ICIC Express Letters
Volume **10**, Number **4**, April **2016**

ICIC International ©2016 ISSN 1881-803X
pp. **825–830**

A SYSTEMATIC DESIGN PROCEDURE FOR BUILDING SMART DIGITAL SERVICES AND SPACES

Taesoo Lim[1], Seung Sik Yoon[2] and Dongsoo Kim[3,*]

[1]Department of Computer Engineering
Sungkyul University
Sungkyul Daehak-ro 53, Anyang City 14097, Korea

[2]Ubidus Corporation
Seoul, Korea

[3]Department of Industrial and Information Systems Engineering
Soongsil University
369 Sangdoro, Dongjak-Gu, Seoul 156-743, Korea
*Corresponding author: dskim@ssu.ac.kr

Received October 2015; accepted January 2016

Abstract. *Introduction of ubiquitous technologies enabled us to transform traditional offline spaces into interactive digital spaces, which include exhibition centers, houses, libraries, museums, shopping shops and so on. Because the types of spaces and technologies are various, we should consider the characteristics of digital spaces and economic and technological feasibility to devise, implement and operate relevant smart services successfully. In this paper, we present a systematic design procedure to cope with such difficulties. The proposed procedure consists of three steps: service analysis, quality analysis and target service analysis. Through these analyses, we can consider the space structure, space vision, human users, costs, hardware and software. We have performed several smart space development projects using the methodology and implemented digital space based on the service design platform called UbiTools.*
Keywords: Ubiquitous platform, Service design, Digital space, IoT (Internet of Things)

1. **Introduction.** Rapid development of embedded systems, distributed and mobile computing technologies makes it possible to establish more and more intelligent spaces around us such as smart meeting rooms, smart homes, intelligent museums, and digital libraries. Meanwhile, ubiquitous computing and IoT (Internet of Things) technologies have received an intensive interest in the past years to realize the intelligent spaces [1]. Ubiquitous and IoT (Internet of Things) technologies aim at providing any intelligent service at anytime, anywhere with the integration of machine and human through the Internet and other communication technologies.

The technology has consistently evolved and produced M2M (Machine to Machine) and IoT (Internet of Things) nowadays. IoT can be defined as hyper-connected network environments, in which information is produced and shared via wired and/or wireless network connecting every thing including human [2]. Such full maturity of technology environments is the first motivation of this research. In order to effectively utilize such ubiquitous and IoT technologies, we developed a service design platform called UbiTools [5].

The second motivation of this research is the business focus in Korean domestic environments. To keep up with global technology trends, the South Korean government established 'ICT wave strategy' for the advancement of Korea ICT industry in 2013. The government proposed 5 core fields consisting of contents, platform, network, device, security and 10 main technologies including IoT platform, intelligent software, context-aware

device and so on [3,4]. Such domestic environments imply to us that the Korean government will consistently drive platform and service technologies, so the business needs will not be decreasing.

Under the technology and domestic environment, we present a systematic design procedure considering the characteristics of digital spaces, and economic & technological feasibility to devise, implement and operate smart services successfully. The proposed procedure considers space structure, space vision, human users, costs, hardware and software. We have performed several smart space projects using the methodology and one of main applications will be presented in detail. Our experiences in real field showed that the proposed design procedure can be used for effectively designing and modeling useful services for digital spaces.

The remainder of this paper is organized as follows. Section 2 presents the proposed service platform and smart service design procedure, and Section 3 describes a main application case of the design procedure in detail. Finally, Section 4 offers conclusions.

2. **Service Design Methodology.**

2.1. **Service platform.** In order to build a successful and valuable digital space, we need a smart service platform to support system management and operation in the digital space as a core technology for implementing smart services. We developed ubiquitous service platform called UbiTools as an integration platform for supporting system management and operation in digital spaces as the core technology for implementing digital services. UbiTools has 5 main functions including monitoring, contents, application, device and service as shown in Table 1 [5].

Table 1. Functions of the service platform

Functions	Descriptions
Monitoring	Remote monitoring of device status connected with UbiTools
Contents	Integrated contents management including remote contents playing and updates
Application	Central administration of application makeup, install and deployment of devices
Device	Implementing central control of device status monitoring and device power
Service	Upon event, delivering the right actions to the right device according to predefined rules

UbiTools monitors the status information of various equipment such as PCs, projectors, and medias. In addition, it supports administrators to retrieve and utilize such information for a variety of purposes. An administrator can remotely control the power of media equipment and inquire the status information of the connected media through the remote control function. If a service trouble occurs, the administrator can send the error information using the PC, SMS, or email communication method. Using the platform quite a few persons can stably manage the digital space through the function of media management, remote administration and deployment of contents and software, contents scheduling and so on.

