

A Study on the Factors Influencing the Satisfaction of Online Service System on the International Research Cooperation*

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ABSTRACT

Recently, as the pandemic COVID-19 has been spread worldwide, international research cooperation has come to the fore to overcome the crisis and develop treatments. Currently, in Korea, with the support from the Ministry of Education and the Korea Research Foundation, the International Research Cooperation Information Center operates an online service system for international research cooperation as a venue for sharing results among international research cooperation researchers and invigorating such research. However, since Korea's performance in international research cooperation is still poor, actively pursuing measures to improve professionalism and diversity based on international cooperation is deemed necessary. Therefore, in this study, factors influencing the level of satisfaction with international research cooperation online service systems were identified, and measures to increase the satisfaction of international research cooperation online service were proposed based on the analysis results. Design of the system quality factors, accuracy and consistency of the information quality factors, and professionalism of the service quality factors were verified to have a significant effect on the satisfaction with international research cooperation online service systems. Accordingly, further strengthening the aspects of design, accuracy, consistency, and professionalism was proposed as a way to increase the satisfaction of international research cooperation online service systems.

1. Introduction

With the recent worldwide outbreak of COVID-19 (Coronavirus disease 2019), the World Health Organization (WHO) declared an international public health emergency in January 2020, raised the global risk assessment of the infection to "very high" in February and declared the new Coronavirus, COVID-19, as a pandemic in March (Namuwiki, 2019).

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In fact, governments and research institutes of major countries have asked the Korean government for Korea's research data to evaluate the state of COVID-19 and establish a disinfection policy. Accordingly, the government has shared research results by processing detailed data on diagnostic tests, drug use, and medical expenses for research purposes. This can be used as fundamental data for efficient resource allocation and verification of treatment effectiveness in the response process of each country (Lee, 2020).

Currently in Korea, with the support from the Ministry of Education and the Korea Research Foundation, the International Research Cooperation Information Center has built DB by gathering information from the International Research Cooperation, while operating an international research cooperation online service system as a venue for sharing research results among the international research cooperation researchers and invigorating such research.

In the future, international research cooperation in countries around the world will become a survival strategy to survive in the era of infinite global competition, and Korea, where international research cooperation is still very poor, must actively prepare measures to improve expertise and diversity based on international cooperation.

In other words, the role and value of an online service system that provides information on international research cooperation conducted in various academic fields as a one-stop has recently emerged in Korea. Accordingly, it is judged that the improvement of the online service system operated by the International Research Cooperation Information Center will be most important.

Therefore, in this study, the factors influencing the level of satisfaction with international research cooperation online service systems were verified by categorizing the factors into system quality factors (convenience, usability, reliability, adaptability and design), information quality factors (accuracy, diversity, consistency, ease of understanding and timeliness) and service quality factors (responsiveness, empathy and professionalism), and improvement measures were proposed for the satisfaction of international research cooperation online service systems based on the analysis results.

It is expected that this study will, first, contribute to vitalizing international research cooperation in Korea by increasing user satisfaction through qualitative improvement of online service systems for international research cooperation and increasing the utilization rate. Second, this study is also expected to play a vital role in encouraging Korean researchers of international research cooperation to promote a high-level international research cooperation by establishing a venue that promote dynamic international research cooperation in various fields for Korea, where international research cooperation online systems are somewhat stagnant.

2. Previous Studies

The information system success model developed by DeLone and McLean (2003), which is one of the most used models for domestic and international research verifying the quality and satisfaction of information systems, was used as the basic frame for the research model. In addition, based on various domestic and foreign studies that verified the quality and satisfaction of information systems by applying this model in various academic fields, factors influencing the satisfaction of

international research cooperation online service systems were selected.

DeLone and McLean (2003) broadly constructed three factors of system quality, information quality, and service quality and used them as independent variables. Moreover, they developed a model to verify the usefulness of information systems by setting ‘Use’ and ‘User Satisfaction’ as the parameters, and ‘Net Benefits’ as the dependent variable. This model is as shown in below Fig. 1.

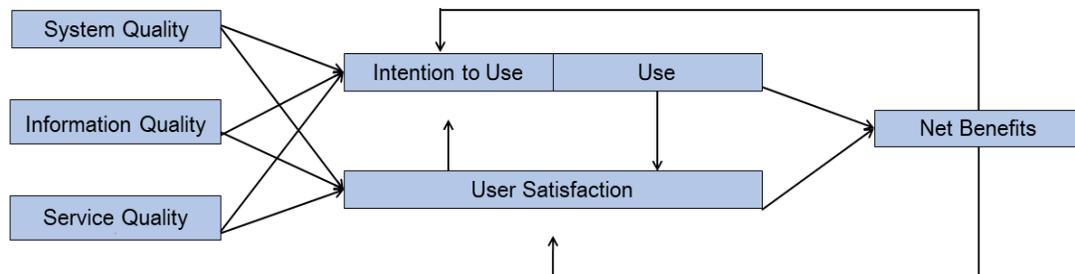


Fig. 1. DeLone and McLean (2003)'s Information System Success Model
 (Source: DeLone & McLean, 2003)

