

## A Study on Public Open Data Service Using Linked Open Data(LOD) Technology

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### Abstract

Recently, utilization of public data has become a major issue as a major driving force for promoting economic growth and encouraging start up. By utilizing the results of public data actively, it is intended to improve the benefits of the people, solve social transparency for governmental institutions, or create new industries business creatively. On the other hand, the public institutions are burdened with the opening of sensitive data. As a new effective technology to overcome this situation, the data format of Linked Open Data(LOD) type is spreading and expanding. LOD enables data to be connected and extended between the data, thereby increasing usability. In this study, we used the IS Success Model to study the factors for activation of Linked Open Data services. Information quality, system quality, and service quality, and how these characteristics are applied to the technology acceptance model. The main measurement variables, perceived usefulness and perceived ease of use, were taken as parameters. The dependent variable is utilization intentions for public data activation. The results of this study can be used as a reference for decision making to public agencies who are in the process of opening and offering public data. The policy makers and stakeholders can be referenced as data that confirms institutional awareness of data openness as well.

**Keywords:** Linked Open Data(LOD), Information, System and Service Quality, Utilization of Public Data

### 1. Introduction

In Korea, the public data portal (<http://data.go.kr>) is used for public data registered by public institutions. The Seoul Metropolitan Government has provided separate services to the Seoul Open Data Square (<http://data.seoul.go.kr>) [1]. Korea e government paradigm for open data has been changed. The government has focused on bi-directional and customized service. At the national level, the Korea Information Technology Agency (KISA) is conducting the LOD pilot project to build a national DB-PDA through a public data portal. A national spatial information distribution system, nationwide road map and electronic map public open data are provided for people as a free of charge, and there is geographical information in Korea [2].

The openness level of public data is mostly made up of the output of documents such as word, pdf, and excel, which are produced during the work of government ministries and public agencies. However, since these data are structured so that machines cannot understand, there is a need to open public data in a form that can connect and expand data.

Linked open data is attracting attention in order to increase utilization of document files which are the prototype of recently produced public data. LOD provides a link of

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data using the standard HTTP protocol on the web through a triple structure that can understand machine [3]. When public data is opened, using Linked Open Data (LOD) technology, anyone can access the desired point regardless of the data provider, and it is possible to create new added value by reusing and utilizing the data link. Linked Open Data is a compound of Linked Data and Open Data. Linked Data refers to open and extensible data types, and according to Wikipedia, linked data is "the term explaining the best way to share and connect the data, information, and knowledge on the Semantic Web by using URI (Resource Identifier) and RDF (Resource Description Framework)"[4]. Also, Data curation is discussed as one of the methods for efficiently processing the rapid increase of research data and the policies are also used for effective use of data [5].

In this paper, we try to identify the factors that determine the intention to use Linked Open Data for public services and private IT companies and individuals who develop services using the data. Theoretically, independent variables, which are properties of linked open data, are selected based on the technology acceptance model (TAM), which is widely used to analyze the use intention decisions.

The parameters are perceived usefulness and perceived ease of use, and ultimately to verify the correlations that influence the intent to use.

The characteristics of Linked Open data that have been proven through research to influence the use of public data are a reference factor in establishing policy direction for revitalizing Linked Open Data. In addition, we will contribute to the improvement of the service of public institutions and the efficiency of administration and create new value added by private companies.

## 2. Related Work

The studies of public data have secured transparency by sharing public information with the public and fulfilling the right to know. In recent years, however, it has attracted a great deal of interest in creating new value with public data and creating new added value.

Linked Open Data has 4 principles. First, URI (Uniform Resource Identifier) is used for all identifiers. URIs use the HTTP protocol and follow standard methods such as RDF or SPARQL. There should be rich link information. The Figure 1 represents Linked Data.

