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Formative versus Reflective Measurement for Multidimensional Constructs

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Formative versus Reflective Measurement for Multidimensional Information Systems Constructs

Abstract

Information systems researchers often conceptualize constructs as higher-order multi-dimensional entities. As is the case with the specification of first-order dimensions, researchers seem to have two basic choices regarding measurement specification at the second-order level: to operationalize second-order factors as either formative (molar) or reflective (molecular). Although several researchers have noted the importance of measurement misspecification when testing measurement models for first-order constructs, limited research has investigated the consequences of measurement misspecification at the second-order level. In this article we empirically investigate whether different measurement specifications at the second-order level can lead to different inferences. Exploiting data from an empirical study investigating the notion of electronic service quality, we test the multi-dimensionality of the construct, using two different measurement specifications: the formative model which assumes molar relationships and the reflective model which assumes molecular relationships. We find that there is poor convergence between the two models in terms of resulting conclusions, highlighting the need for more careful measurement specification of IS constructs at a higher-order hierarchical measurement level. We conclude with implications for research regarding higher-order constructs measurement.

Keywords. Formative Constructs, Reflective Constructs, Second-Order Models, Covariance-Based SEM, Components-Based SEM, Electronic Service Quality, Mobile Music Services

Introduction

Structural equation modeling has been widely used in several studies for testing research models and hypotheses in information systems (IS) research [Gefen et al., 2000]. In addition the complex nature of concepts and variables involved in IS research have led researchers to exploit multi-dimensional constructs [e.g., Doll et al., 1994; Tojib et al., 2008]. Careful examination of IS studies that use multi-dimensional constructs, however, reveals that certain fundamental assumptions about the scales measuring multidimensional constructs must be interpreted with care in order to assure the validity of the study results. Recently, researchers [e.g., Freeze and Robyn, 2007], have highlighted the importance of measurement misspecification in IS research. Measurement misspecification is related to the improper specification of the directional causality of a construct's measures. Petter et al., [2007] find that measurement misspecification is a problem in the IS field. Construct misspecification is deleterious in that it leads to Type I and Type II errors [Mackenzie et al., 2005; Diamantopoulos et al., 2008].

For the measurement of first-order constructs, two choices are available: the reflective conceptualization, representing the assumption that changes in the underlying construct are hypothesized to cause changes in the indicators, and the formative conceptualization representing the assumption that it is the measured items that cause changes to the construct rather than vice-versa. However, by default the majority of IS studies assume a reflective nature in the relationship between items and construct.

Similarly, for the higher order multi-dimensional constructs most studies assume that the dimensions of multidimensional constructs are different manifestations of their overall latent construct i.e., the reflective conceptualization. However, several studies have shown that the dimensions of some multidimensional constructs in management research can also be defined as components, instead of as manifestations, of the latent constructs i.e., the formative conceptualization. The central premise of this study is to empirically investigate and highlight

the importance of the choice of the proper measurement conceptualization of higher-order IS constructs. Specifically, in this study we empirically investigate whether different measurement conceptualizations at the second-order level (i.e., the formative and the reflective conceptualizations) - can lead to different conclusions concerning the relative importance of the construct's sub-dimensions. Data from an empirical study investigating the dimensionality of electronic service quality are used in order to test two different measurement model specifications. First, a model that assumes reflective relationships between items and first order constructs but also reflective relationship between first and second order constructs is tested. Second, we test a model that assumes reflective relationships between items and first order constructs but formative linkages between first and second order constructs. Furthermore, drawing from the call of Petter et al., [200]) and given that IS researchers use both covariance and components-based SEM we test the same models in both PLS and covariance-based SEM (i.e., AMOS). Overall, results suggest that authors and reviewers should be very careful when specifying multidimensional constructs at the second-order level. Additionally, they should always report details regarding their statistical choices especially when they make use of components-based SEM.

In what follows we briefly present the theoretical background of the higher order constructs measurement conceptualization in IS research, then we describe the methodological considerations of our empirical study and present the results from the different models. We end up with conclusions and research implications.

Research Background: Some Probably Misspecified Multidimensional Constructs in Information Systems Research

Constructs are often conceptualized and subsequently operationalized as multidimensional entities [Yi and Davis, 2003]. From a conceptual point of view, a construct is multidimensional when it consists of a number of interrelated attributes or dimensions and exists in multidimensional domains [Diamantopoulos et al., 2008]. In contrast to a set of

interrelated unidimensional constructs, the dimensions of a multidimensional construct can be conceptualized under an overall abstraction, and it is theoretically meaningful and parsimonious to use this overall abstraction as a representation of the dimensions" [Law et al., 1998, p. 748].

Similarly to the first order constructs, researchers have mainly two measurement specification options for the higher-order multidimensional constructs [Jarvis et al., 2003; MacKenzie et al., 2005]. One common view of the relationship between dimensions and the multidimensional construct is that dimensions are different manifestations or actualization of the multidimensional constructs – i.e. the reflective conceptualization. On the other hand, the formative conceptualization suggests another interpretation of the relationship between dimensions and multidimensional constructs. Under the formative view, the multidimensional construct is defined as the outcome of its dimensions.

