

A Study on the Development of Public Digital Signage Services

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Abstract This study is based on the 'National Pilot Project on Digital Signage in Sejong Special City', one of the pilot projects initiated by the Ministry of Public Administration and Security. This project was an attempt to present the digital signage as a 'public service content platform' integrated with smart technologies. This study suggests that the planning strategy for placing public service contents on digital signage platform should focus on interests of local communities or users rather than high-tech suppliers of digital signage. In consideration of growing needs for smart technology-based public service, this study concentrates on the strategy for developing 'public digital signage services'. In addition, 'digital signage service tools' were designed to easily establish or execute the strategy. The aim of this study is developing the strategy to make digital signage a public cultural service platform as well as a digital advertisement tool. The final goal of this study is to demonstrate public value creation performance of the 'Revitalisation Project of Sejong City's Commercial Districts', which was possible thanks to the proactive involvement of citizens coupled with progressive utilization of interactive media.

Key Words : Digital Signage Strategy, Public Service Design, Social Innovation, Digital Contents Service Model, UXR

요약 본 연구는 행정안전부의 시범사업 중 하나인 '세종특별시 디지털 사이니지 국가시범사업'을 위한 기초연구를 기반으로 하고 있다. 본 연구에서는 첨단 기술이 결합된 스마트 플랫폼인 '디지털 사이니지'를 '공공 서비스 콘텐츠 플랫폼'으로 보고 콘텐츠의 배치를 계획하기 위한 전략이 기술우위 공급자 대신 해당 지역 커뮤니티 또는 사용자에 초점을 맞춰야 한다고 전제하였다. 이러한 맥락에서 첨단 기술 기반의 공공 서비스에 대한 수요 증가에 대응하여, '공공 디지털 사이니지 서비스' 개발 전략에 관해 연구하였다. 또한 동 전략을 쉽게 수립하거나 실행할 수 있도록 '디지털 사이니지 서비스 툴'들을 설계하였다. 결론적으로 본 연구는 '디지털 사이니지 기능'을 '디지털 광고 기능' 뿐만 아니라 '공공 및 문화 서비스 기능'으로 확대, 발전시키는 전략을 모색해 보고자 하였다. 연구의 최종 목표는 시민들의 적극적인 참여와 인터랙티브 미디어의 혁신적인 활용을 통해 '세종시 상권 활성화 프로젝트'가 창출하는 공공 가치를 추구하는 것이라고 할 수 있다.

주제어 : 디지털 사이니지 전략, 공공 서비스 디자인, 사회 혁신, 디지털 콘텐츠 서비스 모델, UX 디자인리서치

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1. Introduction

1.1 Research Background

Digital signage, one of the urban services in smart cities is not merely a commercial advertisement or visual promotional tool; it also has public and cultural characteristics and social elements. Due to its technical characteristics based on Internet connectivity, digital signage should be interpreted as a comprehensive service platform in which public facilities and contents are intergrated. Therefore, as Prof. Nakamura (2009) mentioned, digital signage is a next-generation convergence communication platform that provides multimedia contents through applying advanced technologies.

With fresh viewpoints, this study explains that digital signage in public space is regarded as a new convergent public service, since the context of products and services placed on the platform provides various experiences to public users. Thus, the aim of this research is to produce a public interaction service model that can decide the basic directions of contents and services in accordance with regional characteristics in introducing digital signage in public places. In this context, this study is strategic governance design research, which is based on user experience(UX) design methodology and process. This study reviews Sejong Special City's case as a public attempt to pursue social innovation values for the community and society.

1.2 Research Methods and Process

This study explores the social role of design combined with new technology as a social innovation strategy in 'Revitalization Project of Commercial District in Sejong Special City', which has encounter many difficulties due to the Corona pandemic.