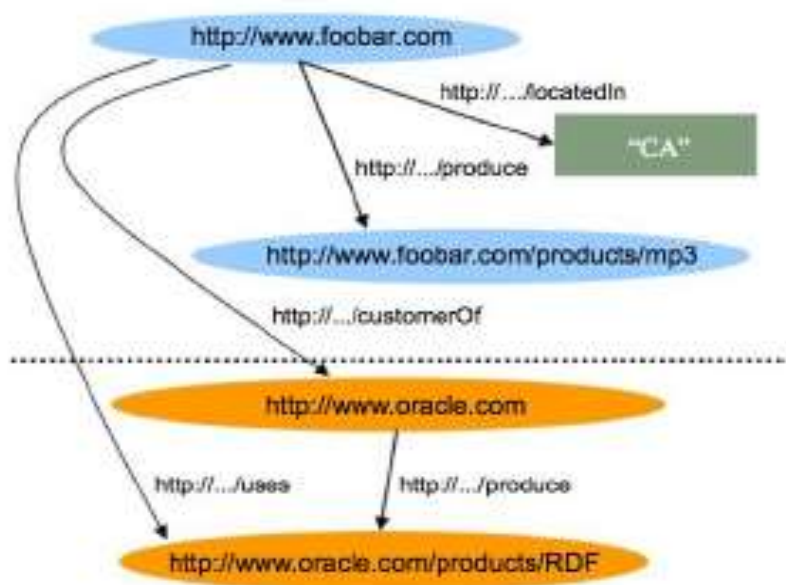


Figure 1. Linked Data

According to the research of Kim Hyun-seong (2012), it has been led public institutions to produce public data in the past depends on policies and plans [6]. However, nowadays, we suggest three ways to utilize unstructured data produced by private companies and individuals. First, many types of services that use big data should be discovered. Second, it is necessary to establish a comprehensive government management system for big data. Finally, we need to build trust in smart government.

Park Se-jin *et al.*, (2013) examined that the existing information disclosure system was limited to simple disclosure such as requests for a single document, viewing, and copying. Therefore, it is not meeting the rapidly changing information processing technology and environment change, and it does not meet the demand of users who want to know the large capacity and real-time information [7].

Bae Seong-hoon *et al.*, (2013) pointed out that unified laws and systems can't be established as factors that hinder the opening of public data. They reviewed the openness of the domestic and foreign public data and organized the legal system. Through analyzing the background and the economic effect of the enactment of the legislation for public data use, it needed to explain the legislation on public data is necessary finally [8].

Shadbolt *et al.*, (2012) analyzed 'data.gov.uk' to investigate the status of open government in the UK and explained the role and authority of the people, the nation and the technology field [9]. First, public data should be provided by the government as an innovative service under the assumption of transparency. The information of schools and other places where the general public can access many of them in their daily lives should be given the right to improve errors. It also explains that the technology environment should enable end users to develop new services and share the benefits of public data.

Jansen *et al.*, (2012) explain that the merits of public data can vary in economic areas [10]. It explains the development of new business models and services using public data, the use of Wisdom of Crowds, and the creation of added value to new fields of private companies. However, many researchers argue that there is uncertainty in the opinion that it can lead to the economic advantages mentioned only by providing public data. Therefore, experts explain that general users need to improve their accessibility because they lack the basic knowledge of public data and the technical competence to utilize it.

Open Data is described as freely redistributed and reused data and must meet the following conditions: First, data must be freely downloadable over the Internet, and data must be easily transformable and affordable at a reasonable cost. Second, data must be provided in a form that can be combined with other data for redistribution and use. Finally, anyone who uses the data must be able to reuse and redistribute it without restriction by commercial, non-commercial, or specific purposes (Open Knowledge Foundation, 2012) [11].

The data connection on the web using Linked Data has the following advantages. First, if the information represented by the structure of RDF is divided into URI identifiers and the link is accessed using the HTTP protocol, the information linked with the linked data can be configured as a single knowledge base instead of the information produced directly. Second, if the public information is used by using linked data, it is possible to check whether the existing information is duplicated or not, and unnecessary service development can be avoided. Third, by providing the data expressed in the standard RDF format, the information linked with the linked data on the web is utilized like a database, and the desired information can be obtained through the query, thereby enabling the information integration. Fourth, SPARQL query allows free use of information resources distinguished by URI. It also enables mash up for data binding and is more specific to data access than Open-API. Finally, the free connection of information enables the production of additional information and the networking of data proceeds [12].

