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The relation between user satisfaction, usage of information systems and performance

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Abstract

This study investigates the validity of two commonly used measures for the success of information systems (IS): usage and user satisfaction (US). A questionnaire survey among Dutch managers was used to assess the mutual relation between both measures and performance. The results indicate that US is significantly related to performance (r=0.42). The relation between usage and performance is not significant. A partial correlation after correction for US is not significant either. This study provides empirical evidence for the popular assumption that US is the most appropriate measure for IS success available.

Keywords: Information systems success; User satisfaction; Usage; Validation of measurement instruments; Survey

1. Introduction

The explanation of information systems (IS[1]) success has been called one of the main goals of IS research [5]. Unfortunately, however, one of the prerequisites for measurement of IS success has been the subject of much controversy [8, 15, 23]. The measurement of IS success has been high on the research agenda for well over 15 years [20]. During these years papers have changed from theoretical discussions and rough measurement of IS success (see e.g. [32] for a survey and discussion of measurement issues) to empirical validation of measurement instruments [2, 11, 25, 26]. Within this period a tendency towards the application of more advanced psychometric methods can be seen. Reliability analysis using Cronbach's α and exploratory factor analysis have gradually been replaced by confirmatory factor models [6, 10, 12].

In parallel with this development, a shift in the success measures can be observed. Laboratory research typically applied measures in which the contribution of IS to performance is determined. Similarly, it has been proposed to compute the contribution of IS to organizational performance in real world studies [1, 9]; indeed, attempts have been made to apply such measures in empirical research. Gallagher tried to determine the value of IS in monetary terms, but his results were disappointing. Two dissertations at Ohio State University tried to assess the influence of IS implementation on financial performance. However,

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[1]In this paper the term IS will be used for management information systems, executive information systems, and decision support systems put to managerial use.

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''[t]he influence of non-controllable variables prevented their reaching a conclusion'' [16]. Apparently it is difficult to assess the contribution of IS to performance in a real world situation: a large portion of the costs and benefits will be qualitative or intangible [4, 24], the assessment of the value of unstructured or ad hoc decision making may be nearly impossible and organizations typically will not record these costs and benefits [24, 25].

Partially as a consequence of the difficulty in direct measurement of the contribution of IS to organizational performance, two alternative success measures gained acceptance: usage and user satisfaction (''the extent to which users believe the information system available to them meets their information requirements'' [25]). Both are supposed to be proxies for the contribution of IS to organizational performance. The validity of research findings in which those measures are used to operationalize IS success ultimately depends on these measures' validity. Consequently, the development of theoretical and empirical foundations for their application deserves a high place on the research agenda.

2. Usage and US as success measures

A rationale for the application of usage as an IS success measure is the idea that it does not contribute to performance if it is not used (and will contribute to performance when it is). An alternative rationale states that users are able to assess the value of the IS and will use it if they conclude that the benefits (rewards) will outweigh the costs (efforts) [27, 31]. On similar grounds Ein-Dor and Segev assume that usage is highly correlated with other criteria (like profitability, application to major problems of the organization, quality of decisions, or performance and user satisfaction) as ''a manager will use a system intensively only if it meets at least some of [these] criteria'' [13]. Both rationales assume that more usage is better, which is not necessarily the case. Furthermore, application of usage as a success measure may suffer from the fact that a system will be used if managers feel that it facilitates their own goals. Thus, both perfect knowledge and goal-congruence between manager and organization are assumed. On another level, it is unclear what exactly is the amount usage of an IS. Also, subjective measurement of usage may be influenced by social desirability and usage measurement may suffer from time-dependent noise. Finally, the application of usage as a success measure may lack sensitivity. Usage measurement will only identify the very unsuccessful systems [3] and whether managers will use an IS mainly will depend on negative aspects of the system. Provided that the benefits of using the IS outweigh the costs, it will be used.

The measurement of user satisfaction (US) will treat the very unsuccessful systems as non-existent, but is easier to differentiate between IS that are used. US measurement assumes that managers know their own information needs and this introduces the necessity of goal-congruence between the manager and the organization. Furthermore, it is assumed that improved performance will automatically follow if the system meets management information needs. This does not imply that satisfaction causes performance: performance and US are both caused by the extent to which information requirements are met. A possible shortcoming was noted by Melone [28], who doubts that users necessarily hold attitudes about their IS and, if they do, whether they are only formed when questions about US have to be answered; this would negatively affect the reliability of responses. She goes one step further and claims that attitudes that are not articulated will not influence perception, judgment, and behavior. This, however, presumes that US causes performance, which is not required: US is a reflection of the extent to which the information needs of the manager have been met and the assumption made in treating US as a success measure is that performance of managers will improve if their information requirements are met.

