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Analyzing M-Service Quality Dimensions Using Multivariate Statistical Techniques

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Abstract

This paper continues previous work of the authors concerning the identification and statistical analysis of the quality dimensions in mobile services (m-services). In this work, the structure of m-service quality into dimensions and criteria, which these dimensions are further analyzed into, is examined and grounded through an empirical analysis. The use of multivariate statistical techniques is decomposed into two stages: in the first stage, Factor Analysis in order to explore the relationship between the examined items (quality criteria) and the constructs (dimensions) proposed through the study of the relevant literature. In the second stage, Cluster Analysis and Principal Component Analysis are employed in order to explore intra-construct relationships. The contribution of this paper lies on the fact that a mix of multivariate statistical techniques is all integrated in a single framework, so that information about the structure of m-service quality criteria and constructs is obtained. The findings of the study confirm the theoretical background and provide valuable managerial insights.

Keywords: M-service quality, Multivariate statistical analysis, Factor analysis, Cluster analysis.

1 M-service Quality

Mobile services (m-services) are different from traditional services in a lot of things. They also need to be examined separately from electronic services (e-services) due to various characteristics. Mobility is the main characteristic of m-services, meaning that services should be provided regardless of temporal and spatial constraints (Heinonen and Pura, 2006). Additionally, three critical factors in designing value-added m-services are: (i) time-sensitivity, (ii) location awareness, and (iii) personalization (Lee and Benbasat, 2004). Nevertheless, service quality is equally important in the m-business setting as in the traditional services setting (Lu et al., 2009). This means that we should assess m-service quality according to the needs and requirements of the users of m-services. It is a fact that, the dimensions (the measurable and particular for that kind of service characteristics) of m-service quality should be identified specifically for m-services and not just copied from the e-services setting. The aim of this study is to contribute to the proper identification, interpretation, and further analysis of the dimensions of m-service quality.

1.1 **Primary dimensions of m-service quality**

M-service quality is a multidimensional hierarchical concept, meaning that the overall construct of quality is located on the top of the hierarchy, its primary components (dimensions) in the middle, and finally, its secondary dimensions at the bottom of that hierarchy. This approach is also adopted in the current study. It is true that most of the researchers have proposed various lists of dimensions to capture as many characteristics of m-service quality as possible. Generally, there has been consensus regarding the primary dimensions of the service quality construct in m-services. The following primary dimensions are identified: (i) *interaction quality*, (ii) *environment quality*, and (iii) *outcome quality* (Lu et al., 2009; Fullerton, 2005). A brief description of them is given in the following lines. Interaction quality refers to the quality aspects of all kinds of interaction between the customer and the provider. For instance, how a problem during the service delivery can be dealt with or how m-services are customized according to the user's needs. Interaction quality is the functional aspect of quality, everything related to how the service is delivered. Environment quality involves the quality characteristics of the environmental factors that affect the delivery of m-services. For instance, the user interface in a mobile device is a such quality characteristic, as well as the conditions of noise, illumination etc. under which the service is delivered. It would be false to ignore the external conditions of connection and use of the service; hence, mobile devices and services should be properly designed to prevent bad external conditions. Finally, outcome quality refers to the quality aspects of the outcomes of the service delivery (e.g., the final impression of the user at the end of the service delivery or any tangible elements that certify the completion of a transaction). In this study, the above classification of the m-service quality construct into its primary dimensions has been retained.

