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Global Expert Mission
Global Technology Report
Immersive Technologies in Korea

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BCCK
BRITISH CHAMBER OF COMMERCE IN KOREA

This report has been prepared by the British Chamber of Commerce in Korea (BCCK), a non-profit member-based organisation which acts as the exclusive service delivery partner for the British Government's Department of International Trade (DIT) in supporting British businesses to enter the Korean market.

The Chamber has been supporting British businesses for over 30 years. The BCCK has a full-time team of 13 bilingual employees in Seoul with in-depth knowledge of multiple sectors and the business dynamics which operate within them. They have a network of contacts that includes 4,000+ people such as buyers, distributors, agents as well as senior executives and potential customers.

The BCCK has worked with a range of companies which include start-ups to multinationals from a number of different sectors such as that of consumer products, retail, e-commerce, automotive, energy, healthcare, electronics and telecoms.

For more information, visit our website http://www.bcck.or.kr or email trade@bcck.or.kr

Innovate UK

Innovate UK is the UK Government's innovation agency. It works with people, companies and partner organisations to find and drive the science and technology innovations that will grow the UK economy. It is an organisation of around 400 staff, drawn mainly from business. It works across the UK, with a head office in Swindon.

It has a strong business focus, and it drives growth by working with companies to de-risk, enable and support innovation. To do this, it works to determine which science and technology developments will drive future economic growth, meet UK innovators with great ideas in the fields it's focused on, fund the strongest opportunities, connect innovators with the right partners they need to succeed and help its innovators launch, build and grow successful businesses.

Since 2007, it has committed over £1.8 billion to innovation, matched by a similar amount in partner and business funding. It has helped more than 7,600 organisations with projects estimated to add more than £11.5 billion to the UK economy and create 55,000 new jobs.

AUDIENCE OF THE FUTURE

The Audience of the Future Challenge Fund has invested £39.3 million in the development of new immersive technologies such as virtual, augmented, and mixed reality; as well as haptics, sonics and other sensory interfaces. The programme has also commissioned research to better understand audiences for immersive productions in the fields of art, culture, heritage, and entertainment.

The 'Audience of the Future' Challenge has invested in:

- A Demonstrator programme of immersive experiences, covering four main entertainment sectors: e-sports and gaming, performance, moving image, and visitor experience
- Production Innovation for Immersive Content: projects creating faster, more efficient immersive content
- An Immersive Technology Investment Accelerator to support early-stage businesses
- Design Foundations support for projects exploring human-centred design
- StoryFutures Academy, a new national centre for immersive storytelling.

Internationally, 'Audience of the Future' represents one of the largest targeted Research and Innovation programmes in immersive technology and experiences.

Contents

Executive Summary

Korea's immersive technology sector has seen a compound annual growth rate (CAGR) of 33% from 2013 to 2019

Worth £2.4 billion in 2019, Korea's immersive technology sector has grown at pace since 2013. Supported by strong information and communications technology (ICT) infrastructure and domestically-based global hardware original equipment manufacturers (OEMs), the sector has seen most growth in terms of its hardware segment. Whilst its software segment is substantially smaller, private and public investment is helping to spur its growth.

Government private/public committee created to drive immersive technology innovation to globally leading levels

An inter-governmental department coalition named the 5G+ Strategy Committee is in the midst of executing its 2019-2023 Immersive Technologies Roadmap, which will lead to a total investment of £847 million. The roadmap provides serious investment to support the advancement of holography and content production technologies as well as greater support for the formation of a strong ecosystem of innovation through services provided by designated regional virtual reality (VR) and augmented reality (AR) production centres.

Private investment channelled into early-stage technology to support full commercialisation

Research and development (R&D) partnerships between conglomerates, small and medium-sized enterprises (SMEs) and research institutions to commercialise innovative immersive technology solutions and products are seeing wider applications in training, manufacturing and engineering, gaming, and healthcare industries. Regulatory reforms to relax once stringent regulations on the application of these technologies are further supporting strong growth in these areas.

Once domestic-only in mindset, Korean SMEs are starting to pursue international opportunities

Korean conglomerates have been active in signing partnerships with global technology companies such as Google and Microsoft. However, SMEs, which make up the majority of companies in this space, have been slow to explore international opportunities. Recent success stories such as Meddiction's, a VR-based health treatment start-up, partnership with Harvard Medical School in 2018, however, have helped to encourage others to follow suit.

Background, Objectives and Research Scope

Innovate UK is increasing the volume and value of its international programmes as part of an active internationalisation strategy focused primarily at the country and sector level in order to more effectively and efficiently support UK companies.

Amongst the sectors of interest are immersive technologies such as virtual reality (VR), augmented reality (AR) and mixed reality (MR) which will fundamentally change products and services over the next twenty years and transform how we experience the world. The UK, a leader in elements of this technology, needs to seek out new audiences, partnerships and markets which will support its further growth in this innovative space.

The British Chamber of Commerce in Korea (BCCK), on behalf of Innovate UK, was commissioned to write a Global Technology Report on immersive technology innovation in Korea ahead of Innovate UK's Global Expert Mission (GEM) in quarter two of 2020. This research focused on determining the areas of immersive technology where Korea is a global leader, the role of private and public support in forging innovation, the link between research and development in universities and the strength of the start-up environment. The aim of the report is to isolate and show the areas of possible collaboration between the UK and Korea.

Research Scope

- Study the wider development of immersive technology innovation in Korea.
- Identify how government support for innovation in these sectors operates and its effect.
- Collect and analyse market, research and innovation level data in relation to the above.
- Identify opportunities for bilateral cooperation with Korea regarding business innovation, funding/investment and supply chain integration.
- Identify potential areas of focus for future Innovate UK international missions.

Methodology and Definitions

The BCCK conducted market research through a combination of desk research, phone calls and in-person semi-structured interviews with industry stakeholders and experts from both the private and public sectors. Desk research utilised publicly available information, including news articles as well as government data and reports.

Definitions

The following definitions were used in this report:

- Immersive technologies: An umbrella term for virtual, augmented and mixed reality.
- Virtual reality (VR): Closed and fully immersive three-dimensional environments.
- Augmented reality (AR): Open and partially immersive environments that allow digital objects to be overlaid onto the physical world.
- Mixed reality (MR): Blending physical and virtual worlds to produce new environments and visualisations where physical and digital objects co-exist and interact in real time.
- Haptic communications: Technology creating the experience of touch.

1. South Korea's Digital Economy

According to the United Nations International Telecommunication Union (ITU), Korea is the most connected country in the world with 95% internet penetration, 98% smartphone ownership and 85% social media usage with local platforms such as Kakaotalk having a market share of 86% and almost 80% of people making online purchases which total £73 billion annually.

To date, Korea's digital economic growth has been driven by world-leading electronics companies such as Samsung and LG Electronics, as well as Korea's three mobile carriers; SK Telecom (SKT), Korea Telecom (KT), and LG U+ which dominate the ecosystem.

However, in recent years, smaller and medium-sized companies such as Virnect and Meddiction are also driving investment and innovation in the space.

The Korean government sees the Fourth Industrial Revolution, particularly the areas of artificial intelligence (AI), virtual reality (VR), 5G mobile networks, Internet of Things (IoT) and data analytics, as the way Korea can become a future global digital leader.

In 2018 Korea's digital economy was worth £127 billion.

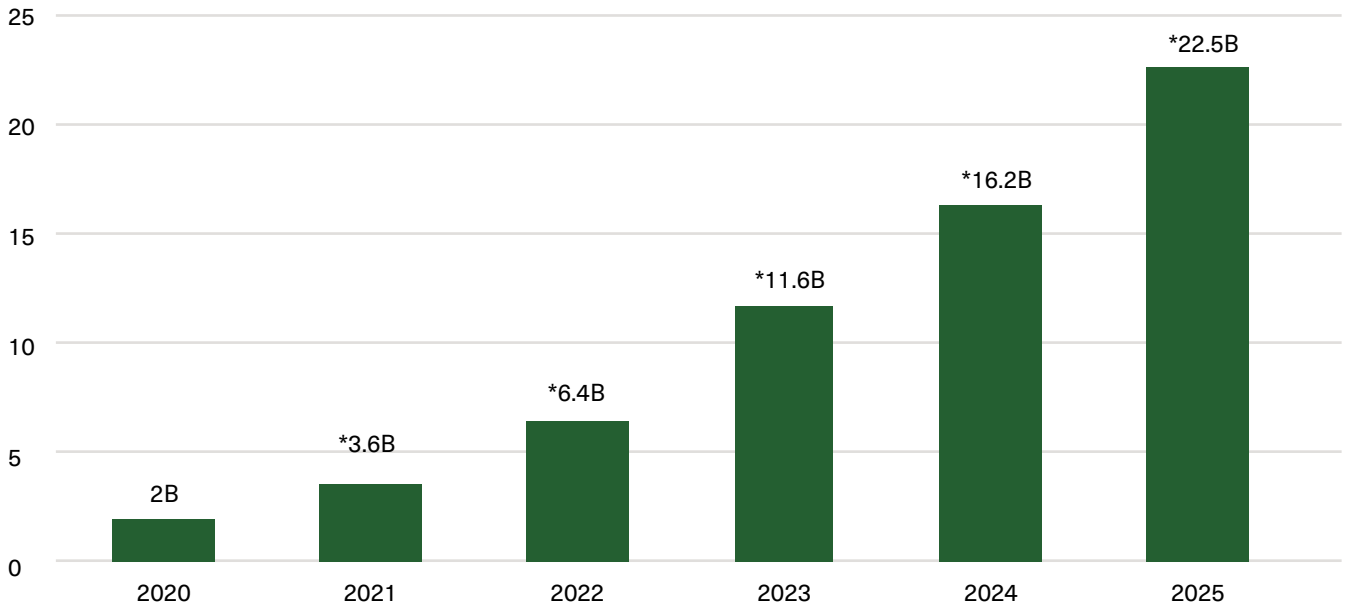
Key Digital Economy Indicators

Population	51 million*
GDP	1,531B GBP (11th globally)*
GDP Per Capita	29,745B GBP (20th globally)*
Urbanisation Rate	84%*
Key Industries	5G, IoT, Cloud Computing, Fintech**
Internet Pernetration Rate	95%**
5G Users	4.7 million**
Mobile Banking Usage Rate	66%**

**Source: Bank of Korea **Source: Data Reportal*

Korea 5G Market Size

*Source: KT Institute for Economic Management (*Predicted)*
All figures are in GBP



1.1 Areas of Advancement

5G Technology

Korea's 5G technology market is worth £2 billion with its value expected to triple by 2022. Korea's three mobile carriers, SKT, KT, and LG U+, simultaneously launched limited 5G services in April 2018 in major cities in Korea and, by December 2019, accumulated 4.7 million users.

Despite the early deployment of 5G in the market, customers have expressed dissatisfaction with the coverage, speed and stability of the network. In response, the Korean government has committed to reaching a 5% 5G penetration rate by the end of 2020. By 2026, it is estimated the country will have full 5G penetration and that 90% of smartphone owners, 39 million people, will use the network.

Samsung Electronics, a relatively smaller player in the network equipment market with a 6.6% global market share, has emerged as a leading player in 5G. Able to provide telecoms companies with a complete end-to-end service which includes network equipment, chipsets and smartphones, the company has a stronger value proposition than some competitors.

