table 17 below). However, the policy environment for investing in new technologies, R&D, cybersecurity and adoption of advanced digital technologies, is considered to be below the level that is required – see Figures 47 and 48 below.

The legal framework is also perceived to be insufficiently agile to respond to change and to new models of digital work – Figure 49.

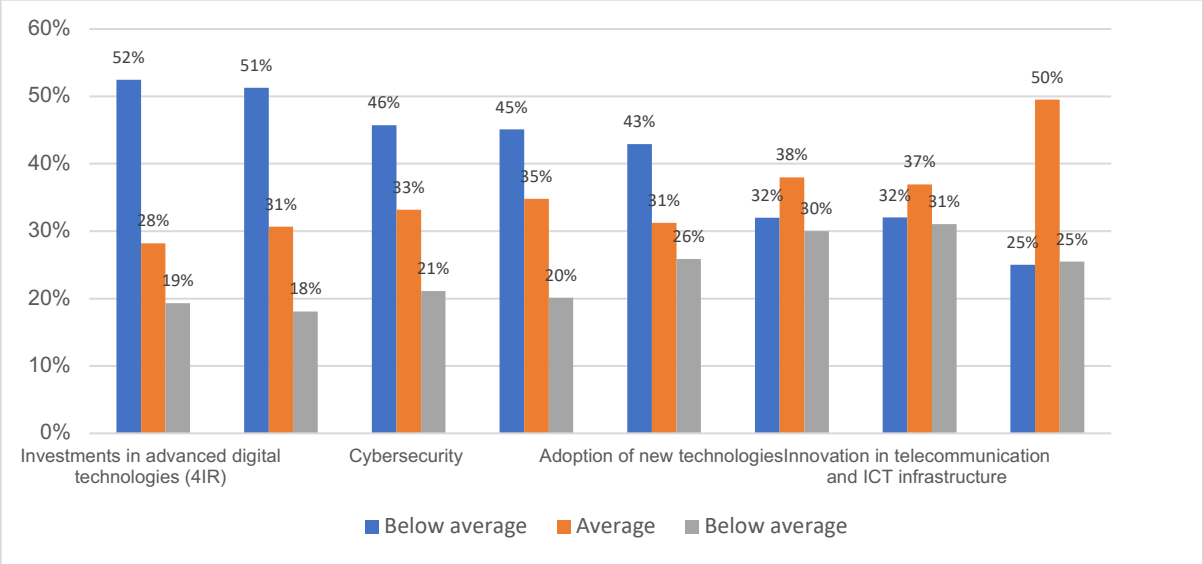
Table 17: Whose responsibility is it to develop the 4IR in Namibia?

Item	Overall Rank	Rank Distribution	Score	No. of Rankings
Government	1		385	161
Public education system	2		329	152
Private sector	3		149	84
TVET sector	4		94	55
Individual citizens	5		90	50
Private education system	6		88	53
International development partners	7		59	38
NGOs	8		19	13

Lowest Rank — Highest Rank

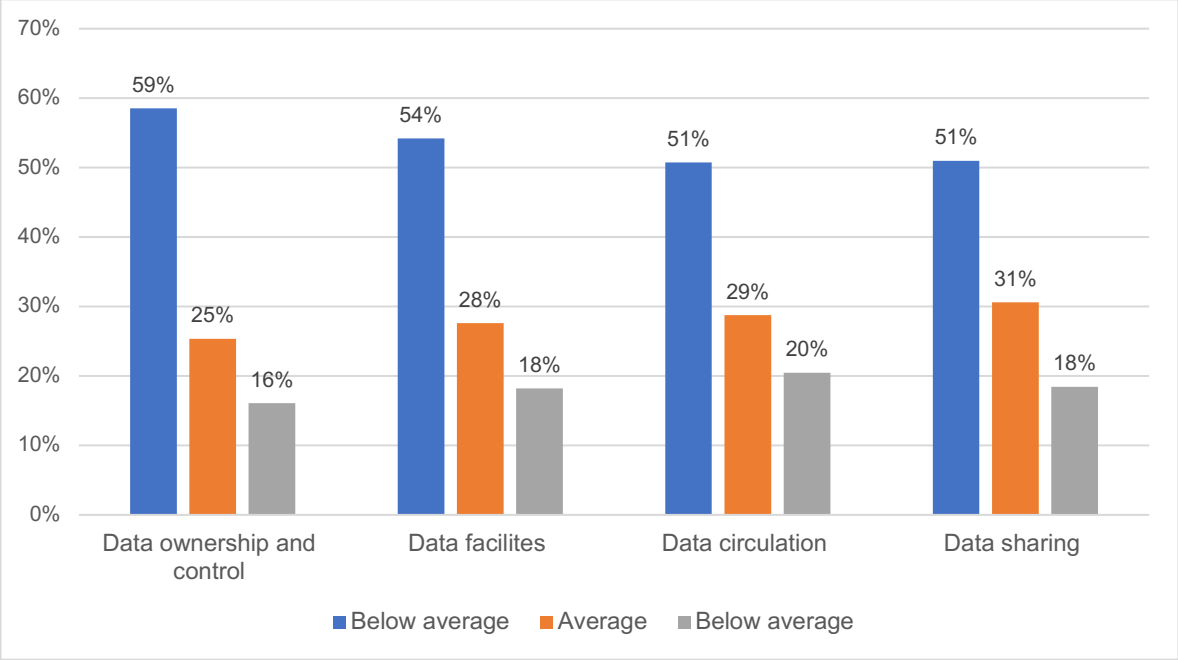
Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Pooled sample

Figure 47: In Namibia, is there a conducive and stable policy environment for the following?



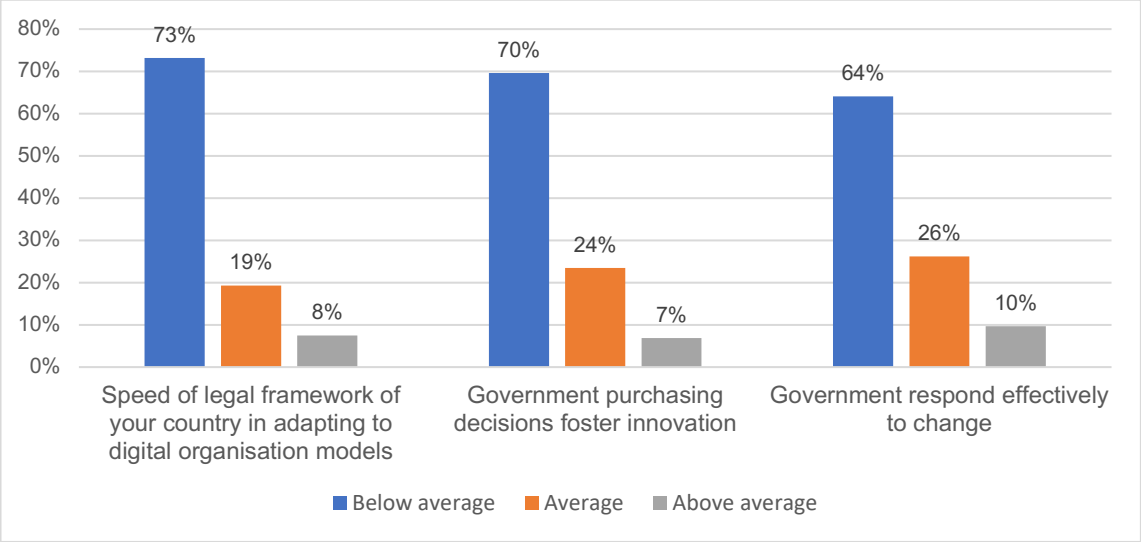
Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Pooled sample (n = 208)
Values may not add exactly to 100% due to rounding.

Figure 48: In Namibia, is there a conducive and stable policy environment for the following?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Pooled sample (n = 206)
Values may not add exactly to 100% due to rounding.

Figure 49: In your view, to what extent does the government do the following?



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Pooled sample (n = 206)
Values may not add exactly to 100% due to rounding,

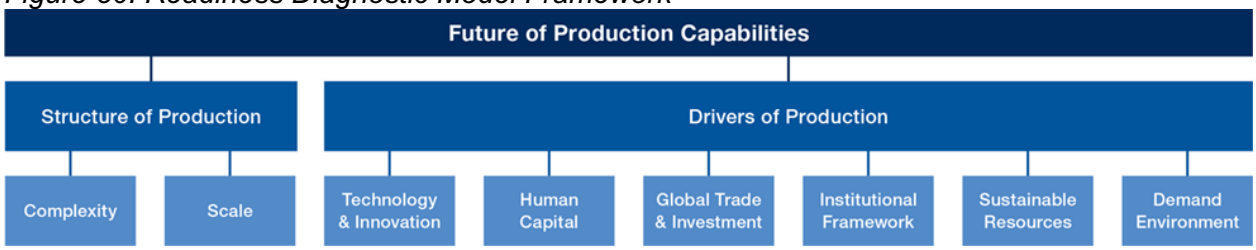
7.5 The Future of Production Capabilities

This section develops a diagnostic impression of the readiness of Namibia's industry for the 4IR, using the WEF methodology on the Future of Production, the middle layer of 4IR Readiness Diagnostic model (see Figure 50 below).

7.5.1 Readiness diagnostic model

The Readiness Diagnostic Model Framework is a tool used to build awareness of the key factors and conditions that have a significant impact on the transformation of production systems.[47] In simpler terms, it helps decision-makers assess the readiness of their country for the changing nature of production, and it focuses on the capabilities of industry. Therefore, this framework was adopted to assess the readiness of Namibia for the future of production, in the context of 4IR. Its top layer, discussed in Section 3 above, focuses on the preconditions that must exist before 4IR can be fully realised. The middle layer focuses on the Future of Production Capabilities.

Figure 50: Readiness Diagnostic Model Framework



Source: World Economic Forum (2018)

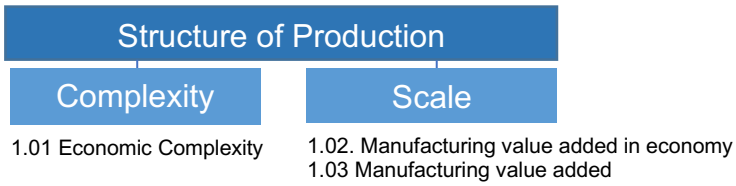
The assessment, as mentioned previously, is made up of two main dimensions, namely the Structure of Production (the country's baseline of production) and the Drivers of Production (key enablers that position a country to transform production systems). These dimensions are discussed below.

7.5.2. Structure of Production

The Structure of Production reflects the complexity and scale of a country's current production base[44] (see Figure 51 below). It is argued that countries with a large and complex structure of production are more prepared for the future as they have a production base to build upon.

[47] *World Economic Forum (WEF) (2018). Readiness For the Future of Production Report 2018 (https://www.weforum.org/reports/readiness-for-the-future-of-production-report-2018)*

Figure 51: Structure of production: Concepts measured



Source: World Economic Forum (2018)

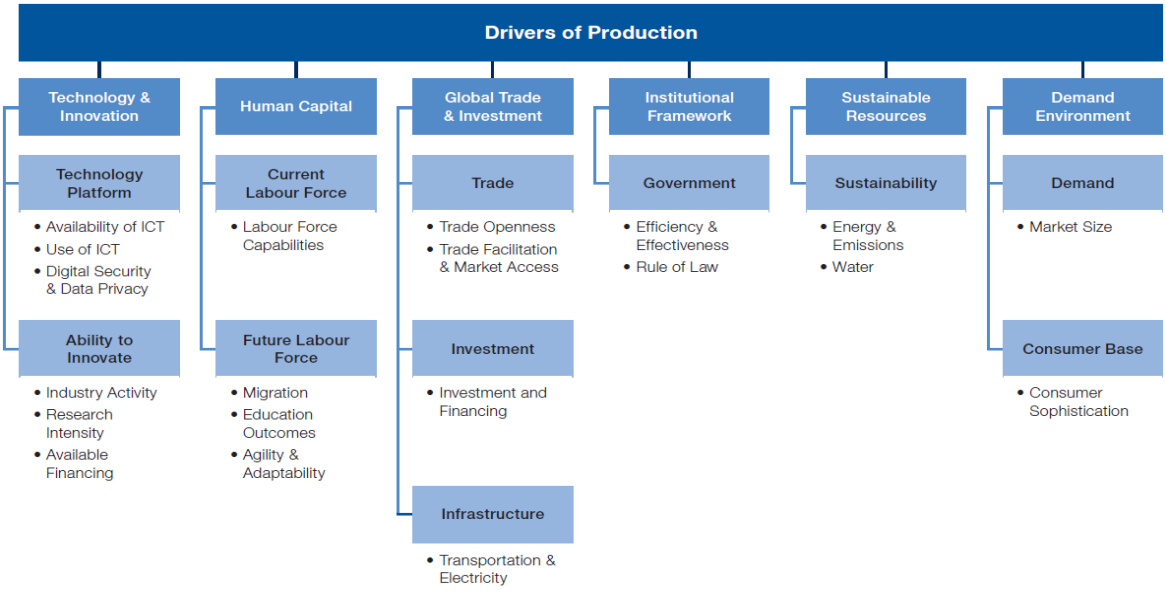
- ***Complexity*** assesses the economic complexity, the mix and uniqueness of products a country can make as a result of the amount of useful knowledge embedded in the economy and the ways in which this knowledge is combined[44].
- ***Scale*** assesses both the total volume of manufacturing output within a country (Manufacturing Value Added) as well as the significance of manufacturing to the economy (Manufacturing Value Added, % of GDP)[44].

In the assessment for Namibia, the Structure of Production was measured using these same concepts. The details of measurement, results and findings are presented in the relevant sections of this report.

7.5.3 Drivers of Production

As previously mentioned, the Drivers of Production are key enablers that position a country to capitalise on emerging technologies and opportunities in the future of production[44]. Six main drivers were identified as shown in Figure 52 below: Technology & Innovation, Human Capital, Global Trade & Investment, Institutional Framework, Sustainable Resources and Demand Environment.

Figure 52: Drivers of production: Concepts measured



Source: World Economic Forum (2018)

The WEF (2018) defines these drivers as follows:

- Technology and Innovation: Assesses the extent to which a country has an advanced, secure and connected ICT infrastructure to support the adoption of new technologies in production. Also measures a country's ability to foster innovation and commercialise innovations that have potential application in production.
- Human Capital: Assesses a country's ability to respond to shifts in the production labour market triggered by the 4IR by looking at both current labour force capabilities as well as the country's long-term ability to cultivate the right skills and talent in the future workforce.
- Global Trade and Investment: Assesses a country's participation in international trade to facilitate the exchange of products, knowledge and technology, and to establish global linkages. Also measures the availability of financial resources to invest in production-related development as well as the quality of infrastructure to enable production-related activities.
- Institutional Framework: Assesses how effective government institutions, rules and regulations contribute towards shepherding technological development, innovative businesses and advanced manufacturing.
- Sustainable Resources: Assesses the impact of production on the environment, including a country's use of natural resources and alternative energy sources.
- Demand Environment: Assesses a country's access to foreign and local demand to scale production. Also measures the sophistication of the consumer base because this aspect can drive diverse industry activity and new products.

The drivers were each measured using the indicators shown in Figure 52 above. The details of measurement, results and findings are presented in the relevant sections of this report.

7.5.4 Methodology: measuring readiness for the future of production

The assessment measured readiness for the future of production within Namibia. In this section, the methodology is presented. Qualitative and quantitative methods were utilised to collect data across the two dimensions of the Future of Production framework. The data was treated in a similar manner as the methodology used by the WEF.

Quantitative Data

The assessment consists of 59 indicators across the Structure of Production and Drivers of Production components. The values for the indicators are tabulated in Appendices G and H, which also delineate the definition of the indicators, units of measure, the sources where indicators were obtained, as well as indicator values for other countries for the purposes of comparison.

In collecting indicator data, the authors faced challenges that included missing data for Namibia. Similar to WEF, scores for missing data were imputed using an income-regional group approach. This process means that average scores from the countries in both the same

region and income as Namibia were used to compute the missing score. Regional and Income classifications for the study's selected sample are shown in Table 18 below.

Table 18: Regional and Income Classifications

Country	Region	Income classification
Namibia	Sub-Saharan Africa	Upper-Middle Income
Botswana	Sub-Saharan Africa	Upper-Middle Income
Estonia	Europe	High Income
Ethiopia	Sub-Saharan Africa	Low Income
Ghana	Sub-Saharan Africa	Lower-Middle Income
Kenya	Sub-Saharan Africa	Lower-Middle Income
Malaysia	East Asia and the Pacific	Upper Middle Income
Mauritius	Sub-Saharan Africa	Upper-Middle Income
Morocco	Middle East and North Africa	Lower-Middle Income
Nigeria	Sub-Saharan Africa	Lower-Middle Income
Senegal	Sub-Saharan Africa	Low Income
Singapore	East Asia and the Pacific	High Income
South Africa	Sub-Saharan Africa	Upper-Middle Income
Tanzania	Sub-Saharan Africa	Low Income
Tunisia	Middle East and North Africa	Lower-Middle Income
Uganda	Sub-Saharan Africa	Low Income
Zambia	Sub-Saharan Africa	Lower-Middle Income

Source: World Bank, World Economic Forum (2018)

It can be seen from Table 18 above that Botswana, Mauritius and South Africa fall within the same region and income classification as Namibia. For this reason, an arithmetic average score of these countries per missing indicator was used. Furthermore, it should be noted that Angola, Rwanda and Zimbabwe are not listed because they were not assessed by the WEF.

Qualitative Data Collection

There are various indicators, such as availability of scientists and engineers and the extent of market dominance, that require opinions (qualitative data) from executives of firms. WEF collected these views through an executive opinion survey. Similarly, this study collected executive opinions through a survey. The study captured the views of 116 companies. Similar to WEF, a score for each executive survey question was calculated as the average of all answers. In other words, for a given question, all individual answers carry the same weight.[44]

Scale and normalisation

In Multi-Criteria Decision Making (MCDM), normalisation is used to define criteria values in the same dimensionless units.[48] Each driver in this study consists of categories and subcategories with different units of measurement. To transform these entities into the same

[48] *https://www.sciencedirect.com/science/article/pii/S1877050922001570*

unit for the purpose of producing comparable data, scale and normalisation are applied.[46] These normalised scores can then be combined to produce aggregated scores.

Similar to WEF, the scores were normalised on a scale of 0-10, with 10 representing the ideal, using a min-max approach.

Weighting

Once the individual indicators were normalised, it was possible to aggregate the scores on a category and driver level. However, the dimension level (Driver of Production and the Structure of Production) was calculated according to the following weighting scheme, proposed by WEF, as shown in Table 19 below.

Table 19: Readiness Assessment Weighting Scheme

Structure of Production	**Weight**
Complexity	60%
Scale	40%
Drivers of Production	**Weight**
Technology & Innovation	20%
Human Capital	20%
Global Trade & Investment	20%
Institutional Framework	20%
Demand Environment	15%
Sustainable Resources	5%

Source WEF (2018)

In their 2018 report, WEF explained that Economic Complexity is the key measure of readiness (hence its high weighting) because countries with a high economic complexity have the ability to make complex and unique products, which is important for future competitiveness in production.[44] Other drivers are given different weights based upon their significance in relation to Economic Complexity,[44] for instance, Sustainable Resources is given the lowest weight due to its low correlation with Economic Complexity.[44]

7.5.5 Results

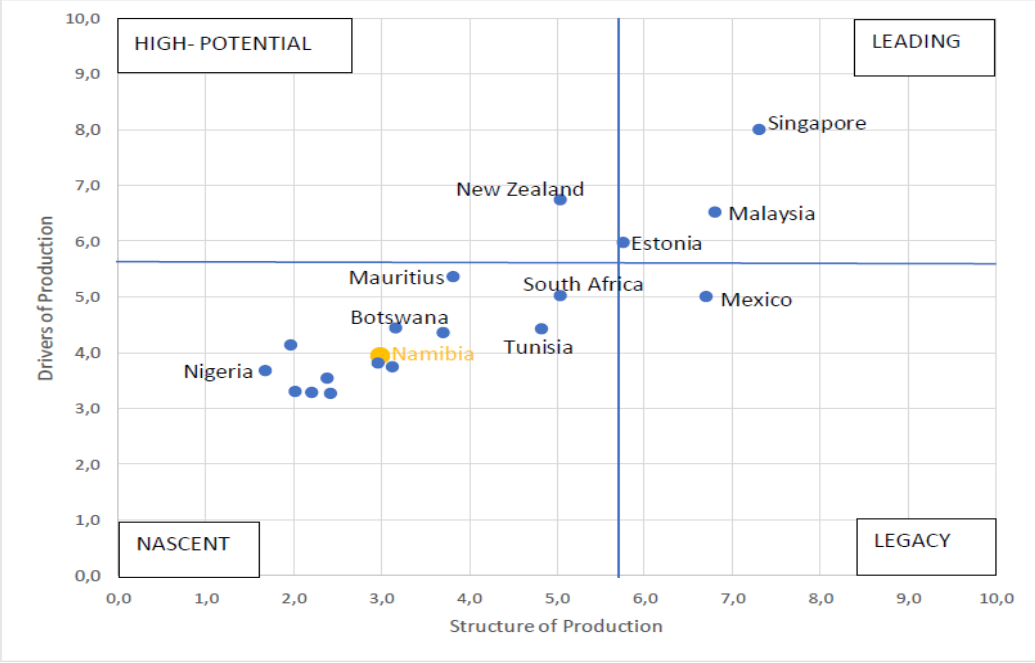
The Readiness Overall Assessment results for Namibia are tabulated below in Table 20. (See Appendices G and H for details.)

Table 20: FOP Readiness Overall Assessment for Namibia

Structure of Production		**3.0**
Driver	**Weight**	**Score**
Complexity	60%	3.9
Scale	40%	1.6
Drivers of Production		**3.9**
Driver	**Weight**	**Score**
Technology & Innovation	20%	3.9
Human Capital	20%	3.6
Global Trade & Investment	20%	3.3
Institutional Framework	20%	5.3
Demand Environment	15%	4.0
Sustainable Resources	5%	2.5

Table 20 above shows Namibia's scores for Structure of Production and Drivers of Production as 3.0 and 3.9 respectively. Instead of a global score, WEF uses these two dimensions to determine the archetypes of each country, placing them within one of the four quadrants. Furthermore, it must be noted that based upon the global average scores of the Structure of Production and Drivers of Production, the lines to divide the quadrants are 5.7 on the x a-axis and 5.7 on the y-axis.[44] The scores in Table 18 above are depicted in Figure 53 below, together with other countries assessed by WEF.

Figure 53: Country Archetypes



Source: Author's computation, data from WEF (2018), Namibia data calculated

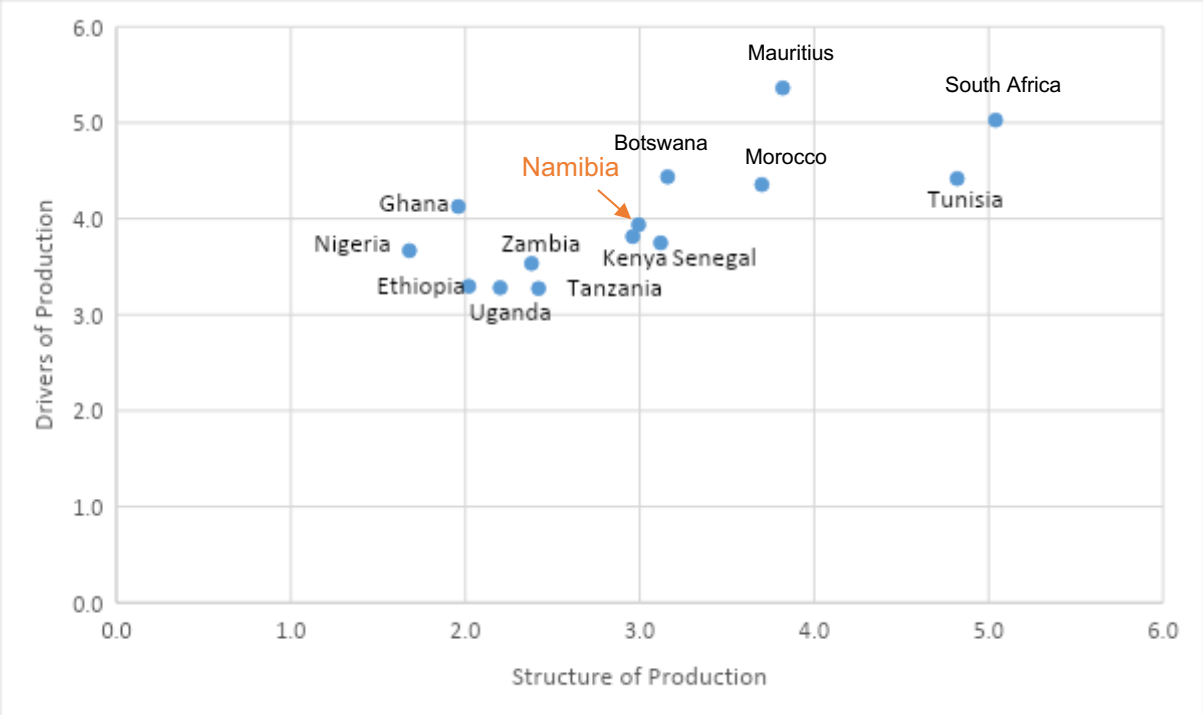
According to WEF (2018), the Nascent countries are those least ready for the Future of Production. From Figure 53 above, it can be seen that Namibia is in the Nascent quadrant, along with other countries within the African continent, such as South Africa, Botswana, Mauritius, Nigeria and Tunisia.

Compared to countries in the Leading archetype (Estonia, Malaysia and Singapore), it is evident that countries in Africa need to put structures in place to improve their scores. This requirement will be expanded in the following section.

7.5.5.1 Overall comparison with other countries

Figure 54 below shows a zoomed-in "snapshot" of the Nascent quadrant.

Figure 54: The Nascent Archetype



Source: Author's computation

Countries closer to the Structure of Production of 5.7 are well on their way to improving their Structures of Production. These are South Africa and Tunisia. It appears there is still some work that Namibia needs to undertake to improve its Structures of Production. There is also a cluster of countries − Nigeria, Ethiopia and Uganda − that have a much lower score for both Structures and Drivers of Production.

The Analysis of the Structures and Drivers of Production are discussed in the next section.

7.6 Analysis

7.6.1 Structure of Production

It is important to note here that the data for Structure of Production and Drivers of Production are as per WEF (2018) for all countries presented in the Future of Production section. Only data for Namibia was sought from various sources and includes more recent data (2020-2021). This fact is indicated as such in the tables and figures presented below.

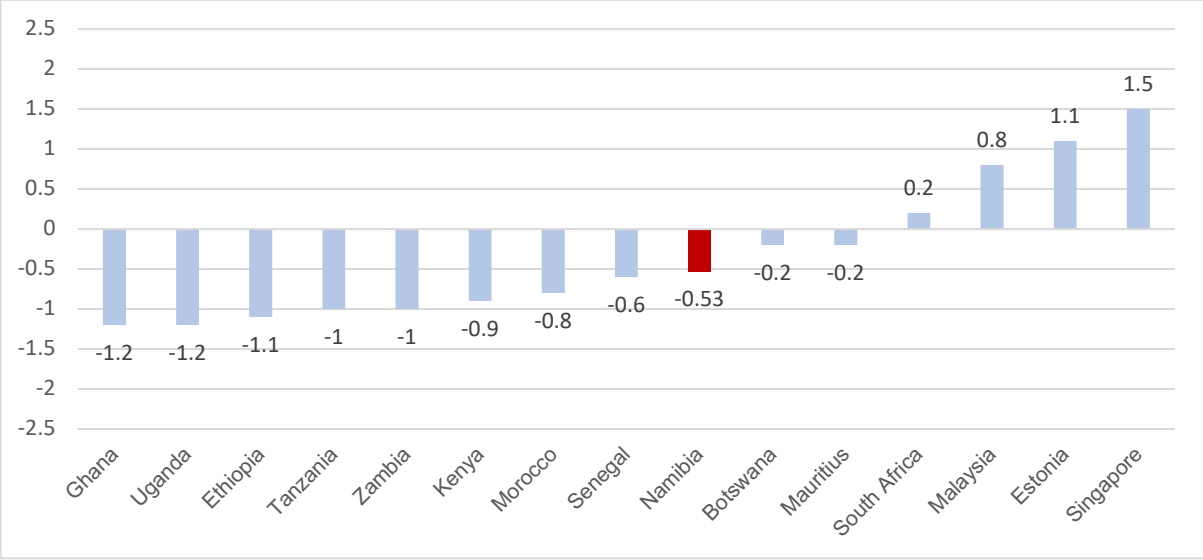
Namibia scored 3.0 out of 10 for the Structure of Production. This score means that the Structures of Production of Namibia may still be small and simple, similar to many countries within Sub-Saharan Africa. Owing to its small production bases, Namibia is likely to find it difficult to expand into advanced manufacturing, because it may still be trying to develop its industrial base.

The components used to measure the Structure of Production are the Economic Complexity Index (Economic Complex) and the Manufacturing Value Added (Scale). These components are discussed next.

7.6.1.1 Complexity

The indicator used to measure Complexity is the Economic Complexity Index (ECI), which is tabulated in Figure 55 below for selected countries.

Figure 55: Economic Complexity Index (ECI): Comparison between Namibia and selected countries



Source: Harvard Growth Lab (2020 for Namibia only), WEF (2018)

It is indicated in Figure 55 above that Namibia's ECI is -0.53. Economic Complex accounts for 60% of the Structure of Production calculation. This finding means that a significant increase in this aspect will result in a major increase in the value allocated to the Structure of Production of Namibia. Hence, for Namibia to move to (at least) the Legacy archetype, it will need to improve its Structure of Production by at least 3 points.

