The Metaverse and the Future of the Arab Region

Public Policy Choices and Actions

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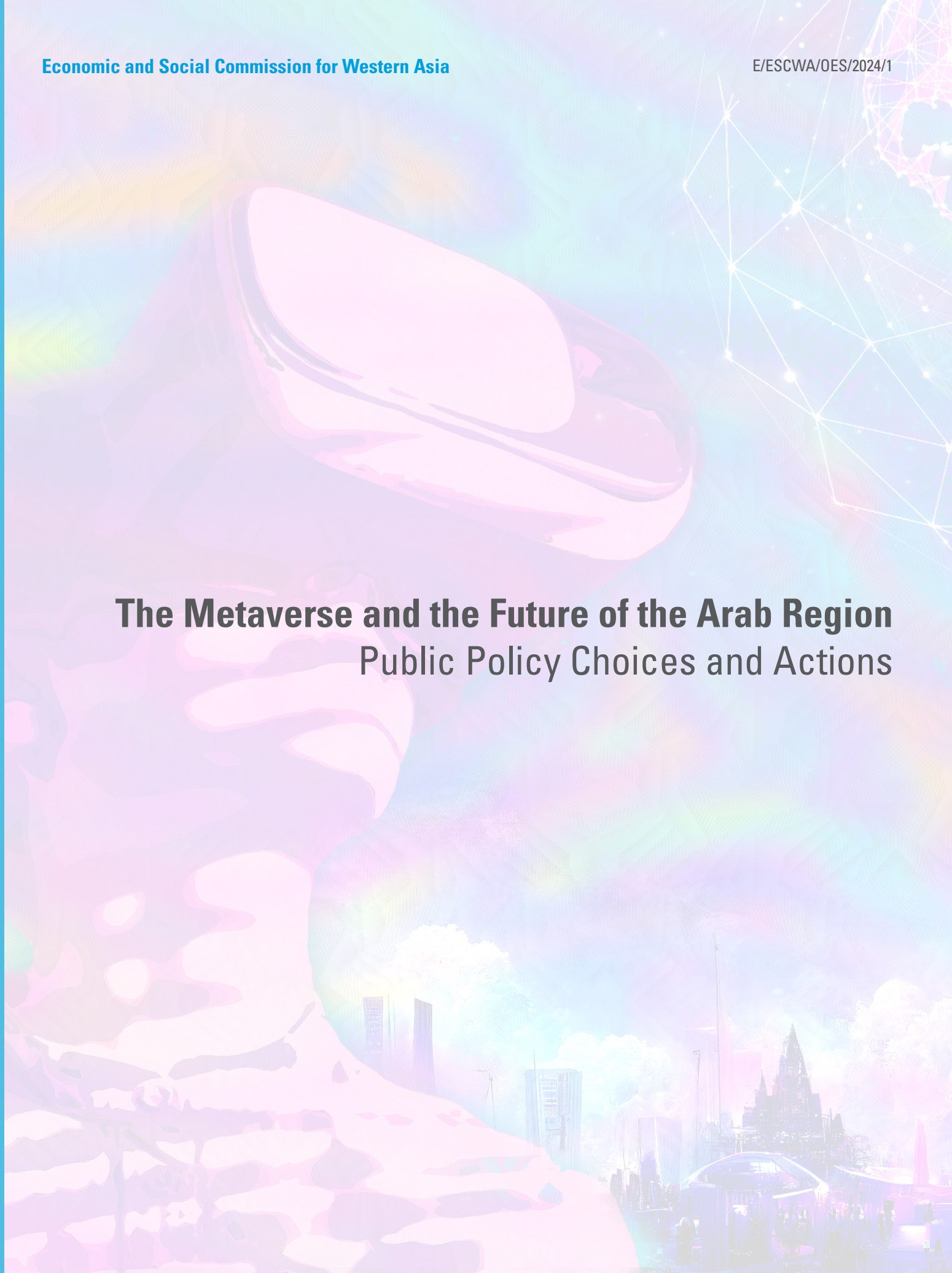

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Preface

Megatrends are phenomena that have reached a point in their evolution at which they are transforming, probably irreversibly, the dominant patterns of life and work that govern the lives of billions of people today. They are never one-dimensional – they are always an interrelated set of social, economic, technological, and other forces of change that collectively spark and fuel such transformations. These strategic forces are already shaping our world in profound ways. They produce disruptive, sometimes positive impacts on existing paradigms at the same time as they create wholly new societal conditions. Consequently, they demand policy actions and other actions by leaders in the public, private, and other sectors, to strengthen and take advantage of their potential positive impacts, at the same time mitigating their potential negative impacts.

This study is the second in a planned series of megatrend analyses by the United Nations Economic and Social Commission for Western Asia (ESCWA). It is intended to support the United Nations Secretary-General's "Summit of the Future" during the General Assembly's high-level week in September 2024, and to support "Our Common Agenda" and the United Nations Sustainable Development Goals (SDGs) more broadly and enduringly. The aims are to understand the implications of some of the most important megatrends impacting Arab countries, communicate these impacts to key stakeholders, and suggest policy and other actions that leaders in every sector can begin to take now to start addressing them.

Just as is true for electric mobility, the topic of the first in ESCWA's series of studies, published in 2023, today the Metaverse can properly be considered a global megatrend. The Metaverse is a developing concept that is used to describe a wide range of types of highly immersive, three-dimensional (3D) experiences in which users can engage on the next generation of the Internet. Using a variety of types of virtual reality (VR) and extended reality (XR) platforms, it opens new perspectives for everything from entertainment to industrial operations and much more. The concept of the Metaverse is further defined and deeply explored in this report.

A number of megatrends are transforming Arab countries and the world, and actions by Arab leaders today are imperative to capitalize on their positive impacts and forestall their negatives. The Metaverse was chosen as the topic for this second in the series of ESCWA studies for several important reasons.

The technologies and use cases of the Metaverse will be a source of new jobs and major shifts in how industries operate in Arab countries and globally.

They will be enablers of major improvements in societal well-being through applications in fields such as education and health care.

They will be a source of significant wealth creation, and they represent a new source of leadership and influence for Arab countries in the global economy.

How the Metaverse will create those impacts is explored in sections 1 to 3 of this report.

This report focuses predominantly on the immersive 3D virtual worlds that most observers and analysts most commonly associate with the Metaverse concept. Several other concepts and technologies are also associated with the next generation of Internet, and they are related to the Metaverse itself in meaningful ways. These include Web 3.0 and virtual assets including cryptocurrencies and non-fungible tokens. Artificial intelligence is also related to the development and use cases of the Metaverse. These concepts and technologies are discussed to a degree, where they are important for context for the report's main focus. More extensive analysis of their implications would require a separate report.

In the sections that follow, three distinct pathways are considered for how the Metaverse could advance in Arab countries. They are not the only pathways, and they are not mutually exclusive. Arab countries can embark on these pathways through deliberate, intentional decisions in the near future to realize any or all of them in the long term. The time for Arab leaders to prepare for the Metaverse megatrend is now, through policy, investment, and other types of actions, in support of the aim of the Summit on the Future "to lay the foundations for more effective global cooperation that can deal with today's challenges as well as new threats in the future".

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ESCWA core team

Mounir Tabet, Deputy Executive Secretary

Naela Haddad, Project Management Officer, Megatrends, Office of the Executive Secretary

Rim Bahmad, Research Assistant, Office of the Executive Secretary

Youzhi Zhang, Associate Programme Management Officer

Leen Abdallah, Research Assistant

Partner organization

The Middle East Institute (MEI), Washington DC, USA

Lead author

Steven Kenney, Director, Strategic Foresight Initiative, The Middle East Institute

MEI research and analysis support

Connor Allen

Lama El Baz

Sierra Blackmon

Ethan Dinçer

Anthony Hope

Mohammad Amaan Siddiqui

Madeleine Walker

Senior MEI study contributors

Ross Harrison, Senior Fellow

Mohammed Mahmoud, Director, Climate and Water Programme

Mohammed Soliman, Director, Strategic Technologies and Cyber Security Programme

Paul Salem, President and Chief Executive Officer

Experts interviewed

Sonal Ahuja, VRAcademi

Hassan Algarhy, Duverse

Corneliu Bjola, University of Oxford

Omar Christidis, Arabnet

Shahrokh Fardoust, College of William and Mary

Steve Grubbs, VictoryXR

Salman Halawi, Metadesignerz

Kathy Hirsh-Pasek, Temple University; The Brookings Institution

Hilmar Koch, Autodesk Inc.

Erin McDannald, Environments by LE

Frank Pandolfe, Leidos

Simone Puorto, Travel Singularity; Polybius

Soumik Sarkar, Iowa State University

Robert Scher, BP America

Omar Al-Ubaydli, Bahrain Center for Strategic, International. and Energy Studies

Tom Wheeler, The Brookings Institution

Expert group meeting participants

Saeed Aldhaheri, United Arab Emirates Robotics and Automation Society; University of Dubai

Mariette Awad, American University of Beirut

Ahmed Elmagarmid, Qatar Computing Research Institute

Salman Halawi, Metadesignerz

Hlekiwe Kachali, UNICEF

Elias Mouawad, United Nations Development Programme

Randeep Sudan, The World Bank

Mounir Tabet, ESCWA

Amjad Umar, Harrisburg University of Science and Technology

Strategic foresight practitioner experts group meeting participants

Yul Anderson, The African American Future Society

Lauren Chanel, Arup Corporation

Heather Galbraith, City of Calgary

Jalal Mapar, U.S. Department of Homeland Security

Victor Motti, World Futures Studies Federation; Alternative Planetary Futures Institute

Isabella Pirolo, Dubai Future Foundation

Jennifer O'Rourke, Government of Canada

Mounir Tabet, ESCWA

Alex Wilner, Carleton University

Implications wheel exercise participants

Mohamad Nawar Al-Awa

Connor Allen

Brian Coppersmith

Ethan Dinçer

Naela Haddad

Anthony Hope

Nibal Idlebi

Steven Kenney

Elias Mouawad

Mohammed Mahmoud

Yousra Mshmsh

Eric Popiel

Nada Salem

Jim Schreier

Mounir Tabet

Youzhi Zhang

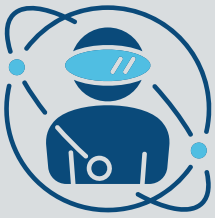
Editing, translation and production

Conference Management Section, ESCWA

Executive summary

This executive summary is drawn from the balance of the report that follows. Citations for all quoted content in this executive summary are provided in the subsequent sections where that content appears.

The Metaverse in context



The Internet and the digital technologies associated with it have profoundly changed the world. A time before "online" is almost unimaginable. "Web 1.0" is described as a "read-only web," while "Web 2.0" (today's era) fundamentally changed this, making information-sharing multidirectional. Today, what it means to be "online" is fundamentally changing again. The next significant leap, already in progress, will be defined by two things.

The first – known as "Web 3.0" – is how access to and control of data, content, and interactions between the entities on the Internet will be conducted and managed. The essential attributes of the emerging Web 3.0 are "decentralization, openness, and greater user utility". It is "based on open-source software with participants interacting directly, without going through a trusted intermediary". Core features include cryptocurrencies, decentralized finance, decentralized applications, non-fungible tokens, and decentralized autonomous organizations.

The second – known as "the Metaverse" – is how people and entities will engage with the digital landscape of the future. That is the predominant focus of this report. What is powerfully important, and materially different from Web 3.0, rests in how the Metaverse makes the Internet immersive. In the Metaverse, users engage with three-dimensional digital content in an experiential way. The Metaverse is an advancement of the Internet where users can shop and play and be entertained, but more importantly where they can work in virtual worlds and create real-world impacts.

By harnessing virtual reality in new ways, the Metaverse offers transformations of online shopping, corporate training, education, marketing, tourism, real estate, manufacturing, finance, health care, social media, remote working, and many other digital experiences.

The power of the Metaverse is also rooted in the ability to create digital counterparts of buildings, industrial facilities, whole cities, supply chains, and other essential infrastructure of the world we live in, and replicate the business and industrial operations that take place in them. The processes being performed within such infrastructure can themselves be "twinned". In industrial and many other applications, by providing detailed real-time understanding of such operational processes in 3D, digital twins help organizations make better decisions about how to optimize them. Manufacturing, health care, supply chain, and retail are some notable industries that are already benefiting from digital twin technology.

The long-term vision of the Metaverse is to create a global and all-inclusive digital space where all Metaverse environments are interconnected in Web 3.0, just as all the Web 2.0 websites are interconnected on the World Wide Web today. This vision is vastly ambitious, and perhaps utopian. But the overarching vision for the Metaverse does not need to be realized – perhaps ever – for many of its transformational impacts to make themselves felt.

Those impacts are already being realized today, and the advances on the horizon over the next decade and beyond will take them even further. The current-day impacts of the Metaverse, and how they will evolve within the next 10 to 20 years, globally and in Arab countries, are the focus of this report.

1 Pathway 1: Metaverse advancement as an element of the transformation of industries and employment in Arab countries

Employment is one of the greatest challenges facing the leaders of Arab countries. The digitalization of economies will not by itself address this challenge, but it will be a big part of the future of jobs. And the Metaverse is the next stage of the digitalization of industries globally, with the potential to be an important part of job creation in Arab countries.

The first dimension of this is that building the entire Metaverse value chain (enabling technologies and more), and creating the virtual worlds that businesses will operate in, is a new source of jobs. Some of these are in fields that exist today, such as software and network engineering, data science and cybersecurity. The scale at which the numbers of jobs in these career fields will grow will be uniquely fuelled by the acceleration of the Metaverse. The Metaverse also "will give rise to additional jobs that did not previously exist, such as virtual economists, virtual law specialists, and AI developers for virtual personal assistants". Many of those jobs will be performed in the Metaverse itself, along with new kinds of jobs in traditional industries that would not be possible outside of immersive 3D virtual worlds.

The second dimension is how the Metaverse is poised to change the operations of businesses in a wide range of industries. The Metaverse will change how a large number of job functions are performed. A key element here is the rapidly emerging "Industrial Metaverse," with its digital twins poised to be one of the most important elements of the Metaverse phenomenon. The scope and scale of the operational improvements they enable is considerable across the entire industrial sector – essentially any business involved in the design, manufacture, or shipping of goods and products will be able to take advantage of digital twins. The Industrial Metaverse concept is also transforming industries and jobs by enabling "virtual prototyping" in automotive, aerospace, defence, logistics, energy, and many other kinds of companies.

The third dimension is another game-changer: the Metaverse will be a key enabler of the green economy and green jobs in the Arab region. While the global transition to a green economy will be massively disruptive to employment in carbon-intensive industries, it is projected to have equal or even greater economic and job creation benefits as it advances.

The connection between the Metaverse and the green economy will manifest in two main ways. Just described is how it "holds the promise of substantial reductions in carbon emissions, whether through the substitution of physical goods with digital ones, replacing real-world presence with virtual interactions, or digital twins that will help us optimize the physical world".

The other primary manifestation is the significant role Metaverse technologies will play in the still-emerging new industries of the green economy. For example, the Metaverse's role in the growing renewable energy industry lies largely in the modelling, design/build, and continuous optimization of increasingly complex and spatially distributed grids. There are examples from around the world of use cases for Metaverse technologies to enable sustainable water resources management, and in the sustainable agriculture industry, where "advancements in carbon sequestration, soil health, plant genetics, and more can all be put to the test in the Metaverse".

Seven recommendations are made at the end of section 2 that would help to accelerate the development of the Metaverse in Arab countries with the aim of transforming employment and industries.

2 Pathway 2: Metaverse advancement as an element of strategies to improve societal well-being in Arab countries

The growth of the Metaverse is poised to enable governments, private sector corporations and entrepreneurs, civil-society organizations, and others to take levels of well-being in Arab countries to new heights in a number of dimensions, including five in particular.

Education – platforms built on or integrating immersive, hyper-realistic, 3D VR will provide new kinds of learning, facilitate access to learning where it was previously unavailable, and much more. Spatial and experiential learning is possible in these platforms, and is more effective than the delivery technologies that came before it. Also notable are the prospects for democratizing education using Metaverse technologies, both in the sense of making it accessible to students from a wide range of cultures and socioeconomic backgrounds, and in the sense of bringing students together to learn, wherever they live.

Health care – the Metaverse will have a range of significant impacts on the practice of medicine and the provision of health care around the world, including in Arab countries. It will offer new ways for people to be diagnosed and treated in immersive 3D virtual environments. This could be transformative for people who face barriers in accessing in-person care. The Metaverse also promises – and is already delivering – new forms of treatment for physiological health issues and conditions; for example, the use of VR and AR in the performance of surgery. Metaverse technologies are also increasingly being used to diagnose and treat mental, emotional, and cognitive health disorders, and they offer new kinds of opportunities for persons living with disabilities.

Climate change – the virtual reality of the Metaverse has important contributions to make to addressing climate change in Arab countries. One of the most significant contributions lies in the previously unachievable insights that digital twins provide into the operations of facilities and their equipment across industries. A recent study revealed that these analytics can help realize a 50 per cent increase in a commercial or industrial facility's sustainability and resilience. The Metaverse also has the potential to shift where and how work is performed. As more work moves into the Metaverse, over time it will decrease the need for physical office space and business travel, reducing the carbon footprint they generate. The Metaverse also offers new means of educating people on the impacts of climate change. A growing number of VR and AR platforms are already being used to provide an immersive and interactive experience that can help people understand the complex impacts of climate change. Research also indicates a potentially significant role for 3D digital modelling for early warning of extreme weather events and other natural disasters related to climate change.

Urban design – just as they are being used for individual buildings and facilities, digital twins are being developed for entire cities, enabling the redevelopment and in some cases large-scale reimagining of Arab and other cities to improve their facilities and the quality of life they offer. Metaverse technologies will also provide new ways for citizens' voices to be heard in future urban redevelopment. This also improves quality of life by helping ensure that urban redevelopment projects incorporate the features that citizens prioritize based on their lived experience.

Government – the Metaverse is providing new possibilities to enhance government services and transform the connection between governments and their people to improve their well-being. It enables governments to provide services and benefits in new, more engaging and more effective ways. Immersive 3D virtual environments also provide governments with opportunities to provide new kinds of services and benefits, producing outcomes unobtainable in the physical world. By virtually modelling policy options, governments gain the ability to position themselves in front of challenges before they emerge or fully manifest themselves.

Seven recommendations are made at the end of section 3 that would help accelerate the development of the Metaverse in Arab countries with the aim of improving societal well-being in these five areas.

3 Pathway 3: Metaverse advancement as a catalyst for new forms of Arab influence in the next global era

The increasing prominence of Arab countries in the technology economy has the potential to expand their global influence. Within the technology economy, a new Metaverse subsector is emerging, one in which Arab countries are deliberately and rapidly positioning themselves to be "first movers". The rules of Web 3.0 and the Metaverse are yet to be established, and new governance institutions yet to be created. As they emerge as engines of the Web 3.0 and Metaverse economies, Arab countries and businesses can also be among the architects of the accompanying governance frameworks.

In the same way that personal computers and mobile phones have fuelled the creation of new industries and business models in nearly every sector of the economy over the last three decades, the Metaverse could unlock as much as $5 trillion in additional value by 2030. The Arab region has the potential to be a key player in this transformation, with projections that "by 2030, the Middle East's digital economy will have grown to $780 billion". Already there are projections that "the Metaverse could contribute $360 billion per year to GDP for the Middle East and North Africa region by 2031".[1] Governments across the Middle East are forming partnerships with information technology companies to advance Metaverse-related technologies.

All this activity portends potentially great success in the ambition of Arab countries to be among the global leaders in the emerging Metaverse economy in the future. It can also position them for a new basis for sustained and growing influence in global economic and cultural affairs by playing a leading role in conceiving and driving the implementation of the rules and governance of the Metaverse and the global Metaverse economy. Arab countries are already taking initial pioneering steps to be among the standard-setters in this area, particularly for the cryptocurrencies and other digital assets that are central to the Metaverse economy.

The Metaverse will increase Arab influence in global affairs in various areas. For example, it will create new kinds of opportunities for the global dissemination of Arab cultures. As described previously, work will begin to move into the interactive environment of the Metaverse. This will open up opportunities for people working in other countries to collaborate with Arab colleagues and learn about their cultures. Even more significant is the rapidly emerging Metaverse tourism industry, which is enabling realistic, immersive, interactive cultural familiarization, both by enabling virtual visits to Arab countries, and by using VR to "[transform] cultural knowledge into content that enhances visitors' experiences" when they travel to these countries. Examples of all-virtual and hybrid virtual-physical Arab tourism already exist, and are growing.

The Metaverse also has the potential to transform how political and diplomatic relations between sovereign nations are conducted, and even some of the foundational principles that define what sovereignty is and means. Beyond the use of virtual reality to augment and modify the conduct of "traditional" international affairs, the Metaverse is also already offering wholly new models for sovereign and diplomatic representation, and for the concept of citizenship, which has historically been integral to the concept of sovereignty, such as virtual embassies and virtual citizenship. Arab countries could position themselves at the leading edge of this transformation to help them to gain influence on the future global diplomatic and political stage.

Seven recommendations are made at the end of section 4 that would accelerate the development of the Metaverse with the aim of enhancing Arab influence in the next global economic and cultural era.

Contents

Abbreviations, acronyms and glossary

2D	Two-dimensional
3D	Three-dimensional
5G	Fifth-generation wireless communication technology
6G	Sixth-generation wireless communication technology
AI	Artificial intelligence
AR	Augmented reality
Avatar	Virtual representation of a user in a Metaverse application or environment
Biometric	Biological measurements
Blockchain	Digital ledgers of transactions over which power is distributed between the nodes, or participants, of a computer network
CAGR	Compound annual growth rate
Cloud computing	On-demand access to computing services via the internet
Cryptocurrency	A digital currency secured by cryptography
DAO	Decentralized autonomous organization
DApp	Decentralized application
Digital currency	A purely electronic form of payment
Digital nomad	Remote employees who work from and in some cases live in multiple locations
Digitalization	The process of integrating digital technologies into the operation of systems and processes
Digital twin	A digital representation of a physical object presented in a digital version of its environment
Edge computing	An emerging computing paradigm involving bringing information storage and computing abilities closer to the devices that produce data and the users who use data
ESCWA	United Nations Economic and Social Commission for Western Asia
G20	Intergovernmental forum for international economic cooperation composed of Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Republic of Korea, Mexico, Russia, Saudi Arabia, South Africa, Türkiye, the United Kingdom, the United States, the African Union, and the European Union
GCC	Gulf Cooperation Council
GDP	Gross domestic product
GDPR	General Data Protection Regulation
GIS	Geographic information system
Green economy	A low-carbon, resource-efficient and socially inclusive economy
Green finance	Finance and investment initiatives that promote environmentally sustainable development
Greening	The process of transforming a physical space or industry into one that is more environmentally sustainable
ICT	Information and communication technology

IFI	International Financial Institution
ILO	International Labour Organization
Immersive	Technology-enabled three-dimensional realistic experiences for users of VR, AR, MR and XR (Metaverse) technologies
Industrial Metaverse	The use of VR, AR, MR and XR technologies in industrial business operations
IoT	Internet of things
ITU	International Telecommunication Union
IXP	Internet exchange point
MILE	Massive interactive live event
MR	Mixed reality
NFT	Non-fungible token
NGO	Non-governmental organization
OECD	Organization for Economic Cooperation and Development
Phygital	Physical plus digital; refers to experiences that have both physical and digital aspects
R&D	Research and development
SAR	Saudi riyal (currency of Saudi Arabia)
SDG	Sustainable Development Goals
SME	Small and medium-sized enterprise
Start-up	A company in the beginning stages of operations
STEM	Science, technology, engineering, and mathematics
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Emergency Fund
VARA	Virtual Assets Regulatory Authority (agency of the Dubai Government)
VASP	Virtual asset service provider
Virtual asset	Any digital representation of value that can be digitally traded, transferred or used for payment
Virtual environment	A computer-generated simulation which is to some degree shared and persistent, allowing its users to interact with it and with each other in real time
Virtual prototyping	The use of software to engineer a product in a digital environment prior to its physical construction
Virtual real estate	Digital property that exists in the Metaverse
VR	Virtual reality
Web 3.0	The third generation of the World Wide Web, characterized by decentralization, openness, and greater user utility
XR	Extended reality

Introduction – the Metaverse in context

Over the last three decades, the Internet and the digital technologies associated with it have profoundly changed the world. The changes induced by this digital globalization are embedded in the daily lives of most people and the operations of most businesses in ways that make a time before the Internet almost unimaginable. By 2023, 66 per cent of the global population had begun to use the Internet, with an annual increase in users of 3.7 per cent. A person now spends on average 6 hours and 41 minutes on the Internet per day. Online business interactions amounted to $3.6 trillion in 2022 alone.[2] Almost regardless of their type or size, businesses see online presence as an imperative for successful commercial and broader activity. The value is far from limited to marketing or reaching consumers – numerous other applications of connected digital platforms also improve productivity and make businesses competitive "from factory to shelf". What the corporate sector widely views as a necessary "rewiring" strategy incorporate technologies into all of its operations is also a broader and ongoing societal rewiring.[3]

Like most technological revolutions, digitalization in and on the Internet has gone far beyond what its pioneers are ever likely to have imagined. The collective set of transformations it represents for people and businesses has been the fastest such development in the last several centuries.[4] Digitalization and the Internet, by turning connectivity over time into hyper-connectivity, has been one of the primary enablers of globalization, the rise of emerging economies, changes in the nature of work, and much more.[5]

A rapid evolution of what it means to be online

In its initial stages, the manifestation of the Internet comprised static web pages that brought readable and informational content online, but little more. "Web 1.0" is often described as a "read-only web," where traditional informational materials such as encyclopaedias, magazines, and other news sources were digitized and made available to those able to connect. Many of the earliest users were academics, who

were empowered to share their work in a new way. Web 1.0 grew rapidly, from about 100 websites to 10,000 between mid-1993 and late 1994, indicating a growth of the user base. But for another decade, it remained a one-directional flow of information from a relatively limited number of creators to a limited number of readers.[6]

Beginning in the early 2000's, "Web 2.0" fundamentally changed the dynamic, making information-sharing multidirectional. It created an Internet space where anyone can create and share their own content and have others dynamically engage with that content and its creator. Web 2.0 quickly moved from users interacting with the websites of the Internet pioneers like Yahoo or eBay to making their own websites and interacting with one another in text, images, and video. New formats for such engagement emerged, such as social media apps and podcasts. Apps for doing business on the Internet emerged, making an Internet-based economy possible in ways that Web 1.0 could not. Web 2.0, initially described as the "read/write web" to distinguish it from the read-only Web 1.0, accelerated to become today's social and mobile web.[7]

Today, what it means to be online is fundamentally changing once more.

Naturally, what the next incarnation of the Internet will look like and how it will be used are not yet fully defined. But a growing number of observers anticipate that the transformation brought about by the change from Web 1.0 to Web 2.0 will be replicated as the world moves forward from Web 2.0 to Web 3.0.

The transformation, already in progress, will be defined by two things.

The first is how **access to** and **control of** data, content, and interactions between the entities on the Internet will be conducted and managed.

The second is how people and entities will **engage with** the digital landscape of the future.

There are numerous overlaps between these two defining dimensions of the Internet of the future – so much so that some experts conflate them. But the distinctions are as meaningful as the overlaps. "Web 3.0" and "the Metaverse" are interwoven and will fuel each other's growth, but they are not the same thing.

The transformation will be defined by two things:

The first is how **access to** and **control of** data, content, and interactions between the entities on the Internet will be conducted and managed.

The second is how people and entities will **engage with** the digital landscape of the future.

How the future Internet will be controlled – Web 3.0

The essential attributes that distinguish Web 3.0 are described in terms that differ slightly from source to source but can be usefully summarized as decentralization, openness, and greater user utility. Well beyond anything seen before, Web 3.0 advances a core concept of "bottom-up" design and operation of the Internet, where the infrastructure is not imposed by proprietary code or controlled by "tech giant" corporations that collect, centralize, and monetize customer and other data. Web 3.0 is akin to "a global peer-to-peer network" that is "based on open-source software and will allow participants to interact directly without going through a trusted intermediary".[8]

The emerging Web 3.0's essential attributes of decentralization, openness, and greater utility form the core of its user empowerment and economic value potential. One of its most important technological enablers are blockchains, a public "record-keeping system" in the form of digital ledgers of transactions over which power is distributed between the nodes, or participants, of a computer network. Its public nature allows end-to-end tracking of any form of such transactions with no possibility of tampering with them; each record or "block" is recorded and then linked

cryptographically with other transactions. The trust, security, open access and efficiency provided by blockchain technology remove the need for the centralized servers and intermediaries that control digital asset transactions in Web 2.0.[9]

The emerging reality of Web 3.0 is giving rise to business, social, and other innovations that will over time become prominent features of our future. One is decentralized finance, an alternative financial system that runs on "smart contracts"[10] stored and run on blockchains. Decentralized finance is increasingly well integrated into the rapidly developing Web 3.0 system, powered by decentralized digital cryptocurrencies which are the unit of value and exchange as traditional currencies are to States. Decentralized finance takes the financial system into an environment without involvement or administration of apex institutions such as central banks[11] – cryptocurrencies (also known as "tokens") operate outside traditional banking systems. They have "no central issuing or regulating authority, instead using a decentralized system to record transactions and issue new units". They are not tangibly owned; creation, ownership, and transactions are purely digital, encrypted, and recorded on blockchains.[12]

Other key features of the Web 3.0 environment are decentralized applications (DApps) and decentralized autonomous organizations (DAOs). DApps take the familiar and defining Web 2.0 idea of apps to a new place where they are built with open-source code, free from third-party interventions, and able to facilitate transactions within the decentralized finance system. Changes can be made to the apps based on suggestions by any user, followed by voting. This approach to decision-making about the evolution and usage of DApps is the essence of the broader concept of DAOs, which are structures for Internet-only-based communities without apex governance that are run fully through a bottom-up approach. Decisions about everything related to the community, from allocating resources to managing tasks to resolving disputes, are submitted and voted on by those who hold the community's self-issued tokens in the relevant DApp or other platform, enabled through smart contracts.[13]

The **Metaverse** allows the user to generate a **virtual equivalent of themselves – an avatar –**

and enter a **3D store** where they experience a more **real-life** version of **shopping**.

