

## **An Integrated Analysis of Quantitative and Qualitative Data for Identifying Factors in Information Services: A Working Paper**

**Giyeong Kim<sup>1</sup>, Nahyun Kwon<sup>2</sup>, Soyoung Yu<sup>3</sup>, Yoonhee Choi<sup>4</sup>**

<sup>1,4</sup> Dept. of Library and Information Science, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 120-749, Korea

<sup>2</sup>Dept. of Library and Information Science, Myongji University, 34 Geobukgol-ro, Seodaemun-gu, Seoul, 120-728, Korea

<sup>3</sup>Dept. of Library and Information Science, Hannam University, 70 Hannam-ro, Daedeok-gu, Daejeon, 306-791, Korea

**Abstract.** The National Discovery for Science Leaders (NDSL) is a leading information service in science and technology in Korea and is governed by Korea Institute of Science and Technology Information (KISTI). Based on previous R&D projects by KISTI, we launched a new research project by reusing and reanalysing previous research data to 1) identify additional statistical data elements for the data collection system, 2) develop possible service performance measures, and 3) improve services by developing a service map. The following report includes interim results as we are in the early stages of this project. Here we identify service factors by integrating quantitative data from the service quality survey (NDSLQUAL) and qualitative data from the research of scientists' information behaviors. In this stage, we are developing an ideal model of information services for the proposed goals.

**Keywords.** NDSL, KISTI, information services, service performance measures, qualitative data, quantitative data, integrated analysis.

### **1. Introduction**

The National Discovery for Science Leaders (NDSL) is a leading information service for researchers and developers in science and technology in Korea. The service was launched in 2008 and is governed by Korea Institute of Science and Technology Information (KISTI), a national research institute to establish national infrastructures of research and development. Since its development, researchers have conducted a number of service-related R&D projects with the primary goal of improving services and developing measures of NDSL service

performance. The projects include use statistics, user profile analyses, service quality measurements, user satisfaction surveys, and surveys of scientists' information-seeking and use in their research life cycle. While these research projects have fulfilled their intended goals, they have not been as successful in identifying overarching service performance factors. We attribute this problem largely to the narrow focus of previous research that has included only a couple aspects of NDSL's services. Hence, we have launched a new research project to overcome the difficulties in service improvement and to develop performance measures by reusing and reanalyzing previous research data.

The purposes of our current project are threefold: 1) identify additional statistical data elements needed to improve the NDSL's current statistical data collection system, 2) develop candidates for performance measures of NDSL's services, and 3) suggest improvements for services by developing a service map of NDSL. For these purposes, we scrutinized the data collected in the previous projects and analyzed them in an integrative way. The project involves several stages, 1) identify service factors from the surveys of service quality and satisfaction, 2) confirm factors with results from the research on information behavior, 3) match the confirmed factors statistically to identify needed statistical data elements, 4) develop performance measures based on factors identified, and 5) develop a service map for the NDSL improve existing services. We are now in the second stages and report our interim results, which include factors of NDSL information services in terms of service performance by integrating quantitative data from the service quality survey and qualitative data from research on scientists' information behaviors. In this stage, we expected to identify weights for individual factors. Our interim results are also expected to provide a strong basis for subsequent stages that include identifying additional statistical data elements to increase our understanding of use behaviors and developing service performance measures. Additionally, we will report the overall expected results of this research project.

## **2. Literature Review**

SERVPERF SERVPERF is a performance-based measurement of service quality that is related to user satisfaction and attitude. This model was coined after identifying the inadequacy of SERVQUAL, which is the performance-minus-expectation-based measurement model. Both SERVQUAL and SERVPERF have the same 22 items that are grouped by 5 dimensions as listed in Table 1 (Cronin & Taylor 1992; Landrum et al. 2009; Parasuraman et al. 1985, 1988, 1991).

Researchers have debated SERVQUAL versus SERVPERF theoretically and empirically in terms of the necessity and operationalization of 'expectation' (Cronin & Taylor 1992; Cronin & Taylor 1994; Parasuraman et al. 1994; Pitts et al. 1997; Van Dyke et al. 1997), which has led to the wide application and continuous comparison of the two services.