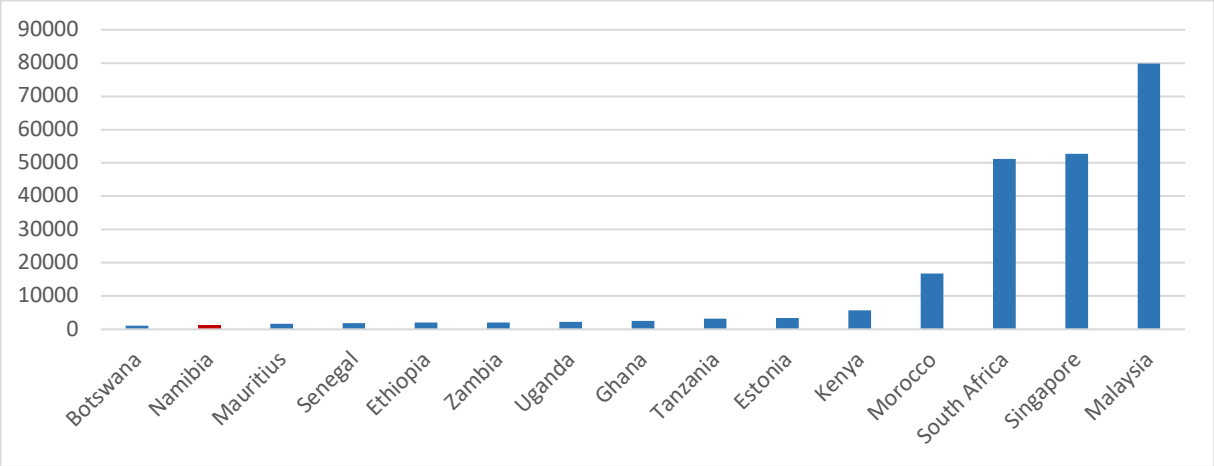
Economic complexity is a measure of a country's productive capabilities that is formulated indirectly by looking at the mix of sophisticated products that it exports. The ECI index, therefore, is calculated based upon the diversification and complexity of a country's export basket (Harvard Growth Lab, 2019). Countries improve their economic complexity by expanding their productive knowledge and developing know-how so that they can produce more complex products, which would then be reflected in their exports. A country such as Singapore for example has a basket that is diversified between commodities and services, hence their high ECI score. Namibia's basket, however, mainly comprises gold, diamonds and unrefined copper and lesser services such as finance, insurance and tourism (Harvard Growth Lab, 2019). Namibia, therefore, should expand its productive capabilities from resource-based activities within the primary sector to the manufacturing and services sector, to produce and export more complex and sophisticated products. This expansion will allow it to move towards a far better ECI.

7.6.1.2 Scale

The indicator used to measure scale is Manufacturing Value Added (MVA). The value added is the net output of the manufacturing sector, calculated after adding up all the outputs and subtracting the intermediate inputs. MVA is often used as a proxy for industrialisation.

MVA values, and as a percentage of GDP, are tabulated below for selected countries (Figures 56 and 57).

Figure 56: Manufacturing Value Added (US Dollars): Comparison Namibia and selected countries

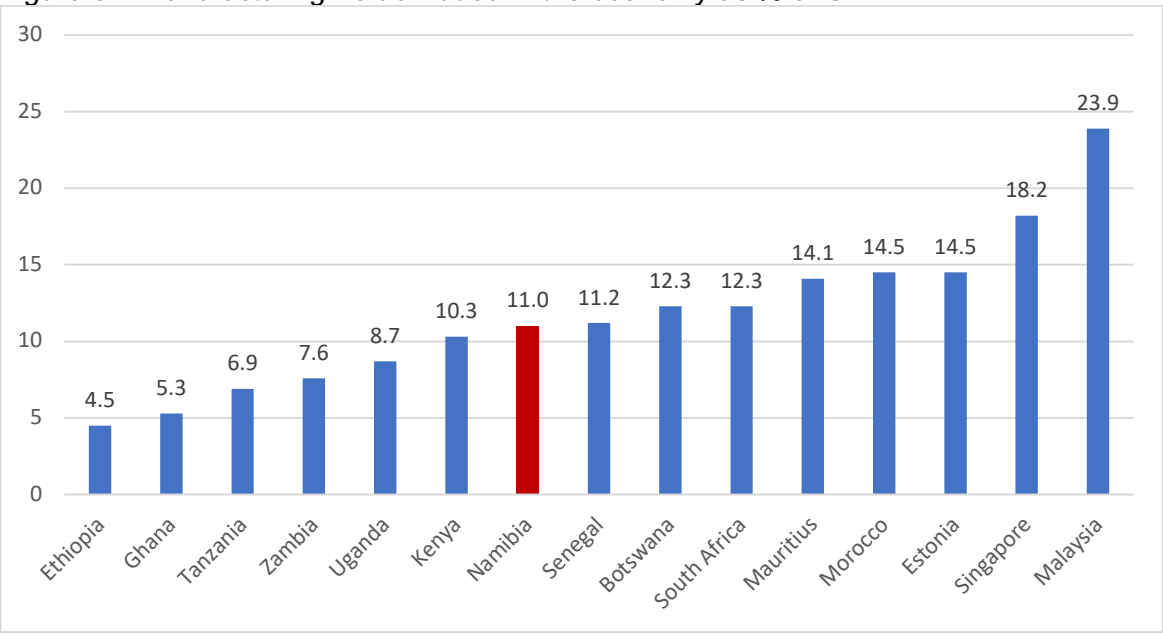


Source: For Namibia, World Bank Indicators (2021). For comparative countries, WEF (2018)

Except for Morocco and South Africa, most African countries have a low MVA, with Botswana and Namibia being positioned at the lower end. WEF (2018) revealed that the countries in the Nascent archetype make up less than 10% of the global Manufacturing Value Added, which can be seen from Figure 56 above, within which the African countries are compared to Singapore and Malaysia.

Figure 57 below shows that MVA accounts for about 11% of the GDP in Namibia, which has been in decline for the past 15 years or so. It is, however, still higher than in other countries in the region.

Figure 57: Manufacturing Value Added in the economy as % of GDP



Source: For Namibia, World Bank Indicators (2021). For comparative countries, WEF (2018)

There are multiple factors that have a significantly positive effect on MVA, namely the drivers of production described below: technology and innovation, skills and human capital, investment, the institutional framework, sustainable resources and demand environment. Increasing the value addition of manufacturing activities, therefore, involves the transformation of production which, in turn, leads to accelerated industrialisation and economic growth.

7.6.2 Drivers of Production

The six Drivers of Production represent factors and conditions necessary to capitalise on emerging technologies and transform production systems[44]. Namibia scored 3.9 out of 10 for Drivers of Production. Namibia's performance is mixed in terms of the Drivers of production, a fact that is discussed below.

7.6.2.1 Driver 1: Technology and Innovation

Table 21: Indicators for the Technology and Innovation Driver

	Technology Platform		**Ability to Innovate**	
	Availability of ICTs	Digital Security and Data Privacy	Industry Activity	Research Intensity
	Internet Users (%population)	Cybersecurity commitment (0-1 best)	Government procurement of advanced technology (1=not at all, 7=to a great extent)	R&D expenditure (% of GDP)
Namibia	41.0*	0.1**	2.7***	0.3****
Botswana	41.0	0.4	3.8	0.3
Ethiopia	24.0	0.3	3.6	1.5
Ghana	58.0	0.3	3.7	0.2
Kenya	29.5	0.6	4.0	0.2
Mauritius	64.9	0.8	3.4	0.2
Senegal	42.6	0.3	3.5	0.5
South Africa	70.0	0.5	3.4	0.7
Tanzania	22.0	0.3	3.5	0.5
Uganda	19.9	0.5	3.5	0.5
Zambia	19.8	0.3	3.5	0.3
Morocco	84.1	0.5	3.3	0.7
Estonia	89.1	0.8	3.5	1.2
Singapore	92.0	0.9	4.9	2.2
Malaysia	89.6	0.9	5.0	1.3

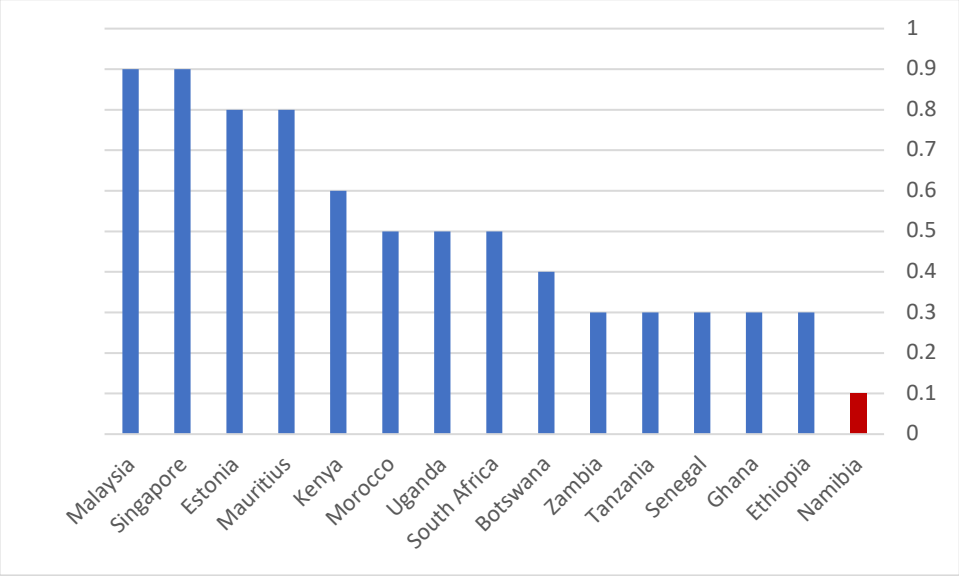
*Sources: *ITU (2020), **ITU (2018), ***2022 Namibia 4IR Readiness Survey (2022), ****Word Bank Indicators, WEF (2018)*

It appears from Table 21 above that technology and innovation remain a challenge for Namibia. The availability of ICTs, proxied by the number of internet users, is 41%[49] which is at the level of countries such as Botswana and Senegal but much lower than some of the frontrunners within Africa − Mauritius (64.5%) and South Africa (70%). In other indicators, it ranks lowest, for example, government procurement of advanced technology is perceived to be low, as well as the commitment to cybersecurity commitment.

Figure 58 below shows the cybersecurity commitment score of Namibia compared with other selected countries. According to the 2018 Global Cybersecurity Index report, Namibia's commitment to cybersecurity is 0.1 on a scale of 0 to 1, where 1 is best.

[49] National sources such as CRAN indicates it as 51%

Figure 58: Cybersecurity Commitment: Comparison between Namibia and selected countries



Sources: ITU (2018)

The performance of other comparable countries such as Botswana, is significantly higher than Namibia in this respect. The countries in the Leading archetype (such as Singapore and Malaysia) show an even greater commitment to cybersecurity.

Digital security cybersecurity policies and enforcement are critical for facilitating the adoption of advanced digital technologies. Therefore, improvements in cybersecurity and the availability of ICTs should be the focus for Namibia, a practice which would, in turn, improve its technology and innovation driver score.

7.6.2.2 Driver 2: Human Capital

Table 22 below shows the indicators for the human capital driver, which include measures for both the current and the future labour force.

Table 22: Indicators for the Human Capital Driver

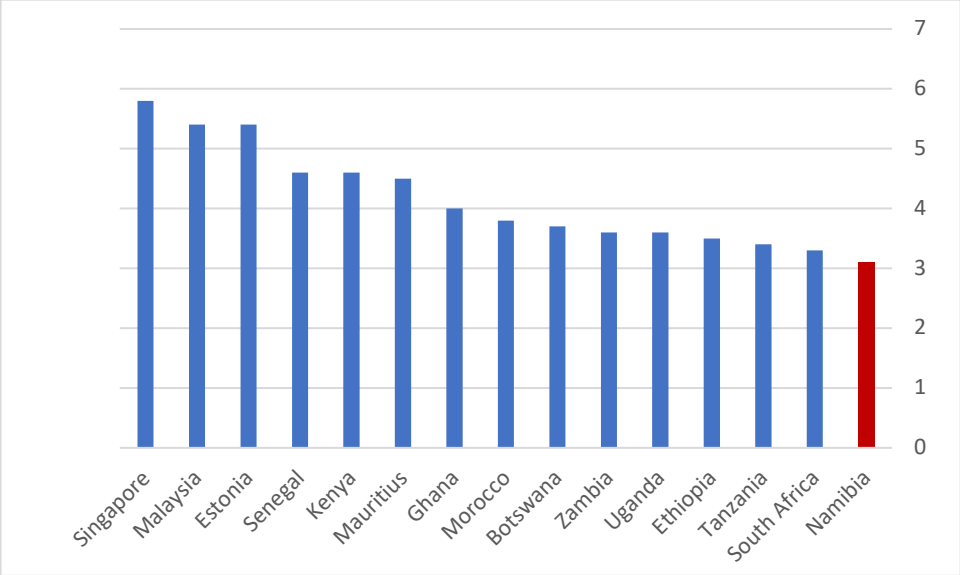
	Current Labour Force		**Future Labour Force**	
	Labour Force Capabilities		**Education Outcomes**	**Migration**
	Digital skills among population 1–7 (best)	Availability of scientists and engineers 1–7 (best)	Quality of math and science education 1–7 (best)	Country capacity to attract and retain talent 1–7 (best)
Namibia	3.1*	3.4*	3.1*	3.1*
Botswana	3.7	3.5	3.7	3.8
Ethiopia	3.5	3.6	3.4	3.4
Ghana	4	3.8	3.7	3.9
Kenya	4.6	4.5	4.3	4.0
Mauritius	4.5	3.9	4.6	3.9

Senegal	4.6	3.7	3.9	3.4
South Africa	3.3	3.5	2.6	3.3
Tanzania	3.4	3.7	2.8	3.3
Uganda	3.6	4.1	3.1	3.0
Zambia	3.6	3.8	3.7	3.4
Morocco	3.8	4.1	3.8	3.2
Estonia	5.4	4.3	5.5	3.4
Singapore	5.8	5.2	6.5	5.7
Malaysia	5.4	5.3	5.3	5.0

*Sources: *2022 Namibia 4IR Readiness Survey (2022), WEF (2018)*

Digital skills, such as coding, are important for the digital revolution and, therefore, it was necessary to determine the extent to which these skills are available with Namibia's current labour force. With a score of 3.1, the survey revealed that almost 34% of the respondents believe that to some extent, there are currently digital skills available, as well as scientists and engineers. This perception contrasts with the 44% of respondents who believe that these skills are not available and the 1% who believes that they are widely available. The 4IR will cause a shift from a production system that is labour intensive to one that is knowledge and skills intensive. Therefore, digital and technical skills are paramount. Namibia was compared to other countries in terms of digital skills as shown in Figure 59.

Figure 59: Digital Skills among population: Comparison between Namibia and selected countries- Digital skills among population 1–7 (best)



Sources: 2022 Namibia 4IR Readiness Survey (2022), WEF (2018)

It is evident from Figure 59 above that industry's perception of availability of digital skills in Namibia is the lowest, compared to other countries in Africa. Furthermore, this figure shows the selected countries in the Legacy archetype (Singapore and Malaysia) have a high perception of availability of digital skills and, therefore, are viewed as ready to meet any changes within the future of production.

Education for the future labour force was also of concern because respondents in Namibia scored the quality of science, maths, and vocational training as average. South Africa and Tanzania have the lowest perception of the quality of maths and science education in their country. It is important that the quality of maths and science education is high because these subjects contribute immensely to the skills needed in the 4IR era. The countries in the leading quadrant have a high perception of the quality of education in these subjects, hence their readiness for the future of production.

With the changing nature of work in production and the time it takes to upgrade the skills levels in a country, the ability to attract and retain the best talent becomes essential. This capacity is particularly important in a developing economy such as Namibia that already experiences skills shortages. According to the 2022 Namibian 4IR Readiness Survey, most respondents believed that the country is not doing enough to attract and retain talent from abroad. Addressing this problem may require enabling new work models and applying staff-retention strategies to avoid or minimise "brain drain", as well as taking a strategic approach to migration, while growing local talent.

In general, human capital is critical to the transformation of production systems,[44] and should be a central focus for Namibia as it transits into the 4IR.

7.6.2.3 Driver 3: Global Trade and Investment

Global trade and investment evaluate a country's participation in international trade to facilitate the exchange of products, knowledge and technology, and to establish global linkages.[44] It also measures the availability of financial resources to invest in production-related development, as well as the quality of infrastructure to enable production-related activities.[44] The components of global trade are trade, investments and infrastructure (see Table 23).

Table 23: Some indicators for the Global Trade and Investment Driver

	Trade		**Investment**
	Trade Openness		Investment and Financing Migration
	Trade (% GDP)	Prevalence of trade barriers, 1–7 (best)	Domestic credit to private sector (% GDP)
Namibia	74.5*	3.3**	72.9*
Botswana	105.9	4.4	31.7
Ethiopia	35.8	3.8	10.9
Ghana	88.6	4.3	19.6
Kenya	37.9	4.2	32.9
Mauritius	107.9	4.8	96.4
Senegal	73.9	3.9	33.3
South Africa	60.5	4.4	144.4
Tanzania	36.8	3.9	14.3
Uganda	45.3	4.6	14.5
Zambia	84.3	4.2	12.0
Morocco	79.8	3.9	64.0
Estonia	155.2	5.2	71.9

Singapore	318.4	5.9	132.9
Malaysia	128.1	4.8	123.9

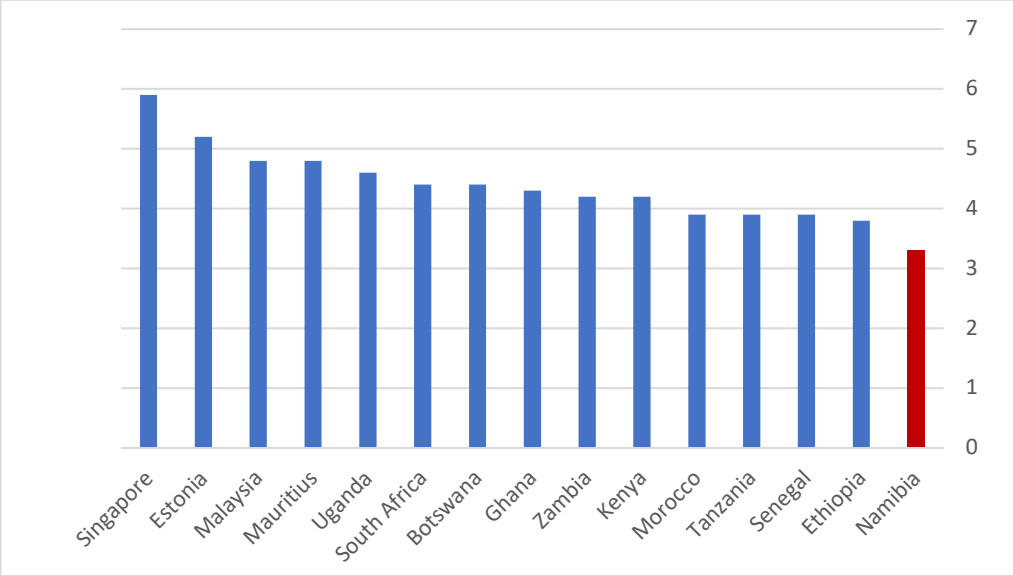
*Source: *World Bank Indicators (2020), **2022 Namibia 4IR Readiness Survey (2022), WEF (2018).*

With regard to trade tariffs, industry stakeholders were asked: "*To what extent do non-tariff barriers (e.g., health and product standards, technical and labelling requirements) limit the ability of imported goods to compete in the domestic market?*"[50]

With a score of 3.3, almost a third (32%) of the respondents believed that to some extent, non-tariff barriers limit the ability of imported goods to compete in the domestic market. Only 3.3% of them believed there was no limitation. Therefore, it is recommended that this issue should be taken into consideration, since a reduction in these barriers is likely to result in improvements in this dimension and, thus, positioning Namibia in a better space for readiness of the future of production.

Namibia was compared to other countries in terms of trade barriers (see Figure 60).

Figure 60: Prevalence of trade barriers: Comparison between Namibia and selected countries - 1–7 (best)



Source: Survey Industry Report (2022), WEF (2018)[44]

Figure 60 above shows that the perception of trade barriers from industry stakeholders is lower (worse) than all other comparative countries. The countries in the Leading archetype (i.e., Singapore and Estonia) display more positive perceptions regarding trade barriers than Namibia. In addition, global trade and investment is one of the lowest ranked drivers of production for Namibia at 3.3. Therefore, a focus on trade barriers might need further consideration.

[50] *https://reports.weforum.org/global-competitiveness-report-2018/appendix-c-the-global-competitiveness-index-4-0-methodology-and-technical-notes/*

7.6.2.4 Driver 4: Institutional Framework

The institutional framework assesses how effective government institutions, rules and regulations contribute towards shepherding technological development, novel businesses and advanced manufacturing practices.[44] The institutional framework driver has the highest scores among the Drivers of Production (5.3 out of 10). These indicators are shown in Table 24 below.

Table 24: Indicators for the Institutional Framework Driver

	Government		
	Future orientation of government, 1–7 (best)	Rule of Law, (-2.5) to 2.0 (best)	Corruption Perceptions Index
Namibia	2.7*	0.3**	49***
Botswana	4.1	0.5	60
Ethiopia	3.7	-0.4	34
Ghana	3.9	0.0	43
Kenya	4.3	-0.5	26
Mauritius	3.9	0.8	54
Senegal	4.1	-0.2	45
South Africa	3.2	0.1	45
Tanzania	3.9	-0.4	32
Uganda	3.8	-0.2	25
Zambia	3.4	-0.3	38
Morocco	4.0	-0.1	37
Estonia	4.2	1.2	70
Singapore	6.2	1.8	84
Malaysia	5.3	0.5	49

*Source: * Respondents to the 2022 Namibian 4IR Readiness Survey (2022), **Worldwide Governance Indicators (2020), ***Transparency International (2021), WEF (2018).*

The respondents to the 2022 Namibia 4IR Readiness Survey appear to be divided with regard to certain aspects of the institutional framework, particularly the future orientation of government. This question comprises the average score of four questions, namely:[51]

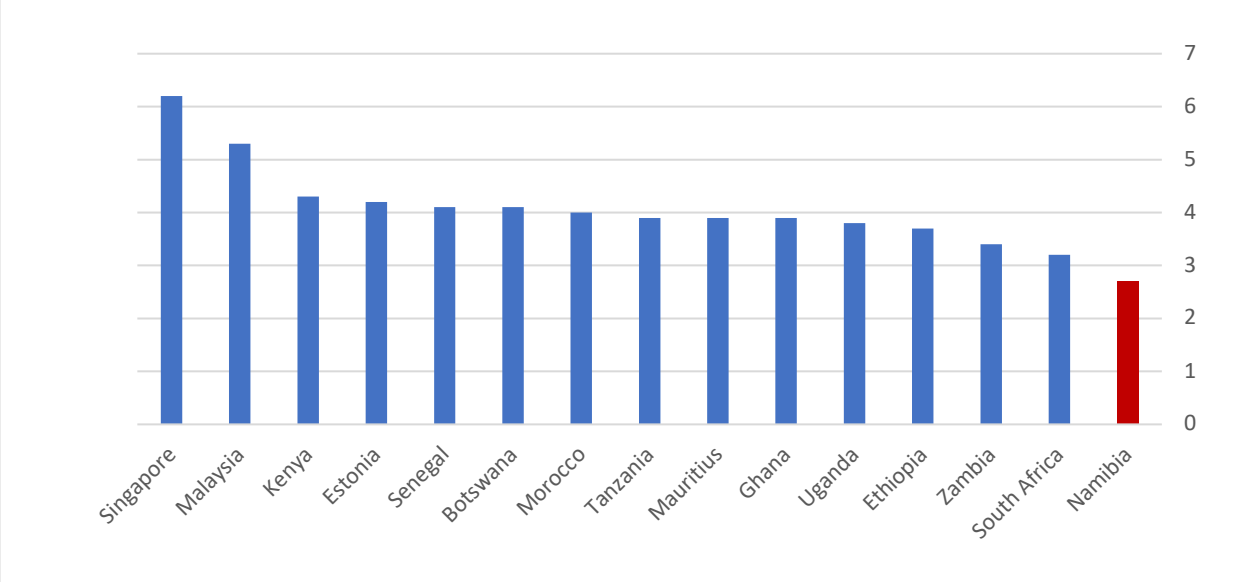
a) *"In your country, how fast is the legal framework of your country in adapting to digital business models (e.g., e-commerce, sharing economy, fintech, etc.)? (1 = not fast at all, 7 = very fast)?"*
b) *"In your country, to what extent does the government ensure a stable policy environment for doing business?"*
c) *"In your country, to what extent does the government respond effectively to change (e.g., technological changes, societal and demographic trends, security and economic challenges)?"*
d) *"In your country, to what extent does the government have a long-term vision in place?"*

In response to question a) 50% of the respondents believe that the legal framework is not fast in adapting to digital business, while about 40% of them think that it is sufficiently fast and the

[51] *https://reports.weforum.org/global-competitiveness-report-2018/appendix-c-the-global-competitiveness-index-4-0-methodology-and-technical-notes/*

rest, very fast. Nevertheless, other components of the institutional framework, such as rule of law, contributed to the higher score. This result suggests that there is room for improvement in Namibia's institutional framework regarding the future of production. Figure 61 shows a comparison between countries, particularly for the future orientation of government.

Figure 61: Future of orientation of government (1–7: best)



Source: Respondents to the 2022 Namibia 4IR Readiness Survey (2022), WEF (2018)

It can be seen from Figure 61 above that compared to other countries; Namibia may be lagging on its perception of the future orientation of government. Singapore and Malaysia, as countries in the Leading archetype, scored the highest on this driver. There are significant improvements needed in the institutional frameworks of African countries to effectively respond to the changes brought about by the 4IR. Stable policy environments are needed that, together with strong legal frameworks, adapt quickly to digital business models.

7.6.2.5 Driver 5: Sustainable Resources

This driver assesses the impact of production on the environment, including a country's use of natural resources and alternative energy sources.[44] The indicators are shown in Table 25.

Table 25: Indicators for the Sustainable Resources Driver

Indicator	**Energy**	**Emissions**	**Water**
	*Alternative and nuclear energy use (% total energy use)	**CO_2 intensity level as a ratio of GDP (US$ billions).	***Wastewater treatment 0–100
Namibia	0.2*	0.3**	70.0***
Botswana	0.2	0.4	41.0
Ethiopia	0.9	0.2	-
Ghana	0.5	0.4	43.3
Kenya	0.8	0.2	52.8

Mauritius	0.2	0.3	58.1
Senegal	0.5	0.6	34.4
South Africa	0.1	1.3	79.4
Tanzania	0.9	0.2	45.5
Uganda	0	0.2	32.7
Zambia	0.9	0.2	58.1
Morocco	0.1	0.6	60.8
Estonia	0.1	0.7	90.9
Singapore	0.0	0.1	100
Malaysia	0.0	0.7	77.2

*Source: WEF (2018), **International Energy Agency (2019), ***Socioeconomic Data and Application Center (SEDAC) (2018).*

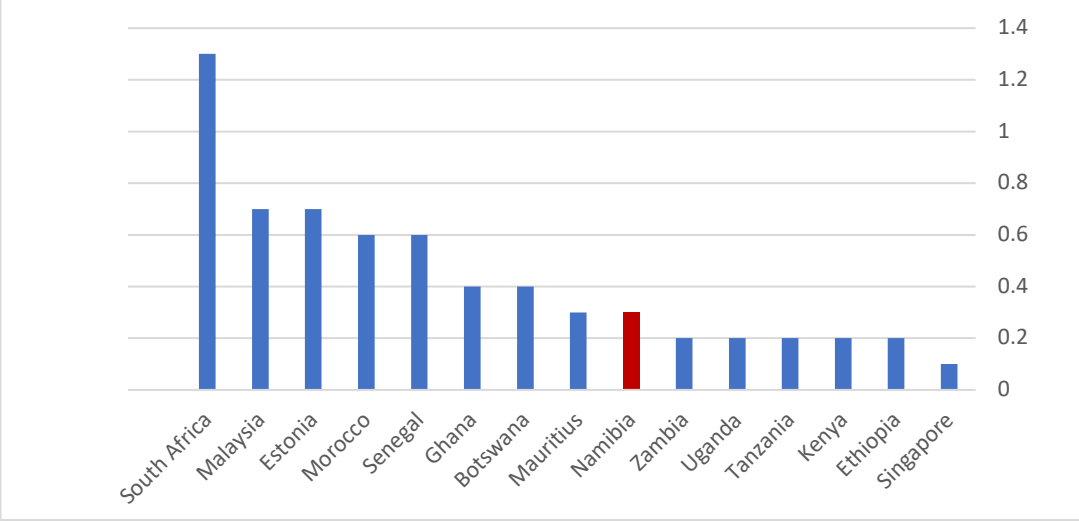
**Alternative energy includes hydropower and nuclear, geothermal, biomass and solar power, among others Calculated for Namibia as an average of 3 countries (South Africa, Mauritius and Botswana) in the same region and income classification.*

*** Total CO_2 (carbon dioxide) emissions in a given country, as a ratio of GDP (US$ billions).*

****The indicator measures the proportion of wastewater collected and produced by households, municipalities, and industry that is treated, weighted by the population covered by the sewage network.*

Sustainable resources weigh only 5%, in the total calculations of Drivers of Production, compared to the other drivers. Therefore, an improvement in this dimension will not yield a large increase in the total Drivers of Production score. Nevertheless, it is important to note that the CO_2 emissions should be looked at, in the light of the United Nations' goal of net zero carbon emissions by 2050. Figure 62 below shows the carbon intensity levels per country.

Figure 62: CO_2 intensity level as a ratio of GDP (US$ billions): Comparison between Namibia and selected countries.