DeLone and McLean (2003) divided the system quality factors into 1) adaptability, 2) stability and easiness 3) usability and 4) accessibility, presented 1) clarity, 2) accuracy, 3) completeness, 4) timeliness, 5) comparability and 6) screen design as the factors of information quality, and listed 1) reliability, 2) responsiveness, 3) timeliness of the provided information 4) empathy and 6) assurance as the factors of service quality.

Later, Kim (2006) investigated the user satisfaction for public library websites and classified three factors (system quality, information quality and service quality) that influence the user satisfaction. Specifically, Kim constructed the system quality factor with 1) usability, 2) interactivity and 3) access, included 1) scope, 2) accuracy, and 3) aesthetics in the information quality factor, and suggested 1) responsiveness as the service quality factor.

Kang and Jung (2008) studied the impact of university information system quality characteristics on the students' satisfaction and categorized the quality factors of information system into three factors (system quality, information quality and service quality). That is, Kang and Jung included 1) convenience, 2) reliability and 3) usability in the system quality factor, divided information quality factor into 1) timeliness and 2) accuracy, and constructed service quality factor with 1) responsiveness and 2) support.

In the same year, Bernroider (2008) argued that information quality factor in information systems is more important than information integration and quality improvement and divided the quality factor of information systems into three domains (system quality, information quality and service quality). Moreover, he listed 1) adaptability, 2) usability and 3) function as the system quality factor, included 1) provision of comprehensive information in the quality factor, and divided service quality factor into 1) system reliability and 2) service availability.

Also, Kang (2015) verified the effects of the quality of museum information systems on the

behavioral intention for satisfaction and divided the quality factors into three domains (system quality, information quality, and service quality). In other words, Kang presented 1) usability, 2) timeliness with accuracy, 3) diversity, 4) accuracy, and 5) ease of understanding as the system quality factor, divided the information quality factor into 1) suitability, 2) reliability, 3) diversity, 4) accuracy, and 5) ease of understanding. and classified the service quality factor into 1) prompt response service for users, 2) user demand response, 3) service, 4) user understanding and care service, 5) mutual opinion exchange service and 6) user preference satisfaction service.

Jung (2016) analyzed the key factors of the construction information system, PMIS (Project Management Information System), affecting the user satisfaction. In order to do so, Jung divided the quality factor into three categories (system quality, information quality and service quality). Jung listed 1) stability, 2) speed, 3) usability, and adaptability as the system quality factor and divided the information quality factor into 1) provision of comprehensive information, 2) accuracy, 3) timeliness and 4) screen design, and included 1) information provided, 2) user/user expertise, 3) reliability, and 4) empathy in the service quality factor.

Recently, Chen (2017) investigated the influence of the system quality, information quality, and service quality of real estate information websites on perceived value, customer satisfaction, and intention to reuse. Specifically, Jin constructed the system quality factor with 1) convenience, 2) design, 3) usability, and 4) adaptability, suggested 1) accuracy, 2) utility, 3) accessibility, 4) consistency as the information quality factor and divided the service quality factor into 1) tangibility, 2) responsiveness, 3) certainty, and 4) empathy.

The information system evaluation factors suggested by researchers at home and abroad are summarized in below Table 1. In this study, the information system success model developed by DeLone and McLean (2003) was set as the basic framework of the research model and factors influencing the satisfaction of international research cooperation online service systems were selected based on the evaluation factors suggested by the researchers.

Table 1. Information System Evaluation Factors

Researcher (Year)	Evaluation Factors
DeLone and McLean (2003)	<ul style="list-style-type: none"> • System Quality Factor: 1) adaptability, 2) stability, 3) convenience, 4) usability, 5) accessibility • Information Quality Factor: 1) clarity, 2) accuracy, 3) completeness, 4) timeliness, 5) comparability, 6) screen design • Service Quality Factor: 1) reliability, 2) responsiveness, 3) timeliness of the provided information, 4) empathy, 5) assurance
Kim (2006)	<ul style="list-style-type: none"> • System Quality Factor: 1) usability, 2) interactivity, 3) access • Information Quality Factor: 1) scope, 2) accuracy, 3) aesthetics • Service Quality Factor: 1) responsiveness
Kang and Jung (2008)	<ul style="list-style-type: none"> • System Quality Factor: 1) convenience, 2) reliability, 3) convenience, 4) adaptability • Information Quality Factor: 1) timeliness, 2) accuracy • Service Quality Factor: 1) responsiveness, 2) support
Bernroider (2008)	<ul style="list-style-type: none"> • System Quality Factor: 1) adaptability, 2) convenience, 3) function • Information Quality Factor: 1) provision of comprehensive information • Service Quality Factor: 1) system reliability, 2) service availability

