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The Metaverse in Asia
Strategies for Accelerating Economic Impact

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Special thanks to Deloitte Economics Institute for their assistance with the economic impact estimates in this report:

Sam Blackie
John O'Mahoney

And their team:

Amrik Ashri,
Ian Rodger,
Josefa Lavandero,
Samuel Smithers,
and Socrates Mokkas.

We would also like to thank the following individuals for their support and contributions:

Ayako Tobe,
Bergita Husni,
Bill Briggs,
Carie-Anne Bak,
Chew Chiat Lee,
Emad Tahtouh,
Frances Yu,
Hanson Wang,
Harrison Lee,
James Walton,
Jennifer Wright,
Jeanette Juay,
Jefferson Djauhari,
Jehil Thakkar,
Kim Sa Heon,
Leigh Mannes,
Lisa Zhou,
Metinee Jongsaliswang,
Mike Bechtel,
Narain Chutijirawong,
Oh Sung Hoon,
Paul Stapelberg,
Peeyush Vaish,
Philip Law,
Rick Wen,
Robert Hillard,
Shevon Huang,
Sreeram Ananthasayanam,
Steve Aditya,
and Uyen Tran Ngoc Tu.

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Executive Summary

Embracing the metaverse could unlock a trillion-dollar opportunity in Asia. Developing the technology stacks, human capital and regulatory frameworks required will benefit a wide range of industries and economic activities.

Neal Stephenson's novel Snow Crash, novel-turned-Hollywood movie Ready Player One, and Facebook's rebranding to Meta, have all embedded the term 'metaverse' in the public consciousness. Though there is no universal definition of the metaverse, we see it as a facet of the 'next internet', a highly immersive virtual world where we will interact, work, and play.

The metaverse is no longer science fiction. Early metaverse platforms are already being used by millions. In Asia, many consumers are already gaming, socializing, attending concerts, and purchasing items on virtual platforms such as Roblox, Decentraland, Fortnite, and Asia's very own Sandbox and Zepeto. Industries and businesses are also experimenting with metaverse technologies. Several governments in the region, including China, South Korea, and Japan, have featured the metaverse in their economic plans.

The potential impact of the metaverse on Asia and globally could be significant if investments are made into fundamental and enabling factors. Though investments made in the next five to ten years may not have immediate short-run returns on output, these investments will likely play out over a longer time frame as the technologies mature.

Using early estimates on the potential metaverse investments from the literature, we estimate that the impact of the metaverse to GDP in Asia could be between US$0.8 trillion - US$1.4 trillion per year by 2035, roughly 1.3-2.4% of overall GDP per year by 2035.[1] However, the development path of this nascent technology still remains uncertain.

> The potential impact of the metaverse to GDP in Asia is US$0.8T-US$1.4T per year by 2035, roughly 1.3 – 2.4% of overall GDP.

How will these economic benefits materialize? The metaverse creates new marketplaces and types of businesses, and could expand access to information, digital content and digital infrastructure. New employment opportunities and ways of working might emerge both at the individual and organizational level.

These impacts have ramifications across many sectors, not just in entertainment and gaming. Retail, e-commerce, and manufacturing processes can be radically transformed. Innovations in healthcare and education will not only create economic value, they may also improve well-being and the human condition.

How much of the economic benefits are realized, and how quickly, depend on unique strategies the underlying economies may take to accelerate economic benefits of the metaverse.

1. Based on metaverse investment ranges from the literature, we explore a central metaverse investment scenario of $700bn over five years being maintained globally to 2029, alongside a boosted investment scenario of $1,350bn. Annualized, these equate to $140bn and $260bn per year, respectively. To estimate the economic impact for Asia, we first estimate the impact of the global investment scenarios on global GDP per year by 2035. Following this, we apportion the impacts on an economy level based on their contribution to global GDP, which are then summed up to form the regional estimate.

Asia's favorable demographics, supply chain market share, and growing influence on socio-cultural trends underline its potential role in shaping the metaverse. This is bolstered by the high level of awareness and support its populations have for the metaverse. Each economy in our analysis[2] is approaching the metaverse from its own unique direction based on its combination of characteristics, which makes this region an interesting one to watch.

Some lean into their **sectoral expertise**. Economies which excel in the manufacture and export of electronics, such as Taiwan and South Korea, may be well-positioned to benefit from the increasing demand for hardware and other user-devices. Economies with large technology or R&D sectors, such as Japan, Singapore, South Korea, and Hong Kong could benefit from the demand for platforms and the design of complementary hardware and software. Vietnam and Thailand are innovating with web3 and blockchain technologies.

Others build on their **strong institutions**. Economies like Hong Kong and Singapore have positive investment environments and strong digital and patent laws. These become welcoming environments for investors and designers keen to make headway in the metaverse.

> Each economy in our analysis is approaching the metaverse from its own unique direction, which makes this region an interesting one to watch.

Yet others tap into their **natural and cultural endowments**. China and Indonesia, for example, which are abundant in natural resources like nickel, rare earth and lithium, are poised for the increase in manufacture of new user-devices. Vietnam, Philippines, Pakistan, India and Indonesia have large digitally-ready workforces. All of the economies can also bank on their rich cultural capital to build creative content for the metaverse.

In this report, we present a three-pillar framework to evaluate the possible economic impact of the metaverse in each economy. First, we identify **macroeconomic determinants** or factors that determine the opportunity available based on economic characteristics such as income levels, sectoral structure, and innovation environment.

We then look at the economy's **technology fundamentals** that are required for the metaverse to exist and operate, including computing power and connectivity, user device ownership, and digital transactions. The third pillar is **ecosystem enablers** that support the adoption of the metaverse. For each economy, we highlight differentiated strategies and key sectors to watch for breakout innovations.

Those with favorable macroeconomics and strong technology infrastructure will likely achieve strong economic value creation from the metaverse first. Given the confluence of technologies needed, the likelihood that the metaverse will allow developing economies to completely leapfrog technology infrastructure, the way mobile technology did, is low.

But macroeconomics are not deterministic. Understanding the potential opportunity and leaning into specific technology and talent investments will also allow for economies to accelerate their journey and achieve economic impact.

2. In this report, we cover 12 economies in Asia including Hong Kong, Taiwan, India, Indonesia, Japan, Mainland China, Pakistan, Philippines, Singapore, South Korea, Thailand, and Vietnam. We may quote Asia figures from other studies which have a different coverage of economies.

The successful future of the metaverse calls for action not just by governments, but all ecosystem actors.

While the metaverse is inevitable, a responsible metaverse is not. To realize the full potential of the metaverse, some important issues must be addressed – climate, inclusion, mental health and online harms, civic discourse, and an economy's social fabric. A more immersive, pervasive internet could potentially exacerbate negative externalities.

But the metaverse could also provide us with new tools to tackle these important issues such as through bridging physical distances, changing behaviors to be more sustainable, and bringing communities closer. Forward thinking can turn these challenges into opportunities.

Positioning Asian economies for the metaverse is a strategic move. The successful future of the metaverse calls for action not just by governments, but all ecosystem actors including telecom operators, technology sector, businesses and start-ups, researchers and academics, metaverse users, and the general public. By investing in key enablers, economies have the potential to accelerate the economic and social benefits of the metaverse.

Over 60% of the world's youth, aged between 15 and 24, live in Asia and Oceania.

South Korea and China are leading the world in 5G deployment.[3]

The 12 Asian economies in our study exported 81% of the total value of cellphones[4] and 75% of integrated circuits[5] globally in 2021.

India, the Philippines and Pakistan are top destinations for IT outsourcing.[6]

1.3 billion mobile gamers across Asia, the biggest mobile player base worldwide.[7]

3. European 5G Observatory, "South Korea leads in 5G rollout, followed by China and Japan", accessed October 19, 2022.
4. The Observatory of Economic Complexity (OEC) "Telephones for Cellular Networks or for Other Wireless Networks." accessed August 25, 2022.
5. The Observatory of Economic Complexity (OEC) "Integrated Circuits," accessed August 25, 2022.
6. Deloitte, 2021 Global Shared Services and Outsourcing Survey Support, 2021.
7. Statista, "Mobile gaming market in the Asia Pacific region – statistics & facts," accessed May 23, 2022.

Metaverse.

\ (me-tə-vərs) \ noun. The concept of a highly immersive virtual world where people gather to socialize, play and work.[8]

8. Merriam-Webster, "What is the 'metaverse'?," accessed September 28, 2022.

Japan

Pioneer of the video game industry is leveraging its strong heritage in digital craftsmanship to create new metaverse industries

South Korea

First major economy to articulate a comprehensive strategic blueprint to foster its metaverse industry

Singapore

As one of the best places in the world to do business, it attracts top metaverse companies to headquarter in the country

Hong Kong

Hong Kong University of Science and Technology is one of the first schools in the world to have a digital twin, along with mixed reality classrooms

Mainland China

The second largest economy in the world seeks to create a metaverse that complements the real economy

Taiwan

Holds more than 90% of the manufacturing capacity for the world's most advanced semiconductors

Indonesia

Building a metaverse to level the playing field for micro, small and medium enterprises

Philippines

Key source of talent for metaverse support services as a leading destination for business process outsourcing

Thailand

With its large creative sector (10% of GDP) and entrepreneurial culture, local metaverse projects are sprouting

Vietnam

Ranked the highest globally on the 2021 Global Crypto Adoption Index and is setting up a Metaverse Village to spur innovation

India

Building robust digital payments infrastructure, including plans for a pilot launch of the digital rupee, which will facilitate metaverse transactions

Pakistan

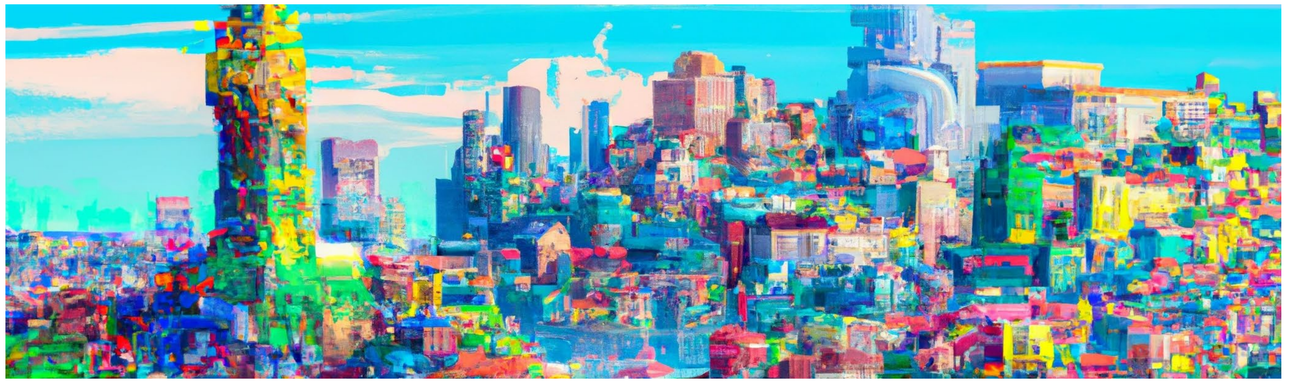
Third largest contributor of technical labor globally, and could be a key source of talent for the metaverse

Note: Refer to specific economic profiles for more details and sources.

AI-Generated Art

The cover page and several images within the report were created using AI art generators, such as Dall-E 2, which generates art based on text and image prompts. Such tools speed up and augment the creative process of digital content and art that could fill the virtual worlds of the future. These were the prompts used to generate images in this report.

Covers



Cityscape of Singapore as painted by Pablo Picasso in 2020, Cubism, Digital art, Unreal engine, Octane renderer, 4K; King Power Mahanakhon; Cityscape of Dehli

Cinematic lighting of the moon and stars casting over Chinatown in Bangkok, featuring neon billboards and tuk-tuks, Synthwave style; Dotonbori district in Osaka, featuring its bright neon Glico signboard

Hong Kong

Monster Building in Hong Kong, photographed from below, Digital art

Spaceman dunking in midair, Choi Hung Estate basketball court in Hong Kong, as painted by Salvador Dali

Dim Sum in Hong Kong, as illustrated in Spirited Away, Studio Ghibli, Digital art

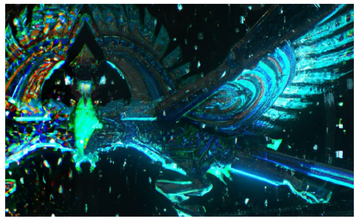
India

Wide shot of a vibrant Taj Mahal on the top of Jodhpur, in a virtual land

Portrait of Indian Bengal tiger as painted by Henri Matisse, Digital art, Unreal engine, Octane renderer, 4K

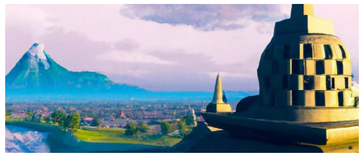
Close up shot of the Interior of Amber Fort, India, in broad daylight, True to life colors, Digital art, Unreal engine, Octane renderer, 4K

Indonesia



Garuda Batik traveling at the speed of light, Digital art, Unreal engine, Octane renderer, 4K

Cityscape of Jakarta in an eye, Macro photograph

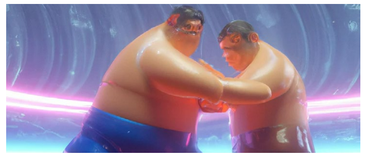


Borobudur, Indonesia, in the style of the anime JoJo, Digital art, Unreal engine, Octane renderer, 4K

Japan

Dotonbori district, Osaka, featuring the Glico man sign, as illustrated by Bored Ape in 2020, Digital art, Unreal engine, Octane renderer, 4K

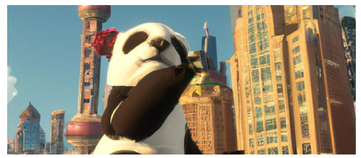
Fushimi Inari Taisha in the middle of the ocean, Kyoto, as illustrated by Hayao Miyazaki in 2020, in broad daylight, Digital art, Unreal engine, Octane renderer, 4K



Japanese Sumo Wrestlers wrestling one another, as illustrated by Goro Fujita, Digital art, Unreal engine, 3D Octane renderer, 4K

Mainland China

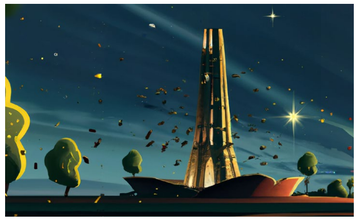
Wide shot of the Galaxy Soho, Beijing, Futuristic building with a flourishing garden roof



Giant Panda skateboarding in the middle of Bund District in Shanghai, VRChat land

Festive Chinese Lion Dance during the New Year celebration as painted by Van Gogh in 2020, Impressionistic hues of light pink and white

Pakistan



Pakistan Monument in the evening with fireflies gleaming in the skyline, Digital art

Hunza Valley colliding against its reflection, Pakistan, as illustrated by Mai Yoneyama in 2020, Digital art, Unreal engine, Octane renderer, 4K

Intricate tile work of Islamic architecture in Lahore, Pakistan, as illustrated by Hayao Miyazaki in 2020, Digital art, Unreal engine, Octane renderer, 4K

Philippines

Wide shot of limestone cliffs and the underground river of Puerto Princessa, Palawan, as painted by Claude Monet; Purple wisteria trees

Banaue Rice Terraces as an tiny island, 180, as illustrated by Takashi Murakami, Panoramic photography

Scuba diving and swimming with 3D rendered turtles made out of golden wattles in Balicasag, Philippines, Digital art

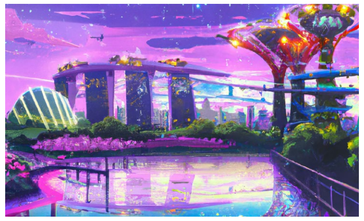
South Korea

Dongdaemun Design Plaza, Seoul in South Korea, as painted by Pablo Picasso in 2020, Cubism, Digital art, Unreal engine, Octane renderer, 4K

Traditional Hanboks from Korea, as designed by Issey Miyake in 2020, Pleats, Digital art, Unreal engine, Octane renderer, 4K

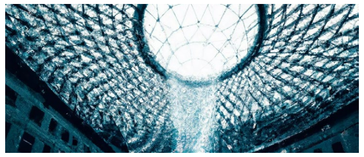
Namsan Tower, photographed from below, as animated by Goro Fujita, True to life colors, Digital art, Unreal engine, 3D Octane renderer, 4K

Singapore



Gardens by the Bay, Singapore, skyline in the style of the anime Sailor Moon, Digital art

Front shot of a Traditional Convenience standalone shop in Singapore, Photographed in film, Wes Anderson, Digital art

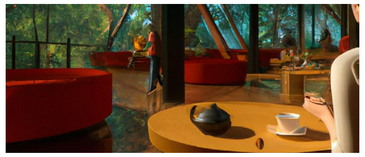


Rain Vortex in Jewel, Singapore, in the style of the film French Dispatch, Stop motion animation

Taiwan

Cityscape of Taipei in the style of the anime Kitmetsu no Yaiba, in daytime, featuring Taipei 101 Business Center, Digital art, Unreal engine, Octane renderer, 4K

Raohe Night Market in the style of the anime Kimi no Na wa during the evening, featuring neon lights, Digital art, Unreal engine, Octane renderer, 4K

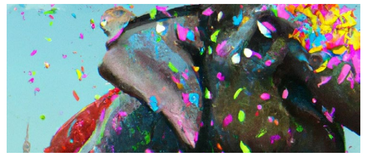


YaoYue Teahouse, MaoKong Taiwan, People enjoying tea at the speed of light in the daytime, Digital art, Unreal engine, Octane renderer, 4K

Thailand

Damnoen Saduak Floating Market, Bangkok, as painted by Kasimir Malevich, Digital art, Unreal engine, Octanerenderer, 4K

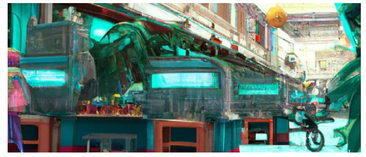
The interior of EmQuartier, Bangkok, photographed from below, as designed by Olafur Eliasson, Digital art, Unreal engine, Octane renderer, 4K



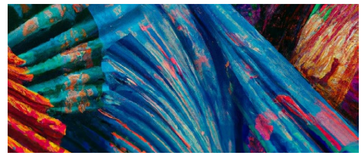
People and Elephants celebrating Songkran, Bangkok, as painted by Ripple Root, Digital art, Unreal engine, Octane renderer, 4K

Vietnam

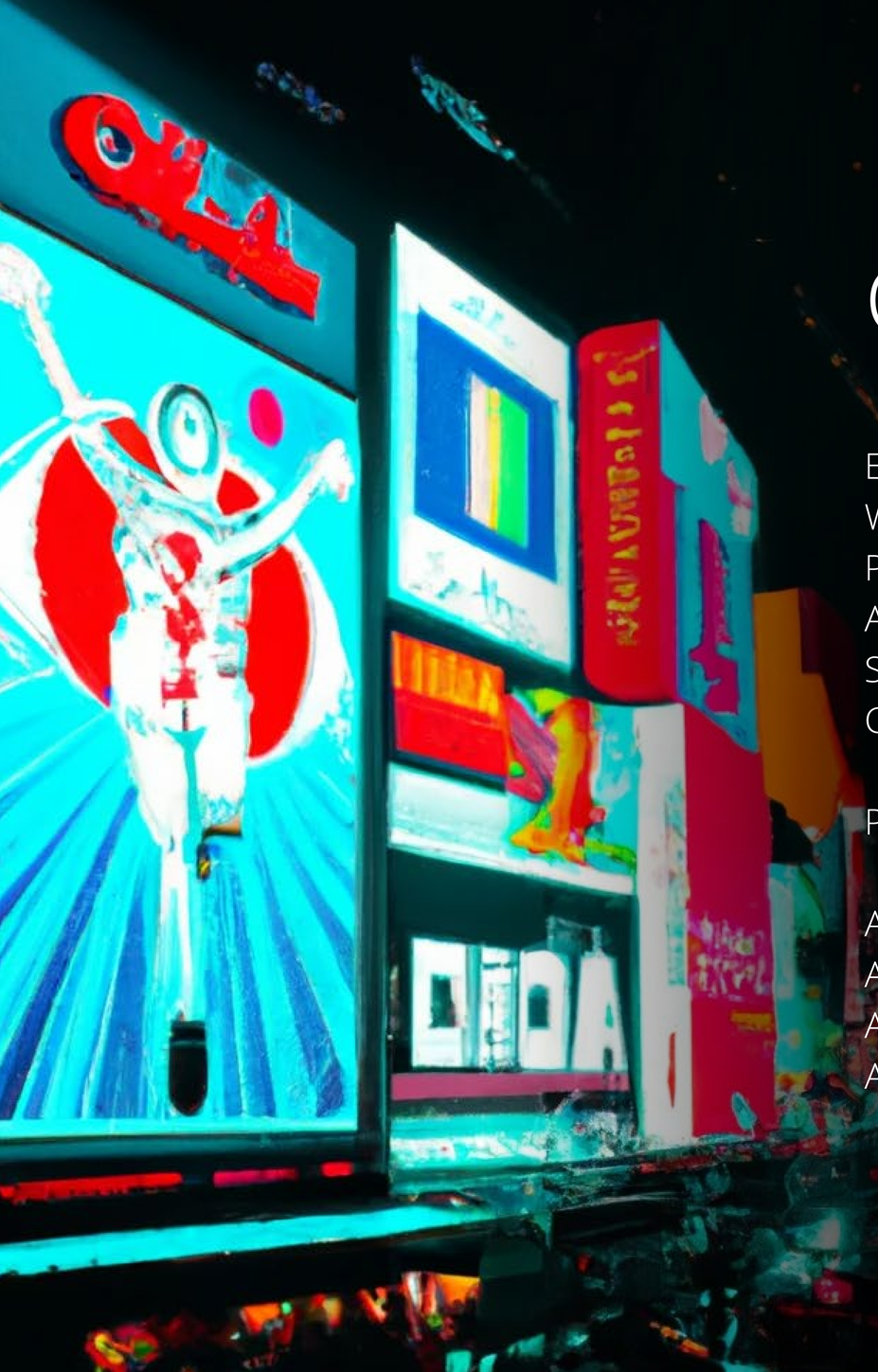
Wide shot of the Old Quarter, Hanoi in Vietnam, as designed by Zaha Hadid, Digital art, Unreal engine, Octane renderer, 4K



Inside Tan Dinh Market, Ho Chi Minh in Vietnam, as drawn by Mai Yoneyama, Digital art, Unreal engine, Octane renderer, 4K



Vibrant assortment of Traditional Patterned Vietnamese fabrics moving at the speed of light, Digital art, Unreal engine, 3D Octane renderer, 4K



Contents

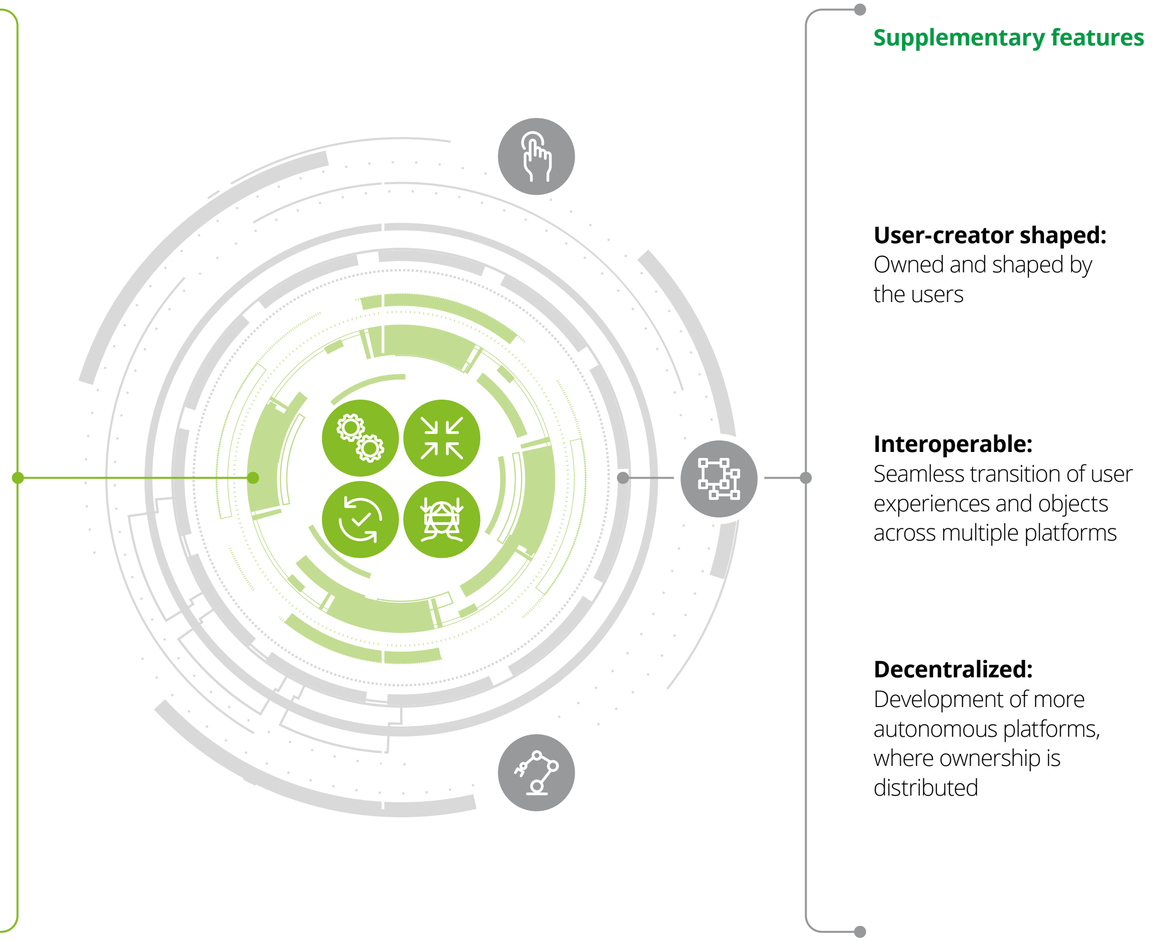
What is the metaverse

While there is not yet a universally accepted definition of what the metaverse is, there are some primary features that will likely manifest given the direction of technological advancements. These include it being persistent, available, synchronous and immersive. These features make it possible to better connect the digital and physical worlds.

There are other features that are driven more by business models, regulations, and societal values. These include the extent to which the metaverse will be user-generated, interoperable and decentralized. How these features will be infused into the metaverse is still evolving with the discourse around them.

The combination of these features create multiple original opportunities for consumers and businesses to reimagine daily life.

Figure 1. Characteristics of the metaverse



Progress towards the metaverse

Early metaverse platforms are already being used by millions, and awareness in Asia is high.

The metaverse is both a technological and cultural phenomenon that has early iterations already present today. In Asia, millions of people are spending their time and money on gaming, socializing, attending concerts, and purchasing items in virtual platforms such as Roblox, Decentraland, and Fortnite. South Korean app Zepeto has over 300 million registered users worldwide.[9] Asia has 1.3 billion mobile gamers, the biggest mobile player base worldwide.[10] On average, gamers in China, Vietnam, India, and Indonesia spend more than eight hours each week on gaming,[11] which is time likely to be spent in the metaverse in future.

These are testament to the region's openness to metaverse experiences, which already lead global averages. In an IPSOS survey, awareness of the term 'metaverse' exceeded the global average in India (80% of respondents), China (73%), South Korea (71%), and Singapore (58%). These economies also have an overwhelmingly positive view of the potential impact of Augmented and Virtual Reality on their daily lives (China 78%, India 75%, South Korea 63%, Singapore 58%).[12]

Decentraland
A 3D virtual world browser-based platform that allows users to buy land on the platform through NFTs.

56k
Global Monthly Active Users (MAUs)

Horizon Worlds
Free virtual reality, online video game with an integrated game system.

200k
Global Monthly Active Users (MAUs)

The Sandbox
A virtual world where players can build, own, and monetize their gaming experiences in the Ethereum blockchain.

200k
Global Monthly Active Users (MAUs)

Zepeto
Free social media app that lets you create 3D avatars to virtually connect with people globally.

20m
Global Monthly Active Users (MAUs)

Fortnite
An online video game with different game modes, including survival, battle royale, and sandbox.

80m
Global Monthly Active Users (MAUs)

Roblox
An online platform and game creation system that allow users to program games and play games created by other users.

202m
Global Monthly Active Users (MAUs)

Source: Public information as of October 2022 from CNBC, DCL Metrics, Blockworks, Yahoo Finance, Epic Games, and Active Player.

9. Byun Hye-Jin, "Naver's metaverse platform Zepeto hits 300m users," The Korea Herald, March 4, 2022.
10. Statista, "Mobile gaming market in the Asia Pacific region – statistics & facts," accessed September 28, 2022.
11. Edgio, "Market Research | The State of Online Gaming 2021," accessed October 5, 2022.
12. Ipsos, "How the World Sees the Metaverse and Extended Reality," accessed September 28, 2022.

The metaverse is a confluence of separate technologies that are rapidly evolving

These early metaverse experiences still have some limitations – streaming lags, cartoonish visuals, rudimentary functionalities. The full experience will only be unlocked when the development of several separate technologies converges. A fully immersive metaverse with smooth real-time rendering of visually rich worlds for millions of simultaneous users is still some years away.

Hardware (User Devices, IoT)
Although VR and AR headsets are often seen as the primary gateway to the immersive metaverse worlds, current advancements in smartphone and personal computing devices can provide a workable interface with the metaverse. This is crucial as issues of accessibility and affordability may limit the extent to which people can engage and benefit from the metaverse. On the industrial end, IoT devices are critical in maximizing the benefits of digital twins and virtual factories. However, affordability, data analytics capabilities and cybersecurity issues must be addressed before we see mass adoption, potentially from 2030.

Computing and Communication Networks

Significant tradeoffs between scale, fidelity and latency must be made based on today's technology. Both compute power and network bandwidth will be critical in overcoming these tradeoffs.

There are multiple possible approaches to improve compute power – enhancing cloud computing, building out edge computing infrastructure, having more powerful consumer devices, and even tapping on decentralized computing resources.

A combination of these could increase computing power by the 1,000 fold needed to support a fully synchronous and persistent experience at scale.[13] But breakthrough may not be far away – Nvidia increased AI performance by a million-fold over the last 10 years.[14]

The processed data then needs to be transmitted to consumers – through fiber optic connections, Wi-Fi and mobile networks. The bandwidth, latency and reliability of these communication networks will affect the experience of end-users. These depend heavily on infrastructure investments, particularly the last mile to the end-consumer. At the time of writing, most economies in Asia are in the early stages of deploying 5G, fewer still have made the latest WiFi 6E available.

Blockchain
Distributed ledger technologies form the foundation of the value transfer layer of the metaverse, enabling the exchange of digital assets. Speed, throughput, data storage costs and regulatory compliance challenges must be overcome for mass application.

Artificial Intelligence
Problem-solving, creativity, social and emotional engagement of AI are still far from maturity. Experts predict there is a 25% chance Artificial General Intelligence will be achieved by 2030, or 50% chance by 2040.[15]

3D Real-Time Rendering
Once 3D content creation can be democratized the way YouTube made video creation and sharing accessible to all, metaverse adoption and applications will accelerate. This is already revolutionizing commercial 3D video creation but there is still some way to go before this is accessible to the masses.

13. Deloitte, The Metaverse Overview: Vision, Technology, and Tactics, 2022.
14. Ibid.
15. McKinsey & Company, "An Executive Primer on Artificial General Intelligence," accessed September 28, 2022.

Figure 2. Metaverse-enabling technologies

Technology	Existing	In progress/ Future
User Devices	Smartphones Laptops/PC Virtual Reality (VR) Headsets Augmented Reality (AR) Headsets	Engaging other senses like smell and touch
Internet of Things (IOT)	Unified standards Industrial applications	Full metaverse requires at least 6G (almost zero latency)
Computing Power	Edge/cloud computing	AI chips (rapid development) Quantum computing (prototype stage)
Communication networks	5G WiFi 6/6E High-speed fiber	Big Data analytics (still maturing) Security (e.g. distributed technology attacks)
Blockchain	NFTs/digital assets Digital currency	Smart contracts Increased throughput Energy consumption
Artificial Intelligence (AI)	Computer vision, sensory perception Machine learning Natural language processing Intelligent voice	
3D Real-time Technology	3D Engine Real-time rendering Space rendering	Lowering cost to increase accessibility

Source: Adapted from Deloitte, The Metaverse Overview: Vision, Technology, and Tactics, 2022.

The advent of virtual humans – their rising role in the metaverse

From virtual news anchors to virtual influencers, AI-humans are beginning to take on roles that traditionally requires a human face and personality. In some instances, they are doing an even better job than their human counterparts.

Research has found that virtual influencers have almost three times the engagement rate (i.e., likelihood of content being liked or commented on) of real influencers. Some are so life-like that 42% of surveyed millennials and Generation Z that had followed a virtual Instagram influencer did not realize they were computer-generated.[16]

Virtual influencers are taking Asia by storm. Imma in Japan, Rozy in Korea and Made-in-Thailand Ailynn are winning lucrative endorsement deals from big brands.

But the most exciting developments might emerge from China. Its state news agency Xinhua introduced the world's first AI news anchor back in 2018. These anchors, who work tirelessly round-the-clock, mimic the gestures and facial expressions of real-life broadcasters.[17] Such technology is quickly finding applications in other fields such as customer service and sales.

With the rising popularity of livestreaming, companies like Baidu and Sogou are developing virtual avatar technologies that could lower costs for businesses compared to hiring real livestreamers.