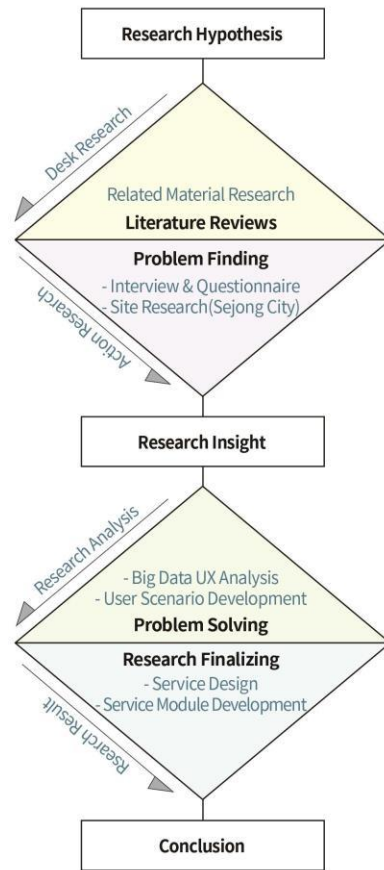


Fig. 1. Study Configuration Diagram

The process of this research project is shown above in Fig. 1, and it is based on the 'Double Diamond' service design process. Additionally, 'user experience'(UX) methodology was adopted as the framework of this study, which helps to conduct the public digital signage's content model development, as the main goal of this study. Through desk research, such as examining existing research documents and reports, this study tests the hypothesis and executes the action research such as surveys and interviews. Although this study is based on 'Sejong Special City's Public Digital Signage Project', it does not fully contain the entire process of the project. Since this study is a more academic research, it focuses on the theoretical side of reviews and

the strategic side of model development as separately from the government report.

2. Literature Reviews

2.1 Transition of Digital Signage Concept

Digital technologies make more effective the operation of managerial values such as transparency, accountability and efficiency but also democratic values such as equality, openness and fairness. (Panagiotopoulos, Klievink & Cordella, 2019) Digital signage is the next-generation screen media after smartphones, and it is a convergent outdoor advertising service in various fields. The latter includes broadcasting and commercial advertisements, public information services, events and commerce[1]. Unlike existing outdoor advertisements, digital signage delivers various contents such as video and still images, or interactive services such as games through a digital screen based on a wired (or wireless) network. In public places or outdoor commercial spaces, this signage includes a medium that delivers various information, such as text and images, through a digital display (screen). The latter entities include products (objects) and services[2]. The convergence of technology and service brought the transition of concept on public media infrastructure such as digital signage. Huge was the impact of digital technologies on the production, delivery and consumption of public services and the public value this consumption creates[3]. These changes and developments in the concept of digital signage have been supported by comments from Prof. Nakamura (2009) that the fifth generation of media, the mobile smartphone, has already been moving toward the sixth generation, including digital signage. In terms of technological factors, the technologies

used in digital signage are the commercialisation of 5G; mass production of LED (Mini, Transparent) and OLED; mirror display; IoT; data analysis; remote control; AI content; AR; VR; voice-recognition; face-recognition; and microservices. (Kim, 2020).

2.2 User-Centred Interaction

The distinguished feature of digital signage is that it is an interactive form of media that provides information through an online network. However, it also interacts with people who don't participate or do participate. Goffman (1959) focused on the background of communication, that is, the context and environment in which communication occurs. The background is that people's behaviours and norms, as well as the meaning they give to communication, change depending on places, such as in the living room, in the classroom at school, or on television[4].

Digital signage goes beyond simply displaying advertising messages to an unspecified number of people, providing target coverage (message exposure) and target OTS (opportunities to see advertisements). Additionally, this signage provides opportunities for processing and enables interactive communication with consumers[5]. Furthermore, digital signage is changing the advertising communication paradigm from the existing one-way paradigm to a two-way structure[6]. In this way, users are able to directly interact with content through the screen or to use a personal mobile device to access services such as events and advertisements, and purchase products[7]. Recently, we came to see the interactive multimodal digital signage as a new model which provides dynamic on-demand contents according to context or user's requirement based on sensing data obtained from surrounding wireless sensor networks[8, 9].