Researcher (Year)	Evaluation Factors
Kang (2015)	<ul style="list-style-type: none"> • System Quality Factor: 1) usability, 2) timeliness with accuracy, 3) diversity, 4) accuracy, 5) ease of understanding • Information Quality Factor: 1) suitability, 2) reliability, 3) diversity, 4) accuracy, 5) ease of understanding • Service Quality Factor: 1) prompt response service for users, 2) user demand response, 3) service, 4) user understanding and care service, 5) mutual opinion exchange service, 6) user preference satisfaction service.
Jung (2016)	<ul style="list-style-type: none"> • System Quality Factor: 1) stability, 2) speed, 3) usability, 4) adaptability • Information Quality Factor: 1) provision of comprehensive information, 2) accuracy, 3) timeliness, 4) screen design • Service Quality Factor: 1) information provided, 2) user/user expertise, 3) reliability, 4) empathy
Chen (2017)	<ul style="list-style-type: none"> • System Quality Factor: 1) convenience, 2) design, 3) usability, 4) adaptability • Information Quality Factor: 1) accuracy, 2) utility, 3) accessibility, 4) consistency • Service Quality Factor: 1) tangibility, 2) responsiveness, 3) certainty, 4) empathy

3. Research Model and Hypothesis

3.1 Research Model

Based on the information system success model developed by DeLone and McLean (2003) and the factors presented in relevant prior studies, factors influencing international research cooperation online service systems were selected.

The factors selected in this study can be broadly categorized into three domains of system quality, information quality and service quality. Characteristics of each factor are as follows. First, convenience, usability, reliability, adaptability and design were selected as the system quality factor. Second, accuracy, diversity, consistency, ease of understanding, and timeliness were chosen for the information quality factor. Third, service quality factor included responsiveness, empathy, and professionalism.

An attempt was made to examine each of the factors to identify the factor having an effect on the satisfaction of international research cooperation online service systems. Below Fig. 2 schematically describes the research model of this study.

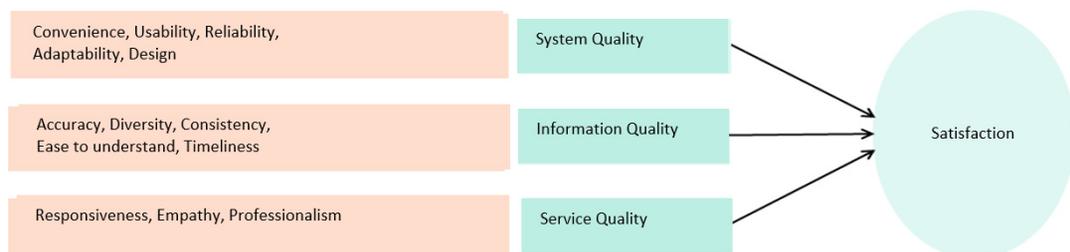


Fig. 2. Research Model

3.2 Research Hypothesis

This study was initiated from a research question raised to understand which of the various factors included in the domains of system quality, information quality, service quality, and satisfaction influence the satisfaction of international research cooperation online service systems.

There is a total of 16 research hypotheses (3 higher-level hypotheses and 13 sub-hypotheses). The system quality and information quality each include 5 sub-hypotheses whereas the service quality includes 3 sub-hypotheses. Table 2 shows the research hypotheses.

Table 2. Research Hypothesis

Item	Hypothesis
H.1	System quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.1.1	The convenience factor of system quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.1.2	The usability factor of system quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.1.3	The reliability factor of system quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.1.4	The adaptability factor of system quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.1.5	The design factor of system quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.2	Information quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.2.1	The accuracy factor of information quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.2.2	The diversity factor of information quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.2.3	The consistency factor of information quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.2.4	The ease of understanding factor of information quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.2.5	The timeliness factor of information quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.3	Service quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.3.1	The responsiveness factor of service quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.3.2	The empathy factor of service quality will have a significant effect on the satisfaction of international research cooperation online service systems
H.3.3	The professionalism factor of service quality will have a significant effect on the satisfaction of international research cooperation online service systems

3.3 Operational Definition of Variables

The operational definitions of the independent and dependent variables set in this study are as shown in Table 3. This study has a total of 17 variables composed of 16 independent variables and 1 dependent variable. The 16 independent variables include 6 variables related to system quality, 6 variables related to information quality and 4 variables related to service quality. In addition, satisfaction level is the dependent variable of this study.

