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Global Expert Mission
South Korea
Smart Cities 2019

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Welcome

Innovate UK global missions programme is one of its most important tools to support the UK's Industrial Strategy's ambition for the UK to be the international partner of choice for science and innovation. Global collaborations are crucial in meeting the Industrial Strategy's Grand Challenges and will be further supported by the launch of a new International Research and Innovation Strategy.

Innovate UK's Global Expert Missions, led by Innovate UK's Knowledge Transfer Network, play an important role in building strategic partnerships, providing deep insight into the opportunities for UK innovation and shaping future programmes.

The Smart Cities Expert Mission travelled to South Korea in June 2019. The findings and insights gathered during the delegation's time are shared in this report.

1. Introduction

Ranked first in the Bloomberg Innovation Index[1] globally for six years in a row, the Republic of South Korea (Korea) is regarded as one of the most competitive economies globally. Confirming this status, the World Economic Forum (WEF)[2] has ranked Korea fifteenth overall for global competitiveness. Korea leads the ICT adoption pillar, boasting some of the world's highest penetration rates of ICTs, and it ranks eighth on the innovation pillar. Notably, Korea ranks first in the world for research and development (R&D) investment as a percentage of gross domestic product (GDP) with an equivalent of 4.55%.[3]

Despite these clear strengths, Korea faces a number of challenges to sustain its economic growth and social wellbeing. In response, Korea intends to diversify its national portfolio to include a clear focus on developing advanced ICT technologies and services with a number of Smart Cities initiatives serving as demonstrators. In this evolving context, the Expert Mission was undertaken to identify and develop opportunities for the UK.

The mission was comprised of representatives from the following organisations:

- Bodvoc Ltd/University of Warwick
- City of Bristol
- Data Performance Consultancy Ltd
- Design 4 Social Change Ltd
- Knowledge Transfer Network
- Ordnance Survey Ltd
- Places for People Ltd
- UKRI - Innovate UK

The mission took place between 8 and 14 June 2019 and included engagement with the following stakeholder groups:

Central Government	City Government	Industry
• The British Embassy in Seoul • Presidential Committee for the Fourth Industrial Revolution (PC4IR) and Sub-Committee on Smart Cities • Ministry of Land, Infrastructure and Transport (MOLIT) • Korea Agency for Infrastructure Technology Advancement (KAIA)	• Seoul Metropolitan Government • Busan Smart City Project Team • Busan Centre for Creative Economy and Innovation • Busan IT Industry Promotion Agency • Sejong Smart City Project Team	• Hyundai Future Technology Strategy Team • Intralink Korea • K-Water • SparkLabs Korea

[1] https://www.bloomberg.com/news/articles/2019-01-22/germany-nearly-catches-korea-as-innovation-champ-u-s-rebounds.
[2] https://www.weforum.org/reports/the-global-competitveness-report-2018.
[3] OECD (2018). Available at: https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm.