Cloud Computing

In 2019, Korea's cloud market was worth £1.6 billion, a rise of 22% from the previous year. Of the total value, Infrastructure-as-a-service (IaaS) is 37.9%, Software-as-a-service (SaaS) 32.2%, cloud software 26.6%, cloud hardware 3% and Platform-as-a-service (PaaS) 0.1%. With only a 13% penetration rate, Korea's cloud market presents opportunities for both international and domestic players.

Dominant foreign cloud computing companies, such as Amazon Web Services (AWS) and the in-house system integrator arms of conglomerates such as Samsung SDS and LG CNS, have been developing multi-cloud systems in their affiliates' servers by adopting and merging both their in-house servers and those of AWS to offer new systems. These companies have ambitious plans to increase cloud usage of their affiliates to over 90% by 2023.

Artificial Intelligence (AI)

In 2018, Korea's total AI market size was worth £36 million, while that of the US was £590 million, the UK £243 million, and China £154 million. Despite its relatively smaller market size, Korea's strength lies in AI chips which are manufactured by Samsung Electronics and SK Hynix. To cement its already strong position in the chip market, Korea is developing memory chips to build into new semiconductors capable of 25 times the processing speed and just one-thousandth the power consumption of existing integrated circuits. This development will be aided by government investment into AI-related R&D, which will total £653 million in 2019.

Market Share By Service Stream

Rank	IasS	PaaS	SaaS
1	AWS (51%)	Microsoft Cloud (18%)	SAP (9%)
2	KT (20%)	AWS (13%)	Microsoft Cloud (9%)
3	LG U+ (3%)	Oracle (10%)	Douzone (5%)

In addition to investment, the government plans to increase the number of AI-trained engineers in Korea to 5,000 (1,400 researchers and 3,600 data management specialists) by 2022 by establishing six AI dedicated graduate schools.

Smart Cities

Eighty-four per cent of the population of Korea live in cities – a higher proportion than in both the US and the UK which have an 80% urbanisation rate, and far beyond the global average of 54%. As such, the Korean government sees the development of smart cities as necessary to solve problems arising from rapid urbanisation.

The government has created two flagship smart cities projects in Busan, Korea's second-largest city, and Sejong, the administrative capital of Korea, in which all government ministries are situated. Both cities will adopt 5G technology, utilise big data, robotics and AI to improve the delivery of public services. Private-public funding for the projects has already totalled £2.5 billion. The ultimate aim of the government is to export its smart cities know-how to developing countries.

Fintech

In 2018, according to the Bank of Korea, the total volume of payments facilitated by simplified mobile payment services reached £43.4 million, up 158% from 2016. In terms of fintech activity in Korea, payment and transfer accounted for 32% of all applications followed by techfin 25%, lending and credit 24%, wealth management 16%, and insurtech 3%.

There has been a big push by the government to liberalise regulation in this space. Exemplifying this, in 2019, the Financial Services Commission (FSC) eased regulation on how companies authenticate customers, legalised crowdfunding and virtual banking. It also plans to license more online banks. The country has two online banks - Kakao Bank and K-Bank - run by Kakao Group, which is Korea's largest social media company and KT, the telecoms company.

Today, there are more than nine million daily users of mobile banking services in Korea, with a digital banking penetration rate of 99% (the highest in Asia). It is very common today for Koreans to pay their bills, access their banks, and shop online through their smartphones using local service providers such as Kakao Pay, Payco, Samsung Pay, Toss, and Naver Pay.

1.2 Mobile Infrastructure

Telecoms

SK telecom kt LG U+

Handset OEMs

SAMSUNG LG Electronics

System Integrators

SAMSUNG SDS LG CNS

1.3 Local Digital Service Providers

e-Commerce Platforms

WEmakePRICE
coupang
11

Taxi Hailing Services

T map taxi
kakaoT

Internet Search Engines

NAVER

Online Banks

kakaobank

2. The Market

2.1 VR and AR: Overview

Primarily powered by its virtual reality (VR) and augmented reality (AR) segments, Korea has risen to become one of Asia's and the world's leading immersive technology markets. Spurred by both private and public initiatives, the market has been growing at a CAGR of 33% since 2013 and is now worth £2.4 billion. Its value is set to be worth £3.7 billion by the end of 2020.

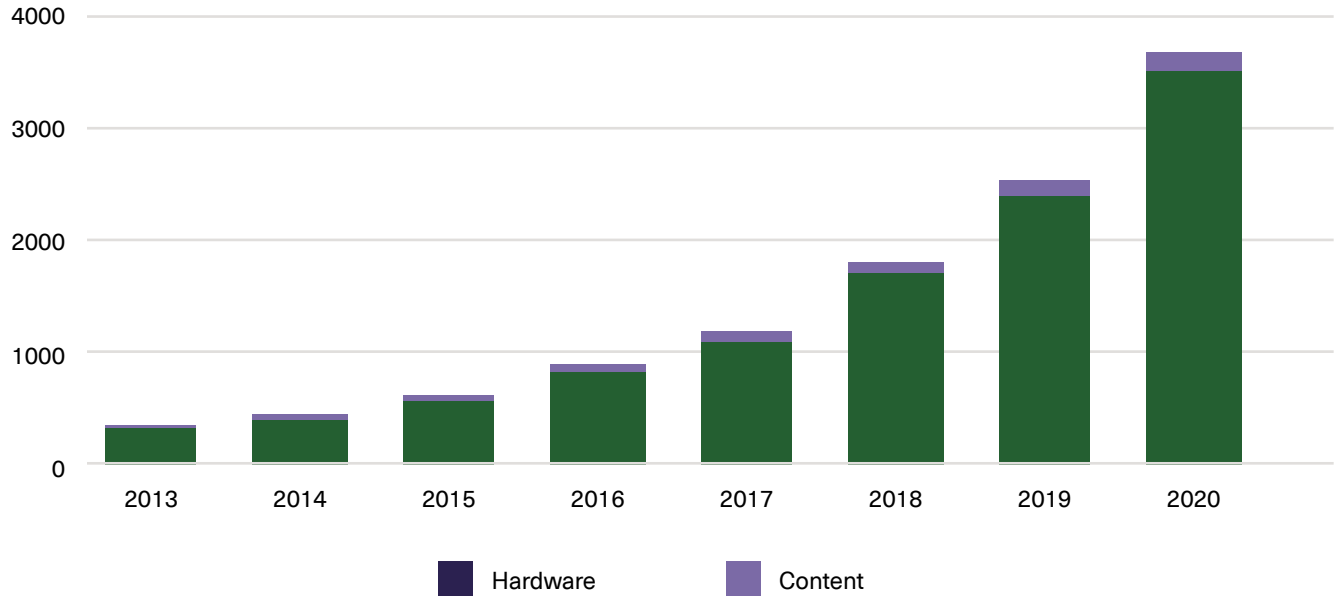
Korea, home to two of the world's largest consumer electronics OEMs, Samsung Electronics and LG Electronics, has led the development of hardware with Head-Mounted Displays (HMD), displays and the optic technology within them and their flagship products, but lags behind other markets such as the United States (US) in the development of components such as sensors and cameras.

In terms of software and content production, as with other advanced markets such as the US, the Korean market is driven by SMEs which account for 92.3% (72) of the total number of companies in the area and generated revenues of £29.6 million (96.5%) in 2018. In a bid to support the growth of these SMEs, plans are underway by the government to add four new regional VR/AR Content Creation Centres to the existing ten centres nationwide.

Outside of SMEs, larger companies such as Korea's three telecoms companies have aggressive investment strategies for immersive technologies. LG U+, for example, plans to invest £1.6 billion between 2020 and 2023 on content production which may change the landscape dramatically.

Korea 5G Market Size

Source: Ministry of Science and ICT
All figures are in GBP



	2013	2014	2015	2016	2017	2018	2019	2020	CAGR ('13~'20)
Hardware	325M	397M	572M	824M	1.1B	1.7B	2.4B	3.5B	40.6%
Content	33M	42M	54M	68M	87M	111B	141M	180M	27.3%
Total	358M	439M	626M	892M	1.1B	1.8B	2.5B	3.7B	

The public sector is also supporting growth in immersive technologies. Government-led initiatives have been active since 2017 when immersive technologies was designated as one of the thirteen technology areas it wants to drive growth in the country's high-technology industry. This includes the launch of the country's 5G network on April 3, 2019, just a matter of hours before the US.

The consistent and reliable high-speed, low latency has hastened the development and application of VR/AR and, now more frequently, MR and haptic technology.

Further to this, in 2017, the government designated three ministries (Ministry of Science and ICT; Ministry of Trade, Energy and Industry; Ministry of Culture, Sports and Tourism) to support research and development, incubation and acceleration of new technologies coming out of Korean SMEs. The national target is to achieve £1 billion in revenues from 100 SMEs by 2022.

In 2019, the Korean government announced plans to spend £844 million by 2023 on immersive technologies and support the training of 5,550 experts in related fields. It also stated its intention to grow the market to a value of £13 billion, of which £3.2 billion would be derived from exports, and ultimately achieve a global market share of 5% by the same year.

Head-Mounted Displays (HMD)

With only 950,000 units sold in 2018, the penetration of HMD technology is still relatively low, but it is expected to grow as 5G expands. To tap into demand, in November 2019 SKT, signed an agreement with Facebook to be the exclusive distributor of Oculus Go in the market.

As well as Samsung Electronics, which released its Gear VR and Odyssey in 2017, telecoms companies have also been bringing new devices to the market. For example, designed as a more mass-market and affordable alternative to the Gear VR, KT rolled out its stand-alone HMD device Super VR in 2019 using Pico G2 devices with 818ppi screen resolution.

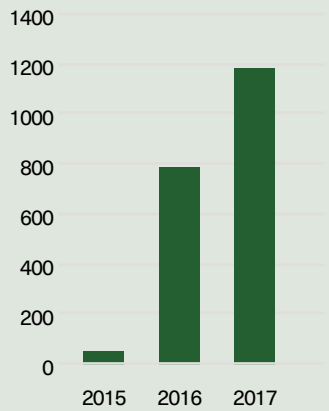
Display and Optics Technology

Korea leads the world in display and optic technologies represented by organic light-emitting diodes or OLED, a key component of HMDs and smart glasses. Korean OEMs own over 90% of the patents for these technologies. To further strengthen its dominance in display technology, the Korean government will invest £537 million by 2025 to support R&D in next-generation OLED display technology and advancement of display manufacturing processes to reduce 50% of production cost. Ultimately the government wants Korea's display industry to take 70% of the global market share by 2025, up from 50% in 2019.

While Korea has expertise in vision/eye-tracking software technology, it relies heavily on foreign VR/AR sensors (hardware) and HMD devices as it imports 90% from overseas.