Dimension	Definition (no. of items)
Reliabilities	Ability to perform promised service dependable and accurately (5)
Responsiveness	Willingness to help customers and provide prompt services (4)
Assurance	Ability to inspire trust and confidence in customers (4)
Empathy	Amount of caring and individualized attention to customers (3)
Tangibles	Physical facilities, equipment, and personnel (5)

Table 1. Five Dimensions in SERVPERF

In addition to this debate, some researchers have attempted to determine users’ perceptions on the five factors in the context of library information service. Results of such studies have identified a priority for responsiveness or reliability in users’ perception (Landrum et al. 2008; Landrum et al. 2009; Nitecki & Hernon 2000), and some overlap among responsiveness and emotional factors such as empathy or assurance (Cook & Thompson 2000).

### 3. Factor Identification in NDSLQUAL

NDSLQUAL is a tool and online survey to measure the service performance of NDSL based on the SERVPERF model. This tool was designed with 7 service elements and 39 items that are rated on a 7-point Likert scale. These elements and their definitions are listed in Table 2. Because of its online characteristics, NDSLQUAL tends to stress a system’s perspective such as user interface, security, and service recovery. In other words, survey responses can be seen as user-centered for questions that are system-centered. Therefore, we attempted to execute factor analyses (FA) with the NDSLQUAL data.

Elements	Definition	Notation (no. of item)
Reliability	Ability to perform promised service dependable, timely and accurately	re (5)
Ease-of-Use	Easiness of use and learnability	eu (5)
User Interface	Interface design, response time of the system, and the structure of the site	qi (6)
Responsiveness	Willingness to help customers and provide prompt services	rs (5)
Security	System security for privacy	se (5)
Quality of Information	Usefulness, preciseness, completeness of the provided information.	qi (6)
Service Recovery	Ability to solve the problems with using services promptly and dependably	sr (5)

Table 2. Seven Elements in NDSLQUAL

A total of 953 NDSLQUAL2012 survey responses gathered in 2012 to measure NDSL service performance from 2011. An FA was performed using non-orthogonal rotation with the assumption of related latent factors. Five factors with eigenvalues over one were identified with 69.95% of the total variance explained. In this primary result, two factors were exactly matched with security and service recovery elements. This finding applies to the system-

centered characteristics of the questionnaire and the high coherence among questions in the elements. We concluded that the two factors were overestimated and other unidentified factors would also be underestimated.

Another FA was executed with the same data after excluding 11 items (5 *se* items, 5 *sr* items, and 1 *re* item) to eliminate the effect of system-centered elements (e.g., security and service recovery). In addition, one *re* item was excluded because of its low communality (.545). Four factors were identified from the second FA with 70.32% of the total variance explained. After long and deep discussions, we decided to adopt four factors identified from the second FA and two system-centered factors identified from the first FA, and conceptualize these into six factors: responsiveness, user interface, searchability, quality of information, security, and service recovery (see Table 3). The factor with the largest explained variance was responsiveness, which supports previous work (Landrum et al. 2009; Nitechki & Hernon 2000).

In terms of conceptualizing factors with loaded items, we found three major characteristics of users' perceptions of NDSL services. First, based on the results from the second FA, users differentiated UI from ease-of-use in terms of searching. Second, users' perceptions on reliability were divided into two factors of responsiveness and quality of information. Third, users perceived ease-of-use and reliability in document delivery service (DDS) as responsiveness. The item of *eu4* and *re4*, which were loaded to the factor responsiveness, support this finding because they are DDS services. In sum, the result showed an external, user-centered perspective of the NDSL service, and the structure of the questionnaire showed an internal, functional, and system-centered perspective of the service.

Factor	Description	Loaded Question items
Responsiveness	Ability to perform promised service dependably, timely and accurately Willingness to help customers and provide prompt services by all means	rs1, rs2, rs3, rs4, rs5, re2, re3, re4, eu4
User Interface*	Ease-of-use in terms of user interface	ui1, ui2, ui3, ui4, ui5, ui6, ui7, ui8
Searchability*	Ease to search and to find information on NDSL services	eu1, eu2, eu3, eu5
Quality of Information	Usefulness, preciseness, completeness, and reliability of the provided information.	qi1, qi2, qi3, qi4, qi5, qi6, re1(excluded in the 2 <sup>nd</sup> FA), re5
Security	System security for privacy	se5, se2, se3, se4, se1
Service Recovery	Ability to solve the problems with using services promptly and dependably	sr2, sr1, sr5, sr4, sr3