US also shares some shortcomings with usage; it may suffer from time-dependent noise [30] and may be influenced by social desirability. Furthermore, the problem of a valid US measure is apparent, but recently considerable progress has been made in developing an instrument and validating it by the application of more advanced psychometric methods.

3. Empirical evidence of the validity of US

Notwithstanding the apparent shortcomings of US as a success measure, the research community seems to

use it as the best proxy. US is increasingly employed in practice [7] and is the most commonly used dependent variable in IS research [22, 33]. In a recent meta-analysis [18] 27 studies used some operationalization of US as the success measure, 17 employed usage, and 13 some other dependent variable. Furthermore, the meta-analysis found a significant, negative relation between effect sizes for usage and the year in which the studies had been carried out. This may well be a consequence of this measure's limited sensitivity.

Some studies apply multiple measures simultaneously and some attempts have been made to gain insight in the mutual relations between success measures and organizational performance. Gatian investigated the relation between US, 'decision-making performance' and 'efficiency.' Her research population consisted of two groups of university and college users of a financial accounting and accounts payable system: department heads and controllers. She found that there was a relatively strong positive relation between satisfaction and both decision performance (assessed by both user groups) and efficiency (only assessed by the controllers group). However, her results may be affected by the fact that her decision performance measure asked users about their perceptions of the contribution of the system to performance: the decision-performance measure may well be considered to be a US measure itself. The efficiency measures assess 'specifically, data processing correctness, report preparation and distribution timeliness' [17]; these variables do not seem particularly suited to assess the contribution of IS to organizational performance. Furthermore, respondents may have tried to answer consistently: a respondent who first indicates that she is very satisfied with the IS is unlikely to answer that the system has a negative influence on her performance.

Iivari and Ervasti investigated 21 different systems in a single municipal organization. For a group of users and a group of user-managers US scores were determined using a version of the Bailey and Pearson instrument that was adapted by the authors in order to be able to determine US with an individual system.[2] Furthermore, implementability of the system was assessed using a scale developed by the authors, and effectiveness of the organizational unit was determined using the Van de Ven and Ferry [34] organizational assessment framework. Iivari and Ervasti found a positive relation between US (in particular ease of use) and implementability. Further results are somewhat ambiguous, but point to a positive relation between US and unit performance.

Etezadi-Amoli and Farhoomand investigated the relation between a newly developed US instrument (similar to the Bailey and Pearson instrument) and a newly developed performance instrument. Their respondents were employed by 22 different organizations and 38% of the respondents occupied a managerial position. They find a strong relation between US and performance. However, the nature of the performance measures employed may have inflated the findings: users were asked about the contribution of the software to their performance.

Igbaria and Chan [21] investigated the influence of US – assessed by the Doll and Torkzadeh instrument – on system usage and 'individual impact.' They used questionnaire data provided by 371 employees of a large organization located in Singapore and found a significant, positive influence of US on both usage and individual impact and of usage on individual impact. However, their results should be interpreted with some caution. The authors did not define usage in terms of frequency of use, as the differences between respondents were rather small. Instead they chose to define usage by the number of computerized applications (e.g. word processor, spreadsheet) used by respondents and the number of business tasks (e.g. writing reports, communicating with others) for which they used the system. This measure might better be labeled 'computer experience.' The individual impact measure is similar to the success measures used by Gatian and Etezadi-Amoli and Farhoomand: users are asked whether the system contributes to ''decision making quality, performance, productivity, and effectiveness of the job.'' The tendency of users to give consistent answers to the questionnaire may, again, have inflated the results.

In my study, unit performance was assessed using the Van de Ven and Ferry measures with two new questions concerning financial performance (revenues and profit). In this way the occurrence of spurious relations between US and performance found in pre-

[2]The authors explicitly acknowledge that the Doll and Torkzadeh US instrument could have been used to assess the relation between performance and US.

vious studies is avoided. The Doll and Torkzadeh instrument will be used to assess US. This instrument has been validated extensively (e.g. [14, 19]) and measures satisfaction with an individual application; this eliminates the need for adaptation of the instrument. In order to counter the criticisms of Etezadi-Amoli and Farhoomand about two-item measures the first version of the instrument (before elimination of items deemed superfluous by Doll and Torkzadeh) was used. Analysis of the relation between the outcomes of this instrument and other performance measures is particularly interesting because it has been criticized for not including performance related variables.

Table 1
Organizational function of respondents (n=170)

Function	%
Concern management	27.1
Division management	10.2
Business unit management	5.4
Line management	12.7
Staff member[a]	41.6
Other	3.0
Total[b]	100.0

[a]Of this group 23.2% indicated that their function was either information manager or controller.
[b]Due to rounding errors the sum of the individual items does not always equal 100%.