While several studies in IS research use higher order multidimensional constructs, careful examination of these studies, reveals that certain fundamental assumptions about the scales measuring multidimensional constructs must be interpreted with care in order to assure the validity of the results. For instance, the end user computing satisfaction (EUCS) scale, among the most widely used higher-order constructs, is conceptualized by the majority of studies as a reflective multidimensional construct [Deng et al., 2008; Doll and Torkzadeh, 1988; Doll et al., 2004; Gatian, 1994; McHaney et al., 2002; Muylle et al., 2004; Tojib et al., 2009]. This conceptualization of the EUCS construct suggests that the separate dimensions of the construct -such as *content*, *accuracy*, *format*, *ease of use* and *timeliness*- are actually different manifestations of the construct and as such "reflect" the construct's content. However, there can be arguments in favor of specifying EUCS as a formative rather than as a reflective second-order construct. Indeed it is not difficult to imagine an information system able to deliver sufficient information (content), but not being able to deliver it in a user friendly (ease of use) or timely manner (timeliness). Furthermore, we can observe two different end-users with identical formative level computer satisfaction, but different levels of sub-dimensions [Chin and Gopal, 1995]. Finally, an increase in any one of these dimensions will increase

EUCS levels without necessarily influencing the other dimensions [Yi and Davis, 2003]. If EUCS is truly reflective then an improvement in the *ease of use* dimension would also imply an improvement in *timeliness* and in other dimensions since they all meant to tap into the same second-order concept [Chin, 1998].

Another example of a construct for which arguments in favor of a formative versus a reflective conceptualization can be made, relates to information systems quality assessment [Kettinger and Lee, 1994; Myerscough, 2002]. According to this stream of literature, information systems quality assessment is related to the user satisfaction and service quality second-order factors (USISF/ServQual). These two second-order factors are modeled as having three (i.e., knowledge and involvement, quality of information product, and support service) and two (i.e., reliability and empathy) first-order manifestations correspondingly. Since an increase in any one of the first-order dimensions (e.g., empathy) will increase the overall magnitude of the second-order construct (e.g., service quality), without necessarily affecting the rest of the first-order factors these second-order factors should be probably theorized as formative [Yi and Davis, 2003].

Finally, another example of a similar construct for which arguments against a reflective model are also tenable is User Satisfaction with Business to Employee portals (B2EPUS) [Tojib et al., 2009]. This multidimensional construct is modeled as having five first-order reflective factors namely *usefulness*, *confidentiality*, *ease of use*, *convenience of access*, and *portal design.* As was the case with the multidimensional constructs previously mentioned, B2EPUS is probably an additive phenomenon, with no single dimension being adequate in describing it. Clearly, perceptions of B2EPUS are the results of these dimensions rather than the cause of them. Furthermore, the B2EPUS dimensional construct, most probably does not exist at a deeper and more embedded level than its dimensions (as is the case with e.g., the construct of general mental ability) [Wong et al., 2008].

At this point it should be noted that we are not suggesting that the authors cited in the above examples should have been aware of the distinction between formative and reflective first-order dimensions at the time their research was conducted, or that their conceptualizations are

by default wrong. Having said that, it should be noted that the question of formative versus reflective specification, especially at the second-order level, is not as easily decided as the current literature suggests [Baxter, 2009]. Importantly, a simple formative/reflective categorization may be simplistic [Edwards and Bagozzi, 2001]. In this study we consider the abovementioned multidimensional constructs as probably being formative rather than reflective in nature, using the technique of "mental experiments" [Bollen, 1989]. However, mental experiments rely on speculation and "appeals to reason" that a construct and a measure co-vary [Edwards and Bagozzi, 2000]. Therefore, this approach does not provide definite evidence of association between a construct and its measure [Edwards and Bagozzi, 2000].

Nevertheless, not explicitly defining the relationship between overall multidimensional constructs and their dimensions probably hinders theory testing and development [Wong et al., 2008]. Therefore, these and similar studies should provide explicit argumentation in order to justify the selection of a reflective versus a formative second-order specification. The work of Gold et al., [2001] is a nice example highlighting the use of such argumentation. In their work they conceptualize *knowledge management infrastructure capability* and *knowledge management process capability* as second-order formative constructs, providing explicit arguments supporting their selection.

On the other hand, the customary practice of not explicitly defining the relationship between constructs and their dimensions in IS research, probably also emanates from the fact that there are still no definite and unequivocal theoretical and/or empirical guidelines that can help researchers decide on appropriate measurement conceptualization at the higher-order factor level (however see Law et al., [1998]). Arguably, distinguishing between formative and reflective higher-order constructs is probably less straightforward than distinguishing between formative and reflective first-order factors (i.e., at the observed variable level). For example, in this study, using guidelines provided by the literature investigating formative versus reflective constructs at the observed variable level [e.g., MacKenzie et al., 2005], as implicitly suggested by some researchers [e.g. Chin, 1998; Edwards, 2001], we argue that EUCS is

probably best modeled using a formative specification. However, it is likely that using these guidelines will always lead researchers specifying multidimensional constructs as formative (e.g., arguably and in most cases, the dimensions of multidimensional contructs can be considered as being not interchangeable). On the other hand there are some researchers suggesting that the relationship between multidimensional constructs and their dimensions should not be confused with the issue of cause and effect indicators of unidimensional constructs. Law et al., [1998] as well as Wong et al., [2008] provide some guidelines that can be useful in this respect. Given the abovementioned discussion, our point is that the specification of the measurement model even at the second-order level is a critical decision that needs to be made on the basis of conceptual criteria [Mackenzie et al., 2005]. Consistent with Law et al., [1998] our argument is that a multidimensional construct is not well defined unless its relations with its dimensions are theoretically specified. In the same vein, consistent with Hardin et al., [2008] we do not consider simply re-specifying existing reflective first-order factors as formative, without considering the substantive theory underlying the construct, as being appropriate.