**Table 3.** Factors and Loaded Items

\*factor identified in the second FA

#### **4. Factor Matching between NDSLQUAL and SERVPERF**

To develop more powerful predictors to measure NDSL service performance, we examined SERVPERF in comparison to the modified 6-factor NDSLQUAL (i.e., responsiveness, user interface, searchability, information quality, security, and service recovery). SERVPERF maintains the same five underlying dimensions of SERVQUAL, namely tangibles, reliability, responsiveness, assurance, and empathy (Cronin & Taylor 1992). This additional examination was necessary because NDSLQUAL is heavily centered on customers' interactions with information systems (IS) and it under represents the human aspects of the service. While both NDSLQUAL and SERVPERF were developed to measure customer satisfaction with the service, there is a clear distinction between the two: the NDSLQUAL was developed with greater attention to the service of information system, and SERVPERF focuses on customer services where caring assistance by service providers is critical.

We scrutinized the nature of the factors and measures of NDSLQUAL against those of SERVPERF and found that responsiveness was the only overlapping dimension. Some factors appeared to overlap initially because of the factor naming. For example, user interface and searchability in NDSLQUAL and tangibles in SERVPERF appeared to concern the physical entity and media tangibility of the information system. However, a close examination of the actual measures revealed that they were two distinctive constructs. The former concerns system performance whereas latter mostly concerns the appearance of service and its providers. Another example was information quality and reliability in NDSLQUAL and reliability in SERVPERF. Here, the former concerns the desirable characteristics of information whereas the latter concerns the delivery of the promised service.

Many measures of the unmatched dimensions in SERVPERF are worded in affective terms and characterized human interactions with service providers. Such examples include “dependability in handling users’ service problems” (reliabilities); “courteous staff;” “staff who have the knowledge to answer users’ questions”(assurance); “staff who deal with users in a caring fashion”(empathy); and “neat, professionally appearing staff”(tangibles). Clearly, the items for assurance, empathy, and tangibles relate to human affect in general, which is largely missing in NDSLQUAL.

In contrast, the measures of the unmatched dimensions in NDSLQUAL were “easy to navigate” (searchability), “ease to use” (user interface), “provides useful information,” “the information it provides is more trustworthy than other services” (information quality), “keeps my personal information safe” (security), and “solves the problem quickly whenever it happens” (problem solving). Security, usability, information quality, and ease-to-use are constructs that frequently appear in IS service quality literature; however, many of these IS characteristics are not included in SERVPERF.

From this comparison, it was clear that neither NDSLQUAL nor SERVPERF represent the dual natures of the NDSL; that is, information system and customer service platform. Thus, we kept all the unmatched NDSLQUAL and SERVPERF together with the common dimension to create a more

comprehensive instrument to measure NDSL service performance. This process resulted in a modified 10-factor model of NDSLQUAL as shown in Table 4.

<b>Matching dimension: Responsiveness</b>	
The willingness to assist customers and to provide prompt service	
<b>Unmatched dimensions</b>	
<b>NDSLQUAL</b>	<b>SERVPERF</b>
User Interface	The perceived performance, convenience, and ease of use when interacting with the system, affected by site design, speed, system architecture
Seachability	Ease to search and to find information on NDSL services
Information Quality	The concern that information provided is accurate, updated, trustworthy, various, and appropriate
Security	Secure communication and observance of information privacy
Service Recovery	The response to customer inquiries, comments, and feedback when such response requires more than one interaction

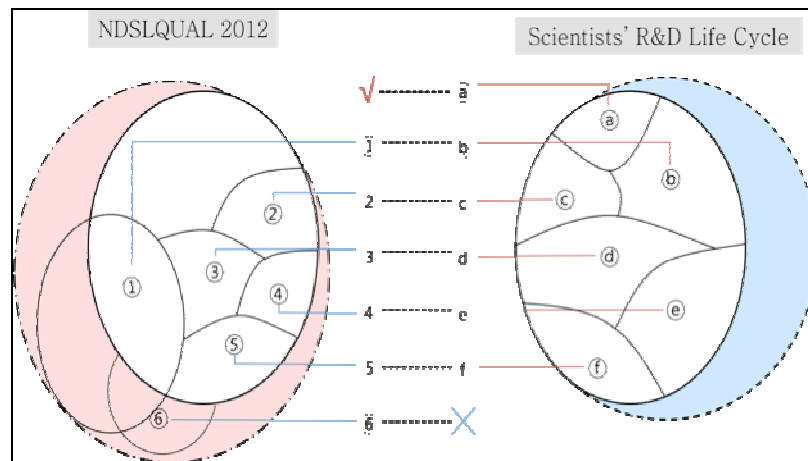
**Table 4.** Matching NDSLQUAL with SERVPERF