The development of technology allows the interactive communication between users and digital signage. The participatory feature makes the identity of digital signage similar to fusion media and virtual public platform that exceeds the simple function of advertising or sending information in one direction. Digital signage technically guarantees directionality and interactivity of information distribution by using an upstream channel (return path), such as wired or wireless Internet. In other words, the interactivity of digital signage creates a two-way connection that allows immediate feedback from users. This interactive function of digital signage can induce direct participation of users, create new experiences based on this participation, and measure user data with quantified and objective effects related to user reactions [10].

2.3 Public Purpose and Locality of Digital Signage

The definition of the word 'public' (公共) is 'affecting all the people or the whole area of a nation or state'. Public media can be defined as a media service based on space and location and used by an unspecified majority of the members of a country or society[11]. Moore's (1995) approach suggests that public management strategies devoted to public value creation do not only need specific organizational capabilities and resources to deliver services that fulfil social expectations but also need to be politically legitimate and sustainable[12].

To be able to adapt to these transformations and better fulfil social expectations and needs, public sector organizations need to acquire or develop capabilities that will enable them to exploit the opportunities and mitigate the challenges associated with digital government initiatives[12].

From a smart city perspective, digital signage and public media become a service with functions and roles that solve urban problems. Public media is one of the services that solve such problems and can thus play a role in promoting urban economic activities while developing the digital signage industry[13]. Beyond this, digital signage is installed in public places to deliver information to a large number of people and is also used as a means of business promotion and marketing. However, digital signage is also very important in public media based on the element of content fusion and interactivity with users discussed earlier.

One of market leaders, Hitachi has launched a service for digital signage market that not only reduces workloads but also provides flexible and reasonable distribution of content in a timely manner[14]. Hitachi is seeking to collect and utilize information automatically from cameras and other sensors installed in the vicinity of digital signage units, and also other information from social networking services (SNSs) such as the weather and traffic conditions in the area[14].

Essential is the effective and timely provision of information in response to societal issues that include an aging population and the information divide between urban and rural areas. Linking digital signage together with Internet of Things (IoT) devices has the potential to improve performance such as the practical evaluation of display effectiveness or providing more extensive services[14]. Therefore digital signage evolves from a simple display function to a bidirectional communication medium through convergence with various information technology frameworks[15].

With above notion, it is possible to respect or promote a particular local culture, necessitating a study regarding the part that considers the

user culture of interaction with it. The interactivity is more effective in digital signage which aroused consumers' affective experience, by associating their attitudes to the advertisement's content and advertisers and finally constructing intellectual brand experience[16]. Additionally, digital signage has a two-way function that transmits public information and collects information through various advanced functions. Accordingly, it can be seen that it will play a major role in the production of big data-based images, and other social, commercial, and cultural information of smart cities.

2.4 Engagement Effect

Interactive digital signage is evolving into a medium that can induce direct participation of users, creating new experiences. Today, as new media with various interactive characteristics emerge and consumers' control over advertisements increases, the media effect has been expanded from passive exposure centred on mass media to a concept such as engagement that actively involves consumers in advertising messages. The 'engagement effect' refers to the degree to which people exposed to advertising media or advertising messages understand, immerse themselves in. It also focusses on information or messages provided by the advertising media. The engagement effect occurs when a creative message makes an impact on the right target audience at the right time and in the right media environment.

For example, digital signage can maximise the engagement effect for a user's emergency contact by providing the most appropriate information by recognising the surrounding environment and the user's specific conditions at the location and time of installation. That is, users need personalised information that fits the

surrounding situation and context, such as place, time, and weather, provided by situation recognition technology. With technological progress, digital signage is rapidly emerging as an advertising medium that attracts attention.