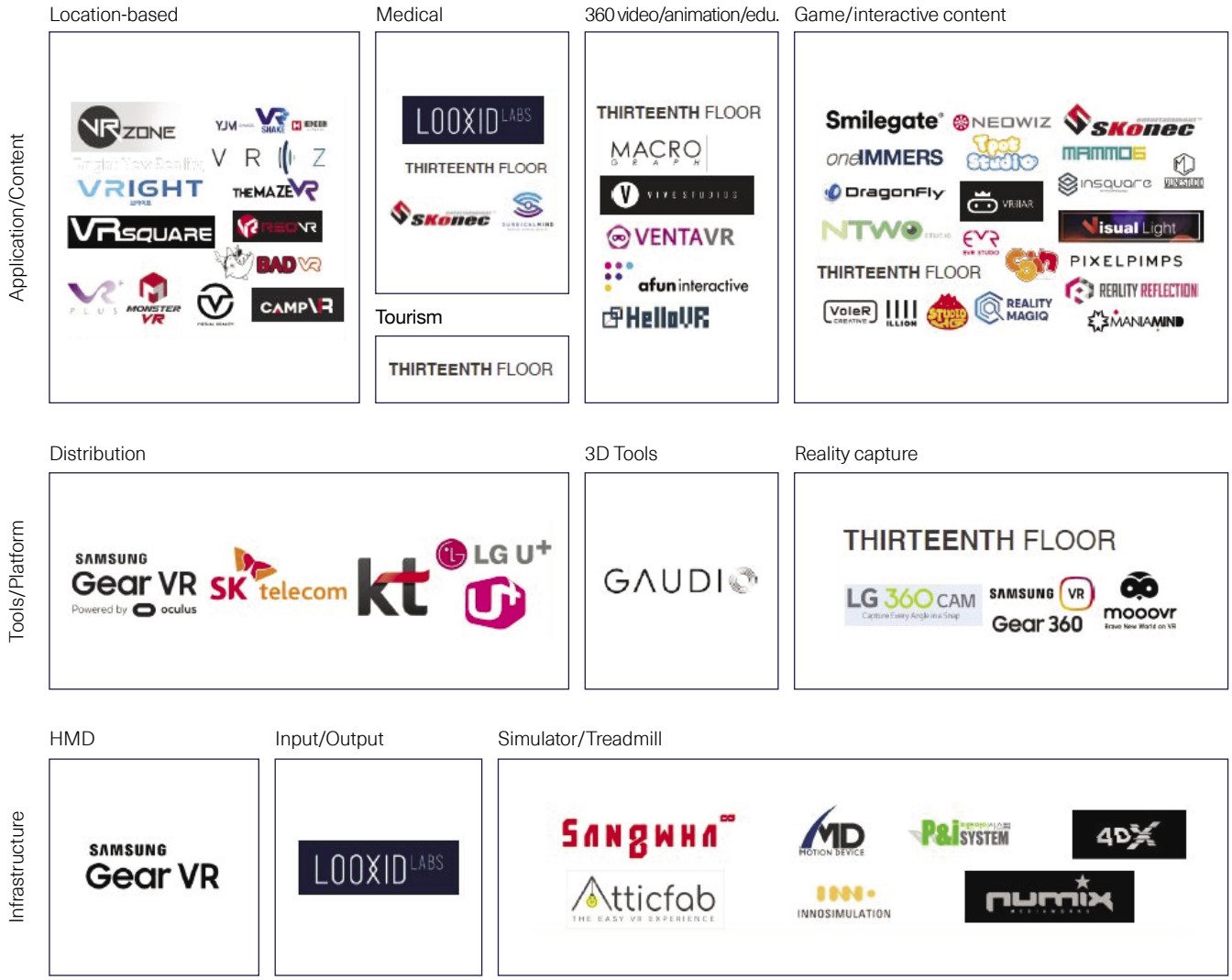
Korea's VR/AR HMD Market

Global VR/AR HMD Market



Source: Ministry of Science and ICT
Unit: Million

VR/AR Ecosystem



Source: Thirteenth Floor

2.2 Mixed Reality: Overview

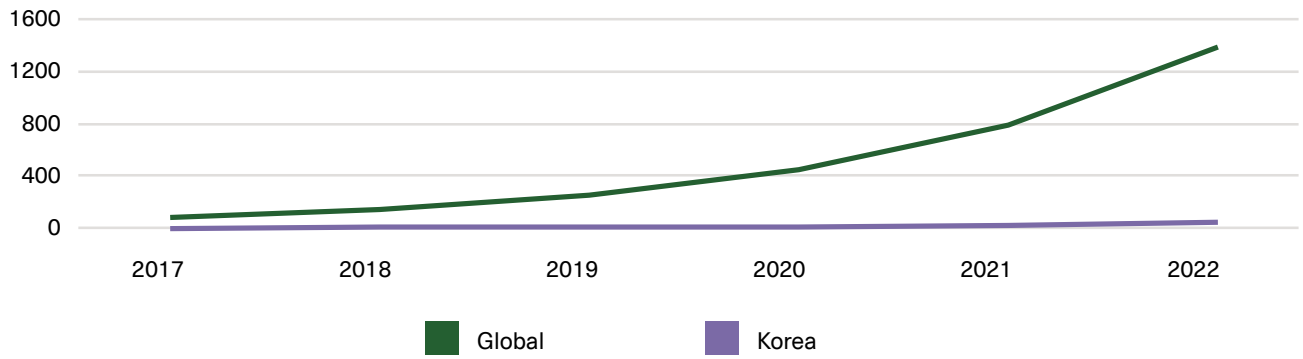
Korea's share of the global mixed reality (MR) market was 3.6% in 2018, worth £5.3 million. Samsung and LG are significant contributors to the market through the manufacturing of OLED displays for HMDs, while a number of SMEs contribute through content production. With the launch of the Samsung HMD Odyssey in 2017, and LG's plans to develop its own device by 2020, various companies in the immersive technology space are developing solutions for application in areas such as entertainment, healthcare and retail.

Efforts are being put into developing MR content by companies such as SKT, which announced its new partnership with Microsoft to build Asia's first Mixed Reality Capture Studio to create volumetric videos by Spring 2020.

Holography is also a key area in which the Korean government has vowed to invest £117 million from 2020 to 2027 to support R&D. This investment is aimed at nurturing homegrown companies in this space and involves forming a hologram cluster in southwestern Jeolla province. Companies such as Hyundai Motors, in partnership with a leading Swiss hologram company, WayRay, announced plans to commercialise holographic AR navigation systems in its cars manufactured from 2020.

Global v Korean Mixed Reality Market Size

Source: Ministry of Science and ICT
Unit: Millions



Unit: GBP

Year	2017	2018	2019	2020	2021	2022
Global	85M	149M	256M	448M	790M	1.38B
Korea	3M	5.3M	9.5M	16.4M	28.8M	50.5M

Significant Players in MR

Hardware	
SAMSUNG	QODE INTERACTIVE
HMD Odyssey	MRI and AI-based gaming platform

Software	
DoubleMe Holographic Mixed Reality Experiences!	EMOTIONWAVE
3D Capture system	Web 3D MR for entertainment
VUTIC	TEKTON SPACE
MR Solutions	MR Educational content
TIM3D	.mill
MR Service developer	MR Content for entertainment

3. The Governmental Approach - Initiatives: Overview

The 2019-2023 Immersive Technologies Roadmap

In 2017, the Korean government designated immersive technologies as one of the thirteen technology areas it wants to drive growth in the country's high-tech industry and set ambitious targets. The responsibility of achieving these targets was given to three government ministries: the Ministry of Science and ICT (MSIT) was charged with the development of enabling technologies and application areas, the Ministry of Culture, Sports and Tourism (MCST) the supervision and support of content production particularly in the entertainment, sports, and tourism sectors, and the Ministry of Trade, Industry and Energy (MOTIE) was tasked to provide support for technologies related to VR/AR/MR devices.

As a follow up to this initiative and after the roll-out of 5G in 2019, the government formed a broad coalition of relevant ministries and private sector companies to enable the development of new technologies in different application areas. The coalition was made up of nine ministries and twelve major conglomerates as well as experts, which is named the 5G+ Strategy Committee. Through this committee, the government plans to invest a total of £847 million.

Targets for 2023

Domestic production
£13 billion
(£783 million in 2017)

Companies of
£32 million revenue
100
(17 in 2017)

Export
£3.3 billion
(£19.5 million in 2017)

2019-2023 Immersive Technologies Roadmap: 4 Major Initiatives

1. Run Large-scale Projects

- Prioritise the introduction of immersive technologies in education and training.
- £118 million of funding to introduce VR/AR technology and devices in public spaces such as museums and galleries. For example, the use of AR/MR to display restored historical artefacts.
- Imbed immersive technologies in military training and war simulations.
- Distribute VR/AR fitting devices in Dongdaemun, Korea's largest shopping district.

2. Infrastructure and Advancement of Core Technologies

- Support the development of core technologies such as plenoptic and five senses information processors in the short-to-mid-term and ultimately in holography.
- Develop the largest immersive technologies content creation studio inside Korea as well as a VR/AR complex and hologram development centre in Seoul.
- Open four new regional VR/AR Content Creation Centres in addition to the existing ten centres nationwide.

3. Support for Industrial Growth

- Subsidise promising start-ups by running 5G Content Flagship Challenges using immersive media (360 multi-view video), immersive communication (VR social media, MR business meetings, and immersive life [VR travel]).
- Create funds for start-ups and export-centric companies. Export 5G content experiential pop-up spaces to the US, China, Vietnam and Indonesia.
- Help form a consortium of conglomerates and SMEs developing content and devices to attend Mobile World Congress (MWC), the Consumer Electronics Show (CES) and other prominent trade shows.

4. Support for Development of Ecosystem

- Train 5,550 specialists in VR/AR.
- Reform regulations that hinder the introduction of new technology. For example, KFDA regulation on medical devices.
- Establish an ICT regulation sandbox for healthcare and defence.
- Designate regulation-free zones for industrial hubs such as the Jeolla-Buk Hologram Technology Regulation Free Zone.
- Organise and hold VR/AR trade shows and fairs.

2019-2023 Immersive Technologies Roadmap: Committee Structure

Central Government Ministries (9)	Private Sector Companies and Experts
Ministry of the Interior and Safety	SK telecom
Ministry of SMEs and Start-ups	kt
Ministry of Land, Infrastructure and Transport	LG U+
Ministry of Science and ICT	SAMSUNG ELECTRONICS
Ministry of Trade, Industry and Energy	LG Electronics
Ministry of Health and Welfare	
Ministry of Culture, Sports and Tourism	
Ministry of Economy and Finance	
Korea Communications Commission	

Commissioner: The position is co-chaired by the minister for MSIT and a private sector specialist.
Committee meetings: Working-level staff meetings are monthly, and senior-level staff meetings quarterly.