For example, the national spatial information LOD is created by merging spatial information data among the national key open data into an address or a data link or a link form. The source information exists in various formats such as ontology, web, and

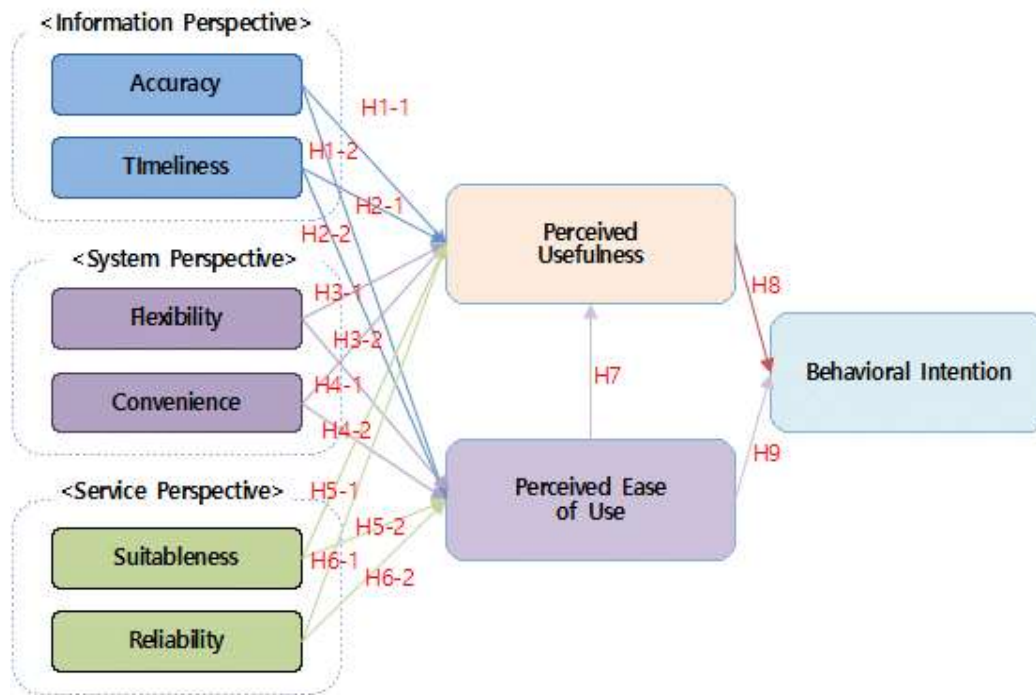
DBMS, and it is fused into a spatial information linkage integrated database based on LOD using the semantic service framework [13]. These days, one further step, what types of spatial patterns exist between experiential elements of sharing experiences and geographical characteristics through social data, and examine a new model of shared experience structure through extracted data [14].

DeLone and McLean (2003) published an improved model in 2003, based on the information system success model first proposed in 1992, ten years later [15]. Improvements in the existing information system success model include the addition of the service quality proposed by Pit et al (1995) as a new variable, and integrate the effects of existing personal and organizational aspects into a single variable called net benefit [16]. IT demands quality of service or desired quality of service (QoS), and issues of quality of service have been studied for a long time [17]. Seddon (1997) applied some of the suggestions to suggest that user satisfaction, user intention and use affect net benefits, and the results are related to information system users' satisfaction, usage and user intention [18]. The relationship between the updated information system success variables is summarized as follows. First, information quality, system quality, and service quality affect user satisfaction, use and intention to use, and secondly, user satisfaction, usage and intention to use influence each other. Finally, user satisfaction, use and intention affect net benefits, and net benefits again affect user satisfaction and use and intention to use.