Traditionally-human roles are starting to be taken over by their virtual doppelgangers. This is both exciting and intimidating, with many business and social implications that will need to be studied.

Image Credits: StarryAI

16. Alexander Frolov, "Virtual influencers – are they all they're cracked up to be?" accessed September 28, 2022.
17. The Guardian, "World's first AI news anchor unveiled in China", November 9, 2018.

Introducing the Virtual Influencers of Asia

Imma

Country of Origin: Japan

First lifelike virtual human and model in Japan, produced by Aww Inc.

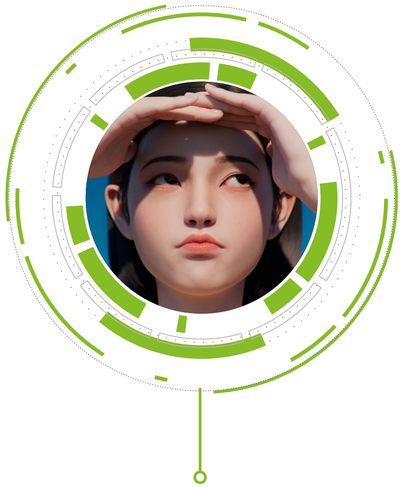
Over 400,000 followers on Instagram. Modelled for top brands including Porsche Japan, IKEA, Dior, Puma, Nike, Amazon, and so on.

Hatsune Miku

Country of Origin: Japan

Open-sourced Anime character made by fans. Virtual singer with a computer-generated voice and 3D graphics

Over 2.5 million followers on Facebook. Teamed up with Lady Gaga and Pharrell Williams on her world concert tours.



Angie

Country of Origin: Mainland China

Lifelike virtual human complete with zits, crooked teeth and other human imperfections. Created by Jesse Zhang with a Shenzhen-based CGI firm

Over 300,000 followers on Weibo and Douyin.

Rozy Oh

Country of Origin: South Korea

First lifelike virtual influencer in South Korea. She is a model, DJ and influencer created by Seoul-based creative company Sidus Studio X.

Over 144,000 followers on Instagram and has earned over US$800,000 from sponsorship deals in 2021 including Tiffany & Co and Calvin Klein.

AI Ailynn

Country of Origin: Thailand

First lifelike virtual influencer from Thailand created by AIS Bangkok.

Although only recently launched in September 2021, she already has 27,000 followers on Instagram. She is the Brand Ambassador for AIS, one of Thailand's largest mobile operator.

Source: VirtualHumans.org, Aww Inc., Crypton Future Media, Jesse Zhang, LOCUS-X, SIA Bangkok

Potential Economic Impact of the Metaverse in Asia

While the development path of the metaverse remains uncertain, early estimates suggest it is a trillion-dollar opportunity for Asia in the coming decades.

The extent of the economic impact of the metaverse both in Asia and globally remains uncertain as the technology is nascent.

Early estimates from the literature suggest that the potential growth and contribution of the metaverse could be significant globally:

- The potential global market size estimates of the metaverse (i.e., revenue) range from US$678.8 billion (Grand View Research) up to US$13 trillion (Citi GPS) per year by 2030.[18]
- The potential GDP impact estimates of the metaverse globally range from US$1.5 trillion per year by 2030 and US$3 trillion per year by 2031.[19]
- For Asia Pacific, a report by the Analysis Group estimates that the net contribution to GDP could be US$1.28 trillion per year by 2031.[20]

As the metaverse and the technologies surrounding it continue to evolve, the form that the metaverse will eventually take and and how much it may displace or be additive to current growth is still uncertain. Therefore, the timing and the size of the economic impact of the metaverse is challenging to forecast and will depend on a wide set of socioeconomic factors and enablers. For example, focusing just on applications such as VR/AR, use cases in various sectors, or parallels with previous technologies may miss potential unforeseen innovations, underestimating the potential impact of the metaverse. On the other hand, accessibility and affordability issues could limit the realization of an economy's maximum potential.

However, capital investments made into developing metaverse technologies, as well as the digital talent and skills to support them, will contribute to economic growth regardless of the final form of the metaverse.

As with innovations such as Web 2.0, the economic impacts of the metaverse will most likely be realized over a decade or more after the initial investments. This follows a S-curve framework where technology typically enters an initial innovation phase before experiencing a period of rapid growth, until the market finally matures.[21]

Nevertheless, published research has provided some key datapoints that, combined with published economic research, can give us further insight into the metaverse's economic potential.

Refer to Appendix A for more details on market sizing research.

18. Grand View Research, "Metaverse Market Size, Share & Trends Report, 2030," accessed September 28, 2022; Citi GPS, "Metaverse and Money", accessed September 28, 2022. Further examples of research that have attempted to undertake market sizing can be found in Appendix B.
19. PwC, "Seeing is believing", accessed September 28, 2022; Analysis Group, "The Potential Global Economic Impact of the Metaverse," accessed September 28, 2022. Analysis Group estimate the net impact based on assuming that the metaverse may evolve like mobile technology in terms of the level and rate of adoption by users and the impact on GDP. The research produces an impact for the APAC region ($1.04tr) with India ($0.24tr) estimated separately.
20. Analysis Group, The Potential Global Economic Impact of the Metaverse, 2022.
21. See a summary of the S-Curve literature by Analysis Group, The Potential Global Economic Impact of the Metaverse, 2022.

Metaverse investments today lay the foundations for the future…

For economic impacts to materialize, considerable sustained investment into developing and operationalizing the metaverse will be needed across key sectors such as infrastructure, computing hardware, and software development. Early estimates by Goldman Sachs suggest that metaverse-related investment may range from US$135 billion to US$1.35 trillion in the coming years, further suggesting that it may land in the US$135 billion to US$700 billion range.[22] A report by McKinsey however suggests that metaverse investments may be closer to the higher Goldman Sachs estimate as they observe that over US$122 billion had already been invested in the first six months of 2022, following US$57 billion of investments in 2021.[23] Given the above, we analyse two investment scenarios:

- A central metaverse investment scenario of US$700 billion over five years being maintained globally up to and including 2029; annualized this US$140 billion per year, equivalent to 0.15% of World GDP in 2021.[24]
- A boosted metaverse investment scenario of US$1.35 trillion over five years being maintained globally up to and including 2029; annualized this US$270 billion per year, equivalent to 0.28% of World GDP in 2021.

…generating additional economic growth over the next two decades…

Investments made into the Information and Communications Technology (ICT) sector have significant impacts on the economy. It has been found that ICT capital accounted for about 15 percent (0.53 percentage points) of world GDP growth between 1995-2003.[25] However, the literature also suggests that these investments spur companies in the supply chains and wider economy to further invest, developing new offerings, that can have material long term growth impacts that are realised over decades.[26]

To estimate the impact of the two investment scenarios, we take a central estimate of the relationship between ICT capital economic output estimated from the economic literature, an elasticity of 0.1.[27] In other words, a 10% increase in net ICT capital stock is associated with a 1% increase in economic growth.[28]

…leading to an economic impact for Asia

Using the sources from the literature, we estimate that these metaverse investment scenarios may lead to an economic impact for Asia of between US$0.8 trillion and US$1.4 trillion per year by 2035.[29] This is approximately between 1.3-2.4% of projected GDP of Asia in 2035.

These are short-term impacts of the assumed continued and sustained investment to 2029, and how these may materialize by the mid 2030s. These figures do not necessarily consider the impact of improvements to supporting connectivity infrastructure required for the metaverse (e.g., the spill-over economic impacts of 5G infrastructure).

This paper adopts the methodology developed in Deloitte's report on "The Metaverse and its Potential for Türkiye". Refer to Appendix B for details on the full methodology.

> The potential impact of the metaverse to GDP in Asia is about $0.8T-1.4T per year by 2035, roughly 1.3 – 2.4% of overall GDP.

22. Goldman Sachs, Framing the Future of Web 3.0. Metaverse Edition, 2021.
23. McKinsey & Company, "Meet the metaverse: Creating real value in a virtual world," accessed September 28, 2022.
24. World Bank, "World Development Indicators," accessed September 28, 2022.
25. Jorgensen and Vu, "Information Technology and the World Economy," The Scandinavian Journal of Economics 107, no. 4 (2005), p. 631-650.
26. Czernich et al., "Broadband infrastructure and economic growth," CESifo Working Paper 2861, 2011.
27. Ketteni, Mamuneas & Stengos, "The effect of information technology and human capital on economic growth," Macroeconomic Dynamics 15, no. 5(2011): p. 595-615 ; Venturini, "The long-run impact of ICT," Emperical Economics 37, no. 3 (2009): 497-515
28. OECD, "STAN STructural ANalysis Database," accessed October 20, 2022.
29. The methodology used to measure impact for Asia can be found at Appendix B.

How the metaverse transforms economies:

As a unifying goal, the metaverse could drive investment in and adoption of the underlying technologies such as 5G, Edge Computing, and IoT. In turn, this propels digital transformation and capability development, which have positive spillover effects to the overall economy. These provide strong justifications for early investment and clear development roadmaps for the metaverse.

Some transformational effects on the region's economies include:

Expansion of access to information, digital content and digital infrastructure. The metaverse will facilitate connections among individuals and communities, removing physical barriers for the transmission of ideas or exchange of goods and services. Indonesia's WIR Group is creating a metaverse platform to bridge the gap between businesses and local consumers, many of whom reside in the country's rural areas with limited access to digital technology and financial services. The platform is anticipated to enable suburban retail stores in Tier 2 to 3 cities to set up virtual shops which allow members in their communities to browse products and have them delivered instantly.[30] A proliferation of use cases for the metaverse will boost demand for improvements in digital infrastructure, making investments by telecommunication providers more viable.

Creation of new employment opportunities including jobs that have yet to exist. To create digital content, develop metaverse experiences and services, and operate the infrastructure, new skills will need to be developed. Analysis by ADB estimated that a 20% expansion in the digital sector could create over 300 million new jobs in Asia over 5 years.[31] The creator economy will also be a significant contributor to several economies in Asia, such as in the case of Thailand where creative industries contribute roughly 10% to its GDP.[32]

30. Tech in Asia, "Indonesia's WIR rides metaverse to IPO success, but revenue stream raises questions," accessed September 28, 2022.
31. Asian Regional Integration Center, Asian Economic Integration Report, 2021, p.292.
32. Royal Thai Embassy, "Thailand's creative industries showing steady growth," accessed September 28, 2022

Improvement in ways of working between geographies, businesses, and organizations. The metaverse could facilitate remote working, training and collaboration across different locations. This will increase productivity and flexibility for workers. The ability to visualize 3D space also creates new forms of collaborations among businesses, government agencies and communities. Singapore is the first to have a country-level 3D digital twin,[33] which supports city planning, as well as the development of industries such as tourism, real estate, commerce, drones in built-up environments, autonomous vehicles, and IoT applications.

Creation of new marketplaces and types of businesses, particularly for digital assets and content. NFTs provide digital artists a way to monetize and generate royalties from their digital creations. Platforms like Roblox and Zepeto create new marketplaces for virtual wearables and items. Beyond individual companies, the Stock Exchange of Thailand is also experimenting with a new digital marketplace to facilitate trading of investment and utility digital tokens.[34]

These provide an early look at the full economic potential of the metaverse. Once these transformations in the digital economy are fully scaled, it will be transformational for the more than 4 billion people who live, work, and play in the region.

33. George Lawton, "How Singapore created the first country-scale digital twin", VentureBeat, February 23, 2022.
34. Open Gov Asia, "Thai Stock Exchange to launch digital asset trading platform," accessed October 26, 2022.

The metaverse will lead to the creation of new marketplaces and types of businesses

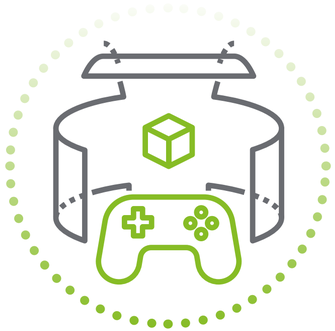
New marketplaces
Users and businesses come together in new marketplaces to exchange digital goods and services, and even products or assets based in the physical world, underpinned by technologies such as digital twins and blockchain.

New types of businesses
Demand for novel metaverse-related products, ancillary services to facilitate engagement with new marketplaces (e.g., training, compliance, strategy and optimization).

Generating value
New marketplaces and businesses will lead to new mechanisms for value creation in economies, providing users with goods and services to enhance their metaverse experience. This can create new employment opportunities.

Sector-specific impacts: the metaverse will have wide ramifications across many sectors

The impact of the metaverse is not uniform, and will be felt first in sectors that are already experimenting with new use cases. Sectors that have made inroads into the metaverse include entertainment and gaming, healthcare, retail and e-commerce, manufacturing, and education.



Entertainment

K-Pop labels are venturing into the metaverse with virtual celebrities, virtual fan-meets, and music releases on metaverse platforms. By doing so, it has created unprecedented levels of reach and engagement with audiences: 46 million fans attended Blackpink's virtual avatars fan event to receive digital autographs from the group.[35] Aespa, a Korean "cross-metaverse" band which features four members with their own virtual counterparts, debuted at number three on the Billboard 200, the fastest female K-pop act in history to enter the top 3.[36] While metaverse technologies are not yet mature enough to stream rich content like concerts to large audiences synchronously in real-time,[37] these early experiments show the potential demand and global reach of such entertainment experiences.

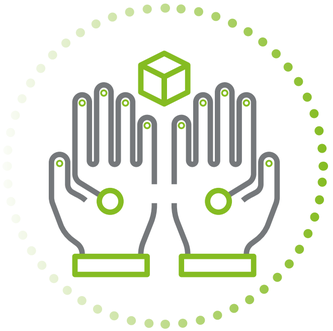
Healthcare

Two major Southeast Asian hospital operators, IHH Healthcare and Siloam International Hospitals, have accelerated investments in VR, AR and metaverse environments to improve telemedicine services.[38] South Korean startup Looxid Labs uses a VR sensory headset to measure working memory, attention level, and spatial perception of the elderly in Seoul and Busan.[39] Singapore's National University Health System (NUHS) is also investing in holographic technology, including using mixed reality to teach medical and nursing students,[40] research on applications in brain surgery, and real-time volumetric rendering and positioning of ultrasound scans.[41] NUHS is one of the founding members of The Holomedicine Association, an international organization comprising clinicians, scientists and industry partners engaged in holomedicine R&D.[42] The economic and social benefits of these developments are enormous, particularly among the fast-ageing societies in the region.

35. Chang May Choon, "South Korea's K-pop stars extending their reach as avatars in the metaverse," Straits Times, September 10, 2022.
36. Soompi, "aespa Becomes Fastest Female K-Pop Act To Enter Top 3 Of Billboard 200 As "Girls" Debuts At No. 1 On Top Album Sales Chart," accessed October 19, 2022.
37. CNA Lifestyle, "JJ Lin's Sanctuary virtual concert fraught with 'streaming issues'", accessed September 28, 2022.
38. Erwinda Maulia, "Southeast Asian hospitals look for high-tech future in metaverse", Nikkei Asia, January 21, 2022.
39. Nation Thailand, "Metaverse technologies bring health care to Korean doorsteps", accessed September 28, 2022.
40. Microsoft News Center, "Medical education goes Holographic with mixed reality from Microsoft", press release, January 11, 2022.
41. PR Newswire, "Holomedicine Research in Singapore, Using Mixed Reality Technology to Enhance Diagnosis, Education and Patient Care," accessed September 28, 2022.
42. ibid.

Retail and e-commerce

Major brands are setting up shop in metaverse platforms like Roblox, Decentraland and Sandbox. AR will also transform the retail experience, with a Meta survey of shoppers in Asia Pacific finding that two-thirds of those who are likely to shop on social media want to try on products virtually, from the comfort of their home.[43] These include viewing how products look in their home, trying products like make-up on themselves, and browsing products. The use of AI can automate customer service experiences in the metaverse, particularly with the language diversity in the region. Hong Kong company Whatsquare is an AI chatbot platform to facilitate "conversational commerce" in 32 different languages in Asia.[44]



Industrial and Manufacturing

Metaverse technologies could lead to better real-time monitoring of supply chains, operational effectiveness, and collaboration between different stakeholders. The Hong Kong International Airport (HKIA) developed a live 3D digital twin linked to real-time data from IoT devices that will facilitate "holistic airport management, predictive decision making and maintenance" for the full life cycle of its buildings. In the future, advanced biometrics powered by facial recognition could also allow passengers to move through checkpoints without the need for document checks.[45]

Education

The use of immersive technologies could enhance education delivery and quality by producing more engaging curriculum content and delivering this at scale including to the differently-abled. Several universities across the region have started experimenting with metaverse classrooms, including Thammasat University in Thailand, the Singapore University of Social Sciences, The Hong Kong University of Science and Technology's Guangzhou campus, and several South Korean universities. Vietnam's High School for Gifted Students, Hanoi National University of Education, has also forayed into the metaverse with a digital cultural museum.[46] Korean startups such as BestTech and Victoria Productions have also developed metaverse solutions (XR content) for education. Nevertheless, the overall effectiveness of remote learning, particularly in developing nations, is subject to inclusive access to the digital infrastructure, which will be discussed later.

43. Meta Foresight, "APAC brands break new ground in the Metaverse with innovative AR experiences," accessed September 28, 2022.
44. Whatsquare, "Whatsquare" accessed October 3, 2022.
45. Airport Authority Hong Kong, AAHK Sustainability Report, 2019, p. 69-70.
46. Coincu, "One of Vietnam's top prestigious schools enters the metaverse," accessed October 19, 2022.

Figure 3: Sectoral impacts in the short-term and long-term

Sectors affected in the short-term	Immediate	Emerging	Long-term (5+ years)
Entertainment & Gaming	Concerts, shows and sports	Immersive games, movies, and socialization spaces	Interactive sports and events (e.g., on the court, in the game)	Interactive virtual tourism	Immersive "theme park" experiences that adapt to customers' data profiles
Healthcare	Virtual wellness and exercise classes	Data analytics-powered health insights and recommendations	Immersive telemedicine and therapy	Digital models of hospital flow and operations	3D models of patients to show simulated impacts of health changes
Retail & E-Commerce	Boutique shopping (e.g., pop-up shops)	Digital customer contact centres	Data-enhanced everyday shopping (e.g., groceries, furniture and appliances)	Immersive home and auto buying	Full sensory immersion in retail experiences
Manufacturing	Reduction of costs through product modelling	Predictive maintenance of equipment	Collaborative product design and modelling	Enhanced quality control through product simulations	Complex operational (e.g., supply chain, process and workflow) simulations to optimize production
Professional Services & Education	Telecommunications and virtual collaboration	Immersive professional training	Digital twins of physical operations and locations	Metaverse-based classroom tools and fully metaverse-native schools	Metaverse-native and dependent companies

Source: Deloitte, "A whole new world? Exploring the metaverse and what it could mean for you," accessed October 19, 2022.

Analysis of Asian Economies

The differentiated strategies of each economy make this region an interesting one to watch.

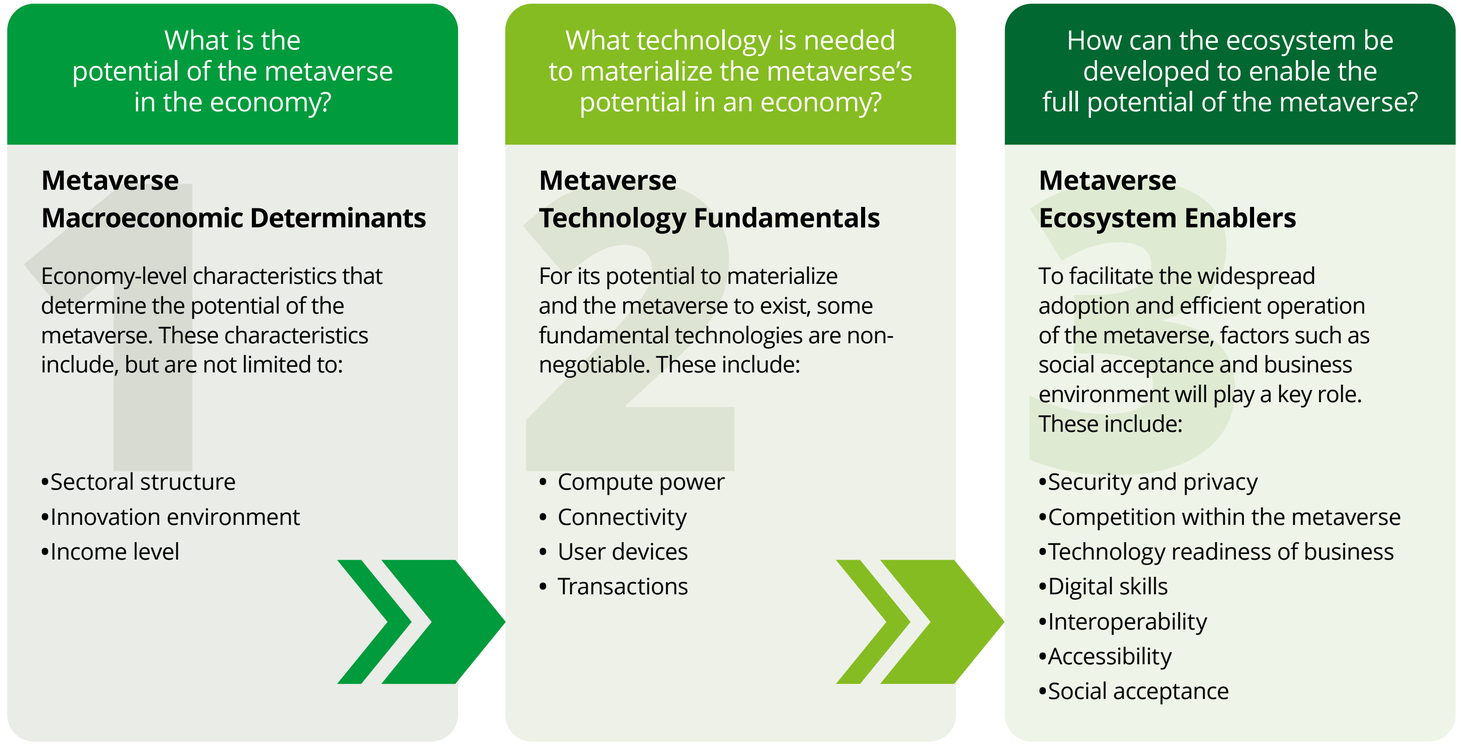
How much of the potential economic impact is realized, and how quickly, depends on the strategies each economy adopts. We take an in-depth look at 12 selected economies – their unique propositions, challenges and opportunities – and provide a holistic understanding of the metaverse potential in each. While it will likely take years for the metaverse to mature, we highlight early adopters in each of the economies today.

The metaverse framework

Based on their respective contributions to global GDP, we derive the GDP contribution for each of the individual economies in our study. We then provide a qualitative analysis of each economy considering each of these three enabling pillars (figure 4).[47] Finally, we seek out early signals for which sectors today demonstrate the potential to lead in the metaverse's development tomorrow. Through looking at sectors to watch, we highlight the forerunners of metaverse development in each economy.

Refer to Appendix C for a detailed description of each characteristic in the three enabling pillars.

Figure 4: Three enabling pillars of the metaverse



Source: Deloitte Analysis

47. Given the uncertainties around the evolution of the metaverse, this provisional framework, which provides a good approximation of the enablers, will be further refined as new and more appropriate indicators indicators are developed in the future.

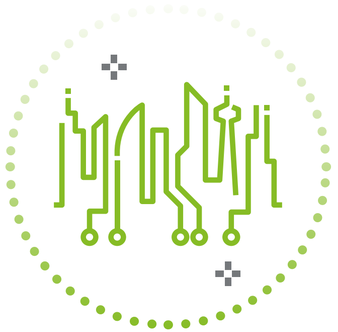
Leveraging strengths for the metaverse

Based on our analysis, the following are possible strategies economies may consider to best play to their strengths.

Sectoral Expertise

Economies with sectoral expertise which align to the anticipated needs of the metaverse can start positioning those sectors today for future demand. For instance, those that excel in the manufacture and export of electronics and electrical equipment, such as Taiwan and South Korea, are well-positioned to benefit from the increasing demand for hardware and other user-devices.

Similarly, economies with large technology sectors or high investment in the research and development of digital technologies, such as Japan, Singapore, South Korea, and Hong Kong, can benefit from increased demand for platforms and the design of complementary hardware and software. Vietnam and Thailand are innovating with web3 and blockchain technologies.



Institutions and Institutional Quality

Institutions such as an economy's political, legislative or business environments can make or break metaverse-related activities. Economies with positive investment environments, strong digital and patent laws as well as protections over intellectual property, will attract large investments into the design and innovation of the metaverse. Hence, economies like Hong Kong and Singapore are attractive for investors and designers keen to make headway in the metaverse.

Natural and cultural endowments

China and Indonesia, which are rich in natural resources (e.g., nickel, rare earth and lithium), are poised to benefit from increased manufacturing of new user devices. Others like Vietnam, Philippines, Pakistan, India, and Indonesia have digitally-ready workforces that can serve manpower needs across the region.

Soft power can be of equal or even greater importance than hard power – economies which do not possess vast natural resources can leverage on characteristics such as geography, language and culture to determine the market size and demand for localized content as well as to build cultural experiences for the wider metaverse ecosystem. For example, economies such as Thailand and India can bank on their strong cultural capital to establish a unique signature in the metaverse early on.

Shaping the Metaverse in Asia

The metaverse presents challenges, but if well managed, therein lies opportunity too.

Image Credits: DALL-E

The metaverse could help tackle important issues through bridging physical distances, encouraging more sustainable behaviors, and bringing communities closer. Nevertheless, a more immersive and pervasive internet can exacerbate negative externalities. Forward thinking can turn risks into opportunities.

Climate Impact. The overall climate impact of the metaverse depends on how it can drive behavioural changes.

The growing metaverse requires more data storage and processing systems to support real-time interactions and new applications of AI. These energy-intensive processes will challenge decarbonization efforts as over 70% of Asia Pacific's emissions footprint remains coal-based.[48] The anticipated demand for new devices and hardware such as VR headsets and internet server will foster greater demand for materials such as rare earth metals (e.g., lithium used in batteries and energy storage systems), with China supplying more than 58% of the world's market.[49] The mining of these materials and the creation of e-waste risks environmental damage.

Some of the climate impacts of the metaverse may be offset by changing carbon-emitting behaviors, such as reducing commute and overseas travel by facilitating remote work. As another illustrative example, virtual fashion reduces the amount of physical apparel produced, correspondingly reducing wastage and the associated climate impact. Virtual fashion is gaining prominence in the metaverse: the Hong Kong-based luxury fashion retailer I.T released an entire collection digitally, with pop-up boutiques that housed no physical apparel, but AR and VR tools for shoppers to "try" clothing on before ordering.[50] By reducing the amount of physical apparel produced, climate impact is reduced.

48. Wood Mackenzie, "Asia Pacific's energy transition conundrum- is net zero possible?" accessed September 28, 2022.
49. Bai et al., "Evaluation of resource and environmental carrying capacity in rare earth mining areas in China," Scientific Reports 12, no. 6105 (2022).
50. The Fabricant, "I.T Hong Kong And The Fabricant Create Luxury Retail Game Changer", accessed October 3, 2022

Inclusion. We have a collective responsibility to ensure the metaverse is accessible to all, within and across societies.

The metaverse opens up new opportunities for people to experience places and events across distance and barriers. In conjunction with the Tokyo Paralympic Games held in 2021, the first official Paralympic game 'The Pegasus Dream Tour' was launched. The avatar role-playing game allowed players to try out various Paralympic sports and watch live performances.[51] This enables sports enthusiasts of all abilities globally to feel part of the Games, even in the wake of global travel restrictions due to the COVID-19 pandemic.

However, users need stable and high bandwidth connectivity to access the metaverse—a requirement not all can presently meet. In developing parts of Asia, ADB estimated that only 41% of households have internet access and only 18% have a computer.[52]

If the cost of devices needed to access the metaverse is high relative to average incomes, then parts of society may be excluded from participating in the metaverse.

Besides digital infrastructure, deficits in digital skills hinder the metaverse's accessibility. In the Philippines, only 16% of children from households with primary and secondary-educated adults possessed the digital skills to access remote learning, compared to 40% from households with tertiary-educated adults.[53]

If relevant stakeholders collaborated to bridge the gap in digital infrastructure and skills, the metaverse can truly become an inclusive space where people's location, gender, physical attributes or personal circumstances matter less than their ideas and attitudes.[54]

Several companies have highlighted their efforts in creating an inclusive metaverse: Meta, for example, has developed over 1 quintillion avatar combinations and launched cochlear implants, wheelchairs and over-the-ear hearing aids for avatars, creating a world where everyone can find themselves represented in the metaverse.[55] Public sector involvement may complement efforts to ensure devices and aids reach all who need them.

Mental Health. An immersive metaverse could lead to social withdrawal and depersonalization, but could also widen the reach of mental health support.

As an immersive virtual space, over-consumption of the metaverse comes with risks related to symptoms of depersonalisation and derealization[56] —symptoms caused by internet addiction. While the link to internet addiction is still not conclusive, a 2013 study in South Korea found that nearly one in ten study participants who were socially isolated for at least three months were addicted to the internet, with more than 50% who were thought to be at high-risk of internet addiction.[57] The advent of the metaverse may encourage users to depend on the metaverse completely for socialization, neglecting the offline world. Should their connection sever due to technical disruptions, these users stand to lose their entire social world, worsening their mental health.[58]

At the same time, the metaverse also holds equal potential to ease such persons back to society. Through the metaverse, virtual consultations and remote diagnostics could make healthcare more accessible. The further use of VR and AR in the metaverse could also enhance the reach of mental health support through providing cognitive therapy and psychiatric evaluations virtually.[59]

51. International Paralympic Committee, "World's first official Paralympic video game launched," press release, July 23, 2021.
52. Asian Development Bank, "Learning and Earning Losses from COVID-19 School Closures in Developing Asia," accessed September 28, 2022.
53. World Bank Group, Remote Learning During COVID-19: Lessons from Today, Principles for Tomorrow, 2021.
54. World Economic Forum, "Building an inclusive metaverse starts now. Here's how," accessed September 28, 2022.
55. Meta, "How we are helping build the Metaverse with Diversity, Equity and Inclusion in Mind," accessed September 28, 2022.
56. Carina Peckman et al, "Virtual reality induces symptoms of depersonalization and derealization: A longitudinal randomised control trial," Computers in Human Behaviour 131, no. 107233 (2022).
57. Lee et al., "Home visitation program for detecting, evaluating and treating socially withdrawn youth in Korea," Psychiatry and Clinical Neurosciences 67, no. 4 (2013), p. 193-202
58. CIO Today, "Healthcare System Reimagined in Metaverse," accessed September 28, 2022.
59. Acceleration Economy, "The future of healthcare and patient care in the Metaverse," accessed September 28, 2022.

If the challenges are well-managed, the metaverse has the potential to result in several societal benefits that might have significant direct and indirect impacts on society, and are not captured by the economic impact studies.

Trust and safety. As the metaverse develops, discourse around how safety can be assured in a more immersive virtual space will continue to evolve.

The relatively anonymous nature of the internet can sometimes facilitate harmful behaviours such as harassment, bullying or verbal abuse. The immersive environment of the metaverse may intensify these experiences for victims. The development of the metaverse raises additional concerns over cyber and identity fraud, data privacy breaches and intellectual property theft.[60]

India is one of the first countries to explicitly mention the metaverse in its policy considerations on bullying and sexual abuse.[61] India's upcoming digital regulatory framework, the Digital India Act (DIA), will look at crimes in the metaverse that spread misinformation or incite violence.[62] Singapore will also be rolling out rules to tackle online harms in Singapore as early as 2023 under the Code of Practice for Online Safety and the Content Code for Social Media Service.[63] Balancing these considerations without stifling innovation will be crucial for regulatory bodies globally.

Politics and Governance. The metaverse fosters both greater connection between the people and the government, and greater political division.

Public institutions are building their digital presence, making information and services more accessible to users. This could improve how communities work together, better address concerns, and encourage civil engagement. Taiwan's digital democracy efforts include allowing anyone to file an e-petition on its national platform, and a collaborative meeting will be held for petitions that receive at least 5,000 signatures.[64] Engagement levels could be even higher if these collaborative meetings were held in the metaverse. Singapore envisions involving residents in decisions about upgrades to their local towns by visualizing proposals through a country-level digital twin.[65]

On the other hand, current Web 2.0 social media platforms show the double-edged quality of the internet to both foster political community and create political division.[66] As more daily activities, including work, move into a virtual and borderless environment, social identities may start to become more attached to online rather than physical communities, exacerbating echo chambers. Community building efforts both online and offline are even more critical to maintain these connections between people.

60. Brian Pinnock, "The metaverse will not be immune to cyber threats," Mail & Guardian, July 26, 2022.
61. Vallari Sanzgiri, "MeitY's Digital India Act Due In Winter Session, Says Report: OTT, Metaverse In Ambit," Medianama, August 17, 2022..
62. Sachin Dave, "Digital India Act to police social media and OTT platforms", Economic Times, October 19, 2022.
63. Irene Tham, "Rules to tackle online harm in Singapore could be rolled out as early as 2023," Straits Times, September 29, 2022.
64. Audrey Tang, "Inside Taiwan's new digital democracy," The Economist, March 12, 2019.
65. Singapore Prime Minister's Office National Research Foundation, "Virtual Singapore," accessed September 28, 2022.
66. Brookings Institution, "How tech platforms fuel U.S. political polarization and what government can do about it," accessed October 19, 2022.

Actionable Insights for Key Stakeholders

While the metaverse is inevitable, a responsible metaverse is not.