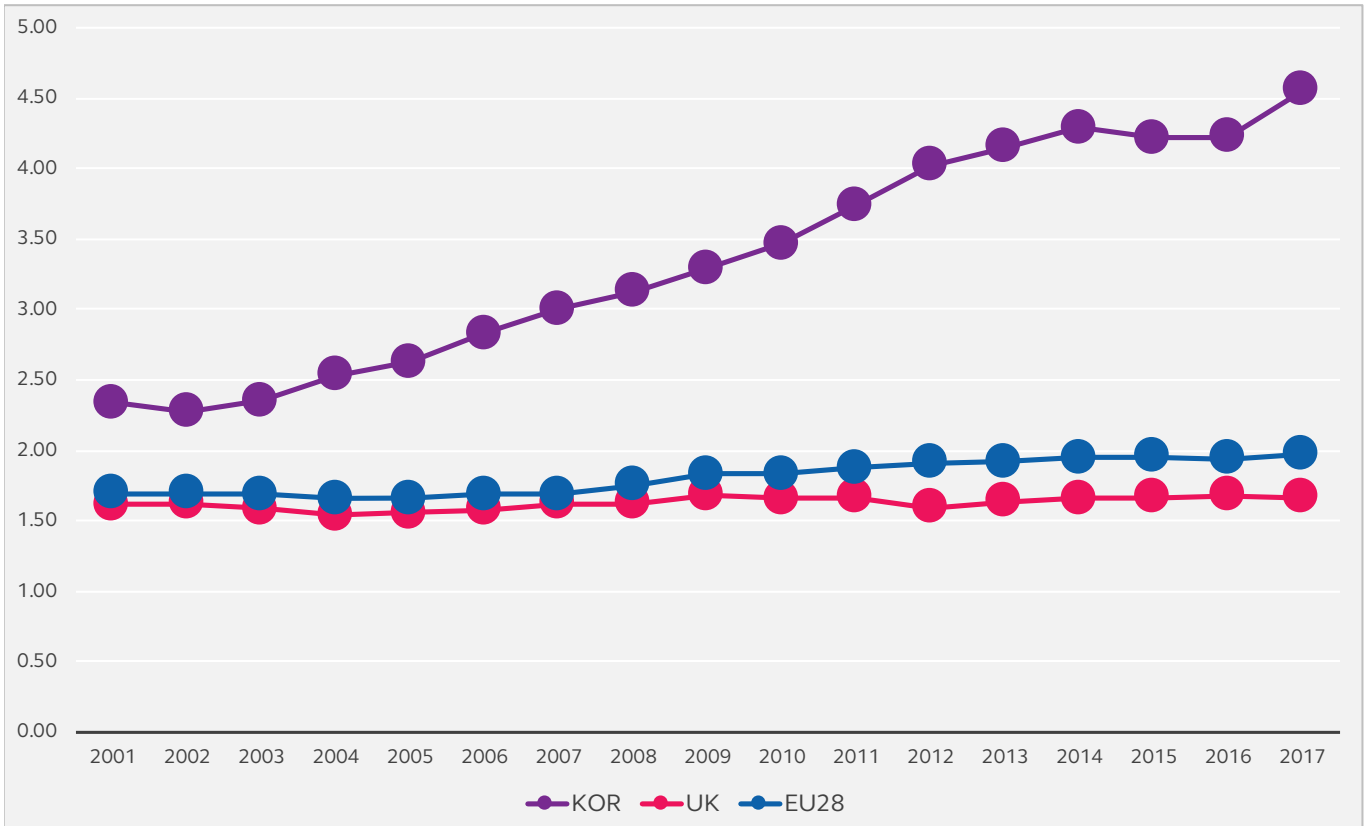
2. Korea Market Landscape

2.1 Overview

Korea (estimated population: 51,336,550) is one of the most advanced economies globally, ranked first in the Bloomberg Innovation Index. As a leading supplier of electronics, automotives and semiconductors to global markets, Korea benefits from a highly-educated and hard-working population that is supported by modern, high-tech infrastructure, including the commercialisation of 5G in March 2019 (country-wide, and the first such roll-out in the world). Korea is also a free-trade leader, which the WEF[4] ranks fifteenth in global competitiveness overall, more specifically: first in ICT adoption (e.g. fibre internet subscriptions); first in macroeconomic stability (e.g. inflation); sixth in infrastructure (e.g. electrification); and eighth in innovation capability (e.g. patents, R&D spend). Notably, Korea ranks first in the world for research and development (R&D) investment as a percentage of gross domestic product (GDP) with an equivalent of 4.55%.[5]

Despite these clear strengths, Korea faces a number of challenges to sustain its economic growth and social wellbeing. These include domestic slow-down in China, the world's second-largest economy, witnessing gross domestic product (GDP) growth rates of a low 6.6% in 2018, its slowest pace in 28 years. Political risk between USA and China, the ongoing revision of the USA-Korea trade agreement, and many non-trade barriers also pose challenges to Korea. Against this external backdrop, Korea faces a number of internal challenges, such as a gap between the rich and the poor, social welfare issues, and environmental degradation. Low fertility is another serious challenge to the Korean economy; combined with an ageing society. These social challenges may slow down economic growth, lower tax revenue, and also increase pressure on public sector services.

In response to these challenges, Korea intends to diversify its national portfolio by extending into ICT-added-value technologies and services via Smart Cities demonstrators. Through the Smart Cities demonstrators, Korea hopes to achieve continued economic and social benefit through the development of its small and medium enterprise



Source: OECD Science, Technology and R&D Statistics: Main Science and Technology Indicators

[4] https://www.weforum.org/reports/the-global-competitveness-report-2018.
[5] OECD (2017). Available at: https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm.

(SMEs) capability, further development of its technology infrastructure, the creation of regulatory alignment, and strengthened international collaboration. This overarching policy initiative may be summarised as Korea's response to the Fourth Industrial Revolution (4IR)[6] and is discussed in more detail below.

2.2 Policy: The Fourth Industrial Revolution (4IR)

The Fourth Industrial Revolution (4IR) refers to the process of innovating various industries (including manufacturing, medicine, agriculture and ICT) using intelligent information technologies such as the Internet of Things (IoT), big data, cloud computing, 5G, mobile, and artificial intelligence (AI) to solve complex urban problems in order to enhance the efficiency of city management and to improve the quality-of-life for citizens. Key drivers for the 4IR in Korea include an excellent ICT infrastructure, with world-class network coverage, connection speed, and data costs. In addition, the minimum wage in Korea increased by 62.5% between 2014 and 2019, and with working hours capped, there has been significant income-led growth. Another key driver for the 4IR in Korea is that public welfare has a particular focus on e-government, Smart Cities, public safety, digital health and pollution control.

Additional drivers for 4IR include cyber threats from North Korea, domestic actors and industrial espionage. In addition, China is rapidly catching up with Korea in many of its core industries and 4IR technologies.

2.3 Infrastructure: Fourth Industrial Revolution (4IR)

A key factor driving the Korean government's 4IR agenda is the Presidential Committee on the Fourth Industrial Revolution (PCFIR). The PCFIR deliberates upon and coordinates important policy matters pertaining to the development and acquisition of new science and technology, including artificial intelligence and data technology, as well as new industries and services necessary for Korean society's adaptation to the 4IR. The committee's legal basis can be found in the Presidential Decree on the Creation and Management of the PCFIR, promulgated and effective as of 22 August 2017. The PCFIR:

- deliberates upon and coordinates policy measures submitted by various ministries and the committee members;
- organises public campaigns related to the 4IR and encourages public participation;
- prepares the groundwork for regulatory and institutional reforms in support of public-private partnerships; and

Meeting with the PCFIR

- fosters ecosystems for new industries (e.g. Special Committee on Smart City, Special Committee on Healthcare).