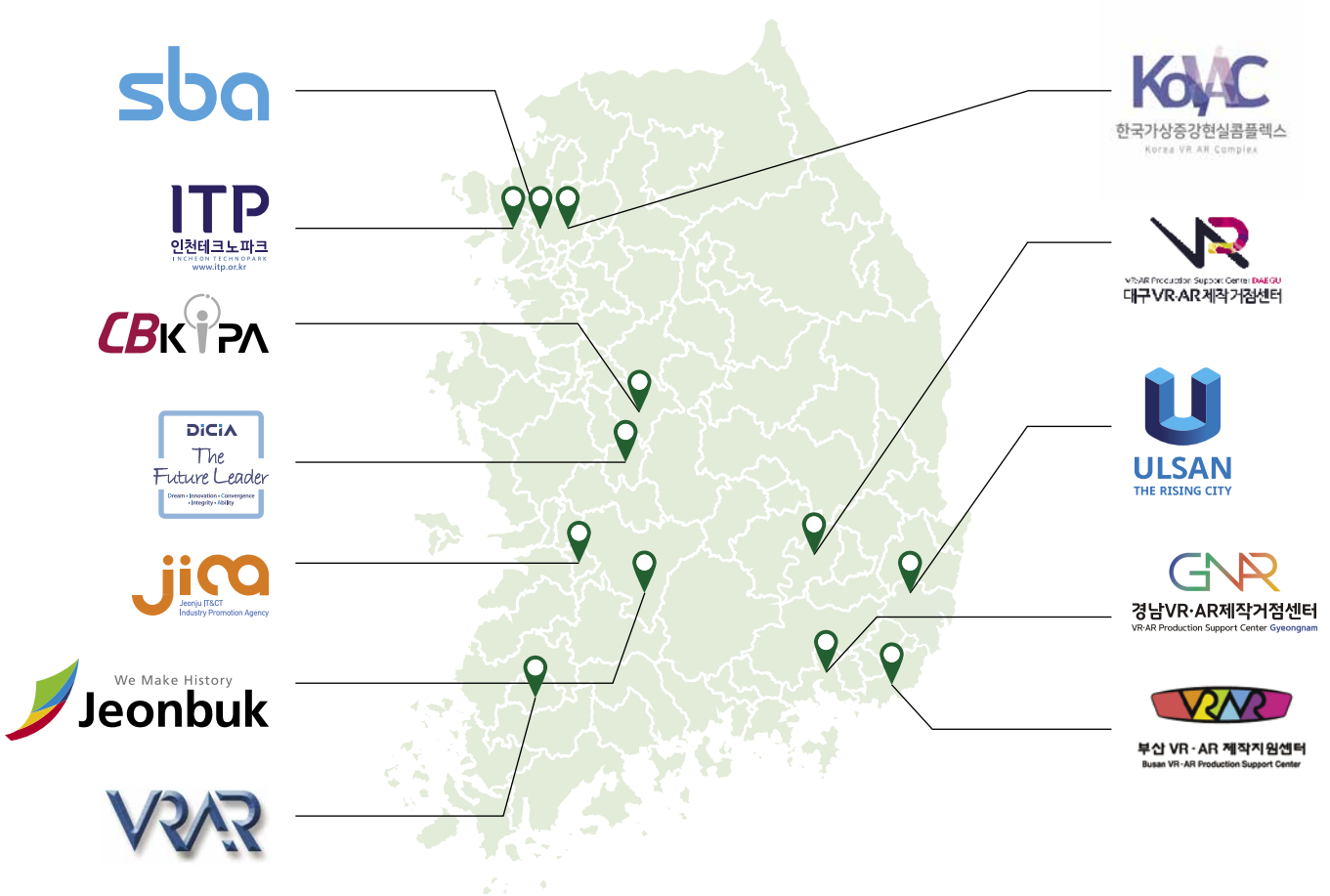
3.1 Regional Centres and Hubs

Overview

In 2017, the Korean government, under the guidance of the Ministry of Science and ICT, designated and subsidised the establishment of ten application-specific regional VR/AR Content Development Centres and Hubs across the country, with plans to build an additional four centres.

These organisations provide a range of services to support SMEs in the areas of R&D, intellectual property, marketing, export readiness, and access to trade shows.

Map of Regional Centres and Hubs



Korea VRAR Complex (KoVAC)

The centre acts as a national central office for VR/AR content production. It is in the final stages of constructing what will be Asia's largest content production lab. KoVAC supports SME's immersive technology development by providing equipment such as HMDs, and workstations for their use. The centre also supports by providing interpretation services and legal advice.
www.kovac.modoo.at

Seoul Business Agency (SBA)

Established in 1998, SBA provides full product cycle support to SMEs. They also offer business support services such as consulting advice on securing investment, conducting business and networking building. www.sba.seoul.kr

G-Hub Gwanggyo

Established in 2015, G-Hub is part of the Gyeonggi (a province outside Seoul) Content Agency. The hub promotes four main projects for SMEs in the areas of infrastructure creation, base expansion, professional training and business development. www.gcon.or.kr

Jeonju IT&CT Industry Promotion Agency

Established in 1998, the centre provides 5G-based media content production, SMEs with physical space to support their businesses in the form of office space and seminar rooms, chroma key studios, media labs and a VR dome testbed. As an agricultural region, particular support is given to those companies in the area of VR farm technology. www.jica.or.kr

Incheon Technopark (ITP)

Established in 1998, the centre acts as a national hub for technology start-ups providing technical support for R&D, overseas standard certifications, patents and advice on prototyping and exports. www.itp.or.kr

Gwangju VRAR Support Centre

Established in 2018, the centre focuses on the automotive, biomedical, and energy industries. The centre provides a business lounge, test bed zone, and the experience zone for SMEs.

Chungcheongbukdo Knowledge Industry Promotion Agency (CBKIPA)

Established in 2003, the centre provides R&D, marketing, and professional training for SMEs in the region. The region specialises in the production of semiconductors and is looking to extend its speciality to immersive technology. www.cbkipa.net

Ulsan VRAR Production Support Centre

Established in 2019, the centre provides training, equipment and exhibition rooms, and a VR/AR lab. The dominant region in Korea for shipbuilding, the Ulsan centre focuses on supporting SMEs that produce technology for this sector. www.ulsan.go.kr

Daejeon Information & Culture Industry Promotion Agency (DICIA)

Established in 1997, the agency has £45 million to support IT companies including VRAR start-ups. The region's VRAR support programme provides funds for content development for SMEs ranging from £0.4 million to £5.8 million. www.dicia.or.kr

Daegu VRAR Production Centre

Established in 2018, the centre supports SMEs that combine 5G service-based medical field and VR/AR/MR technologies, providing up to £72,000 funding to those which meet their criteria. www.dgvr.or.kr

Gyeongnam VRAR Support Centre (GNVRAR)

Established in 2019, the centre provides an experience zone, product development room, business lounge, meeting and training rooms as well as VR/AR display devices, computers and other equipment to SMEs in the shipbuilding and industrial machinery space. www.gnvrar.or.kr

Busan VRAR Production Support Center

Established in 2018, the centre provides incubator and professional training programmes for SMEs in the marine and logistics space. www.bvrar.or.kr

Jeollabuk-do Hologram Hub

In 2019, the central government authorised Jeollabuk-do Provincial Office's (JBPO) plans to build a hologram cluster in its region. The development is expected to provide synergies with its commercial vehicle business. Jeollabuk-do is home to 94% of domestic production.

According to the plan, JBPO will invest £118 million from 2020 until 2027 to develop the five core technologies in holography. JBPO will also utilise the existing Iksan Hologram Content Production Centre to develop content for holograms with a particular focus on resurrecting historical heritage sites that have been demolished. This, in turn, is expected to support its tourism industry.

In its efforts to promote its hologram industry, JBPO hosted the nation's first Hologram Expo in October 2019, which attracted more than 300 companies. www.jbtp.or.kr

3.2 Main Government Agencies

Ministry of Science and ICT and its affiliated agencies

Ministry of Science and ICT

Since 2017, the Ministry of Science and ICT's (MSIT) budget for VR/AR project funding has tripled from £7.1 million to £21 million in 2019. As part of the 2019-2023 Immersive Technologies Roadmap, MSIT will be allocated a budget of £122 million in 2020. Funding will be directed to R&D in holography and core technologies for VR/AR devices, the development of Asia's largest content production centre, the building of four regional VR/AR production centres, and the support of MNCs and SMEs collaborative efforts to expand overseas.

nipa National IT Industry Promotion Agency

Affiliated with MSIT, the National IT Industry Promotion Agency (NIPA) promotes the development of AI, VR/AR, and other software. NIPA primarily executes policies formulated by MSIT. Its VR/AR Industry Team supports the hosting of the Korea VR Festival, administers the 5G VR/AR Flagship Project sponsored by MSIT, and compiles and publishes data on the status of immersive technologies in Korea. It also supports the export of relevant technologies and products.

ETRI 한국전자통신연구원 Electronics and Telecommunications Research Institute

The Electronics and Telecommunications Research Institute (ETRI) is an MSIT-funded research institution situated in Daedeok Science Town in Daejeon. MSIT has assigned ETRI with the task of developing 3D simulation and digital twin technologies for predicting musculoskeletal system disorders with the aim of completing commercialisation by 2020. ETRI is also working on MSIT-funded research to develop safety products to support people who have weak eyesight. ETRI was established in 1976 and has a headcount of 2,300 R&D and administrative staff.

KoVRA Korea VR AR Industry Association

The Korea VR/AR Industry Association (KoVRA) provides its 602 members with services such as organising forums and seminars as well as educational training on hardware and software development. Members are classified into executives, regular members, and associate members. As one of the organisations registered under MSIT, KoVRA holds one of Asia's largest VR/AR festivals – the Seoul VR AR Expo – and has dispatched trade missions to China together with ETRI and NIPA.

Ministry of Culture, Sports and Tourism and its affiliated agencies

Ministry of Culture, Sports and Tourism

The Ministry of Culture, Sports and Tourism (MCST) focuses on assisting content production in VR/AR and helping companies establish a presence in international markets. It works closely with its affiliated organisation, the Korea Creative Content Agency (KOCCA), in developing core technologies for VR/AR games and operating VR/AR centres. MCST's budget increased from £6.7 million in 2017 to £16.8 million in 2019. Since 2017, MCST has funded projects aimed at producing films and animation for VR cinemas, and content for training and healthcare.

한국콘텐츠진흥원
KOREA CREATIVE CONTENT AGENCY

The Korea Creative Content Agency (KOCCA) is a government agency which is affiliated with the Ministry of Culture, Sports and Tourism. It is charged with supporting the creation of an ecosystem to create groundbreaking cultural content. To this end, it operates eight Global Game Hub Centres across Korea, which provide consultancy on corporate management and ultimately seeks to help SMEs export overseas. KOCCA also has funding for MNCs and SMEs seeking to collaborate on content production and supports their global expansion efforts.

KOVACA

The Korea VR/AR Content Association (KOVACA) was established in 2016 to help content developers protect against intellectual property rights infringements and facilitate further introduction of VR/AR content across broader industries. KOVACA also has an advocacy function to affect change in public policy making and industrial regulations, as well as running training programmes for start-ups, and operating an incubation service such as prototype development and commercialisation of their products.

4. Universities – Overview

Korea is considered the most educated country in the world, with 70% of 24 to 35 year-olds having completed some form of higher education, which is 20% higher than that of the US.

In terms of Korea's universities, though less renowned globally, with the highest-ranking tertiary institution, Seoul National University (SNU) ranked 64th according to The Times University list, R&D in these institutions outranks their global competitors in terms of publishing research in collaboration with the private sector. Pohang University of Science and Technology (POSTECH), for example, was top of the list with 23% of its publications written with industry partners in 2017. Samsung, who partook in the most collaborations with these universities, gave out 44 research grants for state-of-the-art technology R&D projects. The accrued number since 2013 was 517 research products and 8,657 researchers worth £1 billion.

In its efforts to improve Korea's research capacity and quality of research output, the Korean government ran something called the Brain 21 programme (BK21), running three phases of development from 1999. It is launching its fourth phase of the programme from Feb 2020. The programme has provided grants of £2.3 billion to masters, PhD, and postdoctoral level researchers in the field of science and technology.

Seventy-four universities and 568 research teams benefitted from this programme. BK21 is run by the National Research Foundation (NRF) of Korea, whose budget for 2019 was £3.8 billion. Established in 1981, it is a grant-giving organisation funded by the MCST to support research into science, entertainment and the arts.

The government also operates universities and research institutions dedicated to the development of innovative science and technology. Four out of five members of the Korean Universities for Science and Technology and Advanced Research (K-STAR), the leading science and engineering universities in Korea - DGIST, KAIST, GIST, UNIST - are run by MSIT. Furthermore, an MSIT-affiliated organisation called the National Research Council of Science and Technology (NST) oversees 25 research institutes whose interests range from aerospace to materials for AR devices.