The successful future of the metaverse calls for collective responsibility by all ecosystem actors, including government, telecom operators and the technology sector, businesses and start-ups, researchers and academics, metaverse users and the general public.

Governments

Governments play an essential role in realizing the economic benefits of the metaverse, while managing the risks. There are five major bottlenecks[67] at this stage of metaverse development which governments can act on in concert with other stakeholders.

- **Enhancing accessibility to the virtual world**. The economic and social benefits of the metaverse rest on the proportion of the population that has access to the metaverse. This includes not only the underlying digital infrastructure such as 5G/Wi-Fi 6E/ fiber connections and devices such as smartphones and computers, but also the social aspects like digital skills and social acceptance.
- **Shaping governance of the metaverse**. As experimentation with metaverse technologies become more prolific, now is the time for policymakers to proactively shape and influence the rules of engagement in the metaverse. Many economies are exploring new laws for digital currency, tokenization of digital assets, and NFT trading. Regulations over online harms, ethical use of AI, and new governance structures will have to evolve with emerging use cases. Frameworks for interoperability are also helpful in preserving consumer freedom and choice.
- **Encouraging industrial applications of the metaverse**. At present, the metaverse is mainly used in entertainment and gaming fields. Government intervention may be required to nudge businesses to adopt metaverse technologies for manufacturing and other industrial uses. For example, China has announced plans to support industrial applications of metaverse technologies,[68] and South Korea is investing US$177 million to develop industry in the metaverse.[69]
- **Managing data security and privacy protection**. As more user data is collected for AI-powered algorithms, opportunities to exploit data vulnerabilities will grow. Regulators will have to balance strengthening information security without stifling technological progress. Vietnam, as with many economies in the region, has plans for legislative reforms in the areas of data privacy, cyber security, consumer protection, and intellectual property.[70]
- **Encouraging sustainable energy usage**. Powering the needs of the energy-intensive metaverse is likely to create challenges for decarbonization efforts.[71] To ensure that the metaverse's supporting infrastructure is built and operated sustainably, forward planning is crucial. For example, moving local data centres into the cloud could be between 22-93% more energy efficient than utilizing traditional local data centres in offices.[72] The metaverse should be viewed as a green opportunity – by redesigning essential activities like transport, logistics, and manufacturing to use the metaverse, governments can actively reduce their carbon footprint.

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68. ibid.
69. Jonathan Keane, "South Korea is betting on the metaverse-and it could be a blueprint for others," CNBC, May 30, 2022.
70. Manh-Hung Tran ,"Rise of the metaverse in Vietnam – What's happening?" July 1, 2022.
71. Medium, "How 'Green' is the METAVERSE? The two sides of the environmental impact of the metaverse," accessed September 28, 2022.
72. World Economic Forum, "Even though it's virtual, the metaverse does actually impact the environment," accessed September 28, 2022.

Telecom Operators and Technology Sector
The metaverse will be defined by the infrastructure it is built upon. Telecom operators thus hold the key to the metaverse, by installing enabling infrastructure (e.g., through 5G networks/Wi-Fi 6E/ fiber connections) and incentivizing mass adoption. By 2025, 14% of the Asia Pacific population is expected to adopt 5G[73] – a development that will directly facilitate the materialization of the metaverse. Telecom operators are not just enablers of the metaverse, but co-creators who are well-placed to lead the development of the metaverse both regionally and globally. Forward-thinking telecom operators may begin planning for edge computing and connectivity services that widen metaverse access, facilitate efficient data transfers, and reduce network congestion.

Private Sector
To unlock the full economic potential of the metaverse, metaverse technologies must be integrated into business practices. Businesses can leverage upon new technologies to reach consumers, improve internal operations, or contribute to platform development. Businesses also play a pivotal role in facilitating the societal transition into the financial metaverse – for example, integrating digital payments would familiarize users with using digital currencies. In economies such as China, India and Indonesia, digital payments have overtaken classical payment methods in popularity.[74]

The private sector could also increase the social acceptance of new technologies by showcasing the potential of additional value for businesses and consumers through exhibitions and demonstrations. For example, South Korea's SK Telecom recent launch of 'Ifland', a new metaverse platform, helped embed the metaverse in public imagination and enhance confidence in new technologies.

Researchers / Academics
The metaverse is a product of constant innovation – as such, R&D is key to a resilient and productive future metaverse economy. Researchers play instrumental roles in developing appropriate hardware such as headsets, smart-glasses and sensors, and in working with industry leaders on applying technology to business problems. In turn, the uptake of new technology hinges upon complex sociocultural factors. Research centers play a vital role by offering hands-on technological experiences to users, which combats cultural aversion to new technologies.
The Singapore University of Social Sciences has set up a Node for Inclusive Fintech, which includes a metaverse lab that raises awareness on the potential of the decentralized web to be used for societal good.[75]

Users and the General Public
Social acceptance of metaverse technologies is key to the metaverse's success. Users will directly shape the metaverse's development through their adoption of new technologies and their advocacy for use cases. With highly adaptable digital consumers who are enthusiastic about new technologies,[76] Asia is likely to respond enthusiastically to the development of the metaverse. However, as with any new technology, it is vital to address fears over uncertainties with the impact on livelihoods, culture and ways of living. The presence of community and advocacy groups to give voice to these concerns can ensure the metaverse develops inclusively.

> "We believe in the open metaverse and that nobody should own or control it. We believe that it should be accessible to as many people as possible."[77]
>
> **Alvin Graylin, China President at HTC**

73. Computer Weekly, "5G connections in APAC to surpass 400 million by 2025", accessed September 28, 2022.
74. TechWire Asia, "It's endgame for traditional payments as mobile wallets emerge victorious," accessed September 28, 2022.
75. Singapore University of Social Sciences, "Metaverse Lab," accessed September 28, 2022.
76. McKinsey & Company, How Asia can boost growth through technological leapfrogging, 2020.
77. Nina Xiang, "HTC Wants to Build An Open Metaverse While Splinternet Accelerates," Forbes, April 13, 2022.

Conclusion

Asia is a prime market for the adoption of this next iteration of the internet. The metaverse presents a trillion-dollar opportunity to significantly transform major economies in the region. Vice versa, the Asian economies will make a meaningful impact on how the metaverse takes shape globally.

1

The uncertainty around the future form of the metaverse results in a broad range of economic impact estimates.

As a nascent technology, there remains uncertainty as to how the metaverse will evolve. This presents a significant opportunity for businesses and governments to invest and shape its development.

2

Certain industries and regions are expected to be the primary beneficiaries of the metaverse, with wider value generated as the technology matures.

Sectors in which early adoption of the metaverse is expected include retail, manufacturing, healthcare, education, and the creative industries which include gaming and entertainment. Therefore, knowledge-based economies are expected to realize the metaverse opportunity in the near-term.

3 How much of the potential economic impact is realized, and how quickly, depends on the strategies each economy adopts.

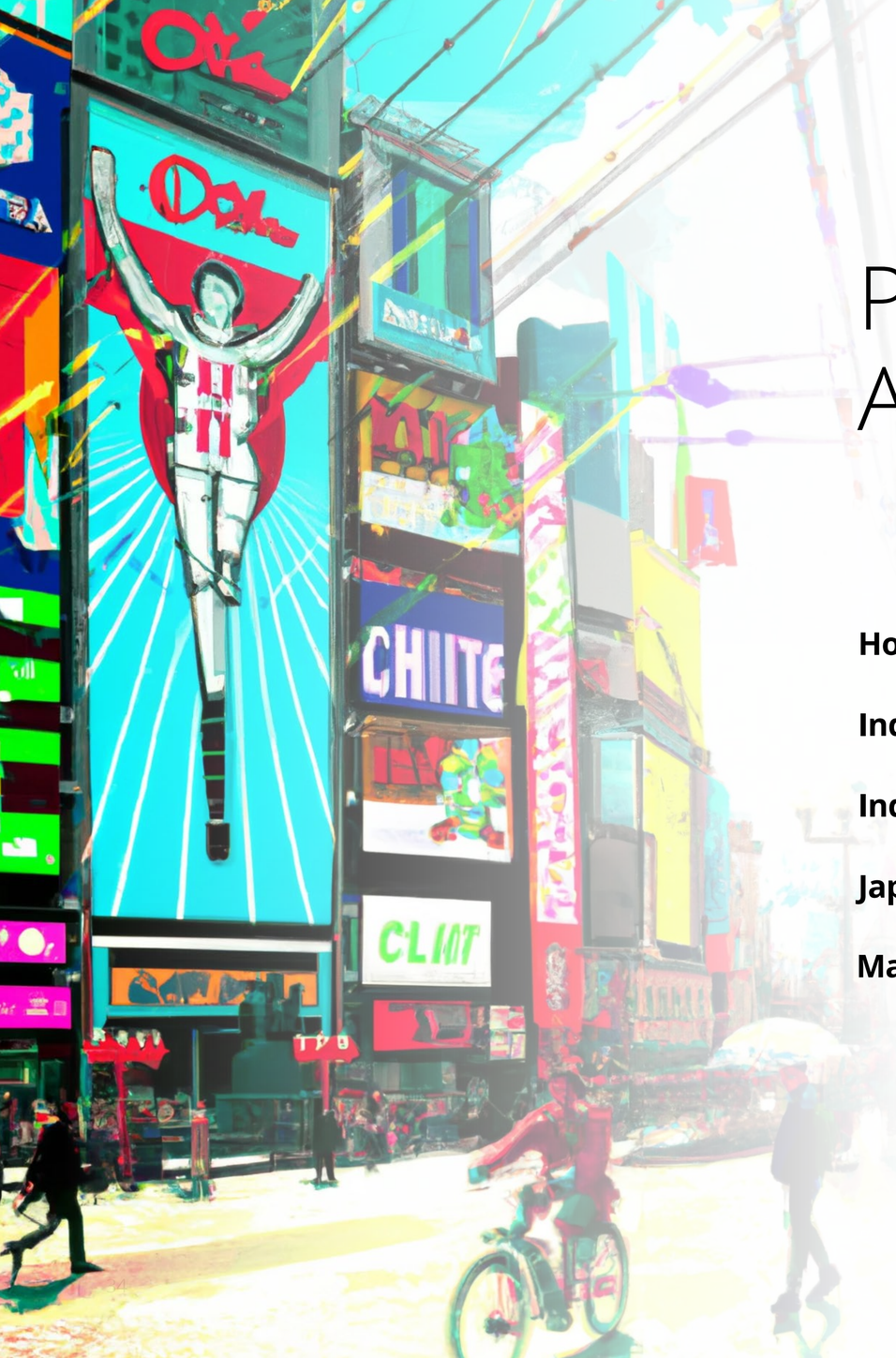
Economies can tap on a range of strategies that play to their strengths in specific sectors, institutions or natural and cultural endowments. At the same time, economies will need to make thoughtful investments to develop enablers and address gaps, so that their overall economic potential is not limited.

4 There is a collective responsibility to create a responsible metaverse that mitigates the risks associated with digital technologies.

Importantly, policymakers and other ecosystem actors must ensure the design of the metaverse and the surrounding legislation and regulations are fit for purpose such that as many of the upsides are gained whilst limiting the impact of any potential pitfalls.

5 If designed well, the metaverse could deliver significant economic and social benefits.

All economies have the potential to realize increased economic growth and productivity whilst also capturing sizable social returns when improving the standard of living for their respective populations.



Profiles of 12 Selected Asian Economies

Hong Kong

Potential 2035 economic impact of the metaverse

US$7-14B per year

Hong Kong

Hong Kong's lead as an international business hub could be furthered with the metaverse. The city's sound polices and investments have created a favorable environment with high internet accessibility and a strong startup scene for businesses.

While the government has been taking a cautious approach towards the metaverse, it is committed to creating a conducive environment for innovation and technology developments. It is looking for metaverse-related technologies to guide its digital transformation to a smart city, including the use of digital twin technologies, such as in the development of the Hong Kong International Airport (HKIA),[1] and smart sensor networks across the city.[2] Companies, like Meta, are responding to its business-friendly environment by tapping on the city as a testing ground for metaverse initiatives.[3]

Metaverse technologies provide opportunities especially for the real estate and luxury goods and fashion industry in the city. Hong Kong-based startup Animoca Brands has a growing portfolio of metaverse businesses, including popular metaverse platform, the Sandbox.[4] Mega City, a cultural hub in the Sandbox metaverse, is one example of a burgeoning virtual real estate sector.[5]

Hong Kong is also leveraging on its position at the intersection of culture and technology to make an impact in the metaverse. Its marquee offerings like Art Basel Hong Kong, Christie's Hong Kong Auctions, are being complemented by the emergence of digital art in the metaverse.[6]

Within this year, there have been over 10 NFT-related events in the city, including "A Woman's World", a NFT art showcase by domestic female artists, Asia's largest NFT exhibition "ARTAVERSE" with more than 100 exhibitors, and K11 MUSEA's "METAVISION", exhibiting more than 200 NFT works.[7]

> "Currently, Hong Kong already possesses excellent information and communication technology infrastructure and business environment, allowing local industries and research institutions to develop related virtual user experience and technologies."
>
> **Alfred Sit, Former Hong Kong Secretary for Innovation and Technology**

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3. Jiaxing Li, "Zuckerberg's Meta To Push Metaverse Initiatives To Hong Kong Cafes and Schools as Interest In Virtual World Hots Up", South China Morning Post, June 14, 2022.
4. Animoca Brands, "About Us", accessed October 3, 2022.
5. ibid.
6. RCommon Affairs, "Hong Kong Heads Into The Future With Digital Art", accessed October 4, 2022.
7. Ibid.

Macroeconomic Determinants

- Hong Kong is overwhelmingly a service-based economy (93.4% of GVA). It has three key industries: financial and insurance services, trading and logistics and education. These are expected to be impacted by the metaverse in the near term.
- Hong Kong is ranked 14th in the world, based on the Global Innovation Index 2022, suggesting a strong propensity for innovation potentially in the form of new services and business models in the metaverse.
- Hong Kong has a high GDP per capita, suggesting that affordability of required immersive hardware on average may be less of a limiting factor on the economic impact of the metaverse.

HONG KONG IN NUMBERS

Potential 2035 economic impact of the metaverse:

US$7-14B per year, 1.3-2.4% of GDP

2020 GDP:

US$368B

Per capita (Constant 2017 US$):

US$55,918 (high income)

Key sectors:

ICT sector:

Population:

7.48M

100% urban

22% below 25

52% with basic digital skills

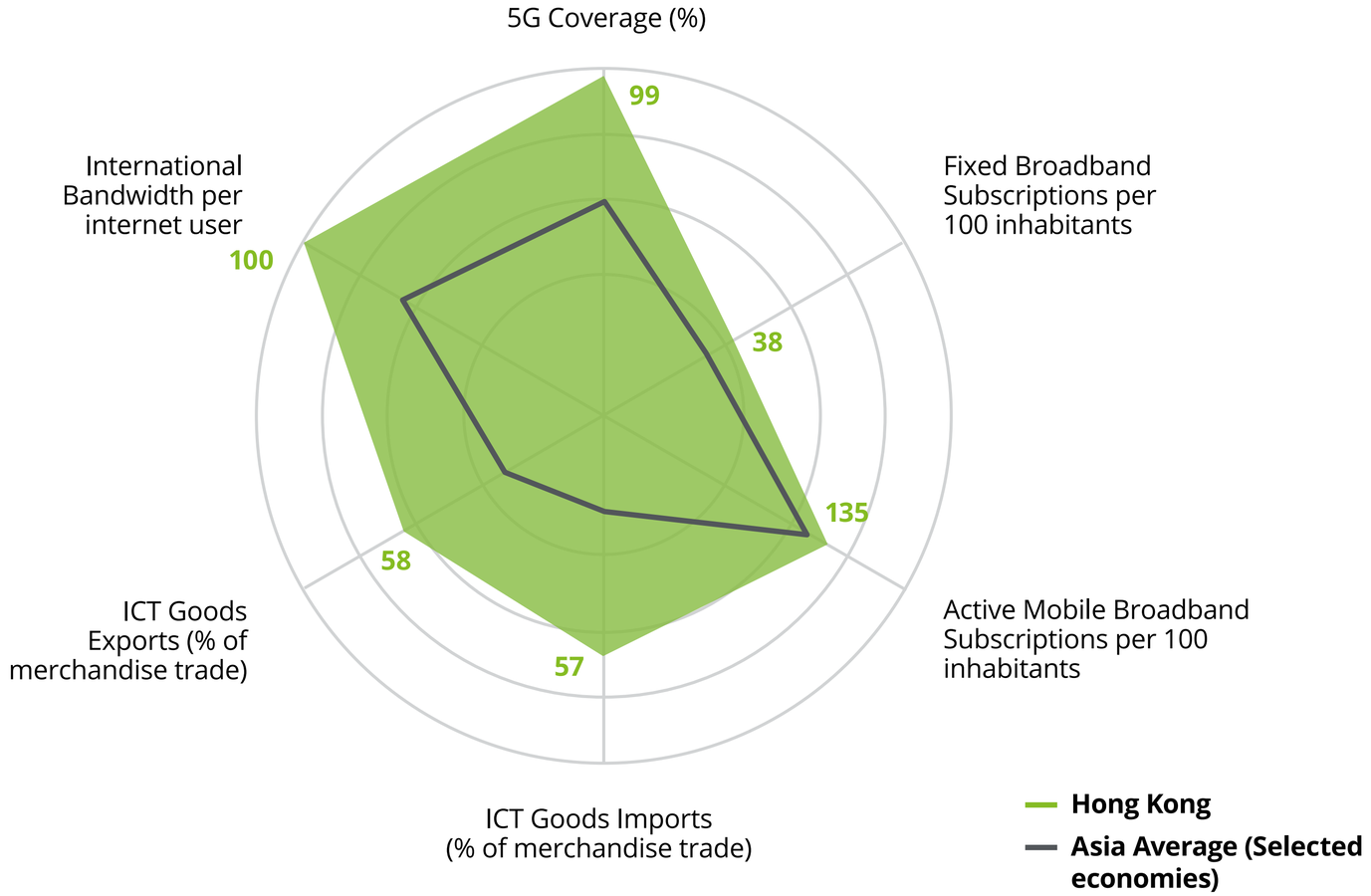
2% unbanked

Global innovation index: **#14/132**

Sources: World Bank World Development Indicators 2020, Our World in Data 2017, ITU Digital Development Dataset 2019, World Bank Global Findex, UN Data
Note: Hong Kong is not ranked on the EIU Business Environment Ranking and Digital Readiness Index

Technology Fundamentals

- Extensive 5G coverage and a high number of active mobile broadband subscriptions will help propel metaverse applications.
- In e-commerce, digital wallets are expected to overtake credit cards and comprise 40% of the city's online transaction value by 2025, which bodes well for the adoption of payment rails in the metaverse.[8]
- Digital skills gap is limiting the uptake of new technologies for more than a third of domestic businesses surveyed by the Hong Kong Government.[9]
- Its Smart City Blueprint 2.0 includes initiatives which can be enhanced with metaverse technologies, such as intelligent transport and traffic management, the use of blockchain technology to enhance traceability of pharmaceutical products, and the use of IoT sensors for pest control, among others.[10]



Sources: GSMA Mobile Connectivity Index 2021, ITU Digital Development Dashboard 2020, UNCTADStat 2019

8. JChartered Public Accountants Australia, "Hong Kong Businesses Embrace Digital Transformation Yet Talent Shortage Bites", press release, August 10, 2022.
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Ecosystem Enablers

Digital Skills

Hong Kong is home to one of the world's leading technological ecosystems, ranking 2nd out of 64 economies in the IMD World Digital Competitiveness Ranking second in 2021. However, due to reduced international labor flow and talent displacement, Hong Kong could face a shortage of 746,000 workers by 2030 due to skill gaps, out of which 8.4% could be in its technology industry.[11]

The government has been taking action to uplift its digital skills training, partnering with industrial stakeholders, like IBM, to train vocational institute students with the latest digital skills like AI and blockchain.[12] It also continues to nurture a pipeline of talent through the Research Talent Hub and STEM Internship Scheme.[13] The Chinese government will also support Hong Kong's talent cultivation, in its efforts to develop the city into an international innovation and technology hub in its 14th Five-Year Plan (2021-2025).[14] Prospects remain bright for metaverse developments as its educated youth base has shown a fair amount of interest in the metaverse, which could be a starting point for more talent to flow into championing metaverse developments.[15]

Competition within the metaverse

In the technology sphere, the city has a proven track record of producing unicorn startups, including SenseTime, Lalamove, WeLab and Klook. The strong startup scene is underpinned by the city's provision of reliable IT infrastructure, financial ecosystem and its proximity to large pools of potential customers in Mainland China.[16]

On the metaverse frontier, Hong Kong-based startup Animoca Brands, continues to grow its portfolio of household names in the metaverse, which includes Axie Infinity, Opensea, Yield Guild Games and Dapper Labs (NBA Top Shot). Kikitrade, a cryptocurrency investment platform is attempting to reinvent the experience by making its platform social-driven.[17] It has also partnered with other platforms under the Hong Kong Metaverse Industry Alliance to promote innovations in the Web 3.0 space, and in the science and technology space.[18] Whatsquare, an AI chatbot platform, has promised to facilitate "conversational commerce" in 32 different languages in Asia.[19] Combined, these developments contribute to an emerging scene that will continue to boost metaverse developments locally, and therefore will increase competition and players within the metaverse.

11. Korn Ferry, "Hong Kong Must Use Its Competitive Advantage To Close The Skills Gap", accessed October 3, 2022.
12. Vocational Training Council, "VTC and IBM announce collaboration to promote digital skills training in Hong Kong," press release, November 30, 2021.
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17. Tech Node Global, "Hong Kong Social Crypto Investing Platform Kikitrade Nets $6 mil Funding Co-led By Appworks and Media Asia", accessed October 4, 2022.
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19. "Whatsquare." accessed October 3, 2022.

Sectors to Watch

Built Environment

Home to one of the world's most expensive real-estate markets, property tycoons and individuals alike are now venturing into virtual land. The average price for a plot of virtual land on Sandbox rose as high as US$20,000 at one point, and has since fallen to around US$5,000.[20] The first phase of a sprawling 'Mega City' has been built in the Sandbox, with partners from the Hong Kong property, film, music, entertainment, professional services, finance, and gaming sectors coming together to co-create this cultural hub.[21] Combining the rich experience in real estate development and entertainment fields, how these collaborators develop their virtual plots to host events, games, or social hubs will serve as an inspiration for how activities in traditional commercial real estate developments could be moved into the virtual realm.

The built environment sector also stands to benefit from digital twins that could be created in the metaverse. Midlands Holdings, one of the largest real estate brokerages operating in Hong Kong and China, has utilized digital twins to create virtual 3D experiences for its entire portfolio of properties.[22] The HKIA has also developed a live 3D digital twin linked to real-time data from IoT devices that will facilitate "holistic airport management, predictive decision making and maintenance" for the full life cycle of its buildings.[23] In the future, advanced biometrics powered by facial recognition could allow passengers to move through checkpoints without the need for document checks.[24] Metaverse technologies is set to change how firms, customers and users come to interact with the built environment.

Culture and Art

The world of culture and art is increasingly influenced by metaverse technologies. As the region's cultural center, its marquee offerings like Art Basel Hong Kong, Christie's Hong Kong Auctions, as well as West Kowloon Cultural District and the M+ Museum are adapting to the rise of digital art in the metaverse.[25] The Hong Kong Museum of Art and the Affordable Art Fair have included digital art within their line-up.[26]

Attempts to integrate developments in the metaverse extends to the adjacent world of fashion and luxury and Hong Kong consumers are shifting consumption towards e-commerce.[27] For example, I.T., a leading multi-brand fashion house in Hong Kong, recently commissioned digital fashion house The Fabricant to represent an entire collection solely in digital form.[28] Through this move to embrace AR and VR technologies in their business model, customers of I.T could interact with shoes and apparel through web browsers and VR headsets. The metaverse is a space conducive to the vigor of the creative industry, and developments in metaverse technologies will only present further opportunities for the industry to experiment and innovate.

20. Xinmei Shen, "Animoca Brands launches new season for The Sandbox amid plunging metaverse real estate prices", South China Morning Post, August 19, 2022.
21. TechNode Global, "The Sandbox expands cultural hub in the metaverse with major Hong Kong partners unveiled in Mega City 2", accessed October 3, 2022.
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23. Hong Kong International Airport, "AAHK Sustainability Report 2018/19: Smart Airport", accessed October 3, 2022
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26. Sue Hua, "Disruption, Digitalization and Connectivity: Asia's Art Market in Transformation," Arts 2022. 11, no.3 (2022).
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India

Potential 2035 economic impact of the metaverse

US$79-148B per year

India

Set to become the third largest economy by 2030,[1] India has a population that is young, digitally connected, and ready for the metaverse. With over half of its population under the age of 30, the country produces the highest number of STEM graduates globally.[2] It is demographically well-positioned to contribute digital labor to the metaverse, especially since it is already a go-to destination for IT offshoring globally and is evolving rapidly into a product development hub.[3]

While the country has no shortage of labor, brain drain has been a growing concern.

Two in three Indian emigrants are highly educated,[4] and the development of the metaverse in India may help to retain talent by providing more opportunities for digitally skilled Indians. Beyond its demographics, attitudes of its population towards the metaverse are more optimistic than the rest of the world. Large Indian corporations such as Infosys and Tech Mahindra have set up metaverse subsidiaries.[5] Further, India's unique cultural propositions in language, religion, and entertainment can give its metaverse offerings a distinct flavor.

However, to reap the full benefits, existing challenges such as technology equity will first need to be addressed so that the full potential of the metaverse can be harnessed in India.

In this case, India's large population will prove to be both a boon and a bane – India will have to encourage its technologically advanced population to enter the metaverse, while ensuring that such progress includes all economic and social groups.

> "When we're thinking about what the next generation is going to look like in terms of where all these creators and developers are going to come from, who are going to really build the foundation of the metaverse, I think it's just obvious that India is going to be a huge part of that."

Mark Zuckerberg, Co-founder, Chairman and CEO of Meta Platforms at Fuel for India 2021, December 2021

1. Yogima Seth Sharma, "India can be 3rd largest economy by 2030 on back of four big reforms: Arvind Panagariya," The Economic Times, February 25, 2022.
2. Niall McCarthy, "The Countries With The Most STEM Graduates," Forbes, February 2, 2017.
3. Ananya Bhattacharya, "Brain drain: Two in three Indian emigrants are highly educated," Scroll.in, April 10, 2022.
4. Ibid
5. Ayushman Baruah, "IT firms tap nascent metaverse to help clients explore its potential," Mint, October 19, 2022.

Macroeconomic Determinants

- Services-led economy (55.0% of GVA), with the three largest sectoral contributors to India's economy being agriculture (18.4% of GVA), followed by manufacturing (14.7% of GVA), and wholesale and retail (11.3% of GVA).
- GDP per capita stood at US$6,187, suggesting that the affordability of required immersive hardware on average may be a limiting factor for a significant segment of the population to enter the metaverse.
- India received a record amount of VC investments in 2021, reaching US$38.5 billion. The record number of investments have fueled India's vibrant start-up ecosystem which is US$400 billion in valuation with 50,000 active start-ups including 107 unicorns.[6] Notably, consumer technology, fintech, and software as a service (SaaS) accounted for 75% of all VC investments by value. The composition of its vibrant ecosystem signify an innovation environment aligned with the metaverse's development.[7]

INDIA IN NUMBERS

Potential 2035 economic impact of the metaverse:

US$79-148B per year, 1.3-2.4% of GDP

2020 GDP:

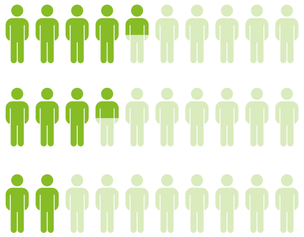
US$2.5T

Per capita (Constant 2017 US$):

US$6,187
(low middle income)

Population:

1.38B



46% urban

35% below 25

22% unbanked

Key sectors:

ICT sector:

Global innovation index: **#40/132**

EIU business environment ranking: **#57/99**

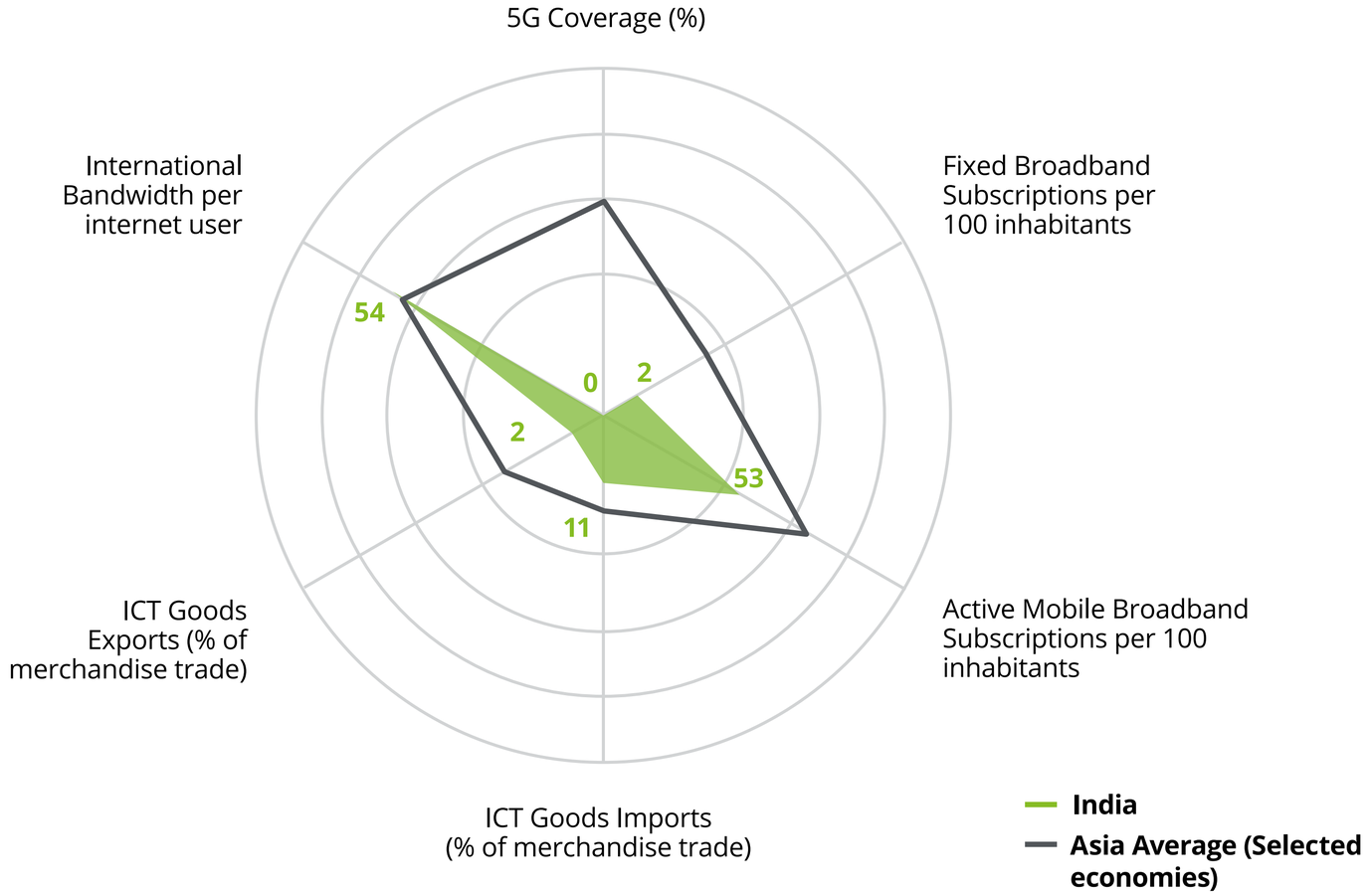
Digital readiness index: **#101/141**

Sources: World Bank World Development Indicators 2020, Our World in Data 2017, ITU Digital Development Dataset 2019, World Bank Global Findex, UN Data

6. Invest India, "The Indian Unicorn Landscape," accessed October 25, 2022.
7. Bain & Company, India Venture Capital Report 2022, 2022.

Technology Fundamentals

- In 2020, smartphone penetration rate was approximately 43.5%. However, given its large population, the volume of smartphone users is high. Current predictions indicate that there will be 1 billion Indian smartphone users by 2026.[8] As the second largest smartphone market in the world, early iterations of the metaverse accessible via smartphone will find a large audience in India.
- There is a digital divide in India in the usage of the internet and access to digital infrastructure based on gender, rural-urban residence, caste, and age.[9] To that end, India also launched the world's largest rural broadband connectivity program, BharatNet, which aims to extend fiber connection to all villages in India by 2025.[10] However, beyond the urban-rural divide, more will need to be done to bridge other areas of the digital divide (for example, in gender) so that the full potential of India's large population can be harnessed for the metaverse.
- Real-time digital payments in India make up 40% of all such transactions globally, which is the highest in the world. The success of its fintech ecosystem in encouraging mass adoption can be attributed to a combination of low cost internet data, high smartphone penetration rate, and India's Unified Payment Interface (UPI).[11]



Sources: GSMA Mobile Connectivity Index 2021, ITU Digital Development Dashboard 2020, UNCTADStat 2019

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Ecosystem Enablers

Social acceptance

Enthusiasm for the metaverse exceeds the global average in India. 80% were familiar with the metaverse, above the global average, and 75% of respondents expressed positive feelings about engaging with extended reality.[12] The enthusiasm and familiarity with the metaverse will support the development and social acceptance of the metaverse in India. Corporations are keen to invest in the metaverse, and consumers are excited to use related products. Already, India is making headway into the metaverse through their first metaverse influencer,[13] the first metaverse wedding,[14] the world's first food metaverse,[15] and several Indian production houses have used the metaverse to enable next generation entertainment.