Motivated by the above literature review, in the next section we demonstrate the effects that different measurement specification choices at the higher-order level can have on structural model results, using empirical data from an IS study.

Different Conclusions Resulting From the Two Measurement Specification Models: An Illustration Using the Electronic-Service Quality Construct

The Construct of Electronic Service Quality

To demonstrate the potential differences in parameter estimates, when researchers conceptualize second-order constructs using either a formative or a reflective mode, we use the multidimensional-construct of electronic service quality applied to a mobile internet music service. Through cellular phones and personal digital assistants, users gain access to

tremendous amount of information and products available on the internet, anywhere and anytime [Chae et al., 2002]. Mobile music is included in the mobile entertainment services mix along with mobile gaming, mobile sports and betting, icon downloads, etc. [Macinnes et al., 2002]. Maciness et al., state [2002, p.218] that "mobile entertainment is an example of a new pure e-commerce service that can create substantial value". The rationale for choosing the electronic service quality construct builds from the importance of the construct as a major antecedent in building favorable consumer behaviors (e.g., remain loyal, willing to pay price premiums, say positive things and recommend the service to other consumers, etc.) but also on its multidimensional nature [Parasuraman et al., 2005; Wonfinbarger and Gilly, 2003].

The Construct of Electronic Service Quality

This study was conducted in the context of a research consortium of companies (wireless network operators, content and technology providers) that were united so as to design and develop a next generation mobile Internet music service with advanced features. Participants were introduced to the functionality of the mobile Internet service, and to the mobile device that would have to use for accessing the service. Participants were then asked to navigate through the service, and implement some basic use case scenarios (e.g. create a play list, listen to it etc). After experiencing the service they were asked to complete the data collection instrument. The data collection instrument was pre-tested against ten mobile users following the aforementioned procedure. Based on the suggestions of these respondents some vague items were reworded. Additionally, in order to avoid measurement artifacts key dependent variables (i.e., satisfaction and behavioral intentions) were assessed before their predictors (i.e., electronic service quality) and items were interspersed. Field tests were conducted in Greece and 144 respondents participated. Construct measures were based on the extant literature and on a qualitative study designed to investigate the dimensionality of the electronic-service quality construct. The qualitative study, served the purpose of verifying the existence of the sub-dimensions already proposed in the extant mobile internet literature and identifying constructs not proposed in the literature and corresponding items (e.g., device

quality). Specifically, we used a convenient sample of 27 participants who were required to experience an experimental non-commercial on-demand handheld internet music service. After using the service, participants completed an open-ended questionnaire, with questions trying to extract their feelings. The findings indicated that seven factors are deemed as important when consumers evaluate a mobile internet service: interaction-, connection-, contextual-, content-, and device quality along with customer service quality and privacy concerns [Vlachos and Vrechopoulos, 2008].

A structural modeling approach was chosen so as to estimate the parameters of the research model. We fitted the tested models using both Partial Least Squares (PLS) and Covariance-based SEM.

Results

Covariance-Based SEM Analyses

First, we illustrate the potential for different conclusions resulting from the two views of multidimensional constructs employing covariance-based SEM procedures using AMOS. To identify the model specifying electronic service quality as a formative second-order construct we added one reflective indicator (i.e., a global service quality measure) to the latent construct and linked the latter to a reflectively-measured latent variable (i.e., transaction-specific satisfaction). This identification strategy is further useful in that it can be used for validation purposes as well [Diamantopoulos et al., 2008].

Additionally, consistent with Petter et al., [2007] we have given great care in the epistemic relationship between the first-order measures and their corresponding constructs. The formative versus reflective orientation for second-order factors translates equally well at the first-order factor level and is referred to as emergent versus latent factors [Chin and Gopal, 1995]. Based on Jarvis et al., [2003] measures employed in this study are reflective with the possible exception of contextual quality measures (e.g., they do not necessarily co-vary with each other, dropping one of the items might change the conceptual domain of the construct

and they have different antecedents) (see Appendix). This construct was measured using two items namely "I can access this mobile service whenever I need", and "I can access this mobile service wherever I need". The first item has to do with time whereas the latter item with space. However, especially for this construct it is not easy to confidently decide whether this is indeed a composite or a factor construct, since the notions of time and space are often inextricable intertwined in people's minds. Due to identification problems, usually confronted in covariance-based SEM analyses, we treated this construct as reflective.

