

A Study on the Service Provision Direction of the National Library for Children and Young Adults in the 5G Era

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ABSTRACT

In order to establish a digital-based use environment for the provision of new information services suitable for the 5G era, it is necessary to discuss the direction of service provision by the National Library of Children and Young Adults in the 5G era. Based on utilization services in other fields, library services in the 5G era, including the development and provision of employee education and training services, ultra-high-definition and 360-degree realistic contents and education on library use, provision of multi-dimensional realistic media streaming broadcasting services, provision of telepresence education programs, activation of virtual communities, implementation of hologram performance halls/exhibit centers, and provision of unmanned book delivery services, environment monitoring, safety monitoring, and customized services, were proposed. In addition, based on 5G service, 5G technology, and library application direction, advancing into a producing and supporting base for ultra-realistic and immersive contents in the 5G era, strengthening online and mobile services in the non-contact era, and establishing a smart library environment were proposed as the service provision direction for the National Library of Children and Young Adults in the 5G era.

1. Introduction

Since its opening in 2006, the National Library for Children and Young Adults, a representative national library that supports research activities of workers and researchers in related fields, has provided opportunities for children and young adults to develop their dreams, imaginations, and hopes for the future through the library. Nevertheless, the National Library for Children and Young Adults has the disadvantage of being located in the commercial district of Teheran-ro, Gangnam-gu, Seoul, to which the access of children and adolescents is limited due to its geographical location. In addition, the National Library for Children and Young Adults has constantly received users' request

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for library relocation for the problems of being located at a commercial district near Gangnam Station where adult entertainment establishments are concentrated, insufficient parking spaces, lack of accommodable spaces for group users or user participation programs, securing multipurpose spaces for family visitors, improvement of environment for spaces for children's materials, distributed storages and restrictions on immediate service provision due to the lack of bookshelves and library spaces. In particular, with the advent of the 4th Industrial Revolution and the 5G era, there have been changes in the reading behavior of children and youth. The 3rd Reading Culture Promotion Basic Plan and the 2019 National Reading Survey, which studied the changes in reading behavior, introduced the changes in reading behavior by broadly dividing them into strengthened qualitative reading, change in reading method that emphasizes how to read rather than what to read, social reading activities that share knowledge and information gained through reading, expanded multimedia reading embracing interactive and multimedia elements, increased preference for e-books among all age groups, higher preference for audiobooks by students than adults, and a trend of decreased annual reading volume. In order to keep pace with such changes in the reading behavior and respond to new information demands of users, it is necessary to establish a digital-based use environment for the provision of new information services suitable for the 5G era and to discuss the direction of service provision by the National Library for Children and Young Adults in the 5G era.

The purpose of this study is to present the direction of service provision, as a library representing children and adolescents, in line with the changing roles in the 5G era by deriving implications through domestic and international case studies. More specifically, it is to set the mid-to-long term development direction centering on the expansion of the participatory reading promotion programs and library service provision direction characteristic to non-contacts, such as providing non-face-to-face and non-contact library services, and establish a plan for reorganization according to service expansion in order to respond to social changes arising from the 4th industrial revolution era, 5G era and COVID-19. In addition, it also aims to suggest a space composition that corresponds to the context of the National Library for Children and Young Adults, service expansion and creative and innovative complex cultural space.

2. Research Method and Content

This study was carried out largely through literature studies and case studies. Literature research includes research and analysis of domestic and international convergence and integrated reading promotion programs and operating services, research and analysis of reading promotion programs and services at the National Library for Children and Young Adults, development directions for children and youth reading promotion programs in the era of the 4th Industrial Revolution, and reading behavior of children and youth and direction of library service provision in the 5G era. Similarly, case studies include research and investigation on the current status and construction cases of children and youth libraries at home and abroad, case studies of children and youth reading content services in domestic and overseas complex cultural spaces, investigation of cases of the use of complex cultural spaces in children and youth libraries at home and abroad, and case studies

of organization and division of duties among children and youth libraries at home and abroad. Also, the study conducted a survey on user needs for the relocation and reorganization of the National Library for Children and Young Adults and collected opinions from librarians and experts for analysis of user needs, opinions of librarians in charge of library services for children and youth, investigations of opinions of experts in the field of library and reading, library and information science, and review and reflection of opinions on each stage of the research through advisory meetings.

3. Theoretical Background

3.1 Concept and Application Industry of 5G

3.1.1 The Concept and Definition of 5G

5G is one of the new technologies that emerged in the era of the 4th industrial revolution. If an analogy between the 4th Industrial Revolution and humans is to be drawn, various devices of the 4th Industrial Revolution corresponds to the body organs, data to the sensory information that human body feels, artificial intelligence to the human brain, and 5G to the neural network that connects all of them together (Hong, 2019). Then, how is 5G that acts as a neural network defined? 5G (fifth-generation mobile communication) is a next-generation mobile wireless network technology, and is defined as mobile communication with improved eight technologies compared to 4G mobile communication (IMT-Advanced).

Table 1. Minimum 5G Mobile Communication Performance

Item	Remark	Item	Remark
Max. transmission speed	20Gbps	Response speed	1ms
User experienced transmission rate	100Mbps	Maximum number of connected devices	10 ⁵ /km
Frequency efficiency	3-5 times compared to 4G	Energy efficiency	100 times compared to 4G
High speed mobility	500km/h	Data processing capacity per area	10Mbit/s/m ²

*Source: Ministry of Science and ICT. 2019

The characteristics per mobile communication generation are shown in **Table 2**. In the 4G era, services that utilize large amounts of data, such as mobile streaming services e.g. Netflix and YouTube, have grown representatively based on the popularization of smartphones and tablets, and increased transmission speed, and text-oriented SNS has changed to share photos and videos. On the other hand, in the coming 5G era, diversification of provided contents and convergence of technologies representing the 4th industrial revolution such as cloud and IoT are expected to be promoted on

the basis of improved features.

Table 2. Characteristics Per Mobile Communication Generation

Item	3G	4G	5G
Year of commercialization	2006	2011	2018
Device	Regularization of smartphones	Popularization of smartphones and tablets	Device diversification
Major change	Beginning of Internet access Emergence of data service	Increased data transmission speed Universalization video calls	Massive connection and speed increase Reduced delay time
Main service	Video call, Internet	Multimedia (video)	AR/VR, Hologram, IoT,
Major global services	Smartphone platform competition: Android, IOS Started using low-volume, text-oriented SNS PC-oriented web hard (insufficient utilization of mobile)	Streaming platform competition: Netflix, YouTube, etc. SNS paradigm shift (photo, video centered) Mobile cloud (web hard level)	Platform for each core service: autonomous vehicle, immersive content, etc. SNS development focusing on high-definition and immersive video Universalization of cloud service (storage and computation functions, etc.)
Max. transmission speed	14Mbps	75Mbps	20Gbps