The PCFIR benefits from the work of successive governments which have committed resources to ICT and 4IR. For example, Korea leads the world in internet speeds and smartphone penetration and is currently leading the global race to commercialise 5G, as detailed below.

The PCFIR's reach across the innovation ecosystem of Korea represents a significant channel to key stakeholders for potential UK-Korea collaboration.

2.4 5G: Global Leader

Korea launched the first 5G deployment worldwide when nearly £2.6 billion was spent by three operators in 5G band auctions. The three operators launched their 5G network simultaneously on 4 April 2019. Initially, there were only a few industrial clients (low-latency video monitoring for supply chain), which was followed by a fast ramp-up in the consumer market, a key driving factor of this being the roll-out of 5G for buildings. As of early May 2019, there was a large customer pool of 260,000 customers and 54,000 base stations installed. The 5G network has difficulty keeping up with demand.

Korean manufacturers are advanced and cover the entire ecosystem. Samsung has one of the 5G base stations. LG and Samsung have a few 5G-ready handsets, with more models to be launched in the near future. Most have a hefty price tag attached to them.

There are several areas of focus for 5G use cases, including Ultra HD content, AR and VR content, Smart Cities, Smart Homes, Smart Factories, and Smart Offices. As many of these use cases can be run on the Long-Term Evolution (LTE) network, operators are struggling to find 5G specific applications and are looking at new ways to recoup the significant investments on the 5G network.

[6] https://www.s-ge.com/en/article/news/20174-mem-korea-industry-40-update.

Generating Momentum

Building on existing UK-Korea collaboration in 5G

In 2018, the Korean 5G Forum (a non-profit organisation established in May 2013 with the aim of globally leading and promoting 5G towards the year 2020) and the UK 5G Innovation Network (which was founded in January 2018 and aims to boost the development of the UK's 5G ecosystem, facilitating the engagement and coordination of organisations and businesses working on 5G activities across the UK) signed a MoU to regulate how they would cooperate and collaborate with one another to achieve their objectives.

The MoU is valid for two years and enables both parties to cooperate, exchange ideas and collaborate in the following areas:

- information exchange regarding 5G mobile communication technology;
- analysis of technology trends;
- discussion of global standardisation trends;
- promotion of 5G ecosystem growth; and
- other areas as agreed between the two organisations regarding next-generation mobile communications.

The scope/objectives of the 5G Forum are to: develop vision and service; study spectrum aspects; identify potential technologies; collaborate for global harmonisation, and act as a bridge between industries and government.

In addition, the UK 5G Innovation Network will enhance links between ongoing research and development and other activities being undertaken by organisations across telecoms and other sectors, as well as across the UK Government's 5G Testbeds and Trials Programme. The Network will also provide information on UK capabilities, and help to encourage increased inward investment.

One of the concrete activities that emerged from the signature of the MoU was the £2.4 million UK/South Korea 5G Challenge[7]. The competition that recently closed had the aim of developing new and novel applications and services that can be ready for 5G and enable collaboration between UK and South Korean organisations.

The successful applicants will test their solutions in a subway environment, initially across the Seoul subway system, but potentially extendable to other forms of transport, and travelling at greater speeds.

The competition is part of the UK's 5G Testbed & Trials (5GTT) Programme, which aims to maximise the opportunities for UK businesses, especially SMEs, to develop new 5G applications and services for both domestic and global markets. The competition was funded by the UK's Department for Culture, Media and Sport (DCMS) and the Korean Electronics and Telecommunications Research Institute (ETRI).[8]

[7] https://www.gov.uk/government/news/the-24-million-uk-south-korean-5g-challenge.

[8] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/797954/Final_copy_-_Infotainment_Services_for_Transport_Environments_Competition_Guidance__1_.pdf.

2.5 IoT Networks: Global Leader

Although Korea is the first 5G deployment worldwide, it also has multiple IoT-specific networks catering for Smart Homes and Smart Cities applications. These include:

- Sigfox: Deployment ongoing, in-country partner, suited for small data.
- LoRa: Deployed in 2016 by SKT, suited for small data.
- LTE-M: Deployed in 2016 by all three operators, suited for data, or voice and video.
- NB-IoT: Deployed in 2017 by LG U+ and KT, suited for small data.

2.6 SME-Enterprise and Innovation

As previously mentioned, to address current and emerging socioeconomic challenges in Korea, the government is encouraging the growth of SMEs. In order to achieve this goal, the government established the Ministry for SMEs and Start-ups (MSS). This shift to SMEs is challenging due in part to the cultural and economic dominance of chaebols, which are large industrial conglomerates that are run and controlled by an owner or family in Korea. Given this, the chaebols have begun to recognise the importance of a vibrant SME sector within the Korea innovation ecosystem. For example, Hyundai provides an accelerator and venture fund to provide a flow of innovative ideas, technologies and SMEs to support their global growth.

With venture capital surpassing KRW3 trillion (US$3 billion) last year and the number of new venture companies exceeding 100,000 for the first time, the government is set to infuse an additional KRW12 trillion (US$12 billion) into the ecosystem by 2022 in order to push venture investment in the country for the second time post the 2000s. Of this investment, a scale-up fund will raise the amount for new venture investment to KRW5 trillion (US$5 billion). In addition, an "M&A-only fund" worth KRW1 trillion will be established by 2021 to encourage companies and investors to participate in recovery markets.[9]

Aligned to the above investment, the Korean government has recently introduced a regulatory "sandbox" to enable regulations to be developed, allowing the Smart Cities policy objectives to be realised. The government also seeks international collaboration and knowledge transfer opportunities, as evidenced by an increasing number of bilateral MoUs related to Smart Cities that have been agreed with countries such as The Netherlands and Germany.