2.2. **Service design procedure.** Based on the service platform, we model and design proper services according to the proposed service design procedure, which consists of service analysis, quality analysis and target service analysis as shown in Figure 1.

The 'Service Analysis' step performs so called 4D methodology, which consists of service discovering, defining, developing and making details. Through this step, we can

FIGURE 1. Smart service design procedure

perform the environmental analysis, space analysis and user analysis. The second step is the 'Quality Analysis' step, in which we can perform cost analysis, value analysis and feasibility analysis. The final step is the 'Target Service Analysis' step followed by the implementation stage. In this step, we can derive final target services and establish the service construction guideline.

The proposed procedure produces several output reports in each activity. The following list shows the output reports categorized by the environment, definitions, cost and design.

- Environments: environmental analysis report, service analysis report
- Definitions: service definition report, media and platform function definition report
- Cost: cost analysis report
- Design: service and platform build report

3. **Application Case.** We have a lot of application cases applying the proposed service design procedure and service platform, which include 'DDP Guide Sign Media Operation System (2014)', 'Korea History Museum (2013)', 'SK T.um (2009-2013)', 'i-Mirror (2014)' and 'Yeosu EXPO (2012)'. Among them, as a best reference model, we deliver our service design procedure using 'DDP Guide Sign Media Operation System (2014)'.

DDP is an acronym for 'Dongdaemun Digital Plaza' and it is located in the central fashion town in Seoul, Korea. The DDP is designed by a world famous architect, Zaha Hadid, and she wanted to provide freshness and complex maze to visitors. Therefore, there was a need for visitors' efficient access from in/outside the DDP considering the DDP's space. In addition, they want to operate, manage and monitor 8 kinds of 90 media devices in the space with little human resources as possible. In order to satisfy these needs, we performed the systematic design analysis through several steps.

The first step is the 'Service Analysis' step composed of service discovering, service defining, service developing and making service details. Firstly, to discover services, we analyzed the DDP, environments, and stakeholders as follows.

- DDP analysis: Service objective, Physical environment, Zaha Hadid's metonymic landscape, service experience time, service space, and service channel.
- Environments analysis: Benchmarking (Tokyo Opera City), lifestyle trend, media trend, and technology trend.
- Stakeholder analysis: Deriving stakeholders and drawing stakeholder map.

Secondly, we defined users and objectives as follows.

- Defining users: Defining persona, determining priority, making up user scenario, and drawing customer journey map.
- Defining objectives: Deducting service issues with each space and service channel, and determining specific objectives with each space and service channel (Refer to Table 2).

Table 2. Service objectives of each space

Category	Service Space	Design Issues	Design Objectives
Prior service	Home	- Using various channel such as PC, mobile, TV, and radio	- Considering service integration of various channels
	Office	- Using mobile equipment during break time	- Implementing simple mobile functions
Site service	Fantasy experience hall	- Desire for new experiences - Huge interests from children and youth	- Considering various interaction methods - Considering youth's style
	Planned exhibition hall	- Exposure methods for various design works' exhibition information	- Continuous information exchange with designer groups

As the final stage of the first step, we developed services in detail as follows.

- Developing services: Deducting service ideas, making service definition table, and composing service scenarios & service functions.
- Defining services in detail: Service components, hardware, software and contents (Refer to Table 3).

Table 3. Detail service definition of mobile information search

Components	Details	Descriptions
Hardware	Smart phone	A personal smart phone belonging to each visitor
Software	Voice search	After recognizing the visitor's voice, doing search process according to visitor's search keywords
	Position recognition	Recognizing visitor's interior position using the Wi-Fi signal of the smart phone
	Language change	Choosing the language according to the visitor's language setting information
Contents	Event information	Detail event information within the site
	Parking information	Presenting the map of the parking lot
	Multilingual information	Multi language information for foreigners
Spaces	Every space in the site	
Users	Domestic and foreign visitors	

The second step is 'Quality Analysis' step composed of value analysis, cost analysis and service matrix analysis. Firstly, in order to determine the value of each service, we defined the user value and calculated the value of each service as follows.

- Defining user value: Setting up value criteria, deducting quantitative and qualitative values, and defining final user values.
- Determining value priority: Service-User weight, Space-User weight, Survey, and calculating service priorities (Refer to Table 4).