Source: International Energy Agency (2019), WEF (2018)

Compared to other countries, it appears that Namibia is comparable to Mauritius in terms of CO_2 emissions. The highest score is South Africa, which displays higher carbon emissions than some more industrialised economies in the Leading archetype, such as Malaysia and Singapore.

7.6.2.6 Driver 6: Demand Environment

The demand environment driver assesses Namibia's access to foreign and local demand to scale production, as well as the sophistication of the consumer base, because this aspect can drive diverse industry activity and new products.[44] It accounts for 15% of the Readiness Assessment Weighting Scheme – results for Namibia and comparative countries are shown in Table 26 below.

Table 26: Indicators for the Demand Environment

	Market Size	**Customer Sophistication**	
	*Market Size[1] 0–100	**Buyer Sophistication [2] (1-7)	**Extent of market dominance[3] (1-7)
Namibia	36.7	3.7	3.6
Botswana	27.0	3.3	3.2
Ethiopia	44.2	3.2	3.5
Ghana	41.1	3.0	4.0
Kenya	42.1	3.2	3.8
Mauritius	23.7	3.8	3.7
Senegal	28.0	2.7	3.9
South Africa	61.8	3.9	3.9
Tanzania	41.9	2.8	3.5
Uganda	35.5	2.5	2.9
Zambia	33.3	2.8	3.6
Morocco	51.3	3.2	3.9
Estonia	30.3	3.7	4.1
Singapore	64.1	4.6	5.0
Malaysia	66.3	4.4	4.8

*Source: WEF (2018), *World Bank Indicators (2019), **Calculated for Namibia as an average of 3 countries (South Africa, Mauritius and Botswana) in the same region and income classification.*

[1] Market size is calculated as an aggregate measure that reflects Gross Domestic Product (GDP) valued at purchasing power parity in billions of international dollars and the imports of goods and services as a percentage of GDP.

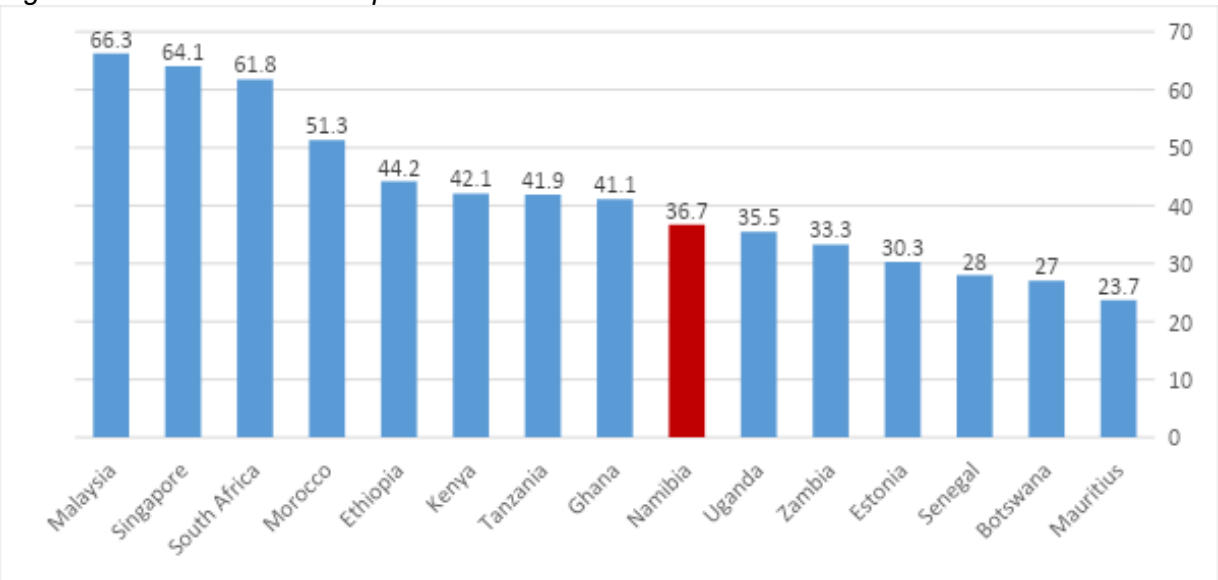
[2] "In your country, on what basis do buyers make purchasing decisions? (1 = based solely on the lowest price, 7 = based on sophisticated performance attributes)".

[3] "In your country, how do you characterize corporate activity? (1 = dominated by a few business groups, 7 = spread among many firms)".[52]

It appears that Namibia ranks relatively well on the demand environment, particularly due to a relatively sophisticated consumer base, reasonably spread corporate activity and a market size that is comparable to other peer African countries.

[52] https://reports.weforum.org/global-competitiveness-report-2018/appendix-c-the-global-competitiveness-index-4-0-methodology-and-technical-notes/

Figure 63: Market Size: Comparison between Namibia and selected countries



Source: WEF (2018), World Bank Indicators (2019)

WEF (2018) defines market size as a combination of country size and foreign markets. It adds that large markets can take advantage of economies of scale in the production of goods and services. Figure 63 above indicates that Morocco, South Africa, Singapore and Malaysia have large markets. It appears Namibia's market size is similar to other African countries such as Uganda and Ghana.

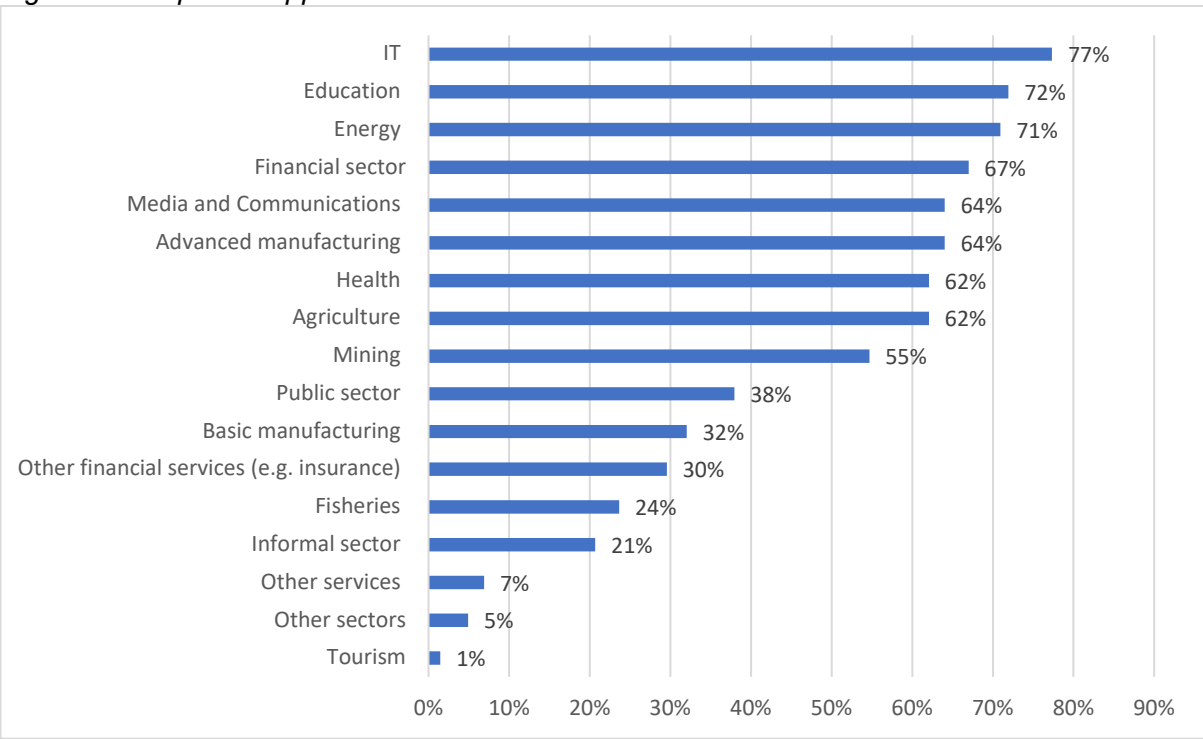
7.6.3 Broader 4IR Applications

In common with most African countries, Namibia is grappling with persistent vulnerabilities such as social and economic inequalities, unequal access to energy, education and health, as well as the pressing need to adapt to fast changes in the natural environment. These challenges have been exacerbated and accelerated by the COVID-19 pandemic. Section 6 explores Namibia's profile in some of these areas based upon existing indicators, and also presents the survey respondents' views on key areas in which the application of 4IR technologies could help tackle some of the most persistent developmental issues. These broader 4IR applications make up the **third layer of the 4IR Readiness Assessment framework**.

Respondents to the 2022 Namibian 4IR Readiness survey, identified IT, education and energy as the top-three sectors for the application of 4IR technologies in Namibia. These domains are followed by the financial sector, media and communications, advanced manufacturing, health and agriculture (see Figure 64 below). Mining, the public sector, fisheries and the informal economy were some of the other sectors in which respondents saw opportunities for 4IR technologies to accelerate Namibia's development and economic growth. An overview and brief discussion of some of these domains are provided in the sections below. The modalities and actions required to bring together the 4IR with some of these broader

applications that can assist Namibia achieve its vision, require further deliberations with key stakeholders across society.

Figure 64: Reported application of the 4IR



Note: Respondents to the 2022 Namibian 4IR Readiness Survey. Pooled sample

7.6.4 Green and Blue Economies

Although Namibia is not one of the largest polluters within the African continent (see Table 27 below), the country has made a commitment to embrace a low-carbon future and move towards renewable energies. Namibia has also recognised its coastal areas as assets that, under the blue economy, include fisheries, marine mining, marine and coastal tourism as well as maritime transport and coastal infrastructure, such as ports, towns and coastal industries (see Table 28 below). This concept is articulated in the Harambee Prosperity Plan II covering the period 2021-2025.[53] A key question facing Namibia is how to ensure that the transition towards a low-carbon and more environmentally sustainable future can be supported and accelerated by the 4IR.

[53] Available at: http://hppii.gov.na/wp-content/uploads/2021/03/HPP2.pdf

Table 27: Green Economy Indicators (2019 or latest available)

	Renewable Energy (% of total final energy consumption)	Total greenhouse gas emissions (kt of CO_2 equivalent)	Carbon Dioxide emissions
Namibia	30.69	10,660	4,220
Angola	54.69	79,680	25,210
Botswana	25.57	11,000	7,250
Ethiopia	88.92	150,960	18,360
Ghana	41.8	37,650	20,040
Kenya	68.08	81,010	22,280
Mauritius	8.94	6,850	4,170
Nigeria	81.4	308,180	115,280
Rwanda	77.86	5,340	1,330
Senegal	37.2	29,230	10,620
South Africa	10.5	555,430	439,640
Tanzania	85.22	84,000	12,450
Uganda	90.22	43,290	5,860
Zambia	84.5	37,570	6,800
Zimbabwe	81.5	30,530	11,760
Morocco	10.69	93,080	71,480
Estonia	31.29	12,870	10,180
Singapore	0.84	67,230	47,380
Malaysia	5.11	313,020	253,270

Source: World Bank Development Indicators (2019)

Table 28: Blue Economy Indicators

	Agriculture, forestry, and fishing, value added (% of GDP) (2021 or latest available)	Quality of Port Infrastructure WEF (1=extremely underdeveloped to 7=well developed and efficient by international standards) (2017)**
Namibia	9.4	5.2
Angola	9.0	2.7
Botswana	2.1	3.1
Ethiopia	37.6	2.7
Ghana	19.7	3.6
Kenya	22.4	4.5
Mauritius	3.8	4.2
Nigeria	23.4	2.8
Rwanda	24.1	2.9
Senegal	15.3	4.4
South Africa	2.4	4.8
Tanzania	25.9	3.4
Uganda	23.8	2.6
Zambia	3.0	2.3
Zimbabwe	7.6	3.1
Sub-Saharan Africa	17.2	-
Morocco	12.6	5

Estonia	2.1	5.6
Singapore	0.0	6.7
Malaysia	9.6	5.4

*Source: World Bank Indicators (**2017, *2021)*

*Note: **The Quality of Port Infrastructure measures business executives' perception of their country's port facilities*

7.6.5 Resource-Based Activities

Namibia's economic structure is largely shaped by its resource-based activities that contribute to about 20% of the GDP – roughly 5% agriculture and 15% mining. Large investments in new mining operations have increased the role those extractive industries already had in Namibia's economy, through which the principal products extracted are diamonds, copper, gold and, increasingly, uranium. Over the past decades, the mining sector has not transformed from the extraction and export of raw materials, into activities with increased value addition (see Table 29). There are examples within Africa of the use of precision farming and sensor technologies, AI, drones and other technological devices in agriculture and mining that are having transformational effects. A deeper study concerning how the 4IR can build value within Namibia's resource-based activities, as well as manufacturing and services, seems essential. Tourism in particular has become a sector of interest and great potential.

Table 29: Economic Indicators (2021 or latest available)

	Manufacturing Value Added (% of GDP),	Industry Value Added (including construction) (% of GDP)	Agriculture Value Added (% of GDP)	Services Value Added (% of GDP)
Namibia	11	25.0	9.4	58.6
Angola	6	43.4	9.0	47.5
Botswana	6	27.8	2.1	65.8
Ethiopia	5	21.9	37.6	36.3
Ghana	11	28.3	19.7	45.9
Kenya	7	17.0	22.4	54.4
Mauritius	12	18.7	3.8	66.4
Nigeria	15	31.4	23.4	49.1
Rwanda	9	20.3	24.1	47.8
Senegal	15	24.7	15.3	49.6
South Africa	12	24.5	2.4	62.7
Tanzania	8	29.3	25.9	34.3
Uganda	16	27.1	23.8	41.9
Zambia	9	46.7	3.0	48.1
Zimbabwe	18	35.8	7.6	49.9
Morocco	15	26.8	12.6	49.1
Estonia	13	22.8	2.1	62.4
Singapore	21	24.9	0.0	69.4
Malaysia	23	37.7	9.6	51.5

Source: World Bank Development Indicators

7.6.6 Health

In Namibia, despite increasing investments in the health sector and the significant percentage of the government budget being allocated to health, health inequalities remain (see Table 30). The extreme income inequalities, youth unemployment and other factors, affect the ability of individuals and households to afford healthcare. 4IR technologies have much to offer in the area of healthcare. Serving remote areas and providing both more efficient diagnosis and therapies are realities that can be realised through the digitalisation of healthcare.[54] In the context of the COVID-19 pandemic and the future shocks that may lie ahead, this area of application requires close attention.

Table 30: Health Indicators (2019 or latest available)

	Life expectancy	Physicians (number per 1 000 people)	Nurses (number per 1 000 people)	Domestic general government health expenditure (% of general government expenditure)	Out of Pocket expenditure (% of current health expenditure)
Namibia	64.0	0.6	2.0	10.7	8.2
Angola	61.5	0.2	0.4	5.4	37.5
Botswana	69.8	0.3	2.9	14.3	3.1
Ethiopia	67.0	0.1	0.7	4.8	37.9
Ghana	64.3	0.1	2.7	6.5	36.2
Kenya	67.0	0.2	1.2	8.3	24.3
Mauritius	74.2	2.5	3.5	10.2	45.7
Nigeria	55.0	0.4	1.5	3.83	70.5
Rwanda	69.3	0.1	0.9	8.9	11.7
Senegal	68.2	0.1	0.5	4.3	51.0
South Africa	64.4	0.8	1.3	15.3	5.7
Tanzania	65.8	0.1	0.6	9.6	22.1
Uganda	63.7	0.2	1.2	3.2	38.3
Zambia	64.2	0.1	1.0	7.1	10.2
Zimbabwe	61.7	0.2	1.9	8.7	24.4
Morocco	76.9	0.7	1.4	7.1	46.8
Estonia	78.3	3.5	6.6	12.9	24.1
Singapore	83.7	2.3	6.2	14.5	30.2
Malaysia	76.3	1.5	3.5	8.5	34.6

Source: World Bank Indicators (2019 or latest available)

[54] *Mazibuko-Makena, Z. & Kraemer-Mbula, E. (Eds.). (2021). Leap 4.0. African Perspectives on the Fourth Industrial Revolution: African Perspectives on the Fourth Industrial Revolution. UK: African Books Collective.*

7.6.7 Education

Education is a precondition for the 4IR, but the 4IR is also influencing education systems across the world as well as in Namibia. Internet-enabled learning has become commonplace in light of the COVID-19 pandemic, and the consumption and production of knowledge is likely to continue to change in the near future as advanced digital technologies increase opportunities to access education and improve education inequalities in Namibia. See Table 31.

Table 31: Education Indicators

	Government Expenditure on education, total (% of government expenditure (2021 or latest available)	Expenditure on tertiary education (% of government expenditure on education) (2017 or latest available)	Literacy rate, adult total (% of people 15 and above) (2020 or latest available)
Namibia	24.8	51*	92
Angola	6.9	9	66
Botswana	15.4	42	87
Ethiopia	24.0	48	52
Ghana	18.6	18	79
Kenya	19.0	13	82
Mauritius	16.1	6	93
Nigeria	5.1	43	62
Rwanda	11.3	20	73
Senegal	21.1	33	52
South Africa	18.4	15	95
Tanzania	20.5	21	78
Uganda	11.3	16	77
Zambia	11.5	9	87
Zimbabwe	19.0	17	89
Morocco	16.9	20	74
Estonia	13.4	27	100
Singapore	11.9	35	97
Malaysia	16.4	21	95

Source: World Bank Development Indicators
Note: [*] latest available is 2014.

7.6.8 Public Service Delivery

Namibia's aspirations to improve public service delivery is visible in the first pillar of the Harambee Prosperity Plan II, which states: "Namibia's economic, social and environmental future rests on Government's ability to place people at the centre of decision-making and development. Effective governance, responsive institutions and an engaged citizenry are the bedrock of democracy and sustainable development."

Increasing the capacity and capabilities of government agencies to manage the 4IR, as well as to engage more effectively with citizens, has become a key goal. Some countries are embracing advanced technologies in the realm of governance. See Table 32.

Table 32: Public Service Delivery Indicators

	Public Service Index (2021 score) (0-10 worst)*	People using at least basic drinking water services (% of population) (2020 or latest available)	People using at least basic sanitation services (% of population) (2020 or latest available)
Namibia	7.4	84.27	35.26
Angola	9.3	57.17	51.66
Botswana	7.1	92.21	80.03
Ethiopia	8.9	49.62	8.91
Ghana	7.4	85.79	23.70
Kenya	8.2	61.63	32.70
Mauritius	3.2	99.87	96.00
Nigeria	9.3	77.61	42.72
Rwanda	7.5	60.41	68.83
Senegal	7.5	84.91	56.78
South Africa	6.9	93.89	78.47
Tanzania	8.8	60.72	31.76
Uganda	8.0	55.86	19.79
Zambia	8.0	65.41	31.90
Zimbabwe	9.0	62.67	35.19
Morocco	5.1	90.40	87.25
Estonia	2.5	99.59	99.14
Singapore	1.5	100.00	100.00
Malaysia	4.3	97.10	99.58

*Source: *The Global Economy Business and Economic data (2021), World Bank Indicators*

**The Public Services Indicator refers to the presence of basic state functions that serve the people. These functions may include the provision of essential services, such as health, education, water and sanitation, transport infrastructure, electricity and power, and internet and connectivity. On the other hand, it may include the state's ability to protect its citizens, such as from terrorism and violence, through perceived effective policing. The higher the value of the indicator, the worse the public services in the country. (https://www.theglobaleconomy.com/rankings/public_services_index/Africa/)*

*** Is access to basic public services, such as order and security, primary education, clean water, and healthcare, distributed equally across urban and rural areas? https://govdata360.worldbank.org/indicators/hfd700167?country=BRA&indicator=42357&viz=line_chart&years=1900, 2020*

7.7 Conclusions

This report provides a detailed assessment of the Country 4IR Readiness Assessment Framework, which consists of three layers: **Preconditions**, **Future of Production**, and **Broader 4IR applications**.

The data for this report has been obtained through: (1) secondary data (i.e., existing national and international data sources), as well as (2) the implementation of a novel survey (2022 Namibian 4IR Readiness survey) implemented across a range of organisations in Namibia conducted during June-July 2022. The survey received a total of 514 responses, including 319 respondents from Namibian companies (116 complete and 203 partial responses) and 195 respondents from a broader set of organisations, such as government agencies, education and training institutions, trade association, international development organisations (76 complete and 119 partial responses).

This report is an input to the Namibia 4IR Readiness Report, which synthesises the extensive work that the Namibian Presidential Task Force on the 4IR has conducted in 2021-2022.

The present report provides an overview of the survey results, as well as an international benchmark based upon the Country Assessment Framework developed for this exercise.

The main conclusions emerging from this report are as follows.

7.7.1 General conclusions

- COVID-19 has had a visible impact upon the way in which organisations approach new technologies and, in particular, digital technologies. Organisations have increased their investments, adoption and strategic partnerships in relation to new digital technologies.
- Namibian companies are aware but generally risk-averse in embracing disruptive technologies. In addition, most organisations lack planning, strategies and budget/funds in place to adopt new technologies.
- Namibia is a net consumer of technologies, and most organisations primarily use off-the-shelf hardware and/or software solutions that have been “tried and tested” and produced outside Namibia. However, there is an appetite for developing and experimenting with new technologies.
- While the adoption of basic digital technologies is quite widespread, the adoption of more sophisticated 4IR technologies (such as advanced cybersecurity, AI, IoT, etc.) are less common. Many organisations, however, plan to adopt these technologies in the near future.
- Those organisations that have adopted 4IR technologies report an overall positive impact of technology upon their business operations. These impacts are visible in improved customer experience, increased efficiency and productivity, as well as in gains in competitive advantage.
- There are critical barriers to the adoption of advanced digital technologies; primarily, (a) lack of capital or funds for investment, (b) lack of knowledge about possible applications of the technology, (c) lack of skills for using the technology, (d) inadequate power or ICT infrastructure and (e) difficulty integrating the technology into the

organisation's processes. These are key areas in which policy interventions could assist more widespread adoption of 4IR technologies in Namibia.

- There is a deficiency of up-to-date data to capture and systematically monitor progress in Namibia's digital transformation and the 4IR. General data collection, processing and maintenance of datasets seem to be weak. The available information is often outdated or not internationally comparable. Data infrastructure is not currently suitable for appropriate monitoring, evaluation and learning (MEL) of policy changes and, thus needs to be updated.

7.7.2 Preconditions

- Namibia performs comparatively well in physical and digital infrastructure. However, internet services largely are perceived to be below average in terms of affordability, and average in terms of reliability and speed.
- Namibia's education system is not perceived to be supportive of digital transformation:
    - The perceived availability of scientists, technologists and engineers in Namibia is below average;
    - Unemployed people in Namibia are seen as insufficiently supported in reskilling in terms of 4IR;
    - The quality of science, mathematics and digital education is perceived to be below average;
    - The quality of vocational training towards the 4IR is perceived to be insufficient; and
    - Complex/specialised digital skills (such as coding, software development and advanced cybersecurity) are lacking.
- Although Namibian organisations do engage in innovation, the levels of innovation within the country are below what is expected for its level of income. Most innovations reported by the survey respondents seem to have been facilitated by digital technologies.
- Namibia has a functional innovation system and a significant portion of respondents reported they had received support from a recognised organisation within Namibia. However, this support is not sufficiently targeting private sector companies, and the majority of outside industry respondents feel that they are not adequately supported in terms of developing tech-driven solutions.
- The policy environment and legal framework for investing in new technologies, R&D, cybersecurity and adoption of advanced digital technologies, is perceived by respondents to be below average.

7.7.3 Future of Production Capabilities

- Namibia was classified as Nascent – a term that implies that 1) it does not have sufficiently complex and diversified structures of production and 2) exhibits unfavourable drivers of production. This assessment means that Namibia is at risk in a 4IR future.

- Namibia's economic complexity can be improved by expanding its productive knowledge and developing "know-how' to produce more complex products, which would then result in an increased diversification and sophistication of production and exports.
- Cybersecurity was identified as a key area of concern. Nevertheless, it is noted that there are activities that are already underway, such as a Cybercrime Bill, that will create a framework to regulate cyber activities, and a National Cyber Security Incidence Response Team to assist with cybersecurity matters. Improved cybersecurity is essential in order to improve Namibia's readiness for future production. Continued efforts in this regard are encouraged.
- Human Capital – There is a need to focus on developing not only basic literature but also the advanced digital skills needed for the 4IR, such as coding and digital reading.
- Education for the future labour force is another category that should be given much thought, especially in terms of the quality of maths, science and vocational training.

7.7.4 Broader Applications

- Respondents to the 2022 Namibian 4IR Readiness survey identified IT, education and energy as the top-three sectors for the application of 4IR technologies in Namibia. These domains are followed by the financial sector, media and communications, advanced manufacturing, health and agriculture. Mining, the public sector, fisheries and the informal economy were some of the other sectors in which respondents saw opportunities for 4IR technologies to accelerate Namibia's development and economic growth.
- There are ample opportunities for 4IR technologies to accelerate and realise Namibia's developmental objectives and move towards a more inclusive and sustainable future. This practice, however, requires commitment and sustained engagement with relevant stakeholders across Namibian society.

8. Workstream Reports

The six workstreams of the Taskforce identified key issues pertinent to their thematic areas. Stakeholder engagements formed a major part of insights for each workstream, augmented by literature reviews, national 4IR Conference and Expo inputs and the CRA framework analysis. Workstreams generated their recommendations, and these were reviewed and triangulated for prioritisation and inclusion as overall final recommendations.

The detailed workstream findings are attached in the Appendices to this report.

9. Namibia 4IR Conference and Expo

The Task Force organised the Namibia 4IR Conference and Expo on 7-8 June 2022 to serve as national dialogue on 4IR and allow the public to provide more input to the assessment. The conference allowed the workstreams to receive feedback on the critical issues per thematic area.

The conference was attended by about 400 delegates consisting of the President, the Vice President, the Prime Minister, Ministers, Deputy Ministers, Executive Directors of Government Offices/Ministries/Agencies, public and private sector organisations, academia, non-governmental organisations, civil society especially youth representatives, and invited international panellists.

The preliminary results from the country CRA assessment were shared and workstreams shared their preliminary work. Each workstream sponsor made a presentation on their preliminary work and had expert panellists as respondents and an open Question-and-Answer session. Each workstream session had a rapporteur who captured main outcomes which formed part of the conference outcomes.

The Expo showcased 4IR innovations of organisations and entrepreneurs. The events were livestreamed on national televisions and various social media platforms such as Facebook and YouTube. Several media activities like televised panel discussions, radio and television one-on-one interviews took place during and after the conference and expo.

Key points raised from the conference included:

Core 4IR Technologies workstream:

- National data availability, access and accuracy are challenging.
- There is a need to confirm the skills deficit for 4IR digital technology skills.
- Introduce different pathways for reskilling and upskilling.
- A strategy for the 4IR direction is needed with 2030 as target.

Future of Work, Labour Force Reskilling and Human Capacity Development workstream:

- Transformation of the education system, assuring quality, defining and directing its purpose, and ensuring transition in key skills as an important precondition for exploiting opportunities brought about by 4IR.
- 4IR will have a serious impact on the job market via automation; therefore, it is important that interventions are in place to mitigate job losses.
- 4IR presents opportunities for transformation of curricula (focus on soft skills such as critical thinking, problem solving, analytical skills), policy and governance.
- Collaboration between industry and government in leveraging the opportunities for 4IR is crucial to assure demands of the labour market.
- To harness opportunities presented by 4IR, the country needs to rethink and reimagine the ways to package and deliver education, taking into consideration the cultural context, digital infrastructure and human elements.
- Comprehensive education and training reform from early childhood development (ECD) to higher education so that active citizens are trained to operate successfully in the digital/4IR space.
- Workers need to be open to reskilling and upskilling demands in order to adapt to the changing tasks workspace and harness future opportunities.
- To leverage opportunities created in the 4IR space, more and broader engagements or an “indaba” involving various stakeholders that include government and private sector will be needed.

Infrastructure and National Data workstream:

- There is need for dialogue and research in:
    - The energy sector to be inclusive of all sources of energy and
    - The telecommunications sector to explore strategies for infrastructure sharing.
- A security strategy for data protection and sharing in the public sector is needed.
- Reclaiming Domain Name is a means to enforce the Computer Emergency Response Team (CIRT) framework and drive prices down.

Industry, MSMEs, StartUps and Investments workstream:

- Prioritise fiscus to support MSMEs and startups because these Namibian companies will solve Namibian problems.
- Industry should show real support to small businesses.

Policy and Regulatory Framework and Governance workstream:

- An overarching national digital strategy is considered high priority.
- Namibia should develop an effective and agile process of assessing and passing laws.

Research and Development workstream:

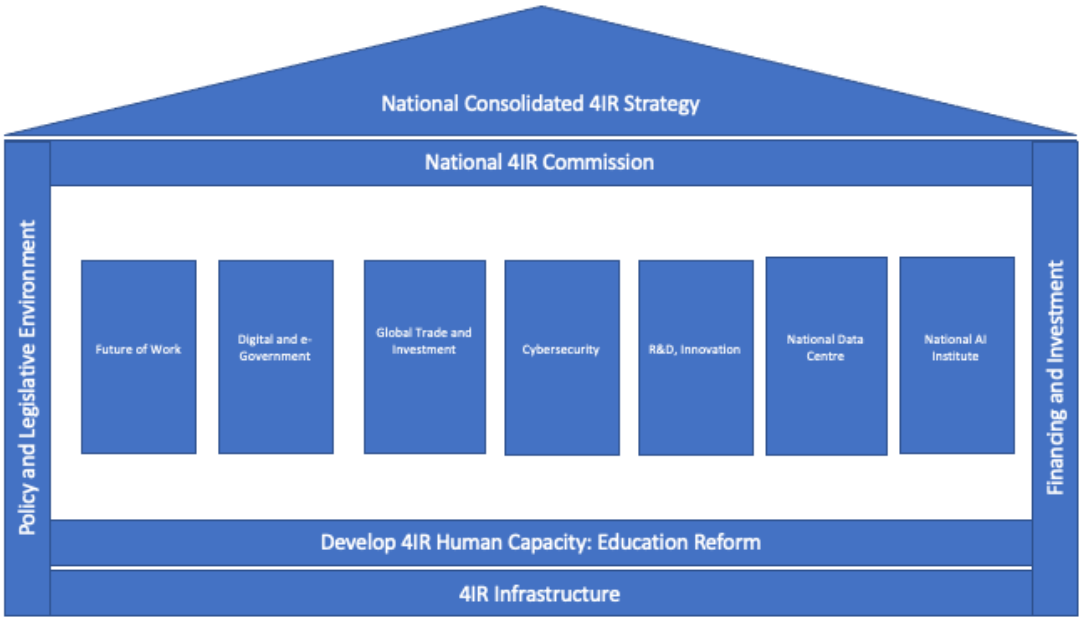
- Namibia should invent innovations to export instead just consuming new technologies.
- 4IR readiness should also be focused on indigenous knowledge management systems (IKMSs) as new epistemologies to leverage.