*Source: NIA National Information Society Agency. 2019

3.1.2 Key Features and Expected Effects of 5G

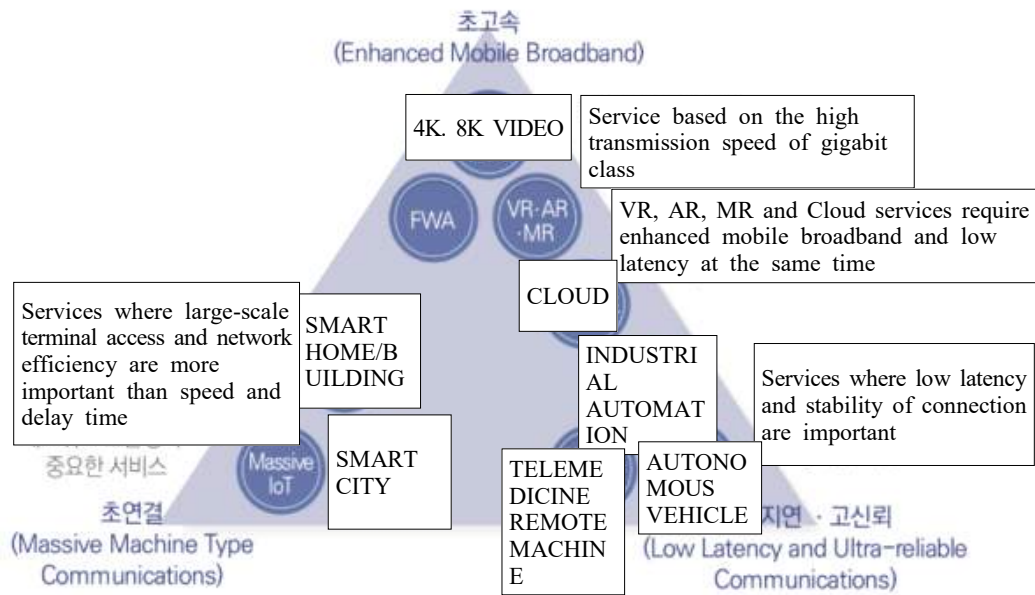
The main features of 5G networks are presented as ① Enhanced Mobile Broadband, ② Low Latency and Ultra-Reliable Communication, and ③ Massive Machine Type Communication (Samjeong KPMG Economic Research Institute, 2019; NIA National Information Society Agency, 2019).

Table 3. Key Features and Expected Effects of 5G

Feature	Detail	Expected Effect
Enhanced Mobile Broadband	Telecom companies increased the speed up to 20 times compared to LTE speed through new technology to secure wide bandwidth and improve speed. (Maximum speed) 1Gbps (4G) → 20Gbps (5G) (Experience speed) 10Mbps (4G) → 100Mbps (5G)	Activating the use of large-data-based contents such as ultra-high definition video, VR · AR · XR, 4K/8K UHD services, and hologram services by transmitting larger data faster. Stable transmission of ultra-large-data content even in dense areas while moving
Low Latency and Ultra-Reliable Communication	Delay time refers to the time taken from request to response when the terminal communicates, and 5G presents its vision of within 1ms.	Implementation of real-time service with no delay by using it in telemedicine and self-driving cars that require immediate response

(Delayed speed) In 5G mobile Fully autonomous driving, telemedicine, communication, a mini-slot with a real-time robot and drone control, interactive reduced slot length (in 4G mobile games, etc. communication, data is transmitted in units of slots, so data transmission requires at least 1ms time) to achieve a response speed of less than 0.5ms. (Speed) 350km/h (4G) → 500km/h (5G)

Massive Machine Type Communications (MTC) The number of devices that can be connected in a unit area (km²) is (IoE), large-scale Internet of Things (IoT) increased 10 times compared to LTE, environment by greatly increasing the number enabling 1 million IoT connections. of terminals and sensors that can be connected (Connection density) 100,000 units to the Internet. per km² (4G) → 1 million units per km² (5G) As an energy-efficient IoT service, it is also used as a base technology for smart city, smart (Energy efficiency) Low efficiency home, and large-scale sensor monitoring. (4G) → High efficiency (100 times compared to 4G) (5G)



*2019. Source: Korean Intellectual Property Office, 2017; Kim Hak-yong, 2019

As such, the key feature of 5G is to transmit large-data contents at a speed of 20 Gbps, which is 20 times faster than that of 4G mobile communication (LTE). In addition, since the data processing capacity is 100 times larger, it does not only have low latency, enhanced mobile broadband, and massive MTC but also receives multimedia services without interruptions while moving at 500 km/h. In fact, it is a system providing IoT services by connecting about 100,000 deices to one base station through a network (Korean Intellectual Property Office, 2017). With the advent of the 4th industrial revolution, immersive display services, such as virtual reality, augmented reality,

and holograms, ultra-low-latency services, such as autonomous driving and remote control of robots, and super-access services, such as IoT, are required by numerous industries, leading to the effortless emergence of 5G mobile communication that can fulfill such requirements (Korean Intellectual Property Office, 2017). Furthermore, it can be also said that a prerequisite environment for the realization and convergence of the 4th industrial revolution technologies has been established through 5G technologies.

3.2. 5G Application Industry and Service

3.2.1 5G Application Industry

5G, the fifth generation mobile communication, is a general-purpose technology characterized by 'high speed', 'large capacity', 'high density', 'high energy efficiency', 'low latency', and 'high stability' and has a great influence on the whole industry. Technology development and standardization have been undertaken to support changes, beyond the changes in daily life, in various industries (Lee, 2019). Virtual reality, augmented reality, autonomous vehicles, medical services, and mining are expected to be some of the major industrial fields to which 5G technology will be applied (OECD 2019), and attempts to incorporate 5G centering on energy, transportation, mobility, healthcare, agriculture, public safety, environment, travel, and culture have been made. It is also anticipated that 5G technology will be expanded to more diverse areas in the future.

Table 4. 5G Application Industry

Industry	Description
Automobile	With the expansion of 5G, the demand for transportation and information that provides the means of transportation can be more easily known and matched. (Smart Mobility) Real-time generation and exchange of information on demand and supply for transportation can be expanded, optimizing travel routes and translating autonomous vehicles into reality
Public transportation	Along with 5G, the level of autonomous vehicles will also improve, and the connectivity of roads, streetlights, traffic lights, and CCTVs will expand. When autonomous vehicles develop, vehicles and roads exchange data, and it is expected that a more efficient and safer environment for transportation will be established.
Manufacturing	If the connectivity inside and outside of factories is enhanced through the expansion of 5G, it is expected that the automation of unmanned factories and all manufacturing areas will expand. (Smart factory) Wireless factory, remote repair and maintenance, ultra-realistic digital twin, etc., utilize 5G features such as ultra-high speed and ultra-low-latency for factory efficiency.
Distribution	(Smart Distribution) The entire distribution process can be shared in real time, providing various services by collecting product supply information and distribution information. 5G is expected to generate and exchange more product supply information, distribution information, and purchase information of consumers. This allows manufacturers to offer more personalized products and services to customers, and rather, can reach customers directly, without going through distribution channels. It is expected that changes in the environment, such as innovation in delivery and