Before testing parameter estimates in the structural and the second-order level model, the measurement model at the first-order level should exhibit a satisfactory level of validity and reliability [Fornell and Larcker, 1981]. We run a CFA model including seven electronic service quality dimensions (each measured with two reflective indicators with the exception of the interaction quality construct which was measured using a single item[1]) to investigate unidimensionality. The fit of the model is excellent (χ^2 (46) =56.3, p=.14, RMSEA=.039, CFI=.98). AVE ranges between .46 and .84 and composite reliability ranges between .63 and .91. All factor loadings are greater than .50 and statistically significant (lowest t-value=3.25) [Hulland et al., 1996]. Furthermore the square root of the AVE of each construct is greater than all corresponding correlations, indicating discriminant validity.

Next, using one data-set we fitted two models: a) a model conceptualizing electronic service quality as a second-order formative construct, influencing two outcome constructs namely satisfaction and behavioral intentions, and b) a model conceptualizing electronic service quality as a second-order reflective construct. In both models the relative importance of service evaluation dimensions on overall service quality can be determined by comparing the absolute path coefficients between constructs [Chin and Gopal, 1995]. Furthermore we investigated whether misspecification of the exogenous second-order construct inflates the structural parameter and the standard error [MacKenzie et al., 2005]. It should be noted, that

[1] Following MacKenzie and Lutz [1989] the measurement error for this single item was fixed at (1−Reliability) times the variance of the perceived item indicator. We further conducted sensitivity analyses (at the range of 0.6 to 1.0) so as to statistically control for the impact of the single-item error variance on parameter estimation.

drawing on the guidelines suggested by MacKenzie et al., [2005] we theorize that electronic service quality should be appropriately modeled as a second-order formative construct.

Figure 1 depicts parameter estimates for the formative model. A formative approach conceptualizes service quality as an aggregate, molar second-order model. Electronic service quality is postulated as an emergent construct /belief [Chin and Gopal, 1995], an "*…aggregate macro presentation of a person's response to an object or action)* [Bagozzi 1985, p.43].

It should be noted that because there is still no definitive answer regarding whether the formative measures for an exogenous construct should co-vary with one another, we follow Petter et al., [2007] and we empirically derive a decision. Chi-square difference between the constrained and the unconstrained model is statistically significant ($\Delta\chi^2$ (21) =94, p<.01), indicating the superiority of the unconstrained model (first-order sub-dimensions were freed in order to co-vary with each other).

Model fit for the formative second-order model is acceptable (($\Delta\chi^2$ (107) =153.4, p=.002, RMSEA=.05 [PCLOSE=.30], CFI=.96). Results from this model indicate that the most important factor for consumers when evaluating the overall superiority of the service experienced is content quality (b=.36) (i.e., sonic quality of audio songs and video-clips). The next most important factor influencing service quality perceptions is contextual quality (b=.33) that is the ability of providing the service anywhere and anytime. Device quality (i.e., look and feel of the mobile phone) (b=.26) and privacy protection (b=.21) follow in order of significance. Interaction quality (i.e., screen layout), connection quality (i.e., downloading speed) and customer service (i.e., resolution of problems) were not deemed as important (they are statistically insignificant)

Insert Figure 1 about Here

Figure 2 depicts parameter estimates for the reflective model. Reflective electronic service quality is conceptualized as a micro presentation of a person's response to a service [Bagozzi, 1985]. Compared to the formative approach, electronic service quality, rather than being

constructed from the seven factors, it is hypothesized to be a latent variable that is indicated by these first-order factors [Bagozzi, 1985; Chin and Gopal, 1995]. It should be noted that the reflective specification besides being theoretically inappropriate (i.e., first-order dimensions likely have different antecedents, they are more likely to cause rather than be caused by overall service quality, and the same level/score of electronic service quality can be achieved through many different configurations of the first-order dimensions) is characterized by one more problem. Specifically, researchers specifying formative second-order constructs as reflective constructs they are likely to face the problem of which first-order factor should they use as the scaling indicator. Such a decision should be more straightforward when researchers deal with constructs that are correctly specified as reflective. To the best of our knowledge this somewhat technical issue has not been reported in the recent literature providing decision rules for determining whether a construct is formative or reflective. It is likely that when researchers have trouble finding which indicator (or first–order dimension) is more suitable for being used as a scaling indicator, then this is likely a sign that they are dealing with a formative construct. Having said that, it seems that research papers in the IS domain, employing covariance-based SEM, fail to recognize (and report) the importance of selecting the appropriate scaling indicator for reflective constructs. This is probably due to software advances that automatically/randomly assign a scaling indicator to reflective constructs. In this study, drawing on traditional models of perceived service quality we use the first-order dimension of content quality as the scaling indicator. Content quality can be thought of as representing the outcome quality component of traditional service quality models [e.g., Rust and Oliver, 1994].

Insert Figure 2 about Here

Model fit for the reflective second-order model is acceptable (($\Delta\chi^2$ (112) =163.9, p=.001, RMSEA=.057[PCLOSE=.27], CFI=.95). In terms of the relative importance of service evaluation dimensions, there is poor convergence between the formative and the reflective

second-order specification. Compared to the results of the formative model, reflective model results indicate that the most important factor for consumers when evaluating the overall superiority of the service experienced is not content quality (b=.45) but rather contextual quality (b=.65). Furthermore, connection quality seems to be the second most important factor (b=.54), whereas connection quality was not significant in the formative model. In the same vein though interaction quality was not significant in the formative model, it is considered as the third most important factor in the reflective mode (b=.52). All seven factors are deemed as important in the reflective model whereas in the formative model four constructs are considered as important. Finally, we find that when compared with the formative model, the structural parameter linking electronic service quality and behavioral intentions (a small increase of 2.6%) as well as its respective standards error (an increase of 120%) are inflated. MacKenzie et al., [2005], find that misspecification of exogenous constructs (at the first-order-level) inflates structural parameters and standard errors. Based on our findings, we provide some empirical support for their findings in the context of second-order level factors.