Among private universities, Sungkyunkwan University (SKKU), run by the Samsung Foundation, is active in the VR/AR space. In 2019, the SKKU Convergence Institute for Culture, Arts, and Media signed a Memorandum of Understanding (MOU) with KoVRA to promote VR/AR content production for the entertainment industry. In the hardware segment, Professor Ho Gyun Jeong, a world-leading scholar in AMOLED display technology, has collaborated with Samsung Display to commercialise display panels for VR/AR devices.

4.1 Major Universities, Leading Departments and Individuals

Below are the major universities whose research teams are actively involved in R&D in the immersive technologies space.

Value Creating University
POSTECH
POHANG UNIVERSITY OF SCIENCE AND TECHNOLOGY
포항공과대학교

Established in 1986, POSTECH (Pohang University of Science and Technology) is a private research university dedicated to research and education in science and engineering. It was ranked 146th in the Times World University Rankings in 2019. The university has a Haptics and Virtual Reality Laboratory (HVR Lab), where human-computer interaction and robotic technologies are being applied to research on haptics and VR/AR technologies.

Junsuk Rho, a professor at POSTECH Mechanical Engineering and Chemical Engineering Department with his student, Inki Kim developed a multifunctional meta-hologram from a monolayer meta-holographic optical device that can create different hologram images depending on the direction of light incident on the device. This technology can potentially be utilised to develop lighter, more convenient VR/AR HMDs. The National Research Foundation of Korea funded the research.

www.postech.ac.kr

KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY
KAIST
1971
한국과학기술원

Established in 1971, the Korea Advanced Institute of Science and Technology (KAIST), is a private university which was ranked 110th in the world by the Times Higher Education World Rankings in 2019. In order to drive innovation in the VR/AR space, the university founded the Ubiquitous VR Lab (UVR Lab) in February 2001, under the control of the Graduate School of Culture Technology (GSCT), to foster the study and development of VR in smart computing environments that process multimodal inputs, perceive user intention and emotion, and respond to a user request through AR.

Professor Woo-wun Taek and his research team at KAIST's UVR Lab developed a VR/AR application called the K-Culture Time Machine for foreign tourists in 2016. The application allows users to remotely experience cultural sites through a 360-degree video with a smartphone mounted on a VR device and check information and related historical people, places, and events. Users can also experience 3D digitally-restored sites.

KAIST spin-off company Tegway, established in 2014, won the CES Award in 2019 for its flexible thermoelectric devices for VR/AR headsets which enables users to feel temperature linked to the content of their VR game. Furthermore, the Sherpa Space, established by a KAIST alumni, won the Eco Design and Smart Energy Award after developing light sources that control the light according to the information of the plant species and growth stages using QD (Quantum Dot) technology.

www.kaist.ac.kr

Ulsan National Institute of Science and Technology (UNIST) was established in 2007 as an affiliated research institute of MSIT. The university is one of the top five science and technology universities in the country and was ranked 205th in the world and 22nd in Asia by the Times Higher Education World University Rankings in 2019. The School of Electrical Engineering and Computer Science provides various immersive technology programmes such as VR Programming, Digital Image Production and VR Converged Content Production.

In 2019, Professor Jae-young Shim of the Electrical and Computer Engineering Department developed a technology to improve LiDAR scanners – allowing them to scan three-dimensional objects. The scanner collects a wide range of accurate data by shooting lights and calculating the return distance to recognise surroundings. The team developed an algorithm that tracks the reflection path of the glass surface to distinguish between real and virtual images. This technology enhances VR HMDs by removing single image reflection using non-linearly synthesised glass images. The work gained recognition when published in the science journal of the Institute of Electrical and Electronics Engineers (IEEE).

UNIST spin-off company, Sapiens Semiconductor, was established in 2017 by Myung-Hee Lee, a professor of Electrical and Computer Engineering. The company is working to commercialise its semiconductor electronic circuit board design technology for micro LEDs used in AR glasses. Their new micro LED design and excellent colour reproduction ability, durability, lifespan, and power consumption are recognised as globally-leading by many institutes in Korea.

www.unist.ac.kr

Daegu Gyeongbuk Institute of Science & Technology

The Daegu Gyeongbuk Institute of Science and Technology (DGIST) was established in 2004 as a public science and engineering university in the city of Daegu. The institute is a research-oriented university offering graduate programmes in 2011 and subsequently undergraduate programmes in 2014. The university is known for its strength in natural science and engineering, specialising in the fields of New Science, ICT Convergence, Medical Robot, Green Energy, Brain Science and New Biology.

In 2018, Professor Jae-sung Hong of the Robotics Department was the first person in Korea to combine AR technology with surgical navigation systems. This allows doctors to visualise a patient's body with a tablet PC equipped with an AR function that can scan the chest to determine the exact location of the heart, blood vessels, nerves and ribs. Due to the difficulty in identifying treatment areas inside tumours, blood vessels, etc., that are not readily visible to doctors or medical staff when undergoing surgery, a surgical navigation system, akin to a GPS system in a motor vehicle, points to the exact location of the treatment area and guides the doctor. In the past, computed tomography (CT) and magnetic resonance imaging (MRI) were used for the procedure.

www.dgist.ac.kr

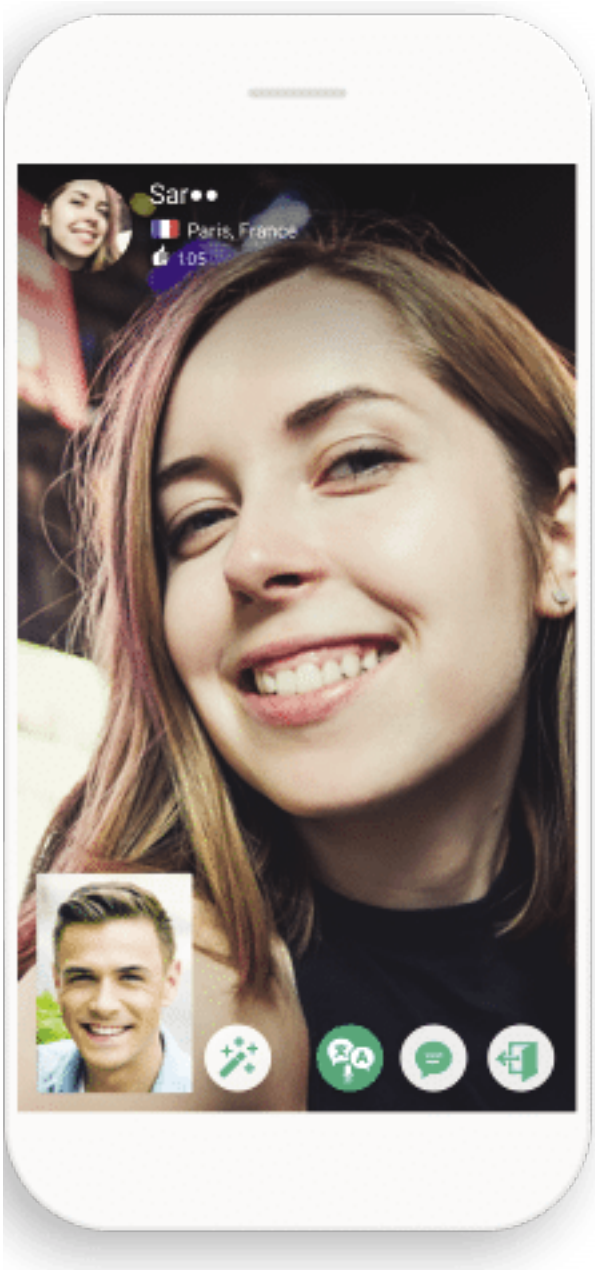
ENGINEERING
COLLEGE OF ENGINEERING
SEOUL NATIONAL UNIVERSITY
서 울 대 학 교 공 과 대 학

Established in 1946, Seoul National University (SNU) is the oldest university in Korea and considered the most prestigious. In 2019, The Times Higher Education World University Rankings ranked the university 64th globally and 9th in Asia. The university comprises 16 colleges, including the College of Engineering (including electrical and computer science and engineering programmes), often ranking in the top five.

In 2017, Professor Byoung-ho Lee from the Department of Electrical and Computer Engineering and his research team developed a Metalens using a 'metasurface' for AR glasses. This new type of see-through lightweight lens increases the field of view of AR glasses - a common problem for many AR technology devices in the market. The research was funded by the Ministry of Science and ICT and supported by the National Research Foundation of Korea`s Basic Research Program and the Global Frontier Task Force. The research was also published in the journal Nature Communications in 2018.

SNU spin-off Hyperconnect was founded by former SNU students Sang-il Anh and Kang-sik Jung in 2014. The company developed a people-matching app called Azar which provides SNS services and video calls with various in-video filter features and stickers. In 2018, Azar was the 9th highest-grossing non-game application in the Google Play Store. Ninety-five per cent of Hyperconnect's total sales of £63 million was made overseas.

www.snu.ac.kr



5. Start-up Ecosystem – Overview

In an economy where Samsung, LG, SK, Hyundai and approximately ten other conglomerates contribute to 44% of its GDP and control two-thirds of facilities investment and exports, SMEs and start-ups alike have traditionally struggled to grow. However, in recent years, driven by increased government funding and young innovative entrepreneurs who are choosing to start companies rather than enter conglomerates, Korea's start-up industry has grown to 30,000 companies - a significant increase from the early 2000s when there were less than 2,000. Start-ups are estimated to be worth £3.8 billion and employ 100,000 people in the country.

The government strongly supports the ecosystem through the Ministry of SMEs and Start-ups (MSS), which was set up in 2017 to support start-ups through the facilitation of investments and formulation of policies. Believing that nurturing the start-up space will help drive the economy and create new jobs, the government has pledged to invest £7.9 billion in scale-up funds. Augmenting government support, a growing number of global and local venture capital firms are investing in the market, providing a record £2.3 billion in 2019.

Korea is ranked fifth globally in terms of the number of technology unicorns with eleven companies that have a market valuation of over US$ 1 billion (currently about £780 million).

Korean conglomerates actively participate in the ecosystem through investments made by their venture arms, running their own start-up hubs with 200 incubators and accelerators and collaborating with start-ups on R&D. From 2014 to 2019, 30% of the top 200 Korean conglomerates' investments were in start-ups.

Despite the active participation of conglomerates as well as various venture capital firms, Korea's start-up ecosystem is still heavily driven by government initiatives. Exemplifying this, of Korea's 11 unicorns, seven received investment from the government's Fund of Funds, an initiative to fund local start-ups, and four received early-stage funding through government-backed investment vehicles and later worked with global venture capitalists to scale the businesses.

Korea's Unicorn

Source: Seoulz.com

Unicorn	Valuation (US$)	Business
Coupang	9B	E-Commerce
Krafton	5B	Gaming
Yello Mobile	4B	Mobile software
Woowa Brothers	4B	Food tech/delivery
We Make Price	2.33B	E-Commerce
Viva Republica	2.2B	Fintech
Musinsa	1.89B	Online fashion platform
L&P Cosmetics	1.78B	Beauty
GP Club	1.32B	Beauty
Aprogen	1.04B	Biotech
Yanolja	1B	Travel tech

Conglomerates' Incubation and Acceleration Programmes

Source: Seoulz.com

Company	Programme	Areas
Samsung Electronics	C-LAB	Mobile communications, visual display, home appliances, future technology
Hyundai Motor Company	Zero One	AI, smart mobility, smart cities, new energy, robotics, IoT
SK Telecom	True Innovation	Big Data
LG CNS	Startup Monster	AI, Cloud, Big Data, blockchain
Lotte Group	L Camp	Fintech, pet economy, haptics, robotics

Most growth, however, has come domestically, with Korean start-ups lacking the collaborative capability and global market strategy that scalability requires. An average Korean start-up has 2.1 global networks compared to the global average of 6.1. In terms of clients of their products or services, only 14% were foreign, which is lower than the global average of 23%.