However, as Lee (2014) argued for this entity to grow into a sustainable advertising medium, tasks must be considered and solved, such as advertising standards and advertising fee structure, securing transparency in transaction order, developing various advertising and marketing techniques linked to other media, and scientific and objective measurement index of advertising effect. Given the claim that communication involves aspects of relationships between communicators as well as content, the characteristics of new media technology are not only the content of the information it contains but also among people, which can also affect relationships. The media environment has changed the face of life and has had a major impact on the linguistic aspect[17]. Due to the Covid-19 environment restricted social interaction and off-line engagement that moved in to the digital communications and on-line consumption. Social connection also enhances mental well-being and it shows the proof that people try to maintain socio-emotional connection during pandemic[18]. To support the public engagement for citizen's quality of life, digital signage's interactive element and contents delivery role become more significant than before.

3. Content Types of Digital Signage

3.1 Digital Signage of Social Usage


Digital signage can be classified into the indoor type and the outdoor type based on the installation environment, and public digital signage is a prerequisite for improving the







quality of digital signage service in a wireless network using a broadband communication network. The platform acts as a medium for the remaining elements such as content, the network and the terminal, while performing an organic function between every pair of elements.

Additionally, content and services are the most important elements of digital signage. Since users expect and assume tasty or luminous contents as more important than others, which is called top-down effects, contents are important in designing and planning stage. No matter it is interactive or not, the given composition and shown contents would determine the participants' consideration and participation[19-20]. It create the value as public and social media that intervene in people's emotions and thoughts, not just commercial activities that produce and consume advertisements.

Table 1 is an analysis of digital signage's social and interaction levels based on existing case research. Existing case studies on digital signage are mainly dependent on the product and service side of these interactions rather than focusing on commercial usage. However, this study tried to distinguish each type of digital signage by adding the social usage and the relationship of environmental conditions.

Table 1. Types of public digital signage and social usage and Interaction level (Revised from the Source: Product and Content Service Guideline for Digital Outdoor Signage in Sejong City 2020)

Types of Digital Signage /Purpose of Usage	Case Image /Location	Environmental Condition	Social Usage Interaction Level
Public Billboard Type /Commercial and public advertisements	 Seoul, Korea (Source: https://metoonice.tistory.com/166)	Single-sided or Double-sided displays	-Commercial advertisements -One way -Low level

Human-scale Kiosk /Commercial advertisements and events	 Seoul, Korea (Source: http://sptoday.com/bbs/board.php?bo_table=article&wr_id=54180)	Single-sided or Double-sided touch screens	-Public information, interactive and SNS Link for event -High level
Multi-shape Screen /Digital media art	 Seoul, Korea (Source: http://egloos.zum.com/hyperdash/v/1756638)	Large multi-shape screens	-Public media art -One way and interactive -Middle level
Building Corner & Façade /Commercial advertisements and digital media art	 Seoul, Korea (Source: https://www.yna.co.kr/view/AKR20190906103800030)	Exterior walls of buildings	-Commercial advertisements -One way -Low level
Rooftop Cube Screen /Commercial advertisements	 Seoul, Korea (Source: https://www.appl-economy.com/news/articleView.html?idxno=58703)	Rooftop of buildings	-Commercial advertisements and Public media art -One way -Low level
Gate and Arch Type /Digital media art	 .Daejeon, Korea (Source: http://www.news.tnt.com/news/articleView.html?idxno=8780)	Multiple display screens	-Public media art -One way -Low level
Street Furniture Convergence / Providing public information	 Sejong, Korea (Source: https://images.app.goo.gl/R3qQaRwwUDTvyTKy7)	Public furniture combined with display screens	-Public Media Art -One Way -Low Level

3.2 Digital Signage and Social Participation

As the types of outdoor digital signage, large scale of the billboard screen or rooftop screen (Images No.1 & No.5 on Table 1) have mainly delivered one-way communication content

without viewers' participation or interaction.