How the digital future will be experienced – the Metaverse

While some consider or refer to the Metaverse as Web 3.0, what is materially different and powerfully important rests in how the Metaverse makes the digital landscape of the Internet immersive. It is truly a landscape, one that users do not simply look at, but rather inhabit. How users are able to act and interact there can and will reflect the attributes of decentralization and openness. But the difference between being on Web 3.0, as opposed to being in the Metaverse, is the key to the potential the Metaverse holds to transform industries and societies in unprecedented ways.

In the Metaverse, users engage with digital content in a three-dimensional (3D) experiential way that the two-dimensional (2D) Web 2.0 can only offer a fraction of. The Metaverse allows users to traverse virtual spaces of incredible detail and hyper-realism and perform realistic actions, by themselves or with others at great physical distance, rather than simply interacting with web pages or video content and the creators of that content. In Web 2.0, a user shopping for clothes scrolls a 2D retail website, viewing pictures of a clothing item from different angles and reading size specifications to determine if it will fit them. The Metaverse allows the user to generate a virtual

equivalent of themselves – an avatar – and enter a 3D store where they experience a more real-life version of shopping. They can determine whether to buy the garment based on its fit on their avatar, whose dimensions precisely match those of the user.

A retail application such as this will seem trivial to some – but it is just one illustration. The Metaverse allows for this immersive experience in an extraordinary number of possible contexts and use cases – a surgeon operating in a 3D virtual hospital, an engineer designing a new transit centre in a 3D virtual design studio, a scientist simulating the effects of a prototype climate change adaptation solution in a 3D virtual replica of Jeddah, and countless others.

In this important sense, the Metaverse is an "embodied" advancement of the Internet where users can shop and play and be entertained, but more importantly where they can work in virtual worlds and create real-world impacts. The immersive nature of the Metaverse allows them to interact and engage with these environments, and the features and other users in them, in realistic ways. In some cases, these environments are digital replicas of places in the real world, in exceptionally realistic detail (for example, the virtual hospital operating theatre). In other cases, they are fabricated (for example, the design studio), or they put digital representations of unreal things into replicas of real places (the example of the virtual prototype for climate adaptation solutions).

The Metaverse integrates the physical world with the online realm to create possibilities that are not realizable in either. It also allows lifelike actions in the virtual realm to have real-world effects in real time. Depending on the capabilities of the technologies being employed, the Metaverse can offer spaces in which interactions among tens or hundreds of thousands of distributed users can coexist.[14] The scope and scale of some of these virtual environments will require dedicated and highly sophisticated applications on immensely powerful computing platforms. But some can happen on current widely used technologies such as laptops and smartphones, which will allow a growing interoperability and expansion of the Metaverse.[15]

The wide range of use cases and concepts employed in the Metaverse mean that there is no single definition of it, and one might not ever be possible. At the same time, there is a degree of consensus regarding the essential characteristics that will make any and all of these use cases possible. A recent report[16] predicts that the Metaverse in all its applications will be defined by:

- **Spatial immersion:** reproduces a sense of presence within the digital space, whether through simple 3D-digital avatars or today's more sophisticated virtual reality or augmented reality technology.
- **Collective shared space:** the virtual universe is shared among users becoming increasingly more synchronous as connectivity and computing capabilities increase.
- **Synchronous live reality:** metaverses can make virtual reality more persistent, as in the real world, maintaining our actions and assets and evolving the metaverse in real time even when we are not connected.
- **Inter-connected space:** metaverses can have different degrees of space inter-connection, including to the physical world (e.g. through augmented reality or Internet of things devices) or to different metaverses (e.g. through standards).

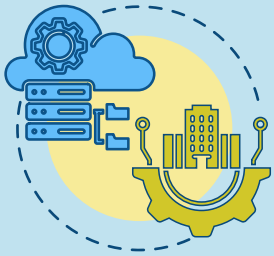
The roots of the Metaverse are in gaming, but it has evolved much further

The "concept underlying the Metaverse is extended reality, or XR. Extended reality is a collective term that refers to three different types of immersive experiences that people can have with the aid of enabling technologies: virtual reality (VR), augmented reality (AR), and mixed reality (MR). The best-known of these technologies is the headset worn by a user. The different forms of XR are on a "virtuality continuum". At one end of the continuum, AR is the physical world with a digital overlay, visualized through the headset – for example, unreal objects are seen in the room where a user is sitting. At the other end, VR is a completely virtual environment or "world" with only digital objects, which might be a replica of a real environment or an entirely fictitious one. MR falls anywhere on the spectrum where a user experiences both physical and virtual objects.[17]

The roots of XR as a widespread phenomenon (beyond specialist applications in, for example, flight simulation training) lie in the gaming industry. In 2023, approximately 3.26 billion people worldwide were "gamers", and the industry was worth $257 billion. Games are not only played but also bought and sold in virtual settings – 89.5 per cent of game purchases are made digitally.[18] VR and AR allows digital objects to be experienced by users as if they were in the game, rather than playing the game on a 2D screen.[19] In combination with VR/AR headsets, other sensor-equipped handheld and wearable devices enable users to take actions in the game by moving their bodies rather than moving a mouse or analogue stick as in traditional gaming.

Because its development is largely rooted in gaming, there is a misconception that the Metaverse is merely an extension of that industry. But by harnessing XR in new ways, the Metaverse is has evolved beyond gaming, and will continue to do so in the future. It is also transforming online shopping, corporate training, education, marketing, tourism, real estate, manufacturing, finance, health care, social media, remote working, and many other digital experiences.[20] All of these transformations will be explored in detail in the next three sections of this report. In the context of gaming, XR is largely aimed at making the experience more entertaining. In this growing number of other contexts, XR is the central element of what makes the Metaverse capable of transforming industries and societal functions, and the source of many new kinds of economic activities and opportunities.

The power of the Metaverse is rooted in the ability to create digital counterparts of buildings, **industrial facilities**, whole cities, supply chains,



and other essential **infrastructure** of the world we live in.

The greatest impact of the Metaverse may be in "digital twins"

The power of the Metaverse is not just the ability to create a digital counterpart of a user so they can navigate and act in virtual spaces. It is also rooted in the ability to create digital counterparts of buildings, industrial facilities, whole cities, supply chains, and other essential infrastructure of the world we live in, and replicate the business and industrial operations that take place in those facilities. The use cases of these "digital twins" will be as impactful in different ways as the Metaverse applications for users in other contexts, if not more so.

Most if not all of the sources working on the advancement of the Metaverse are aligned on a basic definition of a digital twin: "a digital representation of a physical object", or facility, "contextualized in a digital version of its environment".[21] Digital twins also "span the object's lifecycle and use real-time data sent from sensors on the object to simulate the behavior and monitor operations".[22] In this sense, the operational processes being performed within a facility or by an object can themselves be twinned, or at least considered a constituent element of the twin of the object. In industrial and many other applications, by providing detailed real-time understanding of the facility and its operations, digital twins help organizations make better decisions about how to optimize either or both.

Manufacturing, health care, supply chain, and retail are some notable industries that are already using digital-twin technology.[23] For example, a manufacturing company can create a digital twin of its assembly line to comprehensively observe product packaging, material feasibility, costs, machinery status, among other elements, and with significantly enhanced safety.[24] Digital-twin applications are also giving organizations the ability to go beyond traditional reactive maintenance to forms of predictive maintenance that have never been achievable with prior technologies.[25] Digital simulation also allows for more creativity, flexibility, and scope for trial and error to make optimization decisions, resulting in efficiency improvements. For example, research as well as real-world examples show that digital-twin technology has allowed the construction of buildings with carbon emissions 50 per cent lower than those constructed without it.[26] Given the prospects for improvements both in bottom-line results and in corporate environmental, social, and governance outcomes, it is no surprise that the Metaverse digital twin market is valued at $11.5 billion in 2023 with an expected compound annual growth rate of 43 per cent between now and 2030, a total of $138 billion.[27]

The deployment of digital-twin technology even enables actions that are not possible in the physical world. Users working in digital twins can have "superpowers" such as "teleporting" to any physical space within a complex of connected twinned facilities (a different room or floor, a distant assembly line) or even to a different time period (a previous production season, or a week in the future when a simulation of a new experimental process has been completed). Capabilities such as these are already enabling private and public sector enterprises to reimagine their business operations and plan to implement future changes to them while current operations continue uninterrupted.[28]

Synergies with Web 3.0 will help realize the Metaverse's value and impact

As noted previously, the Metaverse and Web 3.0 are related but distinct innovations. The report that follows focuses predominantly on the Metaverse: in other words, on immersive 3D virtual environments, and the impacts that human actions in these digital environments can create, in contexts ranging from the delivery of health-care services and education to the delivery of entertainment experiences to millions of people simultaneously, and many in between.

Some of the defining attributes of Web 3.0 overlap with the Metaverse, and will be valuable in enabling the Metaverse to offer its distinctive experiences and generate its impacts. Two examples of this "crossover" help to illustrate the relationship between the Metaverse and Web 3.0, a relationship which will evolve over time.

The first has to do with platforms for virtual environments. All the virtual environments that have been and will be created in the Metaverse will exist on computing platforms that may be dedicated for that purpose by the creator, or may be in publicly available cloud environments and blockchains. Decentraland, Roblox, and The Sandbox are among the most expansive Metaverse spaces that currently exist. They are open-world platforms that combine VR, AR, blockchain, and Internet technologies to create immersive 3D worlds. They are rooted in the gaming world, but have already evolved in important ways to become some of the most essential "terrain" of the broader Metaverse.

Users interact in these worlds through their digital identities (avatars) in rapidly growing instantiations of a whole new Metaverse economy that will parallel and in some ways rival the traditional physical world economy. This already involves buying and selling digital assets, such as accessories for avatars and real estate, and the Metaverse economy on these and other platforms will continue to expand. Importantly, the Metaverse economy will operate on the decentralized principles of Web 3.0. The Sandbox, for example, allows users to buy land in the virtual world and do anything they wish with it, as they could with a plot in the real world. The cryptoasset exchange Gemini describes The Sandbox as "a decentralized, community-driven virtual world where creators can design, share, and sell in-world assets".[29]

Decentraland, similarly, is "a 3D digital game-like social environment … a user-owned, Ethereum-based virtual world platform that allows users to be part of shared digital experiences" for a growing number of societally important functions in the Metaverse. In addition to the economy of the platform, the other important Web 3.0-Metaverse overlap that Decentraland embodies is its organization and administration system.[30] The non-profit Decentraland Foundation oversees the platform but "the Foundation does not own or control Decentraland, as ownership and governance is decentralized in the community through the DAO".[31] Users control what happens on the platform democratically, in proportion to the number of tokens they hold, in the Metaverse equivalent of a real-world legal and governing structure. A number of important non-gaming users are already operating on Decentraland. They include a public-services office established by the Government of Norway, a virtual embassy of Barbados, and an area within the platform (Decentraland University) where educators can create and teach content outside of traditional education systems.

Another important development over the last decade that illustrates the overlap between the Metaverse and Web 3.0 is non-fungible tokens (NFTs) – digital assets whose ownership and transfer are recorded on the blockchain but whose value is not constant or exchangeable in the same way as cryptocurrencies, which are fungible tokens.[32] The most common NFTs to date have been digital artworks. In 2021, the NFT market was worth $41 billion, which was just $9 billion under the market for conventional art and antique sales. It reached a market capitalization of $29.7 billion in May 2022, but that high was short-lived, quickly plummeting to less than $1 billion where it has remained since. Despite such volatility, NFTs will be one of the key elements of a decentralized Metaverse economy, particularly for transactions among ordinary people (more than 50 per cent of a total of nearly $25 billion in NFT sales in 2022 involved transactions under $200). The NFTs being bought and sold in Metaverse spaces such as Decentraland and the Sandbox today may be dominated by things like accessories for avatars (a market valued at $50 billion in 2023). But the range of types of NFTs and other digital assets, and their utility for societally important functions carried out in Metaverse virtual worlds, will grow.[33]

Enabling technologies give the Metaverse its power and promise, but the Metaverse is more than the sum of its technological parts

A variety of technologies and infrastructure are employed to enable the virtual environments of the Metaverse to be created, shared, experienced, and used to generate value. The VR/AR technologies described above are the vessels through which digitally replicated real-world spaces or fictive virtual worlds are experienced. But the creation and use of those environments relies on other digital technologies. While they are not a significant focus of this report, understanding their contributing role in the Metaverse megatrend is valuable.

One such technology is the **Internet of things (IoT), the name given to a rapidly growing and wide range of** physical objects equipped with sensors and software that connect to the Internet and to each other to exchange data. The Metaverse, and especially the digital twins that comprise such an important category of applications within the overall Metaverse environment, uses IoT devices to enable the smart functions that make digital twins so valuable for manufacturing and other end users' utility. The key is the IoT's "ability to extract data from the physical world and inject it into the virtual world – to achieve desired results, it is critical that data mapped from real-world environments is accurate, planned, secure, relevant, and real-time".[34] This is what opens up possibilities such as pre-planning and design testing in construction, monitoring and tracking emissions in power plants and factories, and simulating prospective changes in the layouts of urban centres.[35] By allowing for this synchronization of physical world and digital twin data points, the IoT enables many of the kinds of use cases that are discussed in subsequent sections of this report.

Recent and anticipated future advancements in artificial intelligence (AI) are also influential in shaping the creation and usage of Metaverse environments. One element of this is the role that AI plays in facilitating the processing and analysis of data flowing between digital twins and their physical counterparts. It will also be important in creating those virtual counterparts of physical objects and processes in the first place, as the massive size of the data sets and the massive volume of computational action involved already exceed the capacity of human data scientists to manage without augmentation.[36] Other applications of AI to advance

the Metaverse will revolve around its "ability to understand and replicate real-world physics, emotions, and interactions", which will be "pivotal in making the Metaverse genuinely immersive".[37] The symbiotic relationship between AI and the Metaverse is only beginning to be understood. As that understanding and its potential advances, there will be a growing perception – and likely a growing reality – that most aspects of the Metaverse will be "AI-enabled," bringing with it a plethora of privacy, competition, manipulation, bias, truth-related, and other challenges.[38]

Finally, for purposes of context, we discuss some elements of infrastructure that make the Metaverse possible – cloud computing, edge computing, and wireless connectivity; in particular, 5G and 6G networks. The Metaverse platforms and applications of today already contain massive volumes of data, and more sophisticated and detailed future applications will only increase this. An analysis in 2022 by Credit Suisse estimated that global data usage will be twenty times today's levels in 2032 as a result of the Metaverse, and chipmaker Intel has projected a need for 1,000 times today's computing power.[39] Cloud computing is essential for the levels of communication, storage, transfer, analysis, and other data processing over the Internet that will be needed for the Metaverse, rather than relying on offline databases, computers, and servers.[40]

At the same time, the hyper-realism and immersiveness that makes Metaverse applications and experiences what they are demand a very rapid flow of data. This increases the importance of research into edge computing, which is aimed at enhancing data processing speed and volume through the creation of networks of devices that perform that processing nearest to its sources of generation.[41] Further advancement of fifth- and sixth-generation wireless communication technology (5G/6G) is an equally important component of meeting the Metaverse's data communication demands[42] – and it will be especially important to Arab countries' Metaverse aspirations, as coverage by 5G infrastructure is uneven and lags behind some other parts of the world.

Further advancement of **fifth- and sixth-generation** wireless communication technology **(5G/6G)** is an equally important component of meeting the **Metaverse's data communication** demands

These and other infrastructure enablers will be essential for the future operation of the Metaverse, alongside continued advancements in more frequently cited technologies such as VR/AR hardware (headsets, hand-held devices, wearable devices with sensors) and haptics that create touch-like physical experiences in the virtual realm to accentuate the physical-digital connection.[43]

The Metaverse vision is boundless, but its impacts are already tangible and powerful

The long-term vision of the Metaverse is to create a global and all-inclusive digital space where all Metaverse environments are interconnected in Web 3.0, just as all the Web 2.0 websites are interconnected on the World Wide Web today. According to one definition, the Metaverse could, and perhaps even should, be at its apex: "a massively scaled and interoperable network of real-time rendered 3D virtual worlds which can be experienced synchronously and persistently by an effectively unlimited number of users with an individual sense of presence, and with continuity of data, such as identity, history, entitlements, objects, communications, and payments".[44]

This vision is vastly ambitious – perhaps utopian. The world has, of course, accomplished this kind of total interconnectedness with the two-dimensional Web 2.0 – because the nature of the data and the technology required to do so has

allowed for it. The enablers for such an outcome for the Metaverse will require exponentially greater levels of technology (computing power, AI, etc.), energy (electricity to operate the technology), policy (regulation and governance for unprecedented challenges), and more. Without a well-engineered mix of these enablers, at far higher levels of advancement than today, it will be a near-insoluble challenge to address issues such as interoperability, cross-platform access, latency, rendering quality, bandwidth and speed.

But the apex vision for the Metaverse does not need to be realized – perhaps ever – for many of its transformational impacts to be realized.

Those impacts are already being realized today, and the advances on the horizon over the next decade and beyond will take them even further. These current-day impacts, and the way in which they will evolve into the very realizable impacts within the next 10 to 20 years, globally and in Arab countries, are the focus of this report.

In the sections that follow, the term "Metaverse" is used extensively in reference to existing, in-development, and envisioned uses of immersive 3D virtual worlds in a wide range of sectors and contexts. It is used simply as a shorthand. It is not intended to imply that the Metaverse developments emerging in the world are part of a monolithic phenomenon – the phenomenon of the Metaverse is multidimensional. It is also not intended to invoke the aforementioned expansive, long-run, ambitious vision of "the Metaverse" as the objective of the pathways that will be explored in the sections that follow. A reality of the Metaverse that is well short of that vision is already creating great benefits for Arab countries, and will continue to do so.

The global Metaverse market is projected to increase by over **13 times** between 2022 to 2030, from **$47.48 billion** to **$678.7 billion.**

The Metaverse is expected to generate **$15 billion** for **GCC countries** by 2030, and some sources value the Metaverse's contribution to a set of **Arab countries' GDPs** at over **$80 billion** by 2035.

The global Metaverse phenomenon is already manifesting itself in Arab countries

By one estimate, the global Metaverse market is projected to increase by over 13 times between 2022 to 2030, from $47.48 billion to $678.7 billion.[45] Other estimates cited later in this report go well beyond this, envisioning a $1 trillion market and opportunity by the same year, and as much as $5 trillion in "impact". The Metaverse is advancing, and its transformational potential is being seen all over the world.

Arab countries are no exception. In a number of them, the Metaverse is anticipated to contribute to economic growth and other societal benefits through applications in the travel and tourism, gaming, retail, banking and financial services, industrial and manufacturing and oil and gas sectors, in various ways.[46] Development of the Metaverse and incorporations of it and related technologies into these and other sectors are rapidly increasing in Arab countries, powered by favourable policy climates, innovation infrastructure, and other enablers. The Metaverse is expected to generate $15 billion for the Gulf Cooperation Council (GCC) countries by 2030, and some sources value the Metaverse's contribution to a set of Arab countries' GDPs at over $80 billion by 2035.[47] The United Arab Emirates and Saudi Arabia are emerging as leaders in the development and increasing use of the Metaverse.[48] The United Arab Emirates has a strategy of aiming to be among the top 10 global Metaverse economies in the world, with targets of $4 billion in GDP, 40,000 virtual employment roles, and opportunities for thousands of companies.[49] Other Arab countries also have Metaverse aspirations, and have strategies for putting enabling conditions such as high internet penetration, device ownership, and computer literacy in place to help them realize those aspirations.[50] Priorities, opportunities, financial and other

Among Arab countries, over **90 per cent of Metaverse investments** are dominated by the **United Arab Emirates** and **Saudi Arabia**, with only Egypt, Tunisia, Morocco, and State of Palestine having investment values of at **$100,000** or above.

resources, and other enablers of Metaverse adoption differ from country to country. Given that diversity, it is unsurprising that among Arab countries, over 90 per cent of Metaverse investments are dominated by the United Arab Emirates and Saudi Arabia, with only Egypt, Tunisia, Morocco, and the State of Palestine having investment values of at $100,000 or above.[51]

But that is today. What the future holds for Arab countries with respect to the Metaverse, and to the infrastructure and other enablers for their Metaverse ambitions, is yet to be created.

It is that future – a range of alternative possible futures – that this report will explore.

Three pathways for advancing the Metaverse in Arab countries

In the sections that follow, three distinct pathways are considered for how the Metaverse could advance in Arab countries. They are not the only pathways, and they are not mutually exclusive. These pathways can be considered as vectors – each represents a direction that the advancement of the Metaverse can take that can gain magnitude and momentum over that period. Arab countries can launch down these pathways through deliberate, intentional decisions and actions in the near future to realize any or all of them as their long-term futures.

Happy Stock/via adobe stock

One pathway involves a transformation of jobs and industries in Arab countries brought about by the Metaverse. Such a transformation is likely to result in the creation of new kinds of jobs, the reimagining and potentially the end of some other jobs, the movement of work into the Metaverse, and a shift in the skills needed in the future workforce.

A second pathway involves developing and employing Metaverse environments and technologies to improve societal well-being as measured through educational, health-care, environmental, urban quality of life, and other outcomes that the environments and technologies enable.

A third pathway considers how the emerging Metaverse phenomenon offers Arab countries an opportunity to lead the world in developing and implementing the regulatory and governance frameworks that will underpin and enable this new subsector of the global digital economy. In doing so, this pathway could create and cement a new source of influence for the Arab region in the global economy and culture.

1

Binary Studio/via adobe stock

Metaverse advancement as an element of the transformation of industries and employment in Arab countries (pathway 1)

New thinking about jobs is critical to creating better futures in Arab countries. New thinking is what will create new jobs, elevate the value that jobs contribute to Arab economies and to the lives and families of workers, and transform workers' relationships to the jobs they hold. The Metaverse is at the centre of an upcoming transformation of industries and jobs worldwide.

This pathway explores how Arab countries could benefit from intentional decisions and actions by leaders in the public, private, and other sectors to develop and advance the Metaverse as an element of strategies to transform Arab industries and employment.

The kinds of use cases and the kinds of social benefits and risks described in this section are among the kinds of outcomes that Arab countries could obtain if decisions and actions are taken to move the Metaverse down this pathway.

A. The economy and jobs of the future are coming to Arab countries, if the right investments are made

In Arab countries, employment is one of the greatest challenges facing leaders as they look to the future. Measures of unemployment in 2022 ranged between 9 per cent and 12 per cent. Arab countries in the Middle East and North Africa collectively have the highest percentage of youth unemployment and female unemployment in the world, estimated at 25 per cent and 22 per cent respectively.[52] Nearly two out of three workers across the region have jobs in the informal sector.[53] Arab countries urgently need means of creating substantial numbers of new job opportunities that are inclusive, capable of sustaining families, and enable social mobility.

By 2030, the **value of the Middle East's digital economy** would be equivalent to about **13.4 per cent** of its GDP, up from approximately **4 per cent** in 2022".

1. Solving digitalization is one part of solving the Arab region's jobs challenge

There are multiple root causes underlying the difficult employment situation in Arab countries. One of them is the relatively slow emergence of a technology sector and the slow advancement of digitalization in industries – and that slow advancement itself has multiple root causes. But in the past five years, this has begun to change. According to a recent analysis, "the Middle East's digital economy is projected to grow more than four-fold to about $780 billion by 2030 from an estimated $180 billion in 2022, a compound annual growth rate (CAGR) of more than 20 per cent that would significantly outpace the global average through the end of the decade. By 2030, the value of the Middle East's digital economy would be equivalent to about 13.4 per cent of its GDP, up from approximately 4 per cent in 2022".[54]

2. The Metaverse is a distinctive next stage of the future digital economy

The acceleration of digital economies will not address some of the most important root causes of the employment situation in Arab countries. But it will be a big part of the future of jobs. The Metaverse is the next stage of the digitalization of industries globally, with the potential, if deliberately pursued as such, to be an important part of that process and its resultant job creation in Arab countries.

For example, by one analysis, the benefits to the Saudi Arabian economy of developing and advancing the Metaverse is projected to range between $20 billion and $38 billion per year in additional GDP by 2035. In the United Arab Emirates, the projected range is from nearly $9 billion to nearly $17 billion per year over the same period; in Egypt, from $11 billion to $22 billion; Morocco, from $2.5 billion to $5 billion per year; and in Jordan from $1 billion to $1.7 billion.[55] A significant proportion of these amounts will be associated with the creation of new jobs.

The benefits to the **Saudi Arabian economy** of developing and advancing the Metaverse is projected to range

between **$20 billion** and **$38 billion** per year in additional **GDP** by 2035.

There are at least three dimensions to the prospect of Metaverse-driven job creation and transformation of employment globally. One is how building the Metaverse will be a job creator. A second is how the Metaverse will change how industries operate, and thus change the jobs in those industries. The third has to do with the key roles that the Metaverse will play in creating the green economies of the future.

B. The first dimension: building the Metaverse itself, and creating the virtual worlds that businesses will operate in, is a source of new jobs

A considerable number of jobs will be created in the engineering functions necessary to build the entire Metaverse value chain, from semiconductors and basic materials through to enabling software, the digital worlds themselves, and the servers and cloud computing environments and 5G/6G networks necessary to make the Metaverse function.

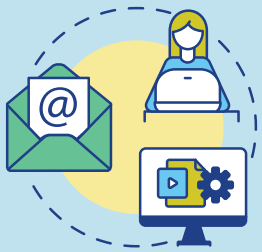
Some of these are occupations that exist today, such as software engineers, network engineers, game designers, data scientists, cybersecurity, and AI

engineers. But the scale at which the numbers of jobs in these career fields will grow will be accelerated by the rapid expansion of the Metaverse. For example, in the case of data scientists, the Metaverse will use millions and eventually trillions of gigabytes of data, generated both by users and by algorithms that make these virtual environments possible, creating demand for huge numbers of professionals with distinctive types and levels of skills in data capture, storage, processing, and analysis.[56]

1. New kinds of jobs within the Metaverse

There are also new kinds of jobs already emerging that are unprecedented because they exist only in the Metaverse. While they sound fanciful today, jobs such as avatar clothing designers, data bounty hunters, Metaverse event directors, Metaverse safety managers, metahuman doctors (for when people's biometric and physiological data become tied to their avatars) will become real.[57] Other sources envision how "the Metaverse will give rise to additional jobs that did not previously exist, such as virtual economists, virtual law specialists, and AI developers for virtual personal assistants".[58] The need for such jobs is clearly small today, but can be reasonably anticipated to increase over the decades to come, along with the need for other jobs that today's Metaverse observers and marketers have yet to conceive.

the Dubai Metaverse Strategy, announced in 2022, "will support **40,000 virtual jobs** and add **$4 billion** to the emirate's economy **in five years**"



As Arab countries have begun to pursue strategies to make the Metaverse part of their economies, these kinds of Metaverse jobs are already beginning to be created. For example, the Dubai Metaverse Strategy, announced in 2022, "will support 40,000 virtual jobs and add $4 billion to the emirate's economy in five years". Another element of the strategy is to attract 1,000 blockchain and Metaverse companies to Dubai through Government-sponsored initiatives and incubator hubs. Additionally, as "the cryptocurrency and blockchain industry has helped give rise to technologies such as the Metaverse and NFTs, it is expected that crypto-based jobs will also continue to proliferate in Dubai and the United Arab Emirates as a whole".[59]

Companies and organizations of many types everywhere in the world, including in Arab countries, will create demand for these and many other new kinds of jobs as they begin to use Metaverse technologies to conduct their business. This starts from the decision itself: "the first thing when a company enters the Metaverse is to have a person who can develop a strategy that involves defining a roadmap and blueprint for a step-by-step approach for building and operating there".[60] This could apply to a brand such as a fashion label, a retail company, or another customer-facing company that decides to create a presence in the Metaverse to attract customers and differentiate itself from competitors. Alternatively, it could apply to an engineering or manufacturing company, a government agency, or another types of company that sees the potential for the Metaverse to add value to its activity, new kinds of efficiencies it can incorporate into its workflows, or other business benefits it can derive from creating a presence and workspaces for its employees in the Metaverse.

In any case, these enterprises will need not only strategic planners who will design immersive experiences and plan how customers, stakeholders, and staff members will engage with them. They will also need AR and VR engineers, 3D graphics designers, artists and architects for 3D drawings and buildings to create digital twins, and more – all types of jobs that did not exist a few years ago, and exist only at modest scale today, but will grow tremendously in numbers over the decades to come.

Comparisons have been made to the new job creation that has emerged in today's Web 2.0 world. "Ten years ago, there were no jobs like social media manager or Facebook page administrator … nowadays, AR is a new technology that requires people who can understand the technology, manage it, and use it in a good way. Therefore, AR will create new jobs, such as AR content director."[61]

2. Jobs at the intersection of the present and the future

Some of the job-creation potential of the Metaverse comes from the job invention to be expected at the intersections of existing professions and new technologies. Take the idea referenced above of avatar clothing designers, bringing together a core role in the fashion industry with computer science and spatial digital engineering. Or the concept of a data bounty hunter: data-mining is already a growing job sector in the two-dimensional Web 2.0 world. The three-dimensional and multi-sensory digital world of the Metaverse involves many more types of biometric and other data, and the rights to these data will also need to be secured. That challenge brings data mining, legal and forensic analysis, and other kinds of skills together into a type of job that has no current equivalent, but that can be imagined to grow in importance and demand. Traditional doctors will be as prevalent and necessary in the future as they have been historically, but metahuman doctors represent a new kind of profession combining medical science with hard computer analytics and other digital skills. The future will be increasingly full of such combined jobs stemming from the development and advancement of the Metaverse.