Receiving investment for tech start-ups is also challenging. The traditional funding structures in the scene have primarily focused on investing in local services rather than core technologies due to the focus on a quick return on investment. In 2017, of all start-ups which received more than £2 million in investment, only 10% were core technology-based start-ups.

5.1 Government Funding

Government Programmes Available for Foreign Start-ups in Korea

K-ICT BORN2GLOBAL K-Global Startup Hub

Established in 2013, Born2Global is a government agency affiliated to the Ministry of Science and ICT (MSIT). Born2Global selects 100 start-ups each year with a high potential to expand their products or services into international markets and provides professional and legal consulting services on patents, accounting, marketing and investment. It houses 50 start-ups in its K-Global Start-up Hub campus, located in Pangyo – the Silicon Valley of Korea.

K-STARTUP GRAND CHALLENGE

Established in 2016, the K-Startup Grand Challenge is run by the Ministry of SMEs and Start-ups (MSS) and the National IT Industry Promotion Agency (NIPA). It is a four-month acceleration programme which attracts over 1,500 foreign start-up applications and selects 80 teams each year. The challenge has helped create an open entrepreneurship ecosystem in Asia and helps Korean companies internationalise through the collaborative opportunities it creates.

TIPS KOREA TECH INCUBATOR PROGRAM FOR STARTUP

Established in 2015, the Tech Incubation Program for Start-up (TIPS) is a programme for both Korean and foreign-owned start-ups. It is modelled on the Israeli public-private partnership programme which supports tech start-ups through mentoring, incubation and the provision of VC and R&D match-funding. Start-ups can receive an investment of up to £650,000 for three years and become eligible to move into TIPS Town, their start-up campus located in Gangnam, Seoul.

5.2 Private Sector Funding

Top Venture Capitals Investing in Immersive Technologies Start-ups

LB Investment

Established in 1996 as part of the LG Group, LB Investment spun-off in 2008 and has invested in more than 500 start-ups globally. In the VR/AR space, LB Investment has invested in VR content-creators Dexter Studios, and Gaudio Lab, which develops software that can be used to incorporate interactive sound into 360-degree content.

INTERVEST

Established in 1999, Intervest is a Korean VC firm focused mainly on biotech start-ups from Southeast Asia, with a particular interest in Vietnam, Thailand, Malaysia, and Indonesia. Excluding biotech, Intervest is investing in VR/AR, AI and blockchain. They have over £780 million of assets under management by 20 investment specialists.

SAMSUNG VENTURE INVESTMENT

Established in 1999, Samsung Venture Investment is a subsidiary of Samsung Electronics. It manages investments related to its parent company and looks for companies with technologies relevant to their business. In 2018, Samsung Venture Investment was one of the companies that funded Looxid Labs, a company that developed an emotion recognition system optimised for AR.

kakaoinvestment

Established in 2015, Kakao Investment is Kakao Corp's venture capital arm. Formed in 2019, Kakao has been focusing on investments in AR and blockchain with notable investments in Letin AR, an optical system provider, and Spatial, an AR workplace platform. It has more than 140 companies in its portfolio.

6. Application Areas

6.1 Gaming: Overview

Gaming is the national pastime for people of all generations in Korea, a country that is home to 28.9 million gamers and the world's fourth-largest games market. Koreans spend on average 49 minutes on 2.31 mobile games daily, which is the longest time spent on mobile gaming in the world. This is largely attributable to the high smartphone penetration rate of 88%.

The Korean gaming market was worth £9.2 billion in 2019, a 6.5% increase from the previous year. Mobile games accounted for 47.3%, followed by PC games (34.6%), and console games only occupied 2.8% of the market share.

Korea's VR/AR gaming industry, in turn, was worth £1.84 billion in 2018 and is expected to reach £3.75 billion by 2020. Government funding and private sector investment have been concentrated on the expansion of VR theme parks and arcades. Exemplifying the focus, four of the top ten VR gaming companies by revenue are VR theme park/arcade operators, and one-third of KOCCA's £21 million subsidies granted during 2017-2018 for the immersive technologies sector went to developing new VR centres. Korea's major conglomerates also operate in this space, as in 2018, KT opened VRIGHT, a VR arcade in partnership with GS Retail, the 4th largest convenience store operator in Asia.

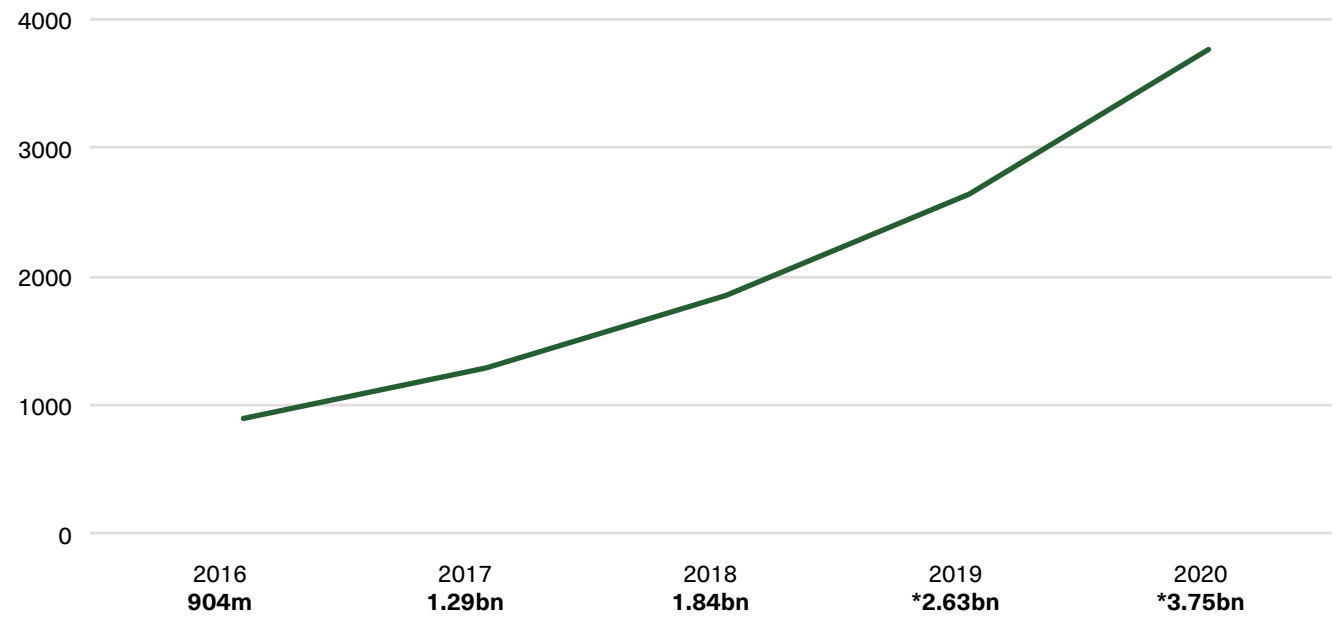
Korean Telcos Develop/Publish VR/AR Games

Major gaming companies, traditionally strong in the PC and mobile space, have struggled to enter the VR/AR space which focuses on arcade and console games. NcSoft, Korea's largest game developer and publisher, even halted its collaboration with Oculus on developing VR games in 2018. Nexon, second only to NcSoft in the market, has stopped the R&D of VR/AR games and is only providing copyright to those seeking to adapt their games to the format.

To fill this void, Korean telecommunication companies are actively foraging into this area. SKT, for example, launched its 5G-based VR service, Virtual Social World, in 2019, which allows multiple users to engage in diverse activities and create content in a virtual space. In the same year, another carrier, LG U+, also launched a cloud-based VR gaming service and announced its partnership with Google to develop VR/AR games.

Korean VR/AR Game Market Size Forecast

Source: Ministry of Science and ICT
Unit: GBP



Application of VR/AR for eSports

With its remarkable year-on-year growth of 40%, eSports is a hugely significant driver of the gaming industry. Known as the Mecca for eSports, Korea, together with China, accounts for nearly 23% of the global market. Immersive technologies are increasingly being integrated into eSports and are changing the way audiences watch gaming and interact with players.

One success story is SKT's latest service offering, Jump AR, which provides a live AR audience experience for the League of Legend (LOL) Champions tournament in Korea, by offering users the experience of a 360-degree view teleportation down to the eSports arena. Other services include VR video replays and MR meet-up events with eSports players, where fans can see the players in both VR and AR.

Key Statistics on Korean VR/AR Game Developers

- Headcount of 29 or less: 88.1%
- Average cost of developing VR games: £396m
- Companies who only sell domestically: 83.3%
- VR Arcades and Theme Parks
  Total: 200+
  Major franchises: VR Plus, Camp VR and VRIGHT
  Branches with monthly revenue of £6,600 or higher: 79.1%

6.1 Gaming: Players

Smilegate®

Established in 2002, Smilegate is a Korean mobile and PC game developer, publisher, and service provider. The company distributes VR/AR games. In 2019, Smilegate launched a VR game digital distribution service for VR arcades, theme parks, and other entertainment venues. It holds the largest number of VR games on its platform, carrying the license to distribute over 80 games to 200+ VR arcades in the country.

DragonFly

Established in 1995, Dragonfly created the world's first online first-person shooter (FPS) game in 2002 and later cemented its position as the most dominant FPS game developer in 2004 with the release of Special Force. Dragonfly is active in overseas markets such as Thailand, China, the US and Europe.

REALITY MAGIQ

Established in 1996, Reality Magiq is a VR game developer focusing on games with high haptic responses and virtual designs. It provides high-quality VR eSports game titles that are suitable for both small and larger VR arcades. It recently created Magic Arena, a VR/AR eSports game stage that can be installed in any kind of open space.

6.1.2 Gaming: Key Player Profile - LG U+

LG U+, Korea's third-largest mobile carrier, began the world's first cloud-based VR gaming service in 2019. The service allows games to be launched directly from cloud servers utilising 200m/s wireless speed enabled by 5G. Games that typically require high specifications and provide six degrees of freedom (6DoF) can now be played on low spec wireless standalone devices. Previously, 6DoF games could only be played through connecting with high-spec computers via cables and using premium HMDs. In order to promote its cloud-based VR games, LG U+ will install VR pop-up spaces within its 90 sales offices across Korea.

LG U+ also operates an online gaming marketplace called U+ VR which helps diversify the range of games available on their service. LG U+ has collaborated with VR game developers such as Kakao VX to expand the 5G-based cloud game service infrastructure and secure more VR content.

In the AR space, in 2019 LG U+ signed an exclusive deal with Chinese start-up Nreal to launch AR glasses in the market by early 2020.