However, the recent services such as the 'Drink an AD' advertisement by Coca-Cola showed the collaboration of multiple media. This advertising campaign linked the screens where users run a sound recognition application by smartphone, producing the sound of drinking beverage. Next, users watched the beverage of the bottle reduced in real-time on the display screen. This service encourages users to participate in an event that gives users one can of Coca-Cola for free when they drink virtually all of them. This is an example of an innovative service design of user engagement.



Fig. 2. Mobile Digital Signage Link Campaign_ Drink an AD
 Source:<http://mtro-chango.blogspot.com/2015/06/coke-z-ero-drinkable-billboard.html>.

The Kiosk type is more exposed to social contribution advertisements and campaigns for the public interest than in the past. It also serves as an alternative to guide signs in museums and tourist destinations. Additionally, several small screens are connected to show artwork such as media art, so the utilisation of the content can be seen as diverse. Interactivity of digital signage is not only relying on the size of digital signage.



Fig. 3. Public Campaign AD by using Face(eye) recognition Tech
 Source:<https://medium.com/@yilinxie/innovation-within-domestic-violence-campaigns-438c34b563c8>.

Recent developments of futuristic technologies allow the big screen to generate interactivity and public participation. These technologies, such as augmented reality (AR), face recognition and eye-tracking technologies make this kind of participation possible without regarding the physical scale or location of digital signage. For instance, London's billboard campaign of home violence (Fig. 3) uses face recognition technology to show the relationship between public engagement and digital signage.

4. Digital Signage Service Development

4.1 Digital Signage Service Module

Before developing a public digital signage service module and its applications, this study configured the stakeholders of Sejong City's public digital signage by referring to both the field research and desk research.

On the strategic side, there are four basic directions in which digital signage must be considered in the introduction, installation, and operation. Fig. 4 shows how many different stakeholders are involved in one digital signage in the public space. Even if digital signage installed in public places transmitted commercial advertisements, the operating body or council should establish guidelines so that the content could indicate the direction of the public interest.

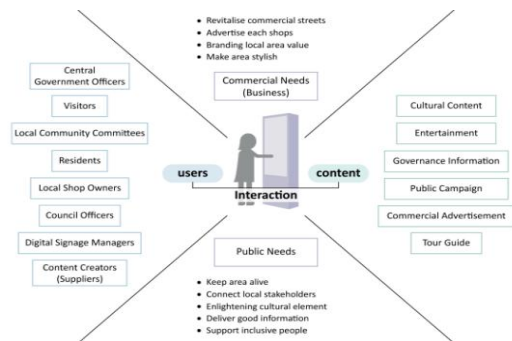


Fig. 4. Digital Signage Stakeholder Map of Sejong City

The first is an 'area-specific' direction that reflects the cultural and regional characteristics. The second is a 'user experience-centred' (UX-centred) direction that takes into account the user's participation, experience and interaction with the overall content, beyond the level of simply receiving information in one direction.

The third is 'product and service convergence', in which the existing simple facility guidelines and outdoor advertisement regulations are combined. That is why interactive digital signage places importance on the quality of content through the combination of facilities and services. In this case, the content must reflect the social and cultural characteristics of users, including residents or visitors. The fourth is the sustainable direction. Digital signage should be set as a principle of sustainable management that considers the environment, energy conservation in the region and maintenance in public places.

Furthermore, sustainability should be continuously updated with fresh content so that it does not become an unnecessary metal object in the street. The detailed guidelines for following the directions must be reorganised to suit each local situation, but all four of the above-mentioned factors must be considered. Additionally, technical aspects of implementing this system should also be evaluated.

4.2 Application Type of Service Module by Regional Characteristics

In the planning of digital signage service, the application ratio of each service module reflecting its regional characteristics and installation location was composed as shown in Fig. 5, using the four basic directions developed earlier in this study.

In consideration of public value and the

interactive experience from the user's side, the service design framework was developed, which reflected the direction of the content service and the classification and configuration module types of the content.