3. The technology and infrastructure needs of the Metaverse will create new jobs

Another source of job creation associated with the Metaverse, an extension of the job creation that Web 2.0 has brought about, lies in the hardware, software, and enabling technologies necessary for 3D immersive virtual worlds and applications. Three key factors have been described as essential in realizing the potential of the Metaverse: "hardware must be built, infrastructure must be transformed, and access must be improved". Hardware needs include not only VR/AR headsets but also huge numbers of unique hologram displays, projectors, batteries, radios, custom silicon chips, cameras, speakers, sensors and more. The infrastructure needs encompass a significant shift towards cloud-based infrastructure to help deliver scalable platforms, both for the social and entertainment Metaverse and the kinds of uses envisioned for the industrial Metaverse. The vision of companies, governments, health-care systems, urban planners and others is for the benefits of Metaverse technologies to reach billions of people. This will require significant improvements in worldwide connectivity and access to hardware. Building, deploying, and maintaining all this technology will create substantial numbers of jobs over the next decades around the world, including in Arab countries.[62]

Even for the current Web 2.0 environment, the need is considerable in Arab countries for the development of infrastructure such as 5G and eventually 6G networks and cloud infrastructure to enable the advancement of the digital economy. This process is underway at varying paces in different countries. For example, 5G subscriptions in the GCC countries are projected to grow from 13 million to 70 million between 2022 and 2028, by which time they will represent 86 per cent of total mobile device

5G subscriptions in the GCC countries are projected to grow from **13 million** to **70 million between 2022 and 2028,**

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connectivity subscriptions in those countries. The projection for 5G subscriptions in 2028 is 32 per cent.[63] Carriers in the GCC are working with global partners to build these networks – for example in Saudi Arabia, a network with 2,000 towers covering 20 cities is under construction; in Qatar, there are 1,200 5G sites in Doha alone.[64] These and other digital infrastructure initiatives can be a foundation for the massive connectivity and other technical requirements for the Metaverse in Arab countries, and can also be a source of local jobs if the right kinds of contracts can be negotiated with partners.

4. In the Metaverse economy, jobs can – and will – be anywhere

The new kinds of jobs that are already emerging and will emerge from the advancement of the Metaverse will be global in the scope of their availability. Many of them will be performed in the Metaverse itself, with members of teams collaborating in the immersive 3D virtual environments they are creating or that are being created for them in which to do their work. As a result, digitally skilled citizens of Arab countries will have the opportunity to gain these jobs and perform them in their home countries, wherever their employers may be based. The phenomenon of "digital nomads" working from anywhere accelerated dramatically during the COVID-19 pandemic, and is now gaining more and more global acceptance. By March 2023, at least 37 countries, including the United Arab Emirates, had formal visa policies in place to attract talented digital nomads.[65] The quality and effectiveness of the virtual work and collaboration experience in the Metaverse will accelerate the digital nomad phenomenon further, creating new employment opportunities outside Arab countries for citizens within them.

Just as important are the new kinds of Metaverse jobs that will be created in and remain native to Arab countries in the growing number of local start-ups, as well as in established local companies moving to enter the Metaverse economy. These already span a wide range of sectors, from real estate to fashion to tourism. Many of these companies are in the Gulf countries, but more and more are raising capital and launching operations in other Arab countries as well.

Gulf countries are also leading the way in terms of established companies creating a business presence in the Metaverse, creating immersive 3D virtual versions of their industry sectors. In 2022, for example, a real estate brokerage in Dubai began selling digital twins of properties as NFTs, either with or without their physical counterparts. Real estate sales in the Metaverse have been projected to double from $500 million between 2021 and 2022, with further growth expected at a 31 per cent CAGR between 2022 and 2028.[66] One property developer has announced plans to invest $100 million to build digital cities, virtual homes, and other forms of digital property in the Metaverse.[67]

In the finance sector, a Kuwait-based bank established two sites in the Metaverse in 2022, one on the Decentraland platform and the other on the Sandbox platform, with the aim

of increasing its engagement with younger generations.[68] In the tourism industry, a Qatar-based airline has launched a VR experience allowing website visitors to experience the airline's products and services, check-in areas and processes, and cabin interiors.[69] Business ventures such as these are creating new kinds of jobs in various sectors, as well as opportunities for data architects, software developers, AI engineers and others to create Metaverse assets.

C. The second dimension: the Metaverse is poised to change the operations of businesses in a wide range of industries

Metaverse technologies have the potential to transform employment in many traditional industries, including in Arab countries. The Metaverse will change how a potentially large number of job functions are performed. The Metaverse will also enable businesses in many industries to grow their existing markets and build new ones, creating a need for additional employees to serve these new customers. The potential for Metaverse technologies to change many industries must be understood in the context of how those industries, and the private sector in general, operate in many Arab countries. Business operations, laws and competition regulations often differ from those in other parts of the world. The challenges facing small and medium-sized enterprises (SMEs) and start-ups also differ from the challenges faced elsewhere. Some industries, such as manufacturing and agriculture, are less established in certain Arab countries than in other parts of the world. These and other conditions that characterize Arab industry may need to evolve in order for the promise of the Metaverse to be realized.

But if they do evolve, the Metaverse can not only change existing industries in Arab countries, but also help previously underdeveloped industries flourish. The resulting potential for job creation could be significant. It would undoubtedly change the nature of many legacy jobs in a range of industries, necessitating a mastery of new skills, thereby potentially making them higher-paid because they will add more value to the companies and other organizations in which these workers serve.

1. The industrial Metaverse is the reimagining of how businesses and their facilities operate

One key element is the rapidly emerging "industrial Metaverse", a concept that may turn out to be one of the most important elements of the Metaverse phenomenon. The scope and scale of the operational improvements it enables is considerable across the entire industrial sector – essentially, any business involved in the design, manufacture, or shipping of goods and products will be able to take advantage of these innovations. One of the greatest opportunities that Metaverse technologies offers lies in the ability of digital twins of a company's physical infrastructure (manufacturing plants, warehouses, labs, power plants, etc.) both to provide insight into the functioning of those facilities and their internal systems and to change how operations and maintenance are performed. Engineers can design, test, and troubleshoot in these precisely detailed virtual environments. Efficiency, safety, cost savings, and other benefits can be realized in day-to-day operations by monitoring and controlling them in real time in a digital twin connected to the physical buildings and systems. It is also possible to use the digital twin "to simulate the behaviour of physical systems under various conditions, making it possible to test different scenarios without making any material or physical changes", thereby proactively "identifying and solving problems before they occur in the physical system".[70]

These and other kinds of operational innovations and efficiencies will be possible because Metaverse technologies enable employees to perform traditional maintenance, plant operation, and other jobs in new ways, either entirely virtually or in hybrid format. Experts in remote locations can join on-site technicians and other staff in a virtual replica of a factory floor or any other part of an industrial enterprise's infrastructure and work "side by side" with them with the same kind of hands-on, contextualized, 3D spatial view their coworkers have. They can diagnose a problem and help craft a solution in the digital twin that can then be implemented in the physical building or system – all without the cost and inconvenience of sending the expert to the location or shutting down the system.

In this example and others, the nature of the jobs of both on-site and remote workers are materially changed by the Metaverse technology. Before long, these kinds of operations and maintenance interventions will be in wide use – and possible using smartphones rather than cumbersome VR/AR headsets, using products that allow technicians to work directly with remote experts.[71] One source describes the capabilities that the Metaverse can add to industrial operations and maintenance as "superpowers" never realizable before: "these superpowers include teleportation, with workers able to jump to any point on a factory floor no matter where they are in the world and see what

Examples around the world of **digital twin** usage **in industrial operations** and **maintenance** are **growing** in number,

in industries ranging from manufacturing to automotive, architecture, construction, health care, energy, and others.

is going on in a digital twin, and time travel, where the factory's activity is recorded and played back so that anomalies can be viewed to see how they happened".[72]

Examples around the world of digital twin usage in industrial operations and maintenance are growing in number, in industries ranging from manufacturing to automotive, architecture, construction, health care, energy, and others. Some are already being seen in Arab countries.

One important example is the oil and gas industry, where digital twins have been used to review designs, with engineers and stakeholders interacting virtually with 3D/4D/5D models and simulations to identify potential issues. The industrial Metaverse is also enhancing remote monitoring in the sector by integrating IoT devices, sensors, and real-time data, enabling engineers to perform maintenance from any location.[73] In 2021, a Kuwait-based oil company developed digital twins of its oil fields in northern Kuwait to automate and optimize its work processes.[74]

2. Virtual prototyping

Another important dimension of the industrial Metaverse that is already transforming industries and the jobs of workers in those industries is virtual prototyping. Recent analysis found more than 70 per cent of surveyed companies in advanced industries using digital twins in their product design, including companies in the automotive, aerospace, defence, logistics, and energy sectors.[75] Metaverse technologies allow designers to eliminate constraints they face in the real world. As one source describes it, "VR allows designers to simulate a prototype in 3D regardless of complexity or scale and interact with and manipulate it in an infinite number of ways".[76] In this way and others, virtual prototyping, including in realistic 3D simulations of the real-world environments in which prospective customers will use the products, increases the potential for product design creativity and optimization to the preferences of those future customers. New skill sets will be vital for workers at every stage of the product design value chain and will open significant opportunities for them.

Retail and automotive are two industry sectors where virtual prototyping is already making significant advances and impacts. The Metaverse is already being used by clothing companies to design clothes and footwear using realistic models in 3D environments. In addition to the opportunities this creates to boost sales and revenue with new offerings, companies are realizing ancillary benefits in their efforts to become more sustainable. Using virtual spaces for product design can reduce carbon emissions and resource consumption by reducing the need to ship samples between departments, and the need for design and marketing staff to travel.[77]

In the automotive industry, multiple aspects of the product design, manufacture, and sales processes are being transformed by Metaverse technologies, and the jobs of workers at all those and other stages of the value chain are changing as a result. Some firms have begun to use 3D virtual environments not only for new vehicle design and R&D, but also for safety testing and optimizing manufacturing processes. In some factories, workers use AR headsets that overlay digital information onto physical components to identify defects before final assembly.[78]

These are only a few examples of how the Metaverse can change industrial processes. A recent report describes how companies have used Metaverse technology to optimize

production processes. One company has started to create a digital twin of a planned future vehicle manufacturing facility to produce next-generation cars more efficiently. It is projected that this practice could improve output in the automotive sector by between 10 per cent and 25 per cent, while reducing unplanned maintenance by 80 per cent and increasing quality by up to 25 per cent.[79]

3. New ways to do old jobs, and new jobs to do – examples from the tourism sector

The tourism industry illustrates further ways that Metaverse technologies will reshape what work is done, and how.

Tourism is a vital industry in many Arab countries. Metaverse tourism will help people all over the world experience travel destinations from their homes in immersive 3D. One result is new kinds of jobs in which people design virtual tourist experiences for virtual travellers. Some of these experiences will be self-guided, but there is also likely to be a new kind of role for traditional tour guides to move their role into the virtual world. Because of the travel restrictions associated with COVID-19, worldwide tourism fell by 73 per cent in 2020 and 85 per cent in the first half of 2021 compared with 2019.[80] As a result, virtual tourism received a boost. One market research estimate suggests that the market size for virtual tourism, which was estimated at $448 million in 2020, will reach $6.5 billion by 2030. Other studies propose figures as high as $6 billion in 2022 and $23.5 billion by 2028, and even $188 billion as soon as 2026.[81]

One market research estimate suggests that the market size for virtual tourism, which was estimated at **$448 million** in 2020, will reach **$6.5 billion** by 2030.

Rather than jeopardize or replace in-person tourism, it is anticipated that Metaverse tourism will be a significant addition to the industry, opening up various new revenue streams. Previously excluded travellers such as people with disabilities will become able to visit and explore places that had previously been difficult or impossible for them to access. New kinds of tourist experiences impossible in the real world become part of what travel and tourism companies can offer, including virtual tours of places which are inaccessible in real life. Examples include Metaverse tours of cities which have been destroyed by natural disasters, and tours of cities as they appeared in antiquity. Virtual tourism will also grow the sustainable travel sub-industry, making fragile ecosystems virtually accessible to millions of visitors. Metaverse platforms will also enable people to explore areas that are affected by conflict, terrorism, or other conditions that make them unsafe to visit physically, becoming a source of needed revenue for those countries.[82]

It is also widely anticipated that applications of Metaverse technologies by the tourism industry will contribute to an increase in traditional in-person tourist travel. With vivid, immersive VR and AR marketing demonstrations, prospective travelers can explore travel products, services, and destinations and get a sense of a country or city, hotel or cruise ship options, or other aspects of a trip they are considering before they book trips they may not otherwise have considered. A recent article cites a number of survey and other statistics that suggest the potential of the Metaverse to boost bookings and revenue across the travel industry: “customers aged 18 to 34 are 130 per cent more likely to book a place if there is a virtual tour, and 50 per cent of adult users on the Internet rely on virtual tours in their research and decision-making process”.[83]

Metaverse tourism is already taking hold in several Arab countries. In 2022, the Dubai municipality announced plans at the World Government Summit to create a digital twin

city of Dubai that visitors can explore without being physically present. The Louvre Abu Dhabi Virtual Tour enables tourists from around the world to visit the museum's galleries. In 2022, a virtual tour of Metatut was launched, the first Egyptian city in the Metaverse, recreating the place and time of King Tutankhamun. In 2021, the Saudi Arabia Agency for Exhibitions and Museums Affairs announced the Virtual Black Stone Initiative which "will allow Muslims all around the world to touch the Black Stone at the Kaaba in Mecca through VR technology". The following year, the Saudi Arabia Royal Commission for Al-Ula announced a digital twin allowing tourists to virtually visit the ancient city of Hegra, the first UNESCO World Heritage Site to enter the Metaverse. A Jordan-based non-profit company is operating "virtual museums and historical sites to document Jordanian history and culture". Lebanon's Ministry of Culture has built "Baalbek Reborn", allowing tourists to visit the Roman Temple of Jupiter in a 3D VR immersive recreation.[84]

Numerous other industries are already realizing the benefits of Metaverse technologies to transform how work is done and seeing how jobs are changing and being created as a result. At this stage, the degree to which such industry transformations will be net creators of significant numbers of jobs is unclear in many cases. But jobs in most industries will increasingly be linked to the Metaverse, making it an essential element of strategies to ensure that current and future generations of Arab workers can fill the jobs these industries will have to offer.

D. The third dimension: the Metaverse will be a key enabler of the green economy and its impact on Arab countries' future employment

The imperatives for transitioning to a green economy in Arab countries are manifold and well known. One driver is the set of impacts of climate change if Arab countries, particularly the Gulf States, continue as high-carbon economies. As has been amply documented, "the countries of the Middle East, especially Arabic-speaking ones, are among the world's most exposed States to the accelerating impacts of climate change, including soaring heat waves, declining precipitation, extended droughts, more intense sandstorms and floods, and rising sea levels".[85] At the same time, a second driver of the green economy is the growing global shift away from fossil fuels, which creates an accelerating need for the oil-exporting countries to shift to new sources of revenue. It is predicted that "oil demand will peak around 2040, possibly reaching 114 million barrels per day, and then plateau or decline precipitously by 2050 depending on multiple factors".[86]

The global transition to a green economy will disrupt employment in the carbon-intensive economy it will ultimately supplant. But it is projected to have create equal or even greater economic and employment benefits as it advances. By one analysis, "although moving away from fossil fuels will cost 185 million jobs, the green economy will create 200 million new roles by 2050, including eight million in renewable power, hydrogen and biofuels".[87] Another analysis projects that "swift action to zero out global greenhouse gas emissions [and shift to low-carbon green economy industries] could add $43 trillion to the global economy by 2050".[88]

Pursued with this aim deliberately in mind, the Metaverse can play an important role in the transition to green economies throughout the world, including in Arab countries.

1. Two types of connections between the Metaverse and the green economy

The connection between the Metaverse and the green economy will manifest in two primary ways. One analysis captures the first of those manifestations in this way: "The metaverse holds the promise of substantial reductions in carbon emissions, whether through the substitution of physical goods with digital ones, replacing real-world presence with virtual interactions, or digital twins that will help us optimize the physical world – from the planet to individual humans".[89]

The other primary manifestation is the significant role Metaverse technologies will play in the still-emerging new industries of the green economy, such as clean energy production, sustainable natural resource and waste management, and others.

Both of these forms of connections between future jobs, current and emerging industries, human behaviour, and the Metaverse are worthy of examination in order to accelerate those connections.

2. Metaverse technologies will "green" how people work, what they consume, and the operations and maintenance of industries and the built environment

All of the uses of digital twins and other Metaverse technologies in traditional industries that were described

in the previous section represent, individually and collectively, one key to the link between the Metaverse and the green economy. That is, many of the changes that Metaverse technologies will enable in how work is done in those industries will make the execution and outputs of business operations in those industries more environmentally friendly – even in carbon-intensive industries such as oil and gas. In other words, in any industry that elects to employ them, digital twins can lead to a substantial degree of "greening" of infrastructure and operations as "facilities managers and asset owners can analyse, in the digital twin, factors such as utilities performance; waste management and recycling practices; heating, ventilation and air conditioning; energy supply; fire safety and protection; IT and communications; lighting; refrigeration; security; [and] water, drainage and plumbing".[90] As they gain understanding of the overall impact that the systems or processes of a building, factory, or other physical asset have on the environment, engineers in any industry can begin experimenting in the digital twin with changes that can then be implemented in the physical twin to reduce carbon emissions.

Changes not only to the operations of industrial infrastructure, but also to the products companies make and how their products are made and sold, are also an aspect of the greening of traditional industries via the Metaverse. For example, the Metaverse is already beginning to offer significant environmental benefits for industries such as fashion, where design and retail practices contribute to overproduction and overconsumption. Fashion customers can try on virtual versions of the products in Metaverse retail outlets, over time reducing the sizable portion of online sales that are returned, doubling transportation miles, packaging, and resources used in stocking.[91]

There will be a growing role for Metaverse technologies in the development of the industries that the **green economy** of the future will comprise, and the "**green jobs**" those industries spawn.

3. Even more importantly, the Metaverse will enable the development of green industries and enable them to realize their potential

There will be a growing role for Metaverse technologies in the development of the industries that the green economy of the future will comprise, and the "green jobs" those industries spawn. By various definitions, this future green economy comprises industries including renewable energy, green buildings, clean transportation, sustainable agriculture and forestry, and sustainable water management, waste management, and land management.

Examples of the usage of 3D virtual visualization and design environments in all of these green economy sub-sectors are increasingly being seen, and are anticipated to grow over time. The next pages examine three of them in detail.

a. Clean and renewable energy

Most Arab countries include the transition to clean and renewable sources of energy for domestic use in their overall national strategies, or as an element of specific national strategies for green economy transition. These include Qatar's National Vision 2030 and the sustainability strategy of the State-owned Qatar Energy company; the United Arab Emirates' Green Economy for Sustainable Development Initiative; Saudi Arabia's National Renewable Energy Program, which aims to


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maximize the potential of renewable energy in the Kingdom; Jordan's Economic Modernisation Vision; Tunisia's Carbon Neutral and Climate Change Resilient Development Strategy by 2050; and Morocco's National Sustainable Development Strategy 2030.

Implementing these strategies will not only help address the climate change challenge and reduce energy imports. It will also create jobs. According to analysis by the OECD, there were nearly 12 million jobs in the renewable energy sector worldwide in 2021, and the International Labour Organization's "World Employment and Social Outlook 2018: Greening with Jobs" report projects that "a shift towards renewable energy sources and greater efficiency, [combined with] the projected adoption of electric vehicles and construction work to achieve greater energy efficiency in buildings", will lead to the creation of 24 million new jobs globally by 2030.[92] This represents nearly 2.4 million jobs in the Arab countries in the Middle East and North Africa alone.

Already today, job creation in this sector is advancing – the OECD's projection of **12 million** such jobs **in 2021** includes nearly **40,000** **in Jordan** and **15,000** **in Morocco**.

Given the plans of nearly every country to accelerate the adoption of renewable energy, it can be anticipated that this job growth will be in many Arab countries, not concentrated only in the wealthier ones. Already today, job creation in this sector is advancing – the OECD's projection of 12 million such jobs in 2021 includes nearly 40,000 in Jordan and 15,000 in Morocco. Even conflict-affected countries have renewable energy industry job creation potential. Scenario modelling about Yemen by the World Bank in 2021 estimated nearly 25,000 new jobs by 2030 (a combination of direct, indirect, and induced) just from solar in a baseline scenario, and as many as 59,000 in the best-case scenario.[93]

The link between the Metaverse and the renewable energy component of the green energy transition lies in large part in the modelling, design, and continuous optimization of increasingly complex and spatially distributed grids. Future grids will have intricately and massively interconnected elements for electricity generation (power plants, turbine farms, solar panel fields), transmission (power lines), and distribution and consumption (substations, businesses and homes, electric vehicles, etc). One part of the equation is that, as renewable energy transition is scaled up,

Metaverse technologies will be essential to visualize all of the elements of smart clean grids prior to construction and operation.

Once they are built and deployed, monitoring and maintenance of the assets that comprise future smart clean grids will be through VR/AR/MR technologies enabling virtual site visits, remote assistance to field workers, and more, all backed by advanced analytics to dramatically improve operations and efficiency. Digital twins of power plants, augmented by IoT devices on physical equipment, will enable utility companies to view the entire facility in 3D and operate it remotely.[94]

Within the broader renewable energy sector, new kinds of jobs are emerging as the wind energy segment accelerates its use of Metaverse technologies throughout its operations. With a 3D virtual rendering of a proposed turbine design or proposed field configuration of turbines, technicians can analyse how a planned wind farm would perform before manufacturing and construction. Extending that to a subsequent 4D simulation of the construction activities with the scheduling, resources, and staffing levels needed will also reduce the cost and duration of the project. Once operational, the digital twins of the individual turbines and the wind farm can run simulations of the physical infrastructure's performance in normal and alternative conditions (for example, in a range of weather environments) alongside analyses of real performance to diagnose the health of the generators and predict the outcomes of changes in operational procedures such as increasing the power rate of the turbine.[95]

b. Sustainable water management

As Arab countries and the rest of the world confront the growing challenges related to water in increasingly difficult climate and other conditions, investment in the green industries that enable sustainable water resource management practices will grow significantly. With this will come resultant increases in existing and new types of jobs. Research by the Pacific Institute over a decade ago found that "implementing sustainable water management requires a broad range of occupations, some of which are quite new". The research identified 136 distinct occupations "involved in achieving more sustainable water resource management outcomes in agriculture, urban residential and commercial settings, restoration and remediation, alternative water sources, and stormwater management".[96]

Sustainable water resource management as an element of the green economy is not only a job creation opportunity. It is also a job protection imperative. According to the United Nations Environment Programme (UNEP) "World Water Development Report 2016: Water and Jobs" nearly 1.5 billion people – half of the world's total workforce – are employed in water-related sectors, and that "from its extraction to its return to the environment, via numerous uses, water is a key factor in jobs creation". According to the analysis, three out of every four jobs that make up the global workforce, encompassing all sectors of the global economy, are moderately or heavily dependent on the availability of fresh water.[97]

As in the clean energy segment, the Metaverse will be an important part of the future of the sustainable water resources management segment of the green economy. Similar to the energy segment, uses for Metaverse technologies have emerged in both the design/build phase and operations and maintenance phase of the water sector value chain. For example, a 3D virtual model can be used to identify hazards and defects in the design development process for treatment plants before they are built. In Australia, the city of Melbourne's water provider has been using this

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technology since 2017; the realistic detail of the VR model provides a more than threefold improvement in the quality and effectiveness of their design reviews over the old approach relying on blueprints and computer-aided design drawings. In operations and maintenance, Metaverse technologies enable virtual site visits to plants and other infrastructure and remote guidance to field staff, 360-degree views of each stage of water treatment processes, real-time information on water quality in treatment plants, and more.[98]

There are numerous other examples from around the world where Metaverse technologies have been used to enable sustainable water resources management. For example, in Scotland, the Government agency in charge of canals launched an initiative in the early 2000s to bring them back to health after decades of deterioration as climate change and its impacts on weather patterns made them prone to flooding. Hydraulic engineers in Italy have used Metaverse technologies to create a virtual 3D map model of the Arno River from its source to the city of Florence, including water and wastewater systems and the city's buildings. Simulations with this digital twin reveal areas vulnerable to flooding, informing emergency response plans as part of the city's water resource management strategy.[99]

The use of digital twin technology and methods is beginning to be seen in Arab countries, including in some of the Gulf countries. This is in part to address water scarcity, which is projected to rise by 62 per cent in the GCC countries by 2025 (and comparable percentages in other Arab countries). The Government of Abu Dhabi designed and built an open-loop control to improve water quality in the Al-Raha beach development using a digital twin of the area's drinking water network. Running multiple scenarios in the digital twin informed the design of facilities upgrades to ensure water quality. In Saudi Arabia, digital twin technology was recently used to develop the Al-Wajeed water master plan, helping ensure the availability of water for a half million drought-affected residents.[100]

In a 2012 scenario-based dynamic modelling analysis, the United Nations Food and Agriculture Organization (FAO) projected additional **agriculture and food employment** ranging between **1.65 billion** and **1.73 billion** globally **in 2050.**

c. Sustainable agriculture

As an element of the green economy, the picture of the impact that the sustainable agriculture sector will have on job growth is somewhat mixed. In a 2012 scenario-based dynamic modelling analysis, the United Nations Food and Agriculture Organization (FAO) projected additional agriculture and food employment ranging between 1.65 billion and 1.73 billion globally in 2050. The analysis assumed several significant interventions in primary-sector employment, including sustainable management practices, the conservation and reconstruction of forest and fish stocks, and investments of between $110 billion and $180 billion per year. The adoption of sustainable management practices alone accounts for between 362 million and 630 million of the employment gains in their more conservative scenarios.[101]

On the other hand, the International Labour Organization (ILO) in 2018 explored a scenario with a different set of assumptions, in which conservation agriculture was adopted in developing countries and organic agriculture in developed countries by 2030. This effort projected 5 per cent fewer jobs in the sector overall, with losses concentrated in Africa and the Asia Pacific region but a 1 per cent rise in employment in agriculture in Europe.[102] The ILO's analysis did describe how the adoption of more sustainable agricultural policies could create wage employment in medium and

large organic farms, and how converting to climate-resilient agriculture practices could create jobs at local level.

What is certain is that shifts in agricultural practices are ongoing and will accelerate around the world, including in Arab countries, and that these changes will have an impact on the future of employment in the sector. Most of the changes are toward sustainable agriculture and many involve the growing integration of digital technologies into agriculture. Metaverse technologies will play an important future role here. The impact of the Metaverse in sustainable agriculture and employment in the sector will manifest itself in several ways.

As in other sectors of both the "traditional" economy and the emerging green economy, digital twins play the most significant role. Farmers will be able to create an authentic digital replica of their farms, making them able for example to "experiment with different cropping practices before actually trying them in the real world". Moreover, "advancements in sustainability practices, carbon sequestration, water quality, soil health, plant genetics and machine efficiencies can all be put to the test in the metaverse – thousands of different scenarios tried in a matter of days, weeks or months".[103] Once digital twins are created, Metaverse technologies integrated with other digital technologies such as sensors, cameras, wearable devices, AI and machine learning will provide the capacity to collect and analyse real-time data about farms and the weather and other environmental conditions that affect them. Results may include higher yields, reduced waste production, improved production quality, improved pest and disease control, and other efficiency and sustainability improvements.[104]

Applications such as this may not yet be in widespread use, but examples are emerging and can be anticipated to increase. One project funded by the Netherlands Ministry of Education, Culture, and Sciences employs cameras, sensors, AR, AI, and machine learning in a fully digitized plant farming and crop management system. Digital twins are continuously updated with photographs of the crops, the AI performs analytics by scanning the pictures, and the agronomist or farmer receives information in AR about weather and plant and soil health.[105]

Another way that Metaverse and related technologies will have an impact agriculture is by promoting sustainable practices and livelihoods. For example, the Ministry of Agriculture in South Korea has developed immersive 3D content that offers virtual tours of farms, and Government institutions to promote the value of agriculture to younger generations. Equipment manufacturers are offering immersive demonstrations of their indoor hydroponic farming products to prospective customers.[106]

There are currently few significant demonstrated applications of Metaverse technologies in agriculture in Arab countries. At the same time, there is a solid basis of interest and activity in other forms of agricultural technology, so an expansion of that interest into using the Metaverse in this sector can be anticipated. The pace of take-up and the specific Metaverse and other agricultural technology priorities will logically be driven in part by how significant agriculture is as a factor in the economies of individual countries. For example, in Morocco, where agriculture represented nearly 38 per cent of jobs in 2020, there is a growing reliance on digital technology to accelerate a transition toward climate resilient agriculture. One recent demonstration of this is a $250 million programme with the World Bank to support the country's Green Generation Strategy.[107] In Egypt, where 11 per cent of GDP in 2022 and 23 per cent of jobs are in agriculture, the Government in June 2023 announced plans to increase green-economy-related investments in its economic and development plan from 30 per cent to 50 per cent by 2025.[108]

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in Morocco, where **agriculture** represented nearly **38 per cent of jobs in 2020,** there is a growing reliance on **digital technology** to accelerate a transition toward climate resilient agriculture.

One recent demonstration of this is a **$250 million** programme with the World Bank to support the country's **Green Generation** Strategy.