Digital skills

With 46% of its population under age 25,[16] India can provide the necessary manpower to fuel the growth of the metaverse. Within this young population, 32% choose STEM tertiary education programs, and the country produced the most STEM graduates globally with 2.7 million graduates in 2018.[17] However, more needs to be done to upskill its broader population – 95% of workers in India reported that more digital skills are needed to cope with changes in their jobs due to COVID-19.[18] The development of the metaverse could create new opportunities that benefit its economy and retain talent within its shores.

Security and privacy

On the cybersecurity front, India is one of the first countries to explicitly mention the metaverse in its policy considerations on bullying and sexual abuse.[19] India's upcoming digital regulatory framework, the Digital India Act (DIA), will look at crimes in the metaverse that spread misinformation or incite violence.[20]

Nevertheless, some observers have expressed concerns over the potential scope of its censorship laws.[21] Such healthy debates are to be expected as India moves towards the complex task of regulating the metaverse ahead of its peers. Complementary to this, data protection laws will also have to quickly catch up. As the world's fastest-growing market for new internet users, India had a record number of cybersecurity incidents in the recent years with the exponential growth of personal data.[22]

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Sectors to Watch

Digital Payments

Digital payments will be a crucial component of the metaverse to trade digital assets. India could feature strongly in this development, as it has the highest rates of real-time digital payments in the world.[23] This is driven by the digital infrastructure developed through the government-led India Stack which sought to bring its population into the digital age. The India Stack involves projects such as Unified Payments Interface, the world's largest real-time digital payment system, as well as Aadhar, the world's largest biometric ID system. Through such a digital infrastructure, India is making massive leaps in financial inclusion. Improvements in digital infrastructure have meant that significant progress in increasing the number of adults with bank accounts was made in just 7 years.[24]

Given this existing infrastructure, if India can build on the existing India Stack into the metaverse's digital components such as blockchain and NFTs, it should be able to rapidly create scale given their large population. To begin, the government released a national blockchain strategy in December 2021. The government is also considering a Digital Rupee, to be issued by the Reserve Bank of India from 2022-23.[25] With more regulatory certainty and a clear legal framework for Virtual Digital Assets, India's mature digital payments systems can be leveraged to orchestrate the economic infrastructure of the metaverse.

Gaming and Entertainment

India is the world's largest mobile gaming market in terms of app downloads.[26] The gaming market in India is anticipated to more than triple to US$7 billion by 2026,[27] a promising development as games are an entry point into the metaverse.

Already, Indian gaming companies such as Alter.game and The Spartan Group have begun to venture into the metaverse.[28] Beyond gaming, India is also making strides in the film industry – Pooja Entertainment bought its first virtual plot in the metaverse and plans to create immersive and life-like experiences for viewers.[29] India media conglomerate, Zee Entertainment, also welcomed its recruits via the metaverse for the first time and plans to introduce NFTs from TV shows, movies, music, and original web series.[30] Through entertainment platforms such as gaming and films, it could make the metaverse more accessible to many who already engage with these platforms.

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Indonesia

Potential 2035 economic impact of the metaverse

US$28-52B per year

Indonesia

As the next facet of the internet, the metaverse can fuel Indonesia's US$70 billion internet economy growth engine.[1] Recording a staggering 49% growth in 2020, the country's internet economy is projected to reach US$146 billion by 2025.[2] President Jokowi has championed the digital economy as a key pillar to propel Indonesia into the top 10 global economies by 2030.[3] The Digital Indonesia Road Map 2021–2024 seeks to accelerate this digital transition by laying out four strategic areas of focus – digital infrastructure, government, economy and citizens.[4]

Indonesia seeks to leverage the metaverse to help micro, small and medium enterprises (MSMEs) grow. If successful, this would quickly catalyze broad-based economic benefits. MSMEs currently employ 97% of Indonesia's workforce[5] and contribute to over 60% of the national GDP.[6] PT Telkom Indonesia, the state carrier, has been tasked by the government to develop a metaverse for local MSMEs to compete with larger foreign businesses.[7] MSMEs are likely welcoming of such platforms having experienced the value of digital merchandising, which kept close to 80% of the MSMEs surveyed open during the pandemic.[8]

> "Don't let other countries create a new world with their own payment system, while the market remains in Indonesia. Then we will regret it."
>
> **Erick Thohir, Indonesia's Minister of State-Owned Enterprises, at the launch of Indonesian metaverse platform "metaNesia", Aug 2022**

1. Bain & Company, Temasek and Google, e-Conomy SEA 2021, 2021.
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Macroeconomic Determinants

- With one of the largest youth populations in the world behind India and China, Indonesia's next generation stands to gain from the metaverse.
- Manufacturing and raw resources make up the bulk of Indonesia's economy, with the three largest sectoral contributors to Indonesia's economy being manufacturing (20.6% of GVA), followed by agriculture, forestry and fishing (14.2%) and wholesale and retail trade (13.4%). Manufacturing is one of the first sectors expected to be impacted by the metaverse.
- As a lower middle income country with a GDP per capita of US$11,446 in 2020, affordability may be an issue for some of its citizens.
- Indonesia is ranked 75th in the world on the Global Innovation Index 2022, lagging behind its Asian peers.
- It has produced 11 unicorn start-ups, one of the most amongst Southeast Asian countries.[9] This constitutes 31% of Southeast Asia's share of unicorns.

INDONESIA IN NUMBERS

Potential 2035 economic impact of the metaverse:

US$28-52B per year, 1.3-2.4% of GDP

2020 GDP:

US$1.03T

Per capita (Constant 2017 US$):

US$11,446 (low middle income)

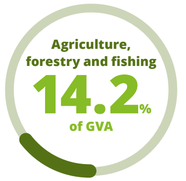
Population:

274M

44% below 25

48% unbanked

Key sectors:



ICT sector:

Global innovation index: **#75/132**

EIU business environment ranking: **#54/99**

Digital readiness index: **#73/141**

9. Choo Yun Ting, More ASEAN Start-Ups Become Unicorn Thanks to Robust Funding, Rising Middle Class: Report, Straits Times, October 21, 2021.

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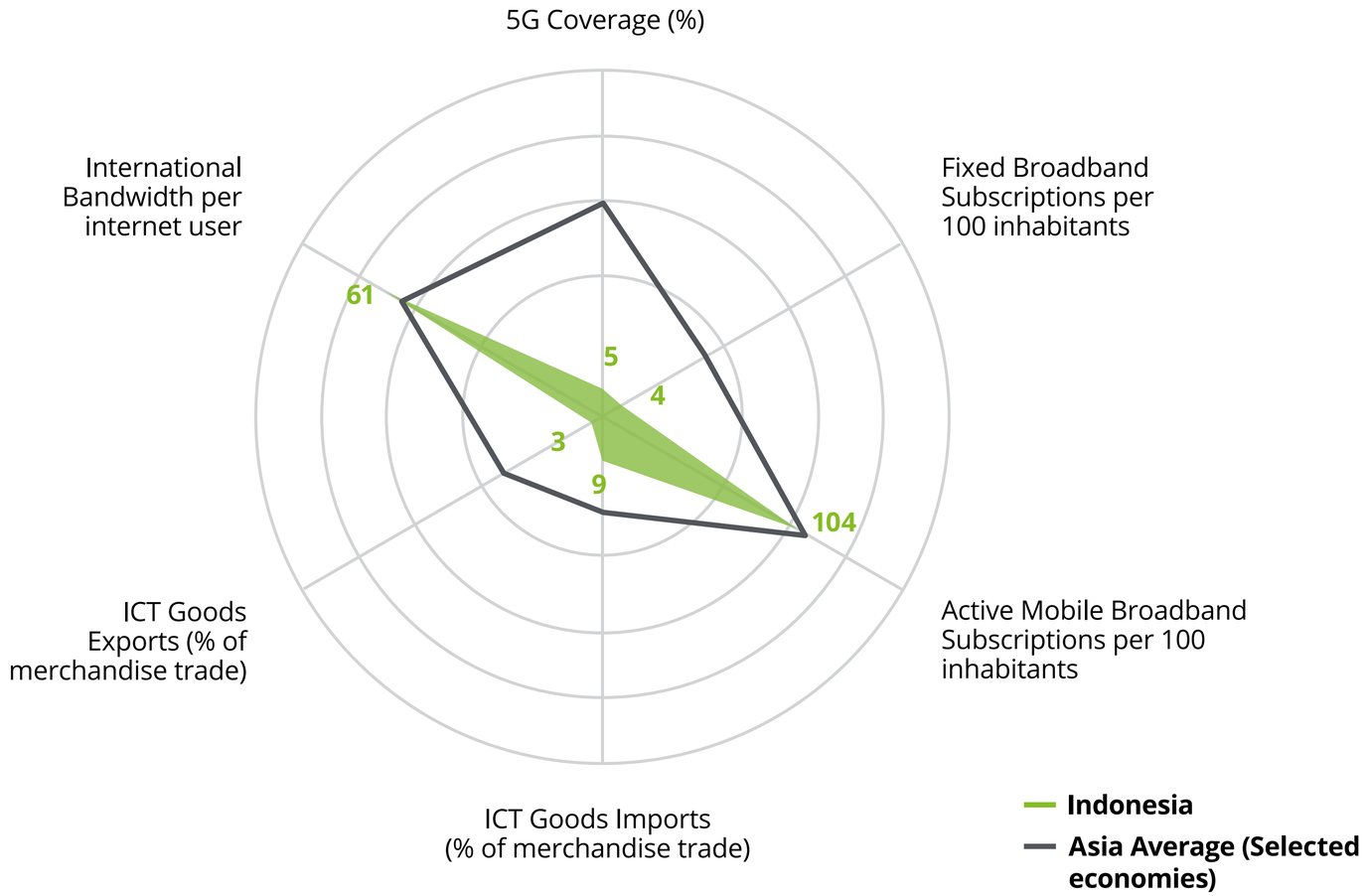
Technology Fundamentals

- Indonesia is a mobile-first nation, and has the fourth most number of smartphone users globally.[10]
- Indonesia is expected to lead Asia in overall IT spending over the next four years, reaching US$6 billion by 2024.[11]
- The establishment of physical cloud infrastructure in Indonesia by global players like Alibaba, Google and Amazon will reduce latency of connection.[12]
- The adoption of digital payments is currently lagging behind the other selected Asia economies.[13]



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Ecosystem Enablers

Digital Skills

As part of the Digital Indonesia Roadmap, Indonesia aims to provide 12.5 million Indonesians with trainings in basic digital skills, digital culture, digital ethics, and digital safety, and 100,000 workers with intermediate digital skills in areas such as cloud computing, artificial intelligence, the internet of things, cybersecurity, and big data analytics.[14] These create the foundations for Indonesia to realize its economic potential in the metaverse. But Indonesia may need much more to sustain its digital economy growth, with the World Bank estimating that 9 million additional ICT workers are needed by 2030.[15] Support from multinationals like Google, Huawei and ZTE could fill this gap. Huawei has pledged to contribute to Indonesia's digital upskilling efforts, and is planning to train 100,000 digital workers to be competent in cloud computing and 5G in the next 5 years.[16]

A digitally competent populace will provide growth impetus for Indonesia's MSMEs, where human capital development is a key barrier for growth.[17] The government has helped to onboard 10.2 million MSMEs onto digital platforms under the #BanggaBuatanIndonesia campaign (Proudly Made in Indonesia).[18] Further growth potential in the metaverse could entice the build-up of digital skills amongst its talent and businesses.

Accessibility

Indonesia's vast geography spans across thousands of islands, which could pose a hurdle to the deployment of metaverse technologies requiring fiber optic and broadband cables, and worsen the digital divide.[19] The Palapa Ring Project, which sought to extend the reach of its fiber optic and wireless network nationwide, was completed in 2019. It has helped to bridge internet connectivity and reduced the inequality in mobile network experience across the archipelago, especially compared to Java, Indonesia's political and economic center.[20] The average 4G availability and download speed experience has improved by 12% and 59% respectively across all regions since 2018.[21]

Indonesia's WIR Group has its sights on creating a metaverse platform to bridge the link between businesses and local consumers, many of whom reside in the country's rural areas with limited access to digital technology and financial services.[22] The platform is anticipated to enable consumers in Tier 2 to 3 cities and suburban retail stores to create digital avatars through its kiosks.

In 2019, 94 million adults across Indonesia did not have access to mobile internet.[23] The expansion of digital infrastructure and platforms will allow Indonesians to have more equitable access to the economic opportunities in the metaverse.

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Sectors to Watch

Start-Up

Indonesia has emerged as one of the foremost emerging start-up ecosystems globally, with Jakarta ranked 3rd on the Global Startup Ecosystem Report 2021.[24] The country has produced 11 unicorns, one of the most amongst Southeast Asian countries.[25] Although still maturing, Indonesia also boasts one of the largest venture capital markets in Southeast Asia.[26] The momentum kickstarted in Jakarta has also spread to other cities, such as Yogyakarta and Tasikmalaya.[27]

Ajaib, an online brokerage platform, has adopted Bored Ape Yacht Club NFT #2831 as its mascot to support Indonesia's adoption of metaverse and Web 3.0 technologies.[28] The newly-crowned unicorn intends to tap on the Bored Ape to educate the public about crypto assets and blockchain technology.[29] Good Games Guild, a budding metaverse startup, has its sights set on creating the largest virtual world economy by incentivizing greater participation in play-to-earn games.[30] It offers scholarships to sponsor play-to-earn gamers, and builds tools to enhance the experience of gaming in the metaverse.[31] Indonesian NFT project, Karafuru NFT, and USS Feed launched the Karafuru Carnival in Jakarta in April 2022. The offline festival featured local NFT projects to the broader public, making it more accessible for a larger audience.[32] Overall, the metaverse is sure to have an impact on the development of the startup ecosystem in Indonesia.

Finance

Islamic finance, or Shariah-compliant financing (SCF) has grown at an estimated compound annual growth rate of 17% since 2009.[33] Being one of the fastest growing sectors in the global financial ecosystem, it has amassed US$1.9 trillion in total assets since 2015. Catering to the largest Muslim population globally, the Jokowi administration has sought to advance the growth of SCF within Indonesia.

Indonesia could play an influential role in how the financial rails of the metaverse are developed in a Shariah-compliant manner that addresses concerns with cryptocurrencies. Bank Syariah Indonesia, formed from a 2021 merger of three state-owned banks, has inked an agreement with the WIR Group to develop virtual banking services in the metaverse.[34] Despite the cryptocurrency ban by Indonesia's National Ulema Council, observers, observers have identified the greatest potential in economic transactions in the Islamic metaverse.[35] Seizing on the burgeoning opportunities in Indonesia, IBF Net, a blockchain company, has set-up a center of excellence in Jakarta to study and develop possibilities within an Islamic metaverse economy.[33] Bank Indonesia, Indonesia's central bank, is also planning to issue a white paper on Central Bank Digital Currency (CBDC) development in end-2022.[37]

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Japan

Potential 2035 economic impact of the metaverse

US$87-165B per year

Japan

With the metaverse, Japan will be able to tap on its strong heritage in digital craftsmanship and technical prowess to benefit a broad range of sectors at a wider scale.

PM Fumio Kishida's administration's plan to bring Japan into the digital era is highly compatible with the development of the metaverse: developing a facilitative environment for the promotion of Web 3.0, including blockchains, NFTs and the metaverse, upskilling digital talent, investing in digital technology, increasing R&D in AI and quantum technologies, creating a start-up boom, and reviving Japan as an international financial center.[1]

This will mark a distinct shift beyond gaming and entertainment, which Japan has established themselves as a leader in.

As one of the world's first gaming markets and currently the third largest,[2] after China and the US, gaming in Japan has become more than a part of the economy – it has assimilated into culture. Long before 'metaverse' came into common parlance, Japan captured the popular imagination with the fantasy worlds of manga, anime and video games. These are now a source of inspiration for many virtual worlds and characters. The video game industry and gaming consoles would not be what they are today if not for Japan. Today, Japan's cultural appeal remains prominent, with spin-offs like Pokemon Go remaining the highest grossing mobile AR game in the world.[3] Compared to the emphasis on industrial uses in the US, early explorations of VR in Japan took on a different trajectory to become a tool for renegotiating personal space and a portal to "other world" fantasies.[4]

Early experiments in metaverse technologies are demonstrating how Japan can capitalize its strong cultural and technological capital to provide new offerings in retail, tourism and many other sectors. The ability to do this at scale will translate to wider economic and social benefits.

> "Japan will develop an environment for the promotion of web 3.0, such as blockchain, NFTs and the metaverse, and achieve a society that facilitates the birth of new services."
>
> **Fumio Kishida, Prime Minister of Japan, at the Guildhall in London, May 2022**

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2. Newzoo, Global Games Market Report, 2022.
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Macroeconomic Determinants

- The metaverse will have wide ramifications across sectors in Japan, including business-to-consumer (B2C) and business-to-business (B2B) industries. Japan is a service-based economy (70.0% of GVA), with the three largest sectoral contributors to Japan's economy being manufacturing (20.5% of GVA), followed by wholesale and retail (12.7%), and real estate activities (11.8%).
- Ranked 13th in the world on the Global Innovation Index 2022, which suggests that Japan has a strong propensity for innovation.
- Opportunity to increase high value-added cultural and creative exports through the metaverse, reducing the reliance on domestic consumption as demographic challenges increase. Japan's overseas anime sales grossed close to US$11b in 2020,[5] accounting for half the market.
- GDP per capita stood at US$39,935, suggesting that affordability of required immersive hardware on average may be less of a limiting factor on the economic impact of the metaverse.

JAPAN IN NUMBERS

Potential 2035 economic impact of the metaverse:

US$87-165B per year, 1.3-2.4% of GDP

2020 GDP:

US$4.38T

Per capita (Constant 2017 US$):

US$39,935 (high income)

Population:

126M

91% urban

22% below 25

60% with basic digital skills

2% unbanked

Key sectors:

ICT sector:

Global innovation index: **#13/132**

EIU business environment ranking: **#19/99**

Digital readiness index: **#16/141**

Sources: World Bank World Development Indicators 2020, Our World in Data 2017, ITU Digital Development Dataset 2019, World Bank Global Findex, Japan National Statistics

5. Association of Japanese Animations, Anime Industry Report 2020, 2020.

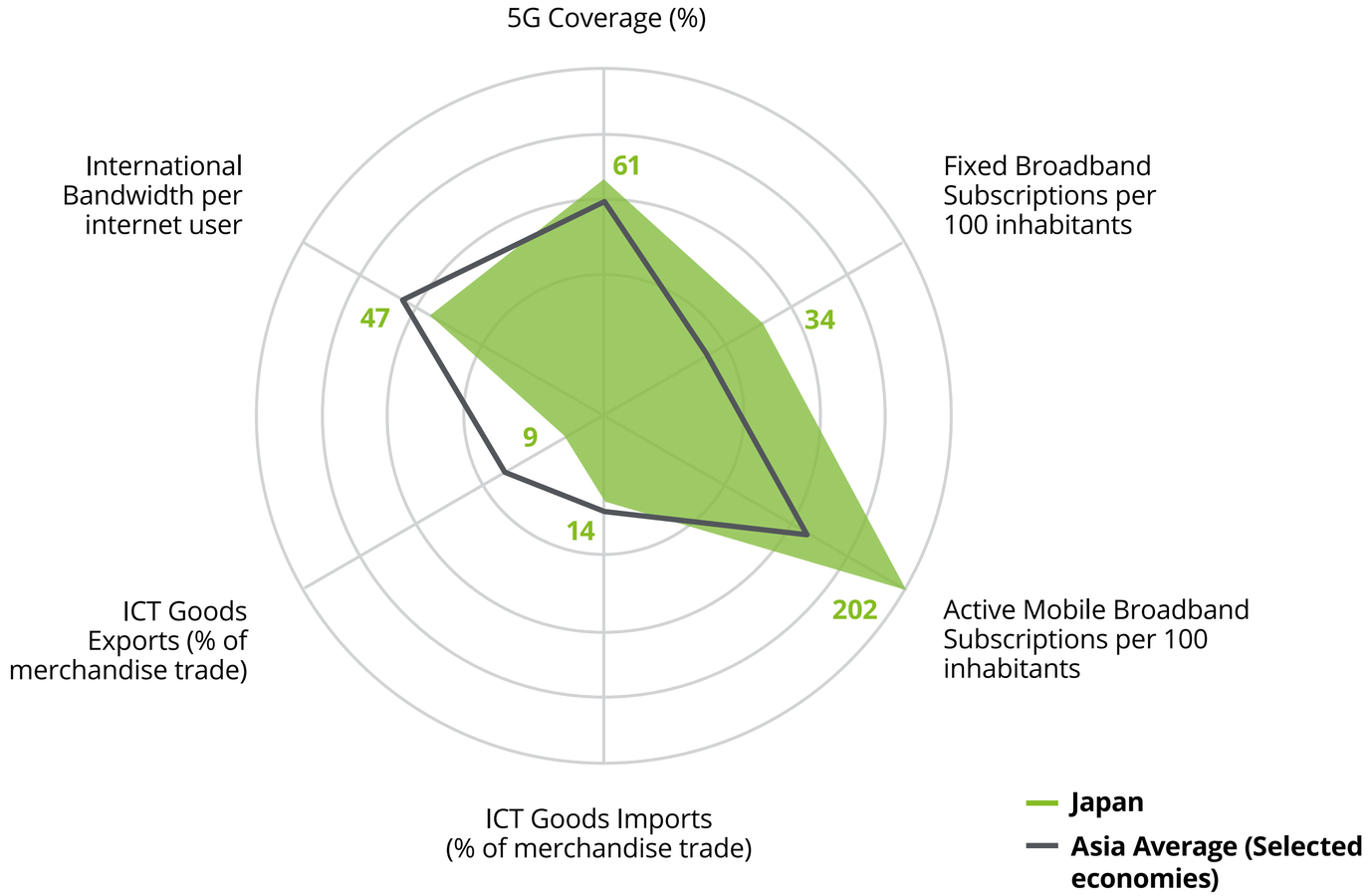
Technology Fundamentals

- The country has deep capabilities across the technology stack in metaverse-related technologies with Sharp as the single biggest supplier of VR displays for Meta Quest 2.[6] In addition, Sony has both hardware and software capabilities, with its Playstation operating system holding a 65% share of the game console market.[7] Tokyo also houses the largest cluster of data centers in Asia, primarily to meet local computing demand.[8]

- Japan aims to create a world-class digital infrastructure as part of its drive for digital transformation in both the public and private sector, including stimulating new services in Web3.0 and the metaverse. Japan is making steady progress in deploying metaverse-ready networks including 5G and WiFi 6E technologies.[9]

- Besides biotechnology, three of the five fields that will receive more R&D funding from the Kishida administration have direct relevance for the metaverse – AI, quantum technologies and digital. A fourth – decarbonization – can improve the sustainability of the energy-intensive metaverse.

- More online activity, including metaverse applications, may drive adoption of digital payments, which make up only 20% of transactions today.[10]



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Ecosystem Enablers

Digital Skills

Investing in people is a demographic imperative. Workers across sectors of the Japanese economy whose jobs require digital skills contribute US$785 billion to Japan's GDP, or 16%. Interestingly, 75% of this value is derived from the non-technology sector, signaling the wider economic benefits of digital upskilling.[11]

Already, Japan's government has shifted vocational training to focus on digital skills and has plans to offer digital training programmes for Japanese workers through universities and technical schools. Educators like University of Tokyo[12] and N and S High Schools[13] have also begun offering their courses within the metaverse. Interest around the metaverse could attract further talent into the sector, particularly from overseas as Japan attempts to diversify its talent pool.

Competition within the metaverse

A thriving start-up ecosystem will drive the creative destruction needed for metaverse innovation. Japan's fledgling funding ecosystem (both early and late stage)[14] has yet to catalyze a sizeable number of unicorns relative to Japan's GDP.[15]

PM Kishida seeks to "create the next start-up boom in Japan", and this could well be in the metaverse space in line with the push towards Japan's digital era. Startups like Cluster Inc and HIKKY are creating immersive environments where creators, businesses and users can co-participate. For instance, Cluster hosted the world's first-ever VR music event in 2017, where more than 5,000 people participated.[16]

There is room for more Japanese businesses to adapt and participate in a more technologically disruptive future, as Japan ranks 53rd out of 63 countries for business agility in IMD's Digital Competitiveness Index.

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14. Tokyo Development Learning Centre, Boosting Japan's Startup Ecosystem: Challenges, Opportunities and Recommendations, 2021.
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16. Masuru Ikeda, "Japan's Cluster secures $3.6M series B to develop own VR live show content," Bridge, October 19, 2022.

Sectors to Watch

Tourism

Prior to the pandemic, Japan was ranked the third most popular tourist destination in Asia.[17] The pandemic was a significant blow to its tourism industry, particularly with the Tokyo Olympics being held in its midst. This prompted experimentation with metaverse solutions, turning crisis into opportunity.

As part of the Tokyo Paralympics, a parallel virtual experience – the Pegasus Dream Tour – enabled spectators around the world to virtually engage in Paralympic sports and festivities.[18] Tokyo Shibuya's 2021 Halloween celebration allowed this annual tradition to continue in the midst of social distancing restrictions.[19] ANA Airways is also developing an interactive virtual platform ANA NEO.[20] Through partnering with tourism agencies around the world, users can visit recreations of famous tourist sites and enjoy new shopping experiences.

Even as Japan's borders open, these early experiments pave the way for innovative travel experiences, and access to new groups of travelers – virtual or physical.

Retail and e-commerce

The metaverse era of the internet offers Japan an opportunity to unlock the cultural capital it has built up since the 1980s-90s to influence other sectors beyond gaming and entertainment. One adjacent sector poised to benefit is retail and e-commerce. An example is former Final Fantasy XV Game Director Hajime Tabata,[21] who is applying his experience as a pioneer in creating user-centric experiences with the popular role-playing game through his start-up JP Games. Japanese retail companies such as Isetan and Daimaru Matsuzakaya have been utilizing virtual reality and live commerce to promote and sell their products.[22]

Another popular trend that emerged in Japan in the mid-2010s is VTubers (or virtual Youtubers); digitally animated characters that can play similar roles to human celebrities like performing concerts and pitching products. VTubers have generated widespread attention, clinching over 1.5 billion in monthly viewership and raking in millions.[23] Brands are discovering the power of VTubers through livestreaming and advertising, not only in Japan, but across the region too.[24]

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Mainland China

Potential 2035 economic impact of the metaverse

US$456-862B per year

Mainland China

Mainland China's deep technology and manufacturing verticals are shaping a metaverse with its own Chinese characteristics. The state wants the trajectory of metaverse developments to complement the real economy,[1] in line with President of the People's Republic of China Xi Jinping's declaration that "the real economy is the very foundation of an economy... and an important pillar of national prosperity".[2]

Beijing has announced a two-year metaverse innovation and development plan (2022 – 2024) to develop the technological infrastructure and promote its use in various fields, including education and tourism.[3] Shanghai included the metaverse in its 14th five-year plan, encouraging its application in areas such as public services, business, social entertainment and industrial manufacturing,[4] and is constructing the Zhangjiang metaverse-themed industrial park. Other provincial governments have also signaled their support, including Jiangsu, Zhejiang, Wuhan and Heifei.[5]

Homegrown technology giants are making metaverse investments through both acquisitions and research. Bytedance acquired VR headset company, Pico[6] and virtual social platform, PoliQ.[7] Alibaba has invested at least US$1 billion in AR and VR startups in recent years.[8] Baidu is developing the technological tools to enable developers and creators to create the metaverse through its XiRang platform.[9] Huawei and Tencent joined hands with other companies to set up The Joint Research Institute of Metaverse and Virtual-Real Interaction with China's premier universities, including Fudan University and Peking University.[10]

Ensuring that they stay on the right side of regulators, industry leaders like Tencent, Ant Group, Baidu and JD.com have joined an industry pledge to ensure digital collectible sales adhere to the ban on cryptocurrencies, requiring real-name authentication of buyers and sellers and reining in secondary marketplaces.[11]

Domestic consumers are already embracing digital consumer store experiences, and livestreaming. Virtual influencers are set to be a key feature of China's US$171 billion live-commerce market, which grew at a compound annual growth rate (CAGR) of more than 280% between 2017 and 2020.[12] With the country's vibrant entrepreneurial spirit, strong government support and direction, and the well-capitalized financial ecosystem in first-tier cities, China stands ready to take advantage of the plentiful opportunities that the metaverse economy will provide.

> "Competition in the internet sector has come to a new stage, and we are going to embrace the fourth generation of the internet, which will be the age of the metaverse."

Luo Jun, Secretary General of the Metaverse Committee of China Computer Industry Association

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Macroeconomic Determinants

- China's economy has a strong and growing service sector focus (50.9% of GVA). The largest sectoral contributor to its economy is manufacturing (29.3% of GVA), followed by wholesale and retail trade (9.5%), and financial and insurance activities (8.0%). These sectors have the potential to be impacted by metaverse technologies in the near term.
- Strong propensity for innovation in the metaverse, with China ranked 11th globally, based on the Global Innovation Index 2022.
- China is an upper-middle income country. Given its large population, there will be a wide range of ways that users will access the metaverse depending on factors such as income and age.
- The policy direction of metaverse-related strategies follows China's current industrial policy of technology independence and increased domestic consumption, as seen in the State Council's Next Generation Artificial Intelligence Development Plan (up to 2030).[13]
- While this may take time to materialize, the country's push for metaverse technologies to integrate with the "real economy"[14] could see developments of more diverse use-cases that differ from other countries.

MAINLAND CHINA IN NUMBERS

Potential 2035 economic impact of the metaverse:

US$456-862B per year, 1.3-2.4% of GDP

2020 GDP:

US$14.6T

Per capita (Constant 2017 US$):

US$16,297

(upper middle income)

Key sectors:

ICT sector:

Population:

1.402B

61% urban

30% below 25

11% unbanked

Global innovation index: **#11/132**

EIU business environment ranking: **#42/99**

Digital readiness index: **#54/141**

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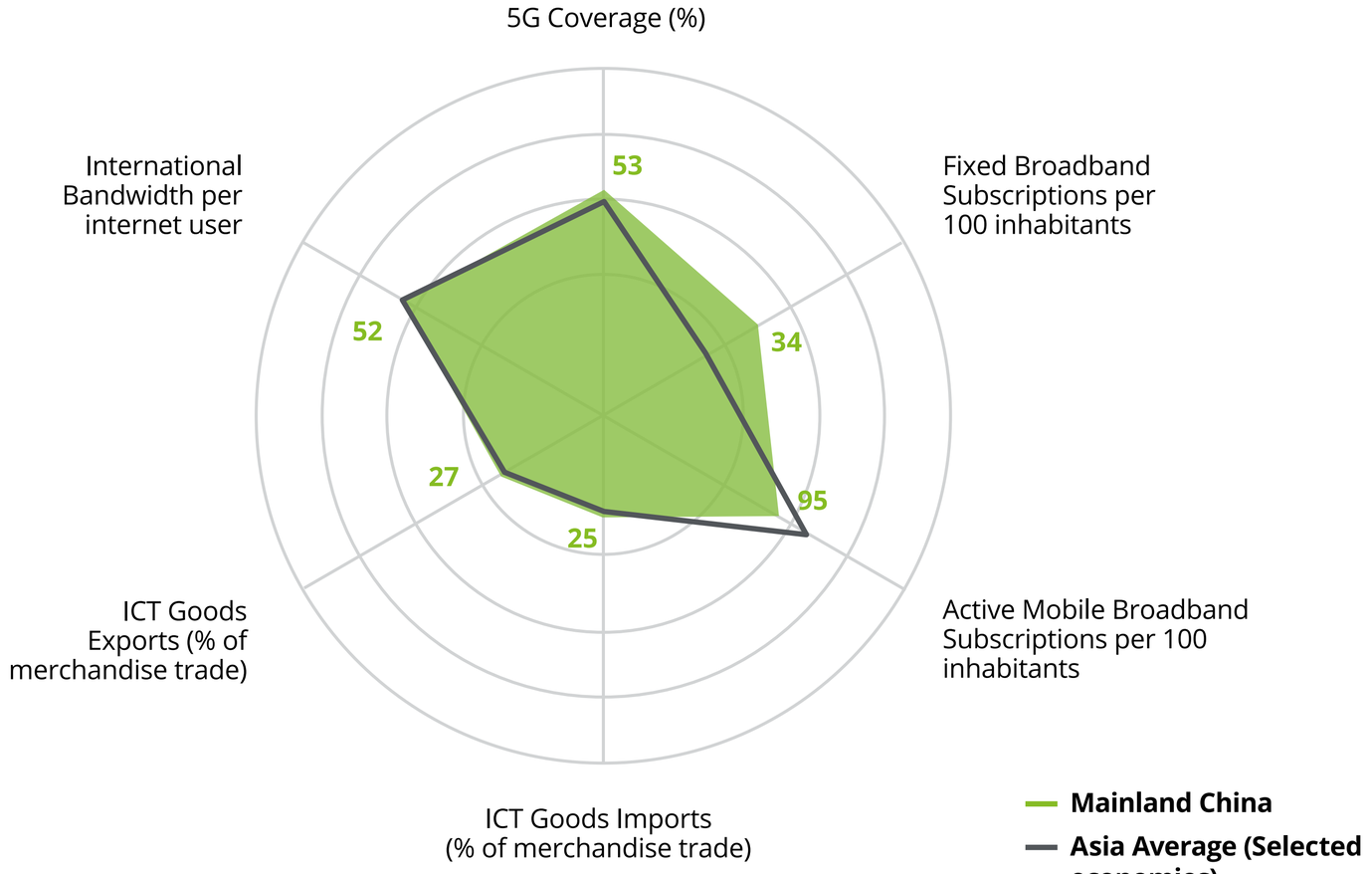
Sources: World Bank World Development Indicators 2020, Our World in Data 2017, ITU Digital Development Dataset 2019, World Bank Global Findex, China National Statistics

Technology Fundamentals

- China's deep technology and manufacturing verticals provide it with the capability to shape a metaverse that has its own Chinese characteristics.
- The nation is building up its own technology independence across supply chains in key areas such as semiconductors,[15] which are necessary to power devices that enable the metaverse. Being the world's largest market for the application of robotics,[16] it has the capacity to further scale up the production of these devices.
- The central government is scaling up its domestic 5G network, targeting for the nation's 5G network to cover most villages by 2025.[17] There are plans for commercialization of 6G technology around 2030.[18] Speed and reliability of the service would have to be further improved[19] to enable higher-fidelity immersive metaverse experiences.
- China is trending towards becoming a cashless society, with 90% of its people in urban areas and 82% in rural areas using digital payments.[20]
- The Ministry of Human Resources and Social Security released a plan to increase digital skill education and training to the public to help more people reap the benefits of digital development.[21]



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Ecosystem Enablers

Competition within the metaverse

China has a complete metaverse value chain across hardware, software and content, which will incentivize competition across firms.[22] Homegrown software giants like ByteDance, Alibaba and Baidu, are racing to be at the forefront of metaverse development. Some have taken steps to build hardware capabilities in the metaverse as the devices are the gateway to future development of the metaverse. Bytedance bought over VR headset company, Pico,[23] and Alibaba-led investment in AR glasses company, Nreal.[24] The firms have also further augmented their software capabilities through acquisition and internal development – ByteDance acquired virtual social platform, PoliQ,[25] and Baidu-developed XiRang platform wishes to provide the technological capabilities for creators to build up the metaverse.[26] Industry alliances are forming, such as the metaverse committee of the China Computer Industry Association, to help the industry join the "racetrack of the digital economy".[27]

On the content side, Multi-Channel Networks (MCNs) are fueling the rise of internet celebrities like Austin Li (better known as Li Jiaqi), a prominent male Key Opinion Leader with 45 million followers on Douyin, known as the "lipstick king".[28] MCN firms are estimated to be behind 40% of all accounts with more than 10 million followers on China's social media platforms.[29] Corporate firepower behind the livestreaming and creator market, coupled with AI-powered tools from the likes of Baidu's XiRang, could help unlock even more interactive, personalized, and real-time experiences in the metaverse for China's new generation of users.[30]

Technology Readiness of Businesses

As China moves beyond cost competitiveness towards technological breakthroughs to power its next phase of growth, firms have ramped up R&D. From 2009 to 2019, gross R&D expenditures in the country rose threefold, to almost US$515 billion, making China the world's second largest R&D spender. This is supported by the central government, with stepped up targets for growth in R&D investments, patent ownership and value generated by the digital economy in the 14th five-year plan published earlier this year.[31] In 2020 and 2021, Tencent and Baidu were amongst the leading companies in the world for VR and AR patent applications.[32]

Huawei and Tencent have also joined hands with other companies to set up The Joint Research Institute of Metaverse and Virtual-Real Interaction with China's premier universities, including Fudan and Peking.[33] Businesses are beginning to leverage upon the possibilities within the digital realm. Shoppers can seamlessly direct their digital avatars on their mobile phone within Taobao's virtual mall during its 618 Shopping Festival.[34] Coupled with China's robust start-up ecosystem, domestic breakthroughs in the implementation of metaverse technologies will emerge in the coming years.