Based on the theory of reasoned Action, Davis (1986) developed the Technology Acceptance Model [19]. The TAM model deals more specifically with the prediction of the acceptability of an information system. The purpose of this model is to predict the acceptability of a tool and to identify the modifications which must be brought to the system in order to make it acceptable to users. This model suggests that the acceptability of an information system is determined by two main factors: perceived usefulness and perceived ease of use. Perceived usefulness is defined as being the degree to which a person believes that the use of a system will improve his performance. Perceived ease of use refers to the degree to which a person believes that the use of a system will be effortless.

### **3. Proposed Mode**

In order to identify the factors affecting the use of Linked Open data, this study used information quality, system quality, and service quality proposed by IS and DeLone and Mclean (2003). In detail, it reflects the accuracy and timeliness of information viewpoints of Linked Open Data, which were used as measurement variables in Song Hyung-min's research (2015), and flexibility and convenience of system perspective [20]. Finally, we try to validate it through a model applied as an independent variable. Perceived Ease of Use, proposed by Davis (1989) in the technology acceptance model, is used to describe the characteristics of the linked open data defined by the classification criteria of the information system success model of DeLone and Mclean (2003) And Perceived Usefulness as parameters, and finally analyze how the perceived usefulness and perceived ease of use of linked open data affect users' intention to use. The research model is designed as shown in Figure 2.



**Figure 2. Research Model**

We analyzed the recognition of accuracy and timeliness, which are characteristics of information perspective on Linked Open Data. In this paper, the accuracy and timeliness of the information viewpoint are designated as important measurement variables for the public data opening through the linked open data.

The characteristics of the system point of view on linked open data are flexibility and convenience. The flexibility of Linked Open data is asserted by Tim Berners-Lee and can be retrieved by using the standard query language SPAQL to express data in the form of RDF when users use linked data. Linked Open data is characterized by the flexibility to provide public data for various situations and the convenience of accessing public data freely.

From the service point of view, the characteristics of linked open data can be divided into suitability and reliability. First, the characteristics of the suitability of the linked open data provide the public data desired by the user through the inquiry and the customized services are available because additional information on other public agencies can be obtained when necessary. Second, the characteristics of the reliability of linked open data should be such that users can get the reliability of service by registering and updating the desired public data in the public entity created through the initial task.

The purpose of this study is to investigate the effects of Linked Open Data features on the perceived ease of use and perceived usefulness, perceived ease of use on perceived usefulness of each of the factors classified by criteria of information system success model. The hypotheses were set as the effects of perceived usefulness and perceived ease of use on the intention to use. The hypotheses setting is as follows.

H1-1: The accuracy of linked open data will have a positive (+) impact on perceived usefulness.

H2-1: The timeliness of linked open data will have a positive (+) impact on perceived usefulness.

H1-2: The accuracy of linked open data will have a positive (+) impact on perceived ease of use.

H2-2: The timeliness of linked open data will have a positive (+) impact on perceived ease of use.

H3-1: The flexibility of linked open data will have a positive (+) impact on perceived usefulness.

H4-1: The convenience of linked open data will have a positive (+) impact on perceived usefulness.

H3-2: The flexibility of linked open data will have a positive (+) impact on perceived ease of use.

H4-2: The convenience of linked open data will have a positive (+) impact on perceived ease of use.

H5-1: The suitability of linked open data will have a positive (+) impact on perceived usefulness.

H6-1: The reliability of linked open data will have a positive (+) impact on perceived usefulness.

H5-2: The suitability of linked open data will have a positive (+) impact on perceived ease of use.

H6-2: The reliability of linked open data will have a positive (+) impact on perceived ease of use.

H7: Perceived ease of use will have a positive effect (+) on perceived usefulness.

H8: Perceived usefulness will have a positive effect (+) on intention to use.

H9: Perceived ease of use will have a positive effect (+) on intention to use.

#### **4. Empirical Analysis**

In order to analyze the factors affecting the use of public data through Linked Open Data, the sample characteristics of the questionnaire survey are as follows. A total of 264 respondents were surveyed through the questionnaire, and among them, 171 were male by 64.8% and 93 were female by 35.2%. By age, 79 (29.9%) were between 21 and 30, 91 (34.5%) were between 31 and 40, and 94 (35.6%) were between 41 and 50 years old.