But there is also interest and activity in agricultural technology in countries where agriculture is much less significant in the economy, rooted in economic development strategies, broader sustainability strategies, or both. In Jordan and Lebanon, local start-up companies are emerging to develop digital technologies for small- and medium-sized farms.[109] Government entities in both Kuwait and Oman are "actively seeking proposals for digital solutions that empower farmers through smart agriculture projects aimed at improving the efficiency and sustainability of food production".[110]

E. Some challenges and blockers to the advancement of this pathway

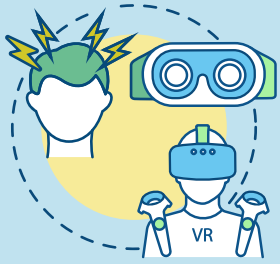
1. The Metaverse is likely to contribute to the elimination of some jobs and some kinds of jobs, even as it creates new ones

Like many if not all major technological innovations before it, the incorporation of the Metaverse into businesses and other organizations can be expected to disrupt work and the economy negatively at the same time as it creates new opportunities. The world already saw a dramatic movement of work into the virtual realm during the COVID-19 pandemic shutdowns, although the tide over the latter half of 2023 has begun to turn back towards in-person work. Some workers have lost jobs from this trend when employers realized that they could outsource the duties of higher-paid employees to less costly remote workers. Nevertheless, automation is a much greater concern than virtuality when it comes to potential job losses. The rapid growth of generative artificial intelligence is anticipated to have a major impact. A recent analysis suggests that "as many as 300 million full-time jobs around the world could be automated in some way by the newest wave of AI". Studies on job losses associated with the Metaverse are few, but the prospect cannot be ignored. Employers and governments will need to consider how negatively affected workers can be retrained or helped in finding new jobs.[111]

2. People working in virtual Metaverse environments will be vulnerable to potentially harmful physiological and mental health effects

Technology professionals and others, including a number who are part of creating the Metaverse and its applications, note potential risks to the safety of potential Metaverse users. There are particular concerns for children and teenagers, who may find that the boundaries between the real and virtual worlds become blurred in extensive exposure. But healthy adults will face risks as well, especially those whose jobs move for parts of the day or even the entire day into the Metaverse. The problem has been described as follows: "The nature of VR introduces new avenues for discomfort, such as disorientation, dizziness, nausea and increased muscle fatigue. Users can be overwhelmed with too much information, and sudden or intense sources of stress" from the hyper-realistic immersive environments they work in. Nearly 100 factors have been identified that could influence VR side effects in the workplace. Further research on these health risks and how to mitigate them will be

The nature of **VR** introduces new avenues for **discomfort**, such as disorientation, dizziness, nausea and increased muscle fatigue.



important. Employers could even face legal liability if their employees suffer harm, making the development of guidelines for Metaverse use in workplaces a priority among the many open regulatory questions about these technologies.[112]

3. New forms of cybersecurity protection will be needed to protect businesses and give them confidence to take their industries and employees into the Metaverse

Most if not all of the cybersecurity risks in the two-dimensional Internet will carry over into Web 3.0 and the Metaverse, with the result that the challenge of protecting against these risks will increase in scope and in scale. There will be vulnerabilities in the networks that businesses and other organizations use for their workers to work in the Metaverse and to conduct their overall business operations, as well as in the peripheral networks that touch Metaverse-generated data and or enable device access. Because of the unique new features and capabilities of the Metaverse, particularly the interconnected, distributed, and immersive natures of the technologies, whole new kinds of security vulnerabilities will arise. Edge computing and Internet of things (IoT) devices will be critical enablers of the Metaverse, meaning countless more entry points into businesses' Metaverse networks and environments. Web 3.0 ledgers and blockchain features will be susceptible to scams, hacks, and malware. Deepfake technology is another new security concern for businesses and their employees in the Metaverse, with AI-powered synthetic media able to generate hyper-realistic 3D content that falsely portrays what the business or employee is doing. Policies and capabilities to protect the companies and other organizations in the industries that use the Metaverse for the future of work will be essential to develop.

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F. Recommendations pertinent to this pathway

Make investment in Metaverse technologies a specific and intentional element in the portfolios of Arab green investment and green finance initiatives

Arab countries can link their sustainable economy transition objectives and Metaverse aspirations through green finance. Green finance is an increasingly significant part of the sustainable development landscape, and is driven not only by the capital of investors but also (and importantly) by government support frameworks. Analysis by the Green Finance Platform in December 2021 showed "some 684 national and sub-national policy and regulatory measures on green finance in place in 100 developed and developing countries, a 264 per cent increase since 2015". Given its proven and potential contributions to combating climate change and promoting sustainability, Arab countries should make investments in Metaverse technology for sustainability innovations a deliberate focus area within their green finance efforts. There is already at least one related precedent in the COP28 UAE Tech Sprint, which is emphasizing "integrating advanced AI, blockchain, and IoT and sensor technologies in sustainable finance". Programmes such as the nearly SAR 700 billion Saudi Green Initiative, the twelve-country Middle East Green Initiative, and projects in four Arab countries facilitated by the Green Climate Fund should carry such efforts further.[113] As a precedent for notional comparison, in 2021 the Government of Denmark released the Danish Recovery and Resilience Plan, which contributes to the financing of a wide range of green agreements and initiatives. Among these, 4 per cent of the investments (approximately 500 million Danish kroner) are in projects that align the Government's digitalization strategy with its green finance strategy; proportionally, this would equate to SAR 28 billion of the Saudi Green Initiative's investments.[114]

Work with multilateral development banks and other international development and finance institutions to secure concessional and blended finance for the large-scale construction of 5G/6G and other Internet infrastructure needed to enable essential connectivity requirements of Metaverse technologies in every Arab country

The deployment of 5G networks began in the Middle East and North Africa in 2019, and has progressed continuously since. Given the high reliance on wireless connectivity in the Arab countries in that region (and worldwide) both at the consumer and enterprise levels, acceleration of 5G implementation and advancement to 6G is essential for economic diversification and growth, and for social well-being, as more essential services move into the digital realm. GCC countries are recognized among the leaders in the pace of 5G adoption – for example, the November 2023 Ericsson Mobility Report projected that subscriptions in the countries of the Middle East and North Africa would rise from approximately 24 million today to 270 million by 2028. This would, however, still represent only 31 per cent of total wireless subscriptions in that year. As important as 5G/6G is to Web 2.0 in every business and consumer application in Arab countries, it is imperative to secure funding for major 5G and 6G expansion to advance the Metaverse. Without it, it is likely to be impossible to "incorporate machine learning and AI into the network and to support immersive extended reality, edge computing applications, and holographic communications".[115] To obtain the financial resources necessary for the significant 5G/6G expansion needed, a model to potentially emulate is the World Bank Group's Digital Economy for Africa (DE4A) initiative, which relies on financing flows and guarantees provided by World Bank Group instruments supported by multilateral and bilateral development partners such as the International Telecommunication Union (ITU) and the development agencies of Japan, France, and Germany.[116]

Develop and implement a multi-pronged policy framework that fosters the creation and success of Metaverse-related start-ups and SMEs through integrated actions in key areas including facilitating access to finance, targeted expenditures in Metaverse-relevant skills in education systems, and business-friendly taxation and other legal mechanisms

SMEs are widely recognized as engines of economic development around the world, and they are particularly significant to the economies of Arab countries. According to a December 2021 report, the SME sector "encompasses 90 per cent of businesses and, depending on the country, provides 10 per cent to 40 per cent of all employment in the Middle East and North Africa". Numerous analyses have detailed the range of challenges these businesses face (many of which are common to other countries as well). One source argues that "lack of access to finance, lack of managerial expertise, inefficiencies of government, lack

of a well-trained workforce, inadequate infrastructure, and bureaucratic obstacles" are the most significant hindrances. Start-ups and SMEs will be a critical element of the development and advancement of the Metaverse sub-sector of Arab digital economies. Especially in an innovation and growth environment where some have concerns that large technology companies could dominate this sub-sector, to help ensure a vibrant role for homegrown Metaverse SMEs, Arab governments should take steps to put a deliberately integrated set of policy and other measures in place that promote their growth and success. Key areas should include facilitating their access to finance (e.g. grants, loans, and other types of financial and other support to enable Metaverse start-ups to establish themselves), targeted spending on Metaverse-relevant skills in education systems, and developing business-friendly environments with favourable taxation and other legal mechanisms.[117]

Promote the use of digital twins as a central element in electricity grid modernization and other efforts to improve operating efficiencies and shift the energy mix in Arab countries to more renewable sources

Digital twins are already becoming an element of the energy transition, and their utility as well as their usage in designing, implementing, and operating smart grids is anticipated to grow rapidly. The digital data with which utility companies plan and maintain their grids will become increasingly voluminous as decentralization and renewables play a greater role in the future. As one source describes it, "digital twins allow utilities to understand and model their grid's performance and plan for the entire lifecycle of grid assets, enabling intelligent grid design and smooth integration of renewables to advance grid modernization". The development of 3D digital models of physical grids throughout Arab countries, whether directly by governments or by other entities depending on the power market structure from country to country, represent the kind of Metaverse-centric green finance investment that can and should combine the goals of energy transition, sustainable development, and a growing Arab role in the expanding Metaverse economy. Policy, incentivization, and other measures to promote the use of digital twins as a central element in electricity grid modernization efforts should be a priority in the next 2-5 years.[118]

Build on Arab countries' existing foundations of cybersecurity laws and practices by establishing additional new ones that are specifically tailored to protect the commercial businesses and enterprises in other sectors that wish to do business in the Metaverse

Some of the known and suspected risks of the Metaverse from a security and safety standpoint are described in this section and also in section 3 of this report. With the growing

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integration of VR/AR and the Internet, the potential for cyberattacks undoubtedly is increasing. As industries increase their use of these technologies in their business operations, or in some cases move work wholly into the virtual world, measures to make those businesses feel their assets and people are safe will be critical. One recent survey showed that less than half (48 per cent) of respondents were "very confident" that existing cybersecurity measures were sufficient to curb cyberthreats in the Metaverse. In another analysis, 60 per cent of business leaders expressed concern that Metaverse security complexities exceeded the measures their or other organizations had available. While those surveys were not specifically focused on Arab countries, similar levels of concern can be anticipated among business leaders there. If the transformation of industries and employment through Metaverse technologies is to succeed, Arab countries should develop or support the development of legislation and regulations that address the unique security aspects of the Metaverse, while protecting users' interests and fostering innovation in the space. Doing so would also support the objectives for influence in the global economy discussed in section 4 of this report.[119]

Provide tax incentives to businesses that incorporate digital twins into how they work to generate efficiencies in their business operations and to reduce their carbon footprint

The economies and the natural environments of Arab countries will benefit considerably as businesses integrate digital twins into their operations to gain efficiencies in energy use and other resource consumption and implement other use cases described in this report. It is in the interest of governments to incentivize digital twin use and other industrial Metaverse applications in businesses through a variety of means. One approach to implementing this is tax credits. In South Korea, tax incentives specifically related to the Metaverse (though not digital twins) have been implemented – businesses using VR/AR devices, designated as "new growth engines," can deduct between 5 per cent and 10 per cent of the amount invested from their corporate tax depending on company size. In Hong Kong, the Government's "New Industrializations Funding Scheme" subsidizes manufacturers that incorporate technologies into their production lines that are central to industrial Metaverse digital twin use, such as IoT, advanced human-machine interfaces, AI, machine learning, deep learning, robotics, and sensors and actuators. Such precedents for using tax systems to promote the adoption of digital technologies can be studied and then adapted to specific conditions in Arab countries for industrial digital twin adoption.[120]

Fund research initiatives on ways to reduce or eliminate the harmful physiological and psychological health impacts on workers spending extended time in Metaverse environments

There have been numerous studies in recent years, including some funded by governments as well as by academic institutions, on the physiological and mental health impacts of people's time and experiences online. Some have indicated adverse effects that include depression, anxiety, loneliness, disruptions to sleep patterns, and others. Research on health effects of the Metaverse is less robust but is accelerating. One survey of several recent such studies points to a range of concerns including loss of spatial awareness, nausea, dizziness, disorientation, myopia from prolonged exposure, and neurological impacts. As industries move into the Metaverse, a better understanding of how workers might be affected is essential. Governments have a role in overseeing organizations' fulfillment of their obligation to create safe environments for their employees who may be spending part or all of their workdays in immersive 3D virtual environments. Conduct or support by Arab governments of research on the health effects of work in the Metaverse would be a valuable manifestation of that responsibility.[121]

2

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Metaverse advancement as an element of strategies to improve societal well-being in Arab countries (pathway 2)

This pathway explores how Arab countries could benefit from intentional decisions and actions by leaders in the public, private, and other sectors to develop and advance the Metaverse as an element of strategies to improve societal well-being as it might be measured in five areas.

The kinds of uses, social benefits and risks described in this section are among the kinds of outcomes that Arab countries could obtain if decisions and actions are taken to move the Metaverse down this pathway.

A. Technology innovations often enable new approaches for improving well-being in societies – the Metaverse is poised to play that role

The socioeconomic disparities in many Arab countries are well known and well documented. Alongside interventions by governments and others to address the gravest of these disparities are broader efforts to raise overall levels of well-being. For example, Qatar includes as part of its National Vision 2030 "a national network of formal and non-formal educational programmes that equip Qatari children and youth with the skills and motivation to contribute to society".[122] The Governments of both Jordan and Morocco are committed in their national visions to reaching 100 per cent universal health-care coverage by 2030.[123] There are a host of dimensions that can comprise "well-being" – alongside education and health, many consider environmental sustainability, social equality and inclusiveness, liveability of cities, security, good governance, and others.

While levels in some Arab countries are near or below the median on some of the commonly tracked measures of some of the above-listed dimensions, there is a clear foundation of social well-being attainment, and indicators of ongoing improvement.

For example, the maternal mortality ratio declined by 50 per cent in Arab countries in the Middle East and North Africa between 1990 and 2015.[124] Most Arab countries have growing investments in digital health technologies (Cloud, 5G, IoT) and increasing focus on sustainability and environmental health. Between 2014 and 2018, the share of Emiratis, Qataris, and Tunisians holding a college degree rose from 24 per cent to 59 per cent, 30 per cent to 47 per cent, and 5 per cent to 20 per cent respectively.[125]

The Metaverse is poised to be something that governments, private sector corporations and entrepreneurs, civil society organizations, and others can employ that can help take levels of well-being in Arab countries to new heights in a number of dimensions, including five in particular.

B. The Metaverse in education – new ways of learning, new access to learning

Education platforms using the immersive 3D VR and AR that the Metaverse offers will provide new kinds of learning, previously unavailable access to learning, and more.

One of the key benefits in terms of how **virtual 3D** immersive environments fuel learning is how enhanced visualization helps foster and more deeply embed the understanding of complex concepts.

1. Spatial and experiential learning at the next level

Digital learning platforms, whether in the classroom or in virtual distance learning environments, have opened new possibilities to education in the last decade. One of the key benefits in terms of how virtual 3D immersive environments fuel learning is how enhanced visualization helps foster and more deeply embed the understanding of complex concepts. Concepts that are difficult to grasp in 2D become more concrete and tangible when rendered in 3D environments. Research in the education field documents the improved understanding, retention, and other outcomes that visual learning provides, especially for complex concepts such as those in the fields of science, technology, engineering, and mathematics (STEM).[126] The Metaverse takes that further. Such concepts become anchored in students' minds even more substantially after engaging with the kinds of realistic and immersive 3D models that the Metaverse offers compared with 2D forms of visual learning.

One interviewee engaged for this study and report described how spatial cognition – spatial memory, spatial understanding, spatial reasoning – was, in his opinion, "ten times more productive and effective in learning than the non-spatial part of our brains".[127] Research supports this, demonstrating that "spatial ability plays an important role in academic achievement, especially in learning STEM – for example, envisioning the shape or movement of an imagined object contributes to the understanding of intersections of solids in calculus, structures of molecules in chemistry, and the formation of landscapes in geology". This is in part because STEM fields make extensive use of "symbolic spatial tools such as graphs, maps, and diagrams, which significantly enhance human reasoning but often pose difficulty for students with low spatial ability".[128] Providing students at every age, and perhaps particularly younger students, with the opportunity to immerse themselves in 3D spatial environments hones these skills, and helps to develop reasoning and other cognitive skills.

The experiential learning that the Metaverse offers presents further opportunities for education. In the Metaverse, one source reports, "students will have first-person experiences, as if they were shrunk down to the size of a virus, or inflated to the size of

a galaxy. They can float through the circulatory system to appreciate the size and scale of arterial walls as plaque builds up due to heart disease. We can transport students through time and space so they can stroll the busy streets of ancient Rome or help build the Great Wall of China".[129] Such experiences inspire students' creativity and spark their imaginations. They also foster empathy and cultural competence because they take students outside of their normal daily experience. One highly regarded example of this is in a Metaverse education module called "1,000 Cut Journey" developed at Stanford University. It allows students "to feel what it's like to be a person of colour in a series of discriminatory experiences over time", a kind of experiential learning that "could be profoundly valuable for teaching everything from history to current events".[130]

2. Global access to new forms of learning in the Metaverse

One defining characteristic of **education** in the Metaverse is that it removes spatial barriers – learners can enter into the same immersive worlds regardless of their **geographic location**.

Another dimension to note is the prospects for "democratizing" education through the use of Metaverse technologies. This is both in the sense of making it accessible to students from a wide range of cultures and socioeconomic backgrounds, as well as bringing them from wherever they live to learn together. One defining characteristic of education in the Metaverse is that it removes spatial barriers – learners can enter into the same immersive worlds regardless of their geographic location. The work they do there together also has spatial persistence, meaning these dispersed students and teachers can exit and reenter the virtual environments with continuity of their lessons and activities.

Remote teaching and learning collaborations in the Metaverse are already happening. Under one scheme, a digital twin campus based on a UK school can be accessed by students anywhere in the world. A planned Kenya-KAIST (Korea Advanced Institute of Science and Technology) virtual campus located in the Konza Technopolis near Nairobi was scheduled to open in September 2023. The virtual campus "will allow the institution to extend its reach across continents, allowing students to learn together on cutting-edge topics without having to leave their home countries".[131]

Equitable access to the technologies involved will be key to realizing the promise of democratizing education through the Metaverse. Through investments by governments, international financial institutions, philanthropies, and others, state-of-the-art Metaverse platforms operating on advanced 5G/6G networks will need to be made available to students from every socioeconomic background. In parallel, development of educational Metaverse applications that function well on less-sophisticated technology such as smartphones and laptops with older operating systems and less computing power will be essential. In most Arab countries, it is anticipated that near-term Metaverse adoption will require the use of existing devices before moving on to sophisticated applications and platforms at scale. It will be important to make the applications accessible through affordable equipment.[132]

3. Using Metaverse data to enhance learning outcomes

At least one other aspect of the emerging impact of the Metaverse on education is distinctive with respect to improving societal well-being in Arab countries and elsewhere – the ways it can contribute to educational outcomes through analysis of data collected about student users of technology. Eye movements and gaze,

body movements, facial expressions, heart rate, EEG, and other physiological metrics are trackable with sensors in VR and AR wearables such as headsets and glasses, gloves and wristbands, and other Metaverse technologies. These data become available for analytics that can support learning outcomes in powerful ways.

Such data can help assess student engagement and comprehension of the content, where and why a student encounters difficulties in a lesson or experience, and other elements of performance and learning outcomes. "AI and learning analytics algorithms can then be applied to the collected information to help educators understand the patterns and generate personalized reports and recommendations for both learners and instructors", one researcher notes. They can even "be used to train AI-based predictive models for early prediction of at-risk students, and to identify possible solutions" to the learning issues those students are facing. These insights will help those students not only in the Metaverse platform, but also in more traditional 2D online environments and in classroom environments not supported by digital technologies.[133]

Learning analytics from biometric and other data collected in Metaverse platforms are already being used in educational institutions using such platforms, and also in the training industry. Interventions based on data analytics can be at learner level – providing feedback to the student on how to adjust their approach or their engagement with the content. They can also be at the level of the educator, enabling the designers of the curriculum or training programme to reconfigure the information flow or instructions if the analytics suggest these are not optimal for desired levels of learning outcomes. In one example, in immersive 3D virtual simulations being used in training in pharmaceutical companies, "every digital footprint can be measured and a dashboard of telemetry data can provide actionable insights to improve the simulation experience".[134]

4. Metaverse education is already advancing worldwide, including in Arab countries

There are a growing number of examples of Metaverse applications in education throughout the world, a number that is poised to increase by orders of magnitude. Education start-ups in the United States, India, Dubai, the United Kingdom, Germany, China, Denmark, Brazil, and other countries have all been founded with the objective of incorporating Metaverse technology into education.[135]

Metaverse education is already making headway in Arab countries. A Dubai-based company focused on teaching students how to create VR environments for classroom use has delivered training to more than 3,000 students, with growing demand.[136] In September 2022, an education start-up based in the United Arab Emirates launched a Metaverse simulation of the country's 2117 Mars mission, which will enable virtual experiences that capture the sensations of being in space and setting foot on Mars.[137]

In Morocco, the Mohammed VI Polytechnic University has launched an Interactive Digital Centre incorporating AR/VR technologies, and the Morocco Government's Office of Vocational Training and Labour Promotion is offering a Metaverse hub through which educators offer hands-on 3D virtual training to students.[138] In Saudi Arabia, King Abdulaziz University showcased a new project in September 2023 called "Building in the Metaverse," bringing 3D VR environments into the training of its College of Architecture and Planning students.[139]

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According to one research estimate, the global market for **health-care-related** Metaverse technologies and applications

will grow from **$9.5 billion** in 2023 to **$79.6 billion** in 2028.

C. Revolutionary advances in health care through the Metaverse

The Metaverse will have a range of significant impacts on the practice of medicine and the provision of health care around the world, including in Arab countries.

According to one research estimate, the global market for health-care-related Metaverse technologies and applications will grow from $9.5 billion in 2023 to $79.6 billion in 2028. The analysis looks at the market in three segments – hardware, software, and services – with AR/VR technology accounting for the largest share of the total market, at 28 per cent.[140] Other market assessments vary, including one estimating $72 billion by 2030, and another projecting only $35 billion by 2028 but growing to $98 billion by 2032.[141] But there is consensus that Metaverse applications in health care will be considerable over the next decade and beyond.

Various global corporations have been pursuing innovations in health care in the Metaverse. In parallel, one study identified almost 550 start-ups that had been actively developing Metaverse health-care applications between 2018 and October 2022. The study found that nearly 75 per cent of health-care providers and 35 per cent of payers were already using Metaverse-related applications in some capacity.[142]

1. The Metaverse is a new means for gaining access to health-care services

One way in which the Metaverse will transform health care is by offering new ways for people to be diagnosed and treated. This could be transformative for people who face barriers in accessing in-person care, such as geography, physical inability to travel to a point of care, and shortage of providers in a particular area. Patients can be seen in immersive, realistic 3D environments, with doctors conducting virtual consultations and providing medical advice and treatment remotely. Health-care providers can also remotely monitor patients' health conditions in lieu of in-person follow-up visits, in some cases reducing the need for hospital stays for observation after treatment. The benefits will include reduced expenses for patients by reducing or eliminating their need to travel, and freeing up hospital rooms to accommodate patients whose needs cannot be met through virtual means. A survey of Metaverse applications in health care describes how "doctors can take suggestions of different panel doctors across the globe, minimizing the need for large multi-specialty hospitals" in areas where it is not feasible to build and staff them.[143]

Examples of remote patient consultation and treatment in virtual Metaverse environments are increasing. A Massachusetts-based health-care company, has gained regulatory approval for ten proprietary VR/AR physical, occupational, and other therapy environments in which patients can receive personalized care in virtual treatment rooms from licensed therapists. A health-care company in the United Kingdom is investing in creating a virtual hospital that it envisions being able "to improve health outcomes for millions of people on a global scale, as geography is no longer a barrier to access". A hospital company in India recently announced a that it was developing a virtual hospital environment; another hospital company has purchased real estate on the Decentraland platform through which it plans to offer health-care services.[144]

The ability for surgeons to gain realistic **3D simulated views of a patient's anatomy** at the site of a surgical procedure "holds significant clinical value for preoperative assessments to develop a more favourable operation plan and increase operation safety"

2. New forms of treatment and intervention are made possible by the Metaverse

The Metaverse also promises – and is already delivering – new forms of treatment not previously possible for physiological health issues and conditions.

One area with significant demonstrated results, and even greater future promise, is the employment of VR and AR in the performance of surgeries. The ability for surgeons to gain realistic 3D simulated views of a patient's anatomy at the site of a surgical procedure "holds significant clinical value for preoperative assessments to develop a more favourable operation plan and increase operation safety" among other benefits. Surgeons can also obtain real-time assistance from experts anywhere in the world during complex procedures, affording their distant colleagues a detailed, fully immersive visual perspective through VR headsets. It is anticipated that the medical profession will see VR and related technologies become an increasingly usual aspect of surgery in the coming decades.[145]

Various other potentially important new forms of treatment are emerging that are uniquely rooted in the experience of virtual worlds. For example, a United-Kingdom-based start-up is exploring the medical applications of its core technology,

a brain-computer interface that allows users to move in VR environments. One such application is a virtual reality hand, controlled by the mind, that can help stroke patients restore movement as part of VR-assisted physiotherapy.[146] In an equally novel new kind of health-care intervention, the use of immersive 3D virtual worlds has demonstrated effectiveness as a pain-management technique. Extended reality has been used in various children's hospitals as a distraction that reduces the need for anaesthesia. In the United States health system, a survey of extended reality treatment receivers found a 72 per cent reduced reliance on opioids among patients for pain management after surgery.[147]

The Metaverse will play a significant role in anti-ageing research and interventions. Immersive, realistic VR for entertainment and engagement with others can help prevent social isolation, a major risk to both the mental and physiological health of elderly people. Metaverse environments also show promise for strengthening the cognitive abilities for people with the symptoms of early stages of dementia. And Metaverse-based monitoring has created a new means of detecting chronic diseases common in geriatric patients before they advance, such as heart-related diseases, diabetes, and chronic obstructive pulmonary disease.[148]

In the contexts of anti-ageing and other areas of health care, digital twins of patients may be among the most powerful new kinds of capabilities. Just as buildings and other physical objects can be replicated in realistic 3D virtual environments, work is also progressing around the world to create digital twins of human organs, other anatomical systems, and eventually entire human beings. Pharmaceutical, biotech, and other health-care companies have joined the European Ecosystem for Digital Twins in Healthcare (EDITH) to advance research into this topic. Scientists and researchers can use virtual environments to simulate ageing processes and the progression of diseases, and test and study the impact of various prospective medications, therapies, and other interventions. One report describes the usefulness of digital twins in health care, since the technology will allow researchers to predictively model diseases and prevent ailments before they occur.[149]

VR, AR, and MR are increasingly being used to diagnose and treat **mental, emotional, and cognitive health disorders.**

3. Metaverse therapies for mental and emotional health disorder sufferers and persons with a range of disabilities

In addition to new horizons in physiological health, VR, AR, and MR are increasingly being used to diagnose and treat mental, emotional, and cognitive health disorders. They have been used to help children with attention deficit hyperactivity disorder; to assist socially anxious individuals in developing communication skills in a "safe" environment; and to reduce suicidal ideation, depression, and anger in trauma patients.[150] Doctors have noted that mental health disorders that have traditionally received less attention, such as depression and obsessive-compulsive disorder, are also receiving greater focus as a result of VR health care.[151]

The Metaverse is also already being used to alter psychological experiences for those with addictions and phobias.[152] XR-based mental health therapies and treatments for anxiety, phobias, PTSD, and stress, have already received regulatory approval in the United States. They are also becoming available in other countries around the world, at a lower cost than traditional therapies. Examples include a VR-based anxiety treatment developed by a Germany-based company, and a platform for exposure therapy.[153]

A platform developed by a Swiss company has been in use to rehabilitate motor skills and cognitive functions in stroke sufferers since it received Government approval in 2017.[154]

Metaverse technologies also offer new kinds of opportunities for people with disabilities. Examples already in use include wearable devices that enhance the eyesight of people with low vision or provide auditory and haptic feedback about physical surroundings, VR simulations that allow people with reduced mobility to explore inaccessible environments, and AR workstations that help people with developmental disabilities in supported employment. Rehabilitative applications include VR headsets that train the spatial hearing abilities of persons with cochlear implants, physical therapy in VR or AR for persons with a physical disability, and immersive training scenarios for people on the autism spectrum, helping them deal with challenging social situations or interpret interpersonal cues. A team of researchers in the United Kingdom has been working since 2022 to advance the use of VR and XR to provide potentially transformative benefits to individuals with a range of physical and other disabilities. The Metaverse makes access to education, social engagement, health care appointments, and work possible for people with disabilities, in some cases for the first time.[155] As development of the Metaverse for such social well-being necessities advances,well-being it will need to take into account design features that make these virtual worlds accessible to people with disabilities.

4. Training and education in the Metaverse for medical and health-care professionals

One of the most promising applications of the Metaverse in the health-care domain is its use in the training and education of doctors, nurses, and other caregivers and professionals. According to one market analysis, medical education and surgical training is anticipated to be the largest single category (26 per cent) of the total Metaverse technology and application market in 2028, a market with a projected value of $79.6 billion.[156]

Immersive 3D interactive environments provide realistic simulations and scenarios for students and practitioners to participate in virtual surgeries, procedural simulations, and diagnostic challenges to enhance their skills and knowledge. Medical specialists can practise complex procedures in virtual clinical environments and familiarize themselves with new equipment before using them with actual patients. According to one source, emergency medicine training and education is a specialty field where VR has made significant contributions – simulated emergency scenarios allow students to practise triage, resuscitation, and critical decision-making in a controlled environment, preparing them for work in situations so urgent and unique that they cannot be practised in the real world.[157]

Real as well as simulated procedures can be observed by other colleagues and students for an immersive realistic form of education in how to perform those procedures. In one example of a real-life procedure used as a Metaverse training opportunity, doctors at Seoul National University's Bundang Hospital recently conducted thoracic surgery in a smart operating room wearing head-mounted devices that broadcast their work step by step to more than 200 observers in the Metaverse.[158] In addition to the realism of the immersive experience, this kind of Metaverse-based training enables cost-effective and scalable learning that reduces or potentially eliminates the need for expensive physical infrastructure and travel.