- Recommendation for Namibia to spend at least 1% of its GDP on R&D

10. Recommendations

Several overarching key issues were identified during the CRA, stakeholder engagements and workstream reports, leading to 13 critical recommendations that would enable Namibia to embrace and leverage the Fourth Industrial Revolution.

Overview of 4IR Recommendations



Recommendation 1: Develop a National Consolidated 4IR Strategy

It is recommended that a national Consolidated 4IR Strategy be developed to address the strategic priorities and provide policy guidance across different sectors.

Gaps in national strategies pertaining to the 4IR have been identified by the workstreams and international bodies. However, it is recommended to consider the various areas and sector-specific strategies that need to be included. The CRA analysis pointed out that a “lack of knowledge about possible applications of the technology” was the second most cited reason for lack of 4IR technology adoption and that most respondents had “difficulty integrating the technology into the organisation’s processes”. These results indicate that awareness and the absence of underlying strategy are weaknesses. This proposed Consolidated 4IR Strategy will include, among other components, the national digital strategy that is under development, as well as national strategies for AI, e-government, tech innovation, research and development, digital economy, education and capacity building, cybersecurity, investment, infrastructure, policy and regulatory environment, societal inclusion, etc.

A national digital strategy or digital transformation strategy can map out the direction of digital transformation, which forms the underlying basis of 3IR, but provides only one pillar for 4IR. Therefore, a distinct 4IR Strategy is still required.

Furthermore, it is recommended that all national strategies undergo verification of whether they embody 4IR concerns. This review exercise should be carried out by the proposed National 4IR Commission (Recommendation 2) and the timeframe should be shorter (three-year) rather than the usual five-year strategy to consider the rapidity of technological change.

It is recommended that the Consolidated 4IR Strategy be benchmarked with the African Union's Digital Strategy, the Africa 4IR Strategy developed by the Africa Telecommunications Union and similar strategies elsewhere, such as the Consolidated Strategy on the Fourth Industrial Revolution for the Association of Southeast Asian Nations (ASEAN).

Recommendation 2: Establish a National 4IR Commission

To eliminate fragmentation and duplication of institutional mandates, functions, activities and resource allocation, it is recommended to establish a cross-sectoral National 4IR Commission to coordinate the implementation, monitoring and evaluation of the Consolidated 4IR Strategy (Recommendation 1). The National 4IR Commission should draw staff secondments from across the public sector, academia and the private sector.

It is recommended that the National 4IR Commission coordinate the stakeholders described in the Consolidated 4IR Strategy. Particular areas of concern include the following.

Resolve national coordination to eliminate fragmentation for ICT

One of the key challenges highlighted by stakeholders and illuminated in desk reviews and the CRA analysis is fragmentation, resulting in a lack of coordination on key concerns including institutional arrangements. The CRA analysis pointed out that Technology and Innovation is somewhat of a challenge for Namibia — it ranks lowest. The future orientation of the government was rated as low. Furthermore, the CRA's Institutional Framework assessed how effectively government institutions, rules and regulations contribute towards shepherding technological development, novel businesses, and advanced manufacturing. The analysis results showed that significant improvements are needed in the institutional frameworks to effectively respond to the changes brought about by the 4IR.

There seems to be no anchor Ministry for 4IR; it impacts cross-cutting issues and a need is identified for an apex coordinator. Although it is recommended that a cross-sectoral National 4IR Commission oversee coordination, implementation, monitoring and evaluation of all 4IR activities across different sectors, an anchor arm of government for the National 4IR Commission might need to be identified.

This coordination problem has to be addressed as it permeates across the public service, but is of particular concern for promoting coherent national data and avoiding structural fragmentation.

National data

National data is severely fragmented, as multiple OMAs such as OPM, MICT, MLIREC, MHAI, MOF, MIT, MHSS, MHETI, NAMRA, BIPA, Social Security Commission, NSA, etc. all have disparate systems with different data sources that are not interoperable, have varying standards and cannot be shared across platforms and systems. National data infrastructure is also scattered, and data is stored in diverse locations and platforms. Ownership and access over data as well as data quality for the multiple data sources are unclear. Often internationally accepted software development standards are not adhered to for operating procedures and standards for systems development. A recommendation to establish a national data centre is discussed in Recommendation 3.

Structural fragmentation

Structural fragmentation refers to the multiple OMAs each having an area of responsibility for similar functions. For example, OPM, MICT, MHETI and CRAN are not clear on responsibility for technology as each has a responsibility that overlaps or is ambiguous. There also needs to be a clear definition of “Information and Communication Technologies” and what is MICT’s mandate in respect to the internationally defined ICT term vs the “Technology” component in MHETI vs “Information Technology” and the area of responsibility for OPM’s Department of Public Service Information Technology Management (DPSITM). CRAN also needs to clearly define its mandate, whether they are the regulator of telecommunications or whether they expand their mandate to the broader ICT sphere. Currently there is ambiguity, overlap and duplication across sectors for not only ICT but also within the sectoral laws which each Ministry creates. Consolidation of Ministries needs to be considered, and it is recommended that a Ministry be repurposed as a Ministry of Science and Technology or equivalent.

ICT infrastructure management

It is further recommended to operationalise a special entity for ICT infrastructure coordination and management to manage infrastructure sharing effectively as set out in Harambee Prosperity Plan II. Operating this entity will ensure the execution of the Infrastructure Sharing regulations already in place. The government internal ICT services and infrastructure should be included in such a special purpose entity. An existing entity can be repurposed.

Recommendation 3: Develop 4IR Human Capacity: Education Reform

The World Economic Forum anticipates a major shift by 2025 with job losses predicted up to 85 million whereas in 2018, the prediction was 75 million job losses.[55] This means that upskilling and reskilling is non-negotiable, and newer ways of learning and teaching have to be adopted to keep up with the rapid pace of development. In general, human capital is critical to the transformation of production systems.[56]

The CRA analysis pinpointed education as the most important component and prerequisite for 4IR in Namibia. However, education was also the top focus area that needed drastic improvement in pedagogy, content, curricula, skills, educator training, infrastructure, digital technology facilities, devices and connectivity to produce the future labour force for 4IR. During focus groups, stakeholders across various sectors lamented the education and skills plight in the country. Most CRA respondents from industry perceived the style of teaching in Namibia as not conducive to the 4IR, since it is predominantly based on memorising and not on creative and critical thinking. The CRA results indicated that most respondents also do not consider the quality of vocational training to be geared towards the 4IR in Namibia. As high as 84% of industry respondents and 77% of all other respondents do not think unemployed people are supported for re-skilling to find employment.

Digital skills for creating and using 4IR solutions are lowest among African countries, concurring with the CRA respondents' and stakeholders' perceptions. The quality of mathematics and science education are perceived to be below average, although they are higher than in South Africa and Tanzania. Furthermore, Namibia scored the lowest of African countries at 3.1 for both current and future labour force across the components of digital skills, mathematics and science education as well as the country's ability to retain and attract talent. Although the availability of scientists and engineers were scored at 3.4, it was still the lowest among the African countries assessed. Therefore, it is recommended that human capital for both the current and future labour force be the priority focus for Namibia. Several specific recommendations follow for improving the future labour force, for education reform and for lifelong learning human capital development.

Improvement of human capital for the future labour force

The CRA analysis showed that education and skills for the future labour force and readiness for production was an area of concern. Most stakeholders across different sectors, expressed the same view during stakeholder engagements and desk reviews that the current education system turns out learners and graduates who are not ready for work, are lacking important competencies, and are regarded as not ready for the 4IR demands.

[55] World Economic Forum. https://www.coorpacademy.com/en/blog/learning-innovation-en/future-of-jobs-the-top-10-skills-to-be-developed-by-2025/

[56] WEF, 2018

The CRA respondents in Namibia scored the quality of Science, Mathematics, and vocational training in general as *average*. Namibia's scores are higher than South Africa and Tanzania, who have the lowest perception of the quality of Mathematics and Science in their country. It is important that the quality of mathematics, science and digital skills are high, as these subjects contribute immensely to the skills needed in the 4IR era.

In reference to education readiness for the 4IR, the quality of science education, mathematics education, vocational training and digital education was rated as below average, with *digital education* of particular concern. *70% of industry respondents rated it as below average*. CRA respondents generally felt that the availability of scientists, technologists, and engineers for 4IR in Namibia is below average as well as the availability of high-quality, professional training services in Namibia. Industry's perception of availability of digital skills in Namibia is the lowest, compared to other countries in Africa.

The 4IR will cause a shift from a production system that is labour intensive to one that is knowledge and skills intensive. Therefore, the importance of digital and technical skills is paramount.

The CRA analysis showed that "Lack of skills for using the technology" was the third most critical issue for Namibia, but digital skills for *creating* technological solutions are essential. Therefore, given that 70% of CRA respondents and most focus group stakeholders perceived digital skills to be generally insufficient, it was necessary to determine the extent to which these different levels of digital skills are available or lacking in the current labour force. Digital skills with different levels of complexity are central for the adoption of advanced digital technologies and the 4IR.

Furthermore, CRA respondents generally felt that "basic digital skills" are adequate, while more complex/specialised digital skills such as coding, software development and advanced cybersecurity are lacking. 4IR digital skills such as AI, machine learning, Internet-of-Things, blockchain are almost completely lacking.

The CRA results indicated that most respondents do not consider the quality of vocational training to be geared towards the 4IR and that unemployed people are not supported for upskilling in Namibia. This highlights the plight and need for reskilling and upskilling support.

Education reform

Namibia needs to define its educational philosophical underpinnings to determine whether Namibia education should focus on national and international competitiveness, self-reliance, or citizen welfare. Secondly, it needs to define how 4IR competencies can be developed to promote learning across all levels of society.

As a longer-term recommendation, Namibia, through the relevant OMAs, should consider the revision of current Acts to align with education curricula for 4IR future skills including digital

4IR skills. This applies to all Acts that relate to Basic Education, TVET, Higher education, NCRST and others that are applicable.

Education reforms at basic education level (Grades 0 to Ordinary Level and Advanced Subsidiary) must be implemented to integrate key digital technology skills such as coding from Grade 0. Infrastructure, connectivity and devices to schools as well as teacher retraining for 4IR skills must be addressed through appropriate partnerships and investments. It is recommended that a holistic education approach be pursued with all stakeholders to find solutions, e.g., pursue public private partnerships.

The TVET sector should prioritise development of a unified TVET framework for articulation and equivalences with institutions of higher learning. Improvement and provision of facilities, revision of curricula, upskilling/reskilling of trainers, and development of standards and norms in the TVET section are critical, as pointed out by the CRA analysis. The TVET sector will play a major role in upskilling and reskilling for jobs for the future.

Higher education institutions' curricula need alignment to the 4IR in terms of future industry needs, advanced digital skills for the 4IR, international standards, regional benchmarked standards and international articulation requirements. However, higher education curriculum development processes are still too lengthy and lack agility to pivot quickly to the fast-paced technological environments and demands. Equally so, the professional councils, NCHE and NQA, have to ensure alignment of 4IR skills and qualification requirements.

Higher education institutions have to reinvent themselves and use a critical 4IR lens to examine their undergraduate and postgraduate degree offerings and implement various modes of learning and teaching. Learning takes place in many forms, and the proliferation of MOOCs from world class universities and numerous online industry certifications creates a threat to universities that are unable to pivot quickly to the changing environments. Shorter courses and certifications, combined with using hybrid methods and newer technologies for teaching are needed.

There is a gap in the higher education sector for technical universities or technical colleges. This is evidenced by the engineering sector, in which no engineering technicians and technologists had been trained over the last years since the certificate and diploma qualifications were dropped by NUST. The technician and technologist level qualification is higher than a TVET level qualification, and Namibia faces a shortage of technician and technologists. This shortage affects the engineering sector severely and indeed has a cascading shortage effect on the emerging Green Hydrogen sector.

The CRA analysis pointed to the following weaknesses for digital technology use and skills availability in Namibia.

- Cybersecurity tools are used by about a third of all CRA respondents, both in industry as well as the broader set of stakeholders with firewalls more prevalent, but encryption tools and methods were seldom used.
- Advanced cybersecurity involving ethical hacking, content profilers, etc. were less common and reported to be used by about 20% of respondents. Cloud computing use was also low, with just about a quarter of the respondents using it.
- The Internet of Things (IoT), clean energy/battery storage/transmission, biometrics and advanced modelling are reportedly used by about 15% of respondents in industry but are less prevalent in other non-industry organisations.
- Sensor technology, big data analytics/data science, artificial intelligence and machine learning were used by about 10% of the respondents in industry, although big data analytics is slightly more prevalent outside industry.
- Digital technologies such as e-commerce, mobile banking/mobile money and cryptocurrency are less used. Other technologies, such as wearables, autonomous vehicles, additive manufacturing (3-D printing), digital twins, blockchain, industrial robots, and augmented/virtual/extended reality, are rarely used across the respondents.

Specialist skills, especially advanced digital technology skills are lacking in Namibia. Although there are numerous offerings in ICT and Engineering, the qualifications are not catering for the new types of jobs. Specialised digital technology skills (e.g. AI, Blockchain, IoT, data engineers, full-stack developers, mechatronics and robotics should be included explicitly in the Human Resources Development Plan (HRDP) and in curricula of tertiary education institutions.

Skills development and lifelong learning

The lack of a national internship programme with apprenticeship levies should be considered. Employers have a higher expectation of student graduate skills, and this expectation is due to on-the-job incremental changes to adapt to newer technologies while academia lags behind. Private sector employers lamented that they need to train the graduates to be market-ready and also felt that they needed to continuously retrain graduates. Furthermore, the private sector employers have recommended a co-financing model for retraining/upskilling graduates. Several private sector stakeholders proposed two initiatives to aid themselves, government and academia to produce graduates fit for work. This involves paid initiatives such as internship programmes, finishing schools, and apprenticeship-type upskilling programmes.

Innovation hubs across the country could be used to upskill unemployed youth. One consideration is the repurposing of defunct multipurpose youth centres to teach advanced digital skills in AI, IoT, drones, robotics and skills beyond simply digital literacy and ICT literacy. These youth centres can be used as makerspaces and training centres for not only upskilling unemployed youth but also reskilling community members. Special programmes such as Work for Tech could form part of a youth innovation programme.

The lack of skills for using 4IR and the lack of knowledge about possible applications of 4IR technologies could be addressed both in the short and long term. In the short term, multi-model skilling methods e.g., VR/AR and MOOCS (online free courses) should be considered to plug the gap.

In the medium to long run, it is recommended that Namibia establish the National AI Institute (Recommendation 13) to coordinate AI and R&D efforts, train and develop new systems and products for 4IR. These efforts should be complemented with the innovation hubs and the repurposed youth centres that will provide upskilling and innovation solutions for the 4IR market.

Digital literacy is an essential skill for all citizens in the 4R and this should also aid in combatting the thriving misinformation campaigns when citizens are fully able to comprehend and analyse online information. The digital literacy movement should commence with public servants and be rolled out to all citizens by introducing a variety of training materials and modes of delivery such as free online courses, tutorials and videos distributed through different OMAs websites and social media channels.

Financing pathways for human capital development

Namibia should finance pathways for labour force education, reskilling and upskilling. A financing model for the future labour force upskilling is important to address the current skills gap and future skills for the emerging occupations. A review of the NTA levy system should be undertaken to truly avail the funds for upskilling and reskilling. A national internship and apprenticeship levy model is proposed similar to the NTA levy system, but it should be driven by one national coordination entity as efforts are currently fragmented and duplicated by several different entities in both public and private sectors. The co-financing model could be an enhanced and revised model of the training levy system of NTA. Education financing can also be achieved through a mixture of government budgetary allocation, the proposed innovation, research and development tax incentives, internship levies, as well as private-public partnerships and foreign direct investments.

In summary, it is *recommended* that Namibia undertakes a comprehensive analysis of the entire education and skills delivery sector and reform the sector from basic education through TVET, higher education and lifelong learning. Broader engagements or indabas involving various stakeholders inclusive of government, private sector, civil society, international partners, international high-tech companies and experts should be held to explore opportunities created by the 4IR space and initiate appropriate interventions. These engagements should serve to help educators, curriculum developers and educational administrators understand the 4IR requirements of education reform.

Recommendation 4: Establish a National Data Centre

Data must be embraced as a national and critical asset. Currently the lack of a National Data Centre is causing a lack of ownership and lack of control of data resources with both internal and external threats. Such threats include, among others, inaccurate and inoperable data,

data silos, fragmented data management, an inadequately skilled labour force and cyber security threats. There is also a lack of overall sectoral strategic frameworks for infrastructure or national data.

An overall national data strategy should be developed and implemented for the National Data Centre. This strategy should form part of the Consolidated 4IR Strategy (Recommendation 1). Given the anticipated data intensive needs of the emerging Green Hydrogen economy, a National Data Centre, especially a green data centre, will serve the needs of the country not only for current data but also for future data, data-driven decision-making needs and 4IR technology development needs.

The key priorities for this strategy should include:

Data Management Pillars

- Strategy and Governance: strategy and data governance frameworks should be developed, adopted and implemented.
- Standards: appropriate standards for data and physical data infrastructure should be addressed.
- Integration: Interoperability of data and integration of various data sources should be addressed, and such frameworks should be implemented.
- Quality: The six dimensions of data quality should be rigorously executed with continuous monitoring and evaluation: accuracy, completeness, consistency, timeliness, validity, and uniqueness.

Infrastructure, Connectivity, Energy, Disaster Recovery

- Newer models of ICT software and platform acquisition such as Software-as-a-Service (SaaS) model and Platform-as-a-Service (PaaS) model should be considered.
- Cloud computing with its edge and roof paradigms must be implemented.
- Data centres are energy and water intensive due to their need for reliable power and water for cooling systems. However, renewable energy sources and different cooling technologies using recycled or desalinated water are to be explored. This is especially pertinent given the developing Green Hydrogen economy that will be highly reliant on data centres but might also address the energy and water resources needed to operate these.
- High Performance Computing servers need to be available for complex data-driven decision making
- High speed fibre networks need to be developed with priority for developing Green Hydrogen hot spots like Lüderitz and Walvis Bay.
- Warm and hot disaster recovery sites with business continuity plans are mandatory for government and national data centres.
- Infrastructure governance frameworks should be developed and implemented, including policies governing data residency and cloud data storage outside Namibia.

Skills

- Qualified 4IR data specialist skills are lacking. These include infrastructure specialists, data engineering, data analytics, big data, advanced software development (different types of expertise), AI, machine learning, IoT, robotics, blockchain and cybersecurity. Such skill development requires hands-on training, and apprenticeships should be considered.

Security

- The 4IR brings about cybersecurity threats across a wide spectrum such as physical security, cloud security, IoT security, application and mobile security, programming security, encryption standards, ethical hacking and network security. Namibia is rated high in cybersecurity weaknesses on most international indexes and the CRA analysis re-emphasised this gap.

Open Data and Data Sharing

- An open data framework with an adoption of recognisable dataset formats should be developed and implemented. Data sharing with the private sector to enhance opportunities is to be revisited, as there is duplication in data harmonisation efforts. The Government should perform data infrastructure interoperation and consequently data sharing with the public and private sector, overhauling the current status quo. A lack of such an open data framework leads to stifling reliable service delivery and innovation both in the public and private sector. Relatedly, lack of trust and working agreements in the public sector leads to resource underusage and fiscal wastage, costing the state in spending on systems based elsewhere while posing security risks to national data through problematic ownership and control structures.

In summary, without a dedicated National Data Centre and open data, there is a lack of opportunities for innovation.

Recommendation 5: Conduct a comprehensive policy and legislative review

It is recommended that Namibian laws and government policies be reviewed to evaluate how they could be improved to promote the benefits of 4IR.

The CRA analysis indicated that the policy environment for investing in new technologies, R&D, cybersecurity and adoption of advanced digital technologies is considered to be below the level that is required. The CRA further shows that the legal framework is also perceived to be insufficiently agile to respond to change and to new models of digital work.

In particular, cybersecurity policies and enforcement are critical for facilitating the adoption of technology.[57] The CRA analysis indicates that Namibia's commitment to cybersecurity is 0.1 on a scale of 0 to 1, where 1 is best. The performance of other comparable countries such as Botswana, is significantly higher than that of Namibia. Therefore, it is recommended that an

[57] *WEF, 2018*

improvement in cybersecurity and availability of ICT be the focus for Namibia, which should in turn improve the Technology and Innovation driver score.[58]

The Task Force, in close collaboration with the World Economic Forum (WEF) and Agile Nations, developed a 4IR Toolkit for Policy and Legislative review to support review processes for 4IR. Agile Nations is a network of seven countries that formed a consortium to enhance agility using various tools: Canada, Denmark, Italy, Japan, Singapore, UK, and the United Arab Emirates.[59] It is recommended that a comprehensive review of legislative instruments be undertaken against this toolkit for critical aspects of 4IR enablement.

Furthermore, increased digitisation of court processes is also an essential component of 4IR readiness. The Ministry of Justice has implemented the first victim-friendly magistrate court room using technology in July 2022.[60] Its plans to roll this out to other courts should be supported.

It is recommended to introduce *regulatory sandboxes* for tech start-ups and tech innovators in sectors where there are challenging legislation issues or lack of legislation, as current legislation will take time to be reviewed and new legislation be passed. A regulatory sandbox provides for live experiments or testing of products and services in a controlled or test regulatory environment for a specific period, lifting certain regulatory restrictions. Regulations are then made based on the experimental learnings. Such regulatory sandboxes are especially popular within the ICT and energy sectors. The fintech sector has already benefitted from regulatory sandboxes by Bank of Namibia[61] for the banked sector and NAMFISA for the unbanked sector.

Several potential legislations should be investigated for enactment, for example:

- An overarching Artificial Intelligence Bill for Namibia
- Digital Currencies Bill
- Central Bank Digital Currency Bill
- Tax Incentives Bill including Research and Development (R&D) tax incentives for multinational companies, private sector and individuals
- Other potential new policies and legislation that need to be promulgated to handle the emerging complexities

The review and enactment of the following existing bills are deemed very important for the 4IR and need to be fast tracked:

- Data Protection Bill
- Cybercrimes bill

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[58] *Also consider global recommendation on Ethics of AI adopted by UNESCO states in 2021 (https://unesdoc.unesco.org/ark:/48223/pf0000377897)*

[59] https://www.gov.uk/government/groups/agile-nations

[60] *https://economist.com.na/72117/technology/technology-helps-establish-the-first-gbv-victim-friendly-courtroom/*

[61] *https://www.bon.com.na/CMSTemplates/Bon/Files/bon.com.na/e8/e833f19c-86ca-4eea-a801-638b912ae6f8.pdf*

- Revised Payment Act
- Civil Registrations and National Identity Bill
- Investment Act revision
- Startup legislation

Stakeholders pointed out that there are too few legal drafters in the country, especially for specific sectors such as the fast-paced ICT sector that should support the 4IR. It is therefore recommended that the Ministry of Justice in collaboration with the University of Namibia (UNAM) and the Namibia University of Science and Technology (NUST) design programmes to train more specialised law graduates in legislative drafting.

The research and support capacity of Members of Parliament are critical for the success of creating the conducive laws for the 4IR. It is recommended that comprehensive and diverse education offerings be availed to parliamentarians and their support resources to understand the 4IR and its legislative requirements.

Recommendation 6: Improve 4IR Infrastructure

The 4IR depends on critical physical infrastructure networks, including transport (road, rail, waterways, airports); energy (electricity, fuel supply); water (supply, wastewater treatment); and solid waste (collection, treatment, disposal). 4IR also depends on digital infrastructure (internet connectivity, data centres, etc.). Electricity is a catalyst for economic and social development, and therefore energy provision is a precondition for the 4IR to thrive. Data and computing infrastructure are also highly dependent on energy.

The World Economic Forum's Networked Readiness Index (NRI) measures the propensity for countries to exploit the opportunities offered by ICTs. In the 2021 Networked Readiness Index (NRI) report, Namibia was ranked 109th out of 134 countries with a score of 35.66 out of 100. This is down from 103rd in 2020 with a score of 36.11. The NRI is based on 4 pillars: Technology, People, Governance, and Impact. Within the Technology pillar, which is based on Access, Content and Future technologies, Namibia was ranked 93rd out of 134 countries with a score of 30 out of 100.[62]

The top sectors identified for application of 4IR were IT, education and energy, followed by the financial sector, media and communications, advanced manufacturing, health and agriculture. Tourism is another sector identified by stakeholders, although it featured low on the CRA survey.

The CRA respondents rated the prerequisite pillar for 4IR infrastructure as the fourth highest concern being "Inadequate power or ICT infrastructure".

[62] *https://www.namibian.com.na/6215980/archive-read/A-Namibian-4IR-Faces-Fundamental-Issues*

4IR Infrastructure not only includes the telecommunications infrastructure, but also includes energy infrastructure. Currently the overall electrification rate is low at 56%, with rural areas not connected to electricity. That stastistic, combined with steep electricity prices, means that energy creates a barrier to 4IR readiness. Stakeholder engagements with the Electricity Control Board, NORED, NamPower and the National Council yielded positive results for alternative solutions, and the Green Hydrogen projects also promise positive spin-offs for electricity provision.

Rural healthcare facilities prove to be a concern, as many such facilities are not connected to electricity and connectivity, thus not making universal healthcare provision a reality. Likewise, 1300 schools are not connected to the internet.

More cell towers and improved bandwidth capacity are required all over the country, especially in rural areas. However, there is limited cooperation among telecommunications providers regarding infrastructure structure. Namibia should invest in improvements to the current infrastructure and backbone as the new Green Hydrogen initiatives demand high-speed internet.

The 4IR can only be realised if engineers and technology experts are part and parcel of policy development, decision-making and planning processes, and not just considered as implementers. The leaders and managers should have domain knowledge in the portfolios that they lead, otherwise decisions may be enforced that have wide-ranging negative consequences to the disciplinary areas and might violate internationally accepted standards.

It is recommended to operationalise a special vehicle entity for ICT Infrastructure coordination and management to manage infrastructure sharing effectively as set out in Harambee Prosperity Plan II.[63] Operating this entity will affect Infrastructure Sharing regulations already in place. A proposal was received through consultations by representatives of the big telco players (MTC and Telecom as well as the regulator CRAN) to set PowerCom (Telecom Namibia's current infrastructure operating company) to be transformed into this special purpose vehicle. However, this needs further consultation and analysis, especially regarding how it will function with the National 4IR Commission (Recommendation 2).

It is recommended to review taxes and customs duties for ICT equipment and gadgets in general, as these pose a challenge for uptake of 4IR activities by the citizenry as well as infrastructure developers.

It is recommended that 5G rollout review be fast-tracked in a way that clearly stipulates the value benefits for the sector. Regular reporting will be necessary to manage public expectations and for awareness purposes.

[63] *HPPII, p64*

It is also recommended that the Government should decisively operationalise the Universal Service and Access Fund. Doing so will offer 1) value in the form of digital resources for minorities in the communities such as those living with disabilities, 2) access to services for unconnected rural communities and 3) literacy skills for out-of-school communities.

Likewise, solutions to decrease the cost of data should be reviewed and zero-rated data provision given for educational institutions such as universities and schools, research and essential service delivery institutions. Namibia has one of the most expensive rates for mobile data on the continent. This issue could be investigated in tandem with the Universal Service and Access Fund.

Government should also effectively operationalise Section 9 of the communications on the establishment and incorporation of DOT NA Association as a resource to contribute to the national ICT agenda.

There exists a need for investments in expanding the network coverage to ensure stable connectivity to meet the foundational requirement for 4IR services. An appropriate budget should be allocated for ICT within OPM and MICT or the National 4IR Commission (Recommendation 2), as well as to the OMAs for improving infrastructure, human resources and services.

Recommendation 7: Develop a framework for the Future of Work

The phrase “Future of Work” refers to the fact that for many workers worldwide, jobs will look very different in the future and require very different skills. The CRA analysis included the WEF Future of Production instrument, which compared Namibia with other countries on particular dimensions and gave Namibia an indication of where improvements are needed. Namibia scored a 3.0/10 for the Structure of Production and a 3.9/10 for the Drivers of Production. Namibia is placed in the category of “nascent” countries that are least ready for the Future of Production, alongside South Africa, Botswana, Mauritius, Nigeria and Tunisia. It is recommended that Namibia should focus on steadily improving its Economic Complexity Index (ECI) from -0.53 to closer to 2.5 by increasing the number of products and services that it exports. One of the drivers assessed to determine Future of Production is Scale, and this is measured by Manufacturing Value Added (MVA). Factors that have a significant positive effect on Manufacturing Value Added (MVA) include secondary education, agricultural land, domestic credit to the private sector, trade openness, inward stock of FDI, population size, and ICT and digital infrastructure/technology. It is envisaged that if Namibia could improve these, including manufacturing activities, the MVA should improve and in turn, the Structure of Production.