TABLE 4. Value based priorities of information service center services

Priority	Service Category	Service Name	Value Scores
1	Information	Finding friends	458.32
2	Entertainment	Virtual space	423.54
3	Shopping	Smart fitting	421.21
4	Information	Smart guide	412.87
5	Information	Event notification	408.65
6	Information	F&B guide	384.25
7	Shopping	Favorite services	377.12
8	Entertainment	Virtual observatory	325.24
9	Information	Voice search	125.33
10	Entertainment	Space game	118.24

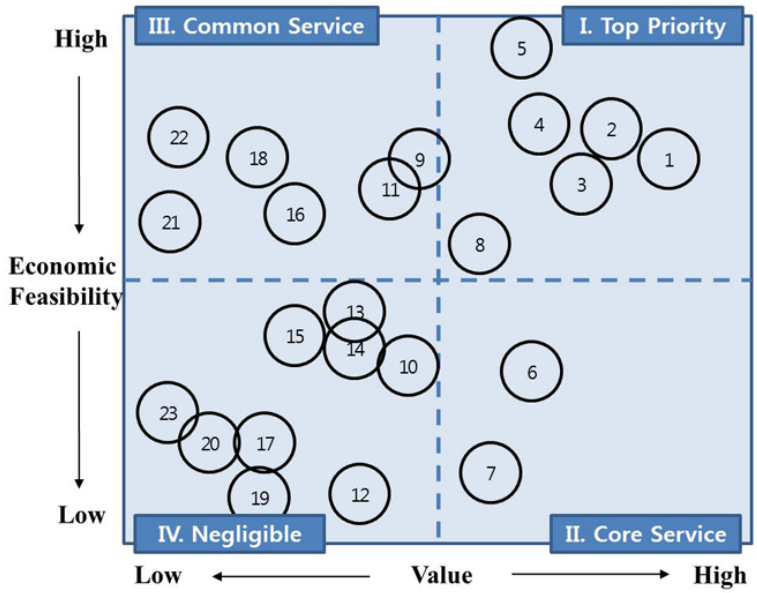

FIGURE 2. Service priority matrix

Secondly, in order to determine final priority of each service, we calculated the costs of each service and presented the final priority to each service based on both value and cost as follows.

- Building costs: Hardware cost, software costs, and contents cost.
- Operation costs: Maintenance cost, H/W replacement cost, contents upgrade cost, and labor cost.
- Determining priority: Cost based NPV (Net Present Value), and service matrix analysis (Refer to Figure 2). Number in circle means value based service priority number. According to Figure 2, we can decide that areas I and II are the main investment zones.

The final step is 'Target Service Analysis' step composed of detail service design, prototyping and construction planning. After this step, the implementation stage follows. In the step, we derived final target services and established the guideline for service construction.

The DDP had three requirements: valuable citizen service, efficient facility management and cost effective implementation. Based on the proposed systematic procedure, it was possible to accomplish such requirements. The citizen can be satisfied with the value

of the DDP. By implementing the UbiTools platform for facility operation, economical services for cost effective implementation have been provided to visitors.

4. **Conclusions.** In this paper, we presented our service platform and service design procedure. Also, we provided the proposed service design procedure in detail through a successful application project called DDP consulting case. Our procedure considers the characteristics of digital spaces, economical analysis, and technological feasibility. In other words, we can consider space structure, space vision, human users, costs, hardware and software. Our practices showed that we effectively designed and modeled useful services for digital spaces.

However, we have future researches to be done. As for the service platform, we need to strengthen IoT functionalities such as intelligent M2M communication. In addition, as for the service design procedure, we need to develop various methodologies customized to space types and objectives. Such a procedure will reduce unnecessary works and produce better results more quickly.

REFERENCES

[1] T. Fu, Y. Wang, H. Shi and H. Fu, Extending intelligent space with ubiquitous computing technology: The rich servants service model, *IEEE International Conference on 2008 Networking, Sensing and Control*, pp.1846-1849, 2008.

[2] C. Kim and M. Kang, Standard and trend analysis of IoT/OneM2M, *Journal of Korea Internet Information Institute*, vol.15, no.2, pp.31-36, 2014.

[3] S. Oh, ICT R&D medium and long term strategy, *TTA Journal*, vol.150, pp.14-19, 2013.

[4] Telecommunications Technology Association, *ICT Standardization Strategy Map*, 2015.

[5] D. Kim, S. S. Yoon and T. Lim, Smart service coordination and management of digital space and some cases, *ICIC Express Letters, Part B: Applications*, vol.7, no.2, pp.401-406, 2016.