	logistics through data connection between the value chains of manufacturers-wholesale-retail, IoT such as drone, and unmanned delivery as well as store innovation, e.g. unmanned stores, will appear.
Energy	With sensors (super connectivity) that will be closely installed along with 5G, the amount of power, gas, and water consumption in various spaces can be measured, controlled, and managed in real time. One of the expected benefits from this is to prevent resource waste and contribute to environmental protection by accurately matching power production and consumption.
Agriculture and livestock industry	In the agricultural and livestock sector, 5G is particularly expected to revolutionize precision agriculture and smart green houses, via automatic measurement, analysis, and management of conditions of agricultural and livestock facilities, such as temperature, humidity, sunlight, carbon dioxide, soil, etc., based on IoT.
Financial service	It is expected to affect overall financial services by omitting unnecessary processes and automating necessary processes as much as possible. Authentication automation is expected to be made available by expanding various wearable devices and applying and expanding biometric information authentication through 5G Consultation, payment, and remittance are likely to be automated with A.I. and robots, and it is expected that the trend of unmanned store in financial institutions will accelerate further (e.g. unmanned banks and credit card companies).
Public Safety	With 5G, more densely installed sensors will enable real-time monitoring of fire, crime, flood damage, etc. Drones and robots may be deployed in the future to solve safety problems detected in real time. In addition, as a simple example, it can also guide fire engine or emergency vehicle to the optimal travel route for it to reach the site as fast as possible. (Disaster Safety) Realization of services to prepare for and respond to disaster situations, e.g. 3D drawing transmission and real-time transmission of wireless CCTV data in case of emergency
Healthcare	It will decentralize the existing medical system and bring about changes that reduce costs and increase benefits. Away from the spatial concept of a hospital, it is expected to develop in the direction of increasing benefits for medical blind spots such as telemedicine. (For example: In Japan, medical insurance can be applied to telemedicine. So, even if you receive medical treatment online through a mobile application, you can receive medical insurance benefits.)
Media & entertainment	With high-speed and large-capacity data transmission and reception of 5G, an environment for using 8K contents, beyond 4K, will be prepared, and the use and spread of high-definition video streaming and ultra-realistic (augmented and virtual reality) content will accelerate. Dynamic and immersive content can be used in sports and industry through education, training, and remote access and control, and if it becomes more sophisticated and further develops, virtual environment can replace the current setting for travel and business meetings Accelerating the influence of individual content creator, such as YouTubers
Education	Student's understanding can be improved and class can be made more immersive by developing ultra-realistic educational contents
Tourism	Can be applied to services for tourists' convenience and entertainment facilities, such as realistic sports and intelligent room service.
Insurance	Products such as life insurance and fire insurance can be personalized through various personal histories such as exercise patterns and driving patterns while setting reasonable insurance premiums.

Smart City	<p>Smart City is a city that improves the quality of life of citizens and the efficiency and competitiveness of city operations and services based on intelligent information exchange using digital technology.</p> <p>It is directly related to the industries affected by 5G, such as automobile, energy/public, healthcare, public safety and public transport, and various other factors are additionally connected or linked to operate the entire city. For example, smart home, gas & water leakage management, pollution management, open data, traffic management, water quality management, smart building, smart parking, electromagnetic wave management, education, electric vehicle charging, smart environment management, smart street light, smart energy, waste management are all linked to be used for efficient operation of the whole city</p>
Working environment	<p>With immersive contents enabled by 5G, a virtual work environment that remotely brings people together and enables them to feel like they work in one place can be created.</p> <p>In business automation, not only the production process automation but also office work automation is expected to accelerate further along with 5G. Currently, RPA (Robotic Process Automation, a technology that formalizes data generated in business processes and performs such processes logically and automatically) is gradually spreading. Through RPA, it is expected to improve office work productivity by reducing simple and repetitive office work and reducing errors.</p>

* Source: NIA National Information Society Agency, 2019. Kim Yun-hyung, 2018. Shin Dong-hyun, 2019. Korean Intellectual Property Office, 2017.

3.2.2 5G Application Service

In 2014, the Ministry of Science, ICT and Future Planning established the ‘Creative 5G Mobile Strategy’ and selected future SNS, mobile stereoscopic image, intelligent service, high-speed service, and UHD/holograms as the five core 5G services. Indeed, KT, Giga Korea Project, and Korea Information and Communication Technology Association also selected and introduced major fields and services that can utilize 5G.

First, KT presented 41 applications in 7 industries based on 5G. The KT Economic Management Research Institute published the 5G guidebook, “The Beginning of All New Worlds, 5G. Changes You.” The 5G guidebook explains features such as massive MTC, ultra-low latency and enhanced mobile broadband and introduces applications that can be used through technologies such as virtual reality, real-time monitoring, and remote control.

Table 5. 7 industries and 41 applications

Connected Car	Network evolution Service	<ul style="list-style-type: none"> • Vehicle-to-everything (V2X) 1. Cooperative formation of autonomous vehicles 2. Autonomous shuttle bus 3. Autonomous valet parking 4. Remote support for autonomous driving in case of emergency 5. Advanced driver assistance system 6. Advancement of HVI such as augmented reality and voice recognition 7. Real-time high-quality entertainment
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Smart Factory	Network evolution	8. Service-type mobility
	Service	<ul style="list-style-type: none"> • Private 5G 9. Intelligent video control 10. Predictive maintenance of equipment and facilities 11. Production quality control 12. Collaborative robot 13. Remote control and automation 14. Virtual training 15. Professional remote support 16. Autonomous unmanned vehicle
Immersive Media	Network evolution	• Edge CDN
	Service	17. Personal immersive media 18. Avatar communication 19. Live broadcast 20. VR theme park 21. MR experience-type sports
Tourism	Service	22. Intelligent room service 23. Amenity robot 24. Smart tourism 25. Immersive sports arena 26. Smart golf
	Service	27. Autonomous cluster driving of freight cars 28. Advanced logistics management system 29. Drone transportation system 30. Smart store 31. VR·AR shopping
Disaster Management	Network evolution	<ul style="list-style-type: none"> • Removal of shaded area in firefighters' communication network • Emergency communication network using aircraft
	Service	32. Locate sufferers 33. Provide real-time evacuation route 34. Wearable device utilization by rescuers 36. Remote emergency care
Public safety	Service	37. Real-time facility control 38. Ocean·river real-time control 39. Park·green area safety management 40. School zone safety management 41. 360 degree video security

In addition, industrial areas that are expected to increase synergy when converged with 5G are selected and invested in.

Table 6. 5 areas of Giga KOREA Project/ Korea Information and Communication Technology Association

Giga KOREA Project		Korea Information and Communication Technology Association	
5G-Auto Drv	Safe autonomous shuttle service Autonomous service for vulnerable road users Artificial intelligence	Immersive 5G Service	Virtual reality/augmented reality service Large data content streaming Telepresence service

	intersection service		
5G-Smart City	Safety service based on wireless CCTV Drone-based remote control service Provision of information based on cloud sourcing	Intelligent 5G Service	User-centric computing service Crowded area service
5G-Industry	Manufacturing specialized machine vision Multifunctional manufacturing robot service AR-based remote equipment management	Omnipresent 5G Service	IoT-based service
5G-Guardian	Fire response service Response services for signs of building collapse Traffic accident on-site response service	Autonomous 5G Service	Smart Transportation Service Robot-based service Drone-based service
5G-Media	VR-based Wellness Service 360 VR broadcast, immersive personal broadcast AR-based media service	Public 5G Service	Disaster monitoring Emergency service

NIA National Information Society Agency also introduced major services that can be implemented based on the three characteristics and five core technologies of 5G as follows. The types that can be applied to industries based on the three characteristics of enhanced mobile broadband, massive MTC, and ultra-low latency were selected as the five core technologies. Most 5G-related services can be implemented with a combination of technologies such as remote control, context recognition, mass connection, fixed wireless access, and ultra-realistic and immersive technologies.