Table 3. Operational Definition of Variables

Variable		Operational Definition	Researchers
System Quality	Convenience	The degree of convenience during system access and use	DeLone & McLean (2003); Kang & Jung (2008); Chen (2017)
	Usability	The degree of easiness and readiness in using and understanding the system	DeLone & McLean (2003); Kim (2006); Kang & Jung (2008); Bernroider (2008); Kang (2015); Jung (2016); Chen (2017)
	Reliability	The degree of reliability and frequency of non-occurrence of system failure	Kang & Jung (2008);
	Adaptability	The extent of adaptability to changing environments and degree of data exchange	DeLone & McLean (2003); Kang & Jung (2008); Bernroider (2008); Jung (2016); Chen (2017)
	Design	The level of aesthetics of system interface design	Chen (2017)
Information Quality	Accuracy	The level of accuracy of information provided	DeLone & McLean (2003); Kim (2006); Kang & Jung (2008); Kang (2015); Jung (2016); Chen (2017)
	Diversity	The extent of diversity of information provided	Bernroider (2008); Kang (2015); Jung (2016);
	Consistency	The level of consistency of the information and terminology used for information provided	Chen (2017)
	Ease of understanding	The level of easiness to understand the information and terminology used in the information provided	Kang (2015);
	Timeliness	The extent to which information is updated and timeliness of information provided	DeLone & McLean (2003); Kang & Jung (2008); Jung (2016)

Variable		Operational Definition	Researchers
Service Quality	Responsiveness	The level of responsiveness to complaints and requests	DeLone & McLean (2003); Kang & Jung (2008); Kang (2015); Chen (2017)
	Empathy	The degree of empathy by providing various communication channels and extent of system operator's empathy	DeLone & McLean (2003); Jung (2016); Chen (2017)
	Professionalism	The level of system operator's problem-solving ability and expertise	Kang & Jung (2008);
Satisfaction		Overall satisfaction for the system	DeLone & McLean (2003); Kim (2006); Kang & Jung (2008); Bernroider (2008); Kang (2015); Jung (2016); Chen (2017)

4. Research Procedure and Method

This study surveyed researchers related to international research cooperation and online service system experts. The survey was conducted online for a total of two weeks, starting from February 26 to March 11, 2020. KSDC DB provided by the Ministry of Science and ICT was used as the online survey tool. The questionnaire was electronically sent to a total of 361 international research cooperation researchers and online service system experts. Among them, 127 questionnaires were collected; however, 102 questionnaires were selected as the study subject after eliminating 25 questionnaires with missing data. In addition, the collected data were processed using SPSS to verify the research results.

5. Analysis Results

5.1 Demographic Characteristics

The demographic characteristics of the respondents are shown in Table 4. Gender-wise, males were 28.4% and females were 71.6%, showing a significantly higher participation among female compared to their counterpart. In terms of age, 33.3% of the respondents were in their 40s, followed by 23.5% of 30s, 17.6% of 20s, 16.7% of 50s, and 8.8% of respondents who were 60 years old or older. In addition, in terms of educational background, 43.1% had a doctoral degree (43.1%), followed by those having master's degree (42.2%), bachelor's degree (12.7%) and others (2.0%). Similarly, occupation-wise, it was found that majority of the respondents were researchers (44.1%), followed by those working in education sector (34.3%), students (13.7%), office workers (3.9%) and others (3.9%)

Table 4. Demographic Characteristics

Survey Item		Frequency	Ratio
Gender	Male	29	28.4
	Female	73	71.6
Age	20~29	18	17.6
	30~39	24	23.5
	40~49	34	33.3
	50~59	17	16.7
	60 or above	9	8.8
Educational Background	Bachelor's Degree	13	12.7
	Master's Degree	43	42.2
	Doctoral Degree	44	43.1
	Others	2	2.0
Occupation	Students	14	13.7
	Education	35	34.3
	Researcher	45	44.1
	Office Worker	4	3.9
	Others	4	3.9

5.2 Verification of Validation and Reliability

In order to prove the validity of the verification results of the hypotheses of this study, the inspection of reliability and validity of the measurement tools must be accompanied. Therefore, exploratory factor analysis was conducted for the evaluation of measurement variables by categorizing them into centralized validity-showing internal consistency between items-and discriminant validity-representing the independence between different dimensions. Principal component extraction method was used as the factor extraction method, factor rotation was performed via Varimax rotation, which is one of the orthogonal rotation methods. In addition, when analyzing the factors, factors loaded with other factors or have less than 0.4 factor loading value were excluded.

Factor analysis is one of the most commonly used analysis methods for evaluating the consistency of the actual measurement results of measurement indicators with the intended theoretical concept. In general, there are two factor extraction methods of the principal component and common factor analysis, and this study used the former method.