During the mission visit, officials from the Korea Agency for Infrastructure Technology Advancement (KAIA) and representatives of the PCFIR expressed strong interest in Korea-UK collaboration, including agreeing to form a UK-Korea MoU related to Smart Cities. The UK strengths that are of particular interest to Korea - and which could form an initial basis for future collaboration and a MoU - include UK capability and expertise in AI, Blockchain, IoT, Standards, and design-led innovation for SME-led growth.

Complementing this, Intralink[10] has identified the following opportunities for growth:

Autonomous vehicles	Driving platforms, machine vision, AI.
Hydrogen for energy	Charging stations and infrastructure to support hydrogen vehicles.
Energy savings technologies	Energy efficiency is critical to Busan and Sejong projects.
Energy management platforms	Data analytics to support intelligent power distribution.
Drones	Korea's UAV hardware/software capabilities are weak due to regulatory restrictions.
Blockchain	Used for EMR, but also logistics such as smart ports.
Sensors	Sensors for IoT applications in industrial, waste management and energy settings.

[9] https://koreatechtoday.com/korean-government-to-create-12-trillion-won-of-a-scale-up-fund-by-2022-for-a-second-venture-boom/
[10] Intralink (2019): Smart Cities South Korea Market Intelligence Report June 2019. United Kingdom: Department for International Trade.

3. Korea Smart Cities

3.1 National Smart Cities Strategy

Smart Cities are a key part of the Korean government's industrial policy. The Smart City projects are designed to achieve twin objectives: 1) improvements in the lives of Koreans; and 2) economic growth through the development and commercialisation of emerging Fourth Industrial Revolution technologies. Technology deployed in Smart City projects has the potential to be deployed nationwide, as well as in markets outside of Korea.

The Smart City policy is coordinated by PCFIR and the Ministry of Land, Infrastructure and Transport (MOLIT). Significant political support has been given to national Smart City projects, and the MOLIT is motivated to finish the flagship projects before the end of President Moon Jae-in's term in 2022.

3.1.1 Projects and Timelines

The Korea Smart Cities initiative is comprised of three types of national projects: 1) Flagship Pilot Projects; 2) R&D Validation Projects, and 3) Urban Regeneration Projects.

Flagship Pilot Projects

Flagship Pilot Projects aim to demonstrate the full capability of Korea's Smart City capability. They are designed to meet the needs of citizens and enable the growth of high-value start-ups and scaleups through demand-led innovation and enterprise. Busan and Sejong City were selected in early 2018 from a total of 39 candidate cities by the PCFIR. Greenfield sites in both cities, approximately 2-3 square kilometres, were chosen due to the ease of development in terms of cost and time. President Moon Jae-in's government has announced two Smart City pilot projects in Busan and Sejong City worth a combined £3 billion, of which £1.8 billion is to be provided by national government funding, which was approved in late 2018. Construction is due to begin in late 2019 with the first residents due to move in by late 2021. Key services in these pilot projects will centre on mobility, energy, education, healthcare and infrastructure.

R&D Validation Projects

R&D Validation Projects aim to advance a Use Case Model in Daegu, and a Living Lab Model in Siheung. Both will be connected to an Open Source Urban Data Hub which includes the collection, storage and sharing of data across an integrated city-wide platform, as well as its use in component services. The cities will serve as testbeds for the Korean Smart City model. The two projects have a combined budget of £75 million and will run for five years through to the end of 2022. Research in Daegu will target intelligent mobility, crime prevention and resilience in response to natural and human-made disasters. Projects in Siheung will concentrate on the environment, welfare and energy.

Urban Regeneration Projects

Urban Regeneration Projects will take place nationwide, including in Daejeon, Gimhae and Bucheon. These projects will aim to resolve the problems of older urban areas through the use of data connectivity, rather than large-scale redevelopment. The projects are small-scale and thematic in nature. In February 2019, MOLIT announced the cities of Daejeon, Gimhae, and Bucheon as the recipients of a total £7.5 million in funding. Daejeon's theme will be a "Re-New Science Town", that aims to showcase general scientific R&D as many corporate and government research centres are located in the city. Bucheon will focus on using big data analytics to monitor and reduce air pollution throughout the city, while Gimhae will invest in AR and VR attractions for its historical sites.

3.1.2 Key Services of National Pilot Projects

A recent report commissioned by the Department for International Trade (DIT)[11] identified that the following key services of the national pilot projects are aligned to sectors where there is significant potential for Korea to meet the needs of its citizens:

Mobility	Autonomous vehicles, last-mile solutions, AI traffic control.
Energy	Smart grid management, solar generation, hydrothermal energy.
Healthcare	Blockchain EMR, drone first responders, caretaker robots, AI diagnostics, wearables for first responders.
Education	Edutech platforms, alternative assessment methods.
Infrastructure	Cloud-based logistics, smart factories, automated water meters.

[11] Intralink (2019); Smart Cities South Korea Market Intelligence Report June, 2019. United Kingdom: Department for International Trade.

These services have also been recognised as holding significant potential to develop wealth-creating innovation and enterprise.