Table 7. Analysis of Major 5G Service Types and Status

5 Core Technologies	Description	Service
Remote control	Can be applied to services sensitive to communication delays such as autonomous vehicles and remote medical robots using the ultra-low latency characteristics of 5G (Opportunity) No. 1 robot distribution rate, manufacturing strength, excellent medical quality (Limitation) Ultra-low latency level, telemedicine system	(Disaster) Disaster monitoring through drone remote control (Traffic) Remote control of vehicle (Construction) Remote control of heavy equipment in hazardous areas (Medical) Remote surgery
Context recognition and diagnosis	Implement a system that quickly transmits large amounts of data to the cloud, analyzes the current situation and provides feedback (Opportunity) Early commercialization of 5G (Limitation) Business Model	(Manufacturing) Machine vision such as identification of defective products (Security) Detection of abnormal activities using CCTV (Construction) Smart measurement through

		3D camera
Mass connection	Big data collection by installing a large number of terminals such as sensors within a unit area using the massive MTC characteristic of 5G (Opportunity) Applicable to national smart city model (Limitation) Insufficient application of smart meters in the energy field	Smart city utilization → Mass connection of energy meters such as power, gas and water → IoT, such as autonomous vehicles, in an unit area is expected to rapidly increase
Fixed wireless access	Provides services at the level of wired Internet speed using fixed wireless access technology in areas where it is difficult to establish wired infrastructure such as rural and coastal areas (Opportunity) Islands, mountains, and global level ports (Limitation) Need to diversify business models	(Remote area) High-speed Internet service (Coastal area) Berthing and convenience services using 5G
Ultra-realistic immersion technology	Improved learning effect and understanding by reducing the constraints of distance, e.g. realizing the environment of a distant space (Opportunity) Hallyu, sports, personal media (Limitation) Device performance, hologram performance hall etc.	(Personal) Ultra high-definition, 360-degree immersive content (Manufacturing) Remote maintenance support, etc. (Culture) Hologram performance, virtual tour, etc.

3.3. 5G Era and Library Service

Among the various 5G application services mentioned above, this study focused on the cases related to the services that have been actively used and implemented. By doing so, an attempt was made to derive implications that should be noted by the library in the 5G era.

3.3.1 Immersive Media Service

Through VR/AR technology, one of the representative immersive media, that reproduces performances as the same as those played at actual sites, users can watch a performance, almost the same quality as that of the actual site, at anywhere they are.

In addition to performances, it can be applied to a wide scope of entertainment contents that are not easy to actually experience, such as sports viewing and documentaries utilizing costly equipment, safety education, expeditions to the far-flung corners of the world, cultural experiences, and virtual experiences of famous places and tourist attractions.

Table 8. Immersive Media Service

Case	Description
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Training Contents	<p>ANA Group introduced local 5G to ANA Blue Base for the first time in the aviation industry in connection with NEC.</p> <p>Plan to enhance the efficiency of aircraft maintenance and crew training by utilizing various IoT devices such as cameras, gaze measuring devices, vital sensors, and VR goggles connected to local 5G.</p> <p>All Nippon Airways (NH) also introduced NEC's VR system in earnest and used it for training about 800 cabin crew members. By simulating and training the crews of in-flight situations that are difficult to be reproduced in reality, such as fire and sudden pressure reduction through VR, it aimed to cultivate cabin crews who can respond promptly and appropriately in case of emergency.</p>	
KT Super VR	<p>Immersive video and VR games can be used through personal immersive media services.</p> <p>In addition, it includes an immersive service that can use 360-degree videos of tourist attractions, performances, and athletic events in live form. Viewers can watch games from desired direction and angle, allowing the viewers to feel the sense of realism and as if they are in the grandstand while at home.</p>	
University of Maryland Health Sciences Libraries	<p>Health Sciences Libraries play a role in helping clinicians, faculty, students, and researchers learn and utilize VR·AR technology.</p>	
Google Expeditions AR tours program	<p>Provide diverse experiences with a focus on cultural characteristics of arts and living things</p>	

*Source: Baek Yeon-sik, 2016. Lee Seong-cheol, 2019

One of the main expected effects that can be derived from the following examples is that it is possible to reproduce situations that are difficult or limited in reality with VR/AR for training. Therefore, for the purpose of library application, first, it is expected to be useful for job education and safety education as employee education and training services for librarians. Second, by developing and providing ultra-high-definition, 360-degree immersive contents, it is expected to be able to produce and provide various immersive contents such as games and travel.




3.3.2 Multi-view Interactive 3D Service

With the development of digital and communication technologies, the distribution and demand for multimedia contents centered on audio and video in various fields such as the Internet and

personal media as well as broadcasting and movies are rapidly expanding. Previous media services focused on the expression of simple sounds and images due to various technical limitations; however, in the world of 5G, it became possible to express and process multi-dimensional immersive media that can give users a sense of immersion and provide multi-dimensional immersive media streaming broadcasting services.

Moreover, multi-view interactive 3D services of 5G can provide users with a sense of depth and three-dimensional effects of videos. Multi-view videos refer to the filming of three-dimensional scenes from multiple angles using multiple cameras; a scene is captured from different angles to provide an image from a desired angle to users. Nonetheless, since there are as many images as the number of cameras, the amount of data is very large, and a technology for effectively storing and transmitting them is essential.

Table 9. Multi-view 3D Service

Case	Description
Sync View	<p>SyncView service, with mobile communication module in micro cameras, transmits ultra high-definition images in real time through Active Antenna, a 5G-based technology. Through a technology that synchronizes different videos, viewers can select videos either from the player's or broadcasting view, providing vivid videos to allow viewers feel as if they play the game</p> 
Mortenson Center	<p>(360° VR library tour) Used for user orientation and education and inside and outside tour of the library. It displays the profile of the librarian in charge when clicking on 'data' or 'information desk' and links to the service page when clicking 'detailed information.' Enhances user experience by sharing videos of programs carried out in the space and promoting library events</p> 
University of Arkansas-Pulaski Technical College	<p>The 360 Virtual Reality Tour provides videos, photos, and brief explanations as if the users were looking at the library, and the library space can be freely explored by moving the space through selecting with the mouse. Web and mobile versions are provided separately, and library tours using virtual reality headsets are also available.</p> 

*Source: Baek Yeon-sik, 2016. Lee Seong-cheol, 2019



The main expected effect that can be derived from the following examples is that the users can feel a sense of realism, as if they are in the library, regardless of the actual location and time. For the direction of library application, first, contents using VR/AR, such as introduction of internal and external spaces of the library and education related to library use, as a form of library use education, are expected to be developed and provided. In fact, 360° multi-view videos have already been used by many libraries for the introduction and exploration of their libraries. Second, it is the provision of multidimensional immersive media streaming broadcasting service;

without visiting the library, performances, events, and various programs held in the library can be filmed as 360-degree videos and provided as live or filmed copies.