To summarize it seems that different conclusions regarding the relative importance of electronic service quality dimensions result from the two different measurement specifications, suggesting that IS researchers should carefully elaborate on the causal directionality linking first and second-order measurement models.

Partial Least Squares Analyses

Since IS researchers use both covariance and components-based SEM we test the same models in PLS as well. To test the two second-order models, we used the repeated indicators method [Chin et al., 2003; Kleijnen et al., 2007]. Furthermore for the sake of direct comparisons, we test the second-order formative model in PLS using the identification strategy employed in the respective covariance-based analyses (i.e., using one reflective indicator namely a global service quality measure and one reflectively measured latent

variable). Significance of parameters estimated was calculated on the basis of 500 bootstrapped samples [Brown and Chin, 2004].

Figure 3 depicts parameter estimates for the formative model using the repeated indicators method (repeated indicators form rather than reflect the second–order construct). Results from this model indicate that all factors are deemed as important. Regarding the relative importance of sub-dimensions it seems that contextual quality is the most important factor (b=.32), followed by content quality (b=.29) and device quality (b=.26).

Insert Figure 3 about Here

Figure 4 depicts parameter estimates for the formative model using the repeated indicators method (repeated indicators reflect rather than form the second–order construct). It should be noted that measurement model properties all conform to accepted reliability, convergent validity, and discriminant validity standards. One exception is the AVE value (.25) for the second-order electronic service quality construct operationalized using the repeated indicators method (composite reliability equals .76). Results from this model indicate that all factors are deemed as important. However, there are differences between this model and the formative second-order PLS model (figure 3). Though contextual quality is the most important factor in both specifications, there is disagreement regarding the rank-order importance of the remaining factors. For example is this model content quality is considered to be the least important, whereas in the formative second-order PLS model, content quality is the second most important factor.

Insert Figure 4 about Here

Figure 5 depicts parameter estimates for the second-order formative model specified using one global service quality measure. The results of this PLS formative specification can be

directly compared to the results of the second-order formative model estimated using covariance-based SEM. These two model specifications provide the same results. The most important factor for consumers when evaluating the overall superiority of the service experienced is content quality. The next most important factor influencing service quality perceptions is contextual quality. Device quality and privacy protection follow in order of significance. Interaction quality, connection quality and customer service were not deemed as important. It should be noted that the non-statistically significant results found cannot be attributed to multi-collinearity, since the highest variance inflation factor across the seven sub-dimensions is 1.35.

Insert Figure 5 about Here

To summarize, in the context of PLS analyses different conclusions regarding the relative importance of electronic service quality dimensions result from the three different second-order level measurement specifications. The same conclusions were also drawn in the context of covariance-based SEM analyses.

Discussion

Table 1 summarizes the results of the study. There is poor convergence between the different models regarding the relative importance of sub-dimensions on evaluating overall electronic service quality. More specifically, there is poor rank-order agreement between the model estimates. For example model 1 (formative-CBSEM), suggests that with regard to electronic service quality managers should mainly focus on four variables, whereas model 2 (reflective-CBSEM) suggests that managers should pay attention to all factors. It should be noted that the focus of the study is not to theorize on electronic service quality, but rather to demonstrate differences on the conclusions that can be drawn when IS researchers choose to model second-order constructs as being formative or reflective and when their estimation methods likely differ (PLS vs. CBSEM).

IS researchers should also pay attention to the estimation method chosen to model second-order multidimensional constructs. It seems that the two methods produce somewhat different results but this is probably due to the repeated indicators method widely used in PLS studies in order to operationalize second-order factors. It should be noted however, that models 1 and 5 seem to produce exactly the same results. This suggests that when second-order multidimensional constructs are specified as formative and they are operationalized using global second-order construct items PLS analyses coincide with CBSEM analyses. We argue that IS authors investigating multidimensional constructs should always report these important technical details into their articles. In the same vein reviewers and editors should be cautious when examining relevant articles and always require the reporting of these specification details, at least in the reviewing process.