3.1.3 Regulations and Vendor Selection

The Korean government has created regulatory sandboxes in both Busan and Sejong. These regulatory sandboxes, approved in September 2018, lift regulations related to Smart City development in areas such as data collection, autonomous vehicles, drones, and land use. If the pilot projects that are rolled out under these sandboxes are successful, the regulations may be revised nationwide to spur the development of Smart City projects by other regional and municipal governments.

Vendor selection will likely use a special purpose entity or public-private partnerships, a final decision is expected in mid-2019. Foreign companies can apply to participate in government-led projects through Korea's Public Procurement Service, but there are cultural, language, and business environment barriers. Foreign companies are, therefore, strongly advised to partner with companies based in Korea. This also is compliant with the government's preference to engage with local businesses, as such foreign companies need to demonstrate added-value.

3.2 Case Studies

The Fourth Industrial Revolution aims to be a people-centred initiative that will improve people's quality-of-life by resolving chronic social problems and creating high-quality innovations and enterprises. The industrial innovation will span healthcare, manufacturing, vehicles, energy, finance and logistics, and agriculture and fisheries. These innovations will aim to resolve social problems that face cities, transportation, welfare environment, safety and defence. To support rapid development and diffusion of technological innovations, the Korean government has established a programme of social-consensus "hackathons" to inform regulatory and institutional reform.

The PCFIR announced a portfolio of innovation initiatives to deliver this vision. Below, five case studies are considered in detail: two new national testbeds (Busan and Sejong); one existing smart city initiative (Seoul); and an R&D validation (Daegu and Siheung).

3.2.1 New Smart City: Busan

K- Water (Korea Water Resources Corporation) is the Smart City developer of the Busan Smart City, which is near the Gimhae International Airport in a coastal area in the south of Korea. The masterplan for this project is led by Mr Jaewon Peter Chun, the National Smart City Master Planner from the PCFIR. As the second-largest city in Korea, the city faces many challenges, including that of an ageing population. With several high-quality universities in the area, there is good potential for Busan to attract and retain talent to deliver on three key areas:

Smart Water City

Busan is known for water, which is a key topic for smart city development. The city has excellent international seaports, and one of the longest rivers in Korea flows through the city. For many years the water has been contaminated due to the illegal disposal of chemical waste. President Moon Jae-in's Administration has put K-Water in charge of cleaning the river pollution problem. K-Water will utilise advanced water-related technologies to realise Smart Water City in Busan and resolve the river pollution challenges.

Smart Tech City

Busan has struggled to attract and retain graduates from the local universities, who often choose to find jobs in the Seoul area. In response, Busan will be positioned as a vibrant innovation ecosystem - a place where start-ups and SMEs can innovate to create and then scale technology-led innovations to serve the needs of Busan and other Smart Cities globally.

International Cooperation In Busan Smart City

The Korean government intends to open its market to foreign entities, which will be supported by its global living lab and international exchanges.

During the mission, delegates conducted a site visit and met with officials from the Busan IT Industry and Promotion Agency (BIPA). With a clear focus on job creation in Busan, BIPA aims to enable a productive start-up ecosystem by offering customised IT/CT training, a one-stop start-up support service, and support for self-sustainable networks.

Within the year, the Busan Smart Cities programme aims to start supporting joint ventures. With a total development budget of approximately £1.2 billion, a significant share of this is earmarked for Korean-foreign joint ventures to demonstrate tech. The criteria for selection has not yet been decided, but the foreign companies would need to have Korean relationships, including the ability and desire to work together. In addition, the programme might ask the other country's government to provide joint funding.

Driving this ambition for innovation and collaboration is the creation of a Busan Smart City innovation ecosystem, which aims to foster new industries and develop into an eco-friendly future waterfront city. Construction will begin at the end of 2019, with the ambition for citizens to move into the new Smart City and experience it first-hand by the end of 2021.

Smart City Busan: Vision

"In a Smart City, technologies come alive for people.

Behind the facade of the facilities visible are the key technologies of the Fourth Industrial Revolution connected like neural networks through every nook and cranny. They will make our lives safer and more convenient.

Those services that have been available separately thus far, including transport, public security, disaster prevention, administration, healthcare and day care, will be linked with each other in a well-organised and efficient manner.

If you live in Busan's Smart City in 2022, you can save up to 124 hours a year: 60 hours spent on daily commutes, 20 hours on administrative work, 5 hours waiting at hospitals and so on. An integrated safety management system utilising Fourth Industrial Revolution technologies will make it possible to notify the general public of information about such disasters as earthquake and fire immediately and to dispatch fire trucks within 5 minutes. The urban crime rate can be reduced by 25% and traffic accidents by 50%.

Everyone can benefit from tailor-made healthcare programmes with a real-time health monitoring system. They will also be able to receive robot-assisted daily support with the adoption of home artificial intelligence assistants, autonomous delivery robots and rehabilitation robots."

- Remarks by President Moon Jae-in at Busan Smart City Innovative Strategy Presentation. 13 Feb 2019.

For UK start-ups, Busan could serve as a testbed for innovative Smart Cities technologies, which they could then use as a pathfinder to enter and scale-up in the wider Asian market.

3.2.2 New Smart City: Sejong

This national pilot project aims to become the leading Smart City in the world. As a greenfield initiative, Sejong is guided by a philosophy to create a sustainable platform city that increases the happiness of citizens and offers creative opportunities. It will directly address urban problems such as pollution, fast energy consumption, serious congestion, and natural ecosystem destruction. In doing so, the city is being designed around values that promote lifestyle, work-life balance, and human-centric and eco-friendly living.