1.2 **Secondary dimensions of m-service quality**

Among the various approaches upon the dimensions of m-service quality, the following are worthy of greater attention (we just mention a few contemporary and relevant to our study approaches): Lu et al. (2009) developed a hierarchical model, retaining the primary dimensions mentioned in the Section 1.1 and proposing 10 sub-dimensions: attitude, expertise, problem solving, information, equipment, design, situation, punctuality, tangibles, and valence. Vlachos et al. (2011) studied m-services in different national settings, proposing the following dimensions of m-service quality: ease of use, usefulness, content variety, aesthetics, customization, privacy, and customer service. They classified the aforementioned sub-dimensions in three primary dimensions: (i) efficiency quality, (ii) outcome quality, and (iii) customer care quality. Gummerus and Pihlström (2011) tried to estimate the value of a wide variety of m-services. They ended up in 9 dimensions of m-service quality: time, location, lack of alternatives, uncertain conditions, emotional value, esteem value, monetary value, convenience value, and performance value. Noteworthy is the approach of Bouwman et al. (2012), which analyzes

a great number of m-services. These points were the basis of our proposition which is presented in the Section 2.

2 Proposed secondary dimensions of m-service quality

The analysis, which is presented herein, is based upon our previous studies of m-service quality (Stiakakis and Georgiadis, 2011; Stiakakis and Petridis, 2013). In those studies, we concluded with 11 secondary dimensions (or sub-dimensions) of m-service quality, taking into consideration the extant literature. The proposed sub-dimensions are described very briefly, as follows: (i) *expertise*: provider's knowledge of the service, (ii) *problem solving*: how the provider can handle user's problems, (iii) *information*: precise and accurate information to the user, (iv) *security/privacy*: protection of information / transactions and user's personal data, (v) *customization/personalization*: providing services to suit user's specifications/needs (these five sub-dimensions constitute the primary dimension of interaction quality), (vi) *equipment*: mobile device and telecommunications network, (vii) *design*: user-interface design, (viii) *context*: conditions under which the service is used (equipment, design, and context belong to the primary dimension of environment quality), (ix) *reliability*: consistency with provider's promises, (x) *tangibles*: tangible elements of the service delivery, and (xi) *valence*: the final impression to the user. The eleven proposed sub-dimensions were further analyzed into 40 quality criteria. This was conducted by means of six experts. The experts were selected academics whose research topic is e- and m-business technologies and services. Even though the number was small, the experts' suggestions were in a satisfactory agreement. The purpose of that analysis was to assess the criteria through a survey for m-service users and to find out whether the criteria were properly grouped into the 11 sub-dimensions of m-service quality. The 40 quality criteria are summarized in Table 1 (Stiakakis and Georgiadis, 2011; Stiakakis and Petridis, 2013).

Sub-dimensions	**Criteria**	**Sub-dimensions**	**Criteria**
Expertise	*V1: Excellent service knowledge by the provider* *V2: The provider responds properly to the user's queries* *V3: The provider understands the user's needs* *V4: The provider understands that the user is based upon the provider's knowledge*	Design	*V24: High aesthetics in the user-interface design* *V25: Ease of use of the service* *V26: Directing the user via screens, forms, etc., when required* *V27: Simplification of the actions required by the user*
Problem solving	*V5: The provider is interested in the user's problems* *V6: Existence of a department dedicated to user support* *V7: Prompt solution of the user's problems* *V8: The provider understands the severity of a potential problem of the service*	Context	*V28: Full exploitation of the location-based information of the mobile device by the service* *V29: Service operation in conditions of unstable connection* *V30: Service operation in conditions of decreased illumination / noise*
Information	*V9: Accurate information by the provider* *V10: The user is notified about the precise service delivery time* *V11: The user's data are effectively processed by the provider* *V12: The provider knows the exact information needed by the user*	Reliability	*V31: Completion of the service on time* *V32: The user is notified of potential delays in the service delivery* *V33: The service can be cancelled / continued by the user if there is a delay*
Security/Privacy	*V13: The user feels safe during the whole service delivery time* *V14: The provider owns a proper security certificate* *V15: The provider warrants the protection*	Tangibles	*V34: The user can print requested or produced items of the service* *V35: The user is provided with evidence for the successful completion of the service*