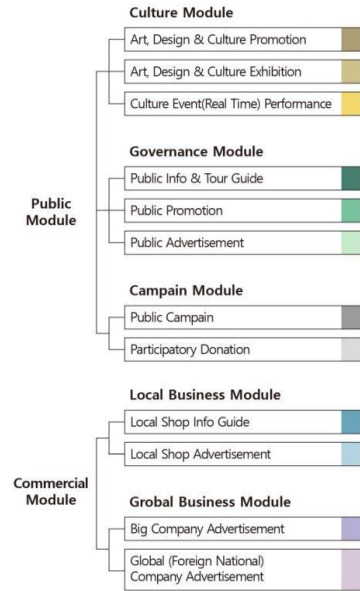


Fig. 5. Digital Signage Service Module Elements

Fig. 6 shows the combination of service applications that reflects the regional commercial and cultural characteristics of elements which can be used as guidelines for public digital signage. Then each service can be constructed by each case in response to the site-specific or culture-specific framework. Since the conflicts from each stakeholder's publicity, locality and individual needs are different, flexibility of strategy framework is crucial and essential.



Fig. 6. Public Digital Signage Service Content Types

The reason that this study designed 'service module' in the development of digital signage content strategy is to help the regional government or council in organizing themselves without extra consultancy in each stage of strategic decision stages.

4.3 Service Contents Application Types

Fig. 7 below shows the application of digital signage's each module of Figure 5 which was developed in this study. Public and commercial, two module groups are divided. Public module groups consisted of three modules of Culture, Governance and Campaign(Fig. 6)and commercial module groups are divided into two modules, such as Local Business and Global Buisiness.

In the city or metropolitan area, more than 60% of 'commercial module' is placed in the relevant commercial positions. Advertisements for large and global companies were placed in over half of the commercial modules (30% of the total) with the aim of attracting global users. This was done to examine the effect of advertisement promotion as a target. In the case of cultural tourism, content was centred in the city centre or the metropolitan area, 60% of public modules were placed with consideration of foreign tourists, and more than 50% of the public modules were involved (30% of the total).

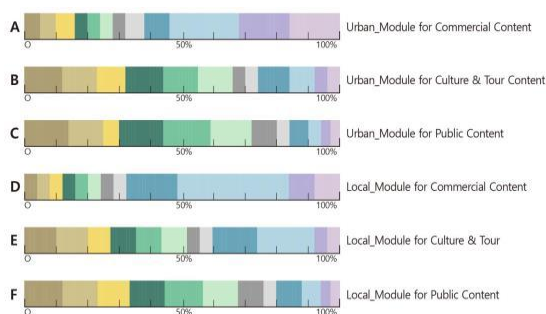


Fig. 7. Digital Signage Service Module Application Types

With the consideration of the high population density of all the age groups in tourist destinations, more contents were added for participating in cultural events.

For instance, in the case of public content focused on the city centre or the metropolitan area, 80% of the total content was placed as public modules, and more than 50% of the public modules (40% of all modules) were placed as public information, publicity and advertisements emphasising publicity.

In addition, in consideration of the characteristics of the region with high population density, the participatory donation was emphasised, compared to other modules. In the case of local and regional commercial content, 70% of the total content was placed as commercial modules, and out of these, more than 70% (50% of the total module) was placed with local guides as local store advertisements.

This module was constructed by considering the activation of local commercial districts as a priority rather than the promotion of large global companies. In the case of local or regional tourism content, 60% of the total content was placed as public modules, and 50% of the public modules (30% of all modules) were placed as cultural modules to emphasise local cultural events. By placing 40% of all modules, 80% (30% of all modules) as regional modules, the aspect of regional activation among tourists was also encouraged.

In the case of local or regional public-oriented content, 70% of the total content is placed in public modules, and more than 50% (30% of all modules) within the public modules was placed as cultural and public content to emphasise publicity and culture. Furthermore, participation events were emphasised to increase the level of interest in public content.