Digital twins of human organs, physiological systems (skeletal, circulatory, etc.), and entire bodies will be part of Metaverse medical training and education, just as importantly as they are part of the future of medical research. One example is the Virtual Heart programme at Stanford University, which "uses VR to simulate the human heart, allowing students to visualize and interact with cardiac structures," helping to "teach complex cardiology concepts and improve students' diagnostic abilities". The educational possibilities extend beyond realistic simulation. "I can hand a student a human heart in the Metaverse", reports one practitioner. "The student can expand that human heart until it's 10 feet tall and then step inside, and the professor can teach."[159]

5. Metaverse health-care advances in Arab countries

Metaverse applications in health care are already making headway in a number of Arab countries. In December 2022, a Dubai-based company launched a Metaverse-based virtual telemedicine solution using VR technology. The project will deliver 3D virtual medical consultation services with access through smart devices, with the ability to reach broader segments of the population. In February 2023, the Department of Health in Abu Dhabi launched the Abu Dhabi Life Science Hub, which will be home to the department's virtual headquarters in the Metaverse. The aim is to provide the entire Abu Dhabi health-care system with a platform to create their own content in the hub.[160]

In Lebanon, a start-up has developed a VR hub to address mental health problems in a low-cost and easily accessible fashion. In June 2022, the General Authority for Health Care in Egypt launched a new medical tourism project using

Metaverse technology to offer potential patients anywhere in the world an immersive experience of the capabilities and features available in its health-care facilities. In Saudi Arabia, the Seha Virtual Hospital enables patients to consult specialists in 35 sub-specialties in more than 100 hospitals throughout the country.[161]

D. Addressing climate change with Metaverse technologies

One of the most urgent issues affecting the well-being of the populations of Arab countries is climate change and its impacts. While the problem is very real, the virtual reality of the Metaverse has important contributions to make to addressing it.

1. Reducing emissions through asset optimization in the Metaverse

These contributions are explored through the lens of business outcomes in section 2 of this report: they allow previously unachievable insights into the operations of facilities and their equipment across industries with a view to optimizing them. Digital twins and IoT sensors on buildings record large sets of data about energy use, electrical system operations, and other factors. Analysis of these data can be an important element of climate-change mitigation strategies across these same industries and sectors. Assessments of the performance of heating and cooling, power distribution, water and waste processing, and other systems throughout a facility will help enterprises in every sector identify action to address the air pollution, carbon emissions, and other sources of climate change their facilities generate.

A recent study revealed that analytics of building operations in digital twins can help bring about a 50 per cent increase in a commercial or industrial facility's sustainability and resilience, stemming primarily from reduced greenhouse gas emissions and carbon footprint. One example the study cited was Nanyang Technological University (NTU), which identified energy savings opportunities achievable through investing in five technologies. The five technologies combined resulted in a more than 30 per cent reduction in energy usage, a reduction of nearly 10 kilotons of carbon emissions, and nearly $5 million in cost savings over the ten-year period.[162]

Other examples are proliferating around the world and shining a light on the role the Metaverse can play in addressing climate change. A digital twin is currently being used to operate a wastewater treatment plant in the United Kingdom. Overseen by a consortium of water companies, it is described as the world's first such plant that is carbon neutral. It models the water treatment process in real time through 60,000 dynamic and static data points, and enables the operator to reduce and remove carbon dioxide, methane, and nitrous oxide emissions, which together comprise more than 50 per cent of all emissions from wastewater treatment. It can be anticipated that this technology will see wider use in addressing the climate-change impact of wastewater treatment in the United Kingdom and beyond.[163]

Transport for London (TfL) is a local government body responsible for most of the transport network in London. It is employing digital twin technology to support the implementation of the Mayor's Transport and Environment Strategies. With the twin, TfL can monitor and track all environmental emissions across the entire transit system. Using 3D visual representations of train tracks and other infrastructure combined with data on temperature and other conditions that the infrastructure is experiencing, TfL is able to streamline operational efficiency leading to sustainability improvements at system level.[164]

The five technologies combined resulted in a more than **30 per cent reduction in energy usage**, a reduction of nearly **10 kilotons of carbon emissions,**

and nearly **$5 million in cost savings** over the ten-year period.

In the United Arab Emirates, the headquarters of a Sharjah-based environmental management company has a digital twin in the Metaverse that replicates its physical structure and systems, tracking parameters and data in real-time to gain operational efficiencies and manage its emissions and other environmental footprints. In Saudi Arabia, the project team that developed the Riyadh Metro created digital twins of the entire system, enabling design optimization that improved the environmental impacts of the system.[165]

2. Reducing the carbon footprint of work and workers

Another way the Metaverse will contribute to climate change mitigation is through the effects it has on where and how work is performed in numerous industries. As the technology becomes more advanced, more work will move into the Metaverse. The remote work in 2D that became necessity during the COVID-19 pandemic will be significantly more effective and productive as they transform into 3D collaborative environments that are much more realistic, immersive, and interactive. New, fully virtual workplaces created from scratch in the Metaverse, plus digital twins of existing physical workspaces for more hybrid work, will gradually reduce the need for physical office spaces and business travel and the carbon footprints they generate. The impact on emissions and climate change from work moving into the Metaverse could be substantial.

Part of that impact is tied to changes in the need for office space and other types of buildings in which people work. Various sources align on the estimate that transport generates between 20 per cent and 25 per cent of global emissions, with the potential to rise to 40 per cent by 2030 and 60 per cent by 2050 unless significant action is taken.[166] Moving work into the Metaverse can be part of the equation to curb these emissions, in part by reducing daily commuting and the need for business travel, much of which is by air (in 2019, greenhouse-gas emissions from aviation were 2.5 per cent of the global total).[167] Additionally, buildings are estimated to be responsible for nearly 30 per cent of global emissions annually.[168] It is difficult to isolate the percentage of transport represented by people's travel to and from work, or the percentage of global building stock dedicated to work in all its forms. But if work in the Metaverse can reduce these emissions by even a fraction, it can make a meaningful difference in combating climate change.

Further impact could come from reducing the need to build new structures for in-person work. Between 2020 and 2060, the world is expected to add about 241 billion square metres of new floor area to the global building stock – "the equivalent of adding an entire New York City to the world, every month, for 40 years". The embodied carbon of just a subset of materials used in the construction of new buildings (i.e., emissions released over the full lifecycle from extraction through manufacturing, transport, construction, and disposal) adds another 15 per cent to global emissions annually. Here again, it is difficult to isolate the percentage of the future built environment that will be used for work purposes, but the same dynamic should be considered here as well – if work moving into the Metaverse reduces the need for new buildings even by a fraction, it would create a meaningful climate benefit.[169]

Between 2020 and 2060,
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A New York-based design firm has developed a massively multiplayer role-playing game in the Metaverse in which players enter a **virtual world** where they are tasked with using innovative technologies and other action to create new ways to **protect the world** against the threat of **climate change**.

3. The power of experiential climate change education

The Metaverse offers a powerful new means of educating and engaging people on the impact of climate change. There is already a growing number of VR and AR platforms in use around the world that have been designed to provide an immersive and interactive experience that can help people understand the complex and far-reaching impacts of climate change.

One example is a project by the United Nations Environment Programme (UNEP) to create an immersive VR experience of a user's personal carbon, and thus their contribution to climate change. The platform integrates 3D graphics and full-sphere surround sound to confront the user with the experience of their carbon footprint as an orange ball of gas that can be as big as 18 metres high. Through the project, UNEP aims to "challenge some common misperceptions and inspire people to think differently about the choices they make each day". The platform has a wide potential reach: 2.6 billion people worldwide are regular online gamers.[170]

Platforms of this kind are intended to create a sense of urgency about climate change and help spur action on the part of the user in ways that reports and speeches and even 2D videos or documentaries cannot replicate. More than a decade ago, researchers at Stanford University's Virtual Human Interaction Lab conducted a study in which subjects read information about how the use of non-recycled paper leads to deforestation. A subgroup then engaged in a VR experience of cutting down a tree. Later, this subgroup was more likely than the control group to conserve paper. The lead researcher argued that VR users felt personally accountable for the damage that occurred. "You're going to need more than an instructional video or a pamphlet to explain something that requires a change in behaviour", said a member of the research team. "You need to make people feel like they're literally engaged."[171]

Using the Metaverse as a form of vivid emotional engagement in climate change education creates a space that allows people not only to be shocked into action, but also to imagine solutions. Some will respond constructively to VR experiences that personalize and magnify the harmful effects of climate change, while others will be more motivated by immersive virtual experiences that personalize and magnify the ability to make a difference in preventing or mitigating those effects. Metaverse experiences of this kind are in development and in use as well. A United-Kingdom-based agency has been using Metaverse environments to provide experiential demonstrations of the environmental and other positive impacts of individuals and enterprises using wind, solar, and other renewable energy sources. A New York-based design firm has developed a massively multiplayer role-playing game in the Metaverse in which players enter a virtual world where they are tasked with using innovative technologies and other action to create new ways to protect the world against the threat of climate change.[172]

The impact of the Metaverse to emotionally engage people in climate change education has the potential to gain in importance if attention is paid to the audience of these experiences, and to how institutions make the experiences available. One non-profit has created an interactive online experience that allows users to explore cross-sector solutions to climate change challenges and affects. The effort focuses on engaging policymakers and business leaders alongside educators, the media, and the public – more than 6,500 leaders across government, business, finance, non-governmental organizations, and academia have taken part.[173]

4. Metaverse role in building climate change resilience

Finally, early efforts at implementing findings from ongoing recent research indicate a potentially significant role for 3D digital city modelling in early warning of extreme weather events and other natural disasters related to climate change. A survey of these efforts published in March 2023 in the journal Sensors describes how bidirectional flows of data between a digital twin of a city and the real physical environment of that city can allow planners to "anticipate and react to floods, erosion, sea-level rise, and even weather forecasts much more rapidly and effectively". To frame the potential impact of this kind of application of the Metaverse in a climate change adaptation context, the authors point to the Mediterranean Sea, where a significant percentage of Europe's population lives within 50 km, with an estimated 1.3 million of those individuals at risk of coastal flooding and its effects.

By way of comparison referencing just the Mediterranean, the relevance to Arab countries is clear, with Morocco, Algeria, Tunisia, Libya, Egypt, Lebanon, and the Syrian Arab Republic all bordering that sea – and other Arab countries also have sea coasts as well and thus face this type of risk. Early warning systems using digital twins of cities close to the sea could prove instrumental in protecting life, infrastructure, and investments. The same technology applications could provide comparable benefits increasing the adaptation to other kinds of extreme climate change events in other Arab countries. Digital twins for this purpose are already in development in Oman, Helsinki and Singapore, and 3D virtual city modelling for climate resilience and adaptation is in early stages in Slovakia, Germany, Spain, Italy, New Zealand, China, Saudi Arabia, Singapore, Norway, South Korea, the United States, and Japan.[174]

In Oman, the focus of Metaverse city modelling is on preparing for **flash floods.**

In Oman, the focus of Metaverse city modelling is on preparing for flash floods. A United-States-based infrastructure engineering software company has created a detailed digital twin of a 250 km^2 area of Muscat encompassing more than 40,000 buildings and their surrounding areas. with the company produced animated videos simulating flooding, allowing the Oman Government to establish secure escape routes for climate emergencies.[175]

E. Reimagining and redeveloping Arab cities in the Metaverse

Almost two thirds of the population of the Middle East live in cities. Over the next 10-30 years, the urban population is projected to grow by many millions through a combination of births and migration.[176] Large cities will continue to expand, and many small and medium-sized cities are also set to experience rapid growth.[177] Quality of life in Arab cities is often a challenge. Crowding from density, health effects and productivity losses from traffic congestion, access to jobs and other necessities, and other factors all impact the well-being of urban dwellers in Arab countries. To accommodate growing populations and to address some of the factors that impact quality of life, redevelopment and in some cases the large-scale reimagining of urban areas will be a significant part of Arab countries' futures.

Metaverse technologies will play a role of growing importance in such projects in the next decade and beyond. It is anticipated that interest and investment by government planners will align with similar interest in the construction industry.

A recent survey of literature explored nearly 150 publications detailing the implementation of digital twins in construction. It demonstrates the industry's strong embrace of the technology to revolutionize how cities and other elements of the built environment will be created.[178]

1. Digital twins of entire cities enable unprecedented redevelopment experimentation

Just as digital twins replicate individual buildings and facilities as described in other parts of this report, they are also increasingly being developed for entire cities, enabling planning officials and urban engineers to experiment with and test urban planning and infrastructure design options before breaking ground in small- or large-scale projects. A report from 2022 argues that in an urban planning context, the Metaverse will "allow cities to anticipate specific impacts of new buildings, street changes, or other land-use decisions". The benefits will be manifold, from cost savings as project concepts can be revised and perfected before any construction begins, to informing planners about innovative alternative options for increasing sustainability and better aligning locations for jobs with where people live. The report cites research projecting nearly $300 billion in cost savings in the United States by 2030 from efficiencies gained through Metaverse-based urban planning. The uses of the Metaverse in the urban planning context go beyond pre-construction design optimization: they also include energy cost savings, safety and resilience improvements reducing costly police and emergency response costs, health-care savings, and others. The prospect is for digital twins of cities to arm planners with insights into second- and third-order consequences, both positive and negative, of development and redevelopment decisions they have not yet made.[179]

That powerful prospect is already being realized in cities around the world. Virtual Singapore, development of which began in 2014 and operational since 2020, is one of the most widely known examples. It demonstrates the multiple dimensions of well-being improvement that urban planning in immersive citywide-scale 3D virtual environments can offer. The risks and costs of breaking ground on development projects with unsound designs or unanticipated consequences are distinctively high given the land scarcity in the island country. The digital twin of above-ground Singapore (a subsurface digital twin of the country is now in development) is not limited to a 3D representation of the physical structures. Historical and real-time geospatial, topological, demographic, movement, climate,

and other data from public agencies enhance decision-making on policies that affect citizen well-being in a variety of ways. Examples of the implementation of the insights from the Virtual Singapore digital twin include park and other greenspace design in the Yuhua district, and analysing pedestrian and traffic flows citywide with a view to enhancing them.[180]

Singapore is far from being alone in developing and using city-scale digital twins to experiment and innovate in urban redevelopment and improvement. A prime example in the United States is the city of Orlando in Florida, whose 3D twin is a regional-scale model which claims to be the first of its kind. It recreates 800 square miles across three Florida counties. The twin enables businesses to consider the benefits and costs of alternative configurations for new shops, warehouses, manufacturing facilities, and other infrastructure in different locations, and to engage with city planners in an immersive, interactive experience to make decisions.[181]

To improve opportunity and livability in the economically disadvantaged Zuidoost area, officials in Amsterdam are developing a digital twin of the neighbourhood and its surroundings. One of the initiatives in Helsinki's Innovation Districts Programme is an AR experience called Green Kalasatama, accessible on the programme's mobile application. Residents can experiment with landscape design visualizations to increase and optimize green space in that district of the city. A report by the World Economic Forum in April 2022 describes other examples of digital twin cities in China, the United States, Malaysia, France, and Australia.[182]

well-beingMetaverse-based urban planning can help to improve well-being. It can also help to reduce threats to well-being. For example, Metaverse technology can enable local government officials to "safely simulate dangerous situations in a city-wide context and implement changes proactively instead of collecting data and putting safeguards in place after an incident has occurred".[183]

Urban redevelopment can be informed not only by "macro-level" digital twins of an entire city, but also by integrating digital twins of individual buildings and other elements of infrastructure within a city. The idea might be described as an Internet of things where the "sensors" are entire buildings, bridges, power plants, electric and water grids, and other facilities in an urban centre. Providing urban planners with access to interconnected 3D digital models of all the structures and complex systems in a city "could inform human-machine decision-making to optimize for operational efficiency, positive environmental impact," and other dimensions of citizen well-being.[184]

2. Empowering citizens to reimagine their own cities

Citizens' voices in future urban redevelopment will also be made possible in unique new ways by Metaverse technologies, helping ensure such projects incorporate the features citizens prioritize based on their lived experience. In one example, local officials in New Rochelle, United States, are incorporating virtual reality into the public engagement process in the pre-construction stage of urban projects. A custom-built platform makes it possible for residents to walk around immersive 3D renderings of proposed new construction projects and provide feedback.[185] In some cases, urban psychology has been used to develop a scientific approach where the impacts of designs on users are tested using virtual reality. In one example, planners selected a crowded part of Tokyo and had test subjects experience it in VR headsets which measured physiological reactions to specific features of the area. They then made design changes in the simulated version of the area and retested it to see the effect of the redesign on specific stressors.[186]

The application of Metaverse technologies to empower citizens to influence and contribute to urban development and redevelopment projects is gaining traction, as demonstrated by a growing number of studies of the efficacy of the approach. In one study and experiment in Honolulu, users were able to provide inputs on prospective designs for a complex of buildings simulated in a realistic 3D virtual environment, selecting their preferences on a range of indicators such as building height, amount of green space included in the complex, and building density. Results indicated that the AR platform tool designed by the study team had a positive effect on promoting public participation in the process of urban design. The immersive and realistic nature of the technology and resultant experience gave participants a greater sense of the impact of changing the indicators on which they were asked to make choices.[187]

In 2012, in a collaboration between the development sector and the gaming industry, UN-Habitat and Microsoft joined with the developer of Minecraft, a block-based sandbox game, to found Block by Block, an initiative to enable community members to engage in public-space planning. Workshops have been conducted in more than 50 countries using Minecraft in a process designed by UN-Habitat to "co-create public spaces that serve the needs of all kinds of residents, with a deeply ingrained sense of ownership that increases the odds of long-term success". According to one source, the programme makes Minecraft "arguably the most used Metaverse [platform] for urban planning, especially in developing countries".[188]

The Metaverse component represents an estimated **$1 billion of the multi-billion-dollar** overall investment in Neom.

3. The Metaverse in the development and redevelopment of Arab cities

Metaverse technologies for urban planning are already beginning to emerge in Arab countries. Perhaps the most prominent example of Metaverse urban development in the Arab countries is the ongoing construction of Neom in Saudi Arabia. Construction of the physical city is being accompanied by a Metaverse platform giving prospective future residents the opportunity to influence the design of the city. The Metaverse component represents an estimated $1 billion of the multi-billion-dollar overall investment in Neom. Neom is not the only Metaverse city model project planned in Saudi Arabia. In October 2023, a South Korean internet company announced a reported $100 million contract with the Saudi Ministry of Municipal, Rural Affairs and Housing to develop and operate digital twins of Riyadh, Medina, Jeddah, Dammam, and Mecca. Additionally, as the Prince Mohammed Bin Salman Non-Profit City is being designed and created, there are plans to produce a digital twin to help monitor and optimize city amenities and critical services including transportation, sustainability and security.[189]

In the United Arab Emirates, the Department of Municipalities and Transport announced the launch of the Abu Dhabi Digital Twin project in October 2022. The project which will create a "complete visual representation of building structures and other assets, integrated with multiple systems" to enable a variety of urban-planning scenarios and support decision-making. A digital twin of Dubai, which began development in 2018, is currently operational under the management of the Dubai Municipality's Geographic Information System Centre. It incorporates 2D and 3D imagery and data from numerous sources, and replicates Dubai from underground to the sky above the city. These data links enable the twin to be used in mapping, monitoring, and optimizing the provision of utilities and other municipal services in real time. The model also includes planned but as yet unbuilt structures in various areas within the city.[190]

F. The Metaverse is improving government services and transforming the citizen engagement experience

Digitalization of government operations and services has been advancing for two decades at varying rates and levels of sophistication around the world. Bringing the provision of services into the digital realm is a key means of increasing citizens' access to those services, improving efficiency, transparency, and other objectives. The Metaverse is the next level of transforming the connection between governments and their people to improve well-being.

1. Virtual services provide real-world outcomes, and in some cases improve them

Part of the power of governments' use of the Metaverse lies in how it enables them to directly offer or facilitate the provision of the services and benefits in new ways that are more engaging and often more effective than how they have traditionally been provided. The Metaverse has the ability to make a wide range of government services

and benefits available in new ways that improve citizens' well-being because they are more personalized, convenient, and not dependent on in-person contact.

The Government of New South Wales in Australia provides a useful framework for considering different roles governments will play as the Metaverse becomes a greater part of people's lives. In different contexts, a government (at whatever level) may be an application user, conducting its internal business using a self-developed or commercially obtained Metaverse environment; an application provider, offering citizens ways to perform administrative steps using virtual environments that an agency develops or commissions; a service provider, using government infrastructure or other resources to make Metaverse applications and experiences available to individuals and organizations; a platform provider, creating and using platforms that other parties use to provide services that require government oversight, such as education; or a regulator, protecting individuals and organizations from risks posed by Metaverse technologies.[191]

One of the most well-known examples to date of government service provision and citizen engagement in the Metaverse has been in the Republic of Korea. "Metaverse Seoul" is the city government's means of making all its services accessible through a 3D VR/AR interface. Launched in 2022 and expanding its scope over time, residents can gain access to municipal services and benefits across various areas. Metaverse Seoul is a central element of an ambitious five-year Metaverse promotion master plan that the government unveiled in October 2021. The plan also encompasses digital twins, which are already in use for urban planning, public safety monitoring and management, and other use cases. As the World Economic Forum describes it, Metaverse Seoul "is not merely a technological feat; it represents a strategic vision to enhance urban life".[192]

Other examples of governments using the Metaverse to provide benefits and services are already numerous, and growing. In 2023, Colombia held its first court hearing in the Metaverse, with the public audience also in the 3D virtual environment.[193] The hearing was conducted and observed in a free virtual collaborative application developed by Meta Platforms called Horizon Workrooms. A year earlier, Brazil also made a pioneering use of the Metaverse in the context of judicial services, resolving a national case that had been in highly contentious proceedings for four years. Commenting on the Brazil case, a lawyer from Colombia's criminal bar association suggested that the Metaverse was "particularly useful for legal cases where people wanted to avoid confrontation, as is often the case in conciliation proceedings".[194]

As in other areas where the Metaverse is being used to improve societal well-being, Arab governments are already enhancing and expanding their services. The United Arab Emirates is leading the way. The Emirate of Sharjah's Commerce and Tourism Development Authority has opened a customer service centre in the Metaverse, and other United Arab Emirates Government entities are also present in the Metaverse. In 2022, the United Arab Emirates Ministry of Health and Prevention launched a "Customer Happiness Centre," a digital platform where patients can contact their medical offices through the Metaverse. The United Arab Emirates Interior Ministry's International Operations Department began using the Metaverse in 2022 to train officials from the International Security Alliance and plans to expand this to training police officers and other officials involved in security operations across the country.[195]

In 2022, the United Arab Emirates Ministry of Health and Prevention launched a **"Customer Happiness Centre,"** a digital platform where patients can contact their medical offices through the Metaverse.

2. The Metaverse enables governments to do things they could not do before

Immersive 3D virtual environments also provide governments with opportunities to provide new kinds of services and benefits and to perform some of their functions in new ways to produce outcomes unobtainable in with traditional methods, raising their ability to provide for and improve their citizens' well-being. The applications of the Metaverse in urban redevelopment described above are one example of governments using Metaverse technology to do things they have been unable to do previously. The ability in Metaverse Seoul to give people the same real-time immersive experience at the city's festivals as people who live in Seoul is another example.

Other governments elsewhere around the world are increasingly following suit. For example, in the United States, officials in the federal Government's forestry service are working with private sector companies to use advanced AI algorithms and digital twin technology to simulate real-world wildfires in real time, and potential future wildfires that have not yet happened, to predict how they might spread as weather and other conditions change. The work is providing new means of generating courses of action for firefighter response teams on the ground to accelerate suppression of fire damage and to direct rescue efforts to people at risk. As climate change and other conditions increase the frequency and severity of wildfires throughout the world, these advances can give governments new "abilities to save lives and prevent costly destruction of property, and even potentially be proactive in their efforts to forestall such effects in advance of future wildfires.[196]

Among a growing number of such novel government capabilities and services made possible by the Metaverse, two others are particularly noteworthy. One has to do with the provision of services to refugees in different countries around the world. Research and real-world examples suggest that "virtual experiences have significant potential to enrich emotional interactions, encourage socialization, improve communication," alleviate trauma and sustain connection with native culture, and provide other benefits to individuals displaced from their countries of origin. In the United Kingdom, a recent experiment demonstrated immersive 3D VR instruction in educating recently arrived refugees about how to navigate the complex National Health Service, and a collaboration between the University of Utah and the Massachusetts Institute of Technology is helping refugees who have recently arrived in the United States to get used to the country.[197]

In an Arab context, several such innovations are being employed today. The MIT Media Lab in Dubai has developed a VR experience called Sphyria that allows Syrian refugees to see their home country as it was before the war caused so much destruction. One of the creators of Sphyria went on to found for a start-up with similar objectives in Lebanon. The global humanitarian aid NGO Mercy Corps partnered with the University of Bradford to create BReaTHe, which uses VR experiences to help Syrian refugees, especially young people, to "feel more connected to their homeland and to build personal and societal resilience". UNICEF has launched the UNICEF 360° project, in which a Metaverse app allows users to experience life in the Za'atari refugee camp in the Jordanian desert.[198]

Some of the most significant capabilities previously unavailable to governments that are now or will soon available through the Metaverse are in two areas: proactive problem diagnosis and resolution, and civic engagement.

UNICEF has launched the **UNICEF 360° project**, in which a Metaverse app allows users to experience life in the Za'atari **refugee camp** in the Jordanian desert.

Akin to predictive maintenance applications in the industrial Metaverse, governments will gain the ability to position themselves in front of challenges before they emerge. They can then experiment with novel policy solutions in "safe" environments before employing them. Governments can use Metaverse environments as spaces to test new programmmes, products, and services. Going further, they can augment the virtual environments with IoT sensors and other technologies in proximity to where the challenge may be at risk of manifesting, "to layer in real-time data, potentially uncovering new insights".[199] One researcher has suggested that "authorities should treat the Metaverse like a laboratory for … experimenting with cutting-edge policy which may benefit broader audiences".[200]

The immersive aspect of the Metaverse is significant in this context. Policymakers can go beyond descriptions of the problem being addressed, and descriptions and theorizing about how solution alternatives might work or outcomes the solutions might produce. They will be able instead to experience both those sides of the policy/action equation, potentially leading to better decisions. Both "Virtual Singapore" and "Metaverse Seoul" are already actively being used in this way.[201]

In the civic context, the possibilities are considerable for previously unimaginable facilitation by governments of citizen engagement. The Internet has already introduced major changes and advancements in this connection, enabling more direct communication between voters and elected officials, the ability to livestream and participate in town halls or their equivalent, and more. The Metaverse takes this to the next level, and again the immersive aspect matters. Rallies and debates in the Metaverse will give citizens "a much more intimate sense of a candidate's policies and platforms," in the view of one analyst.[202] The policy option experimentation "laboratories" described above can involve citizens affected by the issues under consideration. The prospect of blockchain voting could revolutionize how elections are conducted in countries around the world, with risks as well as benefits.[203] At the same time, while such engagement opportunities in the Metaverse can help make governments "a facilitator of democratic participation and community-building," it must be recognized and addressed that unequal access to the technologies could turn that benefit into a new challenge to equity in such participation.[204]

3. Innovative government applications of the Metaverse to achieve the SDGs

In the last several years, as development of the Metaverse has advanced, researchers and technology developers have been exploring its applications in support of the United Nations Sustainable Development Goals. In a number of cases, this work is in direct collaboration with organizations within the United Nations system.

One exploratory study was published in 2022 by the United Nations Department of Economic and Social Affairs as a science-policy brief for the Multi-Stakeholder Forum on

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Science, Technology and Innovation for the SDGs. The authors identified existing and potential applications of Metaverse technology for each of the 17 SDGs. Among them are AR/VR tutorials for complex machinery being developed and used to introduce sustainable agriculture practices in developing countries, and blockchains for secure storage and distribution of food (Goal 2); immersive tutorials, gamifications and simulations for populations facing challenges in using traditional education systems and platforms, for example students with disabilities (Goal 4); Metaverse environments that optimize the sustainability of production and consumption patterns through inventory management and supply chain management improvements (Goal 12); and Metaverse-based models for climate change analysis and mitigation or prevention of climate change impacts on oceans and fragile terrestrial ecosystems (Goals 13, 14, and 15).[205]

In 2022, a new prize competition launched at the ITU's Global Standards Symposium invited young people to a "Metaverse for SDGs Global Prize and VR Competition". Participants created virtual experiences in the Metaverse to raise awareness about the SDGs and to enable themselves and others to learn about the challenges and opportunities related to the SDGs and their achievement. Another aim of the competition is to foster Metaverse development skills among the participants, skills that will be essential for their participation in the future digital economy. This effort will itself contribute to the achievement of SDGs such as Decent Work and Economic Growth (SDG 8) and Reduced Inequalities (SDG 10).[206]

4. Governments are forging the path for Metaverse safety, security, and usability

One of the roles that governments will play in making the Metaverse a means of improving societal well-being is the important role of mitigating the variety of risks and harms the Metaverse can pose to well-being, through legislative and other means.