6.2 Training: Overview

In early 2020, the Korean government announced its VR/AR industrial development strategy, which outlines its plans to prioritise the growth of VR/AR-based training programmes in the military, schools, healthcare, and industrial areas. To this end, it will subsidise private companies' efforts to develop and commercialise products and services for virtual surgeries, AR devices and software for warfare and industrial safety training. Longer-term, the government will support the development of AR microscopes and manuals for manufacturing and maintenance in various applications. Furthermore, it plans to utilise immersive technologies in the field of autonomous vehicle testing.

In the public sector, significant progress has been made in the development and adoption of simulators for emergency and disaster management training. In July 2019, the Ministry of the Interior and Safety developed a VR/AR-based training simulator for earthquakes, fires, and chemicals leakages. The simulators will be distributed to public offices later in 2020.

To date, the regulatory environment, often obstructive, has been unfavourable to the development of key application growth areas. However, major reforms are underway to allow innovative products and solutions to be applied.

For instance, the Ministry of Food and Drug Safety (KFDA) will add a new category in its medical devices classification system to allow VR/AR devices and software to be classified and authorised for sale by July 2020. This move reflects the increasing development of new products using VR/AR, such as rehabilitation software and other training programmes.

In the private sector, SMEs drive growth and innovation with a heavy R&D focus on motion simulators and educational content. However, in November 2019, one of the major conglomerates, CJ Olive Networks, signed a partnership agreement with Immerse to develop training programmes for various manufacturing processes and sell the content to Korea's MNCs.

Below are key areas where immersive technologies are being used in training:

Manufacturing and Engineering

Developed by innovative start-ups in partnership with major power and engineering companies and specialist institutes, VR training platforms are being widely used for the manufacturing and engineering sectors:

- Hyundai Heavy Industries: Adopted VR training system in their safety training centre.
- Korea Western Power: Developed a VR/AR virtual training system using a virtual image of one of their plants.
- Korea Electric Power Corporation (KEPCO) Research Institute: Co-developed a VR/AR electrical sub-station with the Korea Electrical Research Institute (KERI) for training.

Defence

The Ministry of National Defence (MoD) is undergoing reform to apply training systems using immersive technologies. Incremental changes have been made in virtual warfare simulators and virtual training systems such as submarine passenger training systems in the navy. The Korean Military Academy plans to provide advanced training on war games using immersive technologies. To achieve this an MOU was signed with SKT to build 5G infrastructure on academy campuses. In 2019, the Air Force also adopted four unmanned aircraft system (UAS) devices and simulators.

Healthcare

Currently, simulation products used to help train medical staff and support the performing of daily health management for regular consumers do not require KFDA authorisation. As such VR/AR can be applied. For instance, Samsung Medical Centre is using VR to help patients familiarise themselves with the ward before being hospitalised. Furthermore, Seoul National University Bundang Hospital has successfully applied AR imagery before conducting surgery on a cancer patient by viewing the tumour's location and size.

6.2.1 Training Players

M-Line Studio (Product: VR simulator)

Established in 2012, M-Line Studio builds VR simulators for safety training in hazardous environments. Application areas include construction, offshore rigs, and petrochemicals training centres. Their product, Safeline, showcases eight cases of real-life accidents. Its customers include Samsung, Hyundai, LG and SK.

CJ Olive Networks (Product: VR content for vocational training)

Established in 2015 as part of the CJ Group, CJ Olive Networks provides IT services for the manufacturing, logistics and media industries. In 2019, it signed a partnership agreement with Immerse UK to provide VR educational platforms for vocational training. The company will be able to utilise its Immerse Virtual Enterprise Platform as per the agreement and supply training VR content to its sister companies as well as other major Korean conglomerates.

Soltworks (Product: VR/AR for the defence industry)

Established in 2008, Soltworks specialises in state-of-the-art immersive technologies-based military software. Its virtual training system provides training systems and simulations, big data processing technologies and graphics. It has won contracts to provide Interactive Electronic Technical Manual (IETM) software development for light armoured helicopters. They export their VR-related technology to Thailand, Iraq and the Philippines.

6.2.2 Key Player Profile – Innosimulation

Innosimulation

Established in 2000, Innosimulation is a pioneer in VR training simulations for driving, piloting tests and construction machinery, particularly for the navy and air force. It is a spin-off of Kookmin University's automotive technology research lab. It recently signed a deal with Shandong Transportation and Science Institute to supply US$1.3 million worth of simulators required for test driving autonomous vehicles.

Innosimulation has also signed an MOU with Bosch Rexroth Korea on the collaboration on autonomous driving testing using the simulators developed by Innosimulation.

In a further MOU with Eastarjet, one of the major independent low-cost carrier operators not affiliated to any Korean conglomerates, in 2019 it agreed to develop training simulators for their pilots and technicians.

The company exports to over 80 countries thanks largely to its relationship with major conglomerates such as Samsung Electronics, which use Innosimulation' simulators in their Gear VR experience zones globally. It also supplies simulators to automotive and locomotive OEMs such as Hyundai Motors and Hyundai Rotem. Based on these core technologies, it is developing VR simulation equipment for indoor physical activities at theme parks and schools.

6.3 Healthcare: Overview

Korea's healthcare sector is utilising VR/AR technologies to help counter some of the challenges it faces in the treatment of chronic diseases, its ageing population and understaffing.

According to the Korea Health Industry Development Institute (KHID), VR/AR applications for the healthcare sector account for 17% of the total market. In 2019, VC investment in biotech accounted for 24% of total investments, exceeding those made into ICT.

VR/AR applications in healthcare can be divided into three broad areas; medical training using virtual surgeries, rehabilitation therapies, and the treatment of phobias and addiction in the mental health sphere, which is at its clinical trial stages.

The government is preparing new guidelines to help the growth of VR/AR-based services, such as allowing the use of encrypted patient data for the purpose of R&D to support cognitive and behavioural therapies.

R&D in medical technology using VR/AR is increasing, as evidenced by the rising patent applications authorised in the medical VR/AR devices and software category. Between 1998 to 2018, 277 patents were approved, during which the largest increase of 49.4% was seen from 2012 to 2017. Of the 277 patents approved, 81 were related to patient rehabilitation technology followed by medical staff training (45), medical surgeries (38), health management (36) and diagnosis (32).

Korean private hospitals, beneficiaries of the insurance system, are primarily responsible for delivering healthcare services and dominate the research conducted in this area. The Big Five hospitals, Samsung Medical Centre, Asan Medical Centre, Seoul National University Hospital, Severance Hospital and Seoul St Mary's Hospital are all located in the capital and are at the forefront of applying new technologies.

Areas where immersive technologies are being used in healthcare:

Ophthalmology
Relumino, a start-up which is part of Samsung Electronic's in-house incubator, C-Lab, has developed visual aid software for patients who suffer from refractive errors and severe myopia.

The technology allows patients to view original images filtered through a Gear VR lens, allowing distortions to be significantly reduced. It is an economical alternative to other visual aid products which cost up to £10,000. The application can simply be downloaded free of charge from Google Play and launched on a Gear VR device.

Rehabilitation Medicine
In 2018, Cha Hospital Bundang Rehabilitation Centre developed rehabilitation software for patients whose bodies were partially paralysed as a result of a stroke or accident. Inside the virtual world, the patient can simulate swimming in the sea and will be tasked to catch the fish with their hands. Repetition of these exercises has been proven to hasten the treatment process and help paralysed limbs recover.

Surgery
In 2017, Professor Hwan-Sung Cho's team of orthopaedicians at Seoul National University Bundang Hospital, collaborated with DGIST's robotics team to successfully conduct the world's first surgical procedure on a bone tumour using a tablet PC displaying AR images. CT and MRI images were transmitted to software pre-installed in the tablet PC and converted into AR images. These AR images allowed doctors to see the exact location of the bone tumour before and during the surgery, which helped remove the tumour more accurately.

6.3.1 Healthcare Players

Meddiction (Product: VR mental health treatment)

Established in 2008, Meddiction specialises in developing addiction diagnosis and treatment solutions using technologies such as VR. Meddiction has commercialised the world's first alcoholism treatment system using virtual reality in collaboration with Harvard Medical School. Eight medical centres, including the Korean National Mental Hospital, Chung Ang University Hospital and Gangnam Eulji Hospital use Meddiction's products. In 2019, Meddiction signed a partnership agreement with Korean VR content producer Thirteenth Floor to develop addiction treatment programmes merging Thirteenth Floor's VR content and Meddiction's electroencephalogram (EEG) sensors.

Samsung Electronics (Product: VR health management programme)

Established in 1969, Samsung Electronics has been collaborating with VR content developer FNI and Yonsei Severance Gangnam Hospital since 2017 to co-develop patient health tracking and management programmes. Under the partnership, Samsung provides know-how accumulated through the development of its devices and software used in its Gear VR, Gear S3, and S Health, whilst FNI develops content, and Yonsei shares patient data. The priority is to develop a mobile VR-based systematic programme to prevent suicide and various other mental health issues.

Looxid Labs (Product: VR headsets for detecting emotions)

Established in 2015, Looxid Labs built the Looxid VR System, a smartphone-based VR headset with two eye-tracking cameras and six electroencephalogram (EEG) brain wave sensors. The sensors pick up biological signals which are analysed through machine learning algorithms to determine what kind of emotions a subject feels. It is being developed for use in the advertising industry but could be used as a relaxation tool for those in high-stress jobs or as a treatment option for conditions like ADHD. Looxid Labs are focused on foreign markets as the domestic regulatory environment does not allow their product to be sold.

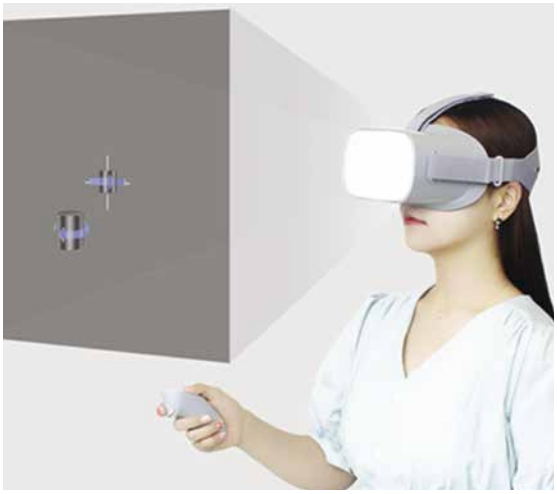
6.3.2 Key Player Profile – Nunapas

Established in 2017, Nunaps is a spin-off from the University of Ulsan College of Medicine, which is affiliated to Asan Medical Centre in Seoul. Nunaps has developed a technology called Nunaps Vision which provides perception training using a VR headset to help treat visual field defects caused by brain damage suffered as a result of a stroke.

The start-up has raised £3.3 million to develop and test its software-based treatments for neurological disorders, after launching its first digital therapeutics clinical trial in the country in 2019.

The condition is experienced by around one-in-five people who have had a stroke and suffer from some form of vision impairment, including the loss of part of their field of view.

Nunaps is comprised of neurologists, engineers and perceptual psychologists as well as artificial intelligence scientists and software and game developers.



6.4 Engineering and Manufacturing: Overview

Korea's manufacturing sector accounts for 29.4% of its GDP, the highest proportion amongst OECD countries, and is 84.3% of total exports. In terms of global manufacturing competitiveness, Korea is ranked third after the US and China.