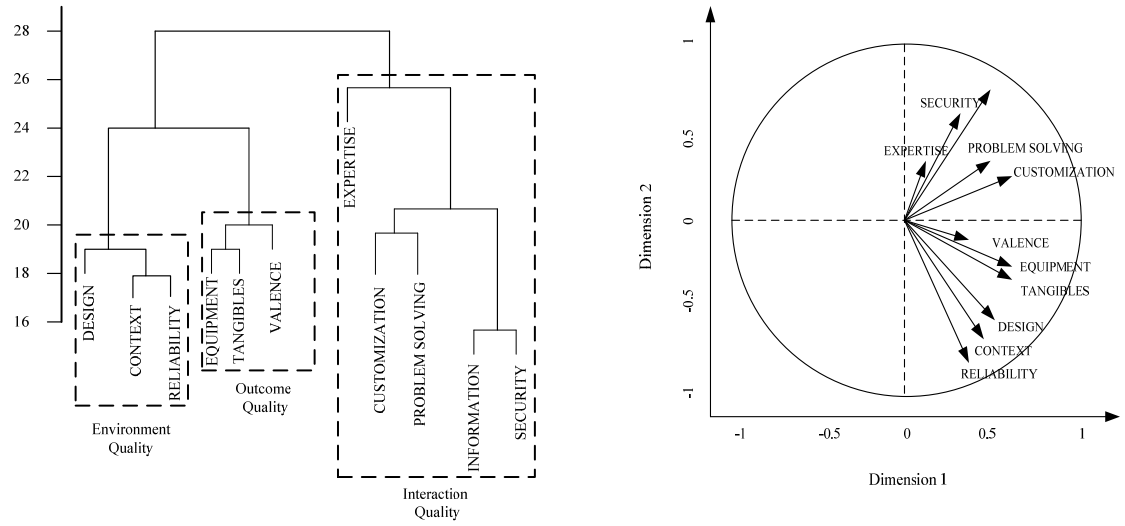
	of the user's personal data *V16: The user's personal data are used by the provider only after their consent*		*V36: Produced or requested items of the service can be sent to the destination selected by the user*
Customization/ Personalization	*V17: Delivery of customized services to the user* *V18: The problems of the users are tackled on a case-by-case basis* *V19: Delivery of personalized information to the user* *V20: The expectations of individual users are met*	Valence	*V37: Interruption in the service delivery causes a negative impression to the user* *V38: The provider should undertake the cost of the interruption in the service delivery* *V39: Delivery of the service in the minimum possible time causes a positive impression to the user* *V40: The user has the feeling of a good experience upon the service completion*
Equipment	*V21: Full exploitation of the possibilities of the telecommunications network* *V22: Full exploitation of the possibilities of the user's mobile device* *V23: The service is delivered at a high speed*		

Table 1. Quality criteria of m-service quality

The m-service users who participated in the survey were asked to evaluate the importance of the 40 quality criteria using the following Likert scale: (a) strongly agree, (b) agree, (c) neither agree nor disagree, (d) disagree, and (e) strongly disagree. We used a sample of 260 experienced users and the survey was conducted in Northern Greece. The principal prerequisite to include someone in the sample was to be an experienced user of m-services in terms of duration of use (more than 3 years) and frequency of use (more than one hour per day). The sample size was adequate enough to conduct a series of statistical analyses (for example, an adequate sample size for factor analysis in our case was 200, five times the 40 quality criteria).

3 Statistical methodologies used

In this part of our work, we present the statistical methodologies which are based on multivariate statistical analyses, used for the data processing (Johnson and Wichern, 1998). This kind of analysis is used when there are more than one variables analyzed in the same time. Many research questions can be answered through this type of analyses; it is also used for exploring underlying structures. The findings of this analysis can lead to important conclusions and will provide better managerial insight. The statistical methodologies used in our analysis are Factor Analysis (FA), Cluster Analysis (CA), and Principal Component Analysis (PCA). All these methodologies are used in an integrated framework, exploring the structures formed for the items and the intra-dimensional relationship formed among the dimensions derived from FA (Wold et al., 1987).