Model 1 Second-Order Formative-CBSEM	**Model 2** Second-Order Reflective-CBSEM	**Model 3** Second-Order Formative-PLS (formative repeated indicators)	**Model 4** Second-Order Reflective-PLS (reflective repeated indicators)	**Model 5** Second-Order Formative-PLS (non-repeated indicators)
Content Quality (.36)	Contextual Quality (.65)	Contextual Quality (.32)	Contextual Quality (.75)	Content Quality (.30)
Contextual Quality (.33)	Connection Quality (.54)	Content Quality (.29)	Connection Quality (.56)	Contextual Quality (.20)
Device Quality (.26)	Interaction Quality (.52)	Device Quality (.26)	Customer Service (.54)	Device Quality (.19)
Privacy (.21)	Device Quality (.46)	Privacy (.21)	Interaction Quality (.53)	Privacy (.16)
Interaction Quality (ns)	Privacy (.46)	Connection Quality (.24)	Device Quality (.51)	Interaction Quality (ns)
Connection Quality (ns)	Content Quality (.45)	Customer Service (.24)	Privacy (.48)	Connection Quality (ns)
Customer Service (ns)	Customer Service (.36)	Interaction Quality (.24)	Content Quality (.42)	Customer Service (ns)

Table 1. Relative Importance of Electronic Service Quality Sub-Dimensions Between Different Second-Order Specifications and Estimation Methods

Conclusions and Limitations

The major argument of this study is that IS researchers should be cautious when they model multidimensional constructs. We highlight the lack of attention in the IS literature to how first-order constructs are related to their second-order constructs and show the importance of

distinguishing between the formative and the reflective views. We conduct an empirical study to illustrate that different parameter estimates and conclusions can be drawn based on the two views of multidimensional constructs. We further investigate whether different conclusions can be drawn depending on whether covariance or components-based SEM is used for parameter estimation. In conclusion, we provide an illustration of the potential effects of model misspecification at the second-order level measurement.

However, there are two factors that limit the extent to which the findings of the study can be generalized. First, the results are based on data from a single sample, which means that it is difficult to know whether the results are sample-specific. Second, our sample is relatively small (n=144) and standard error rates are known to be sensitive to small sample sizes [MacKenzie at al., 2005]. Future research should more formally investigate-using experimental simulation designs- the distinction between a) formative and reflective second-order measurement specification and b) the implications of modeling these specifications using different estimation methods.

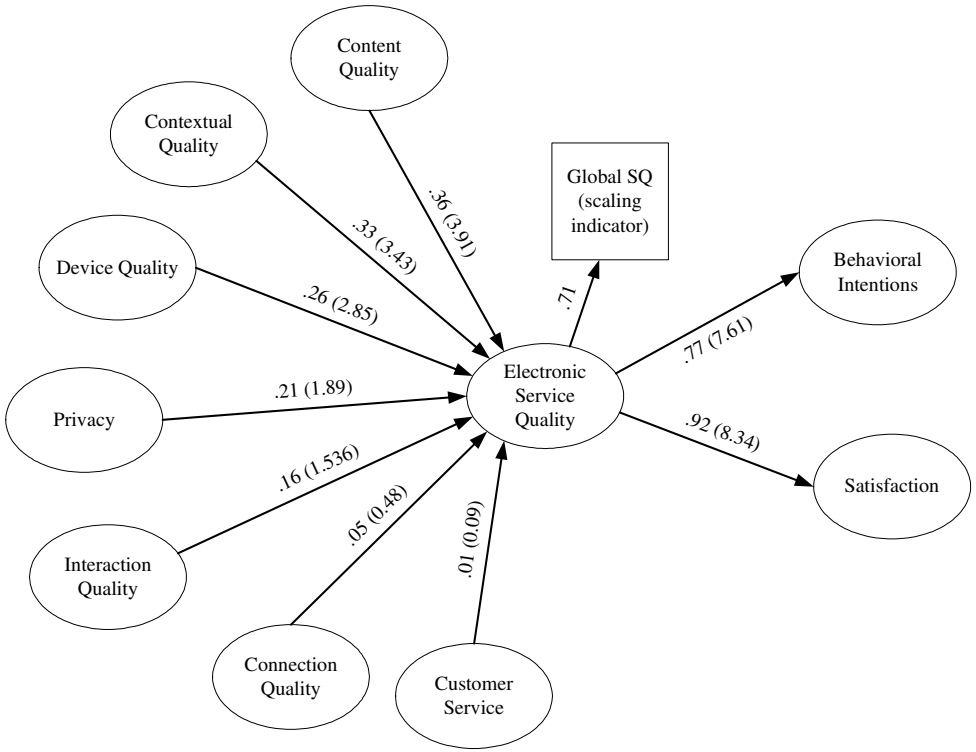

Figure 1. *Electronic Service Quality as a Molar Attitude- Covariance Based SEM Analyses*