In general, factor extraction extracts factors based on the eigenvalue, which is the amount of variance that a factor can explain, extracting factors with an eigenvalue of 1.0 or greater. Here, the meaning of the eigenvalue of 1.0 means that the variance equivalent to one variable is reduced. The factor loading of 0.40 or greater is considered to be statistically significant, and Varimax method

was used to eliminate multicollinearity, which is a correlation between factors.

Reliability is the variance of measured values that appear when measurement for one concept is repeatedly taken. In this study, reliability was measured using the Cronbach's Alpha coefficient to measure the internal consistency. Nunnally (1978) demonstrated that an alpha value of 0.60 or greater is sufficient for exploratory research whereas an alpha value of 0.80 is needed for basic research and 0.90 or greater for applied research fields where critical decisions are required. Moreover, Van & Ferry (1980) also considered that alpha value of 0.60 or greater, which is generally required for organizational unit analysis or similar, indicates that there is no problem related to the reliability of the measurement tool.

5.2.1 Exploratory Factor Analysis for System Quality

The factor analysis for the system quality factor, which is one of the independent variables of the research model, extracted a total of five factors (convenience, usability, reliability, adaptability and design) and the results are as shown in Table 5. As a result of the analysis, the eigenvalues were ranged between 1.507 and 3.228, showing that all independent variables were clearly classified with an eigenvalue above 1.0. The cumulative variance was found to be 80.014%, and the factor loading value was greater than 0.4, verifying the centralized and discriminant validity between the measured variables of the same factor. In addition, the KMO index was found to be .821, and the chi-square value was 633.796 (df = 55, p = .000) in Bartlett's test of sphericity.

Table 5. Exploratory Factor Analysis for System Quality

Survey Item	Component			
	1	2	3	4
Design 2	.890			
Design 1	.881			
Design 3	.831			
Design 5	.794			
Convenience 3		.890		
Convenience 2		.886		
Convenience 4		.700		
Usability 2			.857	
Usability 1			.835	
Reliability 2				.853
Reliability 1				.778
Eigen-value	3.228	2.384	1.684	1.507
Explanatory Variance (%)	29.342	21.669	15.305	13.699
Cumulative Variance (%)	29.342	51.011	66.316	80.014
Cronbrach Alpha	.904	.873	.779	.642

Specifically, the results of exploratory factor analysis on the system quality showed that design was composed of 4 survey items and selected as the design factor with an eigenvalue of 3.228 and 29.342% explanatory variance. Secondly, convenience was composed of 3 survey items and included as the convenience factor with an eigenvalue of 2.384 and 21.669% explanatory variance. Thirdly, usability accounted for 2 survey items and became the usability factor with an eigenvalue of 1.684 and explanatory variance of 15.305%. Fourthly, reliability was composed of 2 survey items and selected as the reliability factor with an eigenvalue of 1.507 and 13.699% explanatory variance. However, adaptability from the system quality factor was omitted during the factor analysis and the study continued after the omission. In addition, the Cronbrach Alpha value of all of the 4 factors was 0.6 or greater, verifying that the measurement tool has no problem.

5.2.2 Exploratory Factor Analysis for Information Quality

The factor analysis for the information quality factor, which is one of the independent variables of the research model, extracted a total of five factors (accuracy, diversity, consistency, ease of understanding, timeliness), and the test results are shown in Table 6. As a result of the analysis, the eigenvalues were ranged between 1.685 and 2.666, showing that all independent variables were clearly classified with an eigenvalue above 1.0. The cumulative variance was found to be 80.963%, and the factor loading value was greater than 0.4, verifying the centralized and discriminant validity between the measured variables of the same factor. In addition, the KMO index was found to be .818, and the chi-square value was observed to be 741.043 (df=78, p=.000) in Bartlett’s test of sphericity.

Table 6. Exploratory Factor Analysis for Information Quality

Survey Item	Component				
	1	2	3	4	5
Timeliness 2	.845				
Timeliness 3	.818				
Timeliness 1	.808				
Accuracy 5		.872			
Accuracy 4		.868			
Accuracy 3		.753			
Diversity 1			.853		
Diversity 2			.692		
Diversity 3			.656		
Consistency 3				.916	
Consistency 4				.786	
Ease of Understanding 5					.815
Ease of Understanding 3					.800
Eigen-value	2.666	2.507	1.957	1.710	1.685
Explanatory Variance (%)	20.504	19.286	15.056	13.156	12.960
Cumulative Variance (%)	20.504	39.791	54.847	68.003	80.963
Cronbrach Alpha	.861	.854	.820	.822	.781

Specifically, the results of exploratory factor analysis on the information quality showed that timeliness was composed of 3 survey items and selected as the timeliness factor with an eigenvalue of 2.666 and 20.504% explanatory variance. Secondly, accuracy was composed of 3 survey items and included as the accuracy factor with an eigenvalue of 2.507 and 19.286% explanatory variance. Thirdly, diversity accounted for 3 survey items and became the diversity factor with an eigenvalue of 1.957 and explanatory variance of 15.056%. Fourthly, consistency was composed of 2 survey items and selected as the consistency factor with an eigenvalue of 1.710 and 13.156% explanatory variance. Fifthly, ease of understanding was composed of 2 survey items and selected as the ease of understanding factor with an eigenvalue of 1.685 and 12.960% explanatory variance. In addition, the Cronbrach Alpha value of all of the 5 factors was 0.6 or greater, verifying that the measurement tool has no problem.