### **5. Linking the Quantitative Survey Factors with Qualitative Interview Data**

The next step was to link the framework of the modified 10-factor model of NDSLQUAL with previous research life cycle data. This linking integrated quantitative data from the service quality survey (more accurately, the conceptual framework developed from the quantitative NDSLQUAL survey) and qualitative research data of scientists' information behaviors. We attempted this data triangulation to identify service performance factors that are not included in the survey instrument.

For this purpose, we used in-depth interview transcripts produced by "Scientists' R&D Life Cycle Study." Taking a grounded theory approach, the lifecycle study interviewed 24 bio- and nano-scientists to understand major

research and information activities that take place during the life cycle of scientific research projects. Scientists were asked to self-report a critical incident while conducting a scientific research project.



**Figure 1.** Matching NDSLQUAL with Scientists' R&D Life Cycle Interview

This analysis is characterized as both confirmatory and exploratory. The analysis is confirmatory in that it can assure the existence of NDSL service performance constructs in the 10-factor model if they are also identified in the qualitative interview scripts. The confirmed constructs can be indicated as

①~⑤ (see Figure 1) as the matching constructs between NDSLQUAL and the

research lifecycle. Construct ⑥ in NDSLQUAL indicates the orphan construct

that was unidentified by the interview content analysis and is subject to a reexamination as a valid construct of the NDSLQUAL. The analysis is also exploratory because we examined the possibility of finding new constructs that are not present in the 10-factor model, but that are critical to measuring NDSL service performance. The new construct, if found, can be indicated as “@.”

The interview script we analyzed was 45 pages in length. The interview consisted of two interview sessions that lasted 2 hours and 53 minutes in total. A total of 24 phrases from the script were identified as commonly analyzed points, meaning that they were coded by two or more coders. To ensure inter-coder consistency, we counted only those points that also matched our data set.

The content analysis of the interview transcripts confirmed 6 of 10 factors from the NDSLQUAL. These factors included responsiveness, searchability, information quality, reliabilities, assurance, and empathy (see Table 5). However, we were not able to find transcript data that matched the other four constructs (i.e., security, user interface, service recovery, and tangibles).

The content analysis of the R&D lifecycle data against the factor model also helped us identify candidates for new factors and measures of NDSL service performance. They were exhaustivity and comprehensiveness of provided information, physical distance, networking, selectivity, community, ease of communication, and information and record management, among others. We are still working in this stage, and we expect to link and integrate those candidates with factors in the model and with each other to develop a better-structured model of service satisfaction with well-defined factors for NDSL services.

<b>Matching Factors</b>	<b>Sample interview transcripts</b>
Responsiveness	“They usually deliver full-text articles in PDF within 2 to 3 days by exhausting all the other libraries if they don’t have it.”
Searchability	“I want to find papers more easily and effectively without spending too much time by browsing all the articles retrieved.”
Information quality	“I usually read review papers, especially the recent ones to catch up with the latest research trends in my field.”
Reliabilities	“I get the new table of contents whenever new issue comes out. That is because I have registered to the RSS feed service at the website of the journal I am interested in.”
Assurance	“Sometimes I ask one of my post-doc fellows to find papers if I depend on his capability in research as well as information search skills.” “Above all, trust is the most important thing to me when I collaborate with other researchers.”
Empathy	“Ideal collaborator? ... Hmm... I want someone who can do what I need... that is, someone who can do the part that I am not able to do in carrying out my project”

**Table 5.** NDSLQUAL Factors Confirmed by Interview Data

## 6. Conclusions

For the purposes in this project, we attempted to develop an ideal model of satisfaction for NDSL information services. First, we identified six factors of information services using factor analyses of NDSLQUAL data. Second, the six identified factors were compared with the five dimensions of SERVPERF. As a result, we developed a temporary service model with 10 factors based on the integration of NDSLQUAL and SERVPERF. Third, we qualitatively analyzed interview scripts from “Scientists’ R&D Lifecycle” to identify factors within



these scripts. To date, we have identified 6 out of 10 factors in the model and several candidates for new factors.