In the next illustration, Figure 8 describes the

social and public side of digital signage's interaction scenario.

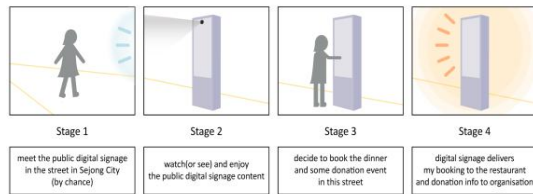


Fig. 8. Socially Aware Public Digital Signage Scenario

Digital signage recognises human movement and automatically shows interesting information from a donation event to attract people. The visitor could encounter the digital signage by chance as Fig. 8's Stage 1. Next, the visitor responds to the digital signage, moved by the video image of polar bear, and decides to donate. Then the public digital signage sends the donation to the handling organisation which helps the visitor be part of social engagement. As a reward, a visitor can take a cute photo by using the inbuilt camera of digital signage itself and play with another user. The user can choose the receptiveness of the AR image, with a polar bear to keep as an SNS souvenir. Unlike other kiosks, this process does not need many choice stages or finger touches. That is, it can work with a cell phone and sensors via the 5G network. Thus, the process creates easy and simple interaction that makes people feel safe and relaxed in public environments.

5 Conclusion

As Hofstede(2011) mentioned, culture refers to the training or refining of an individual's mind from social environments in which he or she grew up, as individuals in a society are intergrated into groups who share the experience[21]. Digital Signages in public spaces will change our potential culture not only

cityscape, which brings a string of needs about the re-positioning its role and importance in the context of new contents platform.

Currently, digital signage is in the early stages of the diffusion of technology and product industries. Thus, the needs for this study begin with the facts that the research infrastructure has not been secured in the applied field, where strategy is an important part, and the interpretation of this integrated and convergent technology service is diverse and has not yet been solidified.

The integrated service guideline module of digital signage developed in this study proposes a smart city public design strategy that encompasses a new area as a product that interacts with users. Unlike general media, digital signage needs to reflect regional characteristics because the element of geographic location works strongly, and it is implemented by applying various content and services according to such regional characteristics. Digital signage is currently classified and regulated as outdoor advertisements. But in terms of providing new services to the public more efficiently, related laws have been revised through the redefinition of digital signage itself. Alternatively, new installation standards must be established[22]. In addition, basically, this process complies with the regulations of public facilities or outdoor advertisements of each local government, but in places like central commercial districts, the regulations are relaxed and applied, as in the pilot project district, and operated in the form of a testbed, with feedback from residents and users.

This research needed to create a better urban digital landscape of a smart city. Prior to the application of the digital signage module that reflects the regionality developed in this study, it must also reflect basic research on social characteristics and cultural resources, and a

sustainable public design can be supplemented through constant communication with residents or users as a strategy.

We have seen development of policies to expand public services and flexible city operations, while promoting corporate activities have become more necessary elements with the introduction of smart cities. Local governments should pursue coordination, harmony and publicity, and companies should develop technologies and services to maintain sustainability while balancing mutual cooperation and balance[23].

In the future, it is expected that digital signage will expand immersive content, and devices will perform IoT functions in cities by applying 5G. Because digital signage devices are equipped with solutions that can collect and analyse spaces, objects and environments, digital signage is expected to play the role of data gateway and intelligent content[23].

The importance of the device platform is increasing due to the interlocking of various devices and the internalisation of solutions. For instance, in Korea some areas, where data-based services have been difficult to use due to personal information protection, the difficulties have been partially resolved through data-related legislation.

Furthermore, there are data issues in terms of information protection and service enhancement. Along with security and guidance for information protection, research on technology development and application for service advancement should be continued[23]. The results of this study could contribute to the improvement of the quality of public life by providing basic data to all government departments, which can establish digital signage-related research or strategies, or to business implementors who are interested in promoting the strategy of application.

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