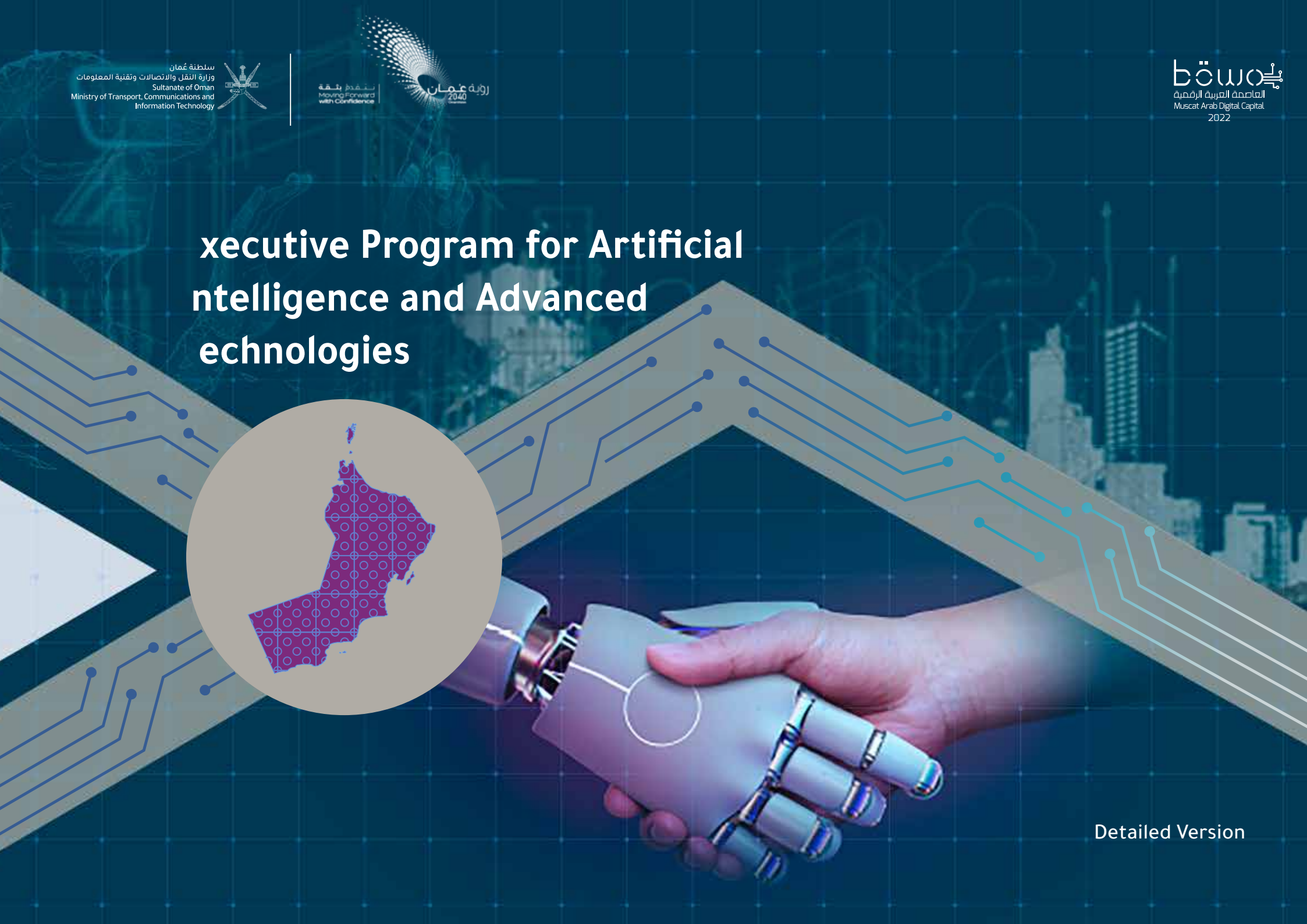
سلطنة عُمان
وزارة النقل والاتصالات وتقنية المعلومات
Sultanate of Oman
Ministry of Transport, Communications and Information Technology

تقدم بثقة
Moving Forward with Confidence

رؤية عمان 2040

مسقط
العاصمة العربية الرقمية
Muscat Arab Digital Capital
2022

xecutive Program for Artificial ntelligence and Advanced echnologies



Detailed Version

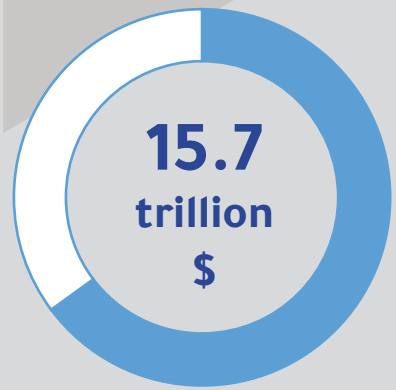
His Majesty Sultan Haitham Bin Tariq Speech

"Our government will follow up progress in various sectors, including small and medium enterprises, and entrepreneurship, particularly those based on innovation, artificial intelligence, and advanced technology. This is in addition to training and enabling youth to benefit from the opportunities made available in this vital sector, so that it could form a cornerstone in the national economy".

HM Sultan Haitham bin Tariq
23 February 2020

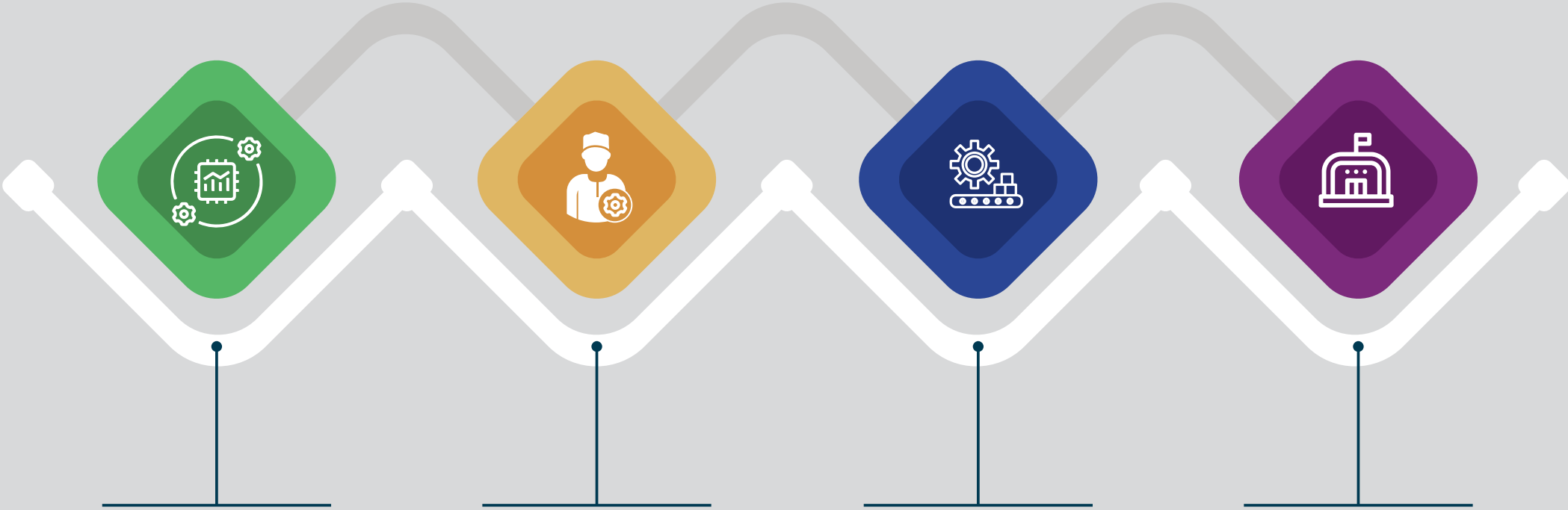
Ministers' Message

Artificial intelligence and advanced technologies are seen as critical technologies that will achieve global leadership in all future industries. Countries are racing to adopt artificial intelligence technologies for various objectives, based on their desire to ensure national security and improve public services provided to society. According to PricewaterhouseCoopers (PWC), the contribution of artificial intelligence in the global economy will reach $15.7 trillion in 2030, of which $320 billion will be in the Middle East.



The contribution of artificial intelligence in global economy will reach $15.7 trillion in 2030, of which $320 billion will be in the Middle East.

The Sultanate of Oman is working to place the essential pillars of artificial intelligence applications in order to create a sustainable economy by benefiting from these technologies in its daily operations, through:



Enhancing the productivity of the sectors targeted for economic diversifiction through the integrated application of smart technologies in those sectors

Developing human talents and capabilities in artificial intelligence technologies

Adopting artificial intelligence in strategic sectors

Governance of artificial intelligence with a human centered vision

In this context, and given the importance of these technologies and the keenness of the government of the Sultanate of Oman to promote and stimulate the adoption of these technologies, Royal Decree No. (90 / 2020) was issued to establish the Ministry of Transport, Communications and Information Technology, including in its organizational structure the National Center for Space, Artificial Intelligence and Advance Technologies in August 2020. Then, the Center operations were carried out in two tracks, establishing the National Program for Artificial Intelligence and Advanced Technologies, and the National Program for Space. The National Program for, Artificial Intelligence and Advanced Technologies has issued an executive program the strategic direction of artificial intelligence and advanced technologies in the Sultanate of Oman. This executive plan included several initiatives and projects related to promoting these technologies in sectors that can contribute to economic growth, social impact, human capacity development and ensuring flexible and effective governance. Implementation of this plan will start at the beginning of this year. It will be reviewed annually to assess the achievement of implementation in each stage.

The executive program aims to improve the Sultanate of Oman's ranking in the Governmental Readiness Index for Artificial Intelligence issued by Oxford Insights to be one of the best 35th countries in 2030 and increase the number of start-ups specializing in artificial intelligence technologies. The Sultanate of Oman is also working to raise the investment in artificial intelligence technologies to 400 million dollars in 2030 and increasing the number of research papers in artificial intelligence issued from the Sultanate of Oman.

H.E Eng. Saeed Bin Hamoud Al-Mawali
Minister of Transport, Communications and IT

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.0 Introduction

Countries around the world have been competing to develop and govern artificial intelligence and advanced technologies and stimulate investment and scientific research in these technologies since the issuance of the first artificial intelligence strategy by the Canadian Government in 2017, thus the number of countries and regional organizations that published AI strategies and action plans reached 30 countries until December 2020 according to the Stanford University AI index report 2021.[1]

According to the Future Grasp Foundation report issued in 2019,[2] the total volume of government investments from various countries that have published their national AI strategies will amount to 152 billion dollars allocated to scientific research and development in this field. With the growing adoption of artificial intelligence technologies and the progress in research and scientific development at the global level, countries should expedite the formulation and implementation of national plans for artificial intelligence and related investments to maintain competitiveness and improve the productivity of the economic and essential sectors with effective governance that guarantees national economic, cultural and security interests - all of which will be affected by artificial intelligence and advanced technologies.

Oxford insights,[3] in its report on the readiness of governments to adopt artificial intelligence, presents three main potentials for the successful use of artificial intelligence technology in government services as follows:

- It requires that the government is ready to rely on AI, and be able to adapt and innovate in doing so.
- The government needs a technical private sector capable of providing innovative solutions and tools on artificial intelligence and advanced technologies.
- These tools need continuous development and improvement through optimal use of data, and require and need the appropriate infrastructure to provide services to citizens and residents with flexibility and high efficiency.

In line with Oman vision 2040, which sets information and communication technology as one of the enabling and stimulating sectors for the productive and essential economic sectors, the Ministry of Transport, Communications and Information Technology has prepared a plan for the national strategic direction of the digital economy[4] in cooperation with partners from the relevant government and private institutions (Figure 1 illustrates the main targets of the national Digital Economy program). The Sultanate of Oman has adopted strategies and plans to build the digital economy, starting from e.Oman Strategy in 2003, then the National Broadband Strategy in 2014, up to the National Digital Economy Program, which the Council of Ministers approved in July 2021. The National Digital Economy Program is a strategic direction for the digital economy in the Sultanate of Oman that seeks to maximize the contribution in the GDP, to surge from 2% in 2021 to 10% in 2040. In addition, the Sultanate of Oman National digital economy's Program aims to advance Sultanate of Oman ranking globally in the various digital economy indicators identified by the Oman Vision 2040, such as the e-government development index and the network readiness index. The National Digital Economy Program includes a set of medium-term executive programs such as the Government Digital Transformation Program, the Digital Infrastructure Program, the Digital Industry program, the E-commerce Program, the AI and Advanced Technologies Program, and the Space Program.

The main objective of the National Program for Artificial Intelligence and Advanced Technologies to formulate a national executive program to encourage the adoption and localization of these technologies. In this context, the Ministry took the initiative to review the strategies of several countries in this field as well as consult on international reports and indicators from various institutions, and coordinate several meetings and workshops with partners from the public and private sectors, academics and entrepreneurs specialized in artificial intelligence and advanced technologies. In June 2021, the Ministry also published a report on future opportunities for applications of artificial intelligence and advanced Technologies in the Sultanate of Oman.[5] This was followed by the publication of the first policy[6] regulating the use of artificial intelligence systems in the state's administrative apparatus units. This policy will promote artificial intelligence techniques in all vital economic sectors.

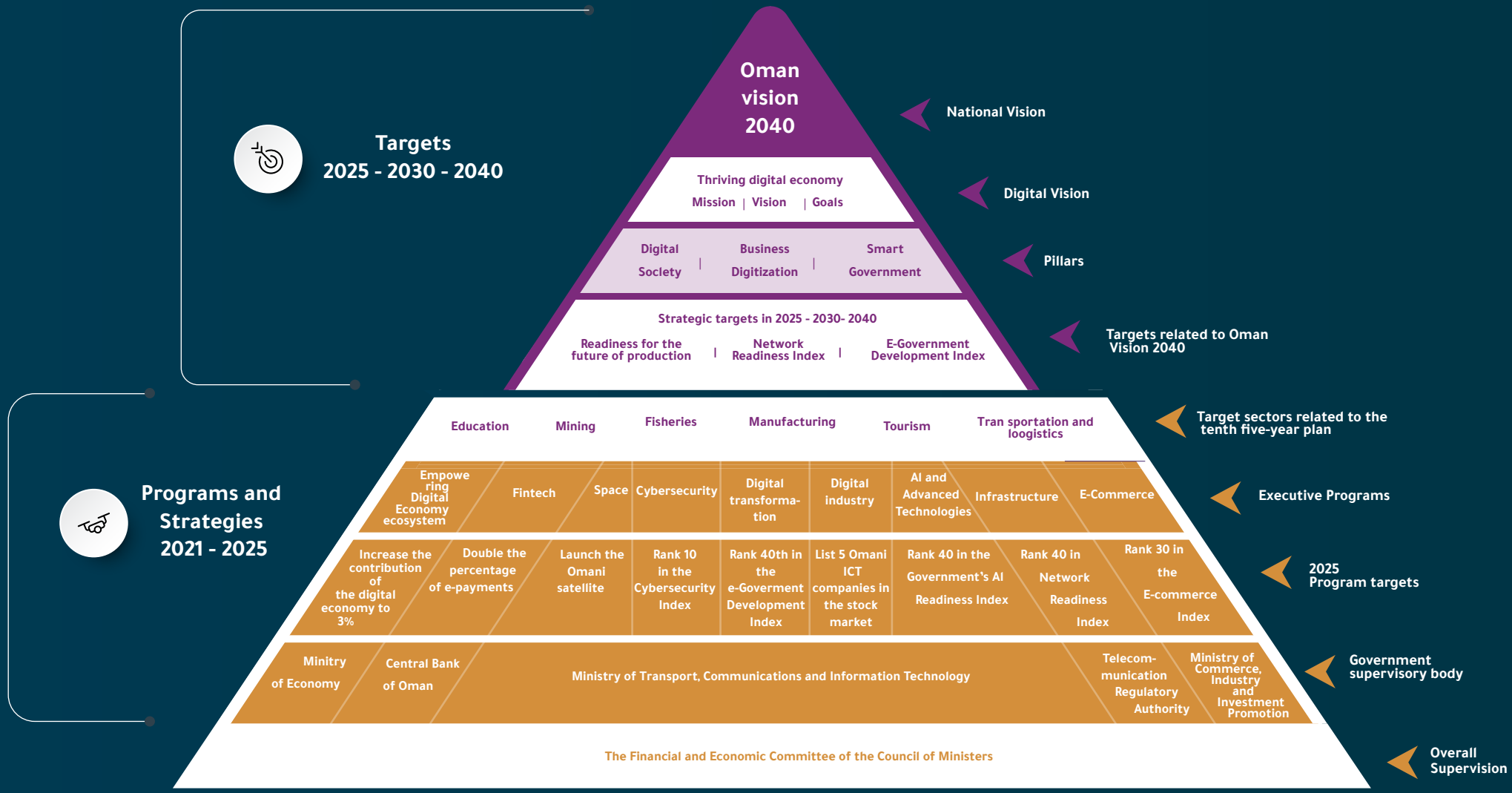


Figure 1: The main targets of the National Digital Economy Program

The Future Vision of the ICT Sector in the Sultanate of Oman

.0 The Future Vision of the ICT Sector in the Sultanate of Oman

The national strategic direction for the digital economy aims to increase the total contribution of the ICT sector to the GDP by doubling it five times over the next twenty years, so that its contribution will reach 10% of the GDP by 2040. The Ministry of Transport, Communications and Information Technology is working to increase the contribution of information technology against the Communications sector by 30% to 35% by stimulating investment in artificial intelligence and advanced technologies related to the Fourth Industrial Revolution along with localization and technology transfer, entrepreneurship and innovation, and accelerating digital transformation in government services and economic sectors (Figure 2 provides an overview of the Strategic Direction for Building the Digital Economy).