With the confirmed factors and newly identified factors, we will develop a sophisticated model of service satisfaction. We expect that the model will be fully supportive for this project and consist of the following elements: 1) a comparison of the model with current NDSL data collection system, which will lead us to identifying newly required statistical items in the system; 2) service performance measures in terms of user satisfaction that can be developed by matching the conceptual model with the statistical items; and 3) a service map for NDSL information services that can be developed based on the model. Of note, the service map will be a foundation to improve NDSL service quality practically.

### References

- Cook, C., and Thompson, B., (2000), Reliability and validity of SERVQUAL Score Used to Evaluate Perceptions of Library Service Quality. *Journal of Academic Librarianship*, 26(4). 248-258.
- Creth, S. D., (1995). A Changing Profession: Central Roles for Academic Librarians. *Advances in Librarianship*, 19. 85 – 98.
- Cronin, J.S. and Taylor, S. A., (1992), Measuring Service Quality: A Reexamination and Extension. *Journal of Marketing*, 56(3). 55-68.
- Cronin, J.S. and Taylor, S. A., (1994), SERVPERF versus SERVQUAL: Reconciling Performance-Based and Perceptions-Minus-Expectations Measurement of Service Quality. *Journal of Marketing*, 58(1). 125-131.
- Katsirikou, A. and Skiadas C. H., (2001). Chaos in the library environment, *Library Management*, 22(6/7). 278 – 287.
- Landrum, H., Prybutok, V., Kappelman, L. A., and Zhang, X., (2008), SERVCES: A Parsimonious Instrument to Measure Service Quality and Information System Success. *The Quality Management Journal*, 15(3). 17-25.
- Landrum, H., Prybutok, V., Zhang, X., and Peak, D., (2009), Measuring IS system service quality with SERVQUAL: Users' perceptions of relative importance of the five SERVPERF dimensions. *Informing Science: the International Journal of an Emerging Transdiscipline*, 12. 17-35.
- Larsen, P. M. (1992): The Age of re-... Rethinking, Redefining, Redesigning Library Organizational Structures. Proceedings of the 6th National Conference of the Association of College and Research Libraries: Academic libraries: Achieving Excellence in Higher Education, 261 – 266.
- Mesthene, E. G., (1970). *Technological Change: Its Impact on Man and Society*. Harvard University press, Cambridge, Massachusetts.
- Nitecki, D. A., and Hernon, P., (2000), Measuring Service Quality at Yale University's Libraries. *Journal of Academic Librarianship*, 26(4). 259-273.
- Parasuraman, A., Zeithaml, V. and Berry, L., (1985), Conceptual Model of Service Quality and Its Implications for Future Research," *Journal of Marketing*, 49. 41-50.

Parasuraman, A., Zeithaml, V. and Berry, L., (1988), SERVQUAL: A Multi Item Scale for Measuring Consumer Perception of Service Quality. *Journal of Retailing*, 64. 12-40.

Parasuraman, A., Zeithaml, V. and Berry, L., (1991), Refinement and Reassessment of the SERVQUAL Scale. . *Journal of Retailing*, 67(4). 420-450.

Parasuraman, A., Zeithaml, V. and Berry, L., (1994), Reassessment of Expectations as a Comparison Standard in Measuring Service Quality: Implications for Further Research. *Journal of Marketing*, 58. 111-124.

Pitt, L. F., Watson, R. T., and Kavan, C. B. (1997). Measuring Information Systems Service Quality: Concerns for a Complete Canvas, *MIS Quarterly* , 21(2). 209-221.

Powell, R. R., (1987). *Basic Research Methods for Librarians*, Greenwood, Westport CT.

Van Dyke, T. P., Kappelman, L. A., and Prybutok, V. R., (1997), Measuring Information Systems Service Quality: Concerns on the Use of the SERVQUAL Questionnaire. *MIS Quarterly*, 21(2). 195-208.