To deliver the Sejong Smart City vision, data and services will flow between seven Innovation Factors, each enabled by an integrated blockchain architecture:

- Mobility: The city maintains the economic expenditure and comfort, with the aim to gradually decrease the total number of cars to one-third.
- Healthcare: The city acts quickly (emergency) and pre-emptively (prevention) throughout the medical network environment.
- Education: The city increases critical and creative thinking and provides education for start-up and jobs.
- Governance: Citizens solve problems in the city by themselves and test basic income through cryptocurrency.
- Culture and shopping: Through customised prediction services, the city provides different cultural experiences and convenient shopping environments.
- Jobs: Through cooperation and co-existence among various parties, the city forms a sustainable economic ecosystem.
- Energy and environment: Renewable energy and E-mobility demonstrate a participating and climate-neutral city model.
- Urban spaces: The city sources flexibility of spatial use, tests job-housing proximity and aims to create an eco-friendly environment.

The technical challenges required to deliver the vision are considerable; correspondingly, there are also significant opportunities for UK-Korea collaboration and synergy.

During the mission, Sejong officials demonstrated that they are open to a dialogue on determining what the offer should

Meeting in Sejong

be for companies validating and demonstrating their services in their testbed, apart from the regulatory sandbox. In addition, the Sejong Smart City project team is actively trying to identify UK start-ups interested in demonstrating their products and services in Sejong's testbed. However, the offer for the companies is yet to be defined.

With a clear aim to crystallise available opportunities, the SIN, KTN, and the European Enterprise Network (EEN) are already working to support the selection of companies and raise awareness of the capabilities of UK Smart Cities start-ups to the Smart Cities team.

Areas where the UK is best positioned to add value include technology standards; AI; user-centred design; and city-based start-up acceleration.

3.2.3 Existing Smart City: Seoul

Seoul has been the Korean capital for 600 years, and is the centre for politics, culture and the economy. Just 60 years ago, Seoul was in the ruins of war and one of the poorest cities globally. Since this time, Seoul has risen with rapid urbanisation to become a world-class metropolitan city with a population of 10 million. The city has become a sustainable Smart City with the ability to solve diverse urban problems such as housing, water and sewage, rubbish collection, transportation and welfare.

Seoul has won the first place seven years in a row in a "Global e-Government Survey", sponsored by the United Nations. The Seoul Metropolitan Government (SMG) provides citizens with CCTV for safety, public WiFi for network connectivity and various services based on the ICT infrastructure. The SMG seeks to solve urban problems by encouraging citizens to express their opinions and participate in public administration more actively through channels such as mVoting, 120 Call Centre, and Seoul Smart Complaint Report.

Since 2013, the SMG has supported the private sector in developing new services that citizens want by disclosing 4,500 public datasets in machine-readable formats. Since 2015, Seoul has embarked on a plan to become the "Global Digital Capital" by 2020. Particular effort has been directed at supporting a number of citizen-enabling initiatives, including the creation of "Social Seoul City", which seeks to achieve 50% of digital projects being led by citizens. The SMG is also proactive in supporting the digital economy through its engagement with digital industries.

The Seoul Smart City initiative is directly controlled and led by the SMG; and, to a large extent, successfully so. There does not appear to be direct and formal engagement with the new Smart Cities projects of Busan and Sejong, suggesting a potential lost opportunity to share knowledge and learning within the Korean ecosystem.

Seoul: Smart City leadership

With a population of around 10 million citizens, and another 15 million people living in its wider reaches, Seoul is a global city with challenges related to pollution, traffic congestion and the limited availability of affordable housing. Mayor Park Won-soon was elected to office in 2011 and started a programme of engagement of citizens. For example, citizens are invited to debate current and major policy issues and to participate in problem-solving for issues faced by their community, both online and offline in "field offices" visited by the mayor, where he can discuss issues directly.

The city also encourages the engagement of its citizens by holding innovation competitions to find smart solutions to Seoul's problems and has provided a collaborative public space in the City Hall for events and activities such as discussions and lectures, as well as exhibitions and community recreation programmes. In mid-2016, the Seoul Digital Foundation was established with the goal of driving and facilitating digital innovation in the city. It is responsible for fostering a digital economy, researching and consulting on information and communication technologies and their potential applications to solve Seoul's problems.

In 2019, the City of Seoul plans to install 50,000 IoT smart sensors throughout the capital city so that by 2022 they are able to collect information on fine dust, traffic and other things related to citizens' lives. In addition, chatbots will be added to its 120 Dasan Call Centre service, a civil complaints hotline. The project involves spending KRW1.4 trillion (£954 million) over the next four years to turn Seoul into a "capital of big data".[12]

With a clear focus on achieving its Global Digital Capital goals, areas where the UK may provide significant synergy and collaboration with the City of Seoul include UK knowledge transfer in user-centred design and city-based start-up acceleration.

3.2.4 R&D Validation in Daegu and Siheung

The National Strategic Smart City Programme includes a Smart City model development project. The City of Daegu will deploy a Use Case Model for service enhancement; and, the City of Siheung will deploy a Living Lab Model for innovation and Business intelligence. Connecting the two cities will be an Open Source Urban Data Hub.

This programme was designed and launched to develop standardised open data hub architecture, which will be the common basis to apply transparency and sharing of administrative services, and to facilitate growth in the digital economy.