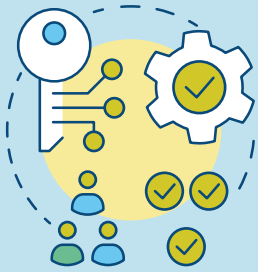
The risks and threats of the Metaverse remain a topic of considerable attention. One such threat is the threat to personal and data privacy and misuse of data when privacy is not secured. As described elsewhere in this report, VR/AR wearable devices (headsets, haptic gloves, etc.) and other Metaverse technologies collect a larger and more diverse range of types of data from users than Web 2.0 technologies. Technology companies are expected to develop applications to collect these data for personalized advertisement experiences and other revenue-generating opportunities that could be to the detriment of users. Some are concerned that companies may already be doing so. There is an even greater risk that malicious actors will either legally or illegally gain access to and abuse users' data with severe consequences, including psychological manipulation, surveillance, political or other forms of duress and manipulation, recruitment of vulnerable individuals, extortion, bullying, and cyberattacks. Because the Metaverse is still an emerging technology, it is an unresolved question whether users' avatars even have privacy rights or remedies against misuse of their data. And because the technology is global, it will be subject to multiple privacy regulations that will require harmonization or at least clarity of jurisdiction.[207]

Another part of the threat to well-being that people will face in the Metaverse is from other Metaverse users, and governments will be compelled to help protect their citizens from these risks. Content moderation in today's Internet and social media is already a contentious and difficult challenge, as evidenced by the growing number of legal cases about purported disinformation, cyberbullying, and other acts by individuals and organizations. In the view of some experts, the issue will be much more complicated in the Metaverse. It will need to address not only speech (whether in text, video, or other form) but also behaviour, and the moderation would need to be in real time to be effective given the real-time nature of Metaverse interactivity. That, together with the envisioned ultimate global scale of the Metaverse's reach and the virtualization of users as avatars, makes the feasibility of behaviour moderation uniquely challenging. Strong governance systems are not yet in place.[208]

A range of other safety, security, protection, and governance issues pose challenges to Metaverse users that governments will need to address. Some of them are overtly criminal threats – one study identified 22 crime threat scenarios in the Metaverse through a literature review, with an additional eight added by experts consulted for the study. Most are types of crimes encountered in the physical world, distinctively adapted to the virtual domain, while some are unique to the conditions that the Metaverse creates. Other risks and threats are less malevolent in nature but will nonetheless be challenges to the well-being of Metaverse users. For example, ownership of creations within the Metaverse is complex, with issues surrounding intellectual property rights, ownership of virtual assets, and the rights of users of virtual assets. The decentralized nature of the Metaverse may make the determination of applicable jurisdictions and enforcement particularly challenging. Related to but distinct from ownership rights issues, tax authorities are already exploring ways to adapt existing frameworks to cover Metaverse activities, extend reporting mechanisms to include virtual intermediaries, and use blockchain technology for real-time tax reporting.[209]

G. Some challenges and obstacles to the advancement of this pathway

A survey **in 2022** showed that nearly **40 per cent** of respondents were concerned about **equity of access** to the Metaverse.



1. The risk of a potential new form of digital divide could emerge in the Metaverse

As this pathway for the Metaverse is pursued, there is considerable potential for closing current gaps in access to essential health, education, and other opportunities for disadvantaged populations in Arab countries and elsewhere. At the same time, such outcomes will only be possible with deliberate attention to the accessibility of the applications and enabling technologies. A survey in 2022 showed that nearly 40 per cent of respondents were concerned about equity of access to the Metaverse. The power of the educational, health-care, and other experiences that the Metaverse offers is highly reliant on computing power sufficient for the graphics and processing demands of virtual worlds, and fast and reliable connectivity infrastructure, among other technical requirements. While the internet connectivity of Arab countries (and other indicators of digitalization) is rising, it stands near the global average of only 65 per cent, and is unequally distributed, with nearly 30 per cent of the populations of Arab countries in the Middle East excluded. Unless they address these challenges, governments risk missing the benefits that the Metaverse offers to boost standards of living and well-being. There is also an important role for the private sector – the major global technology companies as well as the growing number of technology companies in Arab countries – in making the Metaverse available equitably. There are sizable and ultimately profitable markets to be served in Arab countries, as well as corporate social responsibility considerations, but it will require upfront investment to realize those business and benefits and social responsibility commitments. Another element from the corporate standpoint is developing Metaverse applications for education, health care, and other social-benefit purposes that can operate on lower-tech platforms such as laptops and mobile phones, not just on highly advanced platforms. The future may require incentivization to larger companies to prioritize social-good Metaverse investment alongside more immediately profitable social and entertainment applications, combined with efforts to promote and support the emergence of Metaverse-oriented social entrepreneur start-ups.[210]

2. Vulnerable populations could become more at risk even as their well-being benefits

Considerable research, media, and other attention has been devoted to the risks and threats that Metaverse users already face and will face in the future, some of which is referenced earlier in this section. As noted there, harassment, psychological manipulation, deliberate disinformation, and a wide range of criminal acts in or enabled by the Metaverse are among the threat concerns. As the users grow in number for Metaverse applications to advance societal well-being, potentially far greater numbers of citizens in Arab countries and other countries will be at risk, beyond just the users of social and entertainment apps. Among them will be some of the most vulnerable within any country's population. In the education context, young children can be exposed to the opportunities that the Metaverse offers to malicious actors, at a time when regulators and governments are still working to update laws

to protect children in the offline world. In the same way, while Metaverse-based diagnoses and treatments will open up health-care access to underserved segments of populations around the world, those same individuals will become vulnerable to exploitation of their data and to other risks. Additional concerns could arise in the context of governments moving into the Metaverse and using its technologies to provide services and benefits to their citizens. While numerous analyses and surveys have detailed concerns about surveillance by technology companies in the Metaverse, the prospect exists for governments also to employ the same technologies for purposes of monitoring citizens. Strong protections against misuse of the Metaverse will be an important consideration as it becomes more a part of how essential social, health, and other services are accessed by people around the world.[211]

3. Environmental impacts of the Metaverse will counter some of the environmental benefits that it enables

The prospects described earlier in this section for the Metaverse to contribute to climate change mitigation and adaptation are considerable. Greater efficiency in building and infrastructure operations, climate impact education, reduced travel as workplaces shift to the Metaverse, and other uses of virtual environments all will help to being about important improvements in societal well-being in Arab countries and elsewhere. At the same time, the development and use of the Metaverse will have its own significant negative impacts on the environment in the absence of conscious efforts to mitigate those effects. One part of the issue is the energy required to power the Metaverse. According to a widely cited statistic, a 1,000-fold increase in computing power over today's levels will be required to power the Metaverse. The servers on which software runs and data are stored are an additional element. Data centres are estimated to generate 2 per cent of current carbon emissions, a figure which is projected to rise to 14 per cent by 2040. While this is certainly not solely due to the projected growth in Metaverse software and Metaverse-generated data, that growth is anticipated to play a significant role. Servers also use large amounts of water for their cooling systems – by one estimate, billions of gallons per year – which could be uniquely concerning in water-stressed Arab countries. Advances in chip and other technologies, growing use of renewable energy to power data centres, the advancement of edge computing to reduce reliance on massive cloud-based data centres, and other innovations will curb the rise in the Metaverse's impact on climate and environment, but that impact is still projected to be considerable. Developers and institutional users of virtual worlds, including governments, will feel pressure to take a variety of action over the coming decades to help ensure the climate benefits of Metaverse technologies are not outweighed by the climate damage caused by those same technologies.[212]

One part of the issue is the energy required to power the Metaverse. According to a widely cited statistic, a **1,000-fold** increase in computing power over today's levels will be required to power the Metaverse.

Data centres are estimated to generate **2 per cent** of current **carbon emissions,** a figure which is projected to rise to **14 per cent** by 2040.

H. Recommendations pertinent to this pathway

Form an inter-ministerial working group in each Arab country to coordinate and integrate policies and actions within that country's government and with neighbouring countries to promote the adoption of Metaverse technologies in priority well-being areas

The relationships between health care, education, quality living conditions, environmental security, and responsive government services as elements of societal well-being are clear. In most if not all Arab countries, there is already considerable attention paid to aligning policy objectives and actions across the ministries and other government and non-government entities responsible for these areas. Lack of awareness about Metaverse opportunities brings with it the risk of initiatives failing to realize potential synergies, or working at crossed purposes with others. Those risks can only be overcome with intentional cross-coordination efforts. As Arab countries elect to pursue a deliberate pathway as described in this section to develop and employ Metaverse technologies to achieve societal well-being objectives in the five areas discussed, inter-ministerial committees should be established within each country to facilitate the identification of synergistic investments, pool resources, develop strategies to incentivize private sector Metaverse innovations in support of societal well-being, and pursue other shared aims. While there is no such Metaverse-focused inter-ministerial entity in any government, there are closely relevant precedents that Arab governments can study and emulate. These include for example an Interministerial Delegation for Digital Transition in Monaco, and an inter-ministerial committee in India "set up to examine global best practices on the role of government in supporting and fostering the domestic robotics ecosystem".[213]

Design and conduct national, local, and inter-country communications campaigns to raise awareness in populations and business sectors about the Metaverse and its opportunities to create social and economic benefits

Awareness of the Metaverse is increasing worldwide. Numerous studies and surveys provide a wide range of data points on levels of awareness in different countries and regions, different demographics, and different markets and sectors. For example, a March 2022 survey showed that 74 per cent of 300,000 respondents in the United States, the United Kingdom and China were aware of the Metaverse, up from 32 per cent less than a year earlier. A survey carried out in Japan in 2023 showed a rise in recognition of the word "Metaverse" to more than 80 per cent from less than 20 per cent two years previously. In the Middle East and North Africa, awareness levels in the consumer sector were found to be approximately 50 per cent by two different surveys. In the business sector, about 80 per cent of surveyed companies and business leaders in the Middle East and North Africa, and 90 per cent of SMEs, indicated their openness to using the Metaverse in their operations. While these indicators are positive, such surveys report that understanding of the Metaverse is generally well below measured awareness. The breadth and scale of impact the Metaverse can have in contexts such as education, health care, urban redevelopment, and other "practical" or "impact" applications is less well known or understood than its use for entertainment and social purposes. Changing that requires structured, well-resourced communication efforts if the societal well-being potential of the megatrend is to be realized in Arab countries.[214]

Develop and widely promulgate Metaverse-based education programmes with content tailored to Arab countries' contexts to educate people in those countries about climate change and its impacts, ways to reduce their impacts on the environment, sustainability practices, etc.

The power of Metaverse-based educational programmes about climate change and its impacts, and what individuals and enterprises can do about it, is considerable. It offers an arguably new kind of experiential learning for a context in which learning by doing is uniquely difficult, given that the effects both of climate change itself and actions to mitigate it are only observable over a long period of time. The nature of Metaverse environments designed for this purpose enables these experiences to be immediate and intensely engaging. Organizations in Arab countries' public, private, and civil society sectors can make important new contributions to climate-change mitigation and adaptation by emulating the kinds of Metaverse-based educational apps referenced earlier in this section of the report and making them available to a wide range of audiences.

Promote the use of cloud providers and other Metaverse-related technology companies that are actively working to reduce the negative environmental impacts of their products, services, and business operations

For all the positive contributions that the Metaverse can make to carbon emissions reductions and other sustainability

outcomes through their applications in industrial and other business contexts, the harmful environmental impacts of this megatrend are also significant. Efforts to manage and reduce those negative impacts are a priority of a growing number of the companies developing Metaverse applications and providing related services, including by carbon-conscious supply-chain management and actions to reduce their own direct footprints. For example, one source cites that "many cloud service providers have committed to near-term net-zero supply chains, and data centre companies have followed this trend". Sustainable software engineering –an approach to software that emphasizes energy efficiency and environmental sustainability – is another anticipated trend in companies developing the Metaverse. Governments as well as organizations in other sectors in Arab countries should support these trends in a variety of ways, which might include legislative or regulatory actions encouraging or even mandating such practices, and restricting their procurement of technologies and services only to providers who conduct business in alignment with these sustainability priorities.[215]

Require all Metaverse applications that are involved in education, health care, and other essential social services and sectors to also function on low-cost hardware, older operating systems, smartphones, and other technologies affordable to most people

The affordability of Metaverse experiences is influenced by technology costs. The complexity and realism of the features of these environments is one of the most salient cost-influencing factors. Even the lower-cost alternatives among currently available VR headsets are beyond reach for many. For the Metaverse to be integral to lifting levels of societal well-being, particularly through applications in education and delivery of health-care services, where individuals of all income levels need access, making the experiences broadly accessible will be critical. One solution is partnerships between government and industry, for example through subsidies, to make technologically sophisticated Metaverse environments available to those without the means to own their own equipment. But equity in making the well-being benefits of the Metaverse available to all demands that versions of those experiences and services also be available on lower-cost interfaces. Low-tech devices are already proven, and "companies are exploring solutions to reduce the need for high-end local hardware, making Metaverse experiences accessible and cost-effective through less powerful devices".[216] Governments, corporations, and civil society organizations should implement incentives or requirements in their procurement processes for Metaverse developers to engineer such accessible applications in order to have their solutions considered for use in the organizations for any purpose, and especially for purposes that involve essential services such as education and health care.

Fund research and development initiatives on edge computing and other technology advances that will help make the Metaverse environmentally sustainable

The extremely large computing power requirements of the Metaverse – one of the biggest sources of the phenomenon's negative environmental externalities, because of the associated energy use – are described earlier in this report. The need for that level of computing power in turn comes from the huge data sets that make up immersive 3D virtual worlds, and the imperative of low latency for users' actions in these worlds to be realistic and seamless. Edge computing,[217] which involves processing, analysing, and storing data at the source rather than sending it to the energy-intensive server farms of the cloud, is one way to overcome the need for computing power and the associated carbon footprint. While edge computing is well underway in its development, it is very expensive to install and use due to the cost of its customized hardware and software. Spearheading research to further develop edge computing and bring down its costs would be a valuable contribution to mitigating the environmental negatives of the Metaverse that today run counter to its considerable climate change-related and other societal well-being benefits. This could be done either in government science centres, with government incentives to the private sector, or using other approaches. Arab leadership in this field of research would also support broader aims of economic diversification through digitalization. Other areas of research to reduce the environmental impacts of the Metaverse could be a complementary pursuit.[218] One example could be work on innovations in mining cryptocurrencies and NFTs to reduce the intensive energy and water use in current processes.

3

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Metaverse advancement as a catalyst for new forms of Arab influence in the next global era (pathway 3)

This pathway explores how Arab countries could benefit from intentional decisions and actions by leaders in the public, private, and other sectors to pioneer frameworks for regulation and governance of the Metaverse and exploit the capabilities of the Metaverse as an element of strategies to secure new levels of influence in the future global economy and global culture.

The applications, social benefits and risks described in this section are among the outcomes that Arab countries could obtain if decisions and actions are taken to move the Metaverse down this pathway.

A. Arab countries have always played a key role in the global economy and culture – the next era could see a new source of their importance emerge

An interrelated set of transformations in what drives the global economy is underway. This involves a shift towards new sources of energy to promote sustainable development in the face of climate change. Part of it is the next step-change leap in the decades-long growth of the digital/tech sectors. Arab countries are at the nexus of both.

1. Fossil fuel industries have been central to Arab economic power for decades…

The wealth of Arab countries and their role in the global economy have been linked since the 1970s, predominantly to oil and gas exports. With 31 per cent of global production and 48 per cent of proven reserves, the Middle East plays a significant role in setting prices in the global oil market, and therefore has a significant influence on other dimensions of economies around the world.[219] Among these are downstream prices of many goods and services that rely on oil as a production input, business

The economy of the region (measured by GDP) grew by **320 per cent between 2000 and 2022 – from $1.05 trillion to $4.41 trillion.**

Oil-exporting countries account for more than **60 per cent** of that combined GDP.

costs, inflation, and costs passed on to consumers. Arab oil exports also have an impact on international trade balances and currencies, generating substantial revenue for exporters that allows them to invest in a range of industry sectors and thus play a key role in global financial markets. The economy of the region (measured by GDP) grew by 320 per cent between 2000 and 2022 – from $1.05 trillion to $4.41 trillion. Oil-exporting countries account for more than 60 per cent of that combined GDP. The growth rate outpaced that of the United States over the same period (148 per cent, from $10.25 trillion to $25.46 trillion), though it was lower than that of China (1,384 per cent, from $1.21 trillion to $17.96 trillion).[220]

The role and influence of Arab countries in the international financial institutions (IFIs) is largely determined by their voting power. The GCC countries account for about 50 per cent of the voting share of the Arab countries in the IFIs, but only 12 per cent of the total Arab population. This degree of Arab influence in the IFIs is primarily tied to oil and gas resources and accumulated wealth. One dimension of the major Arab oil and gas exporters' role and advocacy in the IFIs (and the regulatory and policy-setting forums of the global economy) has been making sure energy markets are stable from the standpoint not only of energy security, but also the availability of energy at affordable prices so that it can fuel the global economy and maintain global demand for their exports. A second dimension is the accumulation of oil wealth in the forms of international reserves and sovereign wealth funds. By the end of 2023, the accumulated net foreign assets of the GCC countries (plus those of other Arab energy exporters such as Algeria and Iraq) amounted to $3.5 trillion, two thirds of which was held by sovereign wealth funds. This gives these countries a substantial voice in the Group of 20 (G20, of which Saudi Arabia is a full member) and other international economic policy forums, as well as in the IFIs. Saudi Arabia is one of the few countries (and the only Arab country) with its own Executive Director Chair at both the International Monetary Fund and the World Bank, and recently the International Monetary and Financial Committee selected Saudi Arabia's minister of finance as its new chair.[221]

2. … but over time, the Metaverse could come to rival oil as a central element of Arab influence in the global economy of the future

The world is still in the early stages of the transition to a post-fossil fuel world, which many expect will last another two decades or longer. Until that transition is much further along, the Arab countries' role and weight in the global economy and in policy- and standard-setting will remain rooted in its current basis. But that transition will come, and the basis of Arab power in the global economy and its governance will need to come from other sources if it is to be sustained.

The increasing Arab prominence in the technology economy has the potential to be that basis of continued and growing global influence. Within the technology economy, a new Metaverse subsector is emerging, in which Arab countries are deliberately and rapidly positioning themselves to be "first movers". Because success in the future Metaverse economy will be tied not to natural resource wealth but to talent development and attraction of investment, influence in the next global era has the potential to be more broadly shared among more Arab countries than in the past.

3. A shift from twentieth-century financial institutions and standards, to mechanisms for the governance of twenty-first-century interconnected global digital economies, is on the horizon

The international financial architecture, crafted beginning in 1945 after the Second World War, comprising the IFIs noted above and other entities, "is undergoing a stress test of historic proportions" as the United Nations and other bodies have observed. Part of this stress is rooted in the growing inadequacy of its institutions and its funding, governance, and policy mechanisms to contend with a set of global challenges that have emerged and accelerated since the system's formation. These include "unrelenting climate change, increasing systemic risks, extreme inequality, entrenched gender bias, highly integrated financial markets vulnerable to cross-border contagion, and dramatic demographic, technological, economic, and geopolitical changes".[222]

But the system also struggles in guiding a digital economy, rooted in Web 2.0 and other information and communication technology (ICT), for which it was not purpose-built.

Current regulatory institutions lack the understanding and the kinds of authorities needed to govern the scope and scale of the global and integrated digital economy, its means of creating value (i.e. data as well as products and services), or the behaviours of its producers and consumers. Economic activities in the digital economy span multiple sectors and geographies in unprecedented ways, making them subject to patchworks of governance and guidance mechanisms that were designed for a different era.

The rules and authorities of Web 2.0 are still in varying stages of being developed and implemented, while the next form of digitalization – Web 3.0 and the Metaverse – is already gaining momentum globally. The rules and authorities of the Web 3.0 and the Metaverse economies are largely yet to be established, and potential new institutions yet to be created.

The engines of the emerging Web 3.0 and the Metaverse economy subsectors will have the opportunity to be the authors and the institutional powers – and Arab countries and companies have the opportunity to be among those engines and powers.[223]

nateejindakum/via adobe stock

B. The Metaverse economy is accelerating as a source of wealth and influence in the global economic system

The Metaverse, and broader Web 3.0 and cryptocurrency applications and innovations, are emerging as a subsector of the technology economy that together have the potential to eventually rival and perhaps even surpass the Web 2.0 economy that preceded it.

In providing the larger context for the Metaverse opportunity in the Middle East, North Africa, and Türkiye,

an analysis published in August 2022 estimated **a global Metaverse market** value of between **$250 billion** and **$400 billion by 2025.**

1. The emergent Metaverse phenomenon is a global phenomenon

In providing the larger context for the Metaverse opportunity in the Middle East, North Africa, and Türkiye, an analysis published in August 2022 estimated a global Metaverse market value of between $250 billion and $400 billion by 2025. The scope of that analysis was limited to the virtual asset transaction economy within the Metaverse (estimated at $150-$300 billion) and the technologies associated with bringing the Metaverse to life (products and services related to VR/AR/MR estimated at nearly $50 billion, plus cloud and network enablement of Metaverse virtual worlds at nearly $30 billion and $20 billion respectively).[224] A United-States-based cryptocurrency asset management company more expansively projects the Metaverse as a trillion-dollar revenue opportunity by 2030, encompassing the above elements as well as "advertising, social commerce, digital events, and developer/creator monetization". In the company's estimate, revenue from Metaverse gaming alone could nearly double from 2020 to $400 billion in 2025, "and the Metaverse opportunity extends far beyond gaming".[225]

Other analysis is more expansive still, projecting that the Metaverse could be the source of as much as $5 trillion in "impact" by 2030. The "impact" perspective takes into account not only the industry itself, but also the additional value that the Metaverse will unlock, in the same way that personal computers and mobile phones have fuelled innovation and the creation of whole new industries and business models in nearly every sector of the economy over the last three decades. This scope encompasses many of the social well-being and industry transformation applications of the Metaverse explored in the other two sections of this report, such as e-commerce (valued at more than $2 trillion by 2030 according to one estimate), education and learning at all academic levels (as much as $270 billion), and fashion. The financial community sees a potential for wealth creation, with more than $120 billion invested in Metaverse ventures in the first six months of 2022 (more than double the total year figure for 2021) and activity growing particularly in the area of venture capital.[226]

A few specific examples of new "Metaverse-unique" wealth-creation opportunities already being observed provide context for how this megatrend will make a growing impact on the global economy. One is the phenomenon of massive interactive live events (MILEs), in which millions of people can attend concerts, sports games, or other kinds of events in the Metaverse. The first such concert, held in 2019, was attended by 10 million people. A year later, a series of concerts by a hip-hop artist had nearly 28 million concurrent attendees, 46 million total visits, and grossed $20 million. Such events create the prospect of revenue streams unrealizable in

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traditional entertainment events, such as competitively valued non-fungible tokens (NFTs) to serve as a souvenir after the event. The prospect of augmenting live events (music, sports, fashion) that today generate hundreds of billions of dollars globally with virtual and hybrid physical-digital MILEs demonstrates one of the ways the Metaverse will drive economies in the future.[227]

The economic value of **virtual real estate** is increasing rapidly, as demonstrated for example by the growth prices in land auctions on the Decentraland platform from an average of **$20 per plot** in 2017 to **$15,000** in early **2022**.

Real estate in the Metaverse is another new form of economic value creation anticipated to grow to very large levels. Virtual plots of land are already being bought and sold. They are "essentially pixels that act as programmable spaces in VR platforms to develop workplaces, playgrounds," retail showrooms, MILE venues, and venues for other kinds of Metaverse applications. The economic value of virtual real estate is increasing rapidly, as demonstrated for example by the growth prices in land auctions on the Decentraland platform from an average of $20 per plot in 2017 to $15,000 in early 2022. One recent market analysis projects more than $5 billion in growth in the Metaverse real estate market between 2021 and 2026 (from a current value of $1.4 billion according to The Sandbox platform), although the CAGR could actually decline over that period depending on how the physical real estate market affects perceptions of the value of virtual real estate.[228]

Similarly to how the Metaverse real estate market is emerging in parallel to its physical counterpart, the intellectual property rights to digital works such as NFTs could emerge as a new asset class separate from the works themselves. Up to now, purchasing NFTs involves purchasing a token (an electronic certificate of authenticity of a unique copy of a work), but not the work itself, which can be a separate economic transaction generating an additional revenue stream.[229]

As the introductory section of this report notes, the Metaverse is strongly interrelated with but still distinct from Web 3.0, cryptocurrencies and blockchain. At the same time, when considering the impact that the Metaverse will have on the

global economy, these correlated technologies are important to take into account. According to one market analysis, the global Web 3.0 blockchain market size of $1.9 billion in 2021 will grow to a projected $52.9 billion in 2030, a nearly 45 per cent CAGR over the period. The scope of the market definition in that analysis comprises cryptocurrency, conversational AI, data and transaction storage technologies and services, payments, and smart contracts.[230] Other market sizing analyses vary, but all indicate substantial growth.[231] In January 2024, the market capitalizations of the top 20 Web 3.0 tokens (cryptocurrency assets issued and exchanged on decentralized blockchain networks that power Web 3.0 applications) stood at approximately $37 billion.[232]

2. The growing Arab Web 2.0 technology and digital sector positions Arab countries with an increasingly strong foundation for their ambitions in the Metaverse economy

Considerable analysis has documented the challenges that Arab countries have been working to overcome in digitalizing their economies, governments, and societies. Capturing the consensus among them, one widely cited assessment carried out in 2016 described them as "capturing just a fraction of [their] digital potential, due to shortcomings in the strength of local ICT companies, venture funding, digital trade balance, and digital talent pool".[233]

These challenges are far from resolved, but eight years later there is a comparable and growing consensus that there have been prodigious strides, with progress headed to even greater levels.

Analysis from 2023 predicts that "by 2030, the Middle East's digital economy will have grown to $780 billion" – an increase of 333 per cent on the 2022 figure, and a growth rate twice that of the rest of the world.[234] Further research projects a less steep but still substantial rise to $500 billion by the same year, but offers important indicators of the scope of the growth alongside its scale projection. For example, nearly 40 per cent is projected to be outside the GCC group of countries. Additionally, a 20 per cent increase in private equity and venture capital funding to digital economy companies in 2022 also reflected a trend of growth outside the GCC. Only 60 per cent of these investment deals were in companies based in the United Arab Emirates and Saudi Arabia. The study stated that Egypt was "becoming a new focal point with about a 24 per cent deal share". Technology start-ups in the Middle East raised approximately $3.6 billion in total funding in 2022, up 13 per cent from 2021.[235]

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GCC countries are advancing the plans outlined in their national vision documents to make digitalization central to their economies and governments.[236] Among the strongest examples, the Government of Saudi Arabia and businesses in that country together spent nearly $35 billion on ICT in 2023. The last several years have seen substantial investments targeting sub-sectors such as health-care technology, education technology, big data, and AI. Saudi Arabia's technology push is also visible in its launch in 2023 of a $200 million investment fund through King Abdullah University of Science and Technology for early-stage technology start-ups in the Kingdom and in other countries. The United Arab Emirates is also making substantial investments in digital businesses in the same subsectors – for example, analysts project a 75 per cent increase to more than $7 billion in education technology expenditure.[237]

The Government of **Saudi Arabia** and businesses in that country together spent nearly **$35 billion** on **ICT** in 2023.

Saudi Arabia's technology push is also visible in its launch in 2023 of a **$200 million investment fund** through King Abdullah University of Science and Technology for early-stage technology start-ups in the Kingdom and in other countries.

Growth of the technology sector and broader digital economy is not limited to the GCC. For example, Jordan and Lebanon have also emerged as flourishing technology hubs, particularly in software development and financial technology. Jordan's technology sector now contributes around 12 per cent to the country's GDP. The World Economic Forum, partnered with the Bahrain Economic Development Board, began in 2017 identifying an annual selection of top 100 Arab start-ups that are shaping the Fourth Industrial Revolution. In the most recent update published, more than two thirds of the companies chosen by the panel of notable entrepreneurs and investors were from countries outside the GCC, including 17 in Egypt, 27 in Jordan, 7 in Lebanon, 4 in Palestine, and 6 in Tunisia. The Egypt Ministry of Communications and Information Technology recently launched "Digital Egypt," a comprehensive initiative aiming to accelerate digital transformation and promote the adoption of digital technologies across sectors.[238]

This advancement of the Arab technology sector is the foundation for what these countries can and will do in the emerging Metaverse economy. Actions many of them are taking to establish presence there demonstrate an intent to be global leaders starting now, in the early days of that space.

3. Arab businesses and governments are already driving Arab countries' technology sectors to prominent roles and influence in the global Metaverse economy

In research published in May 2023, estimates of the benefits of the Metaverse to the economies of Arab countries are substantial. They range from between $20 billion and $38 billion annually in Saudi Arabia by 2035; between $9 billion and $17 billion in the United Arab Emirates; between $11 billion and $22 billion in Egypt; $2.6 billion and $5 billion in Morocco; and between $1 billion and $2 billion in Jordan (all annually, all by 2035). The report cites a previous estimate that "the Metaverse could contribute $360 billion per year to GDP for the Middle East, North Africa, and Türkiye region by 2031". The gaming industry in that region is one of the fastest growing in the world, projected to be a $5 billion per year market, serving nearly twice as many gamers than the United States (377 million users compared with 210 million) and almost as many as all European countries combined (386 million users). Governments across the Middle East are forming partnerships with technology companies to advance Metaverse-related technologies.[239]

Dubai is among the leaders in centring its economic growth and power in the Metaverse. As one key element of its Metaverse Strategy, it had already attracted nearly a thousand blockchain and Metaverse-based companies by July 2022, and aims to support more than 40,000 virtual jobs by 2030. Start-ups and partnerships in the Metaverse space are proliferating. Art Dubai, the Middle East's leading international art fair, introduced a digital art section in 2022, and three local NFT marketplaces together generated nearly $10 million in sales in 2021.[240]

A variety of investment initiatives are actively developing the Metaverse economy in the United Arab Emirates. A Government-owned financial services and banking group has launched a global accelerator programme for Metaverse start-ups. And in February 2023, an Abu-Dhabi-based technology company launched a $2 billion initiative to accelerate the creation and growth of local Metaverse, Web 3.0, and blockchain start-ups and attract others to relocate to Abu Dhabi with financing and a progressive regulatory environment.[241]

Saudi Arabia is another major Metaverse investor and innovator which aims to become a top force in the global Metaverse economy. One study estimated the Metaverse market in Saudi Arabia at $1.1 billion in 2022, with projected growth to $7.6

In **February 2023**, an Abu-Dhabi-based technology company launched a **$2 billion initiative** to accelerate the creation and growth of local Metaverse, Web 3.0, and blockchain start-ups and attract others to relocate to Abu Dhabi with financing and a progressive regulatory environment.

in Egypt, Metaverse start-ups are active in VR tourism, VR educational applications, virtual 360º digital representation of businesses, and other applications.

billion in 2023. While it does not have a specific national metaverse strategy like that of Dubai, in 2022 Saudi Arabia announced a national gaming and e-sports Strategy that is projected to create nearly 40,000 jobs in the country, 250 homegrown gaming companies, and more than $13 billion in GDP by 2030. The country has also developed and begun implementing a national strategy for data and artificial intelligence. This strategy will be an important element of Metaverse development over the next decade.[242]

Funding initiatives to foster local Metaverse start-ups, and investments in leading international VR/AR, Web 3.0, and gaming companies, are two of the primary ways Saudi Arabia is pursuing its objectives of becoming a leader in the Metaverse. External investments are positioning the country to have an outsize influence on the global Metaverse economy. Examples include a $50 million investment in 2023 in a Hong Kong-based blockchain gaming firm. Also in 2023, the country's public investment fund signed an agreement with a Florida-based AR headset maker, giving it majority control of the company, enabling the country to "play a pivotal role in shaping the future of augmented reality technology".[243]

The emerging Arab Metaverse economy is not limited to GCC countries. For example, in Egypt, Metaverse start-ups are active in VR tourism, VR educational applications, virtual 360º digital representation of businesses, and other applications. A platform founded in Egypt using AR technology to drive domestic and export sales of furniture designed and made by local furniture makers anticipated having as many as 1,000 furniture manufacturing factories and workshops in Egypt contracted to use the platform by the end of 2022. That same year, Egypt's Information Technology Industry Development Agency co-sponsored the country's first "Metaverse hackathon," intended to "inspire Egyptian youth to develop innovative solutions to local pressing challenges by utilizing and developing Metaverse applications, while also contributing to the acceleration of digital transformation in the country".[244]

4. Regulatory and governance gaps are a Metaverse challenge – and an opportunity for Arab influence in the Metaverse economy and larger global economy of the future

All of this vibrant and accelerating activity by Arab countries in the emerging Metaverse economy portends potentially great success in their ambition to be among the global leaders in that sector in the future. In doing so, they could position themselves for a new basis for sustained and potentially even greater influence in global economic and cultural affairs, beyond what the technologies themselves, their applications, and the wealth they will generate can provide. The source of that additional influence can be to play a leading role in conceiving and driving the implementation of the rules, standards, and other means of governance of the Metaverse itself and the global Metaverse economy.