One of the easy gains for improving manufacturing activities would be digital service development and increasing exports, provided there is improvement in the prerequisites. Remote work and especially outsourcing of software development services and products opens opportunities for citizens to be employed transnationally or transcontinentally. It also opens pathways for Namibia to possibly become a digital service hub for international

organisations. For example, worldwide digital skills, especially advanced coders and software engineers are in short supply and virtual software development centres[64] and call centres are outsourced to different countries such as India, China, Egypt, Poland, Brazil, Vietnam, Philippines, etc.

A recommendation is that Namibia investigates how to become an outsource centre for software development services and products through the envisaged National AI Institute and innovation hubs.

In the Future of Work, many jobs can be conducted virtually from anywhere in the world through digital technologies. Organisations improved their infrastructure to accommodate the COVID-induced remote work, and the CRA survey confirmed that not only infrastructure but also processes were improved to allow for remote work. This hybrid trend is envisaged to continue. Remote work has numerous benefits such as increased productivity, savings and efficiency, but can also result in a deterioration of employee wellness and skewed work-life balance. The 4-day work week is a new phenomenon with a pilot programme[65] ongoing to increase productivity whilst promoting smarter work and more work-life balance for happier and healthier employees. However, such 4-day work weeks cannot be applied as a one-fit all model across different sectors. Therefore, it is recommended that in the proposed MLIREC study on the future of work and future job replacements, this aspect be included for thorough investigation.

Namibia, through the National Planning Commission (NPC) and National Council of Higher Education, should hasten the finalisation of the countrywide skills audit by sector, and the National Human Resource Development strategy, projects that are already underway. The ongoing Human Resources Development Plan should be reviewed for inclusion and augmentation of this report's findings and recommendations.

Namibia faces a critical challenge with outdated occupations classifications. It is recommended that Namibia, through MLIREC, review as a matter of urgency the 1996 Namibian Standard Classification of Occupations (NASCO) to accommodate future occupations. This will allow Higher Education institutions to develop and offer programmes that will address the skills for the future. There has been no updated jobs classification across the public sector and just a limited reclassification in the private sector. The qualifications and digital skills in the ICT sector that the public sector tries to recruit do not exist anymore, and therefore recruitment of the ICT labour force is hampered. MLIREC confirmed that a job reclassification has been concluded for the public sector but awaits the completion of the reclassification of the private sector jobs. This job regrading exercise for the public service hampers recruitment due to outdated grading scales.

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[64] *https://www.codeinwp.com/blog/best-countries-to-outsource-software-development/*

[65] https://n.pr/3QpZ2ej

A perceived jobs mismatch has been observed throughout the many stakeholder engagements as job classifications are outdated and do not correspond with newer qualifications. Updated graduate attributes are incorporated into degree programmes as higher education have to benchmark qualifications to the current international standards, articulation requirements and future labour market demands. Even in the private sector, where multinational companies have branch offices in Namibia, job positions that are available at the headquarters in a different country are not transferred to Namibia. The mismatch is also experienced by foreign-trained Namibians returning home who have specialist qualifications but cannot find jobs due to the lack of such industry jobs.

Namibia suffers from outdated data on the labour force. NSA has not produced a Labour Force survey since 2018, and the MLIREC is dependent on this survey data from NSA. Information on the labour force is outdated since new jobs and skills have entered the market especially for the 4IR. NSA indicated a lack of budget provision to conduct the necessary surveys.

MLIREC should assess sectors where many manual jobs will most likely be affected by automation with limited reskilling and upskilling opportunities. Where such reskilling/upskilling of workforce will not be possible over a short period and automation can potentially result in mass job losses, MLIREC should consider ring-fencing such types of jobs to delay complete automation until the workforce is ready.

Overhaul immigration policies and processes

The CRA survey scored Namibia at 3.1 for attracting and retaining talent for future labour force and 4IR, which is the lowest among the African countries assessed. In the same matrix, the lack of available digital skills was also scored at 3.1, while availability of scientists and engineers were scored at 3.4 (also the lowest scores).

Stakeholders expressed the same view that Namibia's immigration on work permits and work visas needs urgent review if the country wants to thrive in the 4IR. The country needs specialist professionals, and attracting such specialist talent from elsewhere helps the country diversify its offerings, transfer knowledge and create more jobs. The Africa Continental Free Trade Agreement should be seen as an opportunity to attract more 4IR talent to the country. Mechanisms for technology transfer and knowledge transfer to Namibians should also be reviewed, whilst monitoring and evaluation thereof should be strengthened.

The review of immigration instruments, tools, policies, regulations and processes should not only undergo digital transformation but will also benefit from a change in policy direction. A culture change exercise should accompany any revision and/or overhaul of Namibia's immigration system. It is recommended that the national skills audit inform the Immigration Board of the shortage and critical skills needs in the country.

Recommendation 8: Prioritise Cybersecurity

The future of work requires hybridity with virtual models of work "anywhere, anytime" to be adopted and advanced manufacturing requires continuous and stable internet connectivity. There are, however, two major areas that Namibia has to resolve to ready itself for the future of work.

Cybersecurity is one of the most significant threats of the 4IR and Namibia is consistently rated extremely high risk due to a lack of cybercrime Act or Data Protection legislation. However, there is also a skills deficit and a lack of knowledge on tools and application areas, lack of knowledge on use of the digital tools, and lack of integration of these tools into business processes. However, CRA respondents indicated that email, social media, websites and signed documents in digital formats are widely used, yet these are transacted without national cybercrime legislation or regulations for digital and e-signatures. Also, appropriate cybersecurity tools, methods, remedial actions, and adequate infrastructure are not in place. National ICT infrastructure is aged and outdated with inadequate software and licensing, which increases the cybersecurity risks to unacceptable levels. This places national data at risk. While national ICT assets have been underfunded for the public sector, the situation is equally undesirable for industry, as CRA respondents outside of industry indicated that investments on maintenance and upgrades are only made when funds are available, which places such infrastructure and software at high levels of cybersecurity and failure risks. About one third of industry respondents indicated that they budget annually for tech maintenance and upgrades.

It is therefore recommended that cybersecurity be elevated to the highest priority for funding, skills and legislation, as it impacts the current and future world of work and play. Cybersecurity should also be considered from a continuous and rapid advancement point of view, in other words, regulations for cybersecurity and accompanying skill sets need to be agile and strive for continuous improvement.

Recommendation 9: Mobilise Financial Resources for 4IR Development

An average of 77% of CRA respondents indicated a lack of capital or funds for investment in 4IR as a significant barrier for adoption of 4IR and digital technologies. Respondents indicated that budgets are inadequate for upgrades and maintenance of infrastructure.

Funding can be considered on two levels. The first consideration is adequate ICT budgetary provisions for OMAs, specifically OPM and MICT, who have inadequate budgets for ICT needs. The second component is to attract investments in ICT for infrastructure, human capital development, entrepreneurs and community development. The Cultural Creative Industries (CCI) inclusive of ICT and digital technologies should fall under the priority lists for investments. Equally equity financing should be prioritised for tech start-ups.

Different sources of funding for education, skills and servicing communities have been identified in previous sections. These different sources of funding include the NTA levies; a national internship programme with contributions raised through public-private partnerships; the universal service fund; and tax breaks, incentives and levies for research and

development. Exploration of mutually beneficial partnerships with both development partners and the private sector can support 4IR developments in Namibia.

Given that the lack of capital was identified as the most significant reason for not adopting 4IR technologies, Namibia could work on attracting Foreign Direct Investment (FDI). However, FDI does not flow without a conducive legal and institutional environment. There must be a clear and effective implementation of investment strategies and policies. Therefore, an overarching recommendation is that Namibia reviews its *investment policy* to take advantage of 4IR opportunities. Namibia can outline the strategy and incentive regime that prioritises investments in future technologies as part of its investment policy.

Recommendation 10: Improve Global Trade and Investment Environment

The CRA analysis recommended that reduction of barriers to e-commerce trade should be an area of particular focus for Namibia. Namibia is a small and globally peripheral market. To circumvent this, the economy is required to integrate as best as possible into flows of e-commerce and reduce barriers barring it from participating and competing. Connectivity, both through the necessary infrastructure as well as an enabling regulatory environment, is thus imperative. This will result in an improved driver of trade promotion, enhancing Namibia's competitiveness.

In accordance with the requirement to promote e-commerce, the regulatory environment needs to keep pace with developments in the marketplace, in particular relating to mobile money and cryptocurrencies. The CRA survey and Network Readiness Index lists Namibia as very weak in e-commerce, and this gap was echoed by interviewed stakeholders. The international global indices also point to the lack of e-commerce activity in the country owing to legislative and regulatory issues and processes of the stakeholders such as Bank of Namibia and Payments Association of Namibia. This regulatory obstacle is preventing Namibia from boosting its service exports.

For example, international payments (as cited by the Culture Creative Industry) are extremely problematic as their products and services such as music, software (apps), films, etc. are sold online via Youtube, Google Play, or Apple Store using most frequently PayPal, but the entrepreneurs and creators are unable to cash out such international payments in Namibia. These entrepreneurs must travel to South Africa and open a South African bank account at the same banks operating branches in Namibia to be able to cash out their international payments. Stakeholder engagements with all players such as Bank of Namibia, Payments Association of Namibia, Bankers Association, Namclear, commercial banks, and others have not yet yielded any concrete solutions as to why international operators such as PayPal (for instance) cannot operate in the country. The Bank of Namibia and Payments Association of Namibia indicated that international payments could be cashed out via Direct Payments Online (DPO), but this does not solve the obstacle for the more globally used PayPal accounts.

It is further recommended that a special ad-hoc committee comprising all players in the financial sector be appointed to resolve obstacles for e-commerce related hurdles and introduce mechanisms to enable citizens to cash out from PayPal accounts. This will enable the Culture Creative Industry, including tech entrepreneurs, to better promote their businesses by expanding beyond the geographic confines of the borders of Namibia and tapping into wider international marketplaces.

Innovation and Future of Production Systems

The CRA analysis points to the centrality of an innovation ecosystem in the support of entrepreneurship since firms in the private sector are key to the commercial application of knowledge and technological advances. According to the results of the CRA survey, innovation is prevalent in Namibia with over 70% of the respondents indicating an introduction of new or significantly improved services over the past 3 years, 56% introduced new or significantly improved processes, and 38% introduced new or significantly improved goods. Although Namibian organisations do engage in innovation, the levels of innovation at the country level are below what is expected for its level of income.

Moreover, most of those innovations have been facilitated by digital technologies, which already serves as an indication of their importance in the productivity and competitiveness of Namibia's industry in current times.

About 35% of the respondents in industry reported to have received support from a government agency in Namibia, and limited support from other organisations such as universities, incubators, etc. However, 64% of non-industry stakeholders seem to have received more support from the government than the private sector across the board. This imbalance is also visible in industry respondents' perception that they do not receive adequate support to develop tech-driven solutions.

Recommendation 11: Develop robust e-government services for 4IR

The CRA respondents generally perceived that the government is the main responsible stakeholder to develop the 4IR in Namibia. However, this perception needs to be changed, as all actors (private sector, academia, government and communities) are responsible for developing 4IR in Namibia. It is recommended that a Communication and Awareness Raising Strategy be developed and implemented to change the perception of actor roles in 4IR. This strategy can form part of the Consolidated 4IR Strategy for the country.

However, CRA respondents perceived the government's orientation to the future as low. Moreover, most government service provision is still predominantly manual and not responsive to the 4IR needs. Government's ICT infrastructure is outdated and skilled technical personnel are inadequate. Government also fails to attract and retain skilled human capital especially with the required advanced digital skills for the 4IR. The ICT budget allocations are too low to implement new systems, maintain or upgrade existing systems with the required software licences. These factors create barriers for e-government and digital government implementation.

It is recommended that the Office of the Prime Minister spearhead a comprehensive assessment of e-government and digital government needs and draw up a comprehensive intervention plan along with funding proposals to be implemented with the support of the proposed National AI Institute, OPM and NIPDB.

Recommendation 12: Strengthen Research and Development (R&D) capabilities for 4IR

The CRA respondents indicated that industry does engage in some forms of in-house R&D and experimentation with digital technologies. However, stakeholders during focus groups indicated that limited large-scale R&D activities are conducted in Namibia, and very few home-grown Namibia companies have their R&D facilities in the country. The R&D facilities are usually located elsewhere, e.g., in South Africa.

Namibia's R&D spending is still less than the 1% of GDP targets set by the Africa Union. In 2014, Namibia stood at 0.35% of the GDP for government spending on R&D,[66] but no newer figures were reported in the UNESCO reports. Globally such expenditure has increased, but all African countries have not met the targets. Sub-Saharan Africa's research expenditure has in fact dropped between 2014 and 2018 from 0.44% to 0.42%. South Africa has the highest scientific spending of 0.83% in 2018 followed by Egypt with 0.72%.

While Africa overall has increased scientific publications in niche areas such as AI and robotics, materials science, energy, biotechnology, nanoscience and electronics, which is considered a mark of economic and academic power,[67] Namibia is still lagging on this front. South Africa leads with 3 774 publications; Nigeria has 1 600 publications; Ethiopia has 305; and Ghana has 231, which represents more than 50% of Sub-Saharan Africa's total publications in artificial intelligence and robotics.

The number of full-time researchers and researcher density is another measure of country's R&D capabilities. Mauritius has increased its researcher density by 86.3%, Ethiopia (67.8%), Madagascar (45.4%), Togo (26.3%), South Africa (21.4%) and Uganda (15.8%).[68] It must be noted that according to UNESCO, the progress of scientific output in Sub-Saharan Africa is due to the 22 World Bank-supported centres of excellence that are producing high-quality graduates with an enrolment of more than 21 000 students in various programmes.

Tech hubs and incubators on the continent doubled since 2016 to 744, but almost half of them are located in just five countries, namely, Nigeria (101), South Africa (91), Kenya (70), Egypt (55) and Morocco (41).[69]

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[66] *UNESCO Science Report 2021*

[67] *https://www.universityworldnews.com/post.php?story=20210616151534847*

[68] *https://www.universityworldnews.com/post.php?story=20210616151534847*

[69] *https://punchng.com/africa-and-the-promise-of-research-and-development/*

Most R&D facilities in Namibia are concentrated at the Universities, while most R&D of the private sector is located outside the country. Thus, it is recommended that joint R&D facilities between government, private sector and academia are established.

It is recommended that R&D government expenditure should be increased with funding support from the private sector and international funders. It is further recommended that the private sector be incentivised with tax breaks for those setting up R&D facilities, conducting R&D or contributing to a centralised R&D government pool. Such tax breaks would increase R&D funding and activities throughout the country. An R&D levy should be considered for those multinationals who have any significant R&D facilities and activities in the country.

It is recommended to foster a conducive research, innovation and development (RID) regulatory framework to promote the realisation of commercialisation of products, processes and services from RID outputs enabled by 4IR-related policy instruments. The National Consolidated 4IR Strategy should include a technovation (technology + innovation) strategy considering local strengths and a global view for the implementation of contextual action plans as well as a monitoring and evaluation system.

Recommendation 13: Establish a National AI Institute

The CRA analysis indicated that cybersecurity, machine learning, cloud computing and artificial intelligence are priorities for companies in Namibia in the coming years. However, industry also indicated "difficulty integrating the technology into the organisation's processes" and a "lack of knowledge about possible applications of the technology" as reasons for slow 4IR technology adoption. Specialist digital skills were indicated as lacking for 4IR technology adoption.

It is *recommended* that Namibia should establish a National AI Institute to coordinate AI and R&D efforts; facilitate the development and use of trustworthy AI systems in public and private sectors; prepare the present and future labour force for the integration of AI systems across all sectors of the economy and society; and coordinate ongoing AI activities across all government agencies to ensure that each informs the work of the others.[70] These efforts should be complemented with the innovation hubs that will provide upskilling and reskilling and innovation solutions for even the unemployed to beprepared for 4IR employment.

A National AI Institute will have an overarching responsibility to oversee all initiatives pertaining to AI and 4IR in the country. As such, the aims of the Institute will be to conduct research and development of AI and other emerging technologies, encourage its adoption, promote innovation incubation, recruit and grow pools of expertise and harness AI capabilities to solve national challenges. The Institute will also have to ensure that the development of AI and associated technologies are ethical, responsible, inclusive and reflect the Namibian values. The AI Institute should work in concert with NCRST, universities, research institutes

[70] https://public-inspection.federalregister.gov/2022-12139.pdf

and centres, private sector and OMAs. A portion of its human resources could be a pool of secondments from those sectors. It is recommended that this national AI Institute reports to the Office of the Prime Minister and is supported by the National 4IR Commission and NCRST to ensure maximum efficiency and access to all resources.

The CRA survey indicated that the top sectors identified for application of 4IR were: IT, education, energy, the financial sector, media and communications, advanced manufacturing, health, agriculture and the informal sector. Tourism was added as per stakeholder engagements.

It is recommended that the AI institute focus initially on those key sectors as identified in the CRA. Particular attention will be paid to cybersecurity, blockchain technologies, IIoT, AI, industrial robotics and big data. This AI institute should in particular, but not limited to, support the emerging Green Hydrogen economy. As such, the AI Institute is to accelerate R&D and innovations in the technology and engineering space for the Green Hydrogen sector.

Finally, the National AI Institute should provision a strategy to become self-sustaining and develop a new industrial ICT service sector for Namibia.

11. Implications and Impact Analysis

Implications for Private Sector:

Given that the lack of capital was identified as the most significant reason for not adopting 4IR technologies in the CRA data, Namibia could work on attracting Foreign Direct Investment (FDI). As it does this, Namibia should consider that FDI does not flow without a conducive legal and institutional environment. For instance, the CRA data suggest that non-tariff barriers limit the ability of imported goods to compete in Namibia's domestic market. According to the WTO, non-tariff barriers typically include trade requirements such as import licensing, pre-shipment inspections, rules of origin, custom delayers, and other trade restriction mechanisms that restrict the free movement of goods and services. Typically, non-tariff barriers are a mechanism by developed nations to control imports of goods and services. However, before any non-tariff barriers mechanism is deployed, the domestic availability of such goods or services is assessed. Given that 4IR Technologies would typically comprise investments in imported infrastructure, Namibia could harmonise its non-tariff barriers, notably the 4IR technologies, to promote foreign investments in this area, This could be done by reviewing the investment policy in conjunction with the trade policies to take advantage of 4IR opportunities.

The Namibian government's ability to harness the 4IR will rely heavily on forging fruitful and collaborative partnerships between all the role players in the society, particularly the government and the private sector. As such, the government should not only rely on FDI to drive domestic 4IR investments; it should also galvanise the support of the domestic private sector capital providers. Furthermore, for this partnership to be mutually beneficial, the

domestic investment policies should accommodate the strategy and incentive regime that prioritises domestic investments in future technologies.

Industry's identified lack of skills for using (and creating) 4IR technologies and the lack of knowledge about possible applications of 4IR technologies was another significant reason for not adopting 4IR technologies in the CRA data. This could be addressed both in the short and long term. In the short term, multi-model skilling methods such as VR/AR and MOOCS should be considered to plug the gap. Namibia should establish the National AI institute to coordinate national AI research, innovation and development efforts in the medium to long run. Since cybersecurity was also raised as a concern, the envisaged national AI institute could also facilitate the development and use of trustworthy AI systems in the Namibian public and private sectors.

In summary: the private sector can potentially benefit when trade barriers are reduced and a more conducive environment is developed for businesses to adapt to the 4IR. Some of these considerations include recommendations to address the e-commerce barriers, improve the ease of doing business through enhanced e-government service provision, introduce more tax incentives, improve the availability and quality of skills, review immigration policies for scarce and specialists skills, prioritise the country's cybersecurity framework, increase support of businesses, MSMEs and tech entrepreneurs for pivoting to 4IR and the digital economy, revise policies and legislation and improve 4IR infrastructure, whilst the AI Institute and improved data availability can foster innovation and R&D support to improve products, services and market access using 4IR technologies.

Public sector

The public sector can potentially benefit from the recommendations for a consolidated 4IR strategy and 4IR Commission to assist with coordination, since lack of coordination is one of the biggest pain points expressed, as well as oversight of 4IR technology development, implementation monitoring and evaluation. Potential solutions are offered for resource mobilisation via foreign direct investment and domestic private sector financing for skills development andinfrastructure.y. The National Data Centre (especially a green data centre) and the AI institute will go a long way in ensuring data ownership, availability, and a focus on developing solutions to Namibian problems, including the development e-government services. The AI Institute could potentially assist in developing a new service industry and digital economy such as developing 4IR platforms, products, services for government, private sector and internationally. The AI Institute should also be positioned to move beyond self-sustainability and become a player in attracting and generating revenue for the country. These two entities can also support the new Green Hydrogen economy.

A key weakness raised in the situational analysis was that there was a lack of coordination resulting in silos, fragmentation across data, infrastructure, governance, operational structures, sectoral policy, and legislative processes. The envisaged National AI institute and National 4IR Commission could also coordinate all ongoing AI activities across all Namibian

government agencies. This would ensure that each government agency informs the work of the others.

Educational institutions

Implications for educational institutions are a focus on the opportunities for the education sector from basic education, vocational education and higher education to lifelong learning. These recommendations also include suggested solutions for key areas of focus such as provision of advanced digital skills and qualifications, innovation platforms, internship and apprenticeship funding and opportunities to participate in development of R&D infrastructure. The assessment also makes recommendations for a change in teaching methods, delivery modes, content, teacher training and school infrastructure to teach a 4IR ready workforce. Furthermore, specific recommendations focus on providing upskilling and reskilling as well as business opportunities for unemployed youth.

General public

The general public might benefit from all recommendations if implemented. These recommendations address e-government service provision, improved ICT and power infrastructure and lower cost of data and devices, access to upskilling and reskilling programmes for unemployed youth, a paid national internship programme, improved education, digital innovation facilitated by a conducive legislative framework such as fewer barriers to e-commerce, payment gateways and forex, as well as consideration for responsible and ethical AI development. Furthermore, the general public might also benefit from free online training programmes facilitated by lower data and device costs and more financing support for digital innovations.

12. Conclusion

The Task Force on the Fourth Industrial Revolution fulfilled the mandate with its terms of reference within a relatively short period of time given the depth, breadth, time and resources that a country's 4IR readiness assessment normally requires. The task was carried by taking stakeholder concerns into consideration, whether they were sourced from focus groups, general and high-level engagement sessions, interviews, social media, print media, radio and television, the National 4IR Conference and Expo and CRA survey. Further inputs were captured through secondary sources such as literature global index reviews.. A limitation of this study is that absolute inclusivity of stakeholder consultations might not always have been possible due to resource and time constraints. Therefore, the capturing of inputs via different public communication and media platforms and the multi-method approach was used in an effort to address inclusivity.

The different sources of data collected served as triangulation and verification of the importance of the top issues defined as areas for improvement and harnessing the

opportunities presented by the 4IR. These top issues are captured in the recommendations and proposed ownership is assigned to different entities.

The 4IR conducive environment is a prerequisite for the unfolding new Green Hydrogen economy and much of the concerns captured through this readiness assessment also pertain to the Green Hydrogen initiatives. Therefore, addressing these recommendations also synergises and benefits the Green Hydrogen initiatives.

The Task Force members fulfilled its mandate *pro-bono* and were equally supported *pro-bono* by numerous volunteers and dedicated research support from University of Namibia, Namibia University of Science and Technology as well as the University of Johannesburg. Multiple individuals have also supported the task as volunteers. Many organisations and OMAs came on-board and supported or sponsored the highly successful Namibia 4IR Conference and Expo.

In my capacity as Chairperson, I, therefore, wish to thank the Task Force members, all stakeholders, support staff from various OMAs, all volunteers, the Vice Chancellors of the three participating Universities for availing resources and staff, all sponsors and exhibitors of the Namibia 4IR Conference and Expo and media outlets. In particular, I wish to thank Prof. Erika Kraemer-Mbula and her team from University of Johannesburg, and Prof. Stephen Gilbert from University of Namibia for the dedication on the CRA; Ms Silke van der Merwe as Project Manager and Ms Daisry Mathias, Presidential Advisor for Youth and Enterprise Development, in her capacity as ex-officio member from the Presidency.

Finally, I'd like to extend gratitude to His Excellency, President Dr Hage Geingob, for the wisdom and foresight to establish the Task Force, appointing an excellent team, and entrusting me to lead the Task Force.

Prof. Dr. Anicia Peters
Chairperson: 4IR Task Force

APPENDICES

Appendix A: Acknowledgements

Acknowledgements go to:

- Workstream leads and volunteers
- Country Readiness Assessment Framework Survey and Analysis volunteers
- 4IR Conference & Expo Core Organising Team
- Project Team
- OMAs support personnel
- NIPDB
- PDU

We wish to thank in particular, Prof. Erika Kraemer-Mbula and her team from University of Johannesburg for supporting the development of the Country Readiness Assessment Framework, survey and analysis. Prof. Stephen Gilbert from the University of Namibia supported this effort.

A special thanks also to Ms Silke van der Merwe (Project Manager), Ms Chero Ripunda and Ms Daisry Mathias, Presidential Advisor for Youth and Enterprise Development.

As well as thank you to all other helpers, sponsors, panellists, speakers, exhibitors and attendees that made Namibia's first 4IR Conference and Expo a huge success.

Appendix B: Task Force Mandate Implementation Plan Executed

Activity	2021						2022							
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
TF Appointment	X													
Review TOR	X	X												
Form WS	X	X												
Workshop I		X												
Desk Review	X	X	X	X	X	X	X	X	X	X	X			
Stakeholder Engagements			X	X	X		X	X	X	X	X			
Benchmarking						X	X	X	X	X	X	X		
Workshop II									X					
Change Readiness Survey										X	X	X		
Analysis											X	X	X	
Namibia 4IR Conference & Expo												X		
Stakeholder Validation									X	X	X	X	X	
Report compilation												X	X	X
Submission														X

Appendix C: List of Stakeholders Engaged

Financial Sector
AgriBank
Bank of Namibia
Bank Whk
Bankers Association Namibia
Capricorn
First National Bank
First Rand
Ministry of Finance
NamClear
NASIA
Nedbank
Payment Association of Namibia
Procurement Policy Unit
Standard Bank

Mining and Engineering
Chamber of Mines
Engineering Council of Namibia
Engineering Professions Association of Namibia
Namcor
Namdeb
Namibia Engineering Society
Namport

Tech Start-Ups
Dololo
FoxGlove
GIZ StartUp Namibia
Green Team Consultants
JABU
Outeku Technologies
Pay Today Namibia
Tara Nawa Computer Software Solutions
Taxi Connect
VEYA
Window Connect

ICT and Data
Complete Entreprise Solutions Namibia
Data Continuity Namibia (DCN)
DOT NA
Green Enterprise Solutions
Impact Tank
Internet Society
IT Guru Solutions
Jumper Namibia
Microsoft 4Afrika
Namibia Qualifications Authority
Namibia Statistics Agency
Office of the Prime Minister
Salt Essentials
Syntex Technologies Namibia

Government and Agencies
Association of Local Authorities in Namibia (ALAN)
Association of Regional Councils in Namibia (ARC)
BIPA
CRAN
Khomas Regional Council
Minister of Defence
Minister of Home Affairs, Safety & Security
Ministry of Education, Arts and Culture
Ministry of Finance
Ministry of Higher Education, Technology, and Innovation
Ministry of Home Affairs
Ministry of Industrialisation and Trade
Ministry of Information and Communication Technology
Ministry of Justice and Attorney General
Ministry of Labour, Industrial Relations & Employment Creation
NAMFISA
Namibia Central Intelligence Services
Namibia Statistics Agency
National Assembly ICT Committee
National Council
NIP
NIPDB
Office of the Prime Minister
Social Security Commission

Infrastructure
Electricity control board
Erongo RED
MTC
MTN
Namdock
Nampower
Namwater
PowerCom

Telecom
Total Energies

Health and Services
Deloitte
IntraHealth Namibia
Prosperity group
PwC

Associations
Association of Local Authorities
Association of Regional Councils
NAM-MIC
Namibia Employers Federation
Namibia Engineering Professions Association
Namibia Trade Forum
NCCI
Rural Farmers hub
Team Namibia

Other Private Sector
AcuNam
Business Intelligence Dynamics
Cannabis and Hemp Association of Namibia
Namib Mills
Onix
PAX African group
SnorusMaximus & Lekr

Education
NCHE
NCRST
NQA
NTA
NUST
UNAM

International Organisations
FAO
GIZ
UNESCO

Local Authorities
All Local Authorities through the ALAN Congress and sectoral engagements

Appendix D: 4IR Conference & Expo Agenda

Tuesday, 7 June 2022 (Public Expo)			
08:00	17:00	Conference Delegate Accreditation	
10:00	17:00	4IR Expo Open to Public	
Expo Opening & Cocktail Reception Master of Ceremony: Ms. Daisry Mathias, Presidential Advisor: Youth Matters & Enterprise Development, Office of the President			
17:30	18:00	Arrival of invited guests	Sponsors, Exhibitors, Industry Guests & Speakers
18:00	18:15	Welcoming Remarks	Prof. Anicia Peters, 4IR Task Force Chairperson
18:15	18:45	Keynote Address	Hon. Dr. Peya Mushelenga, Minister of Information & Communication Technologies
18:45	19:15	Main Sponsors Statement	
19:15	19:30	Vote of Thanks	Mr. Dino Ballotti, 4IR Task Force Deputy Chairperson
19:30	21:00	Cocktail Reception & Networking	

Wednesday, 8 June 2022 (Closed Conference)			
Director of Proceedings: Hon. Christine //Hoebes, Minister in the Presidency			
7:00	**7:30**	**Arrival of Guests**	
7:40		Arrival of Rt. Hon. Saara Kuugongelwa-Amadhila, Prime Minister	
7:45		Arrival of H.E. Dr. Nangolo Mbumba, Vice President	
7:50		Arrival of H.E. Dr. Hage G. Geingob, President of the Republic of Namibia	
8:00	8:20	National & AU Anthems	
8:20	8:40	Remarks & Introduction of Keynote Speaker	H.E. Dr. Nangolo Mbumba, Vice President
8:40	9:10	Keynote Address and Official Opening of Namibia 4th Industrial Revolution Expo and Conference 2022	H.E. Dr. Hage G. Geingob, President of the Republic of Namibia
9:10	9:20	Entertainment	Collective Singers Choir
9:20	10:00	**End of Opening Ceremony** **Group Photo & Tour of Expo** **Tea Break**	
10:00	10:20	4IR Task Force Overview	Prof. Anicia Peters, 4IR Task Force Chairperson
10:20	10:40	Country Readiness Assessment Presentation	Dr. Erika Kraemer-Mbula
10:40	10:50	Breakaway session - Overview	Director of Proceedings
11:00 - 12:00		#1 4IR Infrastructure and National Data (Venue: Breakaway Room – Namib 1)	Presenter & Moderator: Ms. Nashilongo Gervasius
		#2 Future of Work and Labour Force Reskilling (Venue: Main Plenary – Kuiseb)	Presenter & Moderator: Prof. Kenneth Matengu
12:00 - 13:00		#3 Industry, SME & Investment (Venue: Breakaway Room – Namib)	Presenter & Moderator: Mr. Dino Ballotti
		#4 Policy, Regulation & Governance (Venue: Main Plenary - Kuiseb)	Presenter & Moderator: Ms. Grace Hamauka
13:00	14:00	**Lunch**	
14:00 - 15:00		#5 Research & Development (Venue: Breakaway Room – Namib)	Presenter & Moderator: Dr. Erold Naomab
		#6 4IR Core Technologies (Venue: Main Plenary - Kuiseb)	Presenter & Moderator: Prof. Anicia Peters
15:00 - 15:30		**Tea Break**	
		Closing Ceremony	Main Plenary - Kuiseb)
15:30	16:00	Perspective on South African implementation experience on outcomes of the Presidential 4IR Commission & lessons learned	Phila Sithole: Head 4IR Performance Management Office
16:00	16:30	Conference Reflections & Way Forward	Prof. Anicia Peters
16:30	16:50	Gift Handover and Vote of Thanks	Rt. Hon. Prime Minister, Dr. Saara Kuugongelwa-Amadhila
16:50	**17:00**	**AU & National Anthems**	

Appendix E: Detailed Workstream Reports

Workstream 1: Infrastructure and National Data

Introduction

For the Fourth Industrial Revolution (4IR) to fully take off, an effective, agile, and reliable core infrastructure and data system are core requirements. The "always on" factor of the data systems requires reliable energy and ICT infrastructures. Hence infrastructure energy pillars will enable Namibia to be an equitable participant in the digitally connected world and offer a digital alternative to the current paper-based approach to services and solutions.