The following is a list of the working organizations engaged in the use of linked open data by survey respondents. The central administrative agencies, local governments and affiliated institutions that can produce and manage linked open data were 16 (6.1%) with 72 (27.3%) of public institutions. 176 (66.7%) of the private IT companies were able to conduct public data service development using Linked Open Data.

Factor analysis was conducted to verify the validity of the questionnaire items for each variable of the research model. And Cronbach's coefficient for reliability and connectivity of each variable was measured. First, among the content validity, criterion validity, and conceptual validity, this study selected exploratory factor analysis by choosing concept validity to conduct a factor analysis, and the results were as follows: accuracy 2, accuracy 3, timeliness 1, timeliness 5, flexibility 1, easiness 1, usefulness 3, usefulness 5 that are not identically tied as a variable are excluded from these items, and the remaining items were all verified with 0.3 or more. For reliability analysis, Cronbach's alpha is used, and The Cronbach's alpha measure is based on the mean correlation and confirms that the metrics appear in a consistent pattern, and the applied research field is set at 0.9 or more, the basic research field is 0.8.

**Table 1. Analysis of Validity**

	Use intention	Convenience	Reliability	Ease of use	Accuracy	Flexibility	Timeliness	Usefulness	Suitability
<b>Cronbach's alpha</b>	<b>0.904</b>	<b>0.888</b>	<b>0.890</b>	<b>0.867</b>	<b>0.857</b>	<b>0.825</b>	<b>0.761</b>	<b>0.819</b>	<b>0.835</b>

Verification of discriminant validity can be confirmed only when the correlation coefficient between items of the different concept is low. That is, the discriminant validity is confirmed when the value obtained by squaring the value of average variance extraction (AVE) for the constitutional concept is larger than the correlation coefficient with other constitutional concepts. As shown in Table 2, the discriminant validity can be confirmed when the square root of the average variance extraction value of all constructive concepts, except the fitness item in the correlation matrix, is larger than the correlation coefficient for the different constitutional concepts.

**Table 2. Discrimination Feasibility Analysis**

	Reliability	Ease of use	Flexibility	Usefulness	Use intention	Timeliness	Suitability	Accuracy	Convenience
Reliability	0.751								
Ease of use	0.540	0.716							
Flexibility	0.471	0.563	0.739						
Usefulness	0.544	0.614	0.548	0.734					
Use intention	0.549	0.632	0.517	0.660	0.724				
Timeliness	0.562	0.566	0.475	0.522	0.499	0.675			
Suitability	0.592	0.670	0.632	0.668	0.677	0.584	0.668		
Accuracy	0.678	0.397	0.374	0.376	0.465	0.449	0.474	0.779	
Convenience	0.496	0.649	0.583	0.698	0.690	0.556	0.708	0.382	0.748

In order to verify the fitness of the structural equation model, it is possible to verify the redundancy value,  $R^2$  value and total fitness. The fit of the structural model was confirmed when the value of the redundancy was positive, and this study also found the fitness of the model with all positive numbers in 0.116 of ease of use, 0.098 of usefulness, and 0.244 of use intention. Cohen (1988) suggested that the fit of the model  $R^2$  can be verified by using the model fit / value and suggested the criteria. When the value of / is 0.26 or more

it is good with 0.13 ~ 0.26 fair, and 0.02 ~ 0.13 poor, respectively. The overall fitness is determined by the value of square root by multiplying the average value of the commonality and the average value of  $R^2$ . Criteria were classified as 0.36 or higher for good, 0.25 to less than 0.36 for fair, and lower than 0.1 to 0.25 for poor. In this study, as shown in Table 3, the measurement results of Redundancy, / and total fit meet the criteria listed above, and it is found that the fit to the model is high.