Development of the Smart City Model and Base technology includes:

Data hub	Design of the cloud-based open data hub architecture model to collect, process and store data with standard data models and interfaces.
Massive IoT standards	Development of intelligent IoT devices, infrastructure enhancement, network establishment and control technology for massive IoT data processing (e.g. transportation, environment, energy, safety).
Digital twin	Using virtual platform technology development for rendering and real-time establishment and control technology for massive IoT data processing (e.g. transportation, environment, energy, safety).
Data governance	Developing a model to manage Smart City R&D project.

[12] https://hub.beesmart.city/city-portraits/smart-city-seoul-part-1-the-power-of-citizen-participation http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=3060520

Meeting with KAIA

During the mission, discussions regarding the data hub, digital twin and data governance suggested that the Korean approach was still relatively immature. Some of the information management work being undertaken in support of the Digital Framework Task Group in the UK, for example, could offer considerable benefits to the Koreans and also enable the UK to test its concepts in a receptive market. Aligned to this, the UK is significantly engaged with the wider debate about data ethics and trust and the use of citizen's data. Each area represents significant scope for UK-Korea collaboration.

3.3 Barriers to Implementation

In developing its Smart Cities projects, the Korean government has identified a number of areas that it will target to create social benefits (e.g. mobility, healthcare, energy). The Korean government intends to share data arising from these projects to enable start-ups and scaleups to innovate, creating technology-led innovations for social benefit and economic gain. Yet, their silo approach to project planning and implementation limits interaction and diversity, resulting in sub-optimal innovation and enterprise development.

For success in the Fourth Industrial Revolution (4IR), all economies need to embrace the opportunities offered by innovation. Although Korea excels on tangible drivers of innovation such as ICT adoption, where it ranks first globally, it very clearly struggles on the less tangible drivers of innovation. Globally, in critical thinking, Korea is ranked 90th, for interaction and diversity it's ranked 80th, and for entrepreneurial and corporate cultures, it's ranked 50th. This lag could be caused by a tendency toward uncertainty avoidance; indeed, Korea ranks 77th globally for entrepreneurial risk-taking and 88th globally for employee empowerment. A more vibrant innovation ecosystem would allow Korea to more effectively translate their research efforts into economic growth and increase long-term resilience.

The lack of direct user-engagement limits the potential for strong product-market fit and the realisation of the government's policy to support innovation and enterprise. An approach around place-making and full user engagement during each stage of product and service development is not obvious in the current plans. User-centred design and participatory development would go some way to de-risking issues around public acceptance and trust of Smart City solutions, especially as Korea is also looking to enter into European markets.

In addition, the relatively immature approach to data modelling, coupled with the apparent silo approach, will significantly hamper cross-domain information sharing and thus reduce the benefits that could accrue from the development of an integrated data model. The UK's work on high-quality data modelling could facilitate the development of an integrated data model that helps the Koreans to address these constraints. If this were coupled with the development of relevant standards, the benefits would be shared by the UK and South Korea.

With a focus on user-centred development and data modelling, the UK is particularly strong in developing entrepreneurial culture enabled by interaction and diversity. This UK expertise represents a significant opportunity for synergy and collaboration to overcome some of the key barriers to implementation.

4. Synergies

4.1 Collaboration Synergy

As noted above, Korean industry generally seeks to innovate via the development of the incubation model, while the Korean government generally seeks to develop innovation and enterprise through policies that enable the growth of high-value start-ups and scaleups. Both industry and government are keen to forge links with UK expertise.

It is clear that in some areas, Korea is in a particularly strong position with regards to the take-up of advanced technologies and 5G deployment. Given this, the mission observed a disconnect between the policy aim to be people-centred (e.g. user-centred design, co-design) and the use cases, which were mostly tech-led. The UK has particular strengths to offer which could be used to support colleagues in Korea to deliver their policy aim to be people-centred, including user-centred development, AI, standards, and data modelling. Bringing together such capacity and capability provides a unique opportunity for collaboration and synergy. In doing so, city demonstrators in both Korea and the UK could serve as testbeds and demonstrators for home and overseas markets, helping to accelerate improvements in quality of services for all citizens.

Both Korea and the UK have Smart Cities demonstrators running. Many of the social challenges faced in Korean cities are similar to those experienced in UK cities, such as how best to provide social care for older people. To achieve this, enabling technologies such as mobiles, IoT, AI, 5G and big data are used to create technology-led services.

4.1.1 Industrial Innovation and Enterprise

Korean companies such as Hyundai Motors are developing a global accelerator model and venture arms to support innovation and rapid commercial distribution, with reach to such cities as Berlin, Tel Aviv, and San Francisco. UK start-ups are encouraged to participate in such activities.

4.1.2 Innovation Ecosystems

Enabled by its new Smart Cities projects, Korea seeks to create vibrant innovation ecosystems to support innovation and enterprise. The UK has extensive experience in helping start-ups and scaleups to flourish, and this experience may be shared with Korea counterparts to create synergy and collaboration. To illustrate, the total venture capital investment in UK technology in 2018 topped £6 billion, more than any other European country. The recent growth rate of 56% for London tech scaleups makes the cluster first in the world for scaleup growth. With £5 billion of scale-up investment, the UK ranks fourth in the world, after the US, China and India.