To be environmentally sustainable, the drive towards clean and renewable energy should remain at the core of the 4IR. This assertion is supported by the Paris Agreement and amplified by COP26.

Furthermore, reliable, accurate, standardised, integrated and easily accessible citizen data is critical for building e-government services across sectors such as health, transport, and justice (PC4IR, 2021).

Workstream 1 relied largely on qualitative data methodology, using collection instruments such as desktop research as well as focus group interviews with key stakeholders. Further, a quantitative approach has been integrated through the national assessment framework. Thus, stakeholder engagements were key in teasing out key issues discussed in this report.

ICT Infrastructure

In its long-and short-term economic development goals, Namibia has set itself to be a knowledge-based economy by the year 2030. With only 51% of its 2.56 million population connected to the Internet, Namibia should look at accelerating the deployment and availability of affordable, accessible, versatile internet connectivity through reliable ICT infrastructure. The preparation toward these efforts requires significant actions providing improvements towards the global indexes related to the measurements of the country's infrastructure competitiveness.

Of most importance is the Global Competitiveness Index, which in (2019) has placed Namibia at number 67 on infrastructure competitiveness. The Index rates technological readiness at 89 out of the 137 assessed countries with an overall ranking of 91, while the technological sector score stands at 48.1 across all soft infrastructure indicators. Furthermore, this score considers ICT adoption factors such as mobile-cellular telephone subscriptions, mobile-broadband subscriptions, fixed-broadband Internet subscriptions, fibre internet subscriptions, and internet users as a percentage of the population, making it a key consideration for 4IR readiness performance. To meet the requirements of the 4IR, it means Namibia must improve its rankings and infrastructure competitiveness.

The Global Connectivity Index, which is key in assessing Broadband, Cloud, AI, and IoT as technology enablers, has ranked Namibia overall at 74/79 and with a score of 28 out of 120 on connectivity speed. On broadband connectivity, the Index ranks Namibia at 116th globally on mobile speeds. The country is also ranked 141st in the fixed broadband speed category in 2021.

Furthermore, Namibia has been ranked at 84 with a zero (0) score on indicators regarding both government and private sector's willingness to make Wi-Fi and 5G available by the Inclusive Internet Index (2020).

Most importantly, Namibia is also ranked at number 103 in the Network Readiness Index, with an overall score of 40% and below, across all indicators of **technology, impact, people and governance**. However, with an average score of number 88 in the indexes, a lot needs to be achieved for Namibia to benefit from rapid technological connectivity and development.

Key ICT Statistics (CRAN 2022)

- 62 Telecommunications Service Licensees
- 38 Broadcasting Licensees
- 1,328 base stations
- 1 Postal Services Operator

Statistics on Network Coverage (source CRAN 2022)

- Fibre optic cable coverage; 16 524 km
- Internet Users; 51%[71]
- Mobile connectivity; 96%
- National coverage by 4G; 79%
- National coverage by 3G; 89%
- National coverage by 2G; 96%
- Total Broadband Coverage 90.2%

Regions with the lowest 4G coverage (Source: CRAN 2022)

- Kunene; 33%
- Kavango West; 40%
- Omaheke 48%

Regions with the lowest Networks Infrastructure Distribution

- Kavango West; 2.64%
- Kavango East; 3.46%
- Zambezi; 3.46%
- Omaheke; 5.05%

[71] CRAN plus https://datareportal.com/reports/digital-2021-namibia. Other sources cited in the CRA indicate it as 41%

Energy Infrastructure

Technology operations and maintenance in the 4IR are highly dependent on energy. With a national energy supply of 56.3% (World Bank, 2021), Namibia should aim for a sturdy increase in energy supply, providing an opportunity for increased Green Hydrogen energy supply as the country is set to be a lead producer in Africa.

Namibia's main sources of energy are petroleum, hydropower, imported electricity, and coal power, of which the internal power supply amounts to less than one - third of its national energy requirements, creating further opportunities for alternative power supply aimed at meeting the needs of the country.

According to data from the World Bank (2021), the following are some of the energy related statistics for the country.

- Access to electricity: 56.3%
- Energy Imports net: 74.44%
- Fossil Fuel Energy Consumption: 66.72%

National generated electricity sources are:

- Hydroelectric power plant on the Kunene River in Ruacana
- The 120 MW van Eck coal-powered plant north of Windhoek
- Paratus 24 MW heavy fuel-oil powered plant in Walvis Bay
- The 5.78 MW solar plant in Trekkopje in the Erongo region

The renewable energy usage is still small-scale in the country at an estimated 8%, with a current production of 19.5 MW via solar photovoltaic power to the national power grid. In 2019, NamPower, the national power distributor launched a fibre optics project called Grid Online,[72] facilitating a clean and fast wide area network and offering the highest capacity of any internet network connection. This project has been described as the future of digital communication through enhancing fibre optic capabilities through a core competency of the transmission network. While Grid Online focuses on communications rather than power, a fiber optic network uses much less energy than traditional copper wire networks, saving energy for the country.

Due to the vastness of the country coupled with the small size of the power sector, low load densities and long distances between major load centres, energy demands needed for ensuring total nation benefits in the 4IR are set to significantly increase. In this regard, the national Green Hydrogen Production Project, launched in August 2021, will enable the

[72] *https://neweralive.na/posts/nampower-launches-fibre-optic-grid-online*

production and distribution of sustainable and clean renewable energy for the country and whole SADC region.

While Namibia was ranked 105th (NRI, 2019) in the utility infrastructure indicators (electricity access and electricity supply quality), the country still holds as much potential for solar, wind and biomass generation, which have been identified as better energy sources over the years. This combination will allow for a large-scale bioenergy-based production capacity.

Namibia's uranium production is listed amongst the top 10 countries in the world with a production of 8.2% of the global uranium, positioning it as a sustainable renewable energy. Earlier predictions suggested that by 2020, renewable resources could contribute up to 20% of the national electricity production globally. While has not yet happened in Namibia, technologies such as wind, solar hydro and biomass could become economically viable without any subsidies within the next 10 years.

National Data

National data in Namibia is managed through and by diverse processors and collectors, who are both public and private entities. However, evidence of fragmentation of data usage and management is common amongst the OMAs who collect and use data for various purposes such as:

- Office of the Prime Minister: data on public service
- Ministry of Information, Communication and Technology: data on ICT infrastructure
- Ministry of Trade and Industry: data on business and trade registration
- Ministry of Home Affairs and Immigration: national identification, death and immigration data
- Ministry of Defence: national security data
- Ministry of Higher Education, Technology, Innovation: funding, student registration and qualifications data
- Ministry of Labour, Industrial Relations and Employment Creation; employment, social security data
- National Statistics Agency: national data collection and analysis
- Ministry of Land and Resettlement; communal and commercial land registry
- Ministry of Finance; tax registration and collection purpose

Through sector consultation carried out for the purpose of this national assessment, evidence has emerged that the fragmentation of data is mostly due to lack of coordination, dealing with multiple interoperable systems, lack of data-governing law and largely lack of awareness of the data value. Furthermore, concerns exist about the security of data particularly related to the storage of such data in the country, and this has led to severe data restrictions and/or openness about who accesses such data. Largely this situation has been enabled by legacy contracts that ties the hands of OMAs on interoperability, storage and access to data in donated and foreign purchased systems.

On the other hand, trends on data storage in the private sector shows that local data is being stored by both local and multinational institutions preferably out of the country and this is corroborated by preference to conduct research and development out of the country by private sector. Furthermore, local investments and development of data storage systems has failed to gather public interest despite local incentives.

Key issues

ICT Infrastructure

The country is home to well-established but decaying ICT infrastructures for ordinary broadband and public service provision. Over time, this has led to inconsistent and unreliable connectivity supply.

Generally, Internet connection in the country is provided for at least over 1,300 base stations, of which over 35% belong to Telecom Namibia.

Unfortunately, the sector does not receive dedicated national funding or investment. Current investments in the sector are sole initiatives of the private sector. This presents an opportunity for Public Private partnership for the immediate future. As acknowledged and underscored through national policies and guidelines, practical lack of infrastructure sharing across sectors poses current and long-run challenges.

A national resource that could funnel in funds for the development of infrastructure or the ICT sector in general, is the .na (the country domain name) that remains privately-owned with no tangible sectoral or national accountability or value mechanism in place. Other means of developing the sector through the Universal Service Fund (USF) have remained dormant for the past 10 years owing to a supreme court ruling.

Furthermore, the **cost of devices** and ICT related equipment are relatively high as highlighted by Govt Gazette no 7308,[73] highlighting cost of import taxes, high cost of rolling out and expensive telecommunications networks amongst others.

The above as related to infrastructure bears direct implications to cost of data, doubly worsened by lack of infrastructure sharing.[74] Consequently, “Namibia is one of the most expensive countries in Africa for mobile broadband. The price of the cheapest product available in Namibia in Q1 2021 for 1GB monthly prepaid usage was USD 8.3. In comparison,

[73] https://gazettes.africa/archive/na/2020/na-government-gazette-dated-2020-08-14-no-7308.pdf

[74] https://www.eaglefm.com.na/news/lack-of-competition-makes-data-expensive-in-namibia-cran/

the same basket costs 60 US cents in Egypt, USD 4.7 in South Africa or even USD 4.3 in DRC Congo"[75] according to CRAN 2020 Market report.

IXP: In collaboration with the African Union Commission through the African Internet Exchange System (AXIS) Initiative, Namibia became one of the African countries owning an Internet Exchange Point (IXP) in 2014.[76] To date, 15 ISPs are members of the exchange point, however the IXP has faced challenges in the past related to the ageing of the equipment.

WACS: In 2011[77] the first West Africa Cable System (WACS) landed in Namibia owned by Telecom Namibia. In 2012, Mobile Telecommunication Limited (MTC) announced connectivity to the West African Cable System (WACS) via Cape Town by consortium means.[78]

Additionally, Paratus and Telecom Namibia announced a signing of an agreement[79] to land the Equiano subsea cable in Namibia in 2021. The subsea cable has consequently landed in Namibia in early July 2022[80] and is set to provide Namibia with the necessary redundancy. Furthermore, Telecom Namibia is reported to hold local ownership of the South Atlantic Telecommunications cable (SAT-3/WASC), however with no landing point.[81] This has resulted in a coverage of 24,856 km through fibre optic cables, connecting major towns through a fibre point of presence. With one Point of Presence (PoP) for access to the public service information, the fibre cables have also been extended to four bordering countries, Botswana, South Africa, Zambia and Angola, according to information from the Ministry of ICT.

The submarine cables' presence in the country has provided an opportunity for reducing the price of broadband, which would translate into many possibilities in the ICT sector of the Namibian economy. However, that remains to take place, as the country broadband prices remains amongst the highest according to Atlas and Boots.[82]

USF: The Universal Service Fund (USF) provisions are made through Section 57 of the Communications Act of 2009, which directs the implementation to be made under regulator CRAN and supported by funding by a levy of licensed operators' turnover. Unfortunately, the

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[75] https://www.cran.na/yglilidy/2022/03/CRAN-Presentation-Market-Report-Universal-Service-Data-Study-2020-Termination-Rates.pdf

[76] *AU, 2014 "Launching of Internet Exchange Point in Namibia" https://au.int/sw/node/27258*

[77] *Telecom Namibia, 2011 "WACS Submarine Cable Lands in Swakopmund Today" https://www.telecom.na/media-centre/260-wacs-submarine-cable-lands-in-swakopmund-today*

[78] *MTC (2012), MTC Welcomes WACS, https://www.mtc.com.na/uploads/press_releases/MTC_Welcomes_WACS.pdf*

[79] *Submarine Cable Networks (2021) "Paratus and Telecom Namibia to Land Equiano Cable in Namibia" https://www.submarinenetworks.com/en/systems/euro-africa/equiano/paratus-and-telecom-namibia-to-land-equiano-cable-in-namibia*

[80] *Equiano cables lands in Namibia, 6th J ly 2022, https://www.submarinenetworks.com/en/systems/euro-africa/equiano/equiano-cable-lands-in-namibia*

[81] *https://www.submarinenetworks.com/euro-africa*

[82] https://www.atlasandboots.com/remote-work/countries-with-the-cheapest-internet-world/

fund however has never become operational as a Supreme Court ruling of 2018 declared the collection of the levy as unconstitutional. To date, consultations on the levy application continue between the regulator and willing licensees. Recently, MTC and CRAN have settled on the licensing fee collection and usage, paving the way for initial steps towards the Universal Service Fund. Furthermore, the decision of Telecom and other licensees on the collection of the levy that makes up the fund is yet to be publicly articulated on the background of the court case and against recent consultations by the regulator.

Public Wifi: Reports about open and free internet in Windhoek[83] and the coastal areas has made rounds since 2017 through experimental collaborations by investors.[84] However, no evidence exists that these have reached critical mass. On the other hand, private establishments particularly in the city (shopping malls) offer limited free connectivity to their patrons as part of the shopping experience. However, no government or private sector initiatives regarding free public Wi-Fi exist in the country, even though public access Wi-Fi provides the first step to real connectivity. However, the government's Regional ICT Centres[85] offer free broadband connectivity to the users.

5G: In 2020, Cabinet directed[86] the Ministry of Environment, Forestry and Tourism and MICT to undertake a Strategic Environmental Assessment (SEA) prior to the possible introduction of 5G technology in Namibia. This marked the country's first step towards considerable effort on 5G. The results of the SEA are yet to be availed to the citizens. However, MTC, Paratus and Huawei have all been vocal about making 5G available for telecommunications usage.

In terms of **Broadcasting,** the country has 342 FM transmitters, 57 TV transmitters and 36 studios owned by the National Broadcaster. Additionally, the regulator to date has issued 36 broadcasting service licences and 2 signal distribution service licensees in Namibia. Of these, 20 licences are for commercial broadcasting and 16 for community broadcasting. Namibia was one of the countries earlier completing the Digital Terrestrial Television migration already in 2015[87] and the completion of that, was deemed to free up an unprecedented amount of TV White Space (extra room for other information flow in the communication spectrum).

Postal: The postal holding owns 137 Post Offices countrywide, which over the years have increasingly been transformed to offering financial services including FinTech.
Based on the stakeholder consultation meetings with the ministry on ICT and other telecommunication sectors in the country, the sectoral SWOT analysis provided the findings below.

Energy Infrastructure

[83] https://www.namibian.com.na/167053/archive-read/Windhoek-to-provide-free-Wi-Fi
[84] https://wifinowglobal.com/news-and-blog/namibia-seeks-nationwide-wi-fi-access/
[85] https://www.neweralive.na/%2Fen%2Fposts%2Ftheofelus-wants-visible-ict-centres
[86] https://twitter.com/mictnamibia/status/1286299605156716546?lang=en
[87] https://www.news24.com/fin24/tech/news/namibia-beats-sa-to-digital-terrestrial-tv-20150202

The country's mandate for energy falls under the Ministry of Mines and Energy. The local energy production is mostly via hydro means. While 75% of Namibians in the urban areas enjoyed access to energy in 2015, only 24% of their fellow citizens in rural households had electricity in their homes. As a result, only 50.4% of Namibian households nationwide have access to electricity. In 2015 about 63% of the energy requirement in Namibia was imported from neighbouring countries South Africa and Zimbabwe through Eskom. The maximum electricity demand is around 656 MW while at most only 484 MW is produced domestically. The use of renewable energy is still at a small scale and is contributing only 19.5 MW via solar photovoltaic power to the grid. Despite this, the country is expecting the energy demand to reach around 755 MW by 2022 due to the mining, water pumping, agriculture and construction sector and urban growth demand. It is of the desired outcome that by 2022 Namibia has a sustainable mix of locally generated energy capacity of 755 MW to support household and industry development.[88]

NamPower is the main distributor of energy in the country, and it is guided by the law and regulatory policies. However, the company's being the only energy distributor in the country poses major concerns as to why the country's energy consumption, rate tariffs and price remain very high. Other challenges to delivering energy that are faced by the country include: the vastness of the country, the small size of the country's power sector, low load densities and long distances between major load centres.[89] While the 4IR will require more energy, the country is prepared lately to embark on the national Green Hydrogen production project that will enable distribution of sustainable and clean renewable energy for the country and whole SADC region. The Green Hydrogen project was launched in the country as part of the Harambee Prosperity Plan II in August 2021.

Currently, however, the country remains heavily reliant on energy imports. Newer energy infrastructures have not received momentum for further development with the aim to fill existing gaps. Further, nationally the pace has not been set yet for enforcing dual or triple supply of services at one go, for road/energy/ICT infrastructures, despite attempts by the national power supplier.

National Data

Lack of cohesion in data usage is a current stumbling block in unlocking data value for innovations and service delivery. The lack of interoperation of data systems poses a resource gulping challenge, as many of these systems are contract-bound, which ties the hands of "owning" entities in terms of management of these systems. Consultations revealed that government data systems are operated and updated in countries such as India, China, Russia

[88] *https://www.ecb.org.na/images/docs/Investor_Portal/NDP5.pdf*

[89] *https://www.weforum.org/agenda/2021/10/namibia-is-positioned-to-become-the-renewable-energy-hub-of-africa/*

as well as other countries, where data such as the national birth registry, electoral data, land and others as illustrated in the introduction of this report are held. To date, the National Statistics Agency is the leader in handling large sums of national data in the forms of various statistics, with other entities following on. While data processing centres of the agency are seen in the city, it is commonly known that data processed by the private sector, particularly by banks, insurance and related sectors, is largely stored and processed out of the country. This follows the origins of these entities and priority in research and development as well as collaborative investment by this sector.

Consultation also revealed that attempts to build and develop data centres locally have produced samples of diverse centre products as far as 2015 by MTC. However, the entity bemoans lack of trust even by fellow public institutions including ministries and parastatals in utilising the centres. MTC related how it offered the data centres usage for free for a period of a year and thereafter for minimal fee compared to fees currently paid out to external entities. It was announced in March 2022[90] that Paratus was launching a data centre in Windhoek offering securing to multi-tenants in a co-location and caged environment. To date, the centre has been launched, serving as the entity's first data centre in the country and contributing to the localisation of data as an increase in the collection, processing and storage of both public and personal data continues in the country. The worry, however, remains with the lack of an enabling law that currently presents vulnerabilities to personal and public data. The obvious lack of effort in the investment in national data centres and the preference to store national data out of the country are underlying reasons for lack of trust in data handling, which presents a compelling case for the Data Protection law to be effected, especially in the face of various data breaches reported in the country.[91, 92, 93]

[90] *https://www.datacenterdynamics.com/en/news/paratus-launches-namibian-data-center-in-windhoek/*

[91] *https://economist.com.na/71100/retail/shoprite-data-breach-in-namibia-zambia-and-eswatini/*

[92] *https://www.namibian.com.na/178310/archive-read/SSC-leak-exposes-personal-info-online*

[93] *https://neweralive.na/posts/opinion-data-protection-and-privacy-in-namibia-through-COVID-19-lenses*

Strengths	Weaknesses
● *ICT Infrastructure* There exists a diverse form of infrastructure in the sector ranging from tower masts to the WACS cable, the Internet Exchange point to soft infrastructure that entail national operating infrastructures, to the domain resource and broadband spectrum. ● *Energy Infrastructure* With just over 50% of the country having access to energy supply, the prospect for technology uptake based on energy supply and grid availability is likely to increase. ● *National Data* The value of the national data is increasingly being determined through and by usage to provide services nationally by a diverse sector player both in public and private sectors.	● *ICT Infrastructure* The country is home to decaying ICT infrastructures for ordinary broadband and public service operation. This has led over time to inconsistent and unreliable connectivity supply. While acknowledged and underscored by various national policies and guidelines, practical infrastructure sharing poses current and long-run challenges. The sector does not receive national investment as all investments are solely run by operators. A national resource that could bring in funds for the development of the infrastructure or ICTs in general as a sector (the domain name) remains privately-owned. Such resources remain privately owned with no tangible sectoral or national accountability processes in place. Other means of developing the sector through the Universal Service Fund (USF) have remained dormant for the past 10 years. ● *Energy Infrastructure* The country remains heavily dependent on energy imports. Newer energy infrastructures have not received development momentum to fill the existing gaps. At local level, the pace has not been set yet for enforcing dual or triple supply of services at one go for road/ energy/ICT infrastructures. *National Data* Lack of cohesion in data usage is a current stumbling block for the purposes of innovations and most importantly service delivery. Lack of interoperability of data systems poses a resource gulping challenge as many of these systems are contract bound. The absence of a Data Protection law is equally a big challenge. This is important given the amount of personal information which is collected, processed and stored by various data processors in this country. Without an enabling law, the current situation presents vulnerabilities to the public.
Threats	**Opportunities**
● *ICT infrastructure* If left to the players, ICT infrastructures will continue to follow a profit viability base, leaving most rural areas underserved and many unconnected. As a result, this unequal technological development can further worsen poverty, unemployment and inequalities as Namibians domiciled in rural areas are cut off	● Green Hydrogen presents an opportunity not only to improve the energy and water availability, but also to contribute to developing key 4IR skills and capabilities ● Google's Equiano subsea cable with a landing point in Namibia with Paratus and Telecom as partners might result in better bandwidth offerings

from innovation centres and opportunities. The public service ICT infrastructure is likely to deteriorate into obsolescence and pose a risk to national security and render service delivery ineffective. The unaccountable value of the national domain as an infrastructure to the country continues to pose a threat to direct development investment in the ICT Policy and technology in the country. The inoperational state of the Universal Service Fund continues to dog the sector, thereby fuelling lack of development and access to most of the underserved communities, especially the 1300 schools with no internet connectivity to date. The overregulation of spectrum and TV white space is another challenge hampering efforts aimed at increasing connectivity and innovation. ● *Energy Infrastructure* Existing infrastructure in the energy sector is bound to be obsolete as many current users are finding alternative means of power such as solar energy. Lack of national position in regard to dual service delivery on new infrastructure continues to pose a developmental threat in accelerated connectivity. ● *National Data* Without interoperation, data value is not completely determined and lack of interoperability stifles reliable service delivery. The lack of an open data framework stifles innovation both in the public and private sector. A developmental national data framework is urgently needed. Also, lack of trust and working agreements in the public sector leads to resource wastage. This lack of trust in local innovation continues to cost the state in spending on systems based elsewhere and poses a risk to national data through ownership and control structures. Also, having a minimum of dedicated national data centres poses a threat in determining the value of data and incentivising innovation for the data centres infrastructures.	● Regulatory sandboxes present an opportunity to overcome the policy and legislative hurdles, especially for 4IR tech startups ● Youthful population presents an opportunity for accelerating 4IR adoption and capacity development

Final Recommendations

ICT infrastructure

If left to the operators and sector players, ICT infrastructures will continue to follow a profit viability base, leaving most rural areas underserved and many unconnected. This will drive the prospects of 4IR further down. The unequal technology spread in infrastructure can worsen poverty levels, unemployment rates and inequalities as the 47% of Namibians are domiciled in rural areas, where they are cut off from opportunities and access to ICT and innovation centres. The public service ICT infrastructure deterioration poses a risk to national security and renders service delivery ineffective, if left to continue without intentional state funding.

The unaccounted-for value of the national .na domain as an infrastructure poses a threat to direct investment for development in the ICT sector in the country. The inoperational state of the Universal Service Fund continues to dog the sector, thereby fuelling lack of development and access to most of the underserved communities, especially the 1300 schools with no internet connectivity to date. The regulator is said to be over-regulating spectrum licensing and dragging feet on regulating and licensing available TV white space. This behavior hampers efforts aimed at increasing connectivity and innovation in the sector.

Furthermore, the value of the underseas cables is not clearly reflected in the technology ecosystem, given existing disparities between pricing and broadband connectivity in the country.

Energy Infrastructure

Existing infrastructure in the energy sector is bound to be obsolete as many current users are finding alternative means of power such as solar energy. Lack of national strategy regarding dual service delivery on new infrastructure continues to pose a developmental threat in accelerated connectivity.

National Data

Without interoperation, the value of data is not completely determined. Furthermore, a lack of an open data framework leads to stifling reliable service delivery and innovation both in the public and private sector. Relatedly, lack of trust and working agreements in the public sector leads to resource underusage and fiscal wastage, costing the state in spending on systems based elsewhere and posing a security risk to national data through ownership and control structures. Furthermore, without dedicated national data centres, there exists fewer opportunities and a lack of incentives for innovating for data centre infrastructures.

ICT and Energy Infrastructure

- Operationalise a special vehicle entity for ICT Infrastructure coordination and management to manage infrastructure sharing effectively as set out in Harambee Prosperity Plan II (HPPII, p64), Operating this will effect Infrastructure Sharing

regulations already in place. This move has so far been welcomed through consultations by representatives of the big telco players (MTC and Telecom as well as the Regulator (CRAN) to set Powercom (Telecom Namibia's current Infrastructure operating company) to be transformed into this special purpose vehicle.

- An additional special purpose vehicle was suggested to serve the purpose of driving government/public sector ICT services.
- Government should ensure national budget allocation for investment in ICT infrastructure development. Further this presents an opportunity for public private partnerships.
- The cost of gadgets and ICT equipment in general as shaped by high taxes poses a challenge for uptake of 4IR activities by the citizenry as well as infrastructure development.
- Values for the WACS connectivity and the Exchange point value need to be explicitly defined for the public interest, and their economic values should regularly be made available to reflect value responses to the complaints on mobile and ICT services' availability, affordability and accessibility.
- 5G rollout could be fast-tracked, in a clearly defined means that stipulates clearly the value benefits for the sector. Regular reporting will be necessary to manage public expectations and for awareness purposes.
- With heavily reliant on energy for the 4IR technologies, the energy sector should speed up investment and operations for additional energy initiatives.
- There exists a need for investments in expanding the network coverage to ensure stable connectivity to meet the foundational requirement for 4IR-digital technologies and services.
- Government must decisively operationalise the Universal Service and Access Fund without delay. This holds value for digital resources for underserved citizens such as those living with disabilities, members of unconnected rural communities, and out of school communities, which can benefit from digital security and literacy skills.
- Government must effectively operationalise Section 9 of the Communications Act on the establishment and incorporation of a .na (Dot NA) association as a resource to contribute to the national ICT agenda.

National Data

- Government should effect data infrastructure interoperation and consequently data sharing the public and private sector, overhauling the current status quo
- A national open data framework is urgently needed and must adopt recognisable dataset formats.
- Building and establishing diverse ownership of data centres for storing and managing local national data is a key determinant to security while stimulating innovation.
- Investment in infrastructure for a comprehensive national data centre should be key in restoring trust and security for state (public), private sectors (private) and the citizenry (personal data).

- Public and private sector interest in locally developed and locally situated data centres ought to be deepened for the purpose of localisation, creating local data value and ease with interoperation.
- Finally, a National Data Centre should be realised for the benefit of public sector governance and service delivery.