5.2.3 Exploratory Factor Analysis for Service Quality

The factor analysis for the service quality factor, which is one of the independent variables of the research model, extracted a total of two factors (responsiveness, empathy, professionalism), and the test results are shown in Table 7. As a result of the analysis, the eigenvalue for each was 2.273 and 2.1456, showing that all independent variables were clearly classified with an eigenvalue above 1.0. The cumulative variance was found to be 73.636%, and the factor loading value was greater than 0.4, verifying the centralized and discriminant validity between the measured variables of the same factor. In addition, the KMO index was found to be .765, and the chi-square value was 307.049 (df=15, p=.000) in Bartlett’s test of sphericity.

Table 7. Exploratory Factor Analysis for Service Quality

Survey Item	Component	
	1	2
Professionalism 1	.869	
Professionalism 2	.862	
Professionalism 3	.749	
Responsiveness 2		.909
Responsiveness 3		.858
Responsiveness 1		.608
Eigen-value	2.273	2.145
Explanatory Variance (%)	37.888	35.748
Cumulative Variance (%)	37.888	73.636
Cronbrach Alpha	.839	.790

Specifically, the results of exploratory factor analysis on the service quality showed that professionalism was composed of 3 survey items and selected as the professionalism factor with an

eigenvalue of 2.273 and 37.888% explanatory variance. Secondly, responsiveness was composed of 3 survey items and included as the responsiveness factor with an eigenvalue of 2.145 and 35.748% explanatory variance. However, empathy from the service quality factor was omitted during the factor analysis and the study continued after the omission. In addition, the Cronbrach Alpha value of all of the 2 factors was 0.6 or greater, verifying that the measurement tool has no problem.

5.2.4 Exploratory Factor Analysis for Satisfaction

The results of exploratory factor analysis for satisfaction, which is selected as the dependent variables of the research model, are shown in Table 8. As a result of the analysis, the eigenvalue was 2.253, showing an eigenvalue greater than 1.0. The cumulative variance was found to be 56.329%, and the factor loading value was greater than 0.4, verifying the centralized and discriminant validity between the measured variables of the same factor. In addition, the KMO index was found to be .597, and the chi-square value was 121.188 (df=6, p=.000) in Bartlett’s test of sphericity.

Table 8. Exploratory Factor Analysis for Satisfaction

Survey Item	Component 1
Satisfaction 2	.805
Satisfaction 4	.744
Satisfaction 1	.727
Satisfaction 3	.724
Eigen-value	2.253
Explanatory Variance (%)	56.329
Cumulative Variance (%)	56.329
Cronbrach Alpha	.741

Specifically, the results of exploratory factor analysis on the satisfaction showed that satisfaction was composed of 4 survey items and selected as the satisfaction factor with an eigenvalue of 2.253 and 56.329% explanatory variance. In addition, the Cronbrach Alpha value was .741, verifying that the measurement tool has no problem.

5.3 Hypothesis Verification

Hierarchical regression analysis is a method of performing regression analysis while accumulating independent variables according to theoretically set steps. It is used for the purpose of controlling the effect of previously inputted independent variables and comparing how much the newly added independent variable group contributes to explaining the dependent variables. In order to evaluate the relative influence, the final model is judged. Therefore, in this study, hierarchical regression

analysis was performed to find out which of the independent variables had the most influence.

The results of hierarchical regression analysis conducted to understand the effects of system quality factors (convenience, usability, reliability and design), information quality factors (accuracy, diversity, consistency, ease of understanding and timeliness) and service quality factors (responsiveness and professionalism), which are the hypotheses set in this study, are as follows.

First, examining the results of the first stage of the model, only reflecting the system quality factors (convenience, usability, reliability and design), revealed that the usability has a statistically significant positive influence with a t-value of 2.233 for satisfaction. In addition, reliability and design, respectively, showed a t-value of 3.769 and 3.352 for satisfaction, indicating a significant positive influence on satisfaction.

As such, it can be interpreted that as the usability, reliability, and design factors increase as a system quality factor, the level of satisfaction with international research cooperation online service systems also increases. In fact, among other factors, reliability factor was confirmed to have the greatest influence on the satisfaction. In addition, the regression equation of the first stage show $R = .690$, $R^2 = .477$, $Adj R^2 = .455$, $F = 22.095$ and $p = .000$ with an explanatory power of 47.7%.