**Table 3. Fit of Structural Equation Model**

	Standard		Results	
	Redundancy	>=0(Positive number)		Ease of use
Usefulness				0.116
Use intention				0.237
Model fit ( $R^2$ )	Over 0.26	Good	Ease of use	0.555
	0.13~0.26	Fair	Usefulness	0.583
	0.02~0.13	Poor	Use intention	0.519
Overall fit (GOF) ( $R^2$ mean value X square root of AVE mean value)	Over 0.36	Good	0.633	
	0.25-0.3	Fair		
	0.1-0.25	Poor		

In order to confirm the cause and effect of each factor, this study summarized the result of hypothesis verification by path analysis using Smart PLS2.0 in Figure 3. Table 4. shows the summary of a verification of research hypotheses and Table 5. demonstrates an indirect effect verification.

**Table 4. Verification of Research Hypothesis**

Hypothesis	Path coefficient	p value	Results
Reliability -> Ease of use	0.138	0.086	Adopted
Reliability -> Usefulness	0.174	0.077	Adopted
Ease of use -> Usefulness	0.122	0.023	Adopted
Ease of use -> Use intention	0.363	***	Adopted
Flexibility -> Ease of use	0.129	0.094	Adopted
Flexibility -> Usefulness	0.074	0.247	Rejected
Usefulness -> Use intention	0.437	***	Adopted
Timeliness -> Ease of use	0.152	0.069	Adopted
Timeliness -> Usefulness	0.037	0.376	Rejected
Suitability -> Ease of use	0.251	0.036	Adopted
Suitability -> Usefulness	0.19164	0.090	Adopted
Accuracy -> Ease of use	-0.030	0.384	Rejected
Accuracy -> Usefulness	-0.062	0.263	Rejected
Convenience -> Ease of use	0.253	0.021	Adopted
Convenience -> Usefulness	0.356	0.001	Adopted

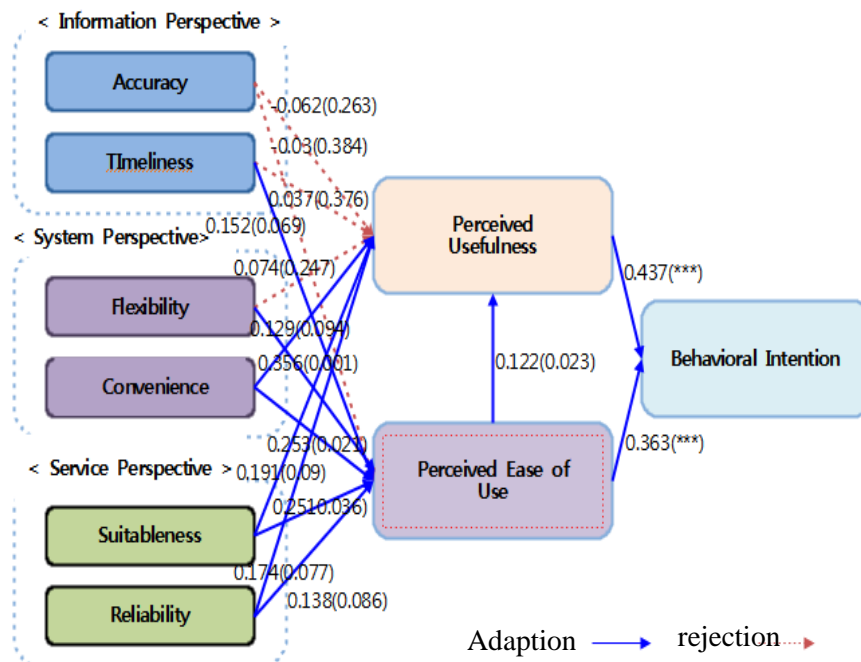
\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.00$