3.3.3 Telepresence service

Technologies that make users feel as if they are in the same place even though they are at a distant place are collectively called Telepresence Service. In addition to feeling the presence of something, it can also consider sharing the five senses, including tactile sensations. In order to share these senses, images such as VR and holograms may be used, or physical systems such as robots may be used (Korea Information and Communication Technology Association, 2022). On the other hand, “telepresence” education is the application of technology to communicate with life-size people far away by using 5G communication technology.

Table 10. Telepresence Service

5G Convergence Service	Description
Hanyang University ERICA Campus	<ul style="list-style-type: none"> - Talent cultivation through telepresence (remote reality) education using 5G communication technology and IC-PBL (industry-Coupled Problem-Based Learning). - Hanyang University uses a method in which life-sized professors appear as holograms for telepresence education and simultaneously provide lectures to three physically separated classrooms, allowing 100 students to ask questions and discuss in real time. - With its first introduction in March 2019, the classes are planned to be expanded to five subjects starting from the second semester, and exports to overseas are in progress
	




*Source: Baek Yeon-sik, 2016. Lee Seong-cheol, 2019

These technologies are expected to contribute to bridging the educational gap by providing high-quality lectures to middle and high school students in farming and fishing villages. As such, the provision of telepresence education programs is also included in the direction of library application. It is highly anticipated that the library will not only provide video contents using 5G technology through various platforms, but also provide real-time education programs regardless of region and distance through telepresence education programs.

3.3.4 Non-contact communication service

Avatar communication is one of the ways to support non-contact communication. For the realization of avatar communication, 3D image big data plays an important role. Artificial intelligence studies the big data through machine learning, analyzes individual photos, and implements them in the form of emoticons. When a 3D avatar capable of projecting one's own image is created based on facial recognition technology, large data transmission and computing technology enable the individual's actions or facial expressions to be expressed in real time, and 5G allows implementing more delicate emotion expression of the avatar.

Table 11. Non-contact Communication Service

Case	Description	
KT, narle	5KT's 5G video call service launched with 5G commercialization 3D avatar, AR emoticon, video call game service, YouTube during phone call, file transfer, photo sharing, etc. are provided.	
SKT, Virtual Social World	A service centered on communicating and building relationships with multiple people who have access to the virtual world. Some consume contents in a space prepared with 7 themes after creating a fictional character (avatar) to represent themselves	
OKSUSU SOCIAL VR	Using a VR device, the users can enter into a virtual space with their avatar and communicate with other participants while viewing the same video content.	




*Source: Baek Yeon-sik, 2016. Lee Seong-cheol, 2019

The main expected effect that can be derived from the following examples is that the users can make friends to shop, listen to music, and participate in K-pop star performances and fan meetings in a virtual space. Therefore, it is possible to promote virtual space communities. The users can enter into virtual space to read, learn, play games, and communicate with other library users.

3.3.5 3D hologram service

Holography is a technology that records three-dimensional information that is no different from a real object using the effect of light interference, and hologram refers to a photographic film or a reproduced image in which an image of an object is recorded through holography technology. (Korea Information and Communication Technology Association, 2022, 5G service roadmap 2022). Through the development of hologram technology, real-time, ultra-immersive mobile holographic communication services are expected to become available in the future. Those who cannot actually go to the stadium and watch major Olympic Games can get a very realistic user experience, compared to watching the games through the TV, via real-time ultra-immersive mobile hologram tables using hologram technology. In addition, through 5G-based real-time hologram technology, holographic text information can be sent and received, and the image of the user who sent the message appears on the mobile device based on the hologram technology. In the case of a video call, it is also possible to provide an unaffected user experience, such as having a conversation with others reproduced through hologram technology on a mobile device.

Table 12. Hologram Service

5G Convergence Service	Description	
Naju National Museum	Gilt-bronze shoe of Mahan from the 6th century, 2/3 of which was remaining, was photographed with 151 special cameras in all directions, and 10,000 images were combined to restore the original gilt-bronze shoe image in 3D hologram Permanent exhibit at Naju National Museum in Naju, Jeollanam-do	
Klive	The world's first holographic performance hall, 'Klive,' organized by the Ministry of Science, ICT and Future Planning, KT and YG Entertainment, is expanding its scope from a K-pop concert hall to the latest technology experience learning center.	
KT Hologram Live	Hologram Live is an ultra high-definition remote hologram service transmitted through 5G mm Wave backhaul technology. Used in interviews and performances	

*Source: Baek Yeon-sik, 2016. Lee Seong-cheol, 2019



The main expected effect that can be derived from the following examples is using hologram technology, one of the hyper-realistic and immersive media, during performances such as concerts to enable singers at various locations to perform as if they are on the same stage. Consequently,

hologram performance hall/exhibition hall is also included in the direction of library application. Various performances and exhibitions through holograms are expected to be available in the performance halls and exhibition halls of the library.

3.3.6 Mobility service

It refers to services that can create new added value through the convergence of 5G and traffic systems, including smart traffic services and drone-based services, such as autonomous driving vehicles, traffic safety, and traffic control. In particular, drones can be used in many application fields with the advantage of being able to monitor and fly a wide area without space constraints, receiving public attention as an industrial field capable of continuous growth. If the technical limitations of drones are overcome through 5G technology, drones are expected to be applied to military, disaster monitoring, large structure management, smart vehicles, disaster rescue activities, logistics, and the construction of a mobile surveillance network using drones. In addition, the 5G network for drone services is divided into and include a data link for transmitting images and collected data captured by drones and a control link for controlling drones. Moreover, drones can also be used for monitoring disasters and checking the condition of large structures such as dams and bridges. In doing so, a network among drones and various sensors installed in the area can be established.

Table 13. Mobility Service

Case	Description	
Nuro's R1 (Self-driving vehicle for delivery)	Kroger, a large distribution company, needs an inexpensive and fast delivery method for customers who have difficulty visiting stores. Accordingly, Kroger entered into a strategic alliance with the self-driving car manufacturer Nuro and began testing autonomous vehicles with a driver on board from the fall of 2019. Nuro's prototype model R1, 1m wide and about 680kg, can carry up to 110kg. It is said that it can deliver fresh food (with separate refrigeration space) and general products as well as dry-cleaned clothing.	
Ministry of Science and Technology Information and Communication on Korea Post	Autonomous mobile post office, robot postman, and postman follower robot will be introduced (October 2020) using 5G and artificial intelligence (AI) technology.	
KT, 5G	5G buses are connected to the vehicle control center through 5G to share the location information of other	

autonomous vehicles and obstacles to prevent collision
bus and drone

Propose new services combining autonomous 5G buses
and autonomous drones



Wing's drone book loan service "Wing," a drone company supported by Google, started lending books using drones to more than 600 teenagers in the Montgomery County School District, Maryland.