4. Research method

A questionnaire survey was sent to 1024 Dutch managers, information managers, and controllers.[3] A separate answer card was attached to the questionnaire; this could be used to obtain a booklet about IS and the results of the survey. The respondents did receive a postage paid return envelope and a letter on university stationery. The letter asked for cooperation and guaranteed that answers would be private. Four weeks after the first mailing, a reminder was send out in which respondents were thanked for their cooperation and in which the cooperation of people who had not yet responded was again solicited.[4] A final gross response rate of 20.7% (n=212) was obtained. The net response rate was 16.6%, as 42 responses could not be used for analysis.[5]

The age of the respondents varied from 23 to 65 years, with an average of 44.9 years. On average respondents have worked 6.1 years in their current function and 11.2 years with their current employer. A large majority of the respondents (94.7%) was male. Of the respondents, 84% had at least a polytechnic, university, CPA or CMA degree.[6] An IS was available to 64.5% of the respondents, 26.7% used the system only through an intermediary, and 11.4% did not use it at all. Table 1 presents descriptives of the function occupied by respondents.

The original Doll and Torkzadeh instrument consists of 18 questions, which are used to measure five dimensions of US: satisfaction with content (5 items), accuracy (4), format (4), and timeliness (2) of information and satisfaction with the system's ease of use (3). Two new indicators were added to the timeliness scale: ''Are the data in the system updated *often* enough?'' and ''Are the data in the system updated *quickly* enough?'' Both confirmatory factor analysis (CFA) and an expert panel were used to validate the resulting measurement instrument. They suggested the elimination of the fourth and fifth item of the content scale, the first newly added item of the timeliness scale and the third item of the ease of use scale. This reintroduces concerns that the number of indicators per construct is too low. However, the inclusion of only two items in the measure was preferred over the inclusion of a faulty item. The elimination of this item did result in an increase in Cronbach's α. A possible explanation it that the formulation of this item (''Is the system efficient?'') is ambiguous. After those analyses an extension of the CFA was used. In it a measurement model where all non-zero factor loadings were set equal to 1 was compared with a traditional measure-

[3]Administration of the questionnaire was made possible by financial support of Oasis Nieuwegein, which is gratefully acknowledged.

[4]The original intent of the answer card was to be able to keep track of respondents and non-respondents. However, the number of questionnaires received without any identification was quite large, and it was decided to send a reminder/thanks letter to all (non-)respondents.

[5]A large number of refusals consisted of a letter indicating company policy of non-cooperation in survey research.

[6]The subjects were Dutch managers, consequently the questions were phrased in terms of the Dutch educational system.

ment model where the non-zero factor loadings are left free. The difference in χ^2 between both models $(\chi^2_{11} = 5.07)$ is not significant. This indicates that in further analyses the sum of the individual item scores can be used. Finally, the reliability coefficients presented on the diagonal of Table 2 are quite satisfactory.

The second success measure, usage, was assessed in four different ways. The respondents were asked how many hours a week, and how many times a week they used their IS. Both measures were also obtained for any indirect usage: the respondents were asked how many hours and times a week an assistant spend to get them results from the IS.

Table 2
Pearson product moment correlations of IS success measures with organizational performance. Underneath each correlation coefficient the number of cases it is based on the significance are presented. Reliability coefficients (Cronbach's α) for multiple item measures are presented on the diagonal of the matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Content	0.90												
	(103)												
	n/a												
2. Accuracy	0.68	0.97											
	(103)	(103)											
	0.000	n/a											
3. Format	0.70	0.59	0.94										
	(103)	(103)	(103)										
	0.000	0.000	n/a										
4. Timeliness	0.59	0.76	0.56	0.91									
	(103)	(103)	(103)	(103)									
	0.000	0.000	0.000	n/a									
5. Ease of use	0.58	0.57	0.73	0.56	0.96								
	(103)	(103)	(103)	(103)	(103)								
	0.000	0.000	0.000	0.000	n/a								
6. US (1+2+3+4+5)	0.84	0.87	0.87	0.82	0.79	0.96							
	(103)	(103)	(103)	(103)	(103)	(103)							
	0.000	0.000	0.000	0.000	0.000	n/a							
7. Hours of direct usage	0.14	0.14	0.11	0.24	0.22	0.19	n/a						
	(100)	(100)	(100)	(100)	(100)	(100)	(103)						
	0.169	0.157	0.266	0.018	0.032	0.056	n/a						
8. Hours of indirect usage	0.14	0.16	−0.01	0.16	0.04	0.11	0.36	n/a					
	(93)	(93)	(93)	(93)	(93)	(93)	(95)	(96)					
	0.169	0.133	0.906	0.116	0.724	0.275	0.000	n/a					
9. Frequency of direct usage	0.19	0.14	0.19	0.23	0.29	0.24	0.53	0.08	n/a				
	(101)	(101)	(101)	(101)	(101)	(101)	(103)	(95)	(104)				
	0.051	0.175	0.055	0.021	0.004	0.017	0.000	0.428	n/a				
10. Frequency of indirect usage	0.15	0.21	−0.05	0.19	0.02	0.12	0.14	0.76	0.12	n/a			
	(98)	(98)	(98)	(98)	(98)	(98)	(99)	(96)	(100)	(101)			
	0.147	0.041	0.608	0.058	0.821	0.239	0.159	0.000	0.240	n/a			
11. Performance (Van de Ven and Ferry)	0.36	0.35	0.41	0.36	0.35	0.44	0.11	0.04	0.15	0.06	0.85		
	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(94)	(101)	(98)	(162)		
	0.000	0.000	0.000	0.000	0.000	0.000	0.294	0.699	0.124	0.582	n/a		
12. Performance (new)	0.26	0.27	0.30	0.29	0.26	0.33	−0.06	−0.08	0.07	−0.01	0.45	0.79	
	(92)	(92)	(92)	(92)	(92)	(92)	(92)	(88)	(93)	(91)	(143)	(146)	
	0.011	0.009	0.004	0.005	0.013	0.001	0.572	0.479	0.535	0.914	0.000	n/a	
13. Performance (11+12)	0.38	0.36	0.42	0.38	0.37	0.46	0.09	0.01	0.17	0.04	0.95	0.70	0.84
	(91)	(91)	(91)	(91)	(91)	(91)	(91)	(87)	(92)	(90)	(143)	(143)	(143)
	0.000	0.000	0.000	0.000	0.000	0.000	0.383	0.908	0.101	0.707	0.00	0.000	n/a