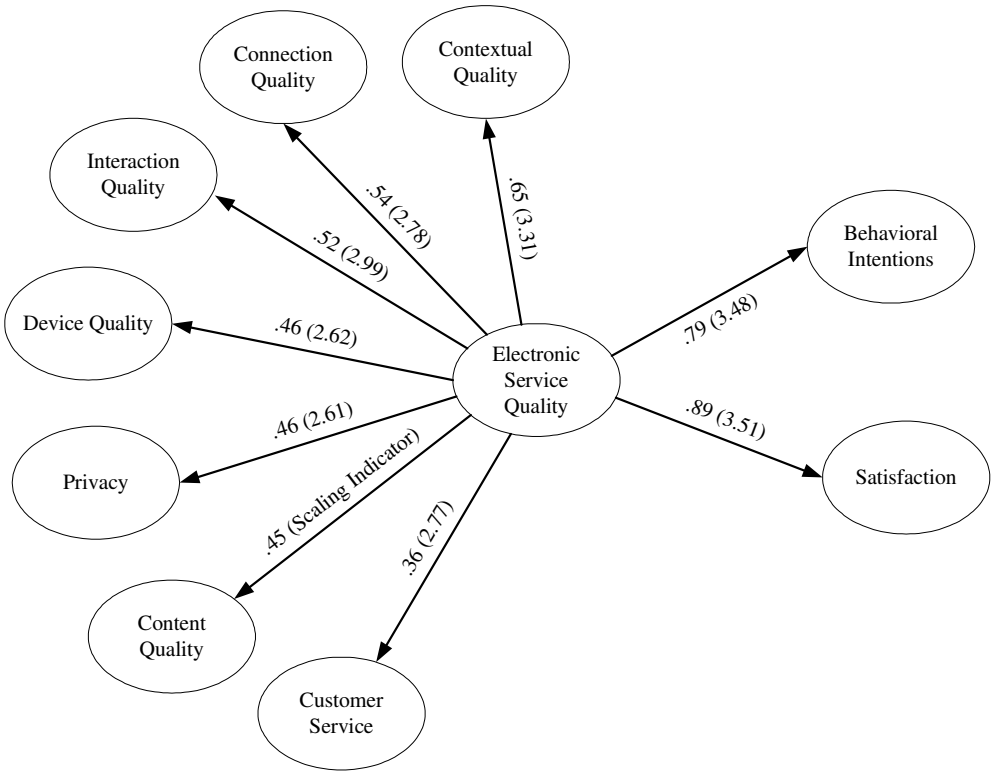

Figure 2. *Electronic Service Quality as a Molecular Attitude-Covariance Based SEM Analyses*