As noted above, the rules and guidelines for governing the Metaverse, Web 3.0, and cryptoasset economies have largely yet to be established. For the United States, Europe, and other powers, their role in creating the governance structures and institutions of twentieth- and early twenty-first-century economies has been a key to the decades of their influence in global affairs. A leadership role in developing

the structures and institutions of Metaverse governance will afford similar influence to countries and other players in the global economy of the future. As Arab countries look and work to become among the world's Metaverse leaders, taking steps in the near term to lay the foundations for its necessary but undefined regulatory, legal, and other governance institutions and standards could be a defining and authoritative element of that global leadership.

The number and breadth of Metaverse and Web 3.0 regulatory and governance issues for which solutions have yet to be developed and agreed are numerous. They have been explored and characterized in a variety of ways,[245] and will be considered here in five categories. There are important links among the individual issues, and a resultant blur among the categories. Many if not all of the issues are and have been present in the Web 2.0 economy and two-dimensional Internet. But distinctive characteristics of the Metaverse and Web 3.0 make most of them, and the exploration of solutions for them, meaningfully different in the emerging economy that these domains represent.

The first category has to do with the regulation of digital currencies (cryptocurrencies), and it presents the first of the many overlaps among legal and governance issues and categories of issues. Cryptocurrencies are a type of digital asset, but they are specifically designed for use as a medium of transaction, while the other types of digital assets such as NFTs can be used for a range of purposes. Cryptocurrencies present a new kind of challenge to currency law, central banking law, and monetary systems broadly, because they "are private money issued and circulated by parties or societies outside the jurisdiction of central banks".[246] There are also considerations of how to protect against money laundering, fraud, and other forms of financial crime that could be perpetrated with cryptocurrencies, as well as other legal and related considerations. The world of cryptocurrency is growing rapidly – projections of the market size vary widely but are all in the billions of dollars, with a market capitalization in early January 2024 of more than $1.5 trillion for the companies behind the currencies being actively traded. As the adoption of cryptocurrencies grows, many foresee a growing need for "regulators stepping in to work hand in hand with the private sector to create a framework that keeps everyone safe".[247]

The rising adoption of cryptocurrencies in the GCC countries, poised to become a significant avenue for digital asset accumulation and wealth creation there, is part of what is setting the stage for propelling Arab countries into the global Metaverse and Web 3.0 economy. It also positions them to be influential in establishing the regulations for this sphere. Cryptocurrency adoption in the GCC is relatively high compared to many other countries around the world, with 48 per cent of GCC luxury consumers owning cryptocurrencies. Importantly, the GCC has a favourable environment for cryptocurrencies, with cryptocurrencies and NFTs allowed for private use in all countries. This suggests the potential for adoption of these elements of the Web 3.0 and Metaverse economy to expand beyond the luxury consumer segment to the broader population over time.[248]

A second category of Metaverse and Web 3.0 regulatory and governance issues has to do with ownership of virtual assets and the intellectual property associated with these assets. The emergence of blockchain has created an environment in which anything in digital form has the potential to be an investable asset. After cryptocurrencies, NFTs are the most widely known

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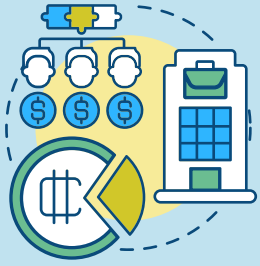
Arab countries are already taking initial pioneering steps to be among the "standard-setters" in creating the needed new regulatory and governance environment for cryptocurrencies and other digital assets.



The most prominent example is the establishment in March 2022 in Dubai of the **Virtual Assets Regulatory Authority** (VARA), a first-in-the-world independent agency regulator for virtual assets.

and exchanged form of virtual asset, but other forms exist as well, such as blockchain-based digital tokens that represent physical assets such as real estate. In the most basic sense, ownership of such assets is associated with the entry of data about them into an account on a blockchain. But in one view, an NFT itself is not owned in a traditional sense by its buyer, because it only exists on the servers of that blockchain platform. This is only one of many open questions about ownership of assets in the Metaverse. One source characterizes the challenge in this area in this way: "the legal framework applicable to the buyers, sellers, and users of digital current assets remains rudimentary, relying on [adaptations of] existing legal concepts that pertain to commodities, value, and exchange" that may not be appropriate to the virtual world – "as its legal status is open to many interpretations, cryptocurrencies and virtual goods [at this time] defy categorization from a legal perspective".[249]

Arab countries are already taking initial pioneering steps to be among the "standard-setters" in creating the needed new regulatory and governance environment for cryptocurrencies and other digital assets. The most prominent example is the establishment in March 2022 in Dubai of the Virtual Assets Regulatory Authority (VARA), a first-in-the-world independent agency regulator for virtual assets. VARA issued its initial and comprehensive regulations for the sector in February 2023, which "cover seven licensed virtual asset activities, including advisory, broker-dealer, custody, exchange, lending and borrowing, payments and remittance, and virtual assets management and investment services". At the foundation of the framework, VARA established a definition of what constitutes a Virtual Asset Service Provider (VASP). Key elements of the framework include rulebooks for how VASPs must structure their company and its management systems; for regulatory compliance and structuring internal systems for managing compliance with VARA rules; for technology controls and security including data protection; and others. Notably and importantly with respect to an envisioned future role and influence for Dubai in the global Metaverse economy, the agency clearly states that "VARA aims to take its mission global by creating an easy-to-replicate framework to regulate the industry".[250]

Saudi Arabia has not established any regulatory frameworks for cryptocurrencies, and the country currently maintains a ban on banks processing transactions involving cryptocurrencies (although there are no legal penalties for digital asset trading by individuals). Some analysts anticipate this could change, looking at the creation in September 2022 in the country's central bank of the role of Virtual Assets and Central Bank Digital Currency Programme (CBDC) Lead. This could point to an intention to innovate and potentially introduce new models for regulating digital government-issued currency, not generally included in definitions of virtual assets but which Saudi Arabia and other countries are piloting. While there are currently no laws in Saudi Arabia specifically governing virtual currencies, various laws may be relevant and adaptable into a new unified framework, including the Capital Market Law and the Rules on the Offer of Securities and Continuing Obligations; the Banking Control Law; and the Rules Regulating Money-Changing Businesses.[251]

Bahrain is actively working to position itself as a fintech leader and model, with its central bank having established a hub to aid emerging Metaverse economy start-ups with innovative regulatory support, a regulatory sandbox enabling companies to test their technology-based solutions for up to a year under supervision, and a cryptoasset module in its central bank rulebook. In Oman, the Capital Market Authority is developing a regulatory framework for virtual asset activities intended to align with aspirations outlined in the country's Vision 2040 strategy. In October

In Oman, the **Capital Market Authority** is developing a regulatory framework for virtual asset activities intended to align with aspirations outlined in the country's Vision 2040 strategy.

2023, for a senior staff member of a major global cryptocurrency exchange firm suggested that Arab countries were becoming more successful in attracting businesses "due to their progressive regulatory approaches; what stands out in the Middle East is regulatory certainty and clarity … you're seeing global [virtual asset] companies coming here because it's easy to do business". Continued and accelerating efforts in this regard could be an essential and defining element of Arab power and influence in the future global Metaverse economy.[252]

A third category of regulatory issues is privacy, with multiple dimensions including data privacy and protection and surveillance in the Metaverse. The collection and exploitation of user data has been a contentious legal issue for some time in the Web 2.0 world. But the technologies that enable the immersive 3D virtual environments of the Metaverse (VR headsets etc.) raise new concerns. As discussed elsewhere in this report, these concerns are rooted in part in the larger number and types of biometric and other data they collect. As the Metaverse comes into use in education, health care, financial services, and other contexts outside of gaming and entertainment, the potential for violations of privacy become even greater. As is true in many of the other legal and governance dimensions of the Metaverse phenomenon, the novelty of the technologies makes it an open but urgent question whether the principles and practices of data protection developed for the different technologies of the 2D Internet are applicable, appropriate, or effective. The prospect of eventual global interoperability across large numbers of Metaverse platforms adds another unique dimension, as regulators will need to consider how to protect against privacy incursions associated with data portability.[253]

It is particularly in the area of privacy and potential misuse of users' data that experts and advocates are increasingly expressing concern that the rapid development and evolution of the Metaverse has outpaced regulatory frameworks. Organizations are emerging to develop standards and "planning to issue guidance to lawmakers on the privacy risks of VR, as well as guidance to companies on how to handle various privacy and cybersecurity concerns". Governments and technology companies are sometimes considered to be among the potential malicious actors.[254] This further complicates the question of what bodies might legitimately drive the establishment of regulatory mechanisms.

The interrelated but distinct concepts of data localization, residency, and sovereignty are an important intersection of privacy and regulation. How these policies are implemented will have direct implications for the growth of the Metaverse as an industry driving national economies and wealth creation, in Arab countries and around the world. Data residency has to do with where data is stored: the physical location of the servers and other infrastructure used to store and process data. Data localization, simply, is the choice or mandate to have the residency of data infrastructure (physical servers, or data centres of a cloud provider) in a specific country. Data sovereignty refers to "the legal authority of a government to regulate the collection, storage, use, and transfer of data within its jurisdiction". For security and privacy, countries are increasingly moving to some form of data localization requirement, compelling companies to navigate varying rules in multiple jurisdictions in order to do business.[255]

The massive volumes of data that Metaverse virtual worlds generate, and the unique sensitivity of that biometric and other data compared to Web 2.0 data, will make data localization another critical regulatory consideration. Innovation and leadership

One illustration of familiar **cybersecurity** and safety threats manifesting uniquely in this new technology realm is rooted in the interconnected nature of the Metaverse and the nature of the **VR/AR headsets** and other enabling technologies.

will be important to develop frameworks that enable growth of the global Metaverse economy while answering privacy concerns. Laws have been implemented or drafted over the last decade in the United Arab Emirates, Saudi Arabia, Qatar, Bahrain, Egypt, Jordan, Morocco, Algeria, and Tunisia, but to date there are none in Iraq, Iran, Kuwait, the State of Palestine, the Syrian Arab Republic, or Yemen. They vary in specifics, but most countries have opted for the stricter type of data sovereignty mandates typified in the European Union's General Protection Data Regulation (GDPR). This may be especially important if building consumer trust in the technology as part of national strategies to promote Metaverse adoption to fuel digital economies in these countries. Emerging as a leader in crafting new kinds of replicable frameworks for Metaverse data sovereignty could be a key element in realizing Arab ambitions to be a top player in the global Metaverse economy.[256]

A fourth category of regulatory and governance issues that must be solved in order to enable Metaverse growth is safety, security and criminality. This is another area where many of the threats and risks have precedent in the 2D Internet world but will have new kinds of manifestations that familiar cybersecurity and Internet safety techniques and practices may be unable to contend with.[257] It is also an example of the blur between categories and individual types of regulatory needs and issues in the Metaverse. If the Metaverse is, or is perceived to be, an environment where users and businesses are highly vulnerable to harmful forms of attack, willingness to use it will be considerably lower than the level needed to meet Arab and other countries' ambitions to have these technologies fuel future economic growth.

One illustration of familiar cybersecurity and safety threats manifesting uniquely in this new technology realm is rooted in the interconnected nature of the Metaverse and the nature of the VR/AR headsets and other enabling technologies. They create new kinds of entry points and opportunities for malicious actors to open up data breaches to commit identity theft and other kinds of malicious activities. Identity theft becomes a different phenomenon when users' identities are in the form of avatars linked to all the individual's personally identifiable data and experience history in the Metaverse. As one analyst describes the prospect, "the treasure trove of sensed XR data will unlock the ability to develop a sophisticated, longitudinal understanding of an individual, from their behaviours, intentions, and actions to their mental and cognitive processes and phenomenological experiences – it will effectively enable third parties to construct a digital twin or model of an individual's identity".[258]

A wide range of other kinds of criminal violations of safety, security, and the integrity of business and financial activities in the Metaverse was noted in section 3 of this report in the discussion of government efforts to ensure their citizens' well-being in the future. The survey analysis cited there considered 30 distinct types of criminal acts in five categories, including fraud, forgery, and other financial crimes (e.g. copyright infringement or counterfeiting of digital assets through blockchain hacks; investment scams based on speculation in cryptocurrency markets); property crimes (e.g. "cyber-physical burglary" in which data collected about a Metaverse user's surroundings through a VR headset is used to target a break-in to their physical residence or business); sex crimes (e.g. non-consensual sexual image offenses, or assault that is experienced as vividly and traumatically as in the physical world, or even more so, due to the immersive nature of the Metaverse environment); other crimes against a person (e.g. harassment or hate crimes), and other crimes (e.g. the use of hyper-realistic 3D deepfakes to perpetrate scams, interfere with lawful activities).[259]

There is both an opportunity and a pressing need for countries and groups of countries to take leading roles in developing the laws and regulations that could protect people and businesses from threats and crimes in the Metaverse. Arab countries could help propel themselves into a prominent role in global affairs if they seize that opportunity.

The fifth category of regulatory issues has to do with the oversight of the Metaverse industry itself. There are concerns about the prospect that a limited number of large corporations will dominate the development and deployment of the Metaverse and drive it in directions that prioritize their business interests over those of users. Privacy, security and safety, user experience, interoperability across virtual worlds, and other considerations are perceived to be at risk from already observed actions and anticipated attempts by "big tech" to monopolize the Metaverse space. Lawmakers are in the early stages of restricting acquisitions of start-up Metaverse platforms and apps, platform and user-interface design choices that give preference to bigger technology companies' own platforms and VR/AR devices, manipulation of nascent standards-setting processes, and other real or perceived anti-competitive practices.[260]

This is another important area where it is necessary to consider whether regulatory frameworks developed for the Web 2.0 world are sufficient, even with modifications, to meet the unique challenges of the Metaverse and Web 3.0 world. For example, debates are ongoing regarding whether the European Union's Digital Services Act (DSA), passed in 2022 to regulate online platforms and intermediaries with goals including a fair and open market, can address anticipated threats to competition in the Metaverse. The alternative is to create new, purpose-built frameworks, but thought leadership and action leadership will be even more necessary for that approach.[261]

In 2022, four academics created one such novel alternative they call the Metaverse Competition Agency, not linked to any government. Intentionally emulating the nature of Web 3.0 and the Metaverse themselves, the administrators of this body aim to influence the regulatory environment as a decentralized autonomous organization (DAO), "building consensus and proposing votes to modify rules using decentralized means. Agencies from the natural world could also do so, but we believe their proposals would get systematically rejected because they are centralized agencies". The legal and regulatory questions about how DAOs operate and make their "leaderless" decisions about virtual asset transactions, data security, contract dispute resolution, and other issues within their virtual communities is itself an area where innovation will be important. Taking a leadership role in that innovation is another opportunity for Arab countries to establish their influence in the global economy of the future.[262]

C. The Metaverse has the potential to also increase Arab influence in global affairs in other ways beyond the economy of the future

As the Metaverse advances, it also has the potential for important impacts and implications for Arab countries' role and influence in global culture, in at least two ways: through virtual tourism, and through innovations in digitally aided international diplomatic and political relations.

Ar_TH/via adobe stock

The Metaverse is changing the role and the value of **physical and geographic place**, not only in conducting economic activities, but also in **cultural engagement.**

It holds the prospect of facilitating and stimulating greater engagement with and appreciation of Arab cultures by people and institutions around the world.

1. The Metaverse creates opportunities for global dissemination of Arab cultures

The Metaverse is changing the role and the value of physical and geographic place, not only in conducting economic activities, but also in cultural engagement. It holds the prospect of facilitating and stimulating greater engagement with and appreciation of Arab cultures by people and institutions around the world. One driver of this will be the realities of digital and hybrid work and how that enables more people all over the world to live anywhere, without their livelihood tied to their domicile. As discussed elsewhere in this report, that will accelerate as work moves more into the much more immersive interactive environments of the Metaverse. It opens up opportunities for attracting new residents to move to and live in Arab countries and experience the people and cultures of those countries without having to leave their existing jobs in their countries of origin. The inverse is also true– citizens of any country in the world can work virtually for Arab employers, and in doing so become more familiar with Arab people and cultures. The difference of the immersive, realistic, 3D shared virtual workspace compared to 2D platforms like Zoom will be the difference between having meetings with distant colleagues and building rapport and empathy with those colleagues and where they come from.[263]

Another driver is how the rapidly emerging Metaverse virtual tourism industry is enabling realistic, immersive, interactive cultural familiarization. As discussed in detail elsewhere in this report, the Metaverse is already beginning to transform the travel experience of consumers around the world, helping people to enjoy "visiting" different countries and experiencing their diverse cultures and history, without leaving their homes. Metaverse tourism also enables hospitality organizations to provide an immersive demonstration of what their countries have to offer. Important from the standpoint of the Metaverse aiding a global rise in appreciation and influence of Arab cultures is how these virtual demonstrations and virtual visits provide not just the ability to see tourist landmarks. Metaverse tourists can also experience cultural practices and traditions, and even engage with digital twins of ancient people who may have established those traditions generations ago, to understand them more deeply.[264]

The integration of Metaverse technologies into physical world sites of cultural significance will further deepen the ability to enrich people from around the world with understanding and empathy with Arab cultures. A pilot study published in April 2023 explored what it describes as "a new cultural ecology in which advanced information technologies are deeply integrated with cultural spaces and exhibits," with AR and VR serving as "tools for transforming cultural knowledge into content that enhances visitors' experiences". The experiment validated a hypothesis that Metaverse experiences deepen participants' cultural learning engagement.[265] But the practice of integrating VR and AR into cultural sites to promote this kind of engagement is anything but experimental. It is being seen in countries around the world in parallel with the growth of purely "stay-at-home" Metaverse tourism – including in a number of Arab countries.

The mix of Arab examples of all-virtual and hybrid virtual-physical Metaverse cultural engagement is already growing. In Saudi Arabia, a locally founded digital agency created a Metaverse environment for the celebration of the country's national day in September 2022, in partnership with the King Abdulaziz Foundation for Research and Archives. The express aim is "to make Saudi Arabia's history and culture accessible

In Lebanon, an art foundation is developing a VR element in its existing **digital platform** to make one of the world's largest and most significant archives of Arab art available globally in a **3D immersive experience** of a variety of cultures of the Arab region.

to the world, and to educate future generations on the full breadth of the Kingdom's great heritage". A year earlier, the country's Agency for Exhibitions and Museums Affairs created the "Virtual Black Stone Initiative" described in section 2 of this report. While it has met with some debate regarding the authenticity of touching the Black Stone as part of a pilgrimage, the ability for Muslims unable to travel and non-Muslims to virtually visit Mecca is a valuable cultural learning opportunity.[266]

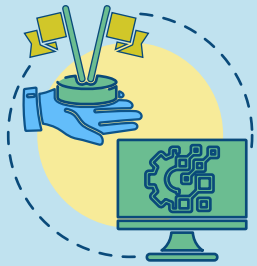
As long ago as 2015, the Government of Jordan partnered with a United-States-based technology company to provide virtual tours of 30 sites in the country, including a historical and cultural tour of the ancient city of Petra narrated by Queen Rania Al Abdullah. In 2017, the company created a 360-degree version of these tours, compatible with basic VR viewers (costing an average of $10), making them accessible to millions more people. A non-profit digital cultural preservation and education organization has created a digital 360-degree visualization experience of the Temple of Eshmun in Lebanon. Also in Lebanon, an art foundation is developing a VR element in its existing digital platform to make one of the world's largest and most significant archives of Arab art available globally in a 3D immersive experience of a variety of cultures of the Arab region.[267]

The Metaverse can also be a powerful component of dissemination of and engagement with Arab cultures with an orientation toward the present and future as well as the present and past. In one example, the Office of the United Nations Special Coordinator for Lebanon (UNSCOL) and the Innovation Cell at the United Nations Department of Political and Peacebuilding Affairs (UNDPPA) partnered in 2023 on a VR documentary called "Dreaming of Lebanon".[268] The aim is to allow viewers to immersively engage with young Lebanese people reflecting on their country, its culture, and their hopes and actions to preserve and advance it in the future. While a key target audience is young Lebanese people themselves, the project can help engage viewers around the world with these important cultural perspectives. Two projects discussed in section 2 that are using VR to support Syrian refugees are pursuing a different but not unrelated aim of connecting or reconnecting Arab citizens to their homeland and culture. Those applications, like all Metaverse tourism experiences, can help members of the Arab diaspora, voluntary as well as involuntary, revive or sustain their ties to their cultures. They can also deepen the understanding of those cultures by people around the world in innovative ways.

2. International relations will in part become a form of "inter-domain relations" as they move into the Metaverse

Finally, there is another way in which the Metaverse will increasingly drive change and create new sorts of impacts in the next era of global affairs. The Metaverse is beginning to transform how political and diplomatic relations between sovereign nations are conducted, and even some of the foundational principles that define what sovereignty is and means. Another element of using the Metaverse to help define an important Arab role in the next global era could be demonstrating leadership in bringing inter-state and "virtual state" relations together into the virtual sphere. This may already be in motion at an early stage: according to one source, "the Middle East and Africa experienced the highest growth rate in the number of articles mentioning 'Metaverse' and 'diplomacy' over the years 2019-2021".[269]

Diplomatic communities and relevant stakeholders are becoming increasingly open to **tech-facilitated diplomacy** and Metaverse technologies offer several high-value applications in this context.



International intergovernmental bodies have been one of the key means of countries' sovereign representation for some 100 years. Arab countries have played a growing role in a number of them in recent years. Saudi Arabia assumed the G20 presidency in 2020, a significant diplomatic achievement. The United Arab Emirates secured a non-permanent seat at the United Nations Security Council in the 2022-2023 rotation. It also hosted the 2023 Conference of the Parties of the United Nations Framework Convention on Climate Change (COP28), as did Egypt for COP27. Qatar has become increasingly active in World Trade Organization (WTO) negotiations, especially in areas concerning the liberalization of trade in services and intellectual property rights (areas with unique importance defining how the Metaverse economy will operate). Qatar has also been significantly involved in the Doha Development Round, which aims to lower cross-border trade barriers.[270]

How negotiations and other relations are conducted among countries in these and other intergovernmental bodies, and in bilateral forums, has the potential to be enhanced and changed by the Metaverse in novel, important ways. A report issued in 2023 describes how "diplomatic communities and relevant stakeholders are becoming increasingly open to tech-facilitated diplomacy" and offers several high-value applications for Metaverse technologies in this context.[271] In one example, VR/AR can be used to create new kinds of transparency and deepened understanding of the implications of policy options. Governments can convert their analyses of the projected outcomes of policies into immersive 3D digital forms that visually and experientially demonstrate rather than explain those outcomes to citizens, businesses, and other key stakeholders. These could also be employed in negotiations with counterparts when the policies are the subject of international negotiations.

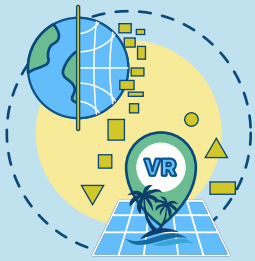
Another example is immersive briefs on critical topics for diplomats. International politics is an environment of time-sensitive engagements with legislators in the home country and counterparts in other countries. Adequate familiarization with details of topics that may be short-notice priorities can make a meaningful difference in the outcomes achieved. Using VR and AR to create interactive and immersive briefs and even "digital twin"-type simulations of alternative outcomes can accelerate and deepen critical learning in the diplomatic setting. The value of Metaverse-based learning for diplomats can also be realized over careers as they move from assignment to assignment – the analysis mentioned above imagines "diplomats from different missions coming together within a single experience and upskilling each other in the process, in the Metaverse".

Analysis by the USC Center on Public Diplomacy takes the application prospects of the Metaverse in international diplomacy even further, into the active conduct of negotiations within immersive 3D virtual environments. Digital representations of negotiators as avatars, or as realistic computer-generated digital twins of specific diplomats, could create environments uniquely conducive to constructive interpersonal engagement, far beyond what has been achievable in 2D video teleconferencing employed in the diplomatic world since the COVID-19 pandemic. As the authors describe it, digital twins of human beings uniquely convey "non-verbal communication cues such as facial expressions, body language, and tone of voice that are crucial in conveying emotions, and project 3D spatiality that allows for multiple perspectives, including first-person or third-person views". The result could be deeper understanding or even empathy with a counterpart's position – perhaps even between adversaries, perhaps even in contexts where the nature of an adversarial relationship precludes meeting in person.[272]

Beyond the use of virtual reality to augment and modify the conduct of "traditional" international affairs, the Metaverse is also already offering wholly new models for sovereign and diplomatic representation, and for the concept of citizenship that has historically been integral to the concept of sovereignty. Several cases provide noteworthy illustrations of this innovation.

For example, Barbados signed an agreement in 2021 with the Decentraland platform to open a virtual embassy in the Metaverse. The country is now carefully working through a set of complex and unprecedented issues of what virtual sovereign territory means, how a virtual embassy adheres to international law such as the Vienna Convention, and more. The Government sees this move as an important way "to increase access to Barbados.gov from across the world, and to democratize access to Barbados' crypto-savvy economy".[273] While to date it is the only country with an embassy in the Metaverse, the USC analysis notes that "recent technological advancements have prompted countries such as Japan, South Korea, the United Arab Emirates, Saudi Arabia and Türkiye to begin devising plans for constructing their own national metaverses".[274] In a noteworthy link to the value of the Metaverse in disseminating Arab and other cultures globally, analysts have noted – and governments have begun to pursue – "opportunities for the Metaverse to change cultural diplomacy … embassies and cultural institutes that engage in cultural diplomacy can create an environment in which foreign audiences may connect with artifacts and other resources that embassies make available to them".[275]

In 2021, Tuvalu began work on its plans to build a **digital version of itself**, replicating islands and landmarks to preserve its history and culture.



Rising sea levels threaten to submerge the country.

Also in 2021, Tuvalu began work on its plans to build a digital version of itself, replicating islands and landmarks to preserve its history and culture. In an interview at the time, Simon Kofe, Tuvalu's Minister for Justice, Communication and Foreign Affairs described the objective of their innovation this way: "the idea is to continue to function as a State, and beyond that to preserve our culture, our knowledge, our history in a digital space" as rising sea levels threaten to submerge the country. At the COP26 meeting in November 2021, Kofe stressed the urgency by addressing the delegates by video standing in the seawaters of the country. In 2002 at COP27, he spoke live from the first completed element of the Metaverse Tuvalu, an immersive 3D replica of the island of Teafualiku.[276]

Other examples portend additional types of revisions to or reimaginings of the traditional concept of diplomatic representation, nation-based citizenship, and the traditional concept of sovereign identity and authority itself.

One is the Free Republic of Liberland. Situated on a 7 km^2 area of land between Croatia and Serbia, it has a president, articles of government, and a Companies Act that governs the legal form and incorporation of local businesses. A delegation recently attended the conference and gala for the fiftieth anniversary of the American Legislative Exchange Council (ALEC). It has no physical inhabitants and no built environment – but a virtual Liberland City, designed by an architect, "has futuristic curving buildings, city halls, working spaces, shops hosting various businesses, and a gallery for NFT art shows". It is a "constitutional republic with elements of direct democracy, run on a blockchain", and describes itself as "a sovereign State" whose laws and rules will be decided through the principles and workings of a DAO. The government and its current 700 registered e-citizens "aim to construct enduring structures to facilitate economic growth for both the residents of Liberland" – growth that will take place entirely in the world of cryptocurrency. Liberland represents a new kind of conception of the sovereign State made possible by the Metaverse.[277]

Palau is pursuing a different model. In early 2022 it introduced a programme aimed at attracting digital residents whose citizenship will be documented in NFTs on a blockchain. The aim is to fuel the economic development of the country by creating a legal and financial services environment that incentivizes virtual residents to build digital-centric businesses headquartered in Palau. A corollary aim, described by the President of Palau at the announcement of the digital residency programme, is to "bring our young people back to Palau to be part of the new technology and innovations out there" in the global economy.[278]

An analysis published in 2022 suggests that models such as that of Palau offer a novel alternative to traditional "residence by investment" and "citizenship by investment" programmes that could be transformative in the global economy of the future. Such programmes allow high net-worth individuals to relocate and obtain a permanent residency visa for a country by making investments such as purchasing a property or investing in a business. Nearly 40 countries offer residency or citizenship-by-investment programmes (including the United Arab Emirates, Egypt, and Jordan) – all based on physical relocation and purchases or investments related to physical property and businesses. The Metaverse opens a new prospect that redefines the concept. Arab countries could position themselves at the leading edge of this to help gain and bolster a leading influence and consequence in the future global economy.[279]

D. Some challenges and obstacles to the advancement of this pathway

1. Current regulations and governance practices for Web 2.0 and the telecom sector could be a suboptimal foundation for a pioneering approach to governance of the Metaverse

Gaining buy-in around the world for Metaverse regulatory frameworks that Arab countries might hope to lead the development and promotion of could face difficulties rooted in perceptions and impacts of telecommunications-sector laws that exist in some countries. One example is the ban on Voice Over Internet Protocol services in countries including Jordan, Kuwait, the United Arab Emirates, Morocco, Oman, and Qatar. The policy is rooted in efforts to protect revenue streams for State-owned telecommunications providers, as well as in national security considerations, but creates constraints and complexity for users, particularly business users. Another issue is the cost impact on business and individual Internet users stemming from limited competition among providers that handle data traffic between countries through their international gateway facilities. Rules around Internet Exchange Points (IXPs) are perhaps most salient when considering the Metaverse, given its very high volumes of data that must move seamlessly and exceptionally fast for user experience in immersive worlds to be effective. Restrictions on access to IXPs are in place in some Arab countries. Additionally, in some countries, governments filter content flowing through networks and, in some specific contexts related to real or perceived security concerns, assume control over whether Internet service is permitted.