Collaboration Models

There are a number of existing collaboration models between the UK and Korea which can be leveraged to accelerate the development of opportunities. These models include:

- Korea is a Eureka Country, which is part of the European Commission's H2020 programme.
- MoU between Korea 5G Forum and the UK 5G Innovation Network.
- MoU with Korea and the UK governments in 2018 to increase bilateral trade and investment.
- The UK has a very active Science and Innovation Network team in South Korea that has Smart Cities as one of its priority areas. Their relations and effective engagement is ideally positioned to be leveraged and expanded to support collaborations in Smart Cities.
- DIT South Korea has Smart Cities as a priority area. It has a series of activities lined up such as a Trade Mission and UK Pavilion at the World Smart City Expo, and an upcoming visit of SK Telecoms to the UK.
- The British Standards Institute has an office in South Korea.

Korean Collaborations: Engagement by other countries

Sweden

- A MoU between KAIA and Viable Cities has been drafted, and the document is under review. The collaboration will focus on Smart City living labs and testbeds and international standardisation. The parties are holding a joint workshop during the Barcelona Smart City Expo in November 2019.

European Innovation Partnership

- KAIA signed a MoU with the European Innovation Partnership on Smart Cities and Communities which was established by the European Commission in November 2018.
- The partnership is on establishing the foundations for international collaboration, the opening of innovative policy lab, networking between cities, joint R&D and tech demonstration.

Portugal

- KAIA signed a MoU with Braga City of Portugal in November 2018.
- The partnership is focused on the development of Smart City solutions, smart water grid, city planning, engineering, building, technology, environment and energy. They are working on the development of a joint R&D programme and researchers exchange programme.

The Netherlands

- In July 2019, the Ministry of the Interior and Kingdom Relations and the Korean Ministry of Land, Infrastructure and Transport (MOLIT) signed a Smart City MoU. This MoU will increase the chances of sustainable cooperation and business.

5. Potential Areas for Collaboration

A recent report commissioned by DIT South Korea[13] has demonstrated that there are concrete commercial opportunities for UK businesses in the Korean Smart Cities environment, as detailed below:

5.1 Sector Opportunities

An analysis of the Fourth Industrial Revolution (4IR) policy by Intralink reported the following sector opportunities:

Transport	Autonomous vehicles, driving platforms, machine vision, AI.
Drones	Korea's UAV hardware and software capabilities are weak due to regulatory restrictions.
Sensors	Specialised sensors for IoT applications in industrial, waste management and energy settings.
AI	Healthcare (e.g. drug discovery, medical care).
Blockchain	Healthcare (e.g. Electronic Medical Records). Logistics (e.g. smart ports).

In addition to the above, one sector where the Korean 4IR programme and KAIA could fortuitously develop collaborations is in the area of energy and renewable energy strategies, given that the country's energy mix for low or zero-carbon generation stands at around 4% and the rapid pace of envisaged city creation in Korea. Potential energy sector opportunities include:

Hydrogen for energy	Charging stations and infrastructure to support hydrogen vehicles.
Energy-saving technologies	Energy efficiency will be a key component across the Busan and Sejong projects.
Energy-management platforms	Data analytics to support intelligent power distribution.

Within the sector of renewable energy strategies, shared projects could include:

- Solar farms in surrounding areas of planned new developments.
- Microgrid, embedded generation and energy storage combinations.
- Better performing building technologies in terms of heat and energy optimisation.
- Out of city wind and solar systems to reinforce the green energy mix on the grid. One of the developments was in a coastal zone providing a clear opportunity for offshore renewable solutions.
- Heat capture and utilisation.
- Domestic energy management and balancing utilising EV battery storage.

[13] Intralink (2019); Smart Cities South Korea Market Intelligence Report June, 2019. United Kingdom: Department for International Trade.

5.2 City-Based Innovation Ecosystems

Over several decades, Korea's five largest companies have been the leading innovation and enterprise solution providers for the nation. However, with ever-increasing global competition, there is growing recognition that innovation and enterprise creation will be an essential driving force for future prosperity. The powerful companies are looking to innovate via the incubation model; meanwhile, the Korean government focuses on the development of city-based innovation ecosystems as a driving force for enterprise creation.

Notably, Korea's Smart Cities projects are advancing independently, with little evidence of a formal policy that brings together a shared vision. This lack of collaboration, if it continues, will likely reduce opportunities for synergy, innovation and enterprise. Notwithstanding this risk, the 4IR encourages international collaboration, especially in the area of knowledge transfer and investment into Korea. Within this policy context, the UK has extensive experience enabling the growth of start-ups and scale-up by enabling inclusive and diverse city-based innovation ecosystems. In cities across the UK, SMEs, corporates, investors, academics, lawyers, and others come together in formal and informal ways to create and grow enterprises. This unique UK experience may be shared with colleagues in Korea, providing mutual benefit.

As Korea advances to the next stage of development, nearly all facets of standards-setting for the above sectors appeared to be in an embryonic state. Recognising UK expertise in standards-setting, KAIA expressed strong interest in UK-Korea co-development of international standards. In particular, there is a significant UK-Korean collaborative opportunity to lead on the development of internationally-recognised Smart City Data Standards for 4IR, servicing innovation and enterprise creation. Joint UK-Korea development of new British Standards Institute standards positioned at the confluence of IoT, 5G, AI, and big data - and which ensure regulatory alignment, deliver enhanced cybersecurity, and generate desired user benefits - is an unmissable global market-shaping opportunity.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