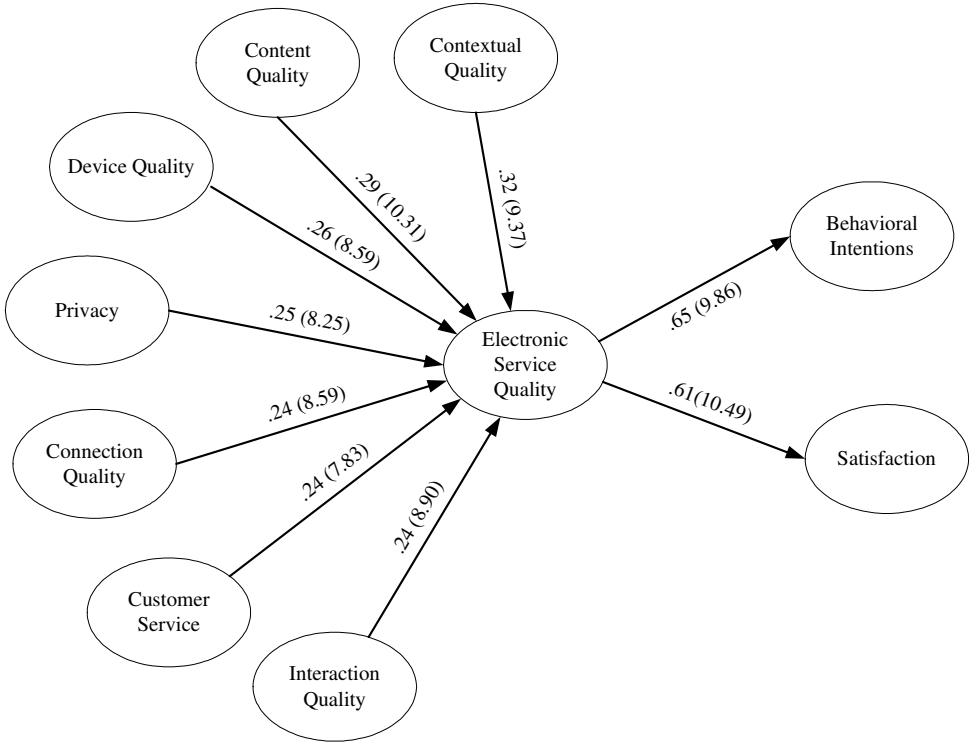

Figure 3. *Electronic Service Quality as a Molar Attitude- PLS Analyses*

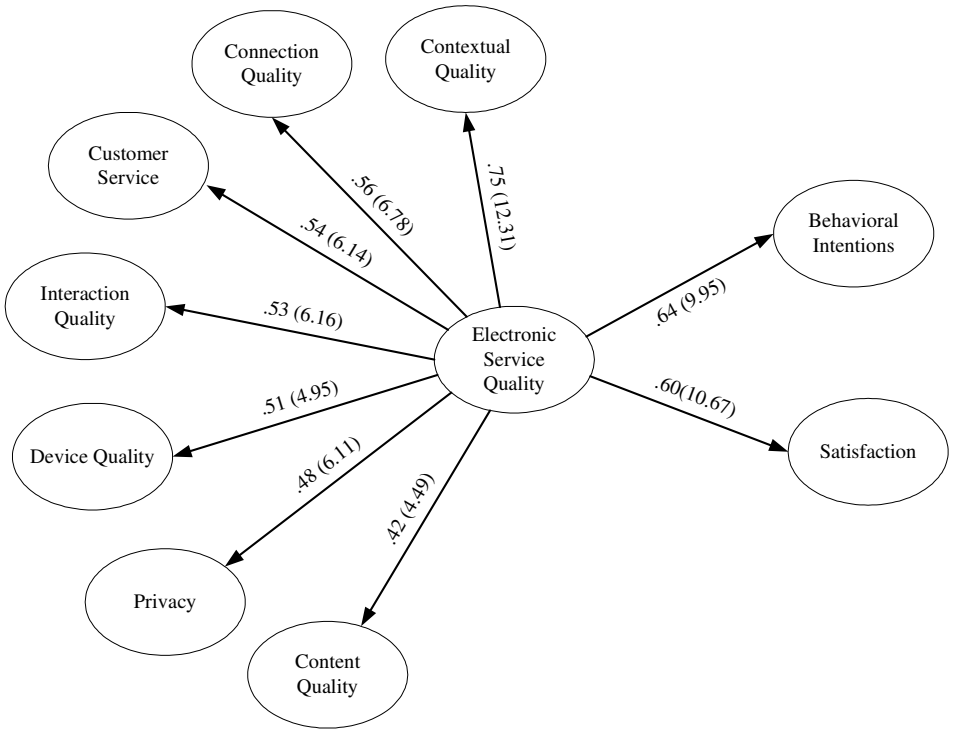

Figure 4. *Electronic Service Quality as a Molecular Attitude- PLS Analyses*

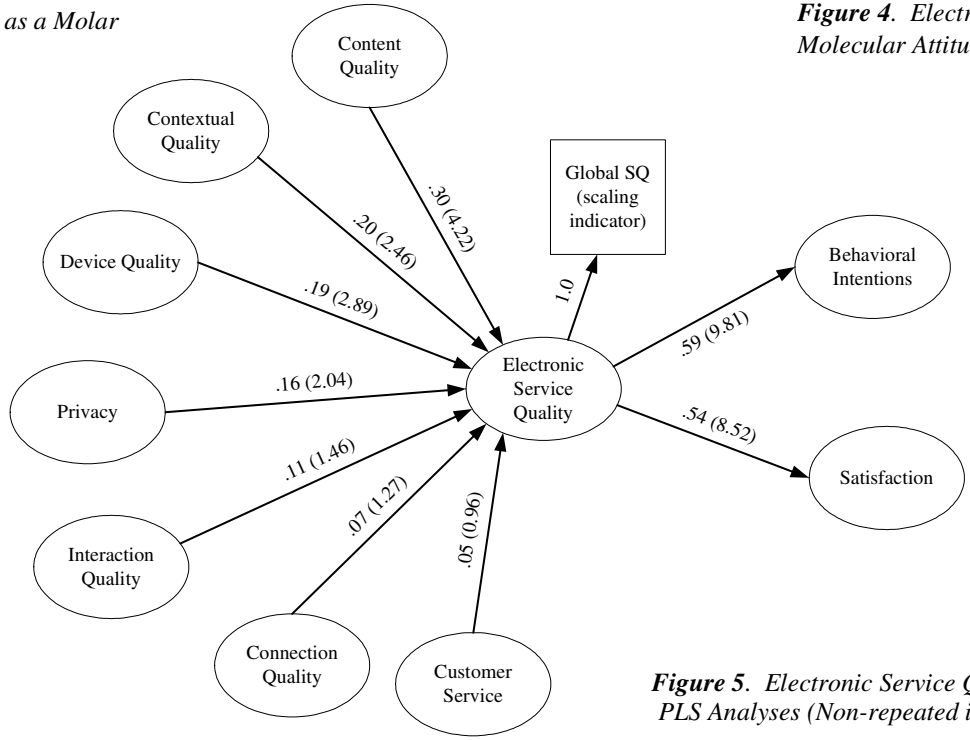

Figure 5. *Electronic Service Quality as a Molar Attitude- PLS Analyses (Non-repeated indicators method)*

APPENDIX

Construct

SQ

The overall quality of my experience with this mobile music service is (1=very poor, 7=excellent)

SAT

Having used this mobile music service I feel…(1-7)

Completely Satisfied/ Unsatisfied

Very Pleased/ Very Displeased

BI

(1=strongly disagree, 7=strongly agree)

I would encourage friends and relatives to use this mobile music service

I would say positive things about this mobile service to other people

Interaction Quality

(1=strongly disagree, 7=strongly agree)

The menus of this mobile service are clearly categorized

Content Quality

(1=strongly disagree, 7=strongly agree)

This mobile service offers music songs of superior audio quality

This mobile service offers video clips of superior audio quality

Device Quality

(1=strongly disagree, 7=strongly agree)

The look and feel of the handset was nice

The size of the screen was good

Privacy

(1=strongly disagree, 7=strongly agree)

I feel safe in my transactions with this mobile service

This mobile service has adequate security features

Connection Quality

(1=strongly disagree, 7=strongly agree)

Downloading time is speedy enough

This mobile service quickly responses for my input or clicks

Contextual Quality

(1=strongly disagree, 7=strongly agree)

I can access this mobile service whenever I need

I can access to this mobile service wherever I need

Customer Service

(1=strongly disagree, 7=strongly agree)

The company is willing and ready to respond to customer needs

When you have a problem, the company shows a sincere interest in solving it

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