*Source: Baek Yeon-sik, 2016. Lee Seong-cheol, 2019 https://www.netmanias.com/ko/post/operator_news/8456;
<http://www.klive.co.kr/>; Shin Dong-hyung, 2019; <https://www.mk.co.kr/news/it/view/2020/05/546571/>,
<https://www.nytimes.com/2020/06/17/us/google-wing-drones-virginia-books.html>

The main expected effect that can be derived from the following examples is that services can be provided in a variety of ways for users who are difficult to make a visit. As such, unmanned book delivery service seems to be within the direction of library application. If remote control technology, artificial intelligence, drone technology and autonomous driving technology are used, book delivery service through unmanned vehicle control is likely to be available. In fact, as mentioned in <Table 10>, Wing's drone service has been used to provide library's drone-based book lending service for the first time to teenagers in the Montgomery County School District, Maryland. After receiving students' orders for books through Google Form, librarians at local libraries search for the books and prepare them by hanging the books on a string lowered to the ground by drones. Then, the drones go to the Wing's drone launch facility to deliver the books to a corresponding destination. When the drone arrives at the destination, it will drop the books and pull back the string to terminate the delivery service

3.3.7 IoT service

Following the Industrial Revolution and the Information Revolution, the whole world is undergoing a revolution of hyper-connectivity based on the Internet of Things (IoT), in which everything is connected to the Internet. As the number of things connected to the Internet rapidly increases and the price of sensors decreases, it is expected to create utility values through disruptive innovation in various fields of society. When 5G is activated, various types of terminals having completely different characteristics compared to 4G will appear. Beyond the smartphones everyone carries around, one person will have several wearable devices, and various devices in living spaces will have a

communication function, ensuring effective communication and generating a very large amount of information. Exceeding the scope of communication between people, vast amount and various dimensions of information, including time and space, will be collected through various object terminals before being stored in a huge storage device and used for various purposes through big data technology.

In addition, mobile broadband public safety communication refers to the radio wave communication used by organizations responsible for instruction or management at emergency sites for various accidents and disasters. Market needs for services that can systematically improve the ability to respond to situations that threaten public safety are expected to arise steadily.

Table 14. IoT Service

Case	Description	
Smart Building	<p>Home networks connecting TVs, PCs (including tablets), game consoles and various home appliances can also be included in the scope of IoT. Depending on the environment, even an entire office or building can be considered.</p> <p>A convergence network including various sensing devices and various functions, e.g. lighting, will be formed with the goal of controlling lighting and temperature in the building, improving energy efficiency, and preventing crime.</p>	
U+ intelligent CCTV (Disaster Accident Monitoring Service)	<p>Install wireless sensors in the areas or places to be monitored</p> <p>By connecting installed CCTVs and etc., public safety can be monitored at all times, and immediate actions can be taken through the linkage with police and fire fighting facilities.</p>	

*Source: Baek Yeon-sik, 2016. <https://blog.lgcns.com/2147>; <https://it.donga.com/29753/>; <http://www.aetimes.kr/news/articleView.html?idxno=11367>

First, environmental monitoring can be derived from the following examples for the direction of library application. It includes various sensing devices and lighting with the aim of controlling lighting and temperature in the library, improving energy efficiency, and preventing crime. Second, the safety of the library can be monitored in real time by connecting CCTVs with wireless sensors installed in the library.

3.3.7 User-centric computing service

The scope of IoT can be divided in various ways from the scope of an individual to the scope of a society (see **Table 15**).

Table 15. User-centric Computing Service

Case	Description
User-centric Computing Service	<p>information on recommended means of transportation and arrival time in line with daily routine through various monitoring devices and location recognition in one’s regular commute or travel path can be provided. Also, various information according to individual’s consumption and eating patterns can be provided.</p> <p>Big data-based situation information collected through various sensors is recognized, interpreted, and inferred to understand the user’s situation before providing or reorganizing contents/services to suit the situation.</p> <p>Intelligent healing services such as personal health management, psychological therapy, stress overcoming, silver care, social life coaching, and business coaching based on big data can be provided by continuously collecting life logs related to personal health, psychological status, and social life</p> <p>Mobile life-coaching service that offers know-hows of professional counselors, psychologists, philosophers, and sociologists based on big data information collected through various sensors can be provided.</p>

*Source: Baek Yeon-sik, 2016. <https://blog.lgcns.com/2147>; <https://it.donga.com/29753/>; <http://www.aitimes.kr/news/articleView.html?idxno=11367>

The main expected effect that can be derived from the following examples is providing information based on big data collected from user terminals and sensors. In addition, it can provide customized knowledge service by converging/processing the experience of library users and the knowledge of experts. Libraries can thus provide customized services and develop library collection based on big data information collected through user terminals and various sensors in the library.

In summary, 5G wireless mobile communication (5G, 5 Generation) technology can be said to be the core infrastructure of the 4th industrial revolution that connects (massive MTC) large data and everything in real time (ultra-low latency) faster (enhanced mobile broadband) without delay (Ministry of Science and Technology Information and Communication, 2019). When 5G mobile communication is commercialized various services are expected to be available through increased information transmission capacity and speed and expanded range of content utilization. Focusing on the services in which 5G has been actively used and implemented, the following implications for libraries to pay attention to and the directions for providing services that can be used in the library in the 5G era are suggested as followed. (see **Table 13**).

Table 16. Library service in the 5G era

Three Characteristics	Expected effect	Library service	
		Category	Sub-category
Enhanced Mobile	Activate the use of large-data-based contents	Immersive Media	(Education and training service for employees) Used for job education and safety education for librarians

Broadband	such as ultra-high definition video, VR · AR · XR, 4K/8K UHD service, and hologram service by transmitting larger data faster.	(Development and provision of ultra-high-definition, 360-degree immersive content) Produce and provide various immersive contents such as games and travel.
	Stable transmission of ultra-large content even in dense areas while moving	(Library use education) Develop and provide contents using VR/AR, such as introduction of spaces inside and outside the library, education related to library use, etc. (Provision of multi-dimensional immersive media streaming broadcasting service) Without visiting the library, performances, events, and various programs held in the library can be filmed as 360-degree videos and provided as live or filmed copies
		Telepresence service (Provision of telepresence education programs) Through telepresence education programs, education programs can be provided in real time regardless of region and distance.
		Non-contact Communication Service (Activation of virtual communities) Users can entering into the virtual space to read, learn, play, and communicate with other library users.
		3D Hologram Service (Hologram performance hall/exhibition hall) Various performances and exhibitions through holograms are expected to be available in performance halls and exhibition halls of the library.
Low Latency: Ultra-reliable Communications	Real-time service implementation without delay by utilizing telemedicine and self-driving cars that require immediate response	Mobility service (Unmanned Book Delivery Service) Utilizing remote control technology, artificial intelligence, and autonomous driving technology is expected to enable book delivery service through drone or unmanned vehicle control in the future.
	Fully autonomous driving, telemedicine, real-time robot and drone control, interactive games, etc.	
Massive MTC	Realization of the Internet of Everything (IoE), large-scale Internet of Things (IoT) environment by greatly increasing the number of terminals and sensors that can be connected to the Internet.	(Environment monitoring) Various sensing devices and lighting are included for the purpose of controlling lighting and temperature in the library, improving energy efficiency, and preventing crime. (Safety Monitoring) Library safety can be monitored in real-time by connecting CCTVs with wireless sensors installed in the library.
	As an energy-efficient IoT service, it is also used as a base technology for smart city, smart home, and large-scale sensor	(Provision of customized services) Personalized services can be provided based on big data information collected through user terminals and various sensors in the library. It can be also used for library collection development, etc.

monitoring.