a) *b*)

Figure 1. a) Dendrogramm of dimensions derived from CA, b) PCA factor map for the examined dimensions

3.1 **Data processing**

The main part of this work is based on data collected from a sample of 260 users of m-services without any exception regarding the sex, age (over 15 years old), profession, and educational background. In the conducted survey a 5 Likert type scale was used, so as the questioners to validate the importance of m-service quality criteria. For the evaluation of each of the examined dimensions of m-service quality, 40 quality criteria ($V_1,\ldots,V_{40}$) were introduced. The theoretically proposed literature was confirmed through a Factor Analysis (FA). Firstly, the quality criteria matrix (V_{ij}) are introduced where *i* stands for index of the entries of the search and *j* for the aforementioned quality criteria. The next step in our analysis is to form the dimensions, in which the quality criteria are analyzed to, thus a Factor Analysis (FA) is conducted, where the factors created are the dimensions of the study, described. The second step of the proposed analysis is to assign values to the proposed dimensions $D_{k(j)}$, where $k(j)$ is a function that assigns each quality criterion to the corresponding dimension/factor derived from FA. Thus, the initial number of the quality criteria used (40), are reduced to the number of dimensions examined (11). The final step is to examine the intra-dimensionality relationship. Two multidimensional statistical techniques, which are widely known in Social and Computer sciences, are used for this purpose; Cluster Analysis (CA) and Principal Component Analysis (PCA). Via this process, valuable managerial implication and useful conclusions from user perspective can be drawn.

In Figure 1a, a dendrogramm presenting the distances of the examined dimensions derived from CA. It can be seen that three distinct categorizations are formed. The first one contains dimensions 'DESIGN', 'CONTEXT' and 'RELIABILITY'. This set of dimensions can be perceived as the 'Environment Quality'. The next categorization that can be seen in Figure 1a contains 'EQUIPMENT', 'TANGIBLES' and 'VALENCE' dimensions forming Outcome Quality construct. The third construct, Interaction Quality, contains dimensions 'EXPERTISE', 'CUSTOMIZATION', 'PROBLEM SOLVING', 'INFORMATION' and 'SECURITY'. Based on Figure 1a, Environment Quality and Outcome Quality constructs seem to be closer in terms of distance. The third construct from right to left (Interaction Quality) is connected to the previously mentioned constructs which are now merged to new class. In that sense, Environment and Outcome Quality are closer related according to m-service users. Regarding each dimension 'CONTEXT' and 'RELIABILITY' seen to

be closer within Environment Quality construct. The next analysis conducted in this work is Principal Component Analysis (PCA) among the dimensions of the study. The principal components are presented in decreasing order of importance (Figure 1b), due to the fact that the first principal component accounts for the biggest variation extracted, while each successive principal component for a little less than the first. In Figure 1b, the dimensions of the study are presented in each of the principal components. The PCA factor map shown in Figure 1b provides also the valuable information of correlations between the examined dimensions.

4 Conclusions

In this paper, a mix of statistical techniques was conducted to confirm the grouping of the 11 sub-dimensions of m-service quality, identified in previous studies, into 40 quality criteria. M-service quality is composed of 11 sub-dimensions which were further analyzed into 40 quality criteria (Table 1) according to the opinions of a number of academic experts. Conducting Factor Analysis, we succeeded to explain the relationships between the quality criteria and the proposed sub-dimensions. Moreover, conducting Cluster Analysis and Principal Component Analysis, it was possible to explain the intra-relationships among the sub-dimensions of m-service quality. These findings confirm the proposed structure of the quality construct and provide insights to m-service quality designers and managers to comprehend its components. The awareness of the hierarchical structure of m-service quality presented herein can assist those people to focus on the problematic quality factors which need to be improved. With the rapid proliferation of mobile devices and services, knowing precisely the m-service quality dimensions is a valuable finding. Further research should be extended to confirm the multidimensionality of m-service quality in specific types of m-services.

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