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Sectors to Watch

Automobile

The metaverse is likely to make an impact in the automobile industry in three key areas – manufacturing, in-vehicle immersive experience and marketing.

BMW Group's Plant Lydia in Shenyang China is set to be one of the world's first plants designed in the metaverse, with the entire production process pre-planned through Epic Games' Unreal Engine 3D creation platform. The use of the platform shortened the construction time of the plant by six months.[35]

As fully autonomous vehicle technology matures, vehicles could be transformed into mobile terminals with full in-vehicle immersive experiences. As a sign of further things to come, Chinese electric car company, NIO, is using AR glasses, produced in collaboration with Alibaba-backed NReal, an AR glasses start-up, to reduce the need for in-car screens.[36] In a bid to accelerate this transition, NIO is also funding ClearMotion's development of in-car 4D motion sensors that coordinate with the vehicle's infotainment system.[37]

Engagement with consumers can be heightened through the metaverse. Baidu-backed JIDU unveiled its first robotic car, ROBO-01, on Baidu's XiRang platform.[38] The launch event was also livestreamed on the firm's WeChat video channel and Douyin. As metaverse technology matures, customers will likely be able to test-drive their vehicle within the metaverse on the day of any vehicle launch.

Healthcare

VR-based applications in healthcare training are being actively explored. Beijing University of Chinese Medicine students have used VR technologies to immerse in a three-dimensional human body marked with acupoints and meridian pathways as part of their acupuncture training.[39] The VR learning system has been touted to be an improvement on traditional acupuncture training based on two-dimensional images and the use of real people as models. Chinese haptic robotics startup, Intelligent Haptronic Solutions, is also developing VR-based digestive endoscopy simulators and training robots to enhance surgical training.[40] As training applications mature, this could pave the way for applications in actual healthcare settings. This might go some way in alleviating the shortage of doctors in ensuring quality care for its citizens.

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Pakistan

Potential 2035 economic impact of the metaverse

US$7-14B per year

Pakistan

As the third largest source of skilled tech labor in the world, Pakistan's labor force may be a significant source of talent to support the metaverse and metaverse-related businesses. With over 100 million broadband users and a median age of 22 years,[1] Pakistan's youthful population is in search of new economic opportunities.

With the establishment of new Special Technology Zones (STZs), Pakistan could be an attractive location for metaverse hardware manufacturers in search of low-cost hardware production and technological talent. Local firms specializing in AR and VR development are emerging, such as WonderTree and Elytra Studios. There is also a growing trend towards e-commerce, with over half of all VC funding in Pakistan channeled towards e-commerce startups.[2]

Pakistani nationals own US$20 billion in cryptocurrency, a figure that has grown exponentially in the past two years.[3] This demonstrates the growth of crypto adoption in Pakistan despite the central bank's recommendation to ban cryptocurrency usage outright in January 2022, highlighting the strength of the population's interest in digital currencies.[4]

Pakistan ranks sixth in the Global Crypto Adoption Index 2021-22 – a development likely spurred by continued inflation of the Pakistani Rupee, which hit 24.93% in July 2022.[5] As cryptocurrency becomes increasingly mainstream, this provides an opportunity for digital payments in the metaverse to take root in Pakistan.

However, Pakistan's exploration of the metaverse will be contingent on its ability to overcome political, climate and economic instability. Advancing technological literacy and expanding internet connectivity will be necessary first steps towards materializing the metaverse there.

> "Blockchain technology could become a powerful tool for tracking transactions, reducing corruption and increasing transparency in public and private sectors [...] A systemic and inclusive approach is needed to fully benefit from the transformative potential of Blockchain technology as well as further its implementation in Pakistan."
>
> **Dr Arif Alvi, President of Pakistan**

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Macroeconomic Determinants

- Pakistan is a service-based economy (56.7% of GVA). However, the single largest sector contributing to Pakistan's economy is agriculture, forestry and fishing (24.4% of GVA), followed by wholesale and retail trade, and manufacturing (12.4%). Retail and manufacturing, in particular, have the potential to be impacted by metaverse technologies in the near term.
- Pakistan is ranked 87th in the world on the Global Innovation Index 2022, suggesting that Pakistan is unlikely to lead the development of new and unique metaverse solutions.
- Pakistan's GDP per capita stood at US$5,144, suggesting that affordability of required immersive hardware on average may be a limiting factor on the economic impact of the metaverse.
- With a widening current account deficit and competing urgent priorities, such as political and economic concerns, there may be challenges in persisting with investments in economic, infrastructural and technological developments needed to support the metaverse.

PAKISTAN IN NUMBERS

Potential 2035 economic impact of the metaverse:

US$7-14B per year, 1.3-2.4% of GDP

2020 GDP:

US$320B

Per capita (Constant 2017 US$):

US$5,144

(lower middle income)

Population:

221M

37% urban

55% below 25

4% with basic digital skills

79% unbanked

Key sectors:

ICT sector:

Global innovation index: **#87/132**

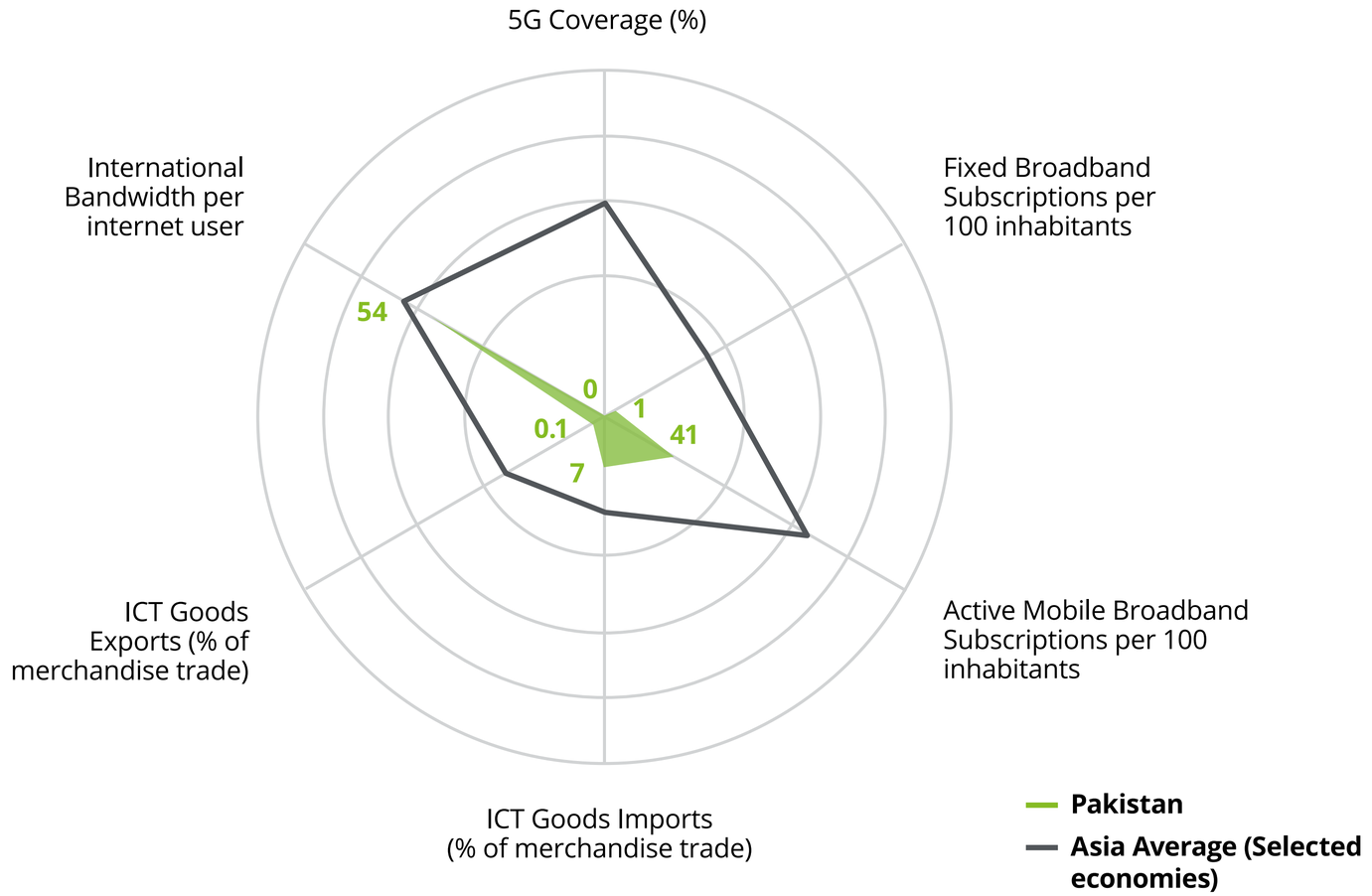
EIU business environment ranking: **#89/99**

Digital readiness index: **#117/141**

Sources: World Bank World Development Indicators 2020, Our World in Data 2017, ITU Digital Development Dataset 2019, World Bank Global Findex, UN Data

Technology Fundamentals

- Relative to the Asian average, Pakistan has room for growth on most major technological development indicators.
- Mobile internet penetration rates in Pakistan are lagging behind those of many regional peers. Nevertheless, Pakistan has over 114 million 3G and 4G subscribers - a number that is growing.[6]
- For the metaverse to become a real part of the country's lifestyle, improved internet accessibility is essential. The Pakistani Government launched seven projects in March 2022 to provide broadband services to over 2.5 million people in areas currently lacking internet connectivity.[7]
- The Government has expanded optical fiber coverage, laying 820km of optical fiber through Gilgit Baltistan, Khyber Pakhtunkhwa, and Punjab between 2015 and 2018.[8] Internet accessibility must improve before the metaverse can be widely adopted by the population.
- Pakistan has a smartphone penetration rate of 22%, lagging behind that of many regional peers.[9] However, the mobile industry in Pakistan is growing – the GSMA predicts that the economic contribution of the mobile industry in Pakistan could reach $24 billion by 2023, accounting for 6.6% of GDP.[10] Growing smartphone ownership is an avenue through which Pakistan may begin to explore metaverse opportunities.
- Pakistan has yet to launch 5G networks, but a roadmap for the 5G rollout is being developed by the Pakistan Telecommunication Authority (PTA). The spectrum for 5G services is targeted to be auctioned to prospective telecommunications providers towards the end of the fiscal year of 2022/23.[11]



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Ecosystem Enablers

Digital Skills

Digital literacy and talent are crucial to both metaverse development and usage. Over 25,000 graduates enter the Pakistani job market each year with degrees in Software Engineering and Information Technology, making Pakistan the third-largest source of digital labor.[12] An edutech tie-up between ESP-Pakistan and Xero Tech is exploring the potential for joint activities in the metaverse for Technical Vocational Education and Training (TVET), cross-training of faculty, and skills development training programs for IT, e-commerce, and entrepreneurship.[13]

State-level solutions are emerging that simultaneously increase digital skills amongst youth while also creating employment opportunities. In the province of Khyber Pakhtunkhwa (KP) – the third-largest province in terms of economy and population – the Government has launched a digital strategy called "Digital KP" aimed at upskilling the province's workforce.[14] An Early Age Programming course teaches coding skills to secondary students across 225 schools,[15] while the Digital Ambassadors Program brings digital literacy programming to rural and underserved areas.

Pakistan still has a long way to go in increasing digital literacy, but sustained investment in digital skills will open up opportunities for both employment and leisure.

Competition within the metaverse

The rapid growth of the startup environment in Pakistan means that we may soon see tech-savvy Pakistani startups entering the metaverse space. Since 2016, almost 300 reforms were introduced to improve the investment climate in Pakistan, and Pakistan has been recognized as the top reformer in South Asia.[16] In response to these changes in business regulation, investment has been flowing into the country. In 2021 alone, Pakistani startups raised over $350 million – more than the previous six years combined.[17]

More Pakistani startups are exploring AR and VR spaces. For example, WonderTree is a Pakistani tech startup established in 2015 that develops interactive AR games for children with special needs. Backed by Samsung and Google for Entrepreneurs, WonderTree has almost 7,000 users, and is deployed in 57 schools and 19 hospitals.[18] More startups are likely to explore providing unique services in the metaverse if global interest, and consequently investment, in the metaverse continues to grow.

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Sectors to Watch

Manufacturing

Developments across the manufacturing sector will be instrumental to the creation of hardware and software required to make the metaverse accessible. Pakistan is developing its manufacturing sector through sustained investment into special technology zones (STZs). Located across major cities such as Islamabad and Punjab, the STZs are intended to attract investment from both local and international companies. In a bid to encourage the growth of Pakistan's IT export industry which is expected to surpass $3 billion in value this year,[19] the STZs provide highly favorable conditions to ICT exporters. Enterprises that move their manufacturing processes into the STZs become eligible for tax exemptions, capital gains, and additional quality of life benefits. STZs have caught the eye of major international brands already: Samsung, the world's largest smartphone manufacturer, now assembles almost all models within Pakistan.[20] As Pakistan's new STZs are completed towards the end of 2022, attractive new manufacturing potential will be unlocked – both for Pakistan, and for metaverse hardware producers.

Retail and e-commerce

The metaverse is expected to revolutionize online shopping, and opportunities exist for this to take flight in Pakistan. Of the US$350 million in VC funding that Pakistani startups raised in 2021, over half of all funding was directed towards e-commerce startups.[21] Pakistan is the 37th largest market for e-commerce, with a revenue of US$5.9 billion in 2021.[22]

Both business-to-consumer (B2C) and business-to-business (B2B) startups have been emerging: offering online shopping, delivery services, and digitalizing the informal retail sector. The future may see the Pakistani e-commerce industry being transformed with virtual and augmented reality spaces for retail. For example, ARER is a newly launched augmented reality tool for furniture retail in Pakistan.[23] Similarly, Pakistan-based Elytra Studios works on developing a range of immersive experiences for businesses to utilize – ranging from 3D architectural visualizations and AR/VR experiences to game development.[24] Given the popularity of e-commerce in Pakistan, it is foreseeable that AR and VR retail experiences will soon become more accessible.

Entertainment

The Pakistani entertainment industry is highly responsive to global trends, and is already adapting to possibilities in the metaverse. Pakistani companies such as Big Immersive are partnering with Oculus and Vive, [25] to revolutionize gaming by creating 3D digital ecosystems for AR and VR experiences across multiple different platforms. Celebrity entertainers are often first entrants into metaverse spaces, and celebrities in Pakistan are no different. metAsia Celebs – a UAE-based entertainment startup – in collaboration with TrustVibes Inc. has launched an Exclusive Metaverse club for artists and musicians in Pakistan.[26] Solo Pakistani entrants are also gaining prominence in the metaverse. Award-winning Creative Director Shaikh Danial, for example, lends his expertise to 'BAPES™?' – a metavestor club focused on strengthening crypto native companies in the metaverse space through the purchase of NFTs.[27]

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Philippines

Potential 2035 economic impact of the metaverse

US$10-19B per year

Philippines

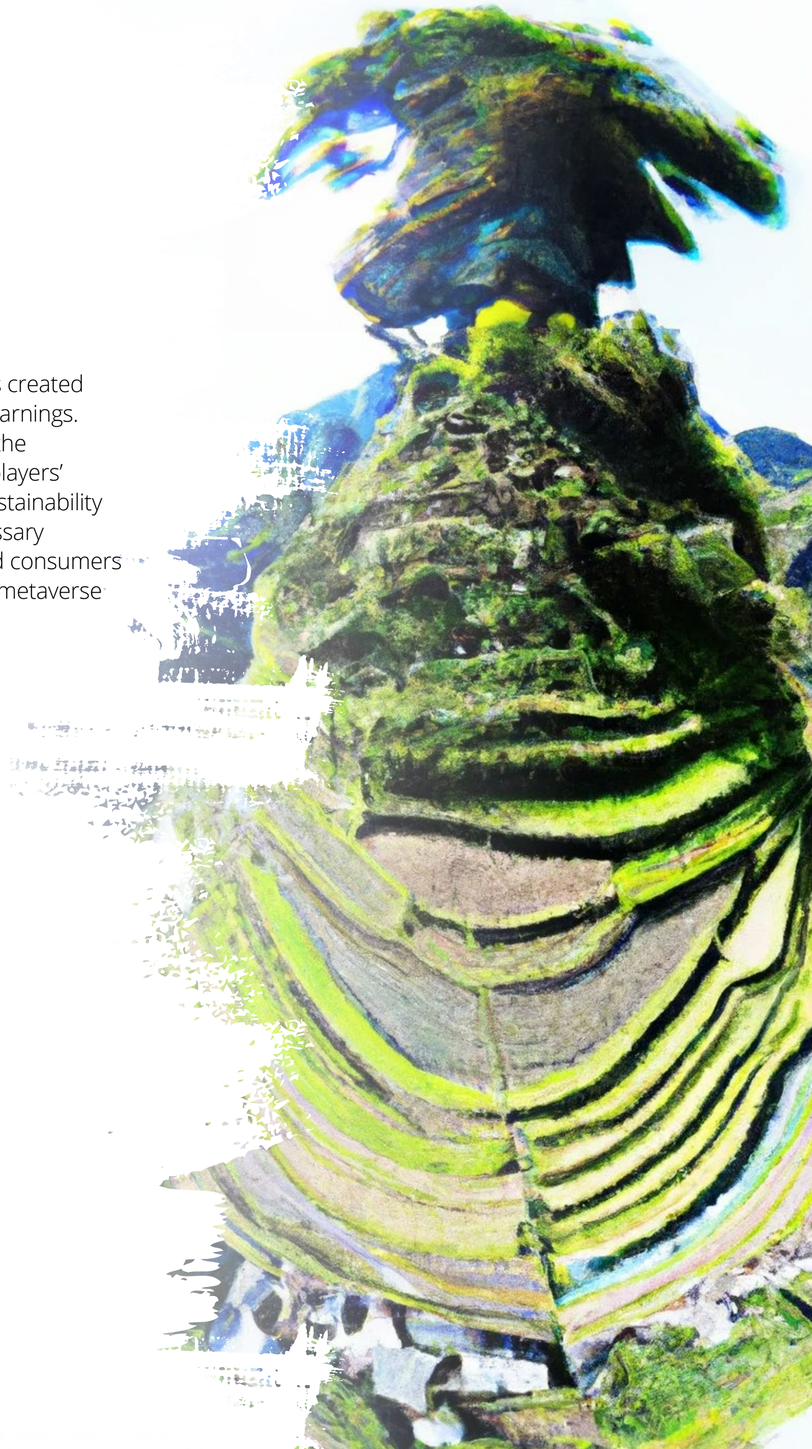
With an internationally-oriented English-speaking population, the metaverse could extend the Philippines' lead as a destination for Business Process Outsourcing (BPO).[1] If fully leveraged, the metaverse could add up to US$19 billion to the economy in 2035, with new employment opportunities for Filipinos in building and enriching the metaverse.

This is provided the country is able to overcome gaps in its digital infrastructure. Internet speeds are slow and unstable, although gradually improving. The Government has embarked on efforts to develop its digital infrastructure, including a Free Wifi for All program and deployment of fiber optic cables and wireless technology through public-private partnerships.

This includes a US$2.1 billion investment by Globe Telecom to deploy 1 million fiber optics cables across the Philippines.[2] PLDT is also investing an additional US$80 million in collaboration with Meta and Google in a new Asia Pacific subsea cable project called Apricot.

The mobile-savvy Filipino population experienced its first taste of the new income-earning prospects of the metaverse during the COVID-19 pandemic. With unemployment soaring to 17.7%,[3] many Filipinos picked up blockchain game Axie Infinity to supplement their income, with one source estimating that as much as 2% of the 2021 GDP for Philippines was directly correlated to play-to-earn games.[4] Players in the Philippines made up as much as 40% of the game's user base at one point. Enterprising start-ups created guilds to sponsor players and share in their earnings. However, a hacking incident and a plunge in the underlying cryptocurrency's value impacted players' earnings severely, sowing doubts over the sustainability of such earnings models.[5] Ensuring the necessary guardrails are in place to protect workers and consumers will be critical to sustain social acceptance of metaverse applications in the Philippines.

> "The metaverse will be an important market where we can promote original Filipino content and creations."
>
> **Bureau of Copyright and Related Rights Director Emerson G. Cuyo, Intellectual Property Office of the Philippines**[4]



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Macroeconomic Determinants

- The Philippines overall is a service-based economy (55.1% of GVA).The three largest sectors contributing to Philippines's economy are wholesale and retail trade (18.5% of GVA), followed by manufacturing (17.7%), and agriculture, forestry and fishing (10.2%). The retail and manufacturing sectors are expected to be impacted by the metaverse in the near term.
- Philippines is ranked 59th in the world, based on the Global Innovation Index 2022, suggesting a lower propensity for innovation. One possible reason is a lack of resources and funding,[6] limiting the rate of metaverse development in the country.
- Philippines's GDP per capita is in the lower-middle income range, suggesting that affordability of required immersive hardware on average may be a limiting factor on the economic impact of the metaverse.
- The country has a high unemployment rate, at 7.2% in July 2021. Developing the metaverse presents employment opportunities for Filipinos, with the IT outsourcing industry already actively recruiting positions for building digital environments in the metaverse.[7]

PHILIPPINES IN NUMBERS

Potential 2035 economic impact of the metaverse:

US$10-19B per year, 1.3-2.4% of GDP

2020 GDP:

US$358B

Per capita (Constant 2017 US$):

US$7,958 (lower middle income)

Key sectors:

ICT sector:

Population:

109M

14% urban

51% below 25

6% with basic digital skills

49% unbanked

Global innovation index: **#59/132**

EIU business environment ranking: **#49/99**

Digital readiness index: **#81/141**

Sources: World Bank World Development Indicators 2020, Our World in Data 2017, ITU Digital Development Dataset 2019, World Bank Global Findex, UN Data

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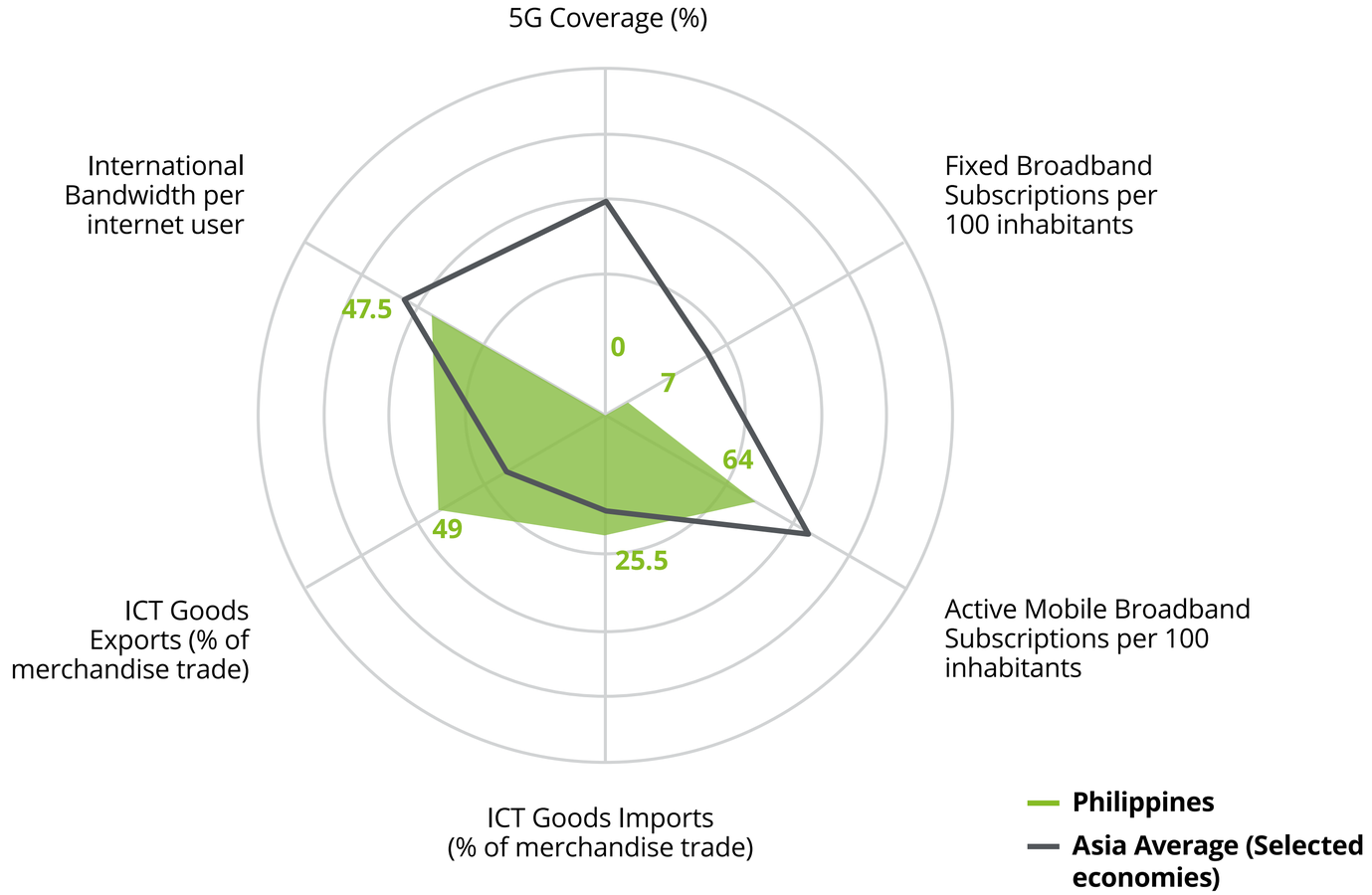
Technology Fundamentals

- The Philippines lags behind the region in connectivity, in terms of international bandwidth per user, 5G coverage, active mobile broadband subscription, and fixed broadband subscriptions. This represents a significant barrier to partake in the envisioned metaverse's real-time interactions and transactions.
- Smartphone device ownership among internet users aged 16-64 jumped from 65% of internet users aged 16-64 in 2019[8] to 98.5% in 2021,[9] and internet penetration rose by 6.1% to 67% from 2020 to 2021.[10]
- Both the public and private sectors are working to expand the country's digital infrastructure, closing the gap between the Philippines and the region's average. In 2021, Globe Telecom invested US$2.1 billion in 1 million fiber lines to establish 4G for mobile data and 5G coverage in accordance with government targets.[11] PLDT, in collaboration with Meta and Google, has also invested in various submarine cables in the Philippines such as Jupiter and the newly announced Apricot, and these cables are anticipated to increase the number of internet users in the Philippines by 8.3 million by 2025.[12]
- The Philippines is the top digital payments adopter in the Southeast Asian region, with digital payments and e-cash anticipated to account for 50% of transactions by 2023.[13] Even in rural areas, an increasing number of Filipinos are paying for their groceries and medicines using e-wallet GCash.[14] This signals that the Philippines could quickly adapt to performing transactions on the metaverse.



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Ecosystem Enablers

Digital Skills

With only 6% of the population with basic digital skills according to ITU, there is a significant gap to close.[15] The Philippines established the Inter-agency Council for Development and Competitiveness of Philippines Digital Workforce in 2022, with the purpose of raising digital skills and competencies to the global standard. The long-term goal is to usher Filipino workers into digital careers in technologies that are related with the foundation of the metaverse like artificial intelligence.[16] Globe Telecom is establishing an IT academy.[17] The Google-supported non-profit Go Digital ASEAN is teaching digital skills to up to 25,000 job seeker and entrepreneurs, boosting the population's digital literacy.[18] One start up, I AM Cardboard Philippines (IAC PH), aims to familiarize a generation of Filipinos with metaverse technologies by bringing VR technology into classrooms, museums, and training programs in Manila.[19]

Social Acceptance

During the peak of the popularity of play-to-earn blockchain-based games, people from all walks of life were participating in it, from tricycle drivers to elderly shop keepers in rural areas in the Philippines. Nevertheless, some were inadvertently burnt by the experience when the value of their holdings fell.[20]

Both authorities and companies must work together swiftly to build a safe and trustworthy metaverse. In one example of such a collaborative approach between regulator and game developer, the Intellectual Property Office of the Philippines (IPOPHL) signed a memorandum of understanding with Singapore-based metaverse virtual world platform Stardust Digital Private Ltd.[21] The Stardust platform aims to connect creators in the entertainment world to a global audience. This tie-up will look into the protection of intellectual property developed in the country, making the nascent platform safer and more appealing to Filipino creatives.[22]

Accessibility

Beyond the capital city of Manila, the internet becomes much slower and more unreliable. Only 47% of adults in the agrarian southern island of Mindanao have access to the internet compared to 84% in Manila.[23]

The government's Department of Information and Communications Technology (DICT) is moving swiftly to tackle the nation's outstanding problems with internet accessibility. The Free Wifi for All Program launched in 2020 to provide ample Wifi coverage in public spaces, beginning with provinces that most urgently need coverage.[24] From the private sector, Telco giants PLDT and Globe also announced intentions to upgrade their services to provide bandwidth and coverage in line with the government's targets.[25] These investments into digital infrastructure will enable more Filipinos to access new opportunities that emerge from the metaverse.

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Sectors to Watch

Gaming and Entertainment

The billion-dollar gaming industry in the Philippines[26]—the second largest in Southeast Asia behind Vietnam—is receiving a boost from venture capitalists, with the Media & Entertainment sector emerging as the second most funded sector for startups in 2021 (US$142.5 million).[27]

One of the most prominent transactions was by blockchain gaming company Yield Guild Games, which raised $17 million in 2021.[28] The company's business model allows users to pool together and form guilds, buying game assets across blockchain games like Axie Infinity and leasing them to players so that they can play without initial capital, in return for a share of the player's earnings. These 'scholarships' reimagine what employment could be like in the metaverse, where players report to guilds. Other startups involved in blockchain gaming from the Philippines include Ark of Dreams, MetaverseGo, and Blockchain Go. The former collaborated with Union Bank to co-create a banking experiences in the game, marking the very first entrance of a Filipino bank into the metaverse.[29]

Business Process Outsourcing

The Philippines is a popular destination for companies to outsource aspects of their business processes, with a highly literate labor force that ranked 2nd in the region in the 2020 English Proficiency Index, behind Singapore.[30]

The BPO industry currently employs 1.2 million workers (often in customer support call centers), contributing US$27 million or 9% of GDP.[31] However, the advent of the metaverse could generate more roles that can be outsourced. Outsourced.ph forecasts that more tech specialists will be needed to manage, create, research, and troubleshoot digital environments in the metaverse, with roles like ecosystem developer, world builder, and metaverse stylist forecasted to be in high demand.[32]

Recruitday is the Philippines' first metaverse-based recruitment platform, where users can participate in a virtual job-fair at any time of day.[33] It also offers courses to upskill workers, familiarizing users with metaverse technologies and preparing them for roles in the BPO industry.