3.4. Service Provision Direction for the National Library for Children and Young Adults in the 5G Era

Based on the 5G application services and the directions of 5G technology application in the library mentioned earlier in the text, the study seeks to suggest the service provision direction for the National Library for Children and Young Adults in the 5G era. More specifically, based on the suggestions made earlier, the promotion works and contents of each phase that the National Library for Children and Young Adults can refer to, in terms of contents and services, are as follows (see **Table 17**).

Table 17. Strategic Tasks of Each Phase (Example)

Service Area		Phase			
Strategic Task Promotion Work		Details	1st Phase (2021-2022)	2nd Phase (2023-2024)	Third Phase (2025~)
2-1 Advancement of services in the era of 5G and 4th industrial revolution	2-1-1 Advancement into a production and support base for ultra-realistic, immersive contents	Laying the foundation as a base for producing and supporting ultra-realistic and immersive contents	●		
		Production and distribution of ultra-realistic and immersive contents	●	●	
	2-1-2 Reinforcement of online and mobile services in the non-contact era	Reinforcement of video contents in library services	●		
		Introduction of online and mobile-based library use education	●	●	
		Introduction of SNS·chat program·video call program based programs	●	●	●
	2-1-3 Establishment of smart library environment	Review of introduced technologies to which a smart environment needs to be implemented	●		
		Promote building a smart library environment		●	●

3.4.1 Advancement into a production and support base for ultra-realistic, immersive contents

In the cultural industry such as reading, performances, sports, and tourism, the need to provide user experiences for holograms and VR/AR contents has been on the rise. Therefore, it is necessary to develop ultra-realistic and immersive contents using cutting-edge technologies for the library in the era of the 4th industrial revolution and 5G.

In order for the library to perform its function as a base for producing and supporting ultra-realistic and immersive contents and to provide programs and services for various immersive contents and ultra-high-quality videos, the library must be equipped with relevant spaces, equipment, and facilities. Daeseong-dong, equipped with a wireless-based standalone VR device through the 'Genie Sarangbang', real-time live sports, movies, and entertainment contents can be enjoyed via VR. In virtual reality, the user can create interactive contents themselves or experience them together. For the production and support of such immersive 5G contents, 5G-based VR/AR content development equipment such as HMD with 5G module and 360° VR camera have been secured.

Meanwhile, from a spatial standpoint, makerspace is a representative space of the recent library where the users can experience and use various technologies to perform different production and creation activities. Therefore, it is deemed essential for the National Library for Children and Young Adults to help the library users experience immersive contents, secure spaces for direct production of realistic contents and ultra-high-quality video and sound sources and expand equipment and facilities through strengthening makerspaces.

Next, the library is expected to become able to develop and provide ultra-realistic and immersive contents. As the transmission and reception of high-speed, large data is made available by 5G, the use and spread of 8K and augmented and virtual reality contents are accelerating. For example, in the field of culture and tourism, with the 'Seokguram HMD Travel Experience Center' service provided at the 2015 Gyeongju Culture Expo, visitors were not only able to virtually experience Seokguram at close range, but also enjoy the game elements included in the program (Newsland, 2015). In addition, hologram works of cultural properties were exhibited at the Children's National Folk Museum of Korea, and demonstration exhibitions were also held at the National Museum newly built in Kazakhstan (Korea Creative Content Agency, 2015). Accordingly, the library sector is also expected to become able to produce and provide various immersive contents based on topics related to reading, such as games, exploration, experience, and travel.

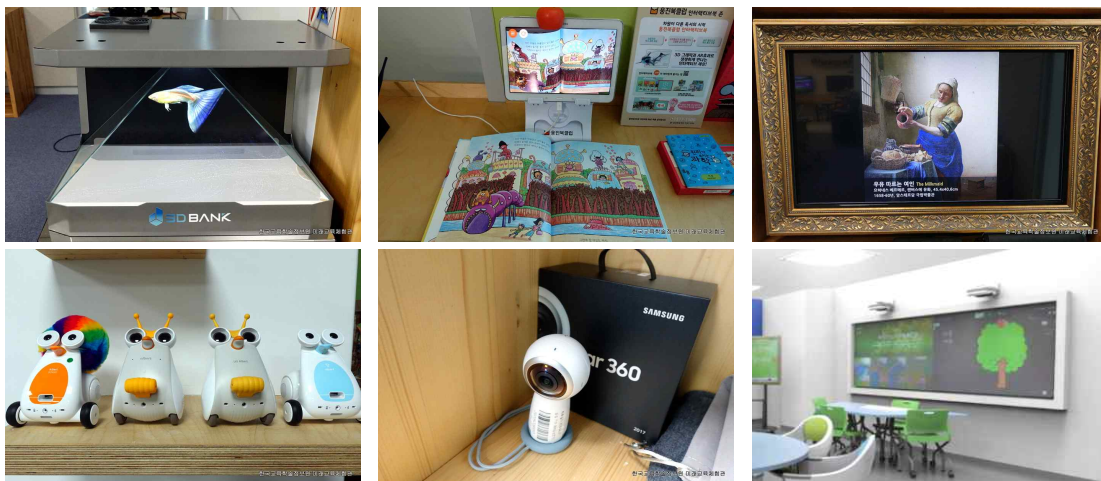
The implementation details for the production and provision are as follows.

First, in order for the library to perform its function as a base for producing and supporting ultra-realistic and immersive contents and to provide programs and services related to various realistic contents and ultra-high-quality images, the library must be equipped with relevant equipment and facilities. For the production and support of such immersive 5G contents, 5G-based VR/AR content development equipment such as HMD with 5G module and 360° VR camera must also be secured. Meanwhile, from a spatial standpoint, it seems necessary for the National Library for Children and Young Adults to help the library users experience immersive contents and secure spaces for direct production of realistic contents and ultra-high-quality video and sound sources through strengtheni

ng makerspaces.

Second, the 'digital textbooks and realistic content apps' and 'future education experience center' promoted by the Ministry of Education, realistic career education contents developed by each city, and SKT's 'Establishment of Augmented Reality (AR) and Mixed Reality (MR) Eco Museum Based on 5th Generation Mobile Edge Computing (5G MEC)' can be used as a reference in setting the direction of the library's hyper-realistic and immersive content development.

The Future Education Experience Center of the Korea Education and Research Information Service can be considered as one of the examples that can be referred to. The Future Education Experience Center of the Korea Education and Research Information Service is used as an experimental space for experiencing future classrooms and researching future education. The center can be regarded as a test bed of IT technology suitable for new teaching-learning model research and future education environment. The main space is composed of general classroom space, exhibition/performance space, group activity space, creative experience space, counseling/research space, and emotion/book space.