Table 9. Hierarchical Regression Analysis (1ST Stage)

Dependent Variable	Independent Variable	1 ST STAGE				
		Non-standard B	Coefficient SE	β	t	p
Satisfaction	(Constant)	.643	.374		1.719	.089
	Convenience	.104	.070	.138	1.478	.143
	Usability	.201	.090	.203	2.233	.028*
	Reliability	.336	.089	.330	3.769	.000**
	Design	.265	.079	.303	3.352	.001**
	Accuracy					
	Diversity					
	Consistency					
	Ease of Understanding					
	Timeliness					
	Responsiveness					
	Professionalism					
	Statistics		R=.690, R ² =.477, Adj R ² =.455 F=22.095, p=.000			

**p<0.01. *p<0.5

Second, the results of second stage analysis, which included the quality factors, showed that the accuracy factor has a significant positive effect on satisfaction with a t-value of 2.117. Similarly,

the t-value of consistency and timeliness factors, respectively, was found to be 2.035 and 2.236, indicating a positive effect on satisfaction.

Consequently, it can be understood that as the information quality factors of accuracy, consistency and timeliness increase, the level of satisfaction with international research cooperation online service systems also increase. Moreover, the regression equation of the 2nd stage model showed R=.782, R²=.615, Adj R²=.574, F=16.096 and p=.000 with an explanatory power of 61.5%.

Table 10. Hierarchical Regression Analysis (2nd Stage)

Dependent Variable	Independent Variable	2 nd STAGE				
		Non-standard B	Coefficient SE	β	t	p
Satisfaction	(Constant)	.220	.359		.612	.542
	Convenience	.069	.069	.092	1.002	.319
	Usability	.088	.086	.089	1.033	.304
	Reliability	.156	.089	.153	1.756	.082
	Design	.122	.082	.140	1.486	.141
	Accuracy	.182	.086	.220	2.117	.037*
	Diversity	.046	.086	.050	.536	.593
	Consistency	.126	.062	.171	2.035	.045*
	Ease of Understanding	.027	.079	.031	.345	.731
	Timeliness	.185	.083	.221	2.236	.028*
	Responsiveness					
Professionalism						
Statistics		R=.782, R ² =.615, Adj R ² =.574 F=16.096, p=.000				

**p<0.01. *p<0.5

Third, the results of 3rd stage model analysis, in which the service quality factors were added to the system quality and information quality factors, revealed that the design factor of the system quality factors has a significant effect on the satisfaction with a t-value of 2.187. Among the information quality factors, accuracy was analyzed to have a significant influence on the satisfaction with a t-value of 2.904 and consistency was also confirmed to have a statistically significant impact on the satisfaction with a t-value of 2.837. Similarly, the professionalism of the service quality factors was observed to have a t-value of 3.990 for the satisfaction, indicating a significant positive effect on the satisfaction within the scope of statistics.

As such, the design factor of the system quality factors, the accuracy and consistency factors of the information quality factors, and the professionalism factor of the service quality factors were confirmed to proportionally increase the level of satisfaction with international research cooperation online systems. Among those, it was found that the professionalism factor has the greatest impact

on the satisfaction, followed by the accuracy factor.

Moreover, the regression equation of this model showed $R=.823$, $R^2=.677$, $Adj R^2=.638$, $F=17.187$, $p=.000$ and Durbin-Watson = 2.120 with an explanatory power of 67.7%, indicating that there is no residual in the regression equation.

Table 11. Hierarchical Regression Analysis (3rd Stage)

Dependent Variable	Independent Variable	3 rd STAGE				
		Non-standard B	Coefficient SE	β	t	p
Satisfaction	(Constant)	.033	.346		.096	.924
	Convenience	-.003	.066	-.004	-.048	.962
	Usability	.058	.080	.058	.725	.471
	Reliability	.065	.084	.064	.766	.445
	Design	.171	.078	.196	2.187	.031*
	Accuracy	.237	.081	.286	2.904	.005**
	Diversity	-.069	.084	-.074	-.820	.414
	Consistency	.167	.059	.226	2.837	.006**
	Ease of Understanding	-.060	.076	-.069	-.791	.431
	Timeliness	.063	.083	.076	.762	.448
	Responsiveness	.076	.081	.080	.943	.348
	Professionalism	.340	.085	.384	3.990	.000**
	Statistics	R=.823, $R^2=.677$, $Adj R^2=.638$ F=17.187, p=.000, Durbin-Watson = 2.120				

**p<0.01. *p<0.5

6. Discussion

Based on the analyzed results, measures were proposed to improve the satisfaction of the international research cooperation online service systems in terms of system quality factors, information quality factors, and service quality factors.