Telecommunications sector reform is an ongoing process in Arab countries (as it also is in many other parts of the world). As countries consider how to take a leadership role in creating future regulatory approaches for the Metaverse, it will be important to consider how current approaches to governing voice and data infrastructure and services may need to change further.[280]

2. Dissimilar levels of technology sector advancement and capacity across countries could inhibit a collective effort to develop future regulatory frameworks for the Metaverse

Future prospects for growing a robust technology sector are recognized to vary widely among Arab countries. The primary factor making the difference is the economic status of each country. High-income countries are most advanced in their ability to foster technology companies through investments, workforce development, and other means. That ability progressively diminishes in the middle-income, less-developed, and conflict-affected countries. Stronger technology sectors will be better able to develop the Metaverse with homegrown start-ups, relevantly focused R&D and product/service development in larger companies, and partnerships with leading global companies such as those established by Saudi Arabia, the United Arab Emirates, and other countries. And the countries with Metaverse sectors that rival other top players in the space will be better positioned to exert leadership in regulatory framework innovation. But stronger

Among those benefits could be a more robust innovation **ecosystem** and larger consumer and **business-to-business** markets to serve with Metaverse technologies and apps.

and accelerated advancement of Metaverse sectors in multiple Arab countries could boost their ability to play that leadership role collectively. Looking to precedents in the Web 2.0 economy, the GDPR, as a product of the European Union, has influence that exceeds what any strong individual European country could exert as a model to emulate globally. There are numerous reasons that greater cross-border trade and economic cooperation is difficult among Arab countries, let alone anything resembling an EU-like economic and political union. But there could be benefits in collaborative efforts to facilitate the growth of local Metaverse sectors in many countries. Among those benefits could be a more robust innovation ecosystem and larger consumer and business-to-business markets to serve with Metaverse technologies and apps. An ability to model a multi-country regulatory framework replicable on a larger or even global scale could be a benefit that has great importance for Arab countries' role in the next global era.

3. Making the shift to Metaverse diplomacy and international affairs will face culture-change obstacles that rival the process and technology adaptations needed to do so

Considerable analysis has documented the advent of digital technologies in the conduct of government business over the last decade. From the implementation of tools as simple as email (at one time seen as ambitious), to chatbots and citizen self-service access to benefits and services, governments have made great strides in digitalization. Research and anecdotal evidence suggests that adoption of digital technologies in diplomacy has moved more slowly, and the shift to conducting international relations in the Metaverse could meet with resistance. Part of the impediment lies in legitimate and potentially very consequential security and confidentiality concerns. The practitioners of foreign and diplomatic affairs work with the most sensitive secrets a country holds, some of which have life-or-death consequences associated. Part of it is bureaucracy, generally recognized

yukinoshirokuma/via adobe stock

to be greater in this area of government than others, in part due to these security concerns. Part of it is tradition – the "time-honoured" ways of doing things in foreign and diplomatic affairs are deeply established. One example from a recent study of digital platform use published in 2022 illustrates this: "by creating fewer opportunities for diplomats to engage in unofficial talks via 'corridor conversations,' the virtual medium presumably constrains their ability to creatively explore shared ways of resolving pressing issues". Procedural actions such as updating documents that govern the field, like the Vienna Convention on Diplomatic Relations and Vienna Convention on Consular Relations, likely will be on the horizon. In addition, it will be important for governments to pay close attention to "change management" demands within the foreign affairs establishments and diplomatic corps in each country as they work to shift their long-established processes into the Metaverse.[281]

4. Using the Metaverse for a "pan-Arab" cultural dissemination objective will have to be pursued alongside individual countries' tourism industry priorities

Tourism is a vital industry for many Arab countries. By one estimate, it generated $246 billion in 2022 (as travel returned to nearly 90 per cent of pre-pandemic levels), and it is projected to rise to $400 billion in 2032.[282] According to one travel industry source, the five most popular destinations were Morocco, Qatar, the United Arab Emirates, Jordan, and Egypt in 2022 and the first quarter of 2023.[283] With a more than 100 per cent increase in 2022 relative to the previous year, Saudi Arabia was the fastest-growing travel market among Arab countries over that period. Projections are for strong further growth at least until 2026.[284] Most Arab countries are expected to continue pressing to expand their tourism revenue, and Metaverse tourism will aid in that objective, both as its own new type of revenue stream and as a stimulus for higher levels of physical travel. The objective to use the Metaverse for building greater understanding and appreciation of all Arab cultures, as one means of cementing and growing Arab influence on the future global stage, suggests the importance of a unified multi-country effort. Crafting the strategy, policy, marketing, and other supports for such an effort will need to consider how it can complement rather than compete with individual countries' economic growth portfolios.

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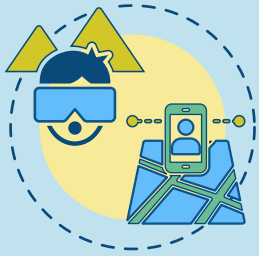

Metaverse tourism will aid in that objective, both as its own new type of revenue stream and as a stimulus for higher levels of physical travel.

E. Recommendations pertinent to this pathway

Establish a new government function in every Arab country to regulate virtual assets and Metaverse security, content, conduct, privacy, trade, taxation, intellectual and other property rights, and other critical elements of the Metaverse

New and pioneering models for regulation and governance of the emerging Metaverse economy and broader ecosystem are the central concept of this pathway. The United Arab Emirates' Virtual Assets Regulatory Authority is an example, standing as the world's first ever and to date only independent and specialized regulator for virtual assets. The phenomenon of the Metaverse is already happening in many Arab countries – cryptocurrency transactions are increasing in volume, implementation of use cases across sectors is proliferating, and the Middle East is one of the fastest growing NFT marketplaces in the world. All Arab countries would benefit from establishing some form of regulatory and oversight function within their government structure, not only for virtual assets but also to manage the myriad other legal and legal-related dimensions of the Metaverse. Doing so would not only demonstrate to the world a shared Arab commitment to leadership in this area of global importance. It would also bolster consumer and business confidence in the Metaverse as an arena to engage, thereby helping grow local economies. It would also be a source of revenue to governments from taxation policies that might be promulgated. The function could be performed by a newly created and dedicated agency like the United Arab Emirates' Virtual Assets Regulatory Authority, or it could be a responsibility added to an existing agency within a country's current government structure. As such a function is established in successive countries, leaders and technical experts in them should meet on a regular basis to share knowledge and best practices, identify common issues, and provide mutual support.

The phenomenon of the Metaverse is already happening in many Arab countries – **cryptocurrency** transactions are increasing in volume, implementation of use cases across sectors is proliferating, and the Middle East is one of the fastest growing NFT marketplaces in the world.

Create a collaborative initiative to promote virtual/Metaverse tourism, with numerous Arab governments and Arab/global tourism industry enterprises all working together in promoting virtual tourism in all countries and cultures

As discussed throughout this report, the prospects for Metaverse tourism as a revenue generator and a means of cultural engagement between Arabs and non-Arabs are promising. Alongside the continued (and continually growing) importance of traditional in-person tourism, it will be a key element of many Arab countries' economic growth strategies in the next decade and beyond. A coordinated and mutually supporting multi-country strategy and campaign to promote Metaverse tourism to all Arab countries would complement individual countries' marketing and promotion efforts while serving the larger aim of communicating the diversity and richness of all Arab cultures. The Metaverse offers a means for Arab cultures to be increasingly central and influential elements of the mosaic of future global culture, and a collaboratively designed and implemented Metaverse tourism promotion initiative can be one key in realizing that ambition. ESCWA could potentially partner with the Islamic World Educational, Scientific and Cultural Organization and other organizations to support such an initiative, helping countries seize the "opportunity to use the 3D internet to immortalize Arab stories, traditions, and landmarks, ensuring they are passed down to future generations [in every country of the world] interactively and engagingly".[285]

Form a group of experts from across all the ESCWA member countries to help build on and accelerate the work of ITU on Metaverse standards, creating a strong Arab leadership role in ongoing efforts to develop and coordinate adoption of shared global standards for interoperability and other essential aspects of the Metaverse

The importance of the work of ITU is widely recognized. As an independent global non-governmental body, the ITU develops specifications and requirements for information and communication technology products, processes, services, and systems that are essential to every sector of the global economy. Every ESCWA member State is a member of the ITU. These Arab countries should join together to volunteer to take on leadership roles within the ITU's considerable ongoing work on the Metaverse to advance standards for interoperability as well as other useful standards. This could be in the form of new technical subcommittees, or coordinating the activities of individual technical committees that address individual areas relevant to the Metaverse, or other forms that could be identified. A coordinated effort among ESCWA member States to accelerate the ITU's work under Arab leadership would be timely and serve as another strong demonstration of a commitment to influence and leadership in the emerging global Metaverse economy.

Initiate pilot programmes to explore and demonstrate the service delivery of consular functions in virtual/Metaverse environments as well as other aspects of international affairs-related government functions such as cultural diplomacy, tourism promotion, and cross-border investment promotion

Several examples in this section of the report show the nascent exploration of the Metaverse as a means and a virtual "place" for conducting diplomacy. Representation in international affairs in venues like embassies is one of the most widely recognized manifestations of national sovereignty, and actions by Arab countries to move that representation into the Metaverse would communicate a strong signal of commitment to pioneering leadership in this new part of the global stage. This could take many forms, as the use case is still in its early stages, and would best be tailored to the capacity of the diplomatic establishment of each country. Engagement with countries such as Barbados and the handful of others that have taken steps in this direction to learn about their experience would help inform the design of pilot efforts in Arab countries. There are also multi-country ideas that could be explored, such as creating virtual environments for holding ESCWA ministerial summits, UNFCCC Regional Climate Weeks, preparatory meetings for representation at the upcoming United Nations Summit on the Future, or other bodies that bring Arab countries together for shared objectives.

Develop new applications in the Metaverse to help displaced persons within and emigrants from Arab countries to sustain connection with their countries and cultures

The scope and scale of the voluntary and in some cases involuntary movement of people to, from, and within Arab countries is considerable. According to a recent report from the United Nations International Organization for Migration, there were 16.2 million internally displaced persons (IDPs) at the end of 2022 – 23 per cent of the global number of IDPs, "making the Middle East and North Africa the region with the second highest concentration of IDPs following the sub-Saharan Africa region".[286] There are also tens of millions of migrant workers living and working outside their countries of origin. And with the growing severity of climate change impacts, it is anticipated that the movement of people to more hospitable living conditions will grow. Among the many dimensions of this issue is how migrants and IDPs can sustain or regain their connection to their cultures. The Metaverse provides new options for helping to address this, as described in examples in this report. The further development and distribution of applications such as these would make a substantial contribution to the preservation of cultural identities as Arabs establish or seek to establish new homes in other parts of the world where their cultures are less accessible and less understood. As they are developed, it will be important to ensure, through support from governments and civil society organizations, that the technologies that provide these cultural connections are affordable and available to those with lesser means.

Establish a mechanism funded primarily by more prosperous ESCWA member States to promote and enable the large-scale adoption of Metaverse technologies in less prosperous member States

The wide range of economic conditions in different Arab countries is well recognized and is traceable to a wide range of root causes. The levels of advancement of digitalization in different countries is expectedly correlated in most cases to whether they are high income, middle income, less developed,

or conflict affected. The emergence of a strong Arab role and influence in the future global Metaverse economy could be accelerated if many Arab countries are each able to develop the sector locally. To do so will require assistance in various forms and from various sources, like the actions in some of the other recommendations in this report (e.g. multilateral bank funding for 5G/6G infrastructure). Direct support from higher-income Arab countries to lower-income ones should be explored as one of the forms and sources of support for fostering a vibrant Metaverse sector. There is a considerable history of such financial support in other contexts, for example in the wake of the COVID-19 pandemic, and in decades of GCC foreign aid to many countries around the globe, 60 per cent of which since 1962 has been directed to other Arab countries.[287] Investment and technical assistance from wealthier States for the development of neighboring countries' Metaverse economy sectors would in one sense be from a spirit of solidarity. But it would also serve the interests of the supporting countries, just as pandemic support has contributed to shared macroeconomic stability. For example, results could include creating a larger local market for their own Metaverse products and services and strengthening the influence of efforts to create regulatory frameworks that can be models for the rest of the world.

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Conclusion – key findings, key messages, and recommendations

The Metaverse has the potential to revolutionize Arab societies and other societies around the world. These technologies will bring about transformations in everything from education and health care, to the design and redesign of cities, to the internal business operations of nearly every industry, to how we combat climate change and how countries represent their sovereignty.

Given the diversity of Arab countries, there is considerable potential for a variety of pathways to be pursued to advance the development and use of the Metaverse. A number of these countries have already made significant steps down some of these pathways. This report has explored three such potential pathways that the Metaverse could take in Arab countries over the next two decades and beyond.

In this section of the report, drawn from the three preceding sections, are key findings, key messages, and recommendations, organized by the type of recommendation that each one primarily represents. Most of the recommendations have more than one dimension. For example, some policy and legislative recommendations also encompass an investment dimension or a technical dimension. Similarly, some investment or technical recommendations also encompass a policy dimension.

Each recommendation also indicates the categories of key stakeholders that will be instrumental in carrying the policy, investment, and technical actions forward through to their eventual successful implementation. Stakeholder types considered are national policymakers, regional and municipal government officials, private sector bodies, civil society organizations, international finance institutions and IGOs, and academia.

Finally, each of the recommendations also supports one or more of the United Nations Sustainable Development Goals (SDGs). Arab governments and other sectors attach great importance to the SDGs. Linking these Metaverse advancement recommendations to SDG strategies and investments will be valuable to help advance that priority. Accordingly, the enumeration below of each recommendation also notes the links to one or more SDGs.

Policy, legislative, and regulatory recommendations (P)

1

Key finding

Small and medium-sized enterprises (SMEs) encompass 90 per cent of businesses and, depending on the country, provide 10 per cent to 40 per cent of all employment in the Middle East and North Africa. While Metaverse start-ups are emerging in Arab countries, they are considerably fewer and growing less rapidly in most countries than in the Gulf countries.

Key message

SMEs are a vital component of growth and job creation strategies in every Arab country – a holistic system of supports to those in the Metaverse space will link those strategies to the new sector of the global economy.

Recommendation

Develop and implement a multi-pronged policy framework that fosters the creation and success of Metaverse-related start-ups and SMEs through integrated actions in key areas including facilitating access to finance, targeted expenditures in Metaverse-relevant skills in education systems, and business-friendly taxation and other legal mechanisms.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Civil society organizations

2

Key finding

The rapid emergence of the Metaverse is driving innovation in power generation, providing an opportunity to develop a secure, sustainable energy trading system using smart grids, virtual power plants, digital twins, and blockchains. Digital twins allow utilities to model their assets' performance and plan for the entire lifecycle of those assets.

Key message

Meeting climate pledges and green economy transition objectives requires substantial modernization of electricity infrastructures in Arab countries – the Metaverse will help by enabling the digital modelling of grid modernization projects that are essential for the smooth incorporation of renewable energy sources into countries' power-generation strategies.

Recommendation

Promote the use of digital twins as a central element in electricity grid modernization and other efforts to improve operating efficiencies and shift the energy mix in Arab countries to more renewable sources.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector

3

Key finding

VR headsets, IoT devices, and interoperability across platforms will be critical enablers of the Metaverse, providing countless more entry points into businesses' Metaverse networks and environments, but also creating security risks. Less than half of business leaders are "very confident" that existing cybersecurity measures are sufficient to curb cyberthreats in the Metaverse, and 60 per cent express concern that Metaverse security complexities exceed the measures that their own and other organizations have available.

Key message

The substantial benefits of the Metaverse to Arab economies and societies are at risk from business and consumer fears that its security dangers might not be adequately addressed – creating means for addressing them will build necessary confidence and also strengthen the broader digital economies that are essential to economic diversification.

Recommendation

Build on Arab countries' existing foundations of cybersecurity laws and practices by establishing additional new ones that are specifically tailored to protect the commercial businesses and enterprises in other sectors that wish to do business in the Metaverse.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector
- Civil society organizations
- Academia

4

Key finding

Governments in Arab countries are beginning to have multiple Metaverse programmes and service offerings in multiple ministries' areas of responsibility.

Key message

The Metaverse is a prominent and urgent example of a growing number of issues that have implications that cross the boundaries of traditional ministerial responsibilities – coordination within individual Arab countries' governments and across countries' borders is essential both to optimize the pathways to realizing Metaverse opportunities and to forestall harmful consequences from inconsistent actions.

Recommendation

Form an interministerial working group in each Arab country to coordinate policies and actions within that country's government and with neighbouring countries to promote the adoption of Metaverse technologies in priority well-being areas.

Key stakeholders

- National policymakers
- Civil society organizations
- Academia

5

Key finding

In Arab countries, awareness levels about the Metaverse in the consumer sector are only approximately 50 per cent. In the business sector, that rises to about 80 per cent. At the same time, in Arab countries as well as in other countries around the world, understanding of the Metaverse and its implications and use cases is generally well below awareness of the trend.-

Key message

Misunderstanding and ignorance of the Metaverse, and perceptions by many that it is primarily a social and entertainment medium, pose a risk to adoption of the practical applications that can drive Arab countries' economic growth, social benefits, and global influence.

Recommendation

Design and conduct national, local, and intercountry communications campaigns to raise awareness in populations and business sectors about the Metaverse and its opportunities to create social and economic benefits.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector
- Civil society organizations
- International finance institutions and IGOs
- Academia

6

Key finding

Meeting the energy requirements to power the Metaverse has negative environmental and sustainability consequences. Data centres globally are estimated to generate 2 per cent of carbon emissions, a figure projected to rise to 14 per cent by 2040 due in significant part to the Metaverse. Servers also use large amounts of water for their cooling systems.

Key message

Companies working to create the Metaverse have both an obligation and an opportunity to be proactive in addressing the harms it can cause to the natural environment – organizations in all sectors of Arab countries can employ a variety of means to reward companies that do so and hold accountable others that do not.

Recommendation

Promote the use of cloud providers and other Metaverse-related technology companies that are demonstrating they are actively working to reduce the negative environmental impacts of their products, services, and business operations.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector
- International finance institutions and IGOs

7

Key finding

Nearly 40 per cent of people familiar with and working on advancing the Metaverse are concerned about equity of access. Even the lower-cost alternatives among currently available VR headsets and other Metaverse enabling technologies are beyond reach for many, and nearly 30 per cent of Arab countries' populations do not have access to the Internet.

Key message

The digital divide is a critical challenge in Arab countries as it is worldwide – the Metaverse can help solve it through applications that intentionally provide social benefits, but only if those applications are made available to the segments of societies most in need of them.

Recommendation

Require all Metaverse applications that are involved in education, health care, and other essential social services and sectors to also function on low-cost hardware, older operating systems, smartphones, and other technologies affordable to most people.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector
- Civil society organizations
- International finance institutions and IGOs

8

Key finding

Cryptocurrencies present a new kind of challenge to currency law and monetary systems because they are issued and circulated by parties outside the jurisdiction of central banks. Virtual assets and intellectual property in the Metaverse defy categorization from a regulatory perspective because their legal statuses are open to many interpretations. In the area of privacy, experts are increasingly voicing concern that the rapid development and evolution of the Metaverse has outpaced regulatory frameworks.

Key message

Governments in Arab countries have the responsibility both to safeguard their citizens from harm and to create conditions for them to prosper – the Metaverse presents a variety of unprecedented challenges and opportunities that demands creation of structured systems of oversight and enablement.

Recommendation

Establish a new government function in every Arab country to regulate virtual assets and Metaverse security, content, conduct, privacy, trade, taxation, intellectual and other property rights, and other critical elements of the Metaverse.

Key stakeholders

- National policymakers
- Private sector
- International finance institutions and IGOs
- Academia

9

Key finding

The foundation of today's Internet is a collection of open standards negotiated by stakeholders to help them share information across platforms to facilitate collaboration on future technologies, projects, and ideas, but no such set of standards has yet been crafted and broadly adopted for the Metaverse. ITU, recognized as the forefront of global standardization in the telecommunications sphere, is doing considerable work to fill this gap, having already published more than 20 reports on Metaverse-standardization-related topics.

Key message

The common standards for the technologies and processes that comprise the Internet are what has enabled it to transform global society – Arab countries have an opportunity to play a pivotal role in creating the analogous framework of standards that is needed for the Metaverse to bring about the next phase in the world's digital transformation.

Recommendation

Form a group of experts from across all the ESCWA member countries to help build on and accelerate the ITU's work on Metaverse standards, creating a strong Arab leadership role in ongoing efforts to develop and coordinate adoption of shared global standards for interoperability and other essential aspects of the Metaverse.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector
- Academia

10

Key finding

The massive scale of adoption of virtual meeting and collaboration technologies during the COVID-19 pandemic included use in government functions related to international affairs. That use will continue – diplomatic communities and relevant stakeholders are becoming increasingly open to technology-facilitated diplomacy and working to address valid concerns about security and other issues.

Key message

As governments move more of their functions into the digital domain, the Metaverse provides an opportunity for Arab countries to take that digitalization to a new level of significance in the functions most emblematic of the concept of sovereignty.

Recommendation

Initiate pilot programmes to explore and demonstrate the service delivery of consular functions in virtual and Metaverse environments as well as other aspects of international affairs such as cultural diplomacy, tourism promotion and cross-border investment promotion.

Key stakeholders

- National policymakers
- International finance institutions and IGOs
- Academia

Investment Recommendations (I)

1

Key finding

Green finance initiatives are a growing phenomenon, with nearly 700 national and sub-national policy and regulatory measures documented in 100 countries since 2015. Technology innovations as an investment focus within these initiatives is also growing.

Key message

Prospects for making the green economy transition and meeting climate pledges including nationally determined contributions under the Paris Agreement can be materially improved in Arab countries by tying them to those countries' Metaverse economy ambitions, given how Metaverse technologies help reduce carbon emissions and aid in other ways in climate change mitigation and adaptation.

Recommendation

Make investment in Metaverse technologies a specific and intentional element in the portfolios of Arab green finance investment initiatives.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector
- International finance institutions and IGOs

2

Key finding

Estimated global data usage will be twenty times today's levels in 2032 as a result of the Metaverse, along with a projected need for 1,000 times today's computing power, vastly increasing the need for wireless broadband networks. At the same time, 5G subscriptions in Arab countries in 2028 will still be only 31 per cent of total wireless subscriptions.

Key message

Every aspect of the digitalization and diversification of Arab economies already requires an expansion of wireless connectivity – realizing the promise of the Metaverse in the economic and other societal objectives of Arab countries will substantially increase the need for more wireless connectivity buildout to enable the VR environments to function.

Recommendation

Work with multilateral development banks and other international development and finance institutions to secure concessional and blended finance for the large-scale construction of 5G/6G and other Internet infrastructure needed to enable essential connectivity requirements of Metaverse technologies in every Arab country.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector
- International finance institutions and IGOs

3

Key finding

Conducting analyses of building operations using digital twins can help bring about a 50 per cent increase in a commercial or industrial facility's sustainability, stemming primarily from reduced greenhouse gas emissions. Government support for applying new digital technologies, especially when they have environmental benefits, is being demonstrated in a growing number of countries including Italy, Japan, Luxembourg, Malaysia, Portugal, and South Korea.

Key message

Improvements in the sustainability of industrial and other businesses in Arab countries, together with increased productivity and consequent growth, can be accelerated with supports to Metaverse elements of corporate investment strategies.

Recommendation

Provide tax incentives to businesses that incorporate digital twins into how they work to generate efficiencies in their business operations and to reduce their carbon footprint.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector

4

Key finding

Arab countries are seeing a growing number of initiatives in which VR and AR technologies are integrated with cultural spaces and exhibits with the express intent of deepening participants' cultural learning engagement.

Key message

The Metaverse provides a unique and consequential opportunity to communicate the historical and contemporary achievements, values, and other tangible and intangible aspects of Arab culture.

Recommendation

Create a collaborative initiative to promote virtual and Metaverse tourism, with numerous Arab governments and Arab and global tourism industry firms all working together to promote virtual tourism in all countries and cultures.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector

5

Key finding

There is a considerable history of financial support from the Arab countries endowed with natural resources to other Arab countries, for example in the wake of the COVID-19 pandemic, and in decades of GCC foreign aid to many countries around the globe, 60 per cent of which since 1962 has been directed to other Arab countries.

Key message

Support from currently high-income Arab countries to foster the development of Metaverse businesses and growth of consumer and enterprise Metaverse user markets in neighbouring countries can benefit their own ambitions of becoming top global Metaverse economies.

Recommendation

Establish a mechanism funded primarily by more prosperous ESCWA member States to promote and enable the large-scale adoption of Metaverse technologies in less prosperous member States.

Key stakeholders

- National policymakers

Technical Recommendations (T)

1

Key finding

The efficacy of immersive virtual reality is proven as a means of visualizing the consequences of climate change in ways that generate a stronger influence on users' climate-change awareness and environmental attitudes than do traditional media.

Key message

Climate change is accelerating and its impacts are worsening, and a number of Arab countries are among the ones most affected around the world – new and more compelling means are urgently needed to help individuals and enterprises in every sector to grasp the situation and become motivated to address it.

Recommendation

Develop and widely promote Metaverse-based education programmes with content tailored to Arab countries' context to educate about climate change and its impacts in those countries, ways to reduce their impacts on the environment, sustainability practices, etc.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector
- Civil society organizations
- International finance institutions and IGOs
- Academia

2

Key finding

The adverse effects of extended periods of time in virtual reality environments include depression, anxiety, loneliness and disruptions to sleep patterns. An additional range of growing concerns includes loss of spatial awareness, nausea, dizziness, disorientation, myopia from prolonged exposure, and neurological impacts.

Key message

Creating new jobs and new kinds of job opportunities is an imperative across many Arab countries, and a challenge that the Metaverse can meaningfully help to address, but the risks of harm to workers can slow or stall that contribution unless they are mitigated.

Recommendation

Fund research into ways to reduce or eliminate the harmful physiological and psychological health impacts on workers spending extended time in Metaverse environments.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector
- Academia

3

Key finding

The extremely large computing power requirements of the Metaverse could be curbed through the advancement of technologies such as edge computing, but it is very expensive to install and use due to the cost of its customized hardware and software. Real-world applications have proven numerous benefits of edge computing, but there are still challenges that it faces that require research.

Key message

Arab countries can strengthen their position and reputation in the global Metaverse economy and the broader digital economy with targeted commitments to solving some of the technological and externality challenges for the global base of Metaverse users.

Recommendation

Fund research and development initiatives into edge computing and other technology advances that will help make the Metaverse environmentally sustainable.

Key stakeholders

- National policymakers
- Regional and municipal governments
- Private sector
- Academia

4

Key finding

Virtual experiences have significant potential to enrich interactions, encourage socialization, improve communication, alleviate trauma, sustain connection with native culture, and provide other benefits to individuals displaced from their countries of origin.

Key message

The Metaverse offers unique new means of improving quality of life and strengthening social stability in Arab countries that are hosts to migrants from other Arab countries or from other parts of the world.

Recommendation

Develop new applications in the Metaverse to help displaced persons within and emigrants from Arab countries sustain connection with their countries and cultures.

Key stakeholders

- National policymakers
- Private sector
- Civil society organizations
- Academia

Endnotes

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This report is an in-depth analysis of the Metaverse's implications as a pivotal global megatrend, specifically focusing on its influence in the Arab region in the period up to 2040. It thoroughly investigates the concept of the Metaverse, emphasizing its potential to revolutionize sectors such as job creation, industrial evolution and economic growth in the Arab region. The report explains the diverse impacts that the Metaverse will have on multiple socioeconomic sectors in the Arab region. The analysis identifies various transformative pathways the Metaverse could enable in the region. These include reshaping job markets and industries through Metaverse-driven technologies, potentially creating new job categories, altering or phasing out existing jobs, shifting work into Metaverse environments, and evolving the necessary skill sets.

The report also describes the Metaverse's capacity to bolster societal welfare in education, healthcare, environmental sustainability, and urban living standards. The report gives an in-depth account of the regulatory and governance frameworks essential for the Metaverse, and suggests that the Arab region is uniquely positioned to lead in establishing these frameworks, potentially becoming a major player in the global digital economy. The report culminates with 19 key findings, messages, and strategic recommendations targeting government agencies, private sector firms, civil society groups, and development leaders. These guidelines are designed to assist stakeholders in harnessing the Metaverse to achieve progress in the Arab region. It offers practical insights and policy recommendations to regional leaders to effectively navigate industry transformations and enhance societal wellbeing. The report also addresses potential challenges and opportunities, ensuring coverage of the Metaverse's multi-dimensional implications for the future of the Arab region.

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