**Table 5. Indirect Effect Verification**

Variables		Path	Path coefficient	T value	Results
Timeliness	11	Timeliness -> ease of use -> use intention	0.055	1.174	Rejected
	12	Timeliness -> ease of use -> usefulness -> use intent	0.008	4.86	Adopted
Flexibility	21	Timeliness -> ease of use -> use intention	0.047	1.276	Rejected
	22	Timeliness -> ease of use -> usefulness -> use intention	0.006	4.695	Adopted
Convenience	31	Convenience -> ease of use -> use intention	0.092	0.976	Rejected
	32	Convenience -> ease of use -> usefulness -> use intention	0.013	3.254	Adopted
	33	Convenience -> usefulness -> use intention	0.155	0.818	Rejected
Suitability	41	Suitability -> ease of use -> use intention	0.091	0.782	Rejected
	42,	Suitability -> ease of use -> usefulness -> use intention	0.013	2.398	Adopted
	43	Suitability -> usefulness -> use intention	0.083	0.708	Rejected
Reliability	51	Reliability -> ease of use -> use intention	0.050	1.052	Rejected
	52	Reliability -> ease of use -> usefulness -> use intention	0.007	4.169	Adopted
	53	Reliability -> usefulness -> use intention	0.076	0.891	Rejected

The final summary for the verification of research hypotheses is shown as in Figure 3.



**Figure 3. Verification of Research Hypotheses**

## 5. Conclusion

In this study, we examine the characteristics of Linked Open data on the information quality, system quality, and service quality proposed by the IS Success model. We have identified the effects of these characteristics by specifying the perceived usefulness and perceived ease of use as parameters, which are the main measurement variables of the technology acceptance model. Finally, a study was conducted to see if it affects the intention to use as a dependent variable.

And this study verified the effects of the characteristics of linked open data on perceived ease of use. The timeliness of the information viewpoint, the flexibility of the system point of view, convenience and reliability of the service point of view are recognized as ease of use.

From a viewpoint of information, it was recognized that it is easy to use public data through Linked Open Data at a desired point of time, and from a system point of view, respondents recognized that it is easy to access public data to freely adapt to various situations. In addition, it has been shown that it has a positive effect on ease of use in that it provides suitable and reliable services through linked open data.

However, the accuracy of the information perspective did not seem to affect the ease of use. From the viewpoint of information, it is not useful to use public data through Linked Open Data to obtain information that is not transformed and not duplicated at a desired point of time. This is unfavorable compared to Excel and Open-API used to open public data, and it is thought that users do not perceive it as ease of use due to lack of practical experience. It is proved that the perceived ease of use affects perceived usability when using public data through Linked Open data. This study could find that the convenience of using Linked Open data and the familiarity with it easily affect the usefulness of public data. Finally, as it is not difficult to use Linked Open data, it is shown that ease of use and perception of usefulness to obtain useful information through Linked Open data have a positive effect on intention to use.

The government will have to establish a long-term roadmap for opening public data using LOD technology and link short-term benefits to the ultimate opportunity. To do this, we propose to develop and disseminate a business model using public data. In addition, it would be useful to provide incentives and start-up support for utilizing public data.

This study derived academic implications and policy implications for empirical analysis results. Nonetheless, this study would like to explain some of the limitations of some studies and give directions for future research.

First, this study tried to conduct a survey evenly by type of Linked Open Data when constructing a sample of this study, it was biased with 88 service providers (33.4%) and 176 private IT companies (66.7%), open service producers. A more generalized analysis would be possible if the bias could be reduced through a variety of sample surveys involving production and consumption.

Second, public data open service through Linked Open Data has not spread to the public, and service development using Linked Open Data is still in its early stage. Having realized that general users did not have enough understanding, this study conducted a questionnaire to the employees of the private IT company, the first public data service producer. However, it is considered that there will be some respondents who are surveyed by IT companies without an accurate understanding. Indeed, it is believed that more accurate and useful results can be obtained if the sample is specified as public agency workers directly involved in providing Linked Open Data Services and IT company workers who develop and plan services.

Finally, analyzing the characteristics of linked open data used as an independent variable by applying the information, system, and service perspectives of the information system success model has limitations to analyze various factors affecting the intention to use Linked Open data.

This study examined the factors affecting the intention to use Linked Open data. Further research is required to further improve the limitations of the sample through detailed questionnaires and to elicit various factors on the characteristics of Linked Open data.

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