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Singapore

Potential 2035 economic impact of the metaverse

US$9-17B per year

Singapore

With a small population and few natural resources, Singapore's transformation into a global economic hub within five decades has been driven by political stability, robust regulatory frameworks, and a plug-and-play business environment that is open to investors. Yet, with an ageing population and consequently a smaller workforce, there is a strong imperative to enhance this strategy by moving its workforce up the value chain while simultaneously attracting more talent from beyond its shores.

A strategy for the metaverse would build on Singapore's existing economic roadmaps, and early investments could pay off in the long term. The metaverse provides Singapore with an opportunity to position itself as an early value-adding innovator to attract tech talent globally to its shores. Attracting high-skilled tech workers aligns well with the country's strategy of focusing on "quality rather than quantity" when it comes to foreign talent.[1]

Beyond attracting talent, the country can also leverage on its reputation, as one of the best places in the world to do business,[2] to make early pivots with specialized strategies to attract top metaverse companies and investors to Singapore. Apart from top companies, other players such as content creators will prove crucial to build an ecosystem. Priming these key players to place Singapore at the top of their minds will allow the small nation-state to remain competitive as the world moves into the next internet.

To reap these benefits, the country has many factors in its advantage. Its regulatory framework provides credibility and stability that complements the dynamic and fluid nature of the nascent metaverse. In 2022, Singapore announced that rules to tackle online harm through minimising local access to harmful material are expected to roll out as early as 2023.[3]

As a global financial hub, Singapore has been a fertile ground for financial innovations in the cryptocurrency, web3 and digital assets space. There is also a Research, Innovation and Enterprise (RIE) strategy in place to invest in forefront technologies such as AI, cybersecurity, trust technologies, and quantum technology.[4] Singapore stands in good stead to support the technological developments that will enable the metaverse to materialize.

These stellar credentials have already led to HoYoverse, the creator of one of the highest grossing games in history Genshin Impact to pick Singapore as its base of operations for their metaverse subsidiary. With the current landscape, Singapore is well-positioned to become an attractive location for these developments – digital natives will find it welcoming to live, work, and play in the metaverse here.

> "Whilst we cannot as yet be certain of the final state at this point on what the metaverse will evolve into, many are confident of its future."
>
> **Edwin Tong, Minister for Culture Community and Youth and Second Minister for Law, at TechLaw.Fest, July 2022**

1. Michelle Jamrisko, "'Quality' labour: Singapore wants foreign skills, to protect jobs," Aljazeera, August 28, 2020.
2. Business Times, "Singapore in 2nd place for ease of doing business: World Bank," accessed October 19, 2022.
3. Irene Tham, "Rules to tackle online harm in Singapore could be rolled out as early as 2023," Straits Times, September 29, 2022.
4. National Research Foundation, "Smart Nation and Digital Economy," accessed October 5, 2022.

Macroeconomic Determinants

- Service-based economy (73.6% of GVA), with the three largest sectoral contributors to Singapore's economy being manufacturing (22.3% of GVA), followed by wholesale and retail (19.3%), and financial and insurance activities (14.6%). These sectors have had early use cases for metaverse technologies such as digital twins for resource deployment, digital clothing, and new payment forms. The impact that the metaverse will have on these key sectors cannot be underestimated.
- Ranked 8th in the world on the Global Innovation Index 2021, suggesting a strong propensity for innovation.
- GDP per capita stood at US$94,506, suggesting that affordability of required immersive hardware on average may be less of a limiting factor on the economic impact of the metaverse.
- World's 10th largest exporter of creative goods, generating US$743 billion in profits.[5] This stands Singapore in good stead for the content-heavy metaverse.

SINGAPORE IN NUMBERS

Potential 2035 economic impact of the metaverse:

US$9-17B per year, 1.3-2.4% of GDP

2020 GDP:

US$330B

Per capita (Constant 2017 US$):

US$94,506 (high income)

Population:

5.6M

100% urban

25% below 25

55% with basic digital skills

0% unbanked

Key sectors:

ICT sector:

Global innovation index: **#8/132**

EIU business environment ranking: **#1/99**

Digital readiness index: **#1/141**

Sources: World Bank World Development Indicators 2020, Our World in Data 2017, ITU Digital Development Dataset 2019, World Bank Global Findex, Singapore National Statistics

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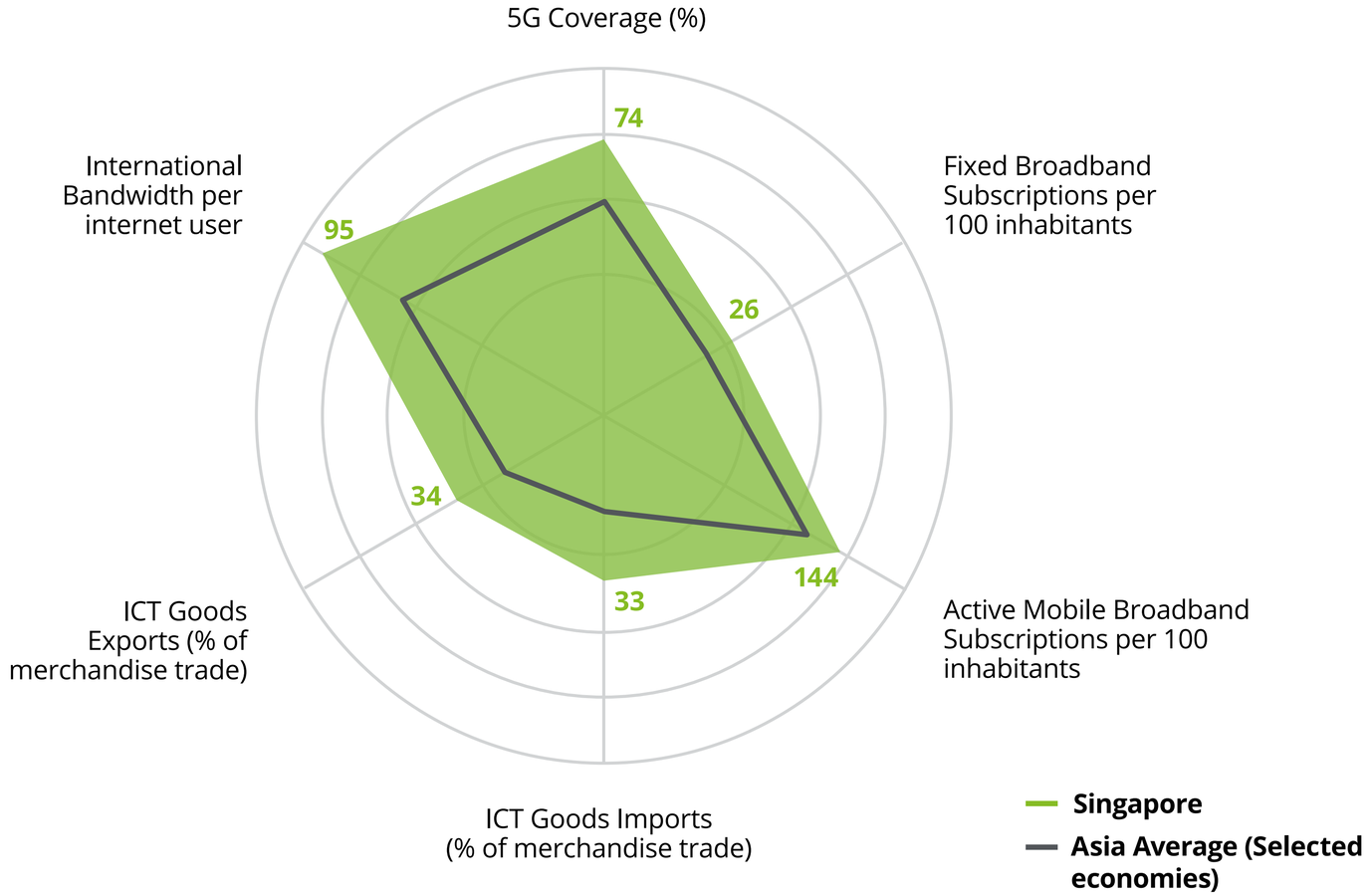
Technology Fundamentals

- The country, ranked first on the Digital Readiness Index, has one of the highest smartphone penetration rates[6] in the world. The metaverse is likely to be accessible to a large proportion of the population.
- More than 60% of Asia Pacific's data center supply is housed in Singapore, indicating the nation-state's potential to support the data and computing-intensive metaverse.[7] Sustainable development of these data centers is also a priority to the small nation-state which is keenly aware of the land and energy demands of data centers. After a 3-year moratorium on the development of data centers in Singapore, the government lifted it in 2022 with new policies that calibrate data center development through sustainable energy sources and more efficient cooling methods.[8]
- A global financial hub, Singapore has a robust digital payments infrastructure which gained traction during the COVID-19 pandemic – 95% of the population aged above 15 have made or received a digital payment.[9] The country launched the world's first unified payment QR code in 2018 and has since pursued aspirations to be interoperable with other digital payments across the region. Thus far, the Monetary Authority of Singapore (MAS) has explored or begun link-ups with digital payment systems in India, Philippines, and Thailand.



Sources: GSMA Mobile Connectivity Index 2021, ITU Digital Development Dashboard 2020, UNCTADStat 2019

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8. Clara Chong, "Singapore pilots sustainable way to grow data centre capacity," The Straits Times, July 20, 2022.
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Ecosystem Enablers

Social acceptance

Nearly 16% of Singaporeans currently own cryptocurrencies, ahead of the 11.4% global average surveyed.[10] This indicates potential openness towards digital assets and the metaverse. However, it is crucial to also look at the attitudes of the population towards technology at large – Roland Berger's Digital Inclusion Index 2021 found that attitudes towards digital advancement have become more conservative in Singapore. This apprehension towards new technologies was attributed to the rise of internet scams and concerns over personal data security.[11] Singapore's regulatory efforts to create a safe online environment are crucial to addressing these fears.

Singapore is highly ranked on global measures of cybersecurity literacy[12] and introduced the Personal Data Protection Act (PDPA) to provide a baseline standard of protection for personal data with requirements governing the collection, use, disclosure and care of such data.[13] As more personal and environmental data is collected in the metaverse, these guardrails will need to be enhanced. Already leading with progressive regulations on cryptocurrencies and digital assets to balance risks with innovation, Singapore's moves will be closely watched by the region.

Competition within the Metaverse

A thriving metaverse is one that includes many stakeholders competing in the product, service, or experience they offer to consumers or other businesses/ platforms engaged in the metaverse. Singapore's vibrant tech sector ranges from corporations such as MiHoYo to metaverse-related startups such as BuzzAR and Brytehall that seek to create new niches in avatar engines and NFTs respectively. Singapore is the top-ranked ecosystem for start-ups in the Asian region and the country is fertile ground for rapid innovation.[14] Notably, 59% of technology MNCs have their Asian regional headquarters based in Singapore.[15]

Singapore also has advantages in digital content creation, as a leading exporter of creative goods. For example, Lucasfilm's ILMxLAB opened its first international studio in Singapore with an emphasis on immersive real-time storytelling.[16] These existing building blocks are optimistic signals for the growth of a rich metaverse ecosystem.

Digital skills

The potential of corporates and start-ups in the metaverse rests on a deep bench of digital talent. Singapore's ability to upskill Singaporean workers as well as attract top talent from beyond its shores is critical. To that end, the government introduced special work visas in 2022, including Tech.Pass and a broader Overseas Networks and Expertise (One) Pass, to attract the world's best talent to its shores.[17]

For Singaporeans, the government launched a national movement, SkillsFuture Singapore, to encourage lifelong learning in areas such as digital skills training, as well as a TechSkills Accelerator (TeSA) to support students and professionals at various stages of their careers to upskill or make transitions to tech roles.[18] Private sector stakeholders have also launched similar programs. As part of Meta's Upskill 2022 initiative, the company launched the region's first Meta Immersive Learning Academy, an educational program that enable beginner AR and VR creators to build their skills and capabilities.[19]

These concerted efforts will raise talent across various parts of the metaverse ecosystem, through upskilling its small population and attracting the top talent from abroad.

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Sectors to Watch

Healthcare

Given an ageing population, Singapore has begun to use immersive virtual technologies to enhance medical education and medical services.

Singapore's National University Health System (NUHS) is investing in holographic technology, including using mixed reality to teach medical and nursing students,[20] research on applications in brain surgery, and developing real-time volumetric rendering and positioning of ultrasound scans.[21] Since November 2021, NUHS has also been one of the three worldwide Holomedicine Centres of Excellence.

Beyond teaching and research, the use of holographic technology has extended into medical practice with Singapore conducting the world's first holography-guided heart surgery.[22]

Urban Planning

Government agencies and start-ups in Singapore have found innovative uses for early metaverse technologies in urban planning. Singapore was one of the first countries to articulate a vision of a country-scale digital twin through Virtual Singapore, a dynamic 3D model of the city which planners can use to visualize how the city will develop and evolve in response to population growth, new construction, and other major events.[23] Since then, Singapore Land Authority had embarked on a number of 3D mapping projects over the years. [24]

Some of these efforts have culminated in OneMap 3D, a dynamic visualization platform that presents an immersive experience of Singapore's surroundings. One use case of the platform is that clients of the real estate industry can view listings with real-time location-based services and detailed location information.[25]

Singapore start-ups such as Vizzio Technologies have also innovated new 3D mapping technologies through combining satellite imaging and AI to create photorealistic models of countries in a short time.[26]

Gaming

Early parallels of the metaverse are observed in online games – where gamers have played, socialized, and shopped in virtual worlds for years. Younger gamers, particularly those between 13 and 17, are more interested in metaverse-style games compared to older players.[27] This demographic is expected to spend more time and money in the metaverse in the future.

Singapore is increasingly involved in the gaming space, particularly by building its reputation as an e-sports destination given that it already has much of the existing infrastructure such as high internet speeds, venue options, and a robust events industry.[28] Singapore companies are also accomplished in the gaming industry – Garena, a Singaporean game developer, published Free Fire, the most downloaded game globally in 2019.

To build on its strong foundations in the gaming space, the country is increasing investments in metaverse game worlds. Singapore's state holding company, Temasek Holdings, invested US$100 million in blockchain gaming company Animoca Brands,[29] which has a broad portfolio of web3 games and intellectual property.

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South Korea

Potential 2035 economic impact of the metaverse

US$36-67B per year

South Korea

South Korea is a first-mover in articulating a comprehensive strategic blueprint to foster its metaverse industry, aiming to become the fifth largest metaverse market by 2026. From the K-pop industry to industrial conglomerates to government agencies, ecosystem actors across the value chain are leaning into the metaverse.

Earmarking KrW 223.7 billion (US$167 million) to kickstart the industry, the Ministry of Science and ICT laid out four major goals – activating the ecosystem for metaverse platforms, nurturing talent, fostering companies, and setting up a safe environment for all metaverse.[1] Over 500 companies, including Samsung, Hyundai and Nexon, have formed a metaverse alliance to coordinate the development of platforms. The government aims to nurture 40,000 metaverse professionals while facilitating foreign talent and startups to enter the Korean market. It will set up a Korean language institute in the metaverse and a "K-Metaverse Academy" that connects global startups with local content companies.[2] Government-sponsored metaverse labs to support the commercialization of metaverse-related technologies and one-stop customized consulting support are also in the plans.[3]

Under the metaverse roadmap, focus sectors include arts, culture, education, K-pop and tourism. These build on South Korea's position as a global cultural trendsetter. Entertainment companies like HYBE (BTS), SM Entertainment (Aespa) and YG (BLACKPINK) are moving its global celebrities into the metaverse with digital concerts and virtual avatars, a trend accelerated by the COVID-19 pandemic.[4] South Korean metaverse social gaming app Zepeto is also a fast-growing creator marketplace for virtual fashion items and has teamed up with global brands like Disney and Nike, and celebrities like BTS.[5]

South Korea's technological lead, with the highest 5G download speeds, universal fiber network access, and leading cybersecurity infrastructure, positions the country well to leverage its cultural advantage into further success within the metaverse.

> "The Government will serve as talent ladder for outstanding work force trained at the K-Metaverse Academy to grow professionally in their respective field by expanding their participation opportunities in connection with government-led projects."
>
> **Lee Jong-ho, Science Minister at the launch ceremony for the K-Metaverse Academy**[5]

1. Ministry of Science and ICT (MSIT), "MSIT to Announce Pan-Government Strategy on Metaverse," accessed September 29, 2022.
2. The Korean Herald, "Korea Aims to Become 5th-Largest Metaverse Market by 2026," accessed September 29, 2022.
3. Ministry of Science and ICT (MSIT), "MSIT Full-fledged Training of Young Developers and Creators in the Expanded Virtual World," accessed September 29, 2022.
4. Tamar Herman, "K-pop labels embrace virtual stars and pursue metaverses to extend their artists' online reach," South China Morning Post, October 19, 2022.
5. Zepeto Studio, "Business- ZEPTO Studio," accessed October 19, 2022.

Macroeconomic Determinants

- South Korea is a service-based economy (62.5% of GVA), although the largest sectoral contributor to its economy is manufacturing (27.9% of GVA), followed by real estate activities (7.8%), and wholesale and retail trade (7.5%).
- As an export-driven economy (~40% of GDP),[6] the metaverse will likely drive international demand for South Korea's electronic exports (e.g. semiconductors, which constitute 17% of its exports)[7] and content exports (which reached almost US$12 billion in 2020).[8]
- South Korea has a strong propensity for innovation, ranking 5th in the world and 1st among selected economies in the Global Innovation Index 2021, reflecting economic strength in innovative computing and mobile technologies.
- As a high income country, affordability of required immersive hardware on average may be less of a limiting factor on the economic impact of the metaverse. Nevertheless, the government has pledged to bridge the digital divide by providing metaverse education to digitally marginalized people.[9]
- To enhance accessibility and encourage interaction with the metaverse, some public and private providers in Korea have also opened VR experience spaces for people to utilize these technologies at a fraction of the cost of VR headsets.[10]

SOUTH KOREA IN NUMBERS

Potential 2035 economic impact of the metaverse:

US$36-67B per year, 1.3-2.4% of GDP

2020 GDP:

US$1.62T

Per capita (Constant 2017 US$):

US$42,336 (high income)

Population:

52M

81% urban

26% below 25

72% with basic digital skills

1% unbanked

Key sectors:

ICT sector:

Global innovation index: **#5/132**

EIU business environment ranking: **#21/99**

Digital readiness index: **#8/141**

Sources: World Bank World Development Indicators 2020, Our World in Data 2017, ITU Digital Development Dataset 2019, World Bank Global Findex, South Korea National Statistics

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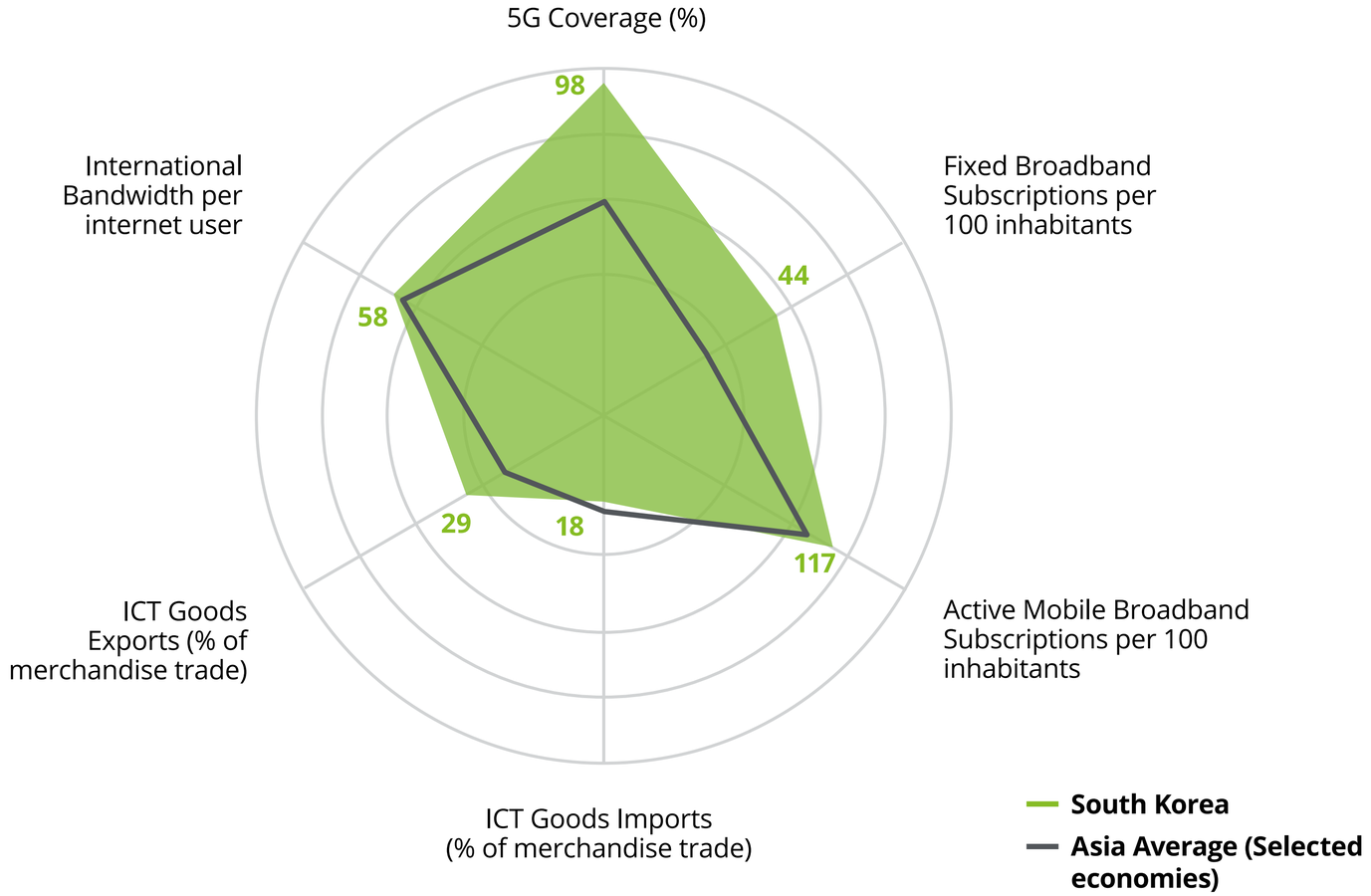
Technology Fundamentals

- South Korea leads in technology fundamentals in Asia, with a solid foundation in digital infrastructure. It stands as one of the global leaders in consumer 5G experience,[11] boasting the highest level of internet availability amongst OECD countries,[12] with widely accessible and affordable high speed internet.
- South Korea is also poised to extend its lead in 6G deployment through commercialization by 2028.[13]
- The gap in available shared data center facilities is closing as South Korea transitions away from local enterprise facilities towards a co-location centric data center market, allowing for more efficient and cheaper entry for enterprises to venture into the metaverse and will go towards closing the wide digital gap between SMEs and large enterprises.[14]
- South Korea has strong cybersecurity, ranking 4th in the ITU's Global Cybersecurity Index.[15]



Sources: 'GSMA Mobile Connectivity Index 2021, ITU Digital Development Dashboard 2020, UNCTADStat 2019'

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12. Organisation for Economic Co-operation and Development (OECD), "OECD internet access data 2020," accessed October 5, 2022.
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14. OECD, "Economic Survey of Korea 2020," accessed October 5, 2022.
15. International Telecommunication Union, "Global Cybersecurity Index 2021," accessed October 5, 2022.

Ecosystem Enablers

Technology Readiness of Business

In South Korea, platform providers such as Naver and Kakao, as well as entertainment, telecommunications, and financial companies draw consumers into the world of the metaverse. With that in mind, a government-led industry alliance, created to establish the country's metaverse ecosystem, has grown from 25 firms at launch to over 500, including Samsung, Hyundai, and SK Telecom.[16] This alliance promises to unlock a wider range of business opportunities across multiple sectors.

South Korea faces the challenge of a high digital gap between large and small firms, particularly in areas like cloud computing, big data, and artificial intelligence.[17] With technological giants like Samsung joining the metaverse alongside smaller and medium-sized companies, the hope is that knowledge transfer and partnerships between firms can accelerate development. The public sector's role in facilitating and fostering cooperation among companies cannot be underestimated.

Security and Privacy

Korea is ranked highly on cybersecurity, it also had the second highest share of internet users experiencing privacy violations in the OECD.[18] The younger populace, aged 10-29, were found to be at much higher risk of internet or smartphone addiction than other age categories.[19]

The government is committed to setting ethical principles for the metaverse to make it a safe environment for all users.[20] As a first step, the metaverse alliance is a useful platform for companies to innovate under the watchful eye of regulators. Nevertheless, forward-leaning regulations and enforcement frameworks are necessary to ensure trust in economic transactions and social well-being.

Digital Skills

To meet its target of 40,000 metaverse professionals by 2026, the government has begun to foster a pipeline of digital talent. The "Metaverse Academy", set up by the Ministry of Science and ICT, had its first intake of future developers and creators in December 2021. [21]

There are also complementary plans for metaverse graduate schools, with two universities, KAIST and Sogang University which will begin enrollment in the second semester of 2022.[22] To attract foreign talent, a Korean language institute in the metaverse and a "K-Metaverse Academy" that connects global startups with local content companies are also in the works.

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Sectors to Watch

Entertainment and Media

Over the past decade, South Korea's entertainment and media industry has grown by leaps and bounds to capture the popular imagination. It has the 6th largest music industry in the world, the 2nd largest in Asia, the highest number of films consumed per capita, and is a top four gaming market worldwide.[23] These pillars of music, film, and gaming continue to grow rapidly as South Korea's cultural pull strengthens.

Metaverse-related content is making it big. Aespa is a 4-member metaverse-themed K-pop group that each have their own virtual avatars. Their first music video had YouTube's fastest climb to 100 million views for a K-pop debut.[24] As one of the most digitally connected societies in the world with fast and reliable internet, South Korea is well-placed to be a forerunner in creating metaverse entertainment experiences.

Manufacturing

The metaverse has the potential to supercharge the diverse manufacturing base of South Korea. South Korean auto giant Hyundai Motors signed a memorandum of understanding with leading real-time 3D content developer Unity to build a digital twin factory. With plans to apply this technology to its new center in Singapore, the virtual factory will enable Hyundai to test-run a factory remotely.[25]

The bigger economic impact can be realized once smaller companies are able to deploy metaverse technologies too. At the world's largest industrial fair Hannover Messe 2022, South Korean start-up DigiForet impressed with its "Manufacturing AI Metaverse Factory", where participants operated various functions connected to a real factory, such as running the plating process and optimizing the operation of a plating bath based on the analysis of the manufacturing AI.[26] Sponsored by the Ministry of SMEs and startups, the experience showcased the possibilities of uplifting the manufacturing competitiveness of Korean SMEs.

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Taiwan

Potential 2035 economic impact of the metaverse

US$17-32B per year

Taiwan

Taiwan's edge in hardware manufacturing equips the economy to play a critical role in the metaverse value-chain – Taiwan's semiconductor foundries account for over 60% of the global market share in production,[1] and 92% for leading-edge semiconductor production.[2] These hardware firms provide a strong foundation for the growth of other firms along the metaverse value-chain. Taiwan Semiconductor Manufacturing Company (TSMC), the world's leading semiconductor foundry, has been chosen by Apple to develop advanced display technology for its proprietary AR devices.[3] Display and optical technologies are also crucial components of AR/VR devices which can be used to access the metaverse. Hence, Taiwan's advantages in manufacturing make it a frontrunner in AR/VR components development and procurement.

The economy has a lofty digital ambition to redefine internet access as a basic human right, paving the way for equitable access to the economic opportunities in the metaverse. The target is underpinned by a robust digital infrastructure plan, announced in 2017 by the Executive Yuan, Taiwan's highest administrative organ. Taiwan has committed to providing 1Gbps internet access in 90% of the territory to eliminate the urban-rural gap. It also plans to cultivate an innovative and digitally-adept workforce through an online innovative learning environment, and nurture digital creative and cultural content into a trillion-dollar industry (US$33 billion).[4] Achieving these plans will expand the economic impact of the metaverse domestically.

Taiwan is touted as one of the world's first open digital democracies. Having piloted consensus-making digital platforms, Taiwan can help to extend these learnings into the metaverse. Policy-making that actively seeks consensus has helped the economy to sidestep the polarization and controversy that has been associated with other digital platforms.[5] The government has been in close collaboration with civic hackers which will begin enrollment tools to nurture a less divided citizenry. Transparency and collaborative decision-making are the principles of the Taiwan civic hackers, which leverage software to augment politics. As an open and interoperable metaverse could foster greater levels of collaboration through its network effects, Taiwan could serve as a beacon on navigating civic participation in the metaverse.

> "Taiwan is a central node of the globe's semiconductor ecosystem and a cutting-edge pioneer on emerging technologies like hardware-software integration, chipsets, processors, 5G and Wifi6. Taiwan developers and artists have also won global awards for VR content creation. These are all essential elements in the metaverse."
>
> **Sandra Oudkirk, Director of American Institute in Taiwan @ Meta XR Hub Taiwan Launch Ceremony, 6 May 2022**

1. Department of Investment Services, Invest Taiwan, Key Innovative Industries in Taiwan: Semiconductor Industry, 2021, p. 6.
2. The White House, Building Resilient Supply Chains, Revitalizing American Manufacturing and Fostering Broad-Based Growth, 2021, p. 12.
3. Lauly Li and Cheng Ting-Fang, "Apple Partners With TSMC to Develop Ultra-Advanced Displays," Nikkei Asia, February 10, 2021.
4. Executive Yuan, "Executive Yuan Unveils Digital Infrastructure Project," press release, March 21, 2017.
5. RadicalxChange, "Taiwan: Grassroot Digital Democracy that Works," accessed October 3, 2022.

Macroeconomic Determinants

- Taiwan's service sector makes up 61% of GVA and employs around 60% of the labor force. The main sectors contributing to Taiwan's economy are manufacturing (33.8%),[6] wholesale and retail trade (16.2%) and real estate (7.9%).[7] These sectors are expected to be impacted by the metaverse in the near to medium term.
- GDP per capita is $28,371 - affordability of required immersive hardware may not be a limiting factor on the development of the metaverse.
- Strong export base, with external trade 118% of GDP. Exports reached record highs of US$446 billion in 2021 despite the weak global economy due to heightened demand for its technological products[8].
- Economies like China (40% of exports)[9] and US (15% of exports)[10] becoming self-sufficient in key technologies may pose challenges to Taiwan's role within the metaverse value chain.