First, among the system quality factors (convenience, usability, reliability, adaptability and design), the adaptability was deleted during the factor analysis. According to the results of the hypothesis verification through the three-stage hierarchical regression analysis, convenience, usability, and reliability were rejected, and only the design factor was verified to have a significant effect on the satisfaction of international research cooperation online service systems. A study by Jo and Roh (2006) also showed that homepage design had a positive effect on the satisfaction of urban residents with rural tourism homepages. Similarly, Park (2016) also demonstrated that the design factor has a significant positive effect on the level of satisfaction of Chinese tourists with tourism homages. Therefore, it is suggested to devise measures to increase the affinity and aesthetics in terms of

system interface design, as a way to increase the level of satisfaction with international research cooperation online service systems.

Second, as a result of performing the three-stage hierarchical regression analysis on the information quality factors (accuracy, diversity, consistency and ease of understanding, timeliness), diversity, ease of understanding and to have a significant effect on the satisfaction level of international research cooperation online service systems. In fact, Kim (2006) also verified that accuracy, among other information quality factors, has a statistically positive effect on the public library website user satisfaction. Similar to his study, Chen (2017) also investigated the accuracy and consistency factors of information quality and found that they have a positive effect on the real estate website user satisfaction. As such, it is proposed to maintain the accuracy of information and consistency of terminology as a way to increase the satisfaction of international research cooperation online service systems.

Third, among the service quality factors (responsiveness, empathy, and professionalism), empathy was eliminated during the factor analysis process. The results of verifying the hypotheses through the three-stage hierarchical regression analysis, the responsiveness factor was rejected, and only the factor of professionalism was analyzed to have a significant effect on the satisfaction level of international research cooperation online service systems. However, Kim (2006) demonstrated that the responsiveness factor of the service quality has a statistically significant effect on the satisfaction of public library websites. Accordingly, as a way to improve the satisfaction level of international research cooperation online service systems, it is suggested to supplement not only the professionalism of the system operator but also the responsiveness to the user's requirements.

7. Conclusion and Suggestions

International research cooperation not only enhances the quality of research achievements by sharing human and material resources among countries, but also has great advantages in that it can contribute to promoting sustainable development from the aspect of national competitiveness. In fact, the research through international research cooperation made superior achievements compared to other studies conducted alone by Korea. However, evaluating the current stage of international research cooperation, in which Korea participate with other countries, reveals that the level of participation is somewhat stagnant.

international research cooperation needs to be further strengthened. Accordingly, this study identified factors affecting the satisfaction of international research cooperation online service systems operated by the International Research Cooperation Information Center and proposed improvement measures for the satisfaction of the online service systems based on the analyzed results.

As a result of the study, among the system quality factors (convenience, usability, reliability, adaptability and design), information quality factors (accuracy, diversity, consistency, ease of understanding and timeliness), and service quality factors (responsiveness, empathy and professionalism) selected in this study, the adaptability factor of system quality and the empathy factor of service quality were deleted during the factor analysis process.

According to the results of the three-phase stepwise regression analysis, a total of four quality factors were verified to have a significant effect on the satisfaction of international research cooperation online service systems. Specifically, it was found that the design factor of system quality, accuracy and consistency factors of information quality, and professionalism factor of service quality have a statistically positive effect on the satisfaction level of international research cooperation online service systems. Among them, professionalism was identified to be the factor with the greatest influence on the satisfaction, followed by accuracy.

Therefore, as a way to improve the satisfaction level of international research cooperation online service systems, first, more efforts should be made to improve affinity-related interface designs than enhancing convenience or usability. Assuming that researchers from various countries visit the international research cooperation online service system, a unique, sensible and attractive system design is deemed to become more important.

Second, as a means to increase the satisfaction level of international research cooperation online service systems, improvement should be made from the aspects of accuracy of information and consistency in terminology rather than the aspects of diversity, ease of understanding or timeliness. Consequently, it can be deduced that researchers in international research cooperation will use such systems only when the accuracy and objectivity of the information provided are guaranteed. In addition, since the systems are used by researchers from various countries, it was found to be important to express terminology in various languages such as English or Korean but use the terminology with consistency.

Third, as a measure to improve the satisfaction level of international research cooperation online service systems, efforts should be made to improve the problem-solving ability and professionalism of system operators, among other service quality factors such as responsiveness. In particular, as the professionalism factor was confirmed to have the greatest influence on satisfaction, it is important to urgently implement active measures such as workshops and education sessions to improve the professionalism of the operators

This study carries a significant meaning in that it will contribute in strengthening the international research cooperation in Korea, not only by improving the user satisfaction through qualitatively enhanced international research cooperation online service systems but also by making the systems a control tower for the international research cooperation in Korea.

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