The national strategic direction for the digital economy includes seven strategic national programs:

The National Program for Artificial Intelligence and Advanced echnologies

The National Space Program

Digital Industry Program

yber ecurity rogram

Digital Transforma- tion Program

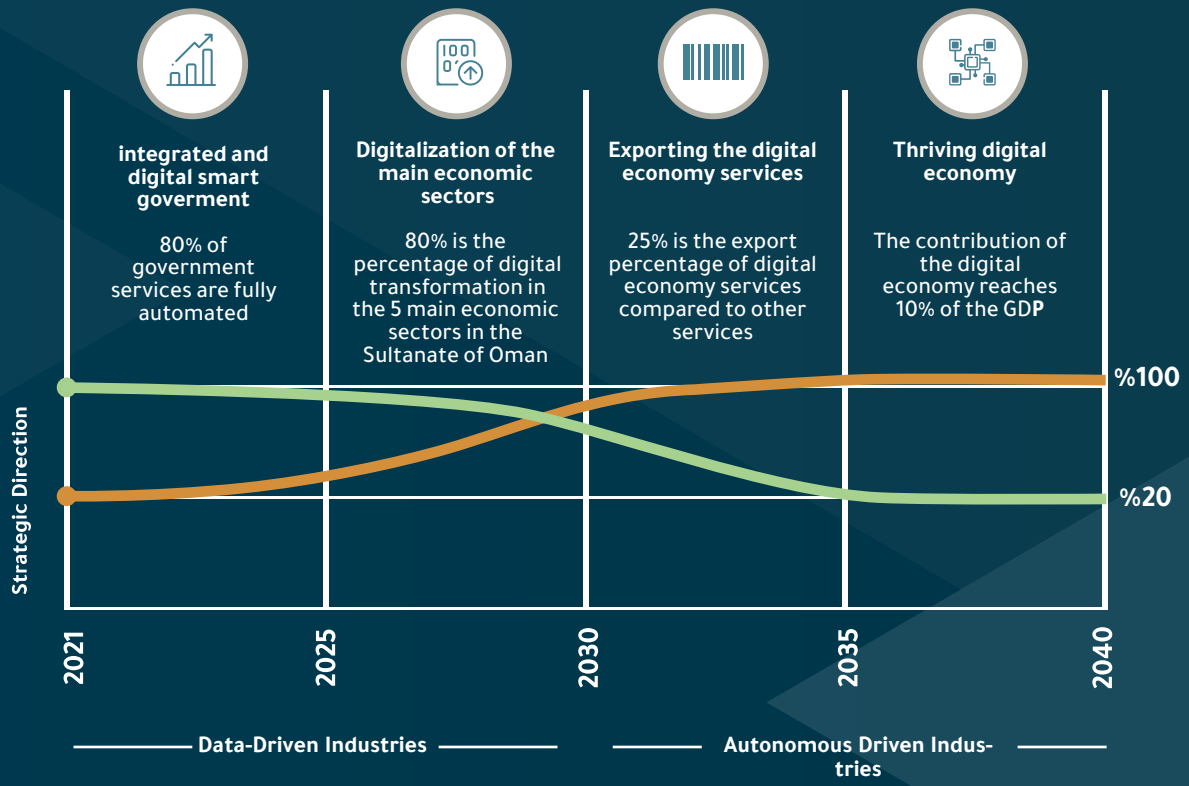
Infrastructure Program

E-commerce Program

The strategic direction for building the digital economy at a sustainable pace 50-5-5
To achieve an increase in the economic contribution by 50% every 5 years

An increase in the information technology share by 5% every 5 years

With the increased digitalization of economic sectors in 2021-2030, technology will emerge as an independent industry in 2030-2040



Technology as an enabler for the economic sectors

Technology as an independent industry

The economic contribution will increase about 5 times during 2040 compared to 2020

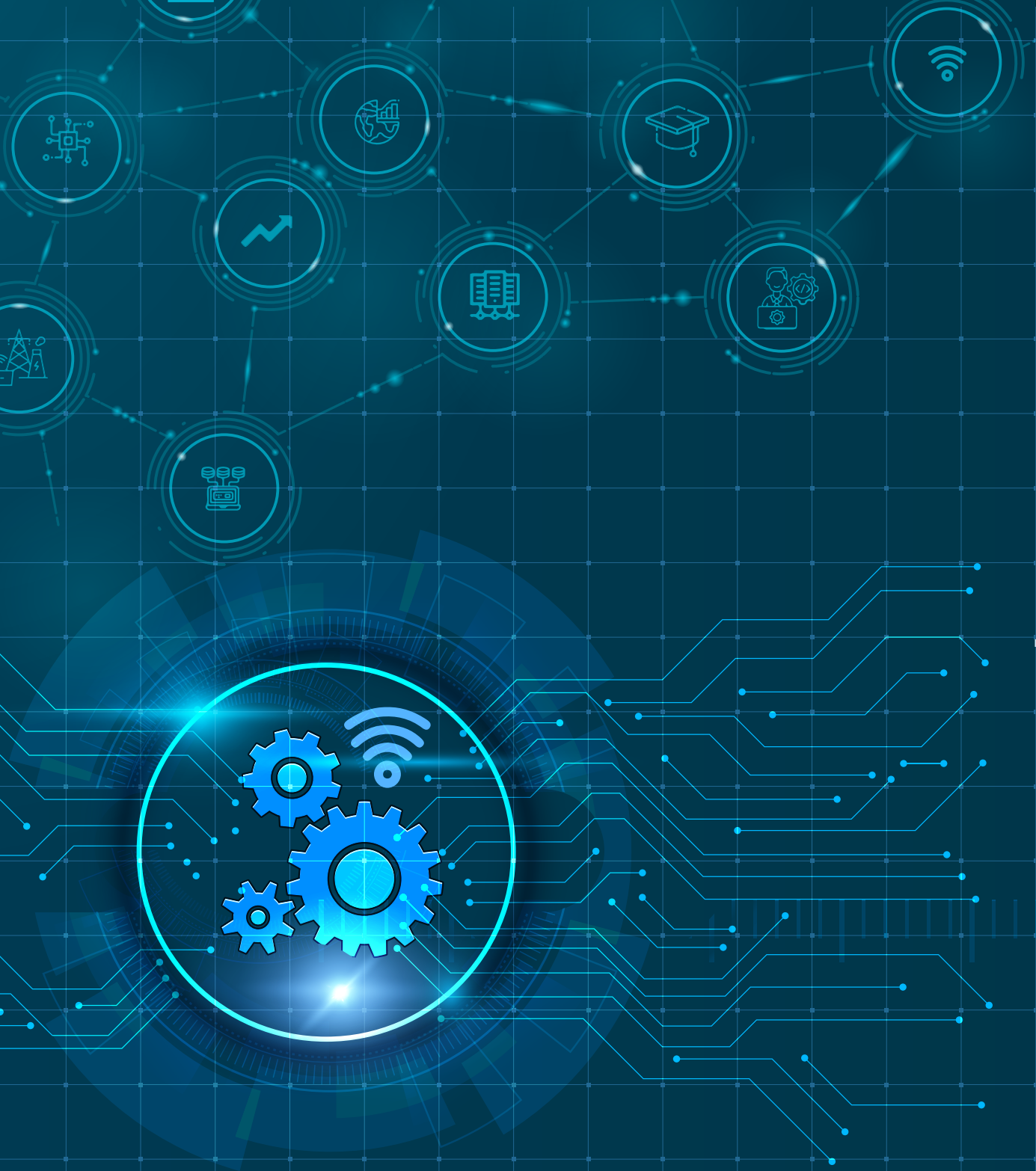
So the contribution of the digital economy will reach 10% of the GDP in 2040

The information technology share ranged between 30% to 35%

Currently, the contribution of the digital economy does not exceed 2% of the GDP

The information technology share is between 10% and 15%

Figure 2: Overview of the Strategic Direction for Building a Digital Economy



The ICT Indicators in the Sultanate of Oman

.0 The ICT Indicators in the Sultanate of Oman

Figure 3 shows the main indicators for the information and communications technology sector, which is one of the most critical enablers for the adoption and localization of artificial intelligence and advanced technologies. The Ministry of Transport, Communications and Information Technology, through the National Digital Economy Program and in cooperation with partners from government and private institutions, aims to:

Empowering competencies to keep pace with the requirements of the labor market and future skills.

Preparing the ICT infrastructure to keep pace with the rapid technological changes.

Manufacturing and localizing emerging technologies, artificial intelligence and advanced technologies.

Achieving the government digital transformation program and providing effective governance mechanisms.

Creating and enabling business environment for companies to adopt new technologies to enhance the digital economy.

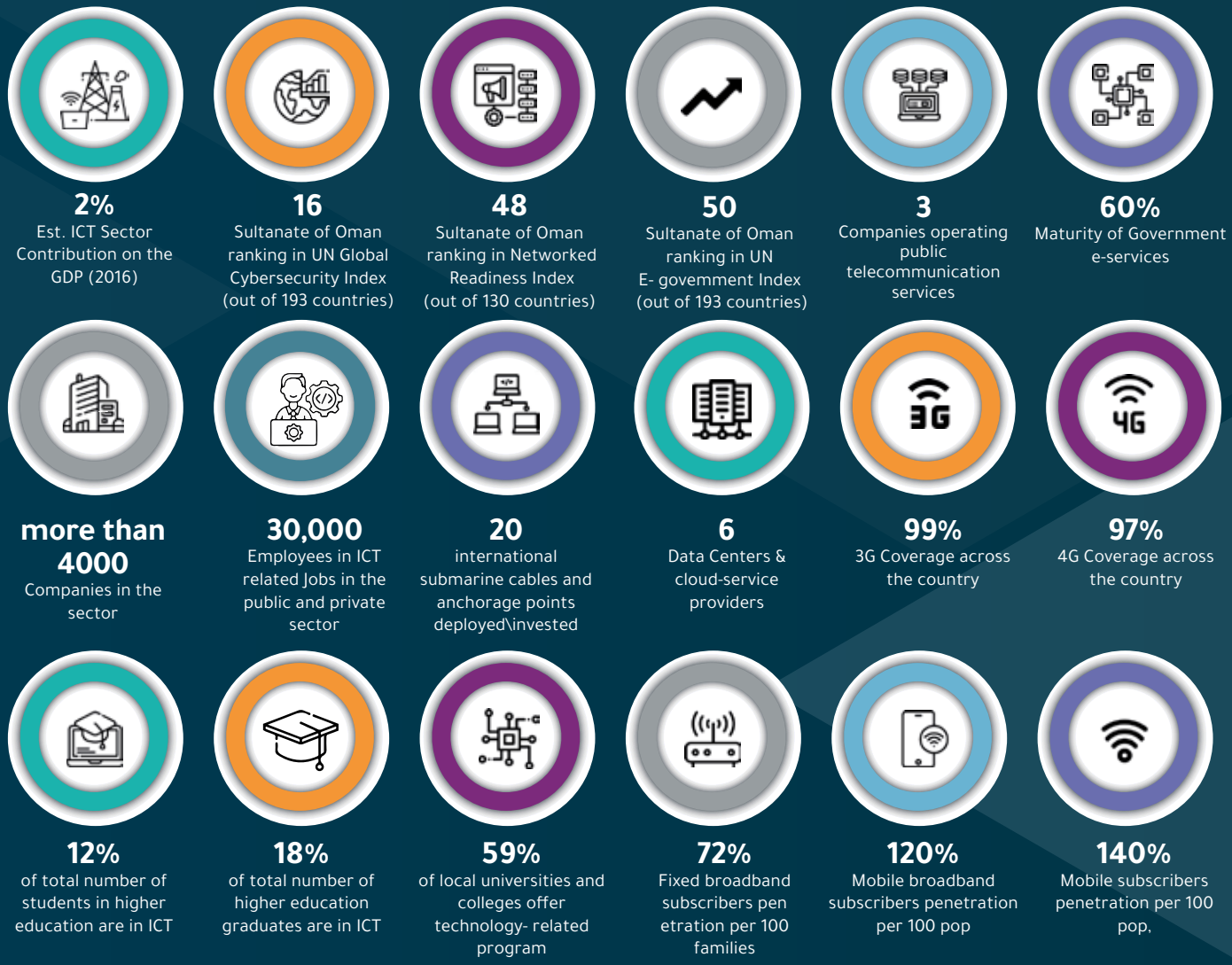
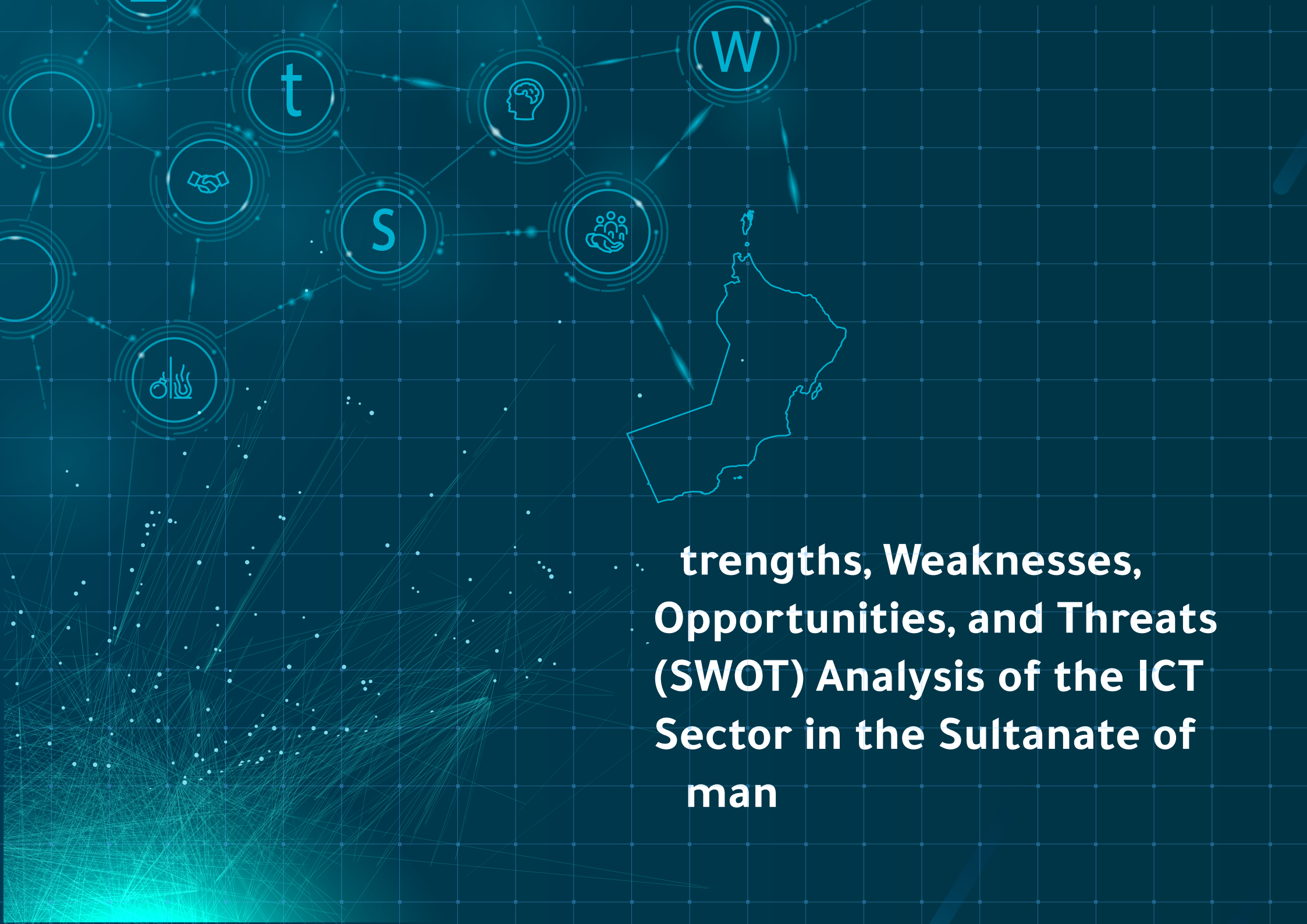


Figure 3: The Main indicators for the ICT sector



trengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis of the ICT Sector in the Sultanate of man

4.0 Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis of the ICT Sector in the Sultanate of Oman

Strength points

- Political stability and geolocation advantage.
- The government's commitment to economic diversification rather than relying on oil revenues only.
- Extensive connections via submarine cables.
- Mobile telecommunication services cover most areas in Sultanate of Oman.
- Good progress in cyber security.
- A large number of graduates in the field of ICT, and they can benefit from and enhance their capabilities in specialized fields through training programs