TAIWAN IN NUMBERS

Potential 2035 economic impact of the metaverse:

US$17-32B per year, 1.3-2.4% of GDP

2020 GDP:

US$656B

Per capita (Constant 2017 US$):

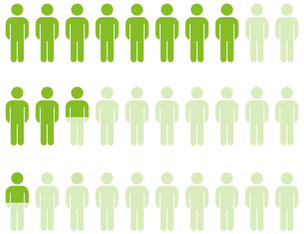
US$28,371 (high income)

Key sectors:

ICT sector:

Population:

23.6M



79% urban

26% below 25

5% unbanked

Note: Taiwan is not ranked on the Global Innovation Index, EIU Business Environment Ranking, and Digital Readiness Index

Sources: Our World in Data 2017, ITU Digital Development Dataset 2019, World Bank Global Findex, Official Government Statistics

6. ING Group, "Taiwan Economic Update: Inseparable From Semiconductors," accessed October 3, 2022.
7. Department of Investment Services, Invest Taiwan, Key Innovative Industries in Taiwan: Service Industry, 2020.
8. Betty Hou and Cindy Wang, "Taiwan's 2021 Exports Soar to Record $446b on Tech Demand," Bloomberg, January 7, 2022.
9. Sarah Zheng, "China Reliance on Taiwan would Make Trade Retaliation Costly," Bloomberg, August 17, 2022.
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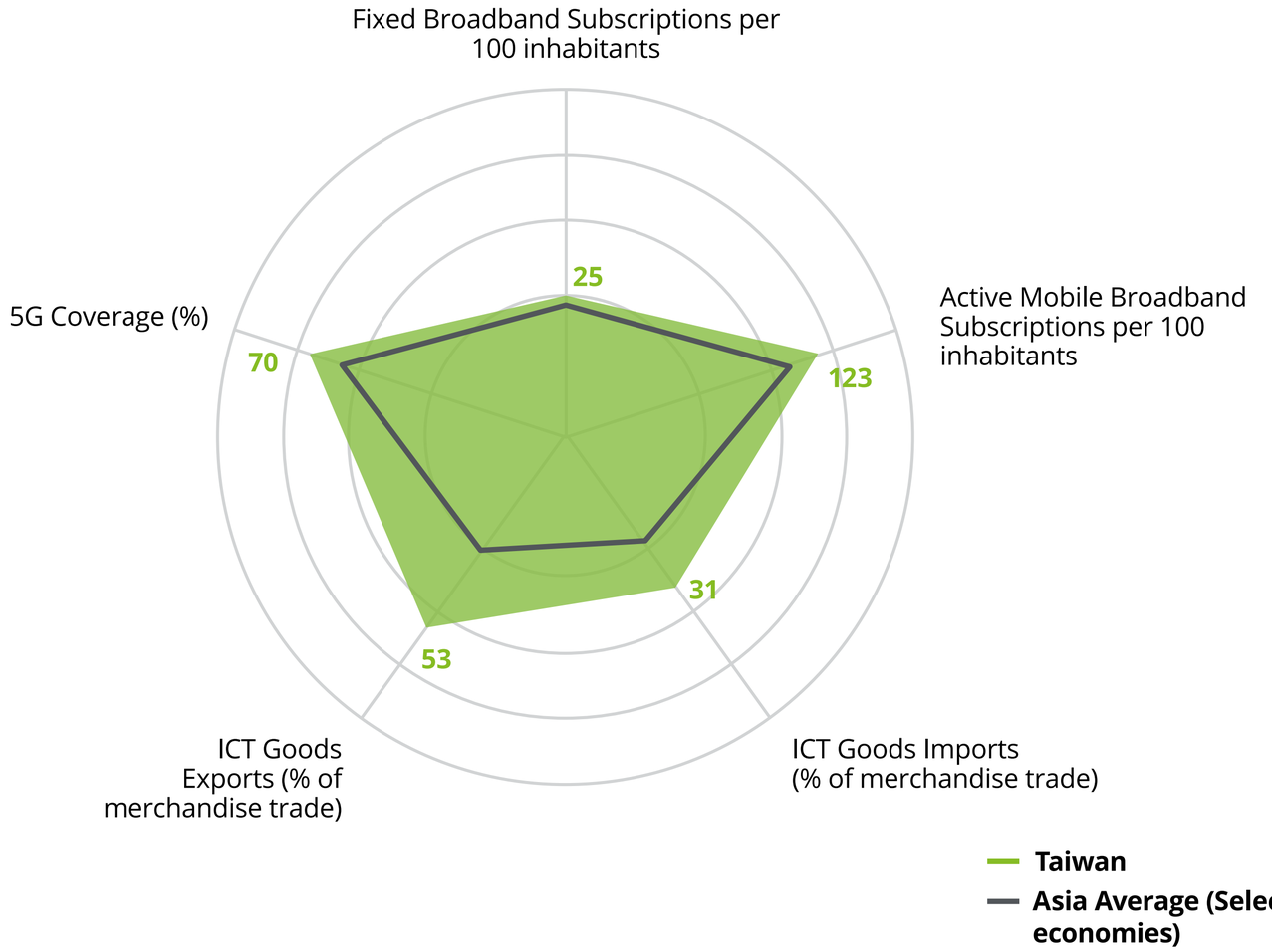
Technology Fundamentals

- Meta choosing to set-up its first Asian Extended Reality (XR) Research Hub in Taiwan[11] is a testament to its strong technology fundamentals
- Its semiconductor foundries account for over 60% of the global market share in production, and 92% of leading-edge semiconductor production.[12]
- The government aims to increase accessibility to high-speed internet to eliminate the urban-rural gap through 1Gbps internet access in 90% of the economy and the setting up of responsive digital government services in rural areas.[13]
- The newly set-up Ministry of Digital Affairs, overseen by Audrey Tang, will further develop digital governance and cybersecurity preparedness, and promote cooperation in digital services and data democratization.[14]
- The ministry has shown a willingness to utilize emerging digital technologies, such as the Web 3.0 InterPlanetary File System (IPFS), to guard its government websites against cyberattacks through a more robust decentralized file network.[15]
- Taiwan's digital skills training is hardware-inclined. The government has set-up semiconductor R&D centers to cultivate industrial talent, with an additional 10,000 semiconductor professionals per year.[16] After the launch of its cybersecurity strategy in May 2021, Taiwan has trained around 2,600 IT security professionals.[17]



Sources: GSMA Mobile Connectivity Index 2021, ITU Digital Development Dashboard 2020, UNCTADStat 2019
Note: Data on International Bandwidth per Internet User is not available for this economy

11. Taipei Times, "Meta Launches Asia's First XR Hub in Taipei," accessed October 3, 2022.
12. Yen Nee Lee, "2 charts show how much the world depends on Taiwan for semiconductors," CNBC, March 15, 2021.
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14. Liu Tzu-Hsuan, "Digital Affairs Ministry to be Launched on Aug 27," Taipei Times, August 6, 2022.
15. Matt Haldane and Xinmei Shen, "Taiwan's Digital Affairs Ministry Turns to Web3 to Guard Against Mainland China Cyberattacks following Pelosi's Visit," South China Morning Post, August 11, 2022.
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17. Department of Investment Services, Invest Taiwan, Key Innovative Industries in Taiwan: Information Security, 2021, p. 3.

Ecosystem Enablers

Competition within the metaverse

Domestic hardware firms like Foxconn, ASUS, TSMC and HTC are global players in their respective fields with deep manufacturing capabilities. Growth in their areas of expertise will be further supported by the administration, with Taiwan's National Development Council identifying digital technology as a core strategic industry to power economic growth.[18]

Nurturing more software-centric firms could help Taiwan bridge the value chain between hardware and content companies in the metaverse. Audrey Tang, Taiwan's digital minister, has commented that the digital ecosystem will benefit from the shorter iteration cycles and service-oriented perspective that software-centric firms can bring to the table.[19]

Although a new wave of software-centric firms have emerged, strengthening the pool of software firms will require a greater diversity of financing options[20] and retention of software talents.

Strengthening the pool of software firms can also bridge Taiwan's deep hardware capabilities with its content producers. With a deep network of artistes that started the Taiwanese Mandopop boom, the first metaverse music label, 0x0, has emerged in the territory.[21] Taiwan is also emerging as a global leader in VR content production, and its VR films have become a regular feature in international film festivals.[22] La Camera Insabbiata, a Taiwan-US co-production, also won the best VR experience award at the Venice Film Festival's 1st VR competition. The documentary "FORMOSA 3D" directed by Charlie Chu, looks at forgotten craftsmanship through augmented reality.[23]

Accessibility

When it comes to ensuring equal access to the metaverse, Taiwan starts from a position of strength. Today, Taiwan ranks the 5th most free on the internet globally in 2021 by the Freedom House,[24] and the freest in Asia. Thanks to President Tsai Ing-Wen administration's commitment to increase internet accessibility as a leading national concern,[25] there are no significant digital divides, except with slight geographical and age disparities.[26]

Taiwan has also implemented the Web Content Accessibility Guidelines 2.0 in 2017 that allow people with disabilities to access web content more easily.[27] By pressing on with this commitment to ensure access for all to the next version of the internet, Taiwan will be a leading example in the region on how this can be achieved and the social benefits of doing so.

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21. Ryan Huang, Violet C Lo and Xin-Wu Lo, "Taiwan Startup Ecosystem Survey," PwC and Taiwan Institute of Economic Research, 2021, p. 26.
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26. Chris Wang, "2012 Elections: Tsai Pledges to Upgrade ICT on a par with Seoul," Taipei Times, December 23, 2011.
27. Web Accessibility Initiative, "Taiwan," accessed on October 19, 2022.25.

Sectors to Watch

Technology and Manufacturing

Taiwanese technology and manufacturing giants are poised to capitalize on the upcoming opportunities in the metaverse. Having established themselves within the global technology ecosystem, companies like TSMC, MediaTek and HTC have hinted at their metaverse plans. Mark Liu, Chairman of TSMC, believes that AR and VR devices could replace smartphones and personal computers, respectively, and TSMC has been developing the technologies needed for metaverse applications.[28]

HTC similarly has the metaverse firmly in its sight, with recent product launches compatible with the metaverse - HTC Vive, a VR headset, and Desire 22 Pro, which comes with a digital asset wallet and VR headset pairing.[29] The explosive demand for increasing compute power met by the growing clusters of data centers across the globes are also quietly powered by Taiwanese original design manufacturers (ODM), like Quanta Computer, Wiwynn, Inventec and Foxconn, all based in Taiwan.[30]

Government

Immersive environments in the metaverse could facilitate the government in achieving various policy aims – from increasing foreign direct investments to more forms of participation methods in democratic processes. In collaboration with Smart City Taiwan Program, iStaging, an AR/VR solution provider, has experimented with providing investors with AR/VR tours during the planning stage of industrial park developments. Taiwan Creative Content Agency (TAICCA), a government agency, is actively promoting the integration of technology and creative content. Its Immersive Content Grant funds creative projects that can be interactive, multiplayer, AR, VR, MR, haptic, sound, or location-based.[31]

The Taiwanese government currently utilizes digital platforms, like join.gov.tw, as local town halls. Access to the metaverse could provide administrators with more tools to run townhalls more smoothly, while increasing the variety of participation methods.

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29. Taipei Times, "'Metaverse' Concept Likely to Create Huge Opportunities, TSMC and MediaTek Say," accessed October 3, 2022.
30. Patrick Moorhead, "Lenovo's Secret Recipe for Hyperscale Success is Called ODM+," Forbes, October 22, 2018.
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Thailand

Potential 2035 economic impact of the metaverse

US$11-21B per year

Thailand

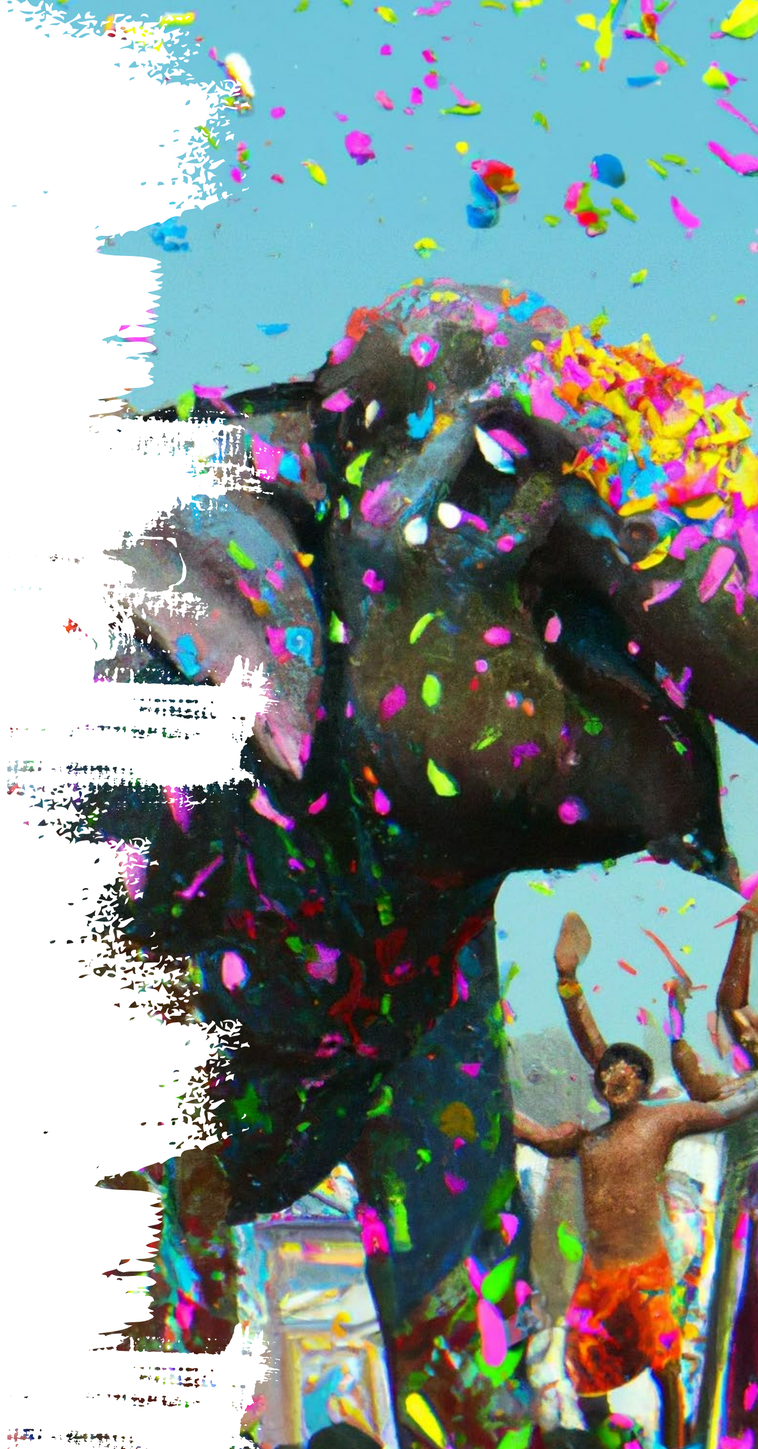
Thailand is one to watch with multiple metaverse projects sprouting from its entrepreneurial business sector. Their willingness to take risks is due, in no small part, to their large market of ultra-connected Thai consumers, who top global rankings for weekly online purchases, cryptocurrency ownership and mobile banking app usage.[1]

The Thai Government has been quick to follow suit, with its Digital Economy and Society Ministry laying out its plans to prepare for the technological sophistication and regulatory complexity of the metaverse.[2]

Digital growth is a vital engine to achieve the country's targets to realize economic prosperity under Thailand 4.0. Thailand has undertaken regulatory reforms in areas related to metaverse activities, including crypto-friendly tax rules, personal data protection and cybersecurity.[3] The country already has a strong technological foundation, with one of the fastest fixed broadband speeds in the world.[4]

Thailand is also well-positioned to shape the opportunities that the metaverse will provide for the creator economy. Thailand's bustling creative sector is influenced by its multi-cultural heritage.

The creative sector contributed 10% of the GDP in 2021, far surpassing Asia's average of 3.5%.[5] The metaverse presents a new platform to generate value from Thailand's combination of creative, entrepreneurial and technological talents.



> "The government has developed wireless broadband to drive the country forward so it can benefit from the advent of virtual reality, metaverse technology and the next evolution of the digital economy."
>
> **Minister Chaiwut Thanakamanusorn, Ministry of Digital Economy and Society, at the Bangkok Post Tech Conference 2022**

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2. Komsan Tortermvasana, "Thailand eyes metaverse gains," Bangkok Post, June 30, 2022.
3. Tita Sanglee, "Is Thailand Ready for the Metaverse?," The Diplomat, December 10, 2021.
4. Bangkok Post, "Thailand Tops Internet Speed Testing," accessed October 3, 2022.
5. Royal Thai Embassy, "Thailand's creative industries showing steady growth," accessed October 19, 2022.

Macroeconomic Determinants

- Thailand overall is a service-based economy (58.3% of GVA). The three largest sectoral contributors to Thailand's economy are manufacturing (25.2% of GVA), followed by wholesale and retail trade (16.8%), and agriculture, forestry and fishing (8.6%).
- Thailand's GDP per capita stood at US$17,253 in 2020, falling in the middle of the pack of the selected economies, suggesting that affordability of required immersive hardware on average may be a limiting factor on the economic impact of the metaverse.
- Thailand is ranked 43rd in the world and 5th among upper-middle income group economies based on the Global Innovation Index 2022. By harnessing its innovation potential, the metaverse could encourage a fresh spurt of growth for the country.

THAILAND IN NUMBERS

Potential 2035 economic impact of the metaverse:

US$11-21B per year, 1.3-2.4% of GDP

2020 GDP:

US$432B

Per capita (Constant 2017 US$):

US$17,253 (upper middle income)

Key sectors:

ICT sector:

Population:

70M

51% urban

31% below 25

17% with basic digital skills

4% unbanked

Global innovation index: **#43/132**

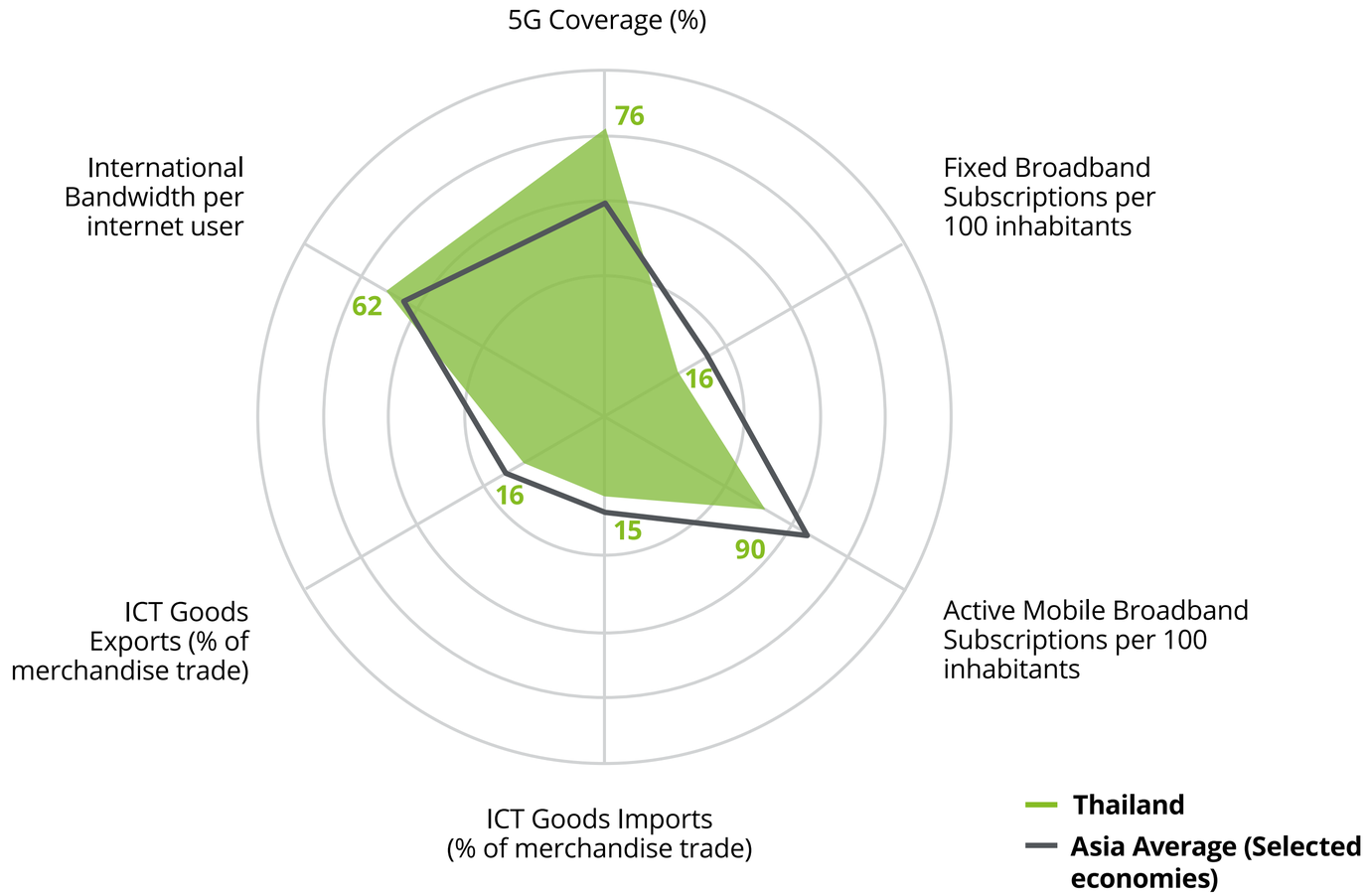
EIU business environment ranking: **#28/99**

Digital readiness index: **#55/141**

Sources: World Bank World Development Indicators 2020, Our World in Data 2017, ITU Digital Development Dataset 2019, World Bank Global Findex, UN Data

Technology Fundamentals

- The Thai population is a highly connected one with 80% of those aged above 15 having access to the internet, 100% owning mobile phones and 92% having made or received a digital payment.[6]
- Thailand has topped We Are Social/Hootsuite's Digital 2022 global rankings for weekly online and online grocery purchases, and ownership of cryptocurrency. The country was also first for mobile banking app usage in last year's ranking.[7]
- The speed of fixed broadband service ranks third globally with an average download speed of 188.75 megabits per second (Mbps).[8] Thailand is set to maintain this lead as it quickly rolls out 5G.
- These impressive statistics mean Thai consumers are in a strong position to benefit from new applications in the metaverse economy.
- Thailand's export-driven economy (~60% of GDP)[9] and large electronics manufacturing base could stand to gain in the near term as related electronic product demand increases. In particular, its emerging semiconductor industry may see accelerated growth. These hinge on the country's ability to maintain political stability.
- With all government data sets set to be stored on the cloud by 2025 as part of the Government Data Center and Cloud project, this unleashes opportunities for the use of big data.[10] Through leading by example with the adoption of cloud technologies, this can increase trust amongst the general population and businesses in these technologies.



Sources: GSMA Mobile Connectivity Index 2021, ITU Digital Development Dashboard 2020, UNCTADStat 2019

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7. We Are Social, "Digital 2022: Another Year of Bumper Growth," accessed October 19, 2022.
8. Speedtest, "Thailand's Mobile and Fixed Broadband Internet Speeds," accessed October 3, 2022.
9. World Bank, "Export of goods and services (2017 – 2021)," accessed October 5, 2022.
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Ecosystem Enablers

Competition within the metaverse

With a strong entrepreneurial culture, Thai companies have been quick to explore opportunities in the metaverse. The Metaverse Thailand project operates a virtual version of downtown Bangkok and enables businesses to operate on their virtual land plot replete with a Singapore business address.[11] Real estate company Magnolia Quality Development has teamed up with a Thai animation company T&B Media Global to sell digital structures in their virtual town Translucia.[12] Thai metaverse designer Brandverse is spearheading a collaboration with mall developer Central Pattana, 7-Eleven, and over 50 other companies and brands, on metaverse business opportunities such as selling digital assets and holding virtual events.[13] Thailand's leading cryptocurrency exchange, Bitkub, has a registered capital of THB 290 million.[14] Beyond serving as an exchange, Bitkub has also launched a metaverse platform where users can trade NFTs, as well as an academy that educates consumers on digital assets and blockchain technology.

Security and Privacy

Thailand has recently implemented data privacy laws,[15] enabling Thai companies to better navigate digital opportunities and encouraging consumer participation through the peace-of-mind it confers. However, the legislation may need further strengthening to anticipate increasing amounts of personal data that the metaverse will collect, such as the tracking of eye movements within VR headsets.

Thailand's cybersecurity also bears concern, with the country lagging behind its Asian peers, coming 44th in GSMA Global Security Index 2020. In his comments at the 2022 Bangkok Post Tech Conference, Minister of Digital Economy and Society Chaiwut Thanakamanusorn recognized the importance of personal data privacy and cybersecurity, especially in the metaverse era.[16] He emphasized his Ministry's commitment to improving cybersecurity through the office of the National Cyber Security Commission and cited plans to strengthen laws for personal data protection.

Accessibility

While Thailand boasts high levels of connectivity, this may not reflect the uneven distribution of accessibility to the internet across the country. Geographically, Northeastern (56.8%), North (59.6%) and Southern (65.2%) Thailand have some of the lowest levels of internet users within the country, far below the figures in Bangkok (83.5%).[17]

75% of households are connected to the internet via a 3G or higher mobile network.[18] However, across income strata, only 59% of households in provinces in the bottom quartile of GDP per capita have an internet connection in the home, compared to 79 per cent in the top quartile.[19] The country will need to rapidly increase the accessibility and affordability of the speedy internet connectivity to its populace, so that Thais can have more equitable access to the emerging opportunities of the metaverse.

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12. Bangkok Post, "T&B Media launches 'Translucia' Metaverse, a Virtual World, partnering with MQDC in property -- a new world first," accessed October 19, 2022.
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16. Bangkok Post, "Thailand eyes metaverse gains," accessed October 19, 2022.
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18. ITU, "E-learning in Thailand: Mapping the Digital Divide," accessed October 3, 2022.
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Sectors to Watch

Tourism

With a yearly contribution of around 18% to GDP prior to the pandemic,[20] tourism is a sector which could derive further value from the metaverse by leveraging on immersive. experiences to further appeal to a greater number of international tourists. This will provide a significant boost to the Thai economy as international travelers outspend their local counterparts substantially, accounting for 60% of all tourism spending despite only making up 33% of overall travelers in Thailand in 2019.[21]

The Tourism Authority of Thailand has begun experimenting in the metaverse with the release of the "Amazing Thailand Metaverse: Amazing Durian" virtual travel experience, a collaboration with the provinces of Chanthaburi, Rayong, and Si Sa Ket. Through their smartphone or PC,[21] tourists can create their own avatar to explore a virtual durian orchard. Users can do so without the need for a VR headset, which creates an accessible immersive experience.

Creative Services

Thailand ranks within the top ten creative goods exporters amongst developing countries.[23] The development of the creative and cultural services is one of the technological and industrial goals described in the "Thailand 4.0" strategy,[24] with the establishment of the Thailand Creative Economy Agency to turn the industry into a creative hub of ASEAN and the offering of both tax and non-tax incentives to the creative industry. Thai virtual influencer agency SIA Bangkok has also demonstrated the technological capabilities to develop realistic AI humans with 'AI-Ailynn', the country's first AI influencer.[25]

Thailand has inventively applied tokenization to attract new sources of funding for creative projects. Destiny tokens, Thailand's first digital investment token in a movie BuppeSanNivas 2, was oversubscribed and sold-out, raising US$7.5 million. The token was released by Kubix, under Kasikorn Bank, to democratize investment opportunities in films to the general public.[26] The movie was released in July 2022, and has been the highest grossing Thai film of 2022 so far.[27]

20. Travel Daily, "Tourism accounts for 18% of Thai GDP," accessed October 19, 2022.
21. McKinsey & Company, "Reimagining travel: Thailand tourism after the COVID-19 pandemic," accessed October 3, 2022.
22. The Star, "Thailand offers virtual 'Amazing Durian' experience on metaverse; aims the tour for tourists to explore durian farms," accessed October 19, 2022.
23. United Nations Conference on Trade and Development, Creative Economy Outlook: Trends in International Trade in Creative Industries, 2018.
24. Royal Thai Embassy, "National strategy Thailand 4.0 officially launched," accessed October 19, 2022.
25. Bangkok Post, "First made-in-Thailand virtual influencer debuts," accessed October 19, 2022.
26. Kaisorn Bank, "KBTG establishes Kubix, a new company for the digital asset business," press release, March 19, 2021.
27. The Nation Thailand, Popular TV drama spin-off sets new box-office record," accessed October 19, 2022.

Vietnam

Potential 2035 economic impact of the metaverse

US$9-17B per year

Vietnam

The Vietnamese are entrepreneurial, creative and young – 37% are under 25 years of age. These traits help the country punch above its weight in shaping the future of the web. Vietnam has been one of the most active players in the Web3 space. Its tech unicorn, Sky Mavis, popularized the "GameFi" (or play-to-earn) concept with its hit blockchain-focused game Axie Infinity. Vietnam also topped the 2021 Chainalysis Global Crypto Adoption Index signalling broad social acceptance of cryptocurrencies largely driven initially by remittance payments.[1] It is still uncertain the extent to which cryptocurrencies and the decentralized web will feature in the future of the metaverse. However, this embracing attitude by not just start-ups, but also by the broader population, of new web technologies and use cases puts the country firmly on its path to achieving its "Make in Vietnam" strategy.[2]

This will provide momentum for the Government to achieve its ambitious target of growing its digital economy from the current 8.2%[3] of GDP to 20% by 2025 and 30% by 2030, transforming from a low-tech manufacturing to a service-oriented economy. The country launched its "Make in Vietnam" strategy in 2019 to develop its domestic ICT industry by shifting from assembly and outsourcing to one with strong local capabilities for product creation and design. The Metaverse Village in Da Nang and a burgeoning digital content industry signal a confident future for made-in-Vietnam metaverse products and its over 1-million strong IT labor force.[4]

The Vietnamese government is actively putting in place the guardrails for the digital age, including a flurry of regulatory reviews of digital-related laws in the next 1-2 years.[5] Already, Vietnam's cybersecurity has improved by leaps and bounds, rising a whopping 75 places in just 5 years from 100th place in 2017 to 25th place in 2021 on ITU's Global Cybersecurity Index.

> "Make Vietnamese tech products created in Viet Nam, manufactured in Viet Nam, designed in Viet Nam, solving Vietnamese issues, reaching out to the region and the world."

Nguyen Xuan Phuc, then-Prime Minister (now President) of Viet Nam, unveiling the "Make in Viet Nam" strategy at the National Forum on Developing Vietnamese Technology Companies, May 9, 2019

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3. Vietnam Net Global, "Vietnam's growth potential lies in the digital economy" accessed October 3, 2022.
4. Saigon Online, "One million people working in IT industry in Vietnam," accessed October 19, 2022.
5. Connect on Tech, "Vietnam: New Draft Law on e-Transactions Targeting Digital Platforms," accessed October 19, 2022.

Macroeconomic Determinants

- Overall, Vietnam is a manufacturing and raw resource economy, with the three largest sectoral contributors to Vietnam's economy being manufacturing (18.5% of GVA), followed by agriculture, forestry and fishing (16.5%), and wholesale and retail trade (12.9%). Phones and computers are among the country's top 10 main export products.
- Vietnam's ICT sector currently only contributes 0.75% of GVA, but this is expected to grow with Vietnam's digital ambitions and "Make in Vietnam" strategy.[6]
- Vietnam is ranked 48th in the world on the Global Innovation Index 2022 and 2nd among 34 lower-middle income economies.
- Vietnam's GDP per capita stood at US$10,338 in 2020, suggesting that affordability of required immersive hardware on average may be a limiting factor on the economic impact of the metaverse.

VIETNAM IN NUMBERS

Potential 2035 economic impact of the metaverse:

US$9-17B per year, 1.3-2.4% of GDP

2020 GDP:

US$259B

Per capita (Constant 2017 US$):

US$10,338 (lower middle income)

Population:

96M

37% urban

37% below 25

17% with basic digital skills

Key sectors:

ICT sector:

Global innovation index: **#48/132**

EIU business environment ranking: **#45/99**

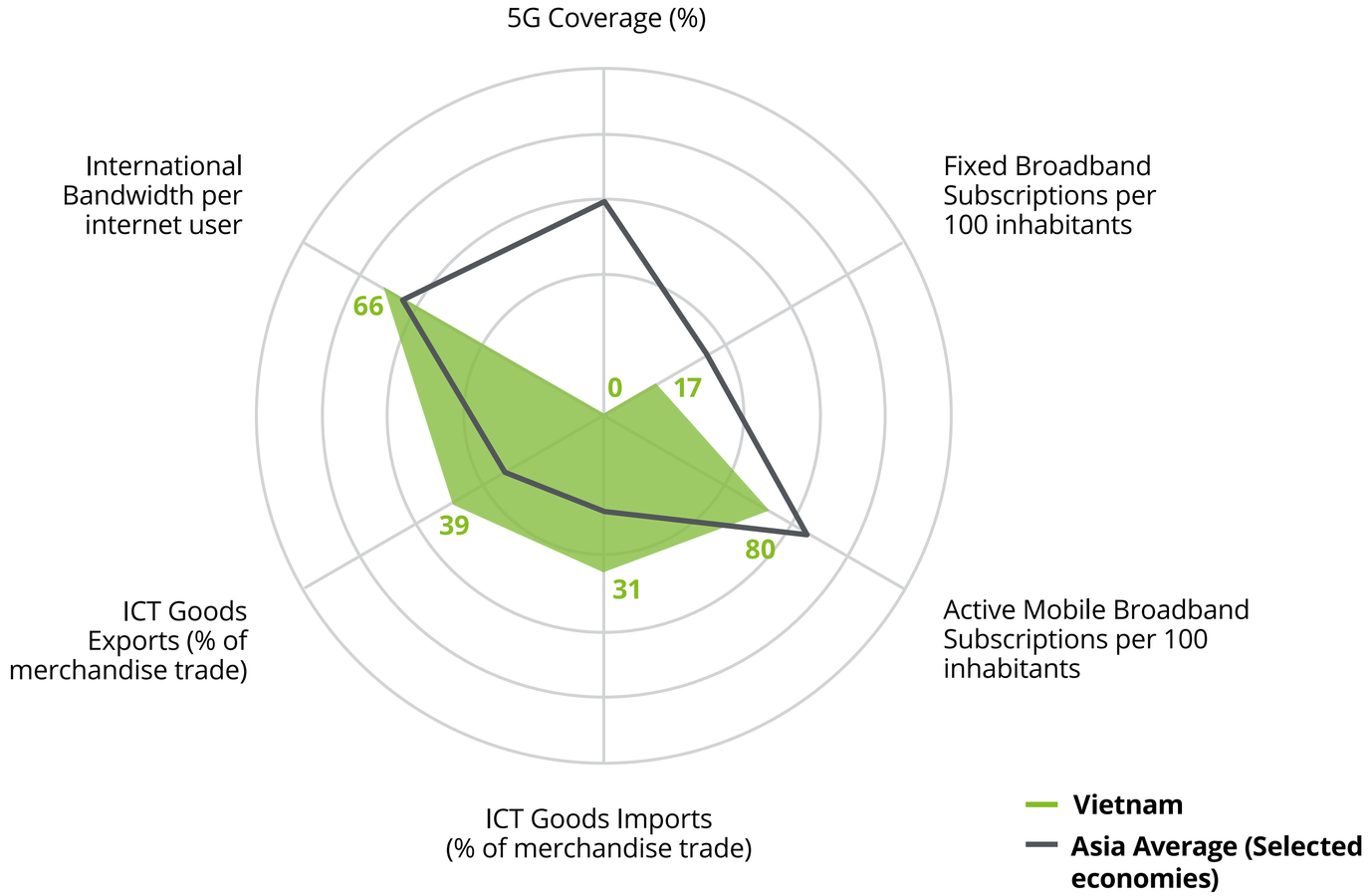
Digital readiness index: **#70/141**

Sources: World Bank World Development Indicators 2020, Our World in Data 2017, ITU Digital Development Dataset 2019, World Bank Global Findex, UN Data

6. Vietnam Investment Review, "Make in Vietnam, by Vietnam for a fresh digital orientation," accessed October 19, 2022.

Technology Fundamentals

- Vietnam was one of the first developing countries to implement 5G trials in 2019 and rolled out 5G deployment in 2022.[7]
- The Ministry of Information and Communications targets to achieve nationwide 5G coverage within 1 year, prioritizing industrial and high-tech parks and dense urban centers.[8] The Ministry has already set up a steering committee to promote 6G R&D.
- Smartphone penetration is high at 68% with plans to increase this to 85% by end 2022.[9] Given affordability challenges, mass smartphone ownership may provide an entry path to metaverse experiences, albeit limited immersivity.
- Vietnam has a high unbanked population, with only 70% of adults having a bank account and nearly half without access to credit.[10] This has driven many to cryptocurrency markets. Ironically, this breeds familiarity with the potential future payment rails of the internet despite the low interaction with traditional banking services.