Workstream 2: Future of Work, Labour Force Reskilling and Human Capacity Development

Introduction

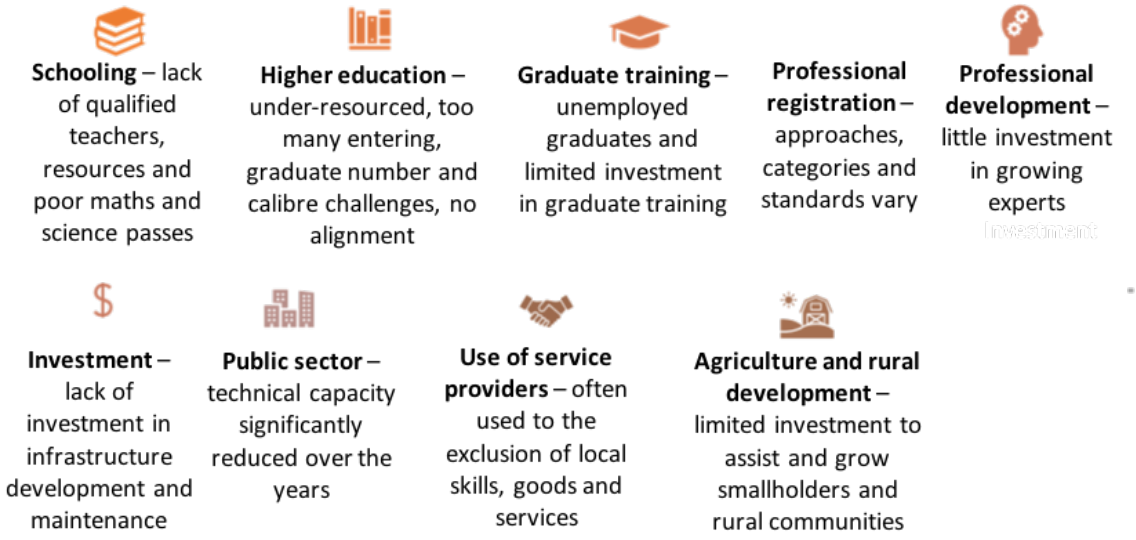
Throughout history, a country has always been caused to happen through and by people's commitment to work. What is work? Anything that a person undertakes with the objective of being productive to meet the human need is called work. When such work is performed with an expectation of monetary reward, it is assigned the meaning of an occupation, normally associated with qualifications and requisite skills. The ability for human beings to undertake work effectively is now, more than ever, affected by technology to the extent that some occupations are at threat of being obsolete while others are still to emerge. New technologies, particularly artificial intelligence and robotics have ushered in the 4th Industrial Revolution (4IR). For practical purposes, we consider the 4IR to be advanced technologies that optimise a country's human development potential in manufacturing, production and good governance. That is to say, 4IR is based on tools generated and made through skills produced from a deliberate national policy. The way any advanced technology is created, used and diffused across geographical space and sectors is dependent on the generation/regeneration of competent skills.

This brief, on the basis of the desktop study, highlights preliminary issues that require in-depth consultations with stakeholders.

Current Status

Globally, it is increasingly common to talk about the potential impact of the 4th Industrial Revolution. Evidence is abundant that shows how this revolution will or has changed how we live, how we work, how the economy will change, how machines will replace human labour, and most importantly, the job losses that may occur as a result. Regardless of the data that one might examine, the indisputable fact is that the future of work will change, and the labour force will require reskilling and upskilling. Some jobs will disappear while others will emerge. It is well documented that a country's national human resource development strategy, anchored on agile national adaptation drives, has always shown to be a powerful tool for human development. Therefore, no country in its innovative public policies, irrespective of its level of development, can afford not to embrace t4IR and ensure a responsive human resource development strategy. Some of the challenges the country faces are listed in the figure below.

Figure 65: Challenges Namibia faces for 4IR skills and future of work



It is therefore urgent that a review is done to determine the bottlenecks to preparing the labour force for the future. In this regard, evidence suggests that Namibia's effort to have a functional human resource development strategy (NHRDS) and its implementation since 2004, 2015 and 2018 have a long gestation period. A new assignment through the National Council for Higher to produce a NHRDS was recently finalised, and an inception report produced in the first week of November 2021. The objectives of this consultancy project included:

a. Complete an assessment of the current and future industrial development niche areas.
b. Conduct a national skills audit survey to establish current and future labour force demands for the identified industrial development.
c. Identify technical skills, professional knowledge and competencies needed to address the demands.
d. Develop strategies for addressing major human resources challenges (including graduate unemployment) in Namibia's labour market.
e. Examine and report on how the tertiary education system could be positioned as a possible leader to address the identified skills needs.
f. Propose modification to tertiary education funding in terms of how multiple sources could provide funding for the HRD effort.
g. Formulate the NHRD Strategy, including an implementation plan to be integrated in all aspects of national, social, and economic development.
h. Include in the final report a suggested plan for system monitoring and evaluation (M&E) and sustainability of past project recommendations.

The consultant is now engaged in discussions with the 4IR Task Force to ensure alignment and to avoid duplication of efforts.

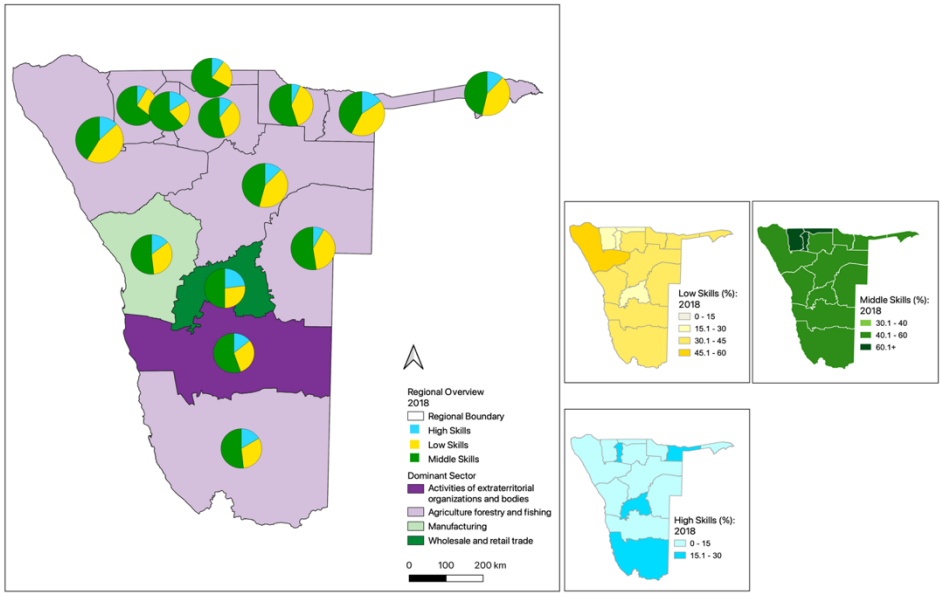
Labour Force and Employment

Globally, it is estimated that by 2025, 85 million jobs may be displaced by a shift in the division of labour between humans and machines due to automation, while 97 million new jobs may emerge that are more adapted to the new division of labour between humans, machines and AI enabled computer algorithms. These shifts may result in job losses if adaptation interventions through upskilling and reskilling are not made. Most jobs to be affected are the low to middle skill jobs. According to the Namibia Statistics Agency (2018), 54%, 32% and 14% of the Namibian Labour Force are in middle, low and high skilled jobs, respectively. The sectors most affected include agriculture, retail, mining, fisheries and the finance sector.

While there is no conclusive skill audit report upon which interventions maybe drawn from, it is safe to say that all sectors who are dependent on low to middle skill jobs face some disruptions. Although the task of digital skilling, reskilling and retraining of current workforce lies with the industry itself and the training institutions, it is incumbent on the government to take preparatory steering steps for the Country 4IR Readiness through continued investment in human capital; establishment of nationwide flagship coding and programming schemes; establishment of a platform for advanced manufacturing and new materials; securing and availing data to enable innovation, as well as incentivizing future industries and platforms for reskilling and upskilling. The main key to Namibia's readiness is the reform and investments in the education system. This task, however, is not to be left alone to the government, it should be a collective effort of all stakeholders, public, private and NGOs.

A question can be asked: how are these skills distributed across Namibia's 14 regions? See Figure 66. Although more robust analysis is still to be done, it is clear that the key driver to skills distribution is the level of education and the type of economic activities that are active where such skills are present.

Figure 66: Skills Levels in Namibia 2018



Source: NSA

Given the above, this workstream has concluded the following.

Final Recommendations

Key Policy Considerations

- The 4IR has brought about new occupations while others have become obsolete. The challenge currently is that the Namibian Standards of Classification of Occupations has not yet been revised since 1996 – albeit there was an attempt in 2012/13. The review is important and urgent to comply and adhere to the International Standards for Classification of Occupations, which many countries have already done.
- Transformation of the education system, assuring quality, defining and directing its purpose and ensuring transition in key skills is an important precondition for exploiting opportunities brought about by 4IR. This can take a phased approach for which missions are defined according to timelines.
- 4IR will have a serious impact on the job market – especially as a result of automation. Therefore, it is important that targeted interventions that target adaption, retraining and upskilling are in place to mitigate job losses. However, interventions are difficult to make without a detailed sector specific skills audit. A national skills audit is therefore urgently required.
- 4IR presents opportunities for transformation – curricula (focus on soft skills, critical thinking, problem solving, analytical skills etc.), policy and governance. In this regard, a country strategy for "Workforce Readiness" will go a long way in guiding industry and training institutions on areas of job adaptations. An important element is the creation of pathways programmes for the youth to choose careers for future jobs.
- Collaboration between industry and government in leveraging the opportunities for 4IR is crucial to meet demands of the labour market. The establishment of science parks and targeted deployment of AI SMEs in institutions of learning may trigger economic growth and promotion of creativity and innovation.
- To harness opportunities presented by 4IR, the country needs to rethink and reimagine the ways to package and deliver education, taking into consideration the cultural context, digital infrastructure and human elements. This will require comprehensive education and training reforms – from ECD to HE so that future and current workers can operate successfully in digital/4IR spaces. The ongoing work by the NCHE on Minimum Standards of Classification of institutions in higher education is crucial as it will create benchmark standards of training.
- Labour Unions and Workers need to be open to reskilling and upskilling demands in order to adapt to the changing tasks in the workspace and harness future opportunities. This includes considerations of the fact that workspace won't be confined to offices only, but that employers will care more about quality results delivered timely rather than being physically present at the office.
- To leverage opportunities created in 4IR space, more and broader engagements or an "indaba" involving various stakeholders that include government and private sector will be needed at regional and national level to allow for ownership of processes.

- Worldwide TVET sectors have proven to play a major role in a country's resilience and employment creation, particularly among the youth. There exists a perception that TVET and vocational education is for those who are poor performers at school. This perception will require policy interventions that emphasise early talent search, talent attraction, talent management and talent retention. TVET and Vocational training institutions will require further investments in human capital, equipment and software.

Key Recommendations

- Education system reform be conducted with clear directionality of purpose in policy. This is important as it sets the purpose of objective by defining it for self-reliance, for international competitiveness and/or for citizen's welfare.
- A national sector-based Skills Audit to be conducted urgently. We are aware of efforts by different entities to do this, but with effective coordination this task could be completed within 18 months.
- The Namibia Standards of Classification of Occupations be undertaken and concluded within 18 months to include new occupations arising from 4IR.
- The ongoing National Human Resources Development Strategy with its implementation plan to be completed and implemented. This is critical as it will also inform the industry and training institutions on the human resource requirements of the country.

Workstream 3: Industry, MSMEs, Startups and Investments

Introduction

Namibia has undertaken an assessment to determine the country's readiness for the 4IR. Recommendations are presented towards a coordinated and coherent policy and legislative framework that can enable Namibia to exploit and harness opportunities presented by the 4IR. Generally, some of the key technological levers are in place, but are fragmented across the public and private sectors and civil society, including academia, women and youth.

Sectors including Agriculture, Health, Manufacturing, Tourism, Telecommunication, Mining and Fintech were assessed by means of consultation as well as desk review, which provided current developments in each sector. A breakdown of these sectors and findings are mentioned below.

1. **Agriculture, Forestry and Fishing Industry** - One of the significant contributors to the Namibian Economy, with a GDP share of 9.2% in 2020.[94] The Labour Force Survey of 2018, showed that the sector employed 167 242 about (23%) of the Namibia population.[95] Several African countries have overcome challenges by implementing Climate Smart Agriculture technology such as data management and analytics tools, remote sensing, robotics, drones, satellite systems, AI and GPS-based applications to promote precision farming. Exponential technologies have the potential to assist Namibian farmers to navigate their farming activities more efficiently and effectively.
2. **Health –** The use of AI, IoT, CRISPR and Big Data in health care has the potential to enhance the quality of life by bringing about innovative ways of diagnosing, preventing and curing disease. Namibia's health services are twofold: private (serving 18% of the population with medical aid) and public (serving the remaining 82%).[96] Access to healthcare is comparably good, with 76% of the population living within a 10km radius of a healthcare facility, demystifying the question of Africa's population and lack of resources, which are proving to be one of the obstacles in providing quality medical care.
3. **Manufacturing -** Manufacturing activities in Namibia remain highly dependent on inputs from the primary industries, where the sector contributes 11% to GDP.[97]

   To break out of the middle-income trap, diversification of the economy and range of exports at increasingly high levels of sophistication is important. Three factors that are critical to the structural transformation of the manufacturing sector are: (i) diversification of the economy; (ii) **s**ophistication of exports (value addition)**;** (iii) good governance. The largest supply-side constraints include the lack of enabling ICT

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[94] *Namibia Statistics Agency, 2020*

[95] *Namibia Statistics Agency, 2019*

[96] *Ministry of Health and Social Services, 2017*

[97] *NPC, 2017*

infrastructure and the policy frameworks/policy agility necessary for emerging GPT investments. High-speed fixed and mobile connections are a prerequisite for more advanced 4IR infrastructural investments such as data centres. Connections must be both widespread and affordable so that the tools for technological adoption and innovation are widely available. From a demand side, ICT skills with a high AI content and innovation ecosystems are essential to take advantage of such infrastructures.

4. **Tourism -** The sector generates multiple financial streams, employment, rural development, poverty reduction and the growth of the country's economy.[98] With the vast amount of technology in today's world, the tourism industry offers possibilities for innovation and expansion of the economy.[99] The industry has already adopted new technologies such as online bookings of hotels and flights that made the sector a digital pioneer, where clients use various technology platforms to embrace 4IR.
5. **Telecommunications -** The industry is characterised by advances in robotics (AI), quantum computing, biotechnology and the Internet of Things (IoT). This convergence of the physical, digital and biological worlds is affecting just about every type of industry, causing dramatic changes in production, management and corporate governance. The telecommunications industry has become intensely more competitive. Rising infrastructure investments that can handle generational changes and the upending of traditional business models has meant that telecommunication companies have to look beyond their core connectivity revenues for profitability.
   Telco's today need to transition beyond traditional services, monetizing their most valuable asset, data, through auxiliary services.
6. **Mining and Engineering -** The industry which has been a labour-intensive industry, is experiencing a trending demand of automation. Dundee Precious Metals - Tsumeb recently announced the introduction of its Safety Object Recognition and Analytics (SORA) Project. This Artificial Intelligence (AI) project creates a safer work environment by using the power of computer vision. The software analyses videos captured by CCTV cameras and uses object detection models to detect if employees are wearing the necessary PPE.
7. **Fintech -** Financial technology can make it easier for foreign capital to flow into the country and deepen local financial markets. According to the Namibian Statistics Agency (2020), the largest contributing sectors to GDP are from tertiary and secondary sectors within the economy. This is unusual for a developing country and the country has consistently failed to attract capital to primary sector projects that may potentially result in inclusive GDP growth.

MSMEs and Startups

Globally entrepreneurship is increasingly being seen as a key driver of job creation and economic growth. The entrepreneurial necessity of accepting and learning from failure is being adopted by organisations and cultures as a norm. According to WIPO (2019), Namibia ranked

98 *[5] NPC, 2017*

99 *BroadReach Consulting [2019, September 7] Africa*

96 out of 126 countries in the innovation ranking. This uninviting statistic confirms why the role of entrepreneurial orientation will fast track and leapfrog with emerging technologies to allow Namibia to position herself in the global economy in fostering a culture of job-creation as opposed to job-seeking. The domestic economic recession triggered in 2016 resulted in the stagnation and eventual regression of employment growth in Namibia and the onslaught of the COVID-19 pandemic has only intensified this plight. More than one third of Namibians who are willing and able to work cannot find jobs, with rising numbers of youth unemployment.

It is common knowledge that startups and Micro, Small and Medium Enterprises (MSMEs) are the cornerstone of developing economies and are an essential source of job creation and poverty eradication. MSMEs play a pivotal role in driving innovation and its early adoption in business. The development of Industry 4.0 is not an end to a means but a means to an end. In many ways, the advancements that come with 4IR can facilitate the growth and sustainability of MSMEs, which will in turn positively impact economic growth, employment, and the attainment of a better standard of living for all Namibians. Fiscus to support MSMEs must be prioritised if we are to innovate and drive Industry 4.0.

Recommendations

Through stakeholder consultations, the following pain points and priority focus areas emerged:

- National internship programme, with apprenticeship levies to be considered
- Regulatory sandbox regarding startup policy and legislation to be considered
- Amending current legislation to enable international cash out payments (PayPal)
- Prioritising equity financing of startups
- Creative & Culture Industry (CCI) should be supported
- Enhanced and revised granting of visa permits to be considered
- Data sharing with private sector to enhance opportunities to be revisited
- Youth dividend coupled with high unemployment to be considered as a strategic opportunity in embracing Industry 4.0.

Workstream 4: Policy, Legislation and Governance

An enabling regulatory environment is the cornerstone of every government, and its significance cannot be overemphasised. During the first 15 years since Namibia's independence, 28 to 29 laws were passed each year on average. However, legislative activity reduced remarkably from 2005, with only 13 laws being passed each year on average. In 2019, Parliament passed only six laws (and two of those were appropriations acts): Public Enterprises Governance Act, Electronic Transactions Act, Prevention and Combating of Pollution of the Sea by Oil Amendment Act and the Bank of Namibia Act. Currently the following bills are in draft format: Draft Data Protection Bill, Draft Cybercrime Bill and Amendments to the Communications Acts, 2009. The Access to Information Bill was passed in the National Assembly on the 21st of June 2022.

Namibia has made major progress regarding the drafting of bills particularly those in the ICT ecosystem. However, a preliminary assessment of these bills has revealed that Namibia's regulations have generally not kept up with emerging technologies. The emergence of technologies and innovation requires the existing regulations to adopt the new advancements; otherwise the regulations risk becoming obsolete. Principles of agile legislation that can resist obsolescence (based on the 12 principles of agile software development), can be found in the World Economic Forum reports "Agile Governance: Reimagining Policy-making in the Fourth Industrial Revolution" (2018)[100] and "Agile Regulation for the Fourth Industrial Revolution A Toolkit for Regulators" (2020).[101]

Key Issues and Challenges

- In Namibia, laws take very long to be enacted, making them obsolete at the time of enactment. Bottlenecks such as slower action by line ministries in drafting bills and limited legal drafters contribute to the long process of enacting laws. Namibia currently has a total of 14 legal drafters, and ideally as a country we should have at least double. In addition, the drafters are often not involved at the policy conception stage that precede legislation, which is problematic, considering that legislation is derived from policy and drafting becomes a much more complicated exercise when policies are unclear, badly conceived, vague, or not even documented to assist legal drafters to get to the true intent of the lawmaker and the true purpose of the legislation. This inevitably leads to extensive delays regarding the passing of legislation. The Access to Information bill recently passed in the National Assembly is a perfect example of the lengthy process it takes to enact laws in Namibia. The bill was incepted in 2016 and took almost 6 years to be passed and is currently before the National Council for review.

[100] https://www3.weforum.org/docs/WEF_Agile_Governance_Reimagining_Policy-making_4IR_report.pdf
[101] http://www3.weforum.org/docs/WEF_Agile_Regulation_for_the_Fourth_Industrial_Revolution_2020.pdf

- Over the years, policies and regulations have not kept pace with emerging technologies. For example, currently there are no laws to regulate virtual assets such as crypto and digital currencies, Bitcoin or blockchain. According to a position paper issued by the Bank of Namibia in May 2018, the Bank does not recognise the use and acceptance of cryptocurrencies as legal tender in Namibia. Additionally, the Bank is strongly against the use of cryptocurrencies as a method of payment for goods and services. Thus, any cryptocurrency exchanges established and operational in Namibia are illegal. Nonetheless, the Bank of Namibia in October 2021, introduced a Fintech Regulatory Framework[102] to offer guidance on how the Bank will adopt financial technology (FinTech) innovations that are not already subjected to the Bank's existing regulations.
- All the laws to permit access to the civil registry, i.e. Namibia's Home Affairs database, are all still in draft format, i.e. the Draft Data Protection Bill and the Civil Registration and Identification Bill, while the National Identity Bill of 1996 is outdated. Data has become the new oil in the 21st century, as the saying goes, hence sharing data across institutions both in government and non-governmental will be of great benefit and a 4IR enabler. Legislation reforms are underway to address how data can be shared across government and other non-government institutions such as Banks, but they are taking too long.
- Namibia does not have an overarching multi-sectoral digital strategy. A strategy is needed to address the need for digitisation, digitalisation and digital transformation across all government services and the public and private sectors that covers the various sectors of the economy, i.e. health, education, transport, agriculture, trade, etc.
- In the banking and financial services sector, there was a clear concern that entrepreneurs that have uploaded web apps on the Google Play store were not able to collect payment for their services. This was attributed to how the Namibian payment system is structured and operates – it is not well integrated with international payment systems. In order to create an enabling environment, payment clearing has to be addressed by the central bank and the banks it regulates.
- The Electronic Signature, which is Section 20 of the Electronic Transactions Act, is not yet in force. The Ministry of Information, Communication, Technology must appoint the Electronic Information Systems Management Advisory Council to oversee the implementation. This process has hampered the implementation of electronic signatures for the country.

Recommendations

- Namibia's legislature should come up with an effective and agile process of passing laws to ensure that laws do not become obsolete due to the lengthy review and stakeholder consultation process. In the same vein, laws should not be rushed through parliament without careful consideration and comprehensive consultations with

102 The Fintech Regulatory Framework is completely different from laws needed to regulate cryptocurrencies and the two should not be confused.

stakeholders. Nonetheless, important legislative action should not lose momentum (Action Owner: Ministry of Justice).

- The Bank of Namibia should introduce a proactive approach to innovation in the 4IR and regulate in a future facing orientation. Similar to the G20 agenda in which jurisdictions are considering legislative changes to deal with crypto assets, Namibia as a nation should follow suit. The Central Bank and NAMFISA are commended for the introduction of regulatory sandboxes for the fintech industry.
- Namibia urgently needs an overarching multi-sectoral National Digital Strategy. Funds should be availed for the implementation of a National Digital Strategy. The multi-sectoral Digital Strategy will be a build-up from a Concept Note that was prepared in February 2020 and approved by Cabinet (Office of President).
- Introduce an integrated payment system for local and international electronic transactions and electronic payments. Integrate the local payment system with the international payment system (Collaboration between Payment Association of Namibia (PAN), Bank of Namibia, Bankers Association of Namibia).
- To address the issue of few legal drafters, the Ministry of Justice in collaboration with the University of Namibia (UNAM) and the Namibia University of Science and Technology (NUST) can design a program to train more law graduates in legislative drafting for different sectors.
- There are also new policies and legislation that need to be promulgated to handle the complexities and demand of the 4IR. Some of these policies are:
    - Laws to regulate robots
    - An Artificial Intelligence Act for Namibia
    - Crypto Currencies Act and Central Bank Digital Currency Act
    - Tax Breaks Act

      (Ministry of Justice, Ministry of Finance, Bank of Namibia, Ministry of Information and Communication Technology)
- Comprehensive education for parliamentarians to understand 4IR and its benefits. This can be done through the University of Johannesburg; it has a **free** 3-month online self-paced course in Artificial Intelligence in the 4IR (Office of President).

Workstream 5: Research & Development

Introduction

We live in the digital era proliferated by the Fourth Industrial Revolution (4IR), characterised by the combination of digital technologies (fusion of physical and biological) (Schwab, 2016). The 4IR is a technological revolution, extensively using artificial intelligence, robotics, and big data, among other driving and enabling technologies. The 4IR has the potential to revolutionise several sectors of the economy using disruptive novel technologies.

Most of the research, innovation, and development (RID) related to the 4IR in Namibia is conducted outside the borders of Namibia. Lack of sufficient expertise has been cited for outsourcing RID activities out of Namibia.

Though institutions of higher learning in Namibia have been conducting research across different disciplines, ranging from engineering, medicine, agriculture, and computing, there is a need to address the skills deficit in data science (ability to analyse large volumes of data). The lack of data science skills in Africa has led to the creation of African Very-long-baseline Interferometry (VLBI) partner countries with digital skills to enable them to fully participate in the technological advances of the 4IR (Madhanpall et al., 2021).

Without the critical mass of scientists (engineers, researchers, and other specialists), Namibia will not be able to conduct ground-breaking research to innovate and create modern technologies to harness the 4IR. Namibia's research and development (R&D) expenditure was 0.35% of GDP in 2014, lower than most SADC countries. For example, Botswana was 0.54%, and South Africa was 0.77% in the same period.

Research, Innovation and Development Global Perspective

Technological innovation positively impacts energy efficiency (Chen et al., 2021). The G7 countries are making massive investments (Yuan et al., 2021) in R&D-based clean technological innovations toward macroeconomic indicators for reducing greenhouse gases emissions through introducing renewable energy (Ali et al., 2021). An increase in fiscal decentralisation, economic globalisation, and R&D expenditures tend to improve performance in innovation, as witnessed in Brazil, South Africa, Canada, Germany, Japan, the UK, and the USA (Chi et al., 2021). The study by Gu et al. (2021) across seven emerging economies (China, India, Brazil, Mexico, Russia, Indonesia, and Turkey) showed that natural resources, technological innovation, income, human capital, and R&D expenditures are essential variables affecting financial development overall. RID is linked to human capital development (Hu, 2021).

For RID, best practices from Singapore, Rwanda, UAE, and South Korea revealed the following key aspects. Singapore's Research, Innovation, and Enterprise (RIE) 2025 plan has a clear articulation of a 1% GDP expenditure towards RIE, which is also seen in South Korea's

continuous increase in its R&D expenditure to GDP ratio. Rwanda's Science Technology and Innovation (STI) 2020 Policy focuses on the establishment of capabilities in areas of scientific research and technology innovation.

On the other hand, UAE's National Innovation Strategy (NIS) emphasises developing a culture of innovation amongst individuals, companies, and governments, structured around the key pillars of an Innovation-Enabling Environment, Innovation Champions and Innovation Priority Sectors. South Korea's Science Technology Innovation Digital New Deal (2021, https://digital.go.kr/front/main/eng.do) clearly defined the extended roles of actors in their national innovation system. It described the core of their National Innovation System: Knowledge, Money and People. In South Korea, introducing Information and Communication Technology (ICT) regulation sandboxes (Jan. 2019) has led to 44 new technologies and services.

Namibia Research, Innovation and Development Benchmarking

Namibia should invent innovations to export instead of being a consumer of new technologies. 4IR readiness should also be focused on indigenous knowledge management systems (IKMS) as a contemporary epistemology to leverage. Thus, IKMS should be part of the preconditions. Researchers should strive to work with the people outside the box: children (including students) and indigenous communities. They possess an excellent creativity potential to influence innovations. Data from local communities should be included in developing novel technologies to diversify the metaverse.

There are several ongoing research projects focused on big data in Namibia, such as the High Energy Stereoscopic System (HESS) in space science. HESS is one of the leading observatories studying very-high-energy gamma-ray astrophysics, thus presenting an excellent opportunity for blue skies research to unlock local in-context technologies to be developed. Namibia should explore having "virtual joint research" (popular in France). The virtual environment can bridge the current research fragmentation to allow industry, government, communities, and academics to collaborate on solving national challenges. Research is often not hindered by finance despite the procurement process that needs to be fast-tracked to have the research equipment in good time.

Industries in Namibia should embrace innovation to overcome the monopolistic history. Intellectual property (IP) management should be integrated into the RID framework. Research output should be made globally valuable for selling it, with proper packaging to generate the funding we want.

Research, Innovation and Development Roadmap for Namibia

Research capacity strengthening (RCS) has been defined as the "process of individual and institutional development which leads to higher levels of skills and greater ability to perform useful research" (Trostle & Simon, 1992). According to capacity development literature, it is

critical to understand the levels of measuring capacity at several levels, including institutional, to assess the performance of parts of the enabling environment, which is referred to as the system, society, national or strategic levels. National capacity to generate robust, innovative, and locally appropriate research is essential to socio-economic development (Pulford et al., 2020).

Hence, a cumulative mix of indicators was therefore synthesised from various literature to assess the RID status and readiness regarding the national 4IR landscape and defined as the 3-6-6 development indicators (DMI), i.e., 3-6-6 DMI. Three (3) levels of assessments were designed to relate to RI outputs, outcomes, and impacts. Review is across six (6) elements of evaluation, namely, impact, infrastructure, income, financing, quality and capacity, within the six (6) national research focal areas (NRFA) as consolidated and defined by stakeholders engaged. The NRFA consists of water, energy, agriculture, health, mining, education and digital services cross-cutting all areas.

The purpose of developing the 3-6-6-DMI was to create standardised measures and tools to assess readiness at a national level, which are proposed to be utilised to establish a statistics matrix to inform fact-based decision-making processes. The need for reliable baseline data as a basis for decision-making cannot be overemphasised. The study identified a limitation of data availability and management; therefore, the DMI is proposed to measure and assess changes' status, trends and intensity to predict future requirements in the dynamic space of 4IR and beyond.