Weak points

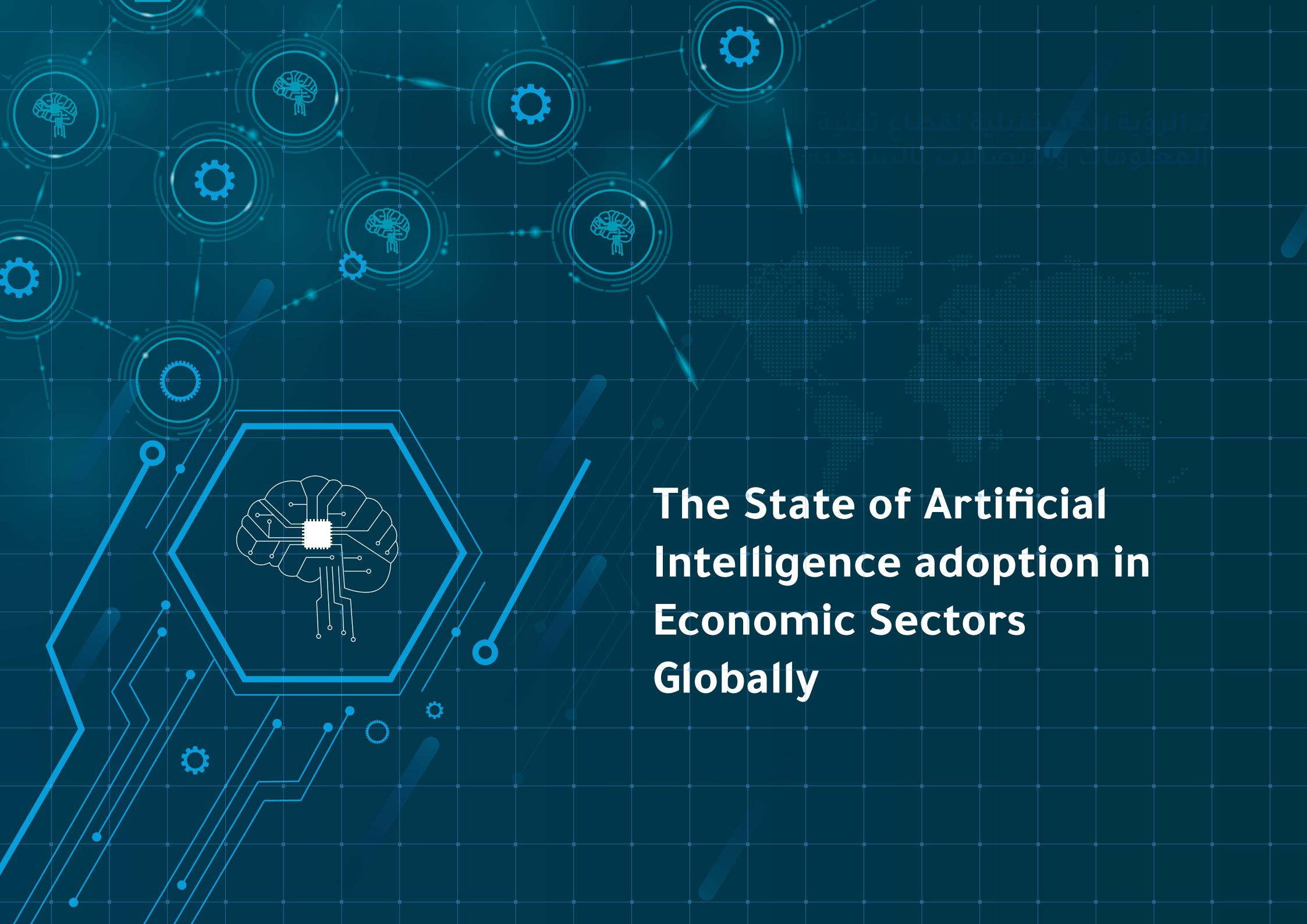
- Small size of local market.
- Lack of focus on technology transfer & localization.
- Delay in keeping pace with the race towards emerging technologies due to limited resources and slow legislation.
- There is some complexity in business environment.
- The maturity and integration of digital government services is not at the desired level.
- Sector's contribution to the GDP is low.
- Limited skills required for graduates in the field of communications and information technology
- There are reservations about funding, regulation, and research and development in the innovation environment.
- Weak coordination and alignment required for sector growth among many stakeholders/partners.

Opportunities

- The increasing demand for ICT services globally and regionally + untapped demands at the local level.
- Access to large markets such as Africa and the Middle East.
- Growing interest from foreign investors in the ICT sector at the regional level.
- Availability of human resources and local startups that employ emerging technologies.
- Oman competitive potential in AI and advanced technologies.

Threats

- Fierce global competition in this field.



The State of Artificial Intelligence adoption in Economic Sectors Globally

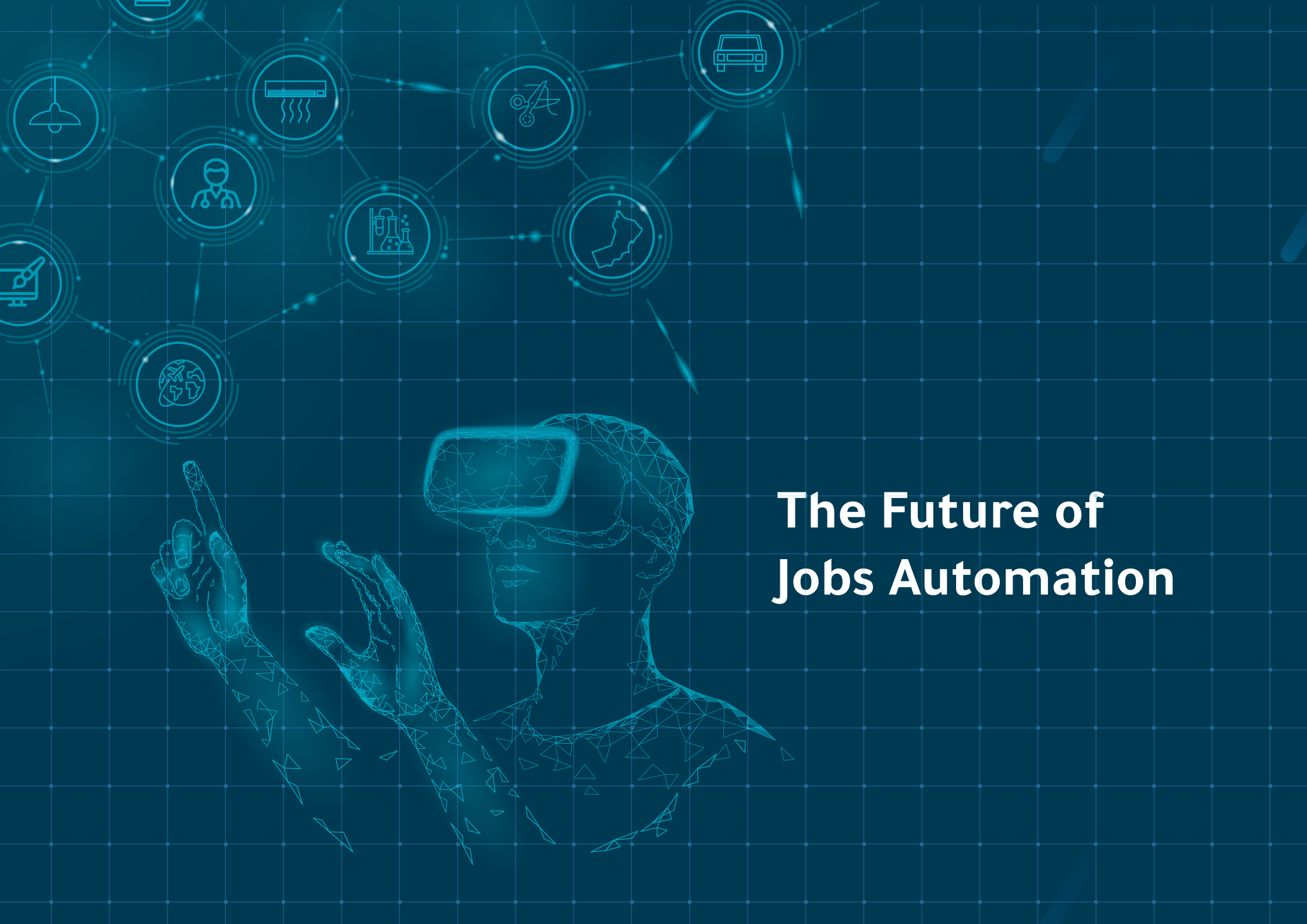
.0 The State of Artificial Intelligence adoption in Economic Sectors Globally

Mckinsey Global Institute[7] published a study on the state of adopting and using of artificial intelligence technologies in the economic sectors. The study shows that the ICT services sector is the most investor and user of these technologies compared to the other sectors, followed by the banking and financial services sector. The study also shows that the construction sector has a minor investment in these technologies. However, the travel and tourism sector proceeds in the adoption of artificial intelligence technologies. The results of this study are aligned with the local investment trends in the Sultanate of Oman, which aim to improve communications network and cloud computing services and expand data centers to accommodate the increasing demand for various technology services, including artificial intelligence technologies, especially from the energy and logistics sectors. Figure 4 shows the volume of investment and adoption of artificial intelligence technologies in different economic sectors.

1. Based on the midpoint of the range selected by the survey respondent
2. Results are weighted by firm size.

Figure 4: Investment Volume and Adoption of AI Technologies in Economic Sectors

SOURCE: McKinsey Global Institute AI adoption and use survey; Mckinsey Global institute analysis

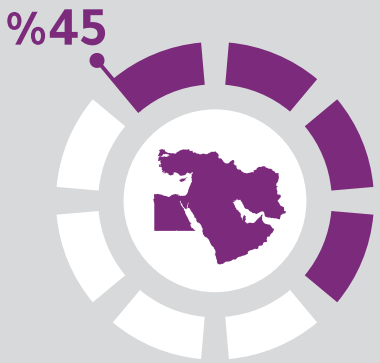


The Future of Jobs Automation

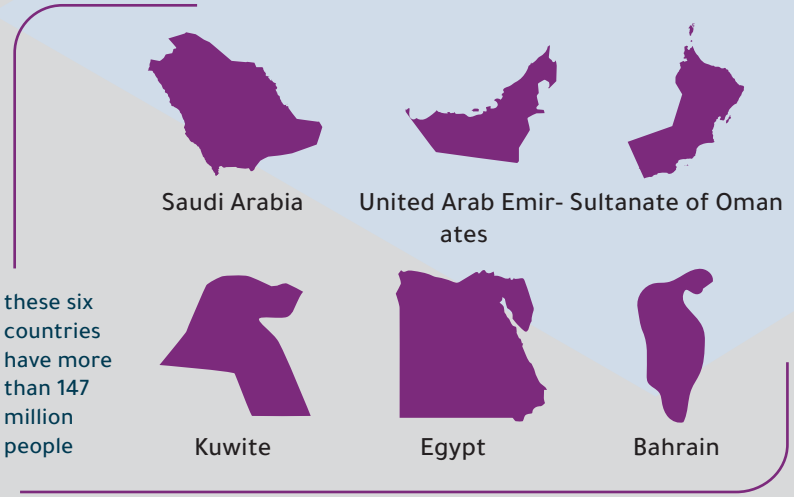
.0 The Future of Jobs Automation

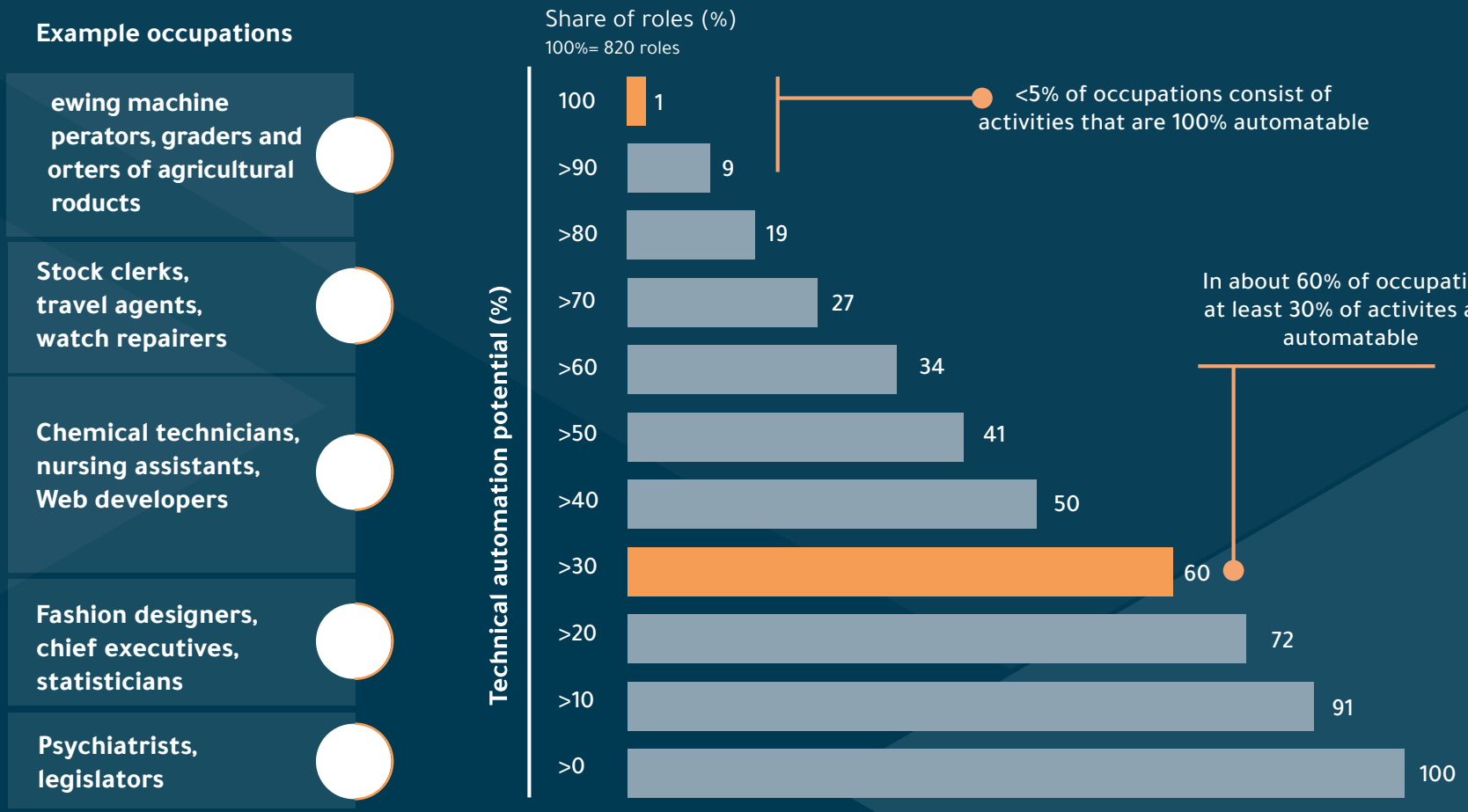
Many studies have raised concerns about the possibility that workers' jobs will disappear and be replaced by artificial intelligence systems in the medium and long term. A Mckinsey Global Institute Analysis report[8] on the future of job automation and increasing productivity indicates that artificial intelligence systems, will completely replace 5% of the jobs available in the USA for example, jobs that do not require cognitive skills, such as workers operating textile equipment and agricultural activities will be replaced by artificial intelligence systems. The report shows that the nature of some jobs can be partially automated using artificial intelligence technologies such as programmers and fashion designers; however, some jobs cannot be entirely automated using these technologies, such as psychiatrists and legal professionals, due to the lack of efficiency of the available technology at this time or for regulatory and legislative reasons. Figure 5 shows the percentage of jobs expected to be fully or partially automated artificial intelligence technologies in different economic sectors.

Another Mckinsey study[9], gives predictions of the possibility of automating 45% of the activities currently in the labor market in the Middle East countries covered in the study, namely, Bahrain, Egypt, Kuwait, the Sultanate of Oman, Kingdom of Saudi Arabia and the United Arab Emirates. (Together, these six countries have more than 147 million people, and a combined GDP of more than $1.5 trillion as of 2016.) This is just below the global average which is 50%, and there is only a small relative difference between the six countries. Saudi Arabia and Sultanate of Oman have the lowest proportion of ctivities currently subject to automation, at 41%, while Egypt showed the highest percentage, at 48%.



The possibility of automating 45% of the activities currently in the labor market in the Middle East countries covered in the tudy





While few occupations are fully automatable,60 percent f all occupations have at least 30 percent echnically automatable activities

Automation potential based on demonstrated technology f occupation titles in the United States (cumulative[1]

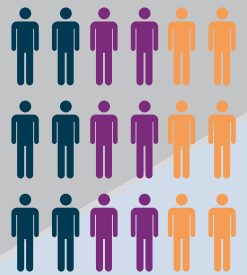
1. We define automation potential according to the work activities that can be automated by adapting currently emonstrated technology.