Sources: 'GSMA Mobile Connectivity Index 2021, ITU Digital Development Dashboard 2020, UNCTADStat 2019'

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9. OpenGov Asia, "Vietnam Targets 85% Smartphone Usage by 2022-End," accessed October 19, 2022.
10. Vietnam Investment Review, "Vietnam faces a possible gap in financial accessibility and awareness," accessed October 19, 2022.

Ecosystem Enablers

Competition within the metaverse

Overall, Vietnam is ranked 54th out of 100 countries by StartupBlink's Global Startup Ecosystem Index 2022, up 5 places from 2021. Vietnam also ranks 5th in Southeast Asia. Targeted focus could help it develop a niche advantage. A Metaverse Village[11] has been set up in Da Nang to build the ecosystem for metaverse technologies including researchers, start-ups, funders and other individuals. The Vietnam Blockchain Association is working with global cryptocurrency exchange leader, Binance, on blockchain research and application in Vietnam. Vietnam can capitalize on the success of tech unicorns like Sky Mavis to attract talent and investment.

Digital Regulations

Comprehensive legislative reform is underway to support Vietnam's digital transformation and prepare for the digital age. In May 2022, the Ministry of Information and Communications released a Draft Law on E-Transaction, which includes a new chapter to regulate digital platforms.[12]

Large platforms will have additional obligations to mitigate risks such as negative impacts on personal lives, freedom of press, children's rights, national health and security. Dominant large platforms must also provide users with information and options to manage algorithmic recommendations.[13]

Other legislations that form the guardrails for the metaverse are also under review, including data privacy, cyber security, consumer protection, and intellectual property.[14] Regulatory reviews for specific sectors such as telecommunication and digital technology industry are also expected in the next 1-2 years. These regulations are anticipated to place Vietnam's digital economy on a firm foundation of clear laws that protect its citizens while allowing new metaverse technologies to flourish.

Accessibility

To fully realize the economic and social benefits of the metaverse, digital inclusion is a priority. With only about 70% of its population using the internet, and 17% with basic digital skills, there is a significant number at risk of being excluded from the metaverse economy. On the cost front, the country has managed to keep its internet rates among the cheapest in the world, with its fixed internet unit price per capita income at 41% of the world's average and mobile equivalent at one-third of the world average.[15] This has contributed to the high level of mobile broadband subscriptions. Nevertheless, gaps in digital and financial literacy will need to be closed for more to participate in Vietnam's digital economy.

11. Vietnam Net Global, "Metaverse Village set up, connecting startups in virtual reality," accessed October 19, 2022.
12. Tilleke & Gibbins, "Understanding Vietnam's Draft Law on E-Transactions," accessed October 19, 2022.
13. Baker McKenzie, "Vietnam: New Draft Law on e-Transactions Targeting Digital Platforms," Lexology, May 1, 2022.
14. These include the Draft Decree detailing the Law on Cybersecurity ("CSD"); the Draft Decree on Personal Data Protection ("PDPD"); the Draft Decree amending Decree No. 72/2013/ND-CP on the Management, Provision, and Use of Internet Services and Online Information ("Draft Decree 72"); the Draft Amendment of Law on Consumers' Rights Protection ("LCRP"); and the Amended Intellectual Property Law. Source: Manh-Hung Tran "Rise of the metaverse in Vietnam – What's happening?" July 1, 2022.
15. Ministry of Information and Communications of Vietnam, "Internet rates in Vietnam are among the world's cheapest, "accessed October 3, 2022.

Sectors to Watch

Gaming

Five of the top 10 game publishers, based on worldwide downloads, in the Southeast Asia, Australia and New Zealand region come from Vietnam. The country accounted for 22% of all games downloaded in Southeast Asia, second to Indonesia with 38%.[16] With a high smartphone penetration rate, mobile gaming forms the largest segment and is growing exponentially. Average mobile gaming revenue per user grew at a compound annual growth rate (CAGR) of 30% over the past 5 years.[17]

With the support of the Ministry of Information and Communications, the Vietnam Game Development Alliance was formed in June 2022 with 60 online video game companies and a 10-member Coordination Committee including VNG, Vietnam Esports, and Viettel Media.[18] With the success of Sky Mavis, VNG and the fast-growing base of mobile gamers in Southeast Asia, Vietnam could leverage these early advantages in designing user-centric experiences and applying the latest digital technologies to drive progress in the country's digital transformation.

Education

Vietnam's e-learning market is projected to reach US$3 billion by 2023.[19] The country was ranked among the top 10 growing Edtech markets globally, posting annual growth rates of 44%, according to the Vietnam Edtech Report 2021. With a growing demand for skilled labor in the manufacturing and tech sectors, the Vietnamese government has set a goal to make online education available at 90% of universities and 80% of secondary schools and vocational training facilities by 2030.[20]

FPT, a leading IT services provider in Vietnam, is capitalizing on these opportunities, rolling out an AI-enabled education app that has garnered 3 million accounts across 40,000 schools so far.[21] One of Vietnam's top prestigious schools, The High School for Gifted Students, Hanoi National University of Education, has also forayed into the metaverse with a digital cultural museum. The museum will contain 3D artifacts and contributions from students across the generations.[22]

Given Vietnam's young population, delivering education using the latest technologies will give students first-hand experience, which will have knock-on effects on other sectors as these digitally-native students graduate.

16. Data.AI, "Vietnam as one of the world's most dynamic mobile gaming markets", accessed October 3, 2022.
17. Statista, "Video Games – Vietnam," accessed September 19, 2022.
18. IT Zone, "Launching an alliance of online video game publishers and manufacturers in Vietnam," accessed October 19, 2022.
19. Vietnam+, "Vietnam's e-learning market projected to hit 3 billion USD by 2023," accessed October 19, 2022.
20. NikkeiAsia, "Vietnam edtech market soars to $3bn on remote learning boom," December 18, 2021.
21. Ibid.
22. Coincu, "One of Vietnam's top prestigious schools enters the metaverse," accessed October 19, 2022.

Appendices

Appendix A - Metaverse market sizing research

The table below provides an overview of research examples that have attempted to estimate the market size (i.e., revenues) of the metaverse. These estimates range from US$678.8 billion (Grand View Research) up to US$13 trillion (Citi GPS) per year by 2030, reflecting the inherent uncertainty in predicting the potential impacts of the metaverse at this stage.

Research Paper	Market sizing (i.e., revenue) estimates
"Metaverse and Money", Citi GPS, 2022.	The metaverse would be potentially an US$8 trillion-US$13 trillion opportunity per year by 2030.
"Framing the Future of Web 3.0", Goldman Sachs, 2021.	The size of the metaverse is highly dependent on how much of the digital market shifts to the metaverse. Estimates for the size of the metaverse correspondingly range from US$2.6 trillion to US$12.5 trillion annually in roughly 20 years or more.
"Value creation in the metaverse", McKinsey & Co, 2022.	By 2030, the value of the metaverse could reach US$5 trillion per year.
"Market Research Report", Fortune Business Insights, 2022.	The global metaverse market is projected to grow from US$100 billion in 2022 to US$1.5 trillion per year by 2029, exhibiting a CAGR of 47.6%.
"The Metaverse. Web 3.0 Virtual Cloud Economies", Grayscale Research, 2021.	The market opportunity for bringing the metaverse to life may be worth over US$1 trillion in annual revenue.
"Metaverse may be US$800 billion market, next tech platform", Bloomberg, 2021.	The metaverse market could grow by 13.1% annually in the near future, growing from US$478.7 billion in 2020 to US$783.3 billion per year in 2024.
"Market Analysis Report", Grand View Research, 2022.	The metaverse could grow at an annual compound growth rate of 39.4% from 2022 to 2030 and generate revenues worth US$678.8 billion per year in 2030

Appendix B - Metaverse Impact Estimation

Metaverse Impact Analysis
This paper adopts the methodology developed in Deloitte's report on "The Metaverse and its Potential for Türkiye".

The metaverse has the potential to be a breakthrough technology, which could change how the economy functions. The impact could be sizeable and across many sectors. Further, the impact could increase as the technology matures, adoption increases, and the number of use cases grow. Given that the metaverse is still in its early stages of development, the full scale of the economic opportunity remains unknown.

As noted within the S-curve literature, the impact will be mostly felt after the first phase of technological innovation. As per Web2.0, the overall cycle could take two or more decades to mature.[1] In this way, its impact is inherently difficult to forecast and will depend on a wide set of socioeconomic factors and enablers. Early estimates, however, suggest that the potential impact of the metaverse could be significant both regionally and globally. Wider literature that assess the metaverse does so in different ways and correspondingly using different methods. Some studies look to evaluate the potential size of the metaverse economy (contribution study), or Total Addressable Market (TAM).

Such estimations do not distinguish between GDP growth and the displacement of other economic activities, for example:

- The potential global market size estimates of the metaverse (i.e., revenue) range from US$678.8 billion (Grand View Research) up to US$13 trillion (Citi GPS) per year by 2030.[2]

Other studies look to the potential impact on global- and country-level GDP growth, aiming to evaluate how GDP may change as a consequence of metaverse adoption and estimating the value of new output generated. For example:

- The potential GDP impact estimates of the metaverse globally range from US$1.5 trillion per year by 2030 (PwC) and US$3 trillion (Analysis Group) per year by 2031.[3]

Each estimation, and estimation approach, is accompanied by strengths and weaknesses. This is underscored by the uncertainty surrounding how the metaverse will develop, the adjacent assumptions required in such estimations, and the validity of such assumptions, which cannot be tested. Therefore, the aim of this analysis was to complement existing literature by developing estimates to understand the potential impact of the metaverse on global economic activity.

By using an alternate methodology, leveraging existing literature and data, it is hoped that this analysis can complement existing studies and provide another perspective onto the prospective impact of the metaverse.

Context and wider literature
For digital innovations such as the metaverse to develop and become available to enterprises and consumers on an international scale, investments will be required across a number of domains. This could include investments across various forms of ICT capital such as metaverse-specific hardware, computing and computing networks, supporting infrastructure and in less tangible assets such as software, databases and content creation. Therefore, to assess the potential impact of the metaverse, a wider review of the literature relating the impact of ICT capital to economic growth was undertaken.

A number of studies have attempted to quantify the relationship between various forms of ICT and economic output or growth to observe how changes in ICT impact economic growth. In this context, a large body of literature focuses on more discrete forms of ICT, digital technologies and connectivity, such as internet access, broadband penetration and mobile connectivity, consistently finding a positive relation with economic growth.[4] For example, looking at 21 OECD countries from 1970-1990,

1. See a summary of the S-Curve literature by Analysis Group, The Potential Global Economic Impact of the Metaverse, 2022
2. Grand View Research, "Metaverse Market Size, Share & Trends Report, 2030," accessed September 28, 2022; Citi GPS, "Metaverse and Money", accessed September 28, 2022.
3. PwC, "Seeing is believing", accessed September 28, 2022; Analysis Group, "The Potential Global Economic Impact of the Metaverse," accessed September 28, 2022.
4. Banerjee, Rappoport & Alleman, "A Cross-Country Analysis of ICT Diffusion, Economic Growth, and Global Competitiveness," accessed September 28, 022.

Roller and Waverman (2001) assessed the impact of telecommunication infrastructure on economic growth, finding elasticities ranging from 0.034-0.154%, indicating a 1% increase in telecommunication infrastructure was associated with a 0.034-0.154% increase in economic growth.[5] Similarly, in an analysis of broadband infrastructure and economic growth across 25 OECD countries in 1996-2007, Czernich et al. (2019) find a 1% increase in broadband penetration is associated with growth in annual GDP per capita in the region of 0.09-0.15%.[6] Katz & Callorda (2018) assessed the link between mobile broadband penetration and changes in GDP per capita across 139 countries between 2004-2017, estimating a per capita output elasticity of 0.150%.[7] The same study also constructed a digital index, consisting of indicators measuring connectivity, infrastructure reliability and affordability. Using this index within their analysis, they found that a 1% increase in the digital ecosystem index was associated with a 0.133% growth in per capita output.

Other papers have looked at output elasticities of ICT capital, focusing on the role of ICT capital's role as a factor of production, alongside labour and non-ICT capital inputs. These studies have consistently found that ICT has a positive impact on output and further has a considerable excess return compared to the income share of ICT. Academic literature assessing the link between ICT capital stocks or services have been conducted primarily focussing on the US, EU and across OECD countries. Such papers have found that a 1% increase in ICT capital is typically estimated to be associated with between a 0.03-0.14% increase in economic growth.

Analysing a sample of 59 countries over the period 1995-2010, Niebel (2014) estimates output elasticities of ICT capital services in the range of 0.066-0.100% employing a regression of an augmented Cobb-Douglas production function.[8] Similarly, Tsachtsiris et al. (2022) attempt to estimate the elasticity of ICT investments with economic growth across 27 countries within the European Union over 1996-2006, produced elasticities ranging from 0.087-0.139% depending on the model employed.[9]

Further, Venturini (2009) attempts to estimate the impacts of ICT capital from a long-run perspective across the US and 13 EU member states from 1980-2004 using a panel co-integration methodology. Elasticities varied according to the estimation model used returning elasticities from 0.056-0.138%.[10] Some studies have found more moderate estimates, however. Hanclova et al. (2015) assess 14 older EU member countries and 7 newer members across two time periods 1994-2000 and 2001-2008.[11] They find that the impact of ICT capital services was significantly higher (0.086%) amongst newer member states compared to older ones (0.031%).

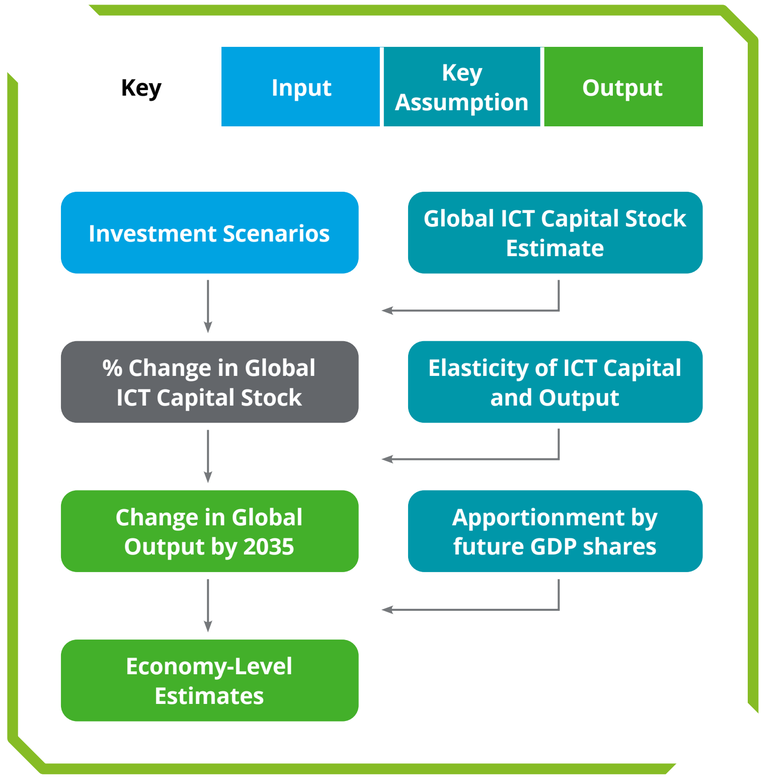
5. Roller and Waverman, "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach," American Economic Review 91, no. 4 (2001), p. 909-923
6. Czernich et al., "Broadband infrastructure and economic growth," CESifo Working Paper 2861, 2011.
7. ITU Publications, "The economic contribution of broadband, digitization and ICT regulation," accessed September 28, 2022
8. Niebel, "ICT and economic growth – Comparing developing, emerging and developed countries," World Development 104, 2018, p. 197-211.
9. Tsacgtsiris, Magoutas & Papadogonas, "ICT and Economic Growth in EU: A macro Level Comparison of Estimated ICT Output Elasticities," Journal of Global Information Technology Management 25, no. 3 (2022), p. 202-216.
10. Venturini, "The long-run impact of ICT," Empiricial Economics 37, no. 3 (2006), p. 497-515
11. Hanclova et al., "Does ICT capital affect economic growth in the EU-15 and EU-12 countries?," Journal of Business Economics and Management 16, no. 2 (2015), p. 387-406.

Method overview

A high-level outline of the methodology is given below, which puts together the economic literature on ICT and metaverse capital investment data, illustrated by Figure 1. Quantitative assumptions are noted within a subsequent section within Table 3, with each step detailed in greater depth in the following sub-sections.

- For economic impacts to materialize, sustained investment into developing and operationalizing the metaverse will be needed. Therefore, investment scenarios were developed from Goldman Sachs estimates.
- Assuming this investment contributes directly to the maintained net ICT capital stock (i.e., metaverse related IT hardware and equipment, software, databases etc.), the change in net ICT capital stocks can be calculated, with the total net ICT capital stock estimated using evidence from the OECD that this is c.7.3% of GDP on average.[12]
- Using the relationship between ICT capital and GDP from the literature, an elasticity of 0.1 used to find the resulting change in GDP can be derived from the calculated change in ICT capital stock. When calculating the impact of investment on GDP for a given year, the new uplifted GDP total from the previous year is fed in. This allows for the compounding of growth over time from the investments. A full derivation is given on page 119.
- Over the time period assessed, we assume this growth is additional to the existing growth path of the economy. Here, GDP growth in future years, in the absence of metaverse investment, is based on IMF forecasts until 2027 and then a fixed growth rate thereafter based on average historic growth rates using World Bank data, shown within Table 2.[13]
- Impacts are assessed up to and including 2035 at a global level. This was done to appreciate both short-run and medium-term impacts of short-term investments. A longer time horizon is not considered given uncertainty into the persistence of initial capital investments and whether this investment will be sustained, and at what level, over a decade from now.
- Economy-level estimates were generated by apportioning impacts across economies based on their share of global GDP, adjusted to account for changes in the composition of global GDP up until the end of the investment period in 2029.

Figure 1: Illustration of methodology



12. OECD, "STAN Database," accessed September 28, 2022. Then, for each year, the annual percentage change in the ICT stock resulting from Metaverse investments can be estimated.
13. Real GDP growth in future years, in the absence of the Metaverse-investment, is based on IMF forecasts until 2027 and then a fixed growth rate thereafter based on average historic compound annual growth rates (CAGR) over the period from 2009-2019 World Bank data on global GDP (measured in constant 2015 US dollars).

Investment Scenarios

In market research conducted by Goldman Sachs in 2021, illustrative scenario analysis of the likely spend on metaverse-related activities was undertaken.[14] This research estimated that investment in developing the metaverse could range from US$135 billion - US$1.35 trillion 'in the coming years', with the likelier scenario falling between US$135bn - US$700bn.[15] Subsequently in 2022, a report issued by McKinsey indicated investment in the metaverse was around US$57 billion in 2021 and in the first six months of 2022 had exceeded US$122 billion, suggesting that investment may be closer to the upper end of the prior Goldman Sachs estimates.[16] Using this information, two potential investment scenarios were investigated, shown in Table 1, with uniform investment profiles over the period of 2022-2029 assumed for simplicity.

Table 1: Investment Scenarios for the development of the metaverse

Scenario		Annualised Investment	Cumulative Investment if Sustained Until 2029
Base Case	US$700B over 5 years	US$140.0B	US$1,120B
Upside Potential	US$1,350B over 5 years	US$270.0B	US$2,160B

As investment figures were developed based upon public company investment in the metaverse and private market funding, these investment scenarios form a narrow view of metaverse-related spending. These figures do not consider investments such as public and private expenditure on infrastructure and connectivity. While these investments may support the development of the metaverse, they are not specific and unique to the metaverse. Thus, though such investments are likely, it is difficult to estimate what proportion of future ICT investment will contribute to the metaverse.

These findings are also subject to model specification, and if investment in the metaverse is higher or lower than assumed here, metaverse-related GDP growth would also be affected.

Estimating global net ICT capital

Data and literature pertaining to net ICT capital stocks is typically constrained given difficulties in measurement. However, datasets have been developed across selected country groups, such as EU and OECD countries. Using the OECD ISTAN Structural Analysis database, estimates for the ICT capital stock were developed with net ICT capital stocks equivalent to ~7.3% across available OECD countries from 2005-2017.[17] Extrapolating this estimate across global GDP, an estimate of global net capital stocks could be derived, taking 7.3% of global GDP, and estimated at around US$7,016 billion in 2021, for example.[18]

Global GDP, in the absence of metaverse investment, was calculated using IMF forecasts of real GDP growth from 2022 to 2027 and then a fixed growth rate thereafter based on average historic compound annual growth rates, shown within Table 2.[19] Similarly, counterfactual global net ICT capital stocks were assumed to follow a similar path, comprising 7.3% of GDP in each year of analysis.

Table 2: Counterfactual real GDP growth assumptions

GDP Growth Assumption	2022	2023	2024	2025	2026	2027	2028-2035
Year-on-year growth	3.6%	3.4%	3.4%	3.3%	3.3%	3.3%	3.16%

Note: Input assumptions used in this estimation such as GDP growth and metaverse investment scenarios are based on point in time forecasts from the literature. As such, these are subject to changes in the macroeconomic environment which may occur over time, and thus final metaverse impact estimates may be larger or smaller.

14. Goldman Sachs, Framing the Future of Web 3.0: Metaverse Edition, 2021.
15. Estimates were based on the market capitalisation rates of large technology firms, such as Meta, Google and Nvidia etc, and Meta's forecasted expenditures over the next 3 years (which is expected to form the largest source of investment).
16. McKinsey & Company, "Meet the metaverse: Creating real value in a virtual world," accessed September 28, 2022.
17. OECD, "STAN Database," accessed September 28, 2022.
18. Note Net ICT capital stocks were used as this gives an indication of the current value of ICT capital accounting for depreciation over time. Gross ICT capital stocks denote the current replacement value of ICT capital, equivalent in value if all ICT capital were to be bought again as new, which would likely give an inflated view of working capital stock value in comparison.
19. Real GDP growth in future years, in the absence of metaverse investment, is based on IMF forecasts until 2027 and then a fixed growth rate thereafter based on average historic compound annual growth rates (CAGR) over the period from 2009-2019 World Bank data on global GDP (measured in constant 2015 US dollars).

Calculating the impact of metaverse investment on global output

To analyze the impact of metaverse investment, an ICT capital-output is used given the broad nature of investments across different types of ICT capital. For our investigation, an ICT capital-output elasticity of 0.1 is taken, with this point estimate forming the midpoint of elasticity estimates produced by Venturini (2009) looking at the long-run return of ICT capital. Whilst the precise impact of metaverse investments cannot be determined given newer technologies being capitalized, this literature gives the best indication of the relationship between ICT capital and economic growth, to date.

The percentage change to global net ICT capital stock was estimated using annualized investments across both investment scenarios. It was assumed that spending in the metaverse would contribute directly to global net ICT capital stocks. Accordingly, the contemporaneous impact on global output could be derived through multiplication with the elasticity for each year of investment, assumed to take place from 2022-2029 (forming δ_t in Equation 1 and Equation 2, below).

The impact of subsequent investments was calculated using the 'new' level of net ICT capital stocks, equivalent to the sum of counterfactual capital stocks in a given year and additions to the stock of capital arising from prior years' investment less depreciation of metaverse-related capital. By viewing investments on an annualized basis, subsequent investments serve to compound changes to GDP from prior years' investments. Growth arising from the additions to the capital stock are assumed to be additive to the existing growth path of the economy.

Using this methodology, the impact of metaverse investments across years can be calculated accordingly. Letting r_t equal the natural assumed growth rate of real GDP in year t, δ_t equal the additive growth arising from metaverse investment in year t (equal to the percentage change in capital stock multiplied by the elasticity of ICT capital and output).[20] Therefore, the share of GDP attributable to the metaverse can be expressed as:[21]

Equation 1: Derivation of GDP impact as a percentage of GDP[23]

$$\text{GDP impact by end of 2035 (\%)} = \frac{\prod_{t=1}^{14}(1 + \delta_t + r_t) - \prod_{t=1}^{14}(1 + \delta_t)}{\prod_{t=1}^{14}(1 + \delta_t + r_t)}$$

This could also be expressed in today's money. If GDP_2022 represents the value of GDP in 2022, the first year of investment, the dollar contribution to GDP of the metaverse by the end of 2035 can be expressed as:

Equation 2: Derivation of GDP impact in dollars, in a given year

$$\text{GDP impact by end of 2035 (\$)} = GDP_{2022}\prod_{t=1}^{14}(1 + \delta_t + r_t) - GDP_{2022}\prod_{t=1}^{14}(1 + r_t)$$

Note that this is equivalent to calculating the difference between the counterfactual GDP (GDP in the absence of metaverse investment) and GDP calculated with metaverse investment, at the end of 2035.

Generating economy-level estimates

The prospective impact of metaverse impacts on GDP were apportioned to economies using re-weighted shares in total global GDP. Reweighting of global GDP shares was achieved by using the compound annual growth rate (CAGR) of respective economies' real GDP over the 2009-2019 period. This was done to appreciate likely changes in the composition of global GDP by the end of the investment period under investigation (up to 2029), due to the faster growth of middle- and lower-income economies that will likely grow in contribution to GDP over time.

Discussion

Under the two investment scenarios investigated, estimates suggest that by the end of 2035, the metaverse could contribute US$1.90 trillion-US$3.59 trillion to global GDP. This is estimated to be between 1.3-2.4% of global GDP in 2035 This is relating to a cumulative impact of US$26 trillion-US$50 trillion when summed up across years from 2022.

It should be noted that the scenarios considered also take a conservative view of the likely investment in the metaverse by looking at spending that is likely to arise from large technology firms in the development of metaverse platforms and technologies. As a result, such scenarios are useful to consider potential additions to the capital stock and the corresponding impact on economic growth, but does not necessarily consider wider, or longer term, investment that may take place across a number of wider domains such as in communications, connectivity and underlying infrastructure (e.g. investment in 5G network infrastructure).

20. Additive growth is equal to 0 after 2029, the final year of investment in each scenario assessed.
21. This follows the accounting approach followed within the Analysis Group estimates.
22. Note the share of GDP, as a percentage, after a given number of years, does not depend on the precise year of when investment begins. World Bank, World Development Indicators

Image Credits: StarryAI

Whilst an attempt has been made to estimate economy-level results, such impacts should be treated as illustrative of the potential impacts based upon the size and contribution of that economy to global GDP. The total impact of the metaverse will be highly dependent on several factors ranging of socioeconomic determinants and enablers. For example, the extent a given economy's infrastructure enables the adoption and integration of the metaverse will determine how the metaverse will be used across sectors. In addition, the affordability and accessibility of the metaverse to inhabitants within that economy are important factors to consider.

Table 3: Overview of key quantitative assumptions used within the economic modelling

Assumption	Value	Source
Global GDP in 2021	US$96T	World Bank, World Development Indicators [23]
Global GDP shares, real GDP growth rates	-	World Bank, World Development Indicators
ICT Investment Scenarios	US$135B-US$1,350B	Goldman Sachs [24]
Global Net ICT Capital Stock	7.30%	Analysis of OECD countries using the OECD ISTAN Database[25]
Elasticity of ICT Capital and Economic Output	0.1	Venturini (2009); Tsachtsiris, Magoutas & Papadogonas (2022).[26]

23. World Bank, "World Development Indicators," accessed September 28, 2022.
24. Goldman Sachs, Framing the Future of Web 3.0: Metaverse Edition, 2021.
25. OECD, "STAN Database," accessed September 28, 2022.
26. Venturini, "The long-run impact of ICT," Empiricial Economics 37, no. 3 (2006), p. 497-515; Tsacgtsiris, Magoutas & Papadogonas, "ICT and Economic Growth in EU: A macro Level Comparison of Estimated ICT Output Elasticities," Journal of Global Information Technology Management 25, no. 3 (2022), p. 202-216

Appendix C - Glossary of Terms for the Three Enabling Pillars of the Metaverse

Macroeconomic determinants. The maximum opportunity offered by the metaverse will vary across regions depending on the structure of the economy and the level of development.

Sectoral Structure: An economy characterised by advanced, digital sectors that can benefit from and engage in the metaverse, will likely reap a bigger economic opportunity following the development of the metaverse. On the other hand, economies which are characterised by primary sectors will likely see limited economic impact brought about by the metaverse in the shorter term. Economies which are manufacturing-dependent will likely be impacted in the longer-term but the extent is currently unknown.

Innovation Environment: The propensity for innovation within an economy indicates the extent to which the metaverse can add value in novel ways and will be built upon, impacting the upper bound of the potential opportunity. In this case, innovation is taken as an inherent characteristic of a country. However, adoption of the metaverse may impact on the culture of innovation.

Income and Distribution Level: The economic development, income level and income distribution of a region could determine the impact of the metaverse. High-income economies where the majority of the population can afford the hardware required to access the metaverse and with relatively even income distribution will likely experience a significant economic impact. In contrast, low-income regions or regions where income inequality is relatively high and the relative cost of accessing the metaverse is much higher will likely see a much lower impact on the economy.

Technology fundamentals. It consists of factors that are required for the metaverse to exist and operate. Notably, these fundamental factors do not necessarily guarantee or contribute to the success of the metaverse, but their totality presents a minimum set of requirements that will allow the metaverse to exist in a given economy or region. As expected, some proxies for these fundamentals include compute power, connectivity, and number of user devices. Other markers include the prevalence of digital payments which provide a sensing of the ability for the digital economy to flourish.

Compute Power: Computing power to support diverse and demanding functions such as data reconciliation and synchronization, motion capture, rendering, calculations etc. is considered essential for the metaverse to function.

Connectivity: Reliable and constant connectivity such as 5G/6G or WiFi networks and fast fixed broadband are essential to allowing real-time interactions and transactions and in facilitating fast, high volume and low latency data exchange across different settings.

User Devices: The development of physical technologies and devices such as VR headsets, mobile phones, sensors, long lasting batteries, etc., that are used to access and interact with the metaverse.

Transactions: The availability of digital payment processes, platforms and operations including digital currencies based on blockchain technology such as bitcoin, is essential in order to support financial transactions in the metaverse. The possibility to participate in a financial transaction and own a digital asset such as NFTs would help the platform replicate the real economy and the incentives that encourage transactions.

Ecosystem enablers: Factors where an economy can invest in or develop to build a supportive ecosystem to promote the development of metaverse technologies. As the metaverse develops in an economy, its success will depend on the actions of various ecosystem stakeholders including businesses (startups and industry), government (regulators and policymakers), researchers, telecom operators/ technology sector and users and the general public.

Security and Privacy: The metaverse will involve the transfer of large amounts of data, including confidential and personal data. Appropriate systems and regulations should be in place to provide users with protection as increased risk of data breach, identity theft or storing of data without consent could discourage consumers from using the metaverse. Nevertheless, existing regulatory frameworks might have not been designed for the metaverse specifically, therefore might not cover the metaverse in full.

Competition within the metaverse: A thriving metaverse is one that includes many players competing in the product, service or experience they offer to consumers or other businesses/platforms engaged in the metaverse. With the arrival of the metaverse, this competition may be driven by new start-ups and enterprises developing products, services and experiences. Therefore, the existing start-up ecosystem can be used as a proxy for the level of competition that may potentially be expected in the metaverse at an economy level.

Technological Readiness of Business: A strong digital business culture where businesses are open to technological change and have the capacity to absorb technologies could accelerate the uptake of technologies supporting the metaverse and therefore improve efficiency and encourage engagement.

Digital Skills: Engagement in the metaverse requires users to have the necessary digital skills in order to benefit from the applications and the various functions offered in the metaverse. If a large portion of the population is digitally illiterate, the full potential of the metaverse might not be realized.

Interoperability: Interoperability in the metaverse would allow users to move seamlessly to different settings and transfer real time data so that their experience is optimized and resembles a real-life setting. The interoperability of the platform would make the metaverse more efficient and potentially enhance the impact and could encourage wide adoption by both businesses and consumers.

Accessibility: The metaverse aims to be a widely accessible and inclusive space, connecting people from around the world. Accessibility could be facilitated through lowering barriers to entry such as the cost of equipment and hardware relative to income levels, limited access to the internet and and level of digital skills.

Social Acceptance: High social acceptance and willingness to try the metaverse may encourage widespread adoption by businesses and consumers, creating strong network effects that could accelerate adoption and innovation.

Deloitte.

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