There are 416,493 manufacturing facilities in Korea with only 687 owned by conglomerates and the remainder owned by SMEs. Despite strong global competitiveness overall, a 30% efficiency rate differential between SME and conglomerate-run factories means that the Ministry of SMEs and Start-ups (MSS) has begun to champion the digital transformation of factories through its Smart Factory Initiative. Since its inception in 2015, the initiative has provided funding to transform 7,900 factories and plans to do the same in 22,000 more whilst also building ten smart factory industrial complexes with a budget of £269 million by 2020. In addition, the government is supporting the establishment of 19 Smart Manufacturing Innovation Centres across the country by 2022 in order to provide test beds for state-of-the-art technologies to be deployed.

VR/AR technologies are seen as critical element of smart factories. They are being quickly adopted, especially in the area of staff training in combination with other technologies such as digital twin. With global leaders in this space, such as the UK's Virtalis, PTC and Schneider Electric leading VR/AR applications in the manufacturing segment, all the major conglomerates and a handful of local SMEs are striving to see technological breakthroughs.

Korea's applications of VR/AR in the designing and planning stages of manufacturing is still at its early stages; however, the rate of adoption has been facilitated by the 2019 roll-out of 5G. The business-to-business provision of 5G began last year with news of KT's collaboration with Hyundai Heavy Industries, Korea's largest shipbuilding conglomerate, to develop its first smart shipyard as well as the opening of Hyundai and Kia's Virtual Automotive Development Lab.

Areas where immersive technologies are being used in manufacturing and engineering:

Automotive

Following the adoption of VR/AR technologies by leading global automotive companies such as BMW in their manufacturing processes, Hyundai and Kia Motors opened their first Virtual Automotive Development Lab in December 2019. The lab allows researchers to use VR technology for the designing and testing of concept vehicles. It is anticipated that by adopting this new system, vehicle development time will be reduced by 20% and annual development costs by 30%. In March 2019, Hyundai established a VR-based design quality verification system to assess each design in simulated environments and scenarios.

Shipbuilding

In November 2019, KT and Hyundai Heavy Industries Group signed a partnership agreement to collaborate on developing advanced smart factory and shipyard solutions based on 5G to improve the efficiency and safety of their facilities. Through the partnership, they have been working on projects to combine KT's 5G network, AI and big data technologies with Hyundai Heavy Industries' robotics and shipbuilding expertise. Elements of VR/AR will be added to the maintenance and operations controls of the factories and shipyards.

Construction

In November 2019, a consortium of Korea's top construction and engineering companies was formed under the leadership of the Korea Institute of Civil Engineering and Building Technology (KICT) and SKT to test smart construction methods for road construction sites. AR technology to monitor 3D floor plan specifications for each site was augmented by Building Information Modelling (BIM) and Light Detection and Ranging (LiDAR) drones to increase precision and was proven to increase productivity by 30%, reduce lead time and lower construction cost by 25%. This was the first time a combination of these technologies was fully applied throughout the land survey, planning, construction and maintenance cycle.

6.4.1 Engineering and Manufacturing Players

Virnect (Product: AR manuals)

Established in 2016 as a spin-off from KAIST, Virnect was Korea's first company to commercialise AR manuals and collaborations for the maintenance, repair and quality assurance of a variety of manufacturing processes. It has 60 clients which include Samsung, LG and KEPCO.

eXtriple (Product: AR collaboration)

Established in 2009, eXtriple develops AR 3D models, AR manuals and collaboration platforms for the manufacturing, maintenance and operation (M&O) sectors. Selected by MSIT to be part of its flagship VR/AR project, eXtriple has supplied AR manuals to conglomerates such as POSCO Chemicals and will start exporting in 2020. eXtriple also develops software and programmes for military M&O as well as a remote healthcare system for sailors onboard ships.

Magenta Robotics (Product: AR robotics)

Established in 2015, Magenta Robotics specialises in robot control, machine vision, system integration, and robotic parts. For its robotic control systems, it developed a VR simulation and training programme for testing robots and has made the user interface (UI) friendly to be easy to use for both trainees and researchers.

6.4.2 Key Player Profile – Maxst

Maxst

Established in 2010, Maxst provides online augmented reality (AR) solutions in the fashion, leisure, logistics, publication, advertising and other industries. The company offers three AR products; Korea's first homegrown software development kit (SDK), a cross-platform engine that provides features and environments to develop applications and a remote communication and effective collaboration tool that helps real-time communication with colleagues in remote locations, and a guide and booklet manual.

In 2016, Maxst developed AR manuals for car passengers and received a £1.3 million investment from Hyundai Motor Company to further apply the technology to make AR car manuals for its premium car model, Genesis.

Maxst AR SDK includes cutting-edge technologies such as Instant Tracker, Visual SLAM, Object Tracker, Image Tracker, Cloud Recognition, Marker Tracker, QR Code Tracker, QR/Barcode Reader and smart glasses calibration.

Since the Maxst AR SDK launch in 2012, it has been used by more than 9,000 development companies globally. On average, seven new applications are being developed every day using the toolkit.

7. Conclusions

Home to two of the world's largest consumer electronic giants, Samsung Electronics and LG Electronics, Korea's strong standing as a hardware manufacturer and status as the world's most connected and internet savvy country makes it a global digital leader.

Worth £2.4 billion in 2019, Korea has a significant immersive technologies industry. It is, however, dominated by the hardware segment where the production of HMDs such as the Samsung Gear VR and HMD Odyssey, as well as high-quality components such as optics, drive revenue.

Software and content production is led by Korea's telecoms companies, who in partnership with SMEs, are leading the development of high-quality content for VR/AR.

Whilst Korea's MR market is still nascent, innovation in the form of Samsung's HMD Odyssey and LG's new MR device, as well as efforts by SKT to partner with Microsoft to open Asia's first MR Capture Studio in Q2 2020, mean that the market will likely soon grow at pace.

Further to Korean government funding since 2017 to support the growth of immersive technologies, in 2020 even greater investments of £847 million will be made into holography and content production. Government agencies such as MSIT, KOCCA and MSS are creating a strong ecosystem of funding and innovation support for companies in this space.

Korea leads the world in joint tertiary institution and industry R&D collaboration. Such collaborations have resulted in the spin-off of cutting-edge technology start-ups. For example, the Korean Universities for Science and Technology and Advanced Research (K-STAR), with dedicated VR/AR research departments, is leading research into holography as well as new materials for HMDs.

With notable start-up successes resulting in Korea having the world's fifth-largest number of unicorns, an entrepreneurial scene is growing in a market where conglomerates typically stifle the innovation of small companies. However, the start-up scene is still relatively small, very domestically focused with heavy reliance on government investment programmes and incubators where venture capital should be.

7.1 Opportunities

Gaming

Despite Korea's global competitiveness in the gaming sector including the eSports market, Korean gaming companies have been slow to enter the VR/AR gaming space. This means there are untapped opportunities for British game developers to supply to VR arcades and build VR cafes. Furthermore, gaming content developers could potentially collaborate with telecoms and ICT companies that have recently been active in establishing partnerships with global players in content production. As such, Korean telecoms companies may be looking for opportunities for joint R&D, investment projects, or to sell games through their content platforms.

Training

Strong in VR training simulators and software in the manufacturing as well as maintenance and operation sectors, Korea's relative weaknesses in healthcare training presents opportunities for British companies. The relaxation of medical devices classification regulations will allow a broader range of VR/AR-based devices and solutions to be sold. With the conservative Korean military equipping its bases with 5G equipment and VR/AR training systems, British companies could collaborate with local players to supply advanced training solutions to both the air force and navy.

Healthcare

VR/AR technologies for healthcare are being developed in Korea, but their adoption rate in major hospitals in Korea is low, which presents opportunities to collaborate with Korean companies to support product commercialisation. Akin to Meddiction's collaboration with Harvard Medical School, British medical institutions could partner with local companies to distribute to Korean hospitals.

Manufacturing and Engineering

With ambitious plans by the government to convert existing factories into smart factories, the lack of advanced VR/AR technologies to support the deployment presents opportunities for British companies. Homegrown AR manuals and collaboration tools are being developed but are not advanced enough to be widely adopted. The automotive, manufacturing and construction industries are trialling different locally available solutions, but there may be a preference for more advanced and proven British options.

7.2 Challenges

Need to Localise

As with other markets, the Korean market has its own players and mode of business, so understanding the local ICT ecosystem and its trends is key to succeeding. Global applications often struggle in many segments where Korea has its homegrown options such as KakaoTalk and LINE, which have their own respective messenger and gaming platforms with huge market share. In terms of mobile gaming, adopting an Android-first approach is essential in a country where Android phones make up 90% of the market. Furthermore, the localisation of user interfaces, including effective use of emojis, the local language, and images, is also critical.

Korean-Only Public Support Structure

The government actively supports the growth of the VR/AR industry and pumps a large amount of financial support and human resource into the space. However, many of the programmes and subsidies are directed at Korean companies and nationals only, which may be a challenge for foreign start-ups seeking to penetrate the local market. Public procurement processes are not designed in an inclusive manner to help foreign companies to access and bid for funding and are often exclusively available for Korean entities. Many of Korea's industries such as defense, telecoms and energy, are exclusively domestically focused, and key stakeholders are often government-affiliated.

Home Market Centric

Despite being an export-oriented economy, Korean companies tend to focus on their domestic business and often neglect overseas opportunities. While conglomerates are more active in collaborations globally, SMEs, which are often risk-averse, can lack the skill and ambition to explore opportunities outside of Korea. Given that SMEs drive a number of immersive technologies areas, any British company seeking to work with them will have to find partners, and explain and convince them of the merits of collaborations which are both internationally founded and domestically beneficial.

Annex 1

Trade Shows and Exhibitions

2020 Seoul VR AR Expo

Dates	April 23 - 25, 2020
Venue	COEX
Organisers	KOTRA, Messe Esang
Number of participating companies in 2020	350+ Expected in 2020
Email	vr@esgroup.net
Telephone	+82-(0)2-6121-6361
Website	http://seoulvrar.com
Details	The Seoul VR AR Expo is a global event that introduces the latest Korea VR AR technologies, including VR·AR content (game, theme park, entertainment, animation, film), VR·AR platforms (online, off-line), VR·AR networks, VR·AR devices (HMD, controller, simulator) and hologram in Korea.

2020 Korea VR Festival

Dates	October (dates TBC)
Venue	COEX
Organisers	Ministry of Science & ICT, NIPA, KoVRA
Number of participating companies in 2020	120
Email	kvrf@kvrf.kr
Telephone	+82-(0)2-2132-1271
Website	http://kvrf.kr/2019/index.php
Details	A tradeshow/exhibition hosted by the government to promote the latest technology trends in immersive technologies. Major telcos, MNCs and SMEs showcase applications of their technologies in manufacturing, defence, healthcare, training, education, platform, gaming and entertainment.

Annex 2

List of Companies in the Report

CJ Olive Networks
Dragonfly
Eastarjet
eXtriple
Hyperconnect
Hyundai Heavy Industries
Hyundai Motors
Hyundai Rotem
Innosimulation
Intervest
Kakao Bank
Kakao Corp
Kakao VX
K-Bank
Kia Motors
Korea Electric Power Corporation
Korea Western Power
KT
LB Investment
Letin AR
LG CNS
LG Electronics
LG U+
LINE
Looxid Labs
Magenta Robotics
Maxst
Meddiction
M-Line Studio
NcSoft
Nexon
Nreal
Nunaps
PTC
Reality Magiq
Samsung Electronics
Samsung SDS
Samsung Venture Investment
Schneider Electric
SK Hynix
SK Telecom
Smilegate
Tegway
Thirteenth Floor
Tina3D
Virnect
Virtalis

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