Figure 5: Percentage of jobs expected to be fully or partially automated

SOURCE: US Bureau of Labor Statistics: A future that works: Automation, employment and productivity, Mckinsey Global Institule, McKinsey

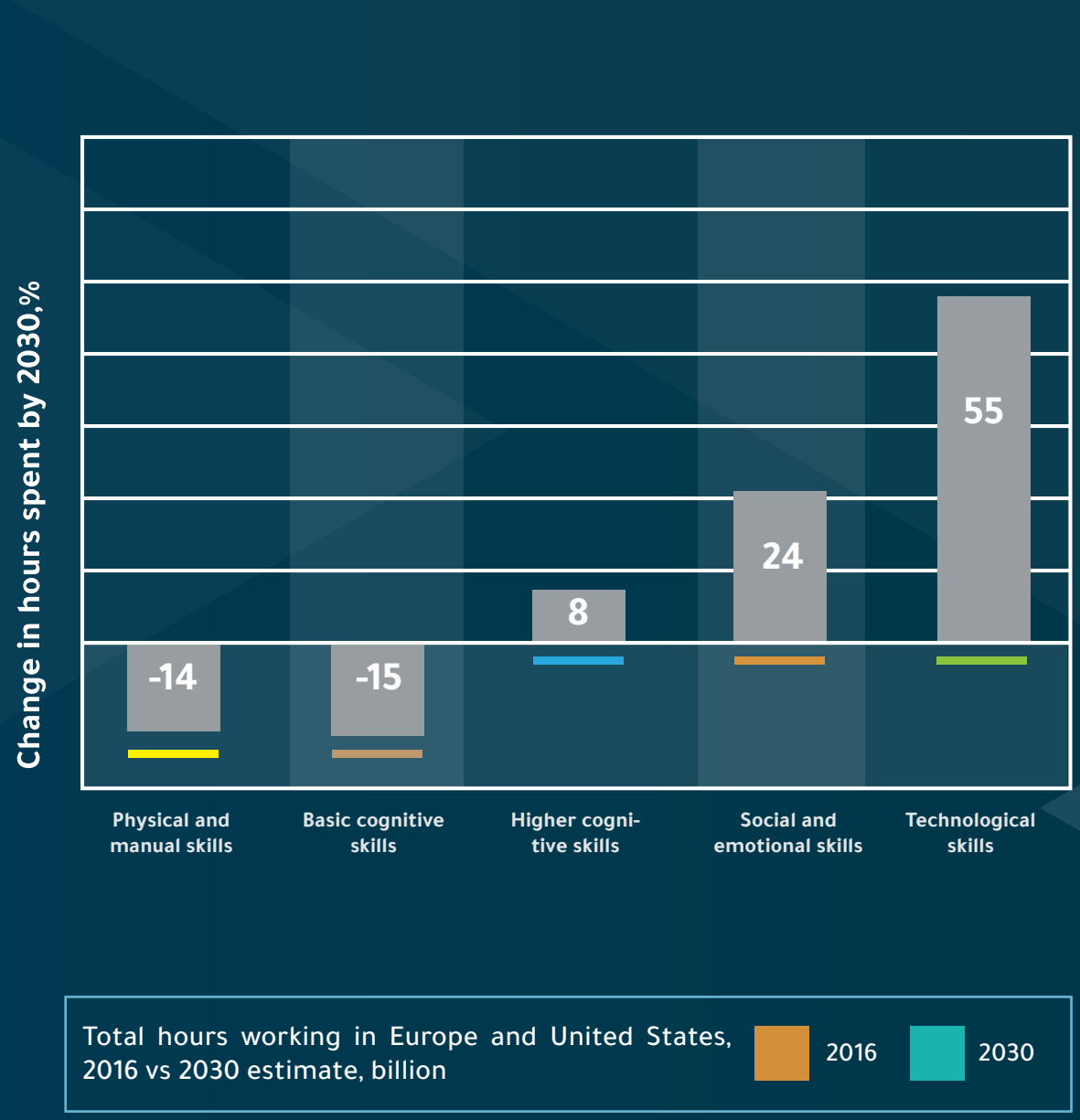
Despite these concerns, other studies by Mckinsey[10] predict that artificial intelligence and advanced technologies will add 555 million to 890 million new jobs by 2030, with different job skill requirements. Figure 6 shows the expected change in the pattern of jobs and related skills in Europe and the USA by 2030. The study confirms that technical progress in many sectors replaced traditional jobs with other jobs, as happened in the semiconductor and electronic chips industry, which created a new type of jobs not available before.

555 million to 890 million new jobs by 2030



According to the report issued by the World Economic Forum in 2020 for the future of jobs[11] which confirmed that due to the spread of automation, more than 85 million jobs are expected to disappear in the next five years, but the number of jobs will be created due to the use of emerging technologies, including artificial intelligence, will reach 97 million new jobs,. Which is more than the number of jobs that will disappear due to these technologies.

97 million new jobs



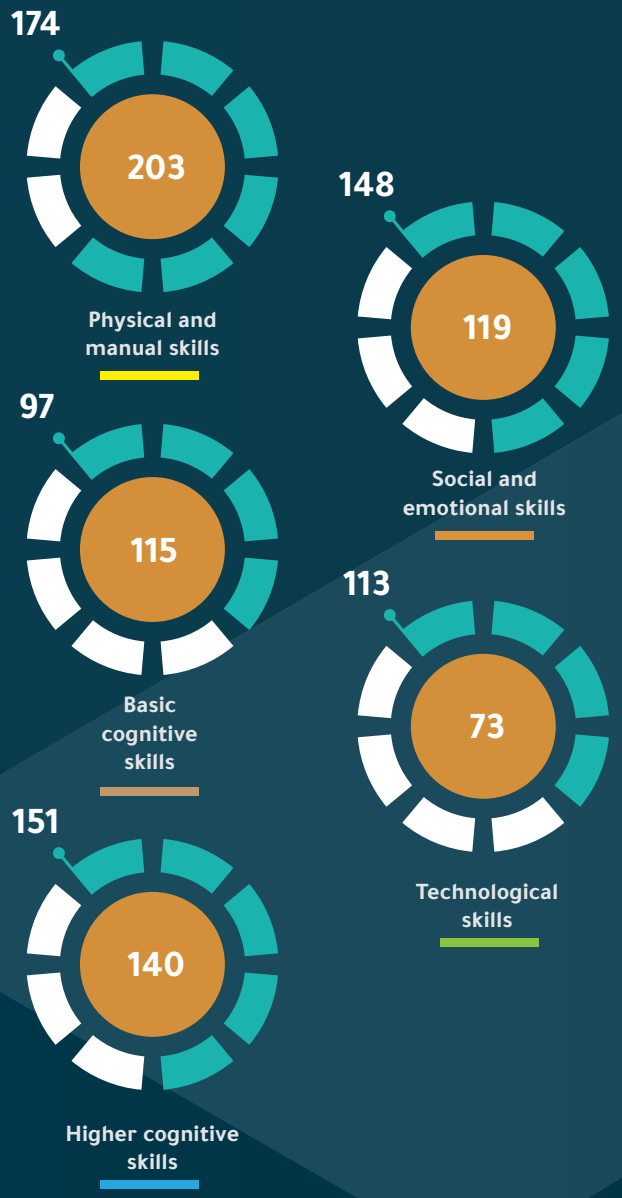


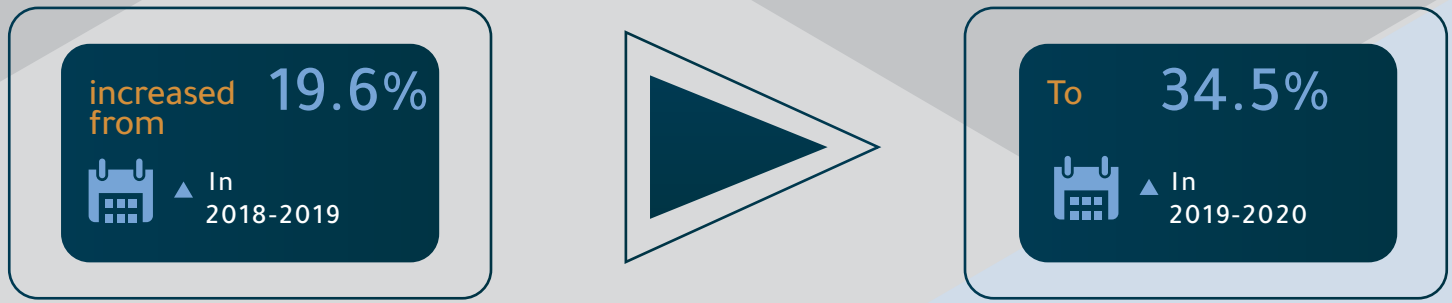
Figure 6: The projected change in the pattern of jobs and related skills in Europe and USA by 2030

Source: Mckinsey Global Institute Workforce Skills Model; Mckinsey Global Institule analysis

Scientific Research and Patents in Artificial Intelligence & Advanced Technologies

.0 Scientific Research and Patents in Artificial Intelligence & Advanced Technologies

The scientific progress of research in artificial intelligence and advanced technologies is accelerating with direct investments from governments worldwide and increasing interest from private sector institutions. According to the Stanford University AI index report 2021, the research papers published in artificial intelligence technologies increased from 19.6% in 2018-2019 to 34.5% in 2019-2020. Academic institutions still issue the most significant proportion of research papers . Still, research institutions from the private sector in the USA come in second place in the rate of publication of research papers in artificial intelligence technologies. In contrast government institutions are second after academic institutions in China and the European Union.



The report also indicates that the percentage of research papers published from the Middle East and North African countries between 2000 and 2019 did not exceed 5.5% compared to the rest of the countries, where East Asia and the Pacific countries topped the rate of publication of research papers in artificial intelligence technologies in the same period by 36.9%.

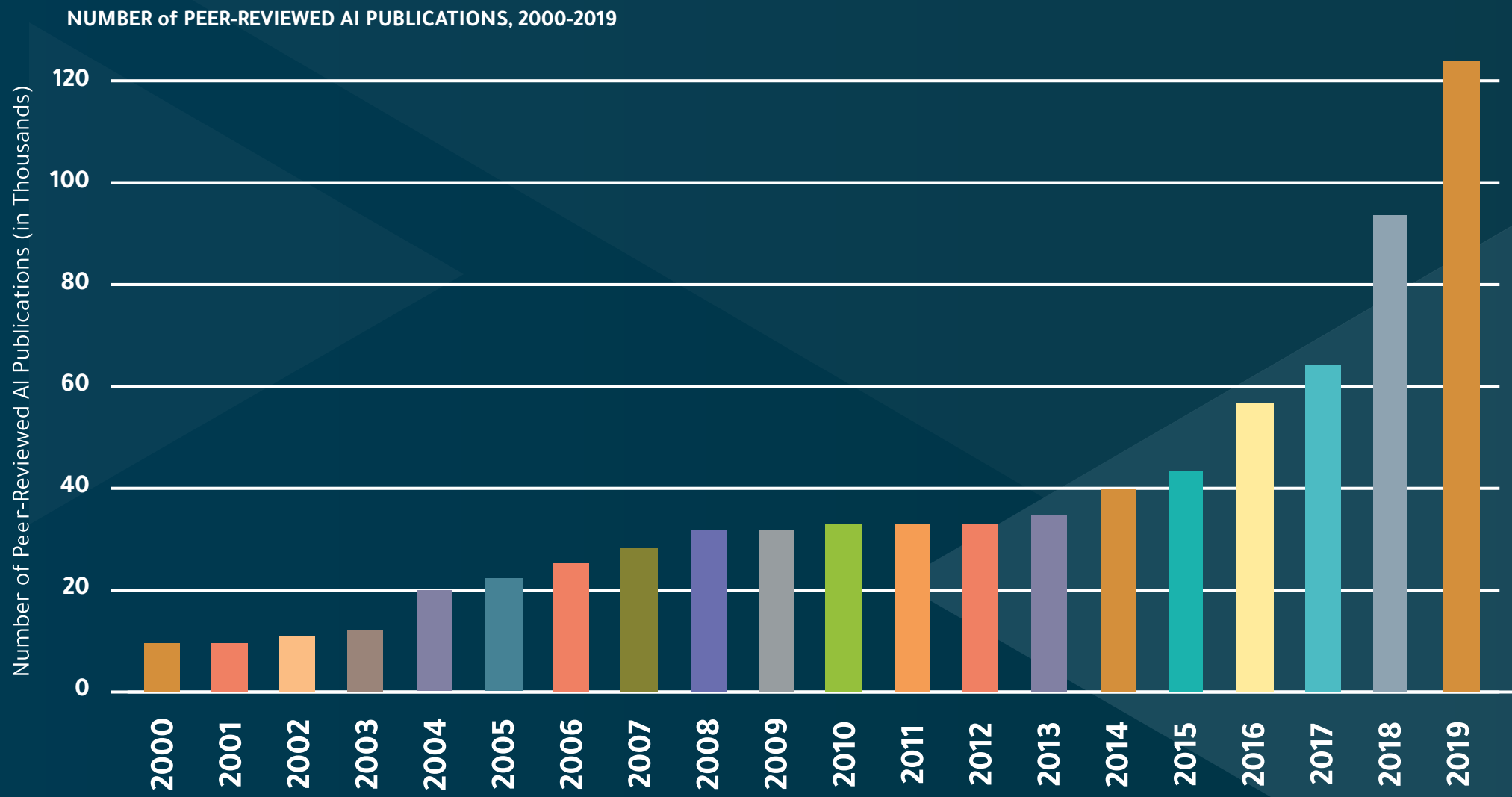


Figure 7: Total number of research papers in artificial intelligence techniques from 2000 to 2019

Source: Elsevier, Scopus 2020

On the other hand, the registration of patents in technologies related to and enabling for artificial intelligence is constantly increasing, as a study published by Clarivate Analytics in cooperation with Sultan Qaboos University[12] shows that patents in deep learning technologies and neural networks come at the front, followed by machine vision technologies. Figure 8 shows the Rate of Growth in Patents in AI-related Technologies. According to the report, published research papers and patents registered in the Sultanate of Oman related to artificial intelligence technologies are still minimal compared to the Middle East and North Africa countries.

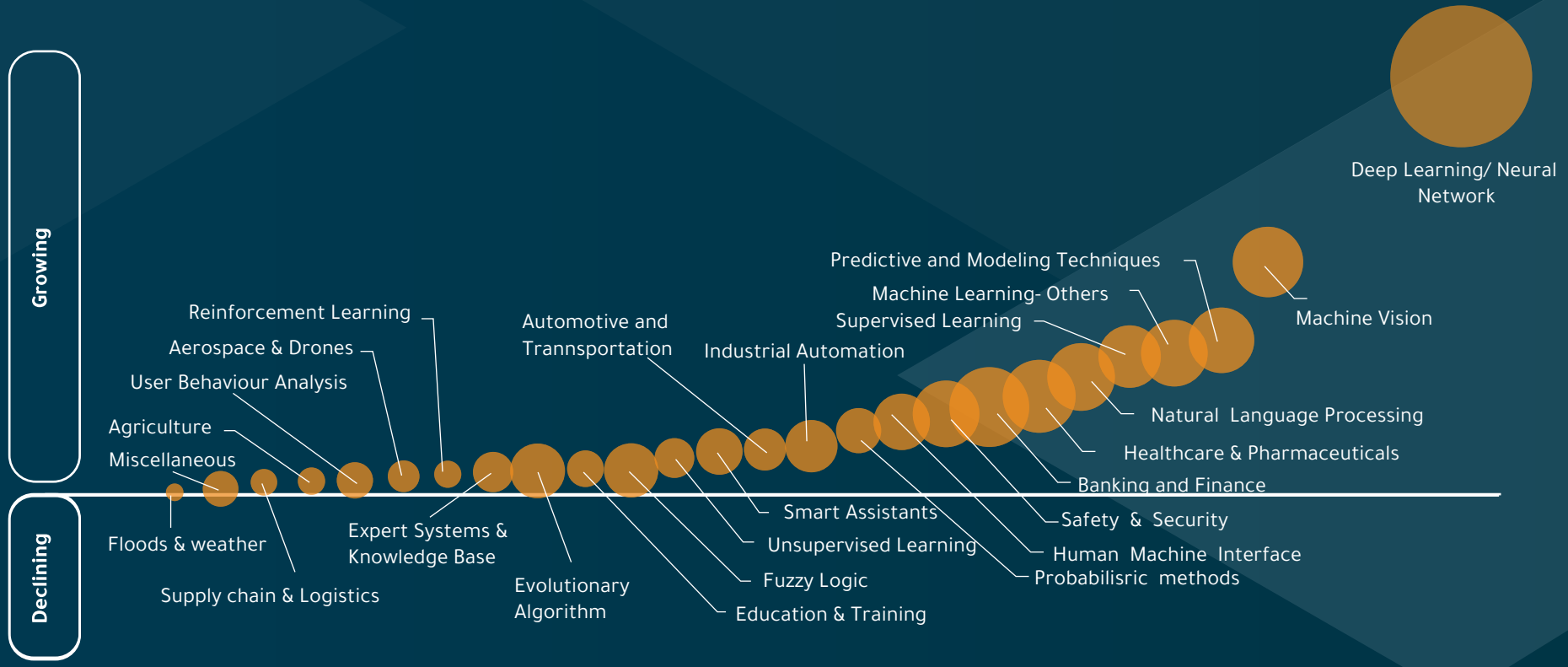


Figure 8: Growth Rate of Patents in AI-related Technologies

Details - Executive Program for Artificial Intelligence and Advanced Technologies

.0 Details - Executive Program for Artificial Intelligence and Advanced Technologies

he vision, mission, and objectives of the National Program for Artificial Intelligence and Advanced Technologies are as followings:

8.1 Vision

Build the Sultanate of Oman's Artificial Intelligence & Advanced Technologies niche space.