Another example would be the digital textbooks and realistic content (AR/VR/360°) apps. According to the 2015 revised curriculum, the Ministry of Education distributed digital textbooks for social science, science, and English to the 3rd and 4th grades students of elementary school and the 1st grade students of middle school this year, mandating software education for the 1,351 middle schools that introduced a course in information to their first grade students (Ministry of Education, 2018). Realistic content apps for 3rd-4th grade elementary school students can be used by installing a separate app for each immersive content, and 5th to 6th grade elementary school students /1st-2nd grade middle school students can install an integrated app for realistic contents to selectively choose and install immersive content apps within the integrated app. There are two ways to access immersive contents. The first method is to install and start the corresponding immersive contents by clicking on the displayed immersive contents in the digital textbook (AR/VR Sub-menu in "Order" > "Order

of Contents”). The second method, including how to install the contents, a list of immersive contents, how to use (application guide), AR marker, uploaded to the Edunet site (<https://www.edunet.net>), "Digital Textbook"> "Realistic Contents Utilization Materials" page (Kim, 2019).

3.4.2 Reinforcement of online and mobile services in the non-contact era

Along with the post-corona, 5G era, 4th industrial revolution and new technologies, the demand for non-contact services has been increasing in all areas of society. In fact, the 5G era has dramatically increased communication capacity and enabled real-time transmission of large-data contents and easy access to the mobile service while moving at high speeds. As such, the environment for ultra-large, high-speed data will allow the users to easily access through various devices, increasing the usability of online and mobile services.

In particular, the reasons to strengthen mobile services are as follows.

First, the global digital content market, which continues to grow as the spread of various smart devices increases, is expected to grow by an annual average of 13.8% from \$474.8 billion in 2018 to \$1,174.1 billion in 2025. Second, mobile convergence media services are emerging in various fields, and the demand for such services is also rapidly increasing. Among various mobile convergence media services, augmented reality/virtual reality, hologram/multi-view interactive 3D service, robot/dro ne-based service, and smart healthcare service have been receiving much attention from the public. Third, more diverse contents need to be developed and provided in line with the social and cultural changes requiring the reinforcement of non-face-to-face, non-contact online services.

According to the needs, the reinforcement of online and mobile services in the non-contact era can be largely divided into four areas. First, the video contents in library services need to be strengthened. Considering that ‘YouTube’ is the application used by domestic smartphone users for the longest time (WiseApp, 2019), all events, exhibitions, lectures, and cultural programs held in the library can be produced and distributed as video contents. In fact, video media increasingly account for larger part of users' preference and use. Rather than accessing print media and reading, the users show a desire to enjoy life through various digital and audiovisual materials (Choi and Cho, 2015). High-speed and large data transmission and reception through 5G will prepare an environment for using 8K contents, beyond 4K, and make high-definition video streaming and ultra-realistic (augmented and virtual reality) contents available and widespread. Therefore, the National Library for Children and Young Adults can also provide live or recorded video contents by filming 360-degree images of various performances, educational and cultural programs held in the library. This is expected to provide various library services to a wider range of users, such as those who cannot visit the library, children in island areas, and marginalized groups through web or mobile.

Second, it is necessary to provide employee education and training through online and mobile services for librarians specializing in children and adolescents' materials. Considering the result of the survey conducted in this study showing that librarians look forward to having more systematic and nationwide education programs, developing and distributing employee education and training programs can be regarded as a representative development direction for online and mobile services. In particular, dynamic and immersive contents are expected to be developed to a level that will

change offline travel and business meetings into online meetings in a virtual environment if further elaborated through education, training, and remote access and control.

Third, education for library use needs to be made available online or through mobile. Contents using VR/AR related to library introduction and use education, such as 360-degree virtual tours, must be developed and provided. In addition, dynamic and immersive contents are expected to be developed to a level that will change offline travel and business meetings into online meetings in a virtual environment if further elaborated through education, training, and remote access and control.

The library should develop and provide contents using VR/AR related to library introduction and use education so that users can explore the inside and outside spaces of the library or take courses related to library use without physically visiting the library. For instance, through thousands of photos taken inside the building, users can enjoy “360-degree virtual tour” for free. In addition, by placing Trigger Images in various places of the library, users can see what facilities and services are provided by the library through an augmented reality app.

Fourth, the generalization of mobile and Internet supply, combined with the SNS post-corona era, is expediting online program progress and communication. Therefore, the National Library for Children and Young Adults is expected to provide reading-related information or operate reading clubs and reading programs through SNS, chat programs, and video call programs that the users use in their daily lives,

3.4.3 Establishment of smart library environment

In a 5G environment, network slicing technology can simultaneously implement mobile broadband and IoT as a single technology and a network (Shin, 2019). In the IoT (Internet of Things) environment, where various mobile devices are connected, wearable devices and mobile devices of users are connected to sensors and spaces in the library, expanding the area of mobile communication. Therefore, it is necessary to establish a smart library environment based on multi-sensor technologies in the 5G environment.

Table 18. Smart Library Environment

Division	Description
RFID System	Intelligent Smart Bookshelf: Check the collection (scan type, insert type) and identify misplaced collections, prevent theft, auto loan and return Seat management: Seat reservation and entry/exit management
Beacon system	Beacon communication is available throughout the library, enabling immediate use of the reading room services in all spaces of the library. Assignment/leave can be designated to reading room users when visiting/exiting the library through the Push function in Beacon application Can be extended directly from inside the reading room through the app Preventing overcrowdedness by progressing exit/checkout using the app at the closing time

Cloud	<p>Introducing a cloud-based library system is expected to contribute to the improvement of user convenience by enabling book search, reservation and extension of checkout period through all IT devices such as the Internet and mobile devices.</p> <p>Dated operating environment can be improved by switching from the method of managing book information mainly using handwritten or computer programs to the method of using cloud services.</p>
Robot	<p>Book arrangement system using autonomous robots</p> <p>Exhibition commentary and information services using robots</p>
IoT	<p>(Environment monitoring) Various sensing devices and lighting are included for the purpose of controlling lighting and temperature in the library, improving energy efficiency, and preventing crime.</p> <p>(Safety Monitoring) Library safety can be monitored in real-time by connecting CCTVs with wireless sensors installed in the library.</p>

5. Conclusion

The purpose of this study is to present the direction of service provision, as a library representing children and adolescents, in line with the changing roles in the 5G era by deriving implications through domestic and international case studies. In particular, this study derives and promotes the four strategies of the 3rd Reading Culture Promotion Basic Plan (2019-2023), ‘Social Reading’, ‘Spreading the Value of Reading’, ‘Realizing Inclusive Reading Welfare’, and ‘Creating Future Reading Ecosystem’. and its 13 key tasks. The mid-to-long-term development direction of the National Library for Children and Young Adults in the 4th Industrial Revolution and 5G era covered in this section is in line with the strategy of “Creating Future Reading Ecosystem.” One of the key tasks for creating future reading ecosystem, “Preparing a Foundation for the Spread of Digital Reading,” is seeking strategic responses to changes in the smart environment. More specifically, the promotion direction is set to develop and operate a reading platform based on artificial intelligence (AI) to use it as a core foundation for everyday reading, prepare a foundation for the spread of digital content development, and improve creativity to enhance interest and value in reading. As a limitation of this study and as an objective of future study, more specific service models based on the collection of opinions of librarians on 5G library services need to be presented.

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