SWOT Analysis

Strengths	Weaknesses
• Education and the established non-governmental organisations (NGOs) and research institutions that deal with RID • RID Supporting structures and Institutions, e.g. Ministry of Higher Education, Technology, and Innovation (MHETI), National Commission on Research, Science and Technology (NCRST), two Higher Education Institutions (HEIs), thirteen private HEIs and thirteen vocational training institutions • Namibia is among the four SADC countries, showing the highest Knowledge Economy Index (KEI)[103] • Safest, culturally rich, and most politically	• Concentrated RID activities and understanding on scholars and professionals mainly • RID not introduced early enough in schools, leading to lack of public appreciation • General lack of leadership and top management buy-in of RID and technology, hence slow digital transformations • Outsourcing of research and development by most of the local industry to foreign consultants • Namibia is ranked low in the Digital Quality of Life (DQL) index 2021[105]

[103] *NPC (2018). https://www.npc.gov.na/?wpfb_dl=334. https://www.npc.gov. na/?wpfb_dl=334*

[105] *Surfshark (2021). DQL 2021 - Surfshark. https://surfshark.com/dql2021? country=NA*

stable nation in Africa, hence attractive to international researchers[104]	• Namibia's national innovation performance is among the lowest in the upper-middle-income countries category • Qualifications and research at HEIs focused on 4IR digital technologies are still low
Opportunities • Existing infrastructure at HEIs and VTC can be used for advanced manufacturing using 4IR technologies • Implementation of RID using 4IR for E-governance solutions viable • The population size and demographics provides an excellent opportunity to distribute accessible e-infrastructure that provides the platform for 4IR RID • Full operationalisation of ICT regional centres and community networks for 4IR RID initiatives is an excellent opportunity for Namibia 4IR RID • ICT regional centres have many benefits such as shared access to ICTs for community Experimental development and poverty reduction, reduction in the digital divide, opportunities for community start-ups to tap into the digital economy, access to education and government information • National projects such as the green hydrogen project defined in the Harambee Prosperity Plan II has great potential to use 4IR RID in manufacturing	**Threats** • E-security and lack of the right skills for 4IR RID in Namibia are a threat; cyber-attacks in Namibia range from phishing, impersonation, online fraud, and scams affecting parastatals and the government • MICT and NCRST must outsource tasks relating to drafting ICT policies and regulations due to a lack of ICT legal in-house skills

Final Recommendations

Namibia must achieve its national developmental targets and position itself as a competitive and leading hub for green services and solutions to transform and develop sustainable communities, industries, and enterprises. For Namibia to be the ultimate green service hub driven by RID for the realisation of 4IR and beyond, it should prioritise these five key recommendations:

- *Foster a conducive RID regulatory framework* – The regulatory environment should promote the realisation of commercial products, processes and services from RID

[104] *Kgabi, N. (2011). The current state of research development in Namibia. https://www.academia.edu/51736554/The_current_state_of_research_development_in_Namibia.*

outputs enabled by 4IR-related policy instruments. The suggested implementing agency is BIPA and NCRST in consultation with the Namibia Research Focus Area (NRFA) Council.

- *Technovation Strategy (T-Strategy)* – A technovation (technology + innovation) national strategy should be well crafted and consider local strength and global view for implementation of contextual action plans. NRFA should draft the T-Strategy in consultation with all research, science, technology and innovation stakeholders.
- *Dedicated funding (RID Levy)* – Invest at least 1% of GDP on RID. Appropriate investment in RID across priority sectors of the economy and innovative companies will catalyse the translation, deployment, and commercialisation of research findings.
- *Monitoring and evaluation (M&E) systems* should be contextualised based on the proposed 3-6-6 RID 4IR Framework.
- *Capacity Development at all levels* – Development at institutional, systemic and individual levels means that appropriate investment should be prioritised in terms of physical research infrastructure and human capital investment. Namibia should provide particular incentives to attract and retain high-quality 4IR experts. National Human Resource Research Excellence awards can be a good start for companies to foster a research and innovation culture. The Ministry of Home Affairs, Immigration, Safety and Security should find amicable solutions, especially for STEM experts from abroad to challenges in obtaining work visas and permits to import research equipment.

Harnessing the 4IR requires creating a critical mass of experts who will research and develop novel techniques that can be applied to solve societal challenges and make significant contributions to the body of knowledge. In addition, Namibia must pay close attention to its strengths and weaknesses to assess its RID readiness for Industry 4.0 and beyond.

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Workstream 6: Core 4IR Technologies

Introduction

The Core 4IR Technologies Workstream supported the Task Force by conducting desktop research focusing on existing core and enabling 4IR technologies in Namibia; engaging industry and stakeholders to determine the current utilisation of 4IR technologies in Namibia; analysing qualitative data received from stakeholders and industry relating to the core 4IR technologies; analysing the quantitative data received from stakeholders and industry relating to the core 4IR technologies; and providing high-level recommendations.

Existing 4IR infrastructure (desktop research and engagement with industry and stakeholders)

The current utilisation of 4IR technologies in Namibia is summarised below.

Mining and quarrying – Currently, in the mining and quarrying sector, the Chamber of Mines has pointed to using an AI tool called Safety Object Recognition and Analytics (SORA) by Dundee Precious Metals for harnessing safety data, recognizing and predicting risk.[106] In the stakeholders' consultation, machine learning as a subset of AI was being utilised for data analytics.

Agriculture and forestry – In agriculture, specifically the meat industry, blockchain technologies are being deployed to trace the product from the source to the consumers.[107] The sector has also used IoT in the form of the Namibian Livestock Identification and Traceability System (NamLITS) for tracking livestock.[108] In nature conservation, there is the utilisation of the Footprint Identification Technique (FIT), which runs on JMP software from SAS and uses advanced algorithms (AI) to analyse more than 100 measurements of a rhino's footprint. FIT helps monitor and map endangered species through an online database of animal footprints.[109] In consulting with stakeholders, it was indicated that rural farmers use precision farming technology. The technology developed is called Capture and utilises satellite images to ascertain the soil temperature and moisture.

Fishing and Fish processing on board – In the stakeholder's engagement, certain stakeholders indicated that they had the drone capabilities that can be deployed on the high seas to safeguard the country's territorial integrity by identifying and prosecuting illegal fishing.

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106 *https://chamberofmines.org.na/blog-post/dundee-precious-metals-tsumeb-uses-ai-create-safer-working-environment/*

107 *https://sciencenode.org/feature/Tracking%20rhinos%20in%20Namibia.php*

108 *[3] Prinsloo, T. & van Niekerk, J. (2017). The role of the Namibian Livestock Traceability Systems in containing the recent foot-and-mouth disease outbreak - case study from the Northern parts of Namibian. available from: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8016172&tag=1*

109 *https://www.meatco.com.na/about-us/how-we-add-value/50/*

Water and electricity – This sector uses IoT; an example is Veolia's smart technologies which contribute to the continuous upgrading of facilities' operational performance. Integrated control centres monitor the status of services in real-time and relay any anomalies to the customer relationship centres, which then schedule work in the field. An energy management system monitors the consumption of water facilities operated by the group and identifies the areas requiring optimization. Veolia has also developed an e-monitoring service that allows individuals, local authorities, and industrial customers to better control their consumption.[110]

Wholesale, retail trade, repairs – In the stakeholder consultation, it was evident that companies in the sector are using applications such as geo-mapping, IoT, and cloud computing to promote e-commerce and smooth the value-chain process. These AI applications are designed to collect and harness data which is used to improve operations within the value chain.

Education – in the higher education sector, there are two quantum computers at the University of Namibia (UNAM) and three pieces of quantum computing equipment at Namibia University of Science and Technology (NUST). There are 3-D printing labs in place. UNAM and NUST have programmes that are offered across a variety of specialisations in computing. UNAM has an MSc in Cybersecurity and NUST has a wider variety such as cyber security, digital forensics, information security, IT Audit and ethical hacking programme offerings. NUST and UNAM will offer degrees in Data Science from 2022 onwards. UNAM has established a Virtual Institute for Scientific Computing and Artificial Intelligence as well as a Namibia Green Hydrogen Research Institute. UNAM has a high performance-computing centre with two supercomputers that analyses big data for the High Energy Stereoscopic System (HESS). HESS consists of five gamma ray telescopes being the biggest telescopes of that type in the world. Another telescope is planned to be placed in the Brandberg mountains.

The University has a tech innovation and entrepreneurship incubation centre. An AI Startup curriculum is being developed in partnership with Google who have provided two grants and expertise thus far. The university is also developing an aerospace and AI innovation centre in collaboration with Scholarship in Canada. The University concluded an agreement with Africa Blockchain Institute in Rwanda to offer an MSc in Blockchain as well as several shorter courses and boot camps.

UNAM has switched its programme offerings to online with very limited face-to-face classes for a few professional programmes from March 2020 and 2021. The university increased its provision of existing data and data devices to all staff and students in the form of 4G devices. In 2021, UNAM upgraded its IT infrastructure to a Hyper-Convergence Infrastructure (HCI) to improve online offerings. The university uses both licensed and open-source software packages for virtual interactions and online learning tools.

As of May 2021, UNAM has established the Namibia Green Hydrogen Research Institute, which boasts a centre for digital and emerging technology across the Green Hydrogen value

[110] *https://www.veolia.com/en/veolia-group/profile/business-activities/water-management*

chain. NUST has established the High Tech Transfer Plaza Select (HTTPS). NUST has used virtual reality (VR) to introduce technology to remote communities such as Donkerbos and the San and has also built a learning autonomous road rover that can navigate roads and recognize objects using an onboard camera.

Health – During COVID, the use of AI was accelerated with the introduction of algorithms such as Natural Language Processing (sentiment analysis), self-tracking tools (IoT),[111] and the use of video conferencing (telemedicine) by medical practitioners and patients.[112] USAID has funded a system for improved pharmaceutical services to patients in the pharmaceutical space called the electronic dispensing tool (EDT). This AI-powered tool maintains patients' profile information, medical history, and data needed to dispense medicine effectively.[113]

Table 33: Summary of existing 4IR technologies and tech skills

Technology									
	Big data	Cloud computing	IoT	3-D Print-ing	Blockchain technologies	AR/VR	Robotics/ Autono-mous Robots	AI	Quantum computing
Available / Non-Available	√	√	√	√	√	√	√	√	√
Skills									
	Data ana-lytics	Cloud Architect and Engineers	Engi-neers / data scien-tists / data analysts	Engi-neers / Graphic artists	Program-mers / Cryptogra-phers / computer scientist	Program-mer / developers / Engineer	Engi-neers / data scientists / data analysts	Engi-neers / compu-ter scien-tists	Engineers / Quantum Physicist
Available / Non-Available	√	√	√	√	√	√	√	√	√

Given the universities' programs to expand the 4IR complementary skills, Namibia is expected to improve standing in global indexes. For example, in the 2019 Global Competitiveness Index, Namibia scored 45.7 and was ranked 103rd regarding the skills of the future workforce.

Observations from the survey

111 *https://www.na.undp.org/content/namibia/en/home/blogs/2020/from-a-virtual-hackathon-to-six-namibian-tech-solutions-for-covi.html*

112 *https://economist.com.na/54141/special-focus/telemedicine-here-to-stay-says-first-care-solutions-ceo/*

113 *https:// siapsprogram.org/publication/the-use-of-pharmaceutical-information-for-decision-making-in-namibias-national-art-program-assessment-report/*

In surveying the stakeholders and industry representatives, three main issues emerged regarding the inability of stakeholders and industry representatives to adopt 4IR Technologies. Firstly, the lack of capital was identified as the most significant reason for not adopting Core 4IR Technologies, followed by the lack of skills for using Core 4IR Technologies and then the lack of knowledge about possible applications of Core 4IR Technologies.

Strengths

4IR technologies are already in use, and 4IR-related skills are already embedded in the economy. Tangible actions include the drones project in the Zambezi, and the swapping of the entire R&D by FirstRand to Namibia. Universities are spearheading several activities relating to 4IR.

Weaknesses

Big companies with 4IR technologies are multinationals. They could rely on their expertise that may have been perfected elsewhere and not transfer necessary skills to Namibians. Imported technology could also be subject to patent laws and taxes, resulting in the migration of profits.

Opportunities

There is a real opportunity to introduce new industries driven by advanced technology resulting in more job opportunities. In addition, Namibia has a high literacy rate, and most of the population comprises young people, making it easier to upskill and reskill with the programmes relevant to meet the country's 4IR needs.

Most of the interviewed private sector stakeholders have begun introducing 4IR technologies in their operations. As a result, there is an opportunity to form private-public partnerships to leverage the existing work for a greater national good.

Threats

Stakeholders and industry representatives identified lack of capital as the most significant reason for not adopting Core 4IR Technologies. In addition, 4IR technologies are costly – investment will require government and private sector collaboration. Further, there also could be a loss of job opportunities in industries that migrate to 4IR, increasing inequality.

Recommendations

Given that the lack of capital was identified as the most significant reason for not adopting Core 4IR Technologies in the CRA data, Namibia could work on attracting Foreign Direct Investment (FDI). As it does this, Namibia should consider that FDI does not flow without a conducive legal and institutional environment. For instance, the CRA data suggest that non-tariff barriers limit the ability of imported goods to compete in Namibia's domestic market. According to the WTO, non-tariff barriers typically include trade requirements such as import licensing, pre-shipment inspections, rules of origin, custom delayers and other trade restriction

mechanisms that restrict the free movement of goods and services. Typically, non-tariff barriers are a mechanism by developed nations to control imports of goods and services. However, before any non-tariff barriers mechanism is deployed, the domestic availability of such goods or services is assessed. Given that Core 4IR Technologies would typically comprise investments in imported infrastructure, to promote foreign investments in this area, Namibia could harmonise its non-tariff barriers, notably the Core 4IR Technologies. This could be done by reviewing the investment policy in conjunction with the trade policies to take advantage of 4IR opportunities.

The Namibian government's ability to harness the 4IR will rely heavily on forging fruitful and collaborative partnerships between all the role players in the society, particularly the government and the private sector. As such, the government should not only rely on FDI to drive domestic 4IR investments; it should also galvanise the support of the domestic private sector capital providers. Furthermore, for this partnership to be mutually beneficial, the domestic investment policies should accommodate the strategy and incentive regime that prioritises domestic investments in future technologies.

The lack of skills for using Core 4IR Technologies and the lack of knowledge about possible applications of Core 4IR Technologies was another significant reason for not adopting Core 4IR Technologies in the CRA data. This could be addressed both in the short and long term. In the short term, multi-model skilling methods, e.g. VR/AR and MOOCS, should be considered to plug the gap. Namibia should establish the national AI Institute to coordinate national AI research, innovation, and development efforts in the medium to long run. Since data security was also raised as a concern, the envisaged national AI Institute could also facilitate the development and use of trustworthy AI systems in the Namibian public and private sectors.

A key weakness raised in the situational analysis was that there was a lack of coordination resulting in silos, fragmentation across data, infrastructure, governance, operational structures, sectoral policy, and legislative processes. The envisaged national AI Institute could also coordinate all ongoing AI activities across all Namibian government agencies. This would ensure that each government agency informs the work of the others.

Critical determinants for success

- All related legislation and policies must be aligned with the country's 4IR strategy.
- Government must promote investments in research and development geared towards 4IR.

Appendix F: National 4IR Commission - Proposed Terms of Reference (High-Level)

1. **Purpose**
    - Oversee the development of a national consolidated 4IR strategy
    - Appointment of human resources (secondments, developers, researchers, consultants)
    - Sourcing of budget and funds
    - Guidance and direction on:
        - Identification of policy enablers
        - Exploring funding models
        - Identification of key priorities and focus areas
        - Identification and validation of key drivers and barriers
        - Development of an implementation strategy
    - Reporting to the Office of the Prime Minister

2. **Term**
    - 5 years (2023-2028) on a secondment basis/*pro bono basis* from government, SOEs, academia, private sector and civil society

3. **Membership**
    - Government
    - Private Sector
    - Education Institutions
    - Research Institutions
    - Experts
    - Civil Society

4. **Structure**
    - Chairperson (1)
    - Vice-Chairperson (1)
    - Workstream Leads (7-9)
        - Infrastructure and Data
        - Skills and Labour
        - Legislation and Regulation
        - Research and Innovation
        - Investment and Entrepreneurship
        - E-Government
        - Private Sector/Industry development
    - Project Support (1)

Appendix G: Methodology - Measuring Readiness for the Future of Production

The assessment measured readiness for the future of production of Namibia. In this section, the methodology is presented. Qualitative and quantitative methods were utilised to collect data across the two dimensions of the Future of Production framework. The data was subject to the same methodology used by the WEF.

AG.1 Quantitative Data Collection

The assessment comprises 59 indicators across the Structure of Production and Drivers of Production components. The values for the indicators are tabulated in Appendix H. The same shows the definition of the indicators, unit of measure, the source where indicators were obtained, as well as indicator values for other countries, for the purposes of comparison.

In collecting indicator data, we came across challenges that included a few missing data for Namibia. Similar to the WEF methodology, scores for missing data were imputed using an income-regional group approach. This means that average scores of the countries in both the same region and income as Namibia were used to compute the missing score. Regional and Income classifications for the study's selected sample are shown in Table AG1.

Table AG1: Regional and Income Classifications

Country	Region	Income classification
Namibia	Sub-Saharan Africa	Upper-Middle Income
Botswana	Sub-Saharan Africa	Upper-Middle Income
Estonia	Europe	High Income
Ethiopia	Sub-Saharan Africa	Low Income
Ghana	Sub-Saharan Africa	Lower-Middle Income
Kenya	Sub-Saharan Africa	Lower-Middle Income
Malaysia	East Asia and the Pacific	Upper Middle Income
Mauritius	Sub-Saharan Africa	Upper-Middle Income
Morocco	Middle East and North Africa	Lower-Middle Income
Nigeria	Sub-Saharan Africa	Lower-Middle Income
Senegal	Sub-Saharan Africa	Low Income
Singapore	East Asia and the Pacific	High Income
South Africa	Sub-Saharan Africa	Upper-Middle Income
Tanzania	Sub-Saharan Africa	Low Income
Tunisia	Middle East and North Africa	Lower-Middle Income
Uganda	Sub-Saharan Africa	Low Income
Zambia	Sub-Saharan Africa	Lower-Middle Income

Source: World Bank, World Economic Forum (2018)

It can be seen from Table AG1 that Botswana, Mauritius and South Africa are in both the same region and income classification as Namibia. For this reason, an arithmetic average score of these countries per missing indicator was used.

Furthermore, it should be noted that Angola, Rwanda and Zimbabwe are not listed in Table AG1 because they were not assessed by the World Economic Forum.

AG.2 Qualitative Data Collection

There are various indicators such as availability of scientists and engineers and extent of market dominance that require opinions (qualitative data) from executives of firms. WEF collected these through an executive opinion survey. Similarly, this study collected executive opinions through a survey. The study captured the views of 116 Namibian companies. Similar to WEF, a score for each Executive Survey question was calculated as the arithmetic mean of all answers. The calculated values are shown in Appendix H.

AG.3 Scale and normalization

Once qualitative and quantitative data were collected, scale and normalisation ensued as follows:

In Multi Criteria Decision Making (MCDM), normalization is used to define criteria values in the same dimensionless units (Vafaei et al., 2022). Each driver in our study consists of categories and sub-categories with different units of measure. To transform these into the same unit for the purpose of producing comparable data, scale and normalization is applied (Vafaei et al., 2022). These normalized scores can then be combined to produce aggregated scores.

Similar to WEF, the scores were normalized on a scale of 0-10, with 10 representing the ideal, using the min-max approach as follows:

$$x_{norm} = \frac{a + (x - x_{min})(b - a)}{(x_{max} - x_{min})}$$

where

x_{norm}	= normalized value
x	= raw value of the country for indicator
x_{min}	= lowest acceptable value for indicator
x_{max}	= best possible outcome for indicator
a	= lowest value in scale
b	= highest value in scale

Since a=0 and b=10 (Scale of 0-10), the equation is simplified and re-written as follows:

$$x_{norm} = \left(\frac{x - x_{min}}{x_{max} - x_{min}}\right) \times 10$$

According to WEF (2018), the target for the lowest acceptable value for the indicator (x_{min}) and best possible outcome for the indicator (x_{max}) are widely accepted policy targets and aligned to WEF Global Competitiveness Index. It must be noted that these values are not explicitly stipulated in the Future of Production report, and therefore, they were obtained using a combination of http://wef.ch/fopreadiness18 and Global Competitiveness Index.

AG.4 Weighting

Once the individual indicators were normalised, it was possible to aggregate the scores on a category and driver level. However, the dimension level (Driver of Production and the Structure of Production) was calculated according to the following weighting scheme:

Table A2: Readiness Assessment Weighting Scheme

Structure of Production	**Weight**
Complexity	60%
Scale	40%
Drivers of Production	**Weight**
Technology & Innovation	20%
Human Capital	20%
Global Trade & Investment	20%
Institutional Framework	20%
Demand Environment	15%
Sustainable Resources	5%

Source WEF (2018)

The WEF report (2018) explains that Economic Complexity is the key measure of readiness (hence its high weighting) because countries with a high economic complexity have the ability to make complex and unique products, which is important for future competitiveness in production (WEF, 2018). Other drivers are given different weights based on their significance in relation to Economic Complexity (WEF, 2018). For instance, Sustainable Resources is given the lowest weight due to its low correlation with Economic Complexity (WEF, 2018).

References for this Appendix

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World Economic Forum (WEF) (2018). Readiness For the Future of Production Report 2018 (https://www.weforum.org/reports/readiness-for-the-future-of-production-report-2018).

Appendix H: Future of Production Calculations in Namibia – Comparison with Other Countries

FUTURE OF PRODUCTION		Final Indicator for Namibia (Normalised)	Indicator for South Africa (According to FOP 2018 Edition)	Indicator for Botswana (According to FOP 2018 Edition)	Indicator for Mauritius (According to FOP 2018 Edition)	Indicator for Zambia (According to FOP 2018 Edition)	Indicator for Estonia (According to FOP 2018 Edition)	Indicator for Malaysia (According to FOP 2018 Edition)
STRUCTURE OF PRODUCTION		3,0	5,0	3,2	3,8	2,4	5,8	6,8
Complexity		3,9	5,4	4,4	4,5	2,7	7,4	6,8
1,01	Economic Complexity	3,9	0,2	-0,2	-0,2	-1,0	1,1	0,8
Scale		1,6	4,5	1,3	2,8	1,9	3,3	6,8
1,02	Manufacturing value added in economy	3,1	12,3	6,4	14,1	7,6	14,5	23,9
1,03	Manufacturing value added	0,0	51204,4	1068,8	1678,9	2086,5	3435,8	79820,6
DRIVERS OF PRODUCTION		3,9	5,0	4,4	5,4	3,5	6,0	6,5
Technology & Innovation		3,9	4,5	3,4	5,1	2,7	5,8	5,9
Technology Platform		4,2	6,2	5,1	6,8	3,6	8,2	8,3
	Availability of ICT							
2,01	Mobile-cellular telephone subscriptions	3,5	142,4	158,5	144,2	74,9	148,7	141,2
2,02	LTE mobile network coverage	3,9	77,6	42,0	36,7	5,8	99,0	88,0
2,03	Internet users	3,3	54,0	39,4	53,2	25,5	87,2	78,8
2,04	FDI and technology transfer	5,5	4,5	4,0	4,4	4,0	4,7	5,4
	Use of ICT							
2,05	Firm-level technology absorption	6,1	5,0	4,2	4,8	3,9	5,3	5,4
2,06	ICT-enabled business models	5,7	4,6	4,1	4,5	3,8	5,6	5,6
	Digital Security & Data Privacy							
2,07	Cybersecurity commitment	1,2	0,5	0,4	0,8	0,3	0,8	0,9
Ability to Innovate		3,6	2,8	1,7	3,3	1,7	3,4	3,4
	Industry Activity							
2,08	State of cluster development	5,1	4,5	3,3	4,4	3,5	3,7	5,1
2,09	Company investment in emerging technology	4,5	4,2	3,3	3,6	3,2	4,4	5,1
2,10	Government procurement of advanced technology	2,9	3,4	3,8	3,4	3,5	3,5	5,0
2,11	Companies embracing disruptive ideas	5,3	3,9	3,4	3,7	3,2	4,0	5,0
2,12	Multistakeholder collaboration	4,6	4,2	3,5	3,6	3,4	4,1	5,2
	Research Intensity							
2,13	R&D expenditures	0,6	0,7	0,3	0,2	0,3	1,2	1,3
2,14	Scientific and technical publications	12,7	17,2	8,2	4,6	5,4	47,6	12,3
2,15	Patent applications	0,0	2,4	0,0	0,6	0,0	21,1	5,7
	Available Financing							
2,16	Venture capital deal volume	0,0	8681,9	88,9	1715,6	237,5	292,8	6155,5
2,17	Venture capital deal volume per size of economy	0,5	27,0	5,8	140,4	10,5	12,2	19,8
Human Capital		3,6	4,6	4,4	5,2	3,1	6,5	6,5
Current Labour Force		4,4	6,0	4,7	6,1	3,2	8,3	6,8
	Labour Force Capabilities							
3,01	Manufacturing employment	5,6	11,2	2,5	14,2	4,1	18,8	16,5
3,02	Knowledge-intensive employment	2,2	22,5	17,8	24,7	7,3	44,0	25,5
3,03	Female participation in labour force	7,4	0,8	0,9	0,7	0,3	1,0	0,6
3,04	Mean years of schooling	3,8	10,3	9,2	9,1	6,9	12,5	10,1
3,05	Availability of scientists and engineers	4,0	3,5	3,5	3,9	3,8	4,3	5,3
3,06	Digital skills among population	3,6	3,3	3,7	4,5	3,6	5,4	5,4
Future Labour Force		2,8	3,1	4,1	4,2	3,0	4,8	6,2
	Migration							
3,07	Migration	1,3	-1,8	8,8	0,0	-2,5	0,0	14,8
3,08	Country capacity to attract and retain talent	3,5	3,3	3,8	3,9	3,4	3,4	5,0
	Education Outcome							
3,09	Quality of universities	0,3	9,0	0,0	0,0	0,0	2,0	9,0
3,10	Quality of math and science education	3,5	2,6	3,7	4,6	3,7	5,5	5,3
3,11	Quality of vocational training	3,7	3,6	4,0	4,3	3,9	4,6	5,3
3,12	School life expectancy	2,8	13,3	12,6	14,9	12,5	16,4	12,9
3,13	Pupil-to-teacher ratio in primary education	3,5	33,6	22,6	18,8	47,9	11,5	11,5
3,14	Critical thinking in teaching	2,9	3,1	3,3	3,5	3,3	4,5	4,8
	Agility and Adaptability							
3,15	Active labour policies	1,9	2,7	3,1	3,9	2,8	4,8	5,0
3,16	On-the-job training	3,8	4,5	4,1	4,5	4,0	4,9	5,4
3,17	Hiring and firing practices	3,2	2,9	3,9	4,3	3,9	4,6	4,9

Global Trade and Investment		3,3	5,6	4,4	5,9	3,2	5,8	7,4
Trade		2,8	5,6	7,7	8,6	6,0	8,7	8,2
	Trade Openness							
4,01	Trade	1,5	60,5	105,9	107,9	84,3	155,2	128,1
	Trade Facilitation and Market Access							
4,02	Trade tariffs	2,7	0,1	0,1	0,0	0,1	0,0	0,1
4,03	Prevalence of trade barriers	3,9	4,4	4,4	4,8	4,2	5,2	4,8
4,04	Logistics performance	3,3	3,8	3,1	0,0	2,5	3,4	3,4
Investment		1,0	4,6	0,5	2,4	0,2	1,7	6,2
	Investment and Financing							
4,05	Greenfield investments	0,0	6242,6	311,8	229,6	1167,3	547,8	14772,0
4,06	FDI inflows	0,0	4534,5	361,0	371,7	1911,9	739,2	10655,8
4,07	Domestic credit to private sector	2,9	144,4	31,7	96,4	12,0	71,9	123,9
Infrastructure		6,1	6,7	4,9	6,8	3,3	7,0	7,8
	Transportation and Electricity							
4,08	Transport Infrastructure	4,5	52,7	38,3	44,1	29,7	49,5	62,9
4,09	Electricity Infrastructure	7,7	80,7	58,8	92,7	36,8	91,4	93,4
Institutional Framework		5,3	5,0	6,2	6,5	4,5	7,3	6,6
Government		5,3	5,0	6,2	6,5	4,5	7,3	6,6
	Efficiency & Effectiveness							
5,01	Regulatory efficiency	7,1	65,6	71,8	76,0	61,8	73,2	83,0
5,02	Corruption Perceptions Index	4,9	45,0	60,0	54,0	38,0	70,0	49,0
5,03	Future orientation of government	2,8	3,2	4,1	3,9	3,4	4,2	5,3
	Rule of Law							
5,04	Rule of Law	6,2	0,1	0,5	0,8	-0,3	1,2	0,5
Sustainable Resources		2,5	5,3	5,5	6,2	6,5	6,2	6,0
Sustainability		2,5	5,3	5,5	6,2	6,5	6,2	6,0
	Energy							
6,01	Alternative and nuclear energy use	1,8	0,1	0,2	0,2	0,9	0,1	0,0
	Emissions							
6,02	CO2 intensity level	1,6	1,3	0,4	0,3	0,2	0,7	0,7
6,03	CH4 intensity level	1,1	0,1	0,2	0,1	0,5	0,1	0,2
6,04	N2O intensity level	0,5	0,1	0,2	0,0	1,2	0,1	0,0
	Water							
6,05	Baseline Water Stress	2,9	3,0	1,4	0,0	0,1	2,8	2,1
6,06	Wastewater treatment	7,0	79,4	41,0	58,1	58,1	90,9	77,2
Demand Environment		4,0	5,5	3,3	3,5	3,5	3,9	6,3
Foreign and Domestic Demand		3,7	6,2	2,7	2,4	3,3	3,0	6,6
	Market Size							
7,01	Market size	3,7	61,8	27,0	23,7	33,3	30,3	66,3
Consumer Base		4,4	4,8	3,8	4,6	3,7	4,9	6,0
	Consumer Sophistication							
7,02	Buyer sophistication	4,4	3,9	3,3	3,8	2,8	3,7	4,4
7,03	Extent of market dominance	4,3	3,9	3,2	3,7	3,6	4,1	4,8