.2 Mission & Objectives

1. Build ecosystem and partnerships with public, private and academic institutions, entrepreneurs and civil society institutions to unify efforts in the field of artificial intelligence and advanced technologies to build local capacities and competencies by linking them to the requirements of the labor market.
2. Encourage the use of artificial intelligence and advanced technologies in essential sectors such as education, health, defense, security and social care, and improve the quality of government services.
3. Contribute to stimulating the productive sectors targeted for economic diversification and improve their performance and making these sectors more attractive by integrating artificial intelligence and advanced technologies in these sectors.
4. Localize industries based on the production of essential components used in artificial intelligence and advanced technologies by involving the private sector and small and medium enterprises working in this field in implementing initiatives and projects related to these technologies.
5. Support the modernization of the education system to keep pace with the basic technical requirements in the field of artificial intelligence and advanced technologies to enhance the competitive capabilities and skills of individuals.
6. Create a flexible regulatory environment and legislation in line with the requirements of artificial intelligence and advanced technologies by updating the relevant systems, laws and strategies.
7. Define and review the criteria and indicators for the Sultanate of Oman's progress in adopting artificial intelligence and advanced technologies in comparison with regional and global countries.

.3 Targeted Sectors

The executive program for Artificial Intelligence and Advanced Technologies targets the economic diversification sectors identified within the tenth five-year development plan and Oman Vision 2040, along with accelerating the adoption of these technologies in the essential and strategic sectors.

The economy diversification sectors are:

1. Logistics and transportation.
2. Manufacturing.
3. Banking and Finance - TradeTech (ex: Fin-tech, e-commerce, etc.).
4. Energy.
5. Culture & Tourism.
6. Fisheries & Agriculture.
7. Mining.

On the other hand, there are other essential & strategic sectors targeted, which are:

1. Smart Government (Digital Transformation).
2. The Information, Communications, and Technology.
3. Education.
4. Health.
5. Security and Defense.
6. Emergency & Disaster management. (relief and rescue)

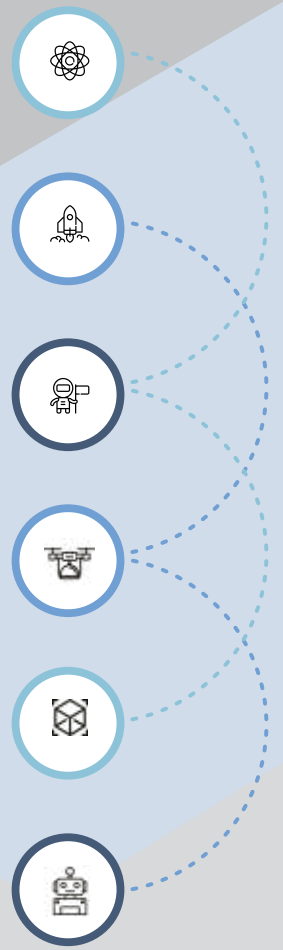
.4 Targeted Technologies

The Ministry of Transport, Communications & Information Technology (MTCIT) works to identify priority technology for investment, research and development in line with national capabilities and the requirements of the economic sectors as well as building a competitive advantage for the Sultanate of Oman in these technology and ensuring the transfer of knowledge and localization of technology in cooperation with partners in the public and private sectors, educational nstitutions and local startups.

.4.1 Complementing AI and Advanced Technologies

The foundation of enabling the artificial intelligence and advanced technologies can be through the below complementing technology:

1. The Internet of Things (IoT).
2. Autonomous Vehicles and Drones.
3. 3D Printing.
4. Robots.
5. Mixed Reality.



.4.2 Examples of Targeted Artificial Intelligence technology

Some examples of targeted Artificial Intelligence technologies are:

1. Machine learning and deep learning.
2. Machine vision.
3. Voice and speech recognition, and language processing.
4. Intelligent analysis and data-driven decision-making.
5. Semiconductors industry, such as designing dedicated artificial intelligence processing unites & smart sensors.

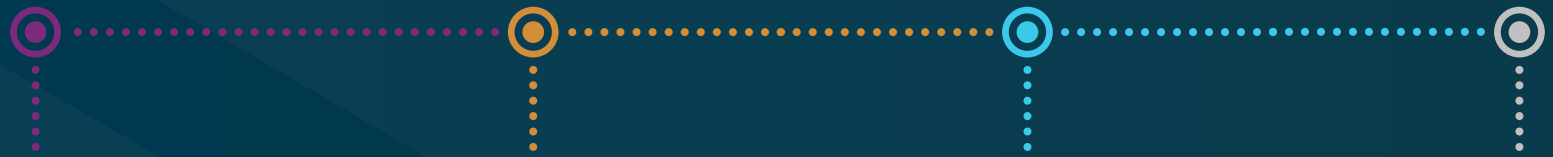
8.4.3 Examples of future advanced technologies*

*These technologies are not necessarily targeted by the Executive Program for Artificial Intelligence and Advanced Technologies.

The examples of future advanced technologies can be in the form of:

1. Leveraging data analysis to direct the production of customized consumer goods according to individuals requirements on a large and efficient scale.
2. Preventive maintenance of machinery and equipment.
3. Recognizing the consumption patterns of individuals.
4. Fabrication of digital chips that simulate the human neural network.
5. Variable pricing of products according to consumption patterns.
6. Marketing of products based on human sentiment analysis.
7. Manufacture and provide products and services based on forecasting.
8. Shipping before ordering.
9. Fulfilling the subconscious desires of the consumer.
10. Accurate delivery: Necessary products are available at reasonable prices when needed.
11. Autonomous Biotechnology & Nanotechnology.
12. The combination of electronic chips with the biological characteristics of humans.

8.4.4 High-level Key Performance Indicators for the executive program:



Sultanate of Oman to rank among top 40 countries by 2025 and among top 35 countries in 2030 in the Government Readiness Index for Artificial Intelligence issued by Oxford Insights, compared to the 49th ranking n 2021.

Increase the number of startups specialized in artificial intelligence technologies development & SMEs providing AI related services by 20% annually. The number of local startups specialized in this field is less than 10 in 2020.

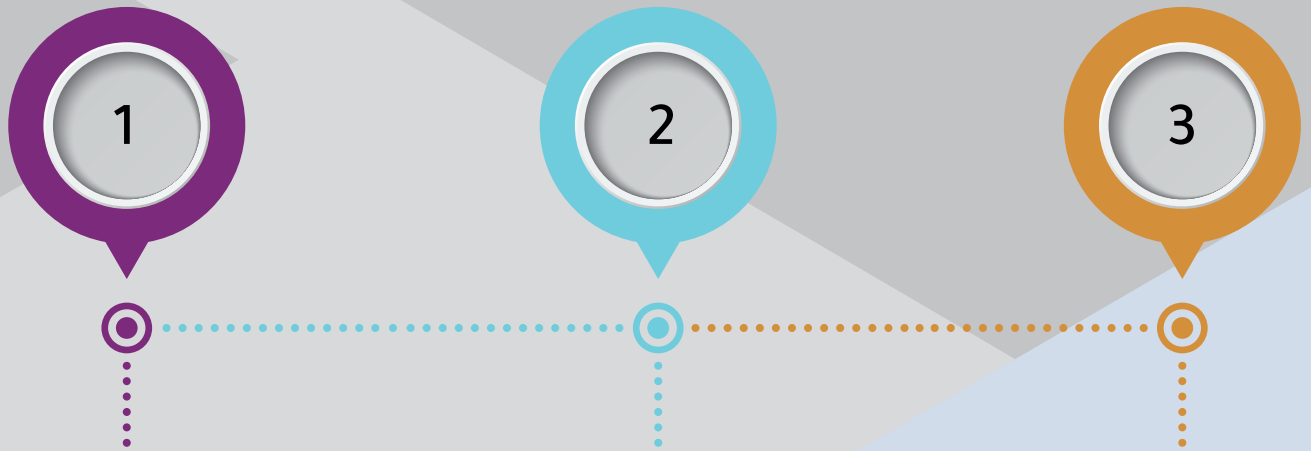
Growth of the volume of investments in artificial intelligence technologies to reach 250 million dollars in 2025 and 400 million dollars in 2030, compared to the size of the investment at present, which does not exceed 20 million dollars.

Increase the number of research papers in artificial intelligence issued by the Sultanate of Oman by 20% annually.

The AI Landscape in the Sultanate of Oman

.0 The AI Landscape in the Sultanate of Oman

Generally, the AI high level system stack whether for Sultanate of Oman or other countries considers the following essential layers:



Each layer considers several components that contribute to complementing other layers. Each part includes many projects and initiatives supporting AI practices and uses whether directly or indirectly. The Infrastructure Layer contains essential components for the AI deployment needs such as Sensors, AI chips, data management, communication & computing. In contrast, the Technology Layer comes next depending on the infrastructure layer capabilities to provide the requirements' for the AI domains either fully or partially such as speech recognition systems, natural language processing (NLP) platforms, machine vision analysis techniques, machine and deep learning models, intelligent decision making systems, etc. The next layer considers putting the AI technologies of the previous layers into operations reflected in the form of applications and uses cases. These applications or use cases are practicing the AI uses partially or fully considering the intersection of sciences, engineering, and innovative solutions which includes robotics, drones, autonomous vehicles, robotic process automation systems, personal assistance tools, industrial solutions, business intelligence and chatbot based services, etc.

The AI landscape in Sultanate of Oman includes several existing projects and initiatives. Most of these projects and initiatives (if not all) contribute to the indirect or partial application of AI uses in Sultanate of Oman. In other words, these projects and initiatives are shaping the ground for AI kick-off. However, the journey for Sultanate of Oman on its national level is still long to mature in the AI applications and uses.

.1 The AI Infrastructure Layer

The AI infrastructure layer in Sultanate of Oman includes projects in the form of Fab-labs, R&D, or prototyping labs initiated by small and medium enterprises (SMEs) aiming for the production of some hardware tools like sensors and customized AI chips beside an IoT & smart meters factory targeting utilities sector. In addition to that, Sultanate of Oman has a rich data that can be utilized effectively in artificial intelligence applications and stimulate the development of machine and deep learning algorithms while encouraging the publication of a set of open data to provide the opportunity for researchers, entrepreneurs and private institutions to provide data-based services. Communication and computing is another component of the AI infrastructure that is represented by the projects of 5G networks expansions by the telecommunication firms, cloud computing services, fiber optic expansion projects, Wireless Sensor Network, and other wideband projects.

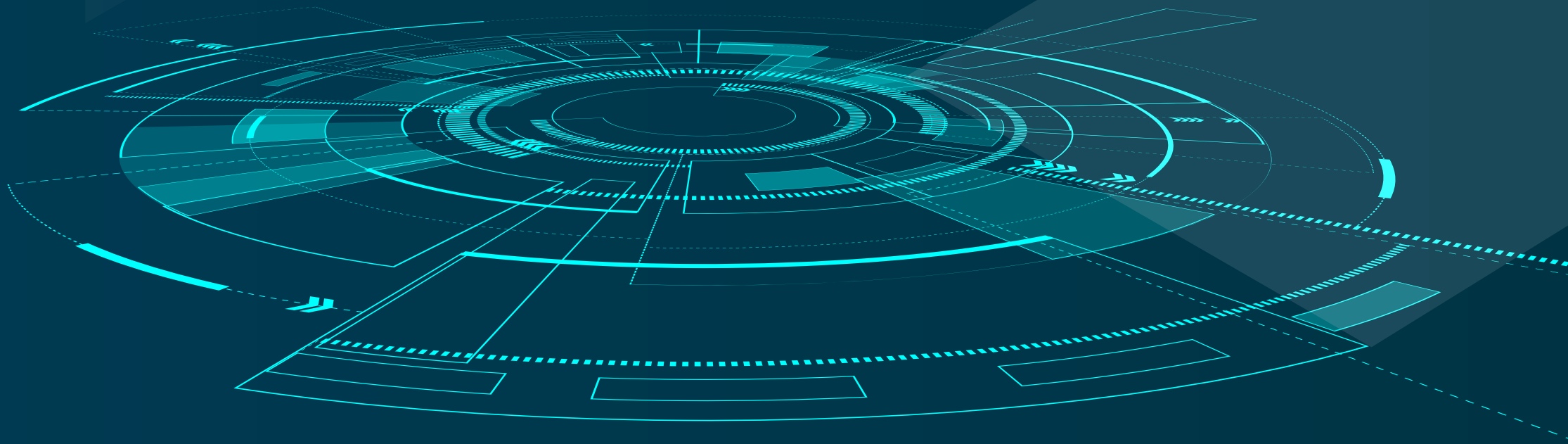
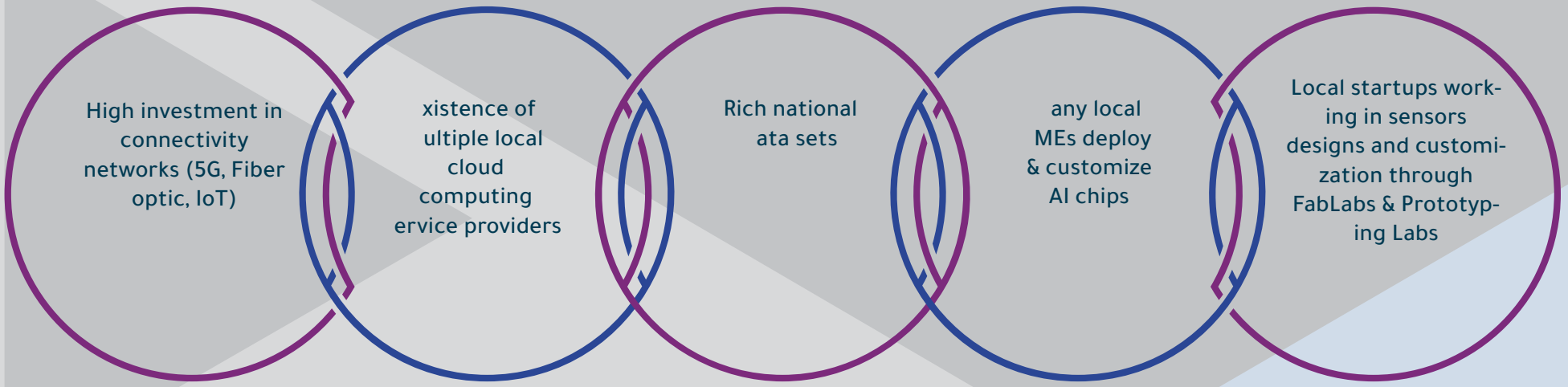
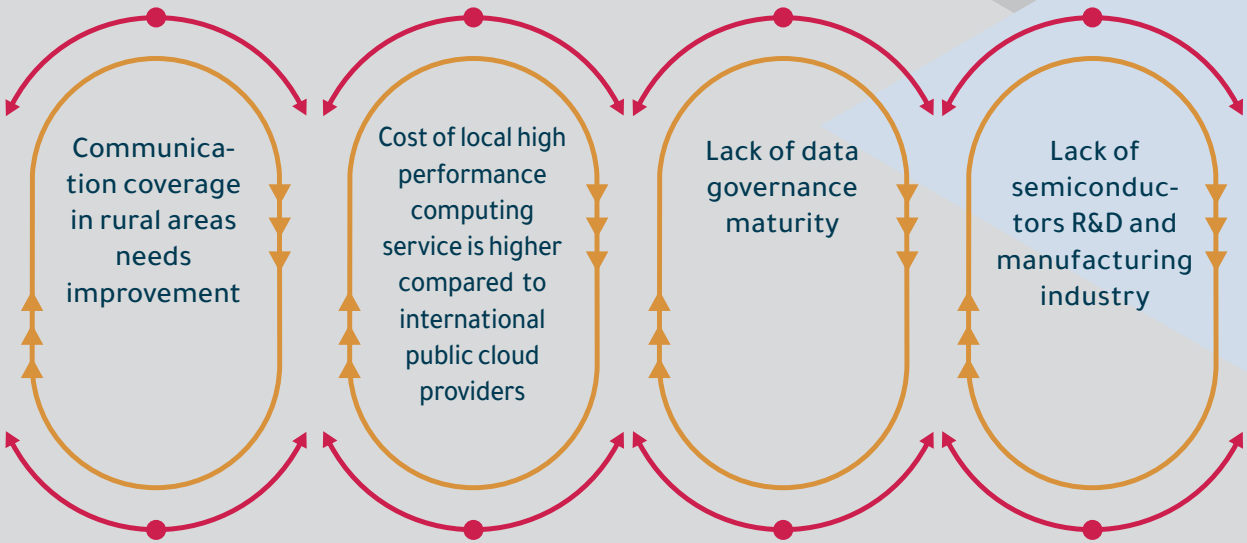


Diagram below summarize the opportunities & challenges analysis of AI Infrastructure layer.