To assess performance, the Van de Ven and Ferry measure was used; modifications were not deemed necessary. Using the same format, scores for a newly developed second performance measure were obtained for profitability and development of revenues. Although this measure has the disadvantage that it will not be applicable to the situation of every respondent, it provides a more direct linkage to bottom-line performance measures. The estimates on the diagonal of Table 2 indicate that the reliabilities of the Van de Ven and Ferry measure are reasonably high. Although α for the new measure is somewhat below average, it still is acceptable [29].

5. Results

All relations in Table 2 are presented in the form of correlation coefficients. In addition, the number of observations and the two-tailed significance level are presented.

As expected, the relations between US and organizational performance are all significant. Noteworthy is the fact that all six correlations between US and the Van de Ven and Ferry performance measure are stronger than the relation with the newly developed bottom-line performance measure. This may be a consequence of the lower reliability of the latter measure. A re-estimation of the correlation matrix using LISREL (in order to allow for the incorporation of reliability) slightly increases the correlations found,[7] but shows the same pattern. A possible explanation is that financial performance is mainly determined by factors (e.g. general economic conditions) that cannot be influenced by the respondent (and her IS).

Even more noteworthy is the observation that all correlations between the usage measures and performance are insignificant. Partial correlations between the usage measures and performance after correction for US have been estimated as well. All partial correlations turned out to be lower and were insignificant. The concerns about the validity of usage and the preference for US in empirical research seem well justified. A dichotomous usage measure may still be a valid operationalization of IS success, but provided the system is used, the usage criterion fails to show a significant relation with performance. Due to the limited number of non-users in the sample only a tentative test of the relation between this dichotomous usage measure and performance could be made. An ANOVA was carried out to find out whether users and non-users differed significantly on the performance measures. Although performance is lower for non-users, the difference is not significant ($F_{1,101}$=2.74; p=0.10, $F_{1,93}$=0.79; p=0.37, and $F_{1,92}$=2.24; p=0.14 for the three performance measures, respectively). A non-parametric test using Mann–Whitney's U test found no significant differences either.

Of the relations between the subdimensions of US, ease of use and timeliness show the highest correlation with both hours and frequency of direct usage of the system. Intuitively, it makes sense that systems that are more easy to use are used longer and more frequently. It makes sense to assume that users who are more satisfied with timeliness of the information provided by their IS – which possibly indicates that the information is updated more regularly – will use it more frequently.

On the other hand, the relation between both indirect usage measures and the US-subdimensions format of the information provided by the system and ease of use almost equals zero. This makes some intuitive sense: for indirect usage situations ease of use will be less relevant and the format of the information provided will be filtered by the assistant. However, this may also reflect the fact that managers who use their IS mainly indirectly may not be able to provide adequate estimates of the format and ease of use dimension.

6. Conclusions and discussion

Overall, the results increase the confidence in the application of US as a criterion for IS success. In particular if the large version of the instrument is employed, US can be measured with sufficient reliability. Furthermore, the strong and consistent correlation with the performance measure indicates that the

[7] This is always the case; unreliability of measurement will attenuate the correlation coefficient. A correction for attenuation can be made by $r'_{xy} = r_{xy}/\sqrt{r}_{xx}\sqrt{r}_{yy}$, in which r' is the corrected correlation coefficient, and r_{xx} (r_