Opportunities



Challenges



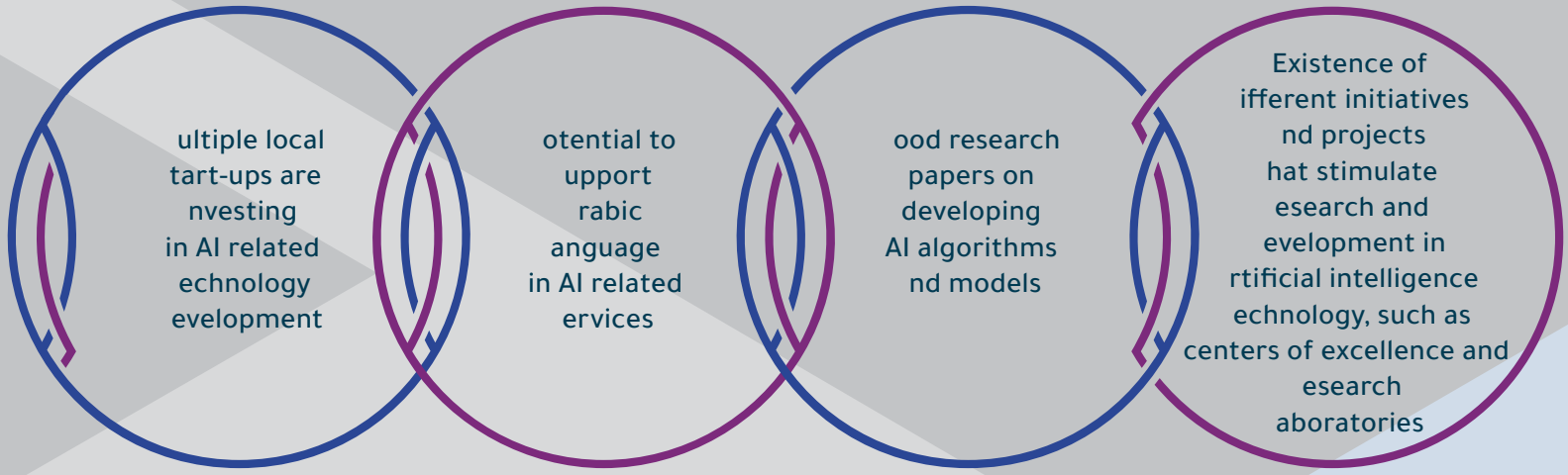
.2 The AI Technology Layer

The AI technology layer in Sultanate of Oman includes projects in the form of R&D utilizing open source platforms, emerging technologies and innovative solutions, in addition to the APIs provided by large international corporates. All these existing projects can shape a solid ground for AI domains like speech recognition, machine learning and deep learning, natural language processing (NLP) and Machine vision. The intelligence decision-making platforms also have potential in Sultanate of Oman considering providing them through local cloud providers in the form of AI as a service (AiaaS).

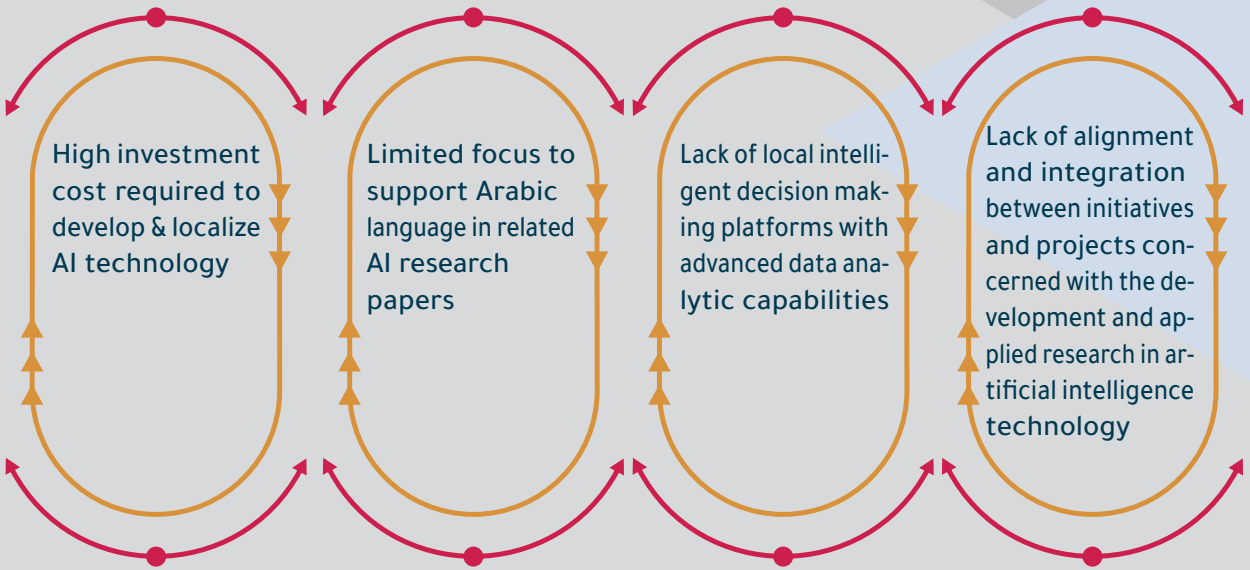
Machine vision analysis technology for identifying HSE (Health, Safety & Environment) violations is a project considered by a giant oil production company in Sultanate of Oman that can be regarded as one of the leading projects in this domain. Other factors are considered to be solid kick-off ground for the machine vision domain in Sultanate of Oman, which is innovative startups solutions and academic R&D to integrate IoT with AI utilizing open source libraries & tools.

The diagram below summarizes the opportunities & challenges analysis of the AI technology layer.

Opportunities



Challenges



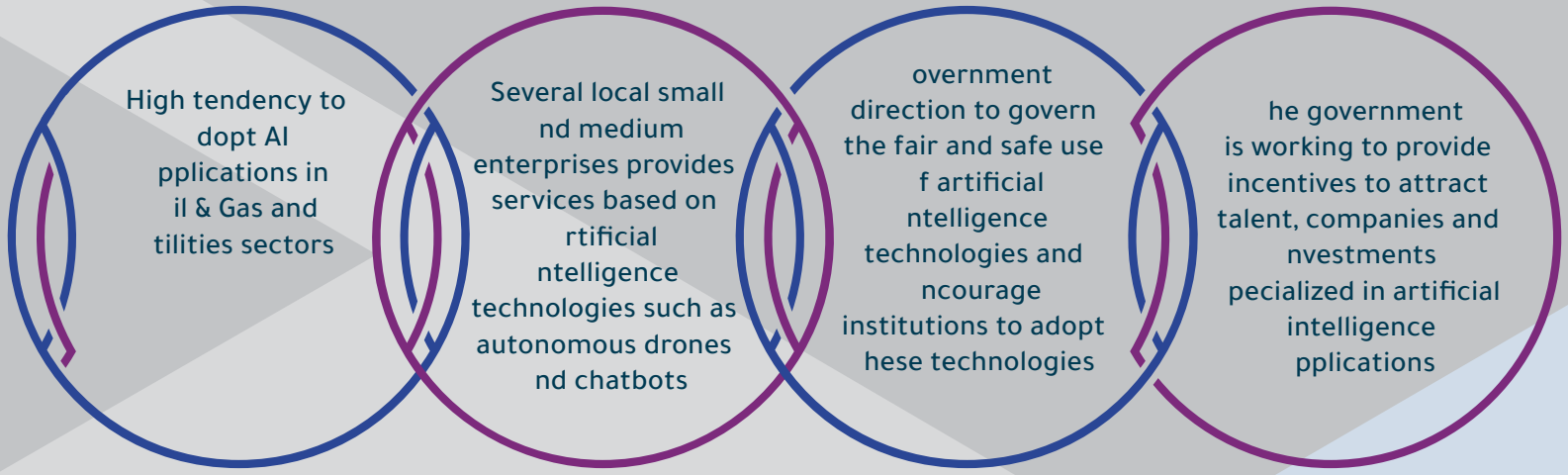
.3 The AI Use Cases & Applications Layer

Examples of use cases and applications of AI in Sultanate of Oman are as follows:

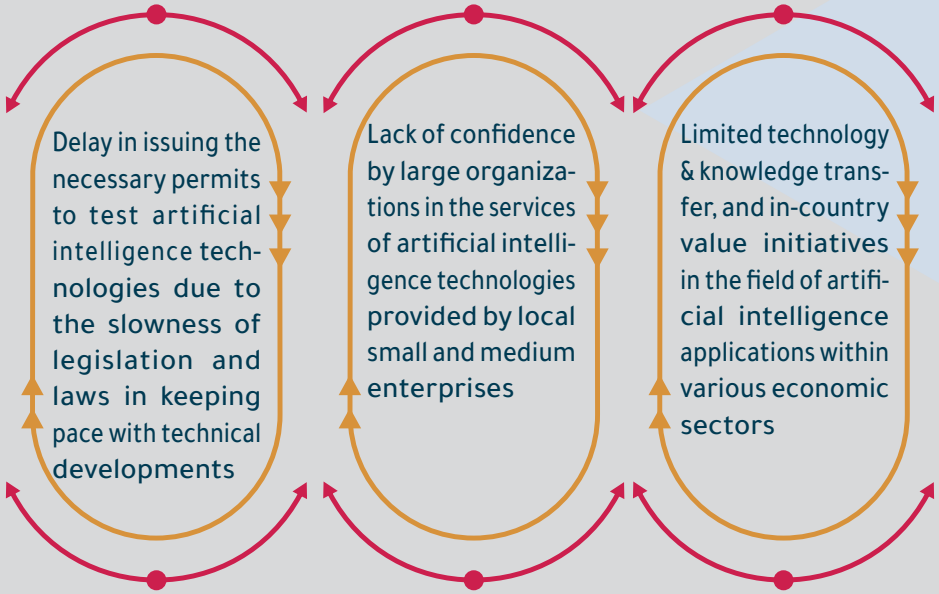
Robotics: Warehousing by robots is a project currently running by an oil and gas firm. In addition, there are smart/auto warehousing solutions already in operation by a local factory in Al Rusail Industrial City.
Autonomous driving: A proof of concept (POC) for delivering parcels within a residential area is under planning stage by a local SME with a residential management entity.
Drones: A proof of concept (POC) for delivering parcels to rural areas is another initiative under planning stage by a consortium of an international company with three local SMEs. Using drones for agricultural pest control and detections, digital content drones, and a fixed wing drone by an SME are good initial examples.
Personal Assistance platforms: Many large companies provide personal assistant systems, for example, Amazon's Alexa platform and Google Assistant. These companies offer developer APIs linked to these platforms that local startups use to develop innovative products. There is also a tendency to use and customize these solutions in airports and libraries to improve the customer experience.
Customer Service innovative solutions: this is represented by the use of chatbots attend to customers by the telecommunication companies, utility services firms, and airports.
Business intelligence: Many organizations deploy robotic process automation solutions, telecommunication services targeted marketing, and breast cancer diagnosis project adopted by the health sector.
Industrial applications: The oil and gas sector is the leader in adopting artificial intelligence in operational processes through initiatives to improve productivity and reduce costs in oil production fields. Examples of those initiatives: Proactive Predictive Maintenance Project, Oil Spill Monitoring Project, Improvement of Water Flow During Production Operations, Drill Pipe Monitoring Project to prevent damage, and use machine vision to monitor violations of health, safety and environmental policies. In addition, in electricity and water services, smart meter and electronic metering projects use artificial intelligence technologies to improve the quality of service.

he diagram below summarizes the strengths & weaknesses analysis of Use Cases & Applications.

Opportunities



Challenges

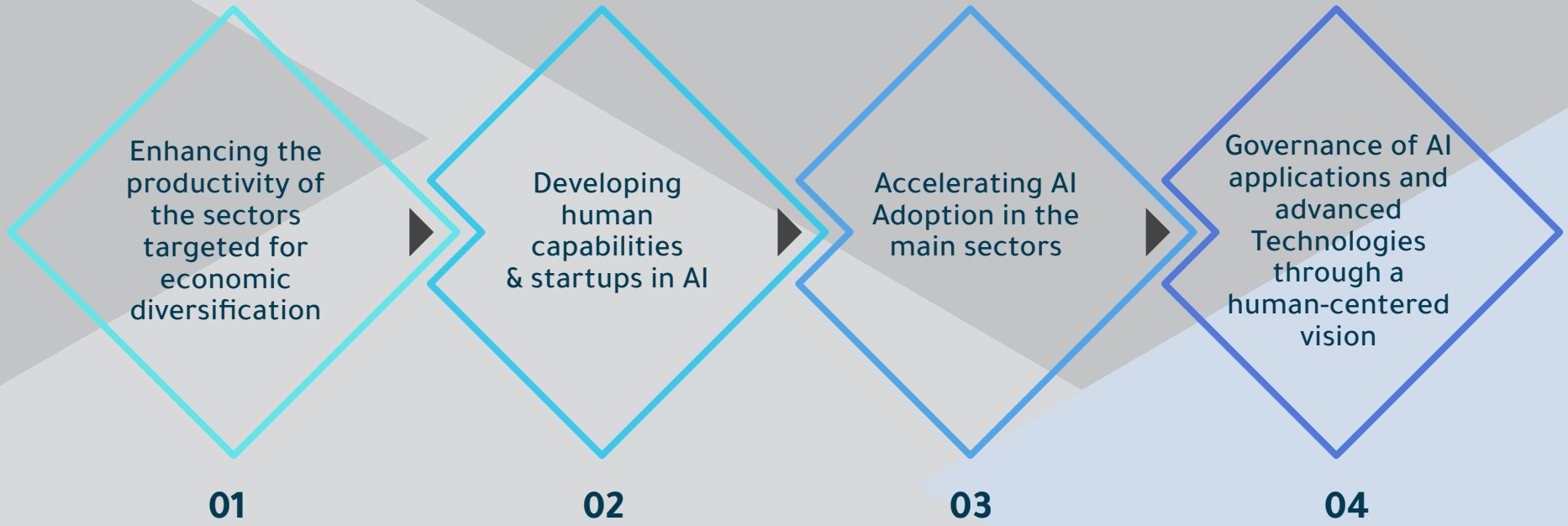


The following diagram summarizing the AI landscape in Sultanate of Oman.

Executive Program Pillars, Projects & Initiatives

10.0 Executive Program Pillars, Projects & Initiatives

The executive program for AI & Advanced Technologies is based on the following pillars:



Several sectors initiated several initiatives that encourage the adoption of artificial intelligence applications and advanced technologies in the Sultanate of Oman. These initiatives support the progress of the four targeted pillars in the executive program for Artificial Intelligence and Advanced Technologies, as they have been aligned and integrated with the industries and projects proposed in the program.
The initiatives have been captured and analyzed through meetings and workshops with the related entities, partners, and sector representatives.

0.1 Pillar 1: Enhancing the Productivity of the Sectors Targeted for Economic Diversification

The direction of this pillar considers the following focus areas:

Adopting artificial intelligence in sectors that contribute to economic growth and social impact through the integrated application of smart technologies in the sectors of fisheries, agriculture, transport, logistics, energy, mining, manufacturing and tourism, while providing the necessary qualification programs for the workforce to deal with the expected impact of the job pattern and future skills

Localization and technology transfer of AI technologies by supporting R&D in building algorithms, libraries and software tools, in addition to building and adopting open source software and hardware that enable AI and its applications

Accelerating the deployment of modern communication technologies that will accommodate the requirements of artificial intelligence applications and advanced technologies

Enhancing the application of AI technologies in cybersecurity

Upgrading the local cloud-computing infrastructure to process AI applications

The following table covers the related initiatives of (Pillar 1) that are implementing -fully or partially- the AI and advanced Technologies in Sultanate of Oman by some entities or in the pipeline classified in the form of projects, targeted key performance indicators, expected timeline, and the main sectors involved in execution:

Projects 1.1 : Promote the application of AI to sectors that can maximize economic growth and social impact

Initiatives	Target KPIs	Time frame	Involved Sectors
1.1.1 Implementation of robots / IoT / Drones that simulate behavior of workers (e.g: Use of robots on unmanned farms / fisheries).	projects	022-2025	Agriculture, Energy and ransportation.
1.1.2 Implementation of Smart factory using IoT and AI. (e.g: Predictive automated maintenance of machinery and equipment, cooperative production by humans and robots.)	2 projects	2022-2025	Manufacturing
1.1.3 Implementation of smart energy house / buildings powered by AI	2 projects	2022-2025	Energy
1.1.4 Implementation of smart water consumption management in buildings and distribution network powered by AI.	2 projects	2022-2025	Energy, Water Services

Projects 1.2: Foster the Development of Smart Products & Build AI Support Systems

Initiatives	Target KPIs	Time frame	Involved Sectors
1.2.1 Speed up the deployment of a highly intelligent next-generation Internet* * Part of ICT infrastructure rogram	High Speed Fixed Broadband Network Access to Buildings as per 2020 Census: • 75% covered with fiber-optic network • 85% covered by fixed broadband networks Mobile broadband networks reach the population by 98% Updating / transferring 90% of the 3G network stations to stations that support the 4G or 5G network.	2022-2025	Communications
1.2.2 Promote the advanced application of AI technology in the field of cybersecurity	2 projects	022-2025	Cyber Security

Initiatives	Target KPIs	Time frame	Involved Sectors
1.2.3 Offer an incentive (Stimulus) tax deductions package up to a certain percent for manufacturers adopting AI&AT solutions.	Issue of resolution to manage incentives packages	022-2025	Related ministries and government bodies.
1.2.4 Upgrade local cloud computing platforms to offer AiaaS products with accreditation.	2 local cloud computing companies offer Aiaas	2023-2025	Cloud computing (local companies)

Apart from the initiatives mentioned above, there are other initiatives or projects related to (pillar 1), which have a high potential to enhance the productivity of the targeted sectors for economic diversification but are not adopted by any entity or sector in Sultanate of Oman. Some of these suggested initiatives or projects are shown in the following diagram:

Promote the popularization of intelligent Open AI hardware and application of high-precision, low-cost smart sensors

Support the AI development frameworks, algorithm libraries, and toolsets; and support the construction of open source AI platforms.

Reform the technological standards to facilitate the introduction of new IoT technologies (including narrowband IoT) so that IoT services can be provided at mobile communication frequencies.

Use AI to optimize postal and logistics processes, thereby maximizing the efficiency of postal and courier services, and introduce an advanced drone-based traffic logistics system.

Create two state-of-the-art urban logistics complexes that combine logistics, distribution, and cutting-edge industries (and ensure the broad application of self-driving transportation robots at logistic center sites.

Integrate AI&AT with renewable energy initiatives

A cyber immunity system to collect routinely a wide range of information on diverse types of malicious code and cyber vulnerabilities to prepare for possible cyber-attacks and ensure the security assessment of AI applications.

Explore AI applications through:

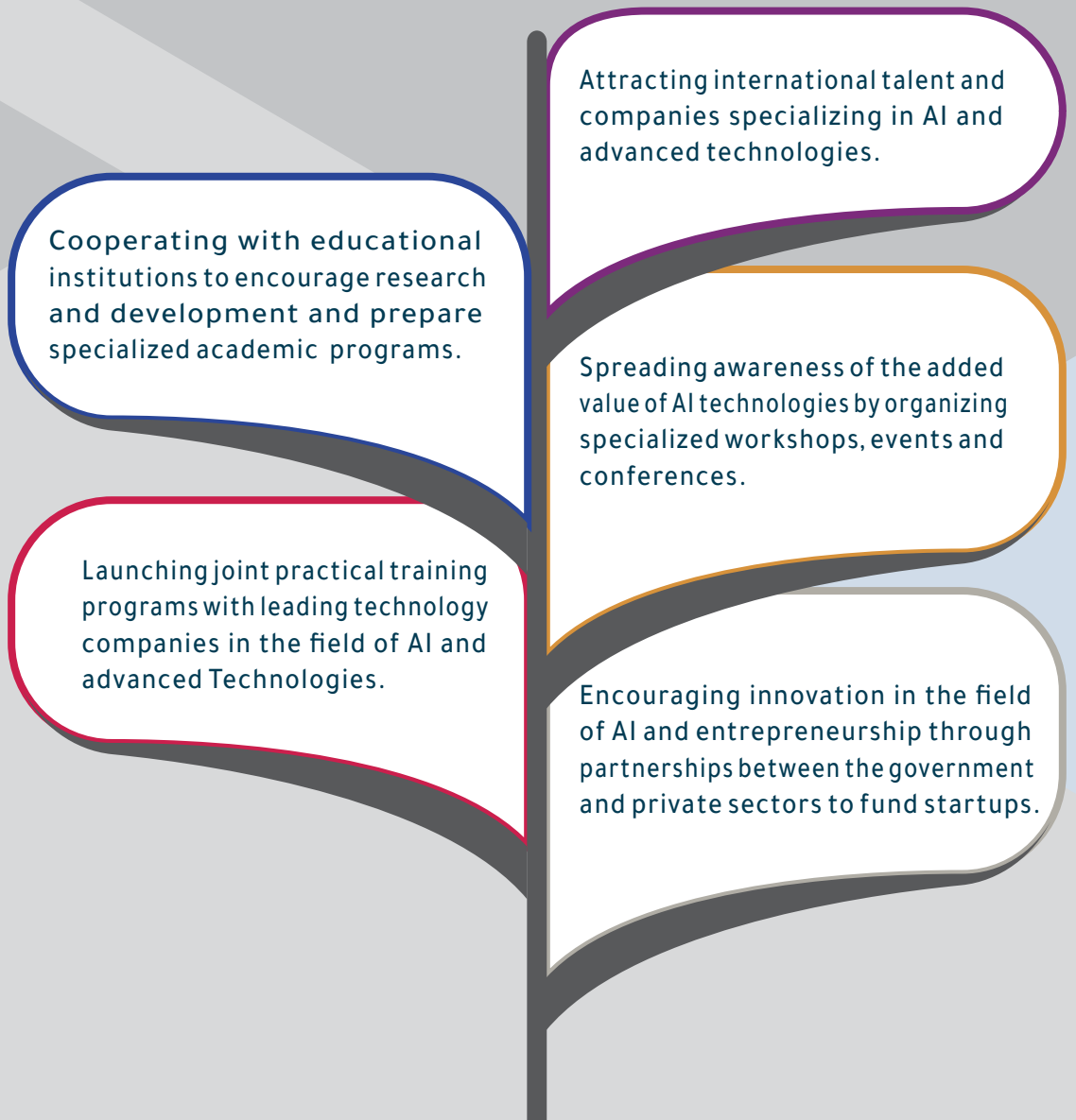
1. Graphics Processing Units (GPUs).
2. Application Specific Integrated circuits (ASICs).
3. Field Programmable Gate arrays (FPGAs).
4. Quantum Computers,
5. Neuromorphic Chips,
6. Nanomaterial-Based Chips,
7. Optical-Based Integrated circuits
8. Biochemical Circuits.

Invest proactively in the programmable (Wireless) Radio Frequency technology that is energy-efficient, lightweight, and compact in size.
Invest in network technology that can be applied to vehicles and sensor grids; and wearable sensor grid technology based on the (human) central nervous system.

Support and encourage the use of automation systems based on data analysis and IoT in manufacturing lines.

0.2 Pillar 2: Development of Human Capabilities in AI

The direction of this pillar considers the following focus areas:



The following table covers the related initiatives of (Pillar 2) that are implementing -fully or partially- the AI and advanced technologies in Sultanate of Oman by some entities or in the pipeline classified in the form of projects, targeted key performance indicators, expected timeline, and the main sectors involved in execution:

Projects 2.1 : Train advanced R&D personnel and AI professionals

Initiatives	Target KPIs	Timeframe	Involved Sectors
2.1.1 Develop core personnel specializing in AI & Data Science who are capable of leading new industries. Support skills acquisition accelerators, higher education and grants in data science and AI.	Launch new higher education programs	2022-2025	Education
2.1.2 Providing financial incentives for reskilling of employees in AI technologies technically and legally. Align data science and ai training programs with the initial and conceptual projects in the targeted industries	8 Programs	2022-2025	Education, Labor

Projects 2.2 : Build AI R&D Network

Accelerate the R&D and industrialization of core technologies, such as machine learning and vision, natural language processing, mart Sensors, Speech recognition and synthesis, Intelligent support for decision-making.

xplore Sultanate of Oman niche space in Advance Tech like: Realization of subconscious desires, large-scale personalized ustomization.

Initiatives	Target KPIs	Timeframe	Involved Sectors
2.2.1 Create framework for promoting Artificial Intelligence & Advanced Technologies research.	Publish AI R&D framework The annual average of research papers in artificial intelligence issued by the Sultanate of Oman is currently 87. The target in 2025 is 265 The target in 2030 is 665	2023-2024	Research & Innovation
2.2.2 Incentivizing core and applied research in AI that considers sectors that can maximize economic growth and social impact.	2 projects	2023-2025	Research & Innovation
2.2.3 Capitalize on existing Centers of Excellence to target Artificial Intelligence as well as Introducing a big data academy, data analysis certification and other similar learning programs.	2 Centers	2022-2025	Education, Communication, Energy.

Projects 2.3: Attract international talent and firms

Initiatives	Target KPIs	Timeframe	Involved Sectors
2.3.1 Ease the hosting of Artificial Intelligence & Advanced Technologies specialized international talents. -Attract global startups to provide their services in the local market and build partnerships with the local companies.	Policy formulation	2023-2025	Education, Labor

roject 2.4: Encourage problem-solving- and critical thinking-centered education.

Initiatives	Target KPIs	Timeframe	Involved Sectors
2.4.1 Increase software and STEM education for elementary and middle school students to enhance their computational thinking and problem-solving capabilities.	Introduce AI as part of educational curriculum	2022-2025	Education
2.4.2 Prepare clear training track for academic instructors.	Preparing two programs in partnership with higher education institutions	2022-2025	Higher Education
2.4.3 Establish joint Job attachment programs with international AI leaders. Direct all currently available opportunities in training, local add value, social responsibilities and offsets programs.	2 programs initiated	2022-2025	Information & Communication Technology

roject 2.5 : Spreading Awareness on AI Advantages

Initiatives	Target KPIs	Timeframe	Involved Sectors
2.5.1 Organize AI specialized workshops, events & conferences	2 events annually	2022-2025	Education, Information & Communication Technology
2.5.2 Organize AI and data contests and events to encourage science esearch Development Programs	To hold 1 program annually	2022-2025	Education
2.5.3 Establish Specialized AI and data science Club	AI club to be launched	2022-2025	Information & Communication ,Technology Civil Society

roject 2.6: Localize AI innovation and entrepreneurship via (SME's & start-ups)

Initiatives	Target KPIs	Timeframe	Involved Sectors
2.6.1 Ease funding of local AI startups & SMEs Establish public-private fund for investing in establishing AI startups	targeting 5 startups. - SMEs which currently adopt AI in its services are 10, Target to reach 20 SMEs by 2025 and 30 SMEs by 2030. - Target to support 5 startups specialized in AI technologies by 2025 and to reach 10 AI startups by 2030.	2022-2025	Information & Communication Technology
2.6.2 Promote TradTech with AI	1 project	2022-2025	Logistics, e-Commerce
2.6.3 Build a sector based sandboxes (logistics, energy, manufacturing, etc).	2 Sandboxes	2023-2025	Financial, Industrial & Economical Estates

Apart from the initiatives mentioned above, there are other initiatives or projects related to (pillar 2), which encourage the development of human capabilities in AI; however, no entity or sector has adopted them yet in Sultanate of Oman.
ome of these suggested initiatives or projects are shown in the following diagram:

- Promote the expansion of international research collaboration projects by assigning preferential points to R&D Centers vying to carry out national R&D projects, etc.
- Identify research issues and topics through public-private dialogue and organize AI Grand Challenge contests, through which inventors of award- winning solutions may receive research grants.
- Recruit talented master and doctoral degree holder talents to take intensive classes with the top experts in their respective fields and participate in cutting-edge R&D projects.
- Develop a large-scale pool of test specialists and personnel capable of performing pre-launch AI service tests.
- Organize annual AI recognition and award events
- Develop digital textbooks featuring AR/VR content and distribute them along with an open online market on which students can browse and purchase-learning materials suited to their interests and aptitudes.
- Organize AI Challenges, Multinational Intelligent IT Startups Camp, and other such events to discover and recruit prospective startups, and support their participation in international competitions
- Install wireless Internet networks at all schools and develop a model for modern schools that incorporate AI and VR into learning and support adaptive learning.
- Develop an intelligent learning platform that can analyze students' academic records, assign educational activities suited to their interests and levels of progress, and help improve their learning.
- Sponsor presentations in national/ international AI conferences and seminars.
- Support the design and development of advanced video lectures on a wide range of subjects via a massive open online course (MOOC) system and increase incentives for the creation of a sustainable learning system, by having universities grant students credits for the MOOCs they complete,
- Capitalize on OS CoE, 4IR center, Research centers in HEIs, IPM centers (5G & IoT), MoE innovation centers, centers in Industry (PDO, Be'ah ,Omantel, etc.).
- Prioritize AI startups for Gov AI procurements and funding considering a specific limit in OMR
- Support SMEs to get access to AiaaS cloud computing platforms

0.3 Pillar 3: Accelerating AI Adoption in the main Sectors

The direction of this pillar considers the following focus areas:

Supporting the demand for artificial intelligence applications in the local arket through government procurements.

Continuing to develop smart government services considering he utilization of artificial intelligence applications.

Facilitating access to national data by creating a platform for national data management, publish open datasets, and enhancing the integration of government data systems.

Applying artificial intelligence in public services such as health, education and smart government applications that deal directly with citizens, residents and investors, in addition to enhancing the role of the government as a primary supporter of adopting these technologies and aligning AI initiatives with existing plans for digital transformation.

The following table covers the related initiatives of (Pillar 3) that are implementing -fully or partially- the AI and advanced Technologies in Sultanate of Oman by some entities or in the pipeline classified in the form of projects, targeted key performance indicators, expected timeline, and the main sectors involved in execution:

roject 3.1 : Proactively apply AI to public services

Initiatives	Target KPIs	Timeframe	Involved Sectors
3.1.1 Use AI to customize public services to satisfy the needs of individuals/ ervice providers.	2 projects	2022-2025	Information & Communication Technology
3.1.2 Encourage (Heath & Welfare) industries to adopt AI by implementing ustomized support measures. Develop and provide the necessary tools to bolster AI uses in social nd health care.	2 projects	2022-2025	Health

roject 3.2 : Open National Data assets to support the construction of standard test datasets

Initiatives	Target KPIs	Timeframe	Involved Sectors
3.2.1 Facilitate the creation of large foundational annotated data sets. Implement Data Dictionary project, which aims to standardize data systems across government. Establish a national data portal to support data infrastructure, eventually easing the utilization of machine learning for machines and systems. Establish and manage large national data sets to ease the development of AI related algorithms and tools.	Alignment of national data strategy and open data action plan.	2023-2025	National entities governing national data

Apart from the mentioned above, other initiatives or projects related to (pillar 3), have a high potential to accelerate AI adoption within strategic sectors; however, no entity or sector has adopted them yet in Sultanate of Oman. Some of hese suggested initiatives or projects are shown in the following diagram:

Apply AI&AT to civil defense systems, which currently depend on human cognition and judgment specifically while managing natural disasters like storms.

Analyze the history of citizens' & residents service use and related trends on social media using AI so as to improve the quality of administrative services and develop new services.

Government Data Assets commercialization

A program via which the government enters into agreements with innovative businesses for the development and supply of new products, services, and solutions that do not yet exist in the market (e.g., drones, Unmanned farming equipment, etc.).

Share AI software developed by the public sector in the form of open source software and Open APIs

Develop an open system, connected to private and public data platforms, for the systematic storage and utilization of sensor data generated by various IoT devices of smart cities.

Introduce AI-based service operation systems to gather public opinions in real time and simulate possible policy results to promote optimal decision-making.

Implement AI for credit and financial information services (example: Mala'a center)

Intelligent system that can identify citizens who are having difficulty making a living by collecting data on suspensions of electricity or water supply services, unpaid insurance premiums, etc.

Predicting Storm damage: AI can be used to perform factor analyses on the histories, densities, and building materials of urban structures to identify urban areas that are likely to be hit the hardest in the event of storm or other such natural disaster.

Foster the ecosystems of the AI industry by disclosing and sharing machine-learning algorithms accumulated through national R&D projects, with businesses, universities, and research institutes.

Encouraging the use of blockchain technology to enhance the security of data management.

Develop precision diagnostic techniques and treatments for three major cancers (lung, stomach, and colorectal), a next-generation medical information system based on cloud computing, and an intelligent diagnostic and treatment support system

Using computer vision to identify the registration status of vehicles, etc.

Channel technological innovation toward supporting and assisting human activities (eating, using the bathroom, moving about, etc.) so as to solve many of the daily problems and difficulties faced by the elderly and people with disabilities

Develop and improve body-invertible, super-compact robots that are capable of moving through blood vessels and organs to perform diagnostic and therapeutic functions

Develop and distribute next-generation diagnostic equipment and enhance the intelligence of the national counter-epidemic system in order to protect the public against outbreaks of infectious diseases.

Work with well-known platforms to make four major categories of data with great potential in terms of AI development (web search, location, purchase, and social media data) available to the public as test materials

Develop an AI-based knowledge database using data from Ministry of Health and hospitals, properly converted into machine-learning formats. Develop a system to integrate electronic medical records (EMRs) and genetic information

Develop personal assistance applications (e.g., "personal health aide" that checks the user's health every day and an instant messenger to allow convenient exchanges of health information)

Ensure effective monitoring and regulation of large corporations attempting to misappropriate the technologies and technical workforces of smaller companies and enhance supervision to prevent data theft, thereby minimizing any potential obstacles to illegal merger-and-acquisition (M&A) deals.

Develop 4D bio-printing technology capable of producing skin grafts and transplant organs that can adapt to and evolve, in vitro, in response to each patient's physical and environmental characteristics

Use AI to eliminate blind spots in the public healthcare system and develop and distribute innovative healthcare devices, such as caretaker robots capable of understanding the emotions and needs of the elderly, nursing robots, and muscle-enhancing wearable suits

0.4 Pillar 4: Governance of AI and Advanced Technologies for a Human-Centered Vision

The direction of this pillar is focusing on the ethical, fair, and safe use of AI applications. It considers the process of a continuous reviewing and updating of laws and policies to stimulate the adoption of AI and advanced Technologies, in addition to managing ethical issues by laying the foundations that consider human aspects, community privacy, governance of data collection processes, and the development of safe AI algorithms.

The following table covers the related initiatives of (Pillar 4) that are implementing -fully or partially- the AI and advance technologies in Sultanate of Oman by some entities or in the pipeline classified in the form of tasks, activities, the targeted number of projects, the expected timeline, and the partners involved in the execution:

nitiative 4.1 Review laws and policies to stimulate AI adoption & manage ethical issues (existing and unresolved)

Tasks	Activities	Target KPIs	Timeline	Partners
4.1.1 Establish human-centered ethics to govern data-collection processes and AI Algorithms.	Issue and update regularly the AI ethics guidelines to minimize any potential abuse or misuse of AI and advanced Technologies by developing a clear ethical guide for developers and users alike (e.g: Inequality and labor disruption, socioeconomic polarization, biases and discrimination against minorities, etc.)	Release policy & guideline	beginning in 2022	The governance & compliance related entities.

Tasks	Activities	Target KPIs	Timeline	Partners
4.1.2 Update the existing legal system to expedite and facilitate theapplication of AI and advanced Technologies industries.	Update the current processes to prevent any possible delays in the materialization of AI due to legal or institutional obstacles	Revision and update of the related existing laws	Expected to start in 2022	The governance & compliance related entities.

Initiative : 4.2 Form a National AI steering committee

Tasks	Activities	Target KPIs	Timeline	Partners
4.2.1 Establish a National AI think tank & steering committee	Establish a systemic process to govern AI applications (tools, algorithms, evaluations, decisions)	Issue a regulatory resolution to govern the applications & tools of artificial intelligence and advanced technologies	Expected to start in 2023	The governance & compliance related entities, Education Sector, Private Sector, Entrepreneurs, non-Gov organizations (NGOs).

Apart from initiatives mentioned above, there are other initiatives or projects related to (pillar 4); however, there is no entity adopted them yet in Sultanate of Oman. Some of these suggested initiatives or projects are shown in the following iagram:

A policy program that allows the testing of new technologies and services for fixed targets and fixed periods of time without being restrained by current regulations (suitable for the testing of future general AI applications).

Lengthy debates will likely to be held between manufacturers and users regarding whose responsibility is greater, such as in the case of the death of the driver of a self-driving Tesla car in May 2016.

The current law on product liability limits liabilities to natural and legal persons only, making it difficult for victims to file claims against software or hardware developers for AI-related accidents.

Based on the pillars, initiatives, tasks, and activities covered in the previous parts, the following figure shows the high level AI framework of Sultanate of Oman.

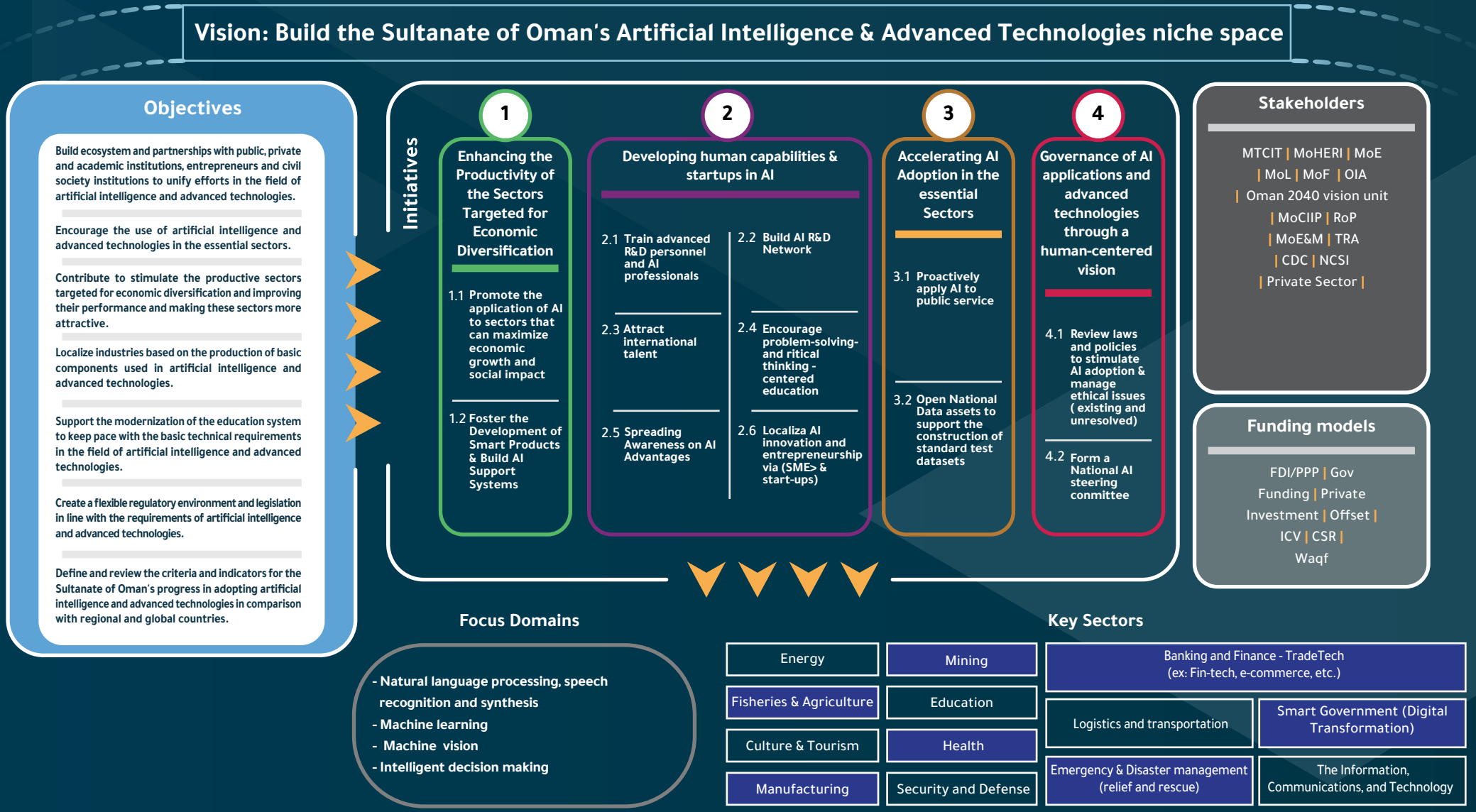


Figure (9): Oman's AI Framework

The AI & Advanced Technologies Executive Program Governance and Follow-up Framework

1.0 The AI & Advanced Technologies executive program Governance and Follow-up Framework

Implementing the direction of the National Program for Artificial Intelligence and Advanced Technologies for the Sultanate of Oman is part of the Digital Economy plan governance. It is based on three primary authority levels; as mentioned below:

The Financial and Economic Committee manating from the Council of Ministers

This committee is responsible for the overall supervision and approval of the program plans, strategies, and initiatives, and ensures its integration with National Oman Vision 2040

The Technical Committee for the Digital conomy

the role of this committee is to monitor the progress of its related strategies and initiatives, and support in overcoming the obstacles and challenges for moving forward

The National Program for AI and Advanced Technologies Team in the Ministry of Transport, communications, and information Technology

This team is responsible for ensuring the smooth progress of implementing running the AI related initiatives, projects and policies via the targeted sectors, conducting performance-reviewing checkpoint meetings / sessions, and report the gaps and suggested solutions to get the necessary support to overcome the challenges

The following diagram summarizes the above-mentioned progress shaping the eco-system of the National Program for AI and Advanced Technologies.

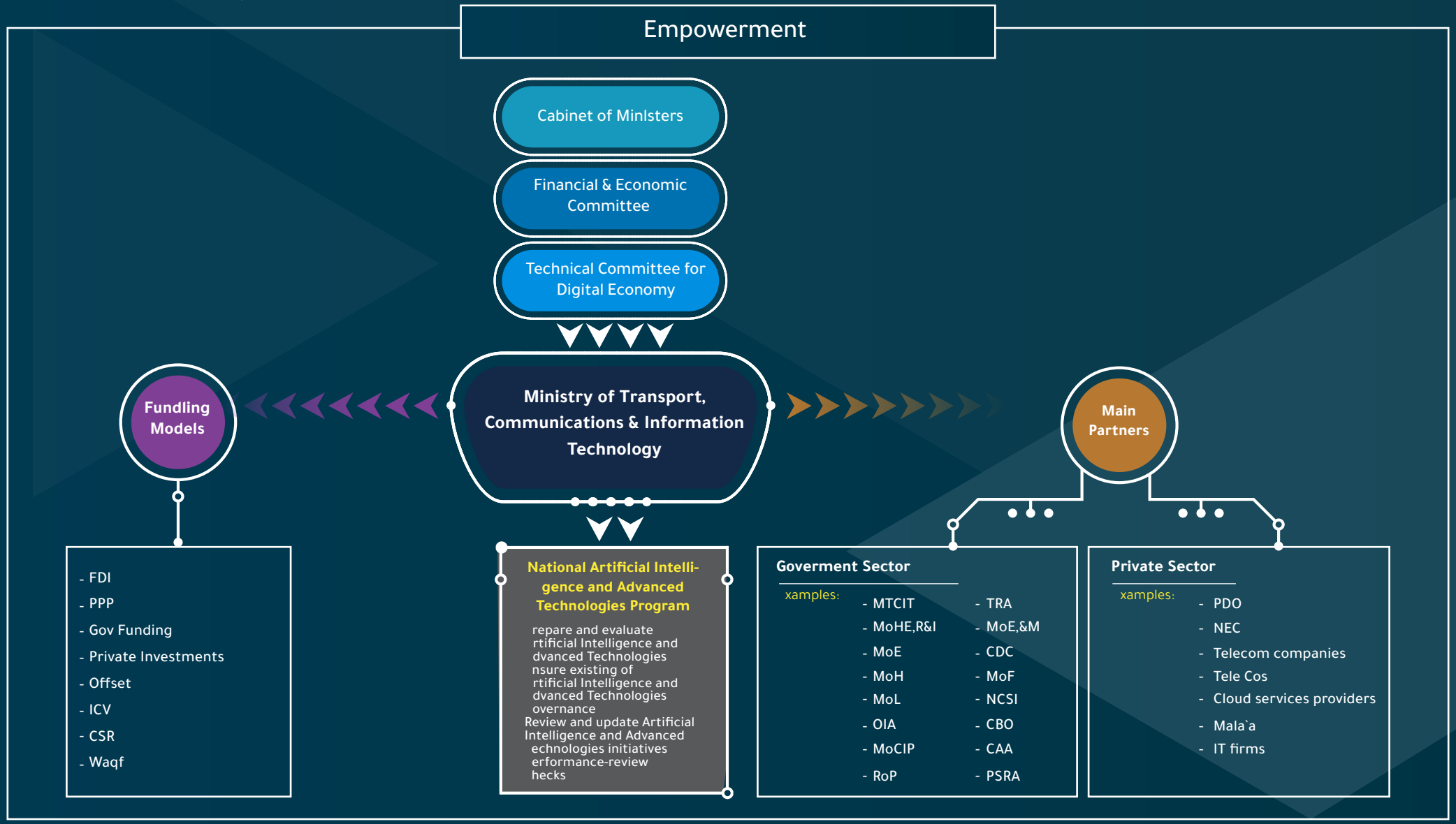


Figure (10) : system work and governance of the Executive Program for artificial Intelligence and Advanced Technologies

Appendices

Appendix A: Definitions

Artificial Intelligence (AI): is a system that can simulate human cognitive skills such as analyzing external data and devising new knowledge bases and using them to achieve new goals and tasks, and its ability to solve problems and self-learn.

Advanced Technologies (AT): can be defined as a set of tools based on AI that aims to create new and advanced scientific and technological products that can be applied, transferred and deployed into several fields without direct human intervention to change their algorithmic or physical structure.

The difference between artificial intelligence and advanced technologies

Artificial Intelligence	Advanced Technologies
is harnessing specific applications to simulate human capabilities such as predictions and decision making, using off-the-shelf algorithms based on techniques such as machine learning and machine vision, with the aim of accomplishing a specific task. Therefore, the level of AI use is classified here as Narrow AI, and some scholars describe it as Internet AI or Business AI.	is harnessing and integrating huge number of input sources to develop a state of autonomy comparable to human cognitions so that the system is capable to analyze, think, predict, select and take the most appropriate decision quickly, accurately and quality as outputs beyond human capabilities, taking into account future scenarios to achieve results with greater impact that can be transferable to situations and environments different from the one it was designed for. This comprehensive system has the ability to fuse biological and physical data to develop advanced innovations. The level of artificial intelligence use is classified here as General AI.

Appendix B: AI Glossary

Dataset - a set of data that has undergone preprocessing (processing)under to the requirements of Sultanate of Oman laws on information, information technologies, and information protection, and that is needed to develop software based on artificial intelligence

Data Labeling - a step in the processing of structured and unstructured data over the course of which the data (including text documents, photographs, and video images) are assigned identifiers that reflect the data type (data classification) and/or the data are interpreted to solve a specific problem, including through the use of machine learning techniques

Hardware - a system of interconnected technical devices that are designed for data input (output), processing, and storage

computing system - a hardware-software complex or several interconnected complexes that form a single infrastructure, and that are designed to solve problems and process data (including computations)

Analytics and business intelligence (ABI) is an umbrella term that includes the applications, infrastructure and tools, and best practices that enable access to and analysis of information to improve and optimize decisions and performance.

The data Scientist role is critical for organizations looking to extract insight from information assets for "big data" initiatives and requires a broad combination of skills that may be fulfilled better as a team. For example, collaboration and teamwork are necessary with business stakeholders to understand business issues. Analytical and decision modeling skills are required to discover relationships within data and detect patterns. Data management skills are needed to build the relevant dataset used for the analysis.

Natural-language processing (NLP) : concerned with giving computers the ability to understand the text and spoken words in much the same way human beings can.

The Internet of Things (IoT) is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment.*

Neural Networks: a computer program that operates in a manner inspired by the natural neural network in the brain. The objective of such artificial neural networks is to perform such cognitive functions as problem solving and machine learning.

Machine learning: discipline concerned with implementing computer software that can learn autonomously.

Algorithm: An algorithm is a specific procedure for solving a well-defined computational problem.

Data mining: Data mining is the practice of automatically searching large stores of data to discover patterns and trends that go beyond simple analysis. Data mining uses sophisticated mathematical algorithms to segment the data and evaluate the probability of future events. Data ining is also known as Knowledge Discovery in Data (KDD).

Deep learning: is a subset of machine learning in which multi-layered neural networks—modeled to work like the human brain—'learn' from large amounts of data. Within each layer of the neural network, deep learning algorithms perform calculations and make predictions repeatedly, rogressively 'learning' and gradually improving the accuracy of the outcome over time.

A robot is: an autonomous machine capable of sensing its environment, carrying out computations to make decisions, and performing actions n the real world.

unmanned aerial vehicle (Drone): eans a Remote Pilot Aircraft (RPA) operated by a remote pilot.

Big data: is high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information rocessing that enable enhanced insight, decision making, and process automation.4

Nanotechnology: an area of science that deals with developing and producing minimal tools and machines by controlling the arrangement of separate atoms. 5

Biotechnology: the use of living things, especially cells and bacteria, in industrial processes.5

"Robotic Process Automation" RPA: The term RPA most commonly refers to configuring the software to do the work previously done by people, for example transferring data from multiple input sources like email and spreadsheets to systems of record like Enterprise Resource Planning(ERP)and Customer Relationship Management (CRM)systems.

Appendix C: Institutions contributed to the executive program for Artificial Intelligence and Advanced echnologies

Sultan Qaboos University
iNNOVATEQ company (Innovation Technical Solutions LLC)
Authority for Public Services Regulation
Million Date Palm Plantation Project
Oman Water and Wastewater Services Company
ASYAD Group
ESBAAR Company
Sohar Port
The Ministry of Agriculture, Fisheries and Water Resource
Oman Technology Fund
Ministry of Health
Ministry of Commerce, Industry, and Investment Promotion
Aphcarios Engineering Solutions company
NAMA Group
National Energy Center
Ministry of Higher Education, Scientific Research and Innovation
Cloud Acropolis company
Oman Credit & Financial Information Centre (Mala'a)
German University of Technology
Telecommunications Regulatory Authority
The Omani Society for Intellectual Property
Madinat Al Irfan
Rihal company
Artificial Horizon company
Impact Integrated company
Oman Data Park company
Petroleum Development Oman company
Ministry of Education
UVL Robotics
Oman Airports
Public Authority for Special Economic Zones and Free Zones
InnoTech Oman company
Innovation Factory Center
Oman ICT Group
Oman Convention & Exhibition Centre
Microsoft Oman company
Google company
Makers Oman
Oman Cables company
Areej Vegetable Oils And Derivatives company
University of Technology and Applied Sciences
Royal Oman Police
Oman Post company
Etco company
Data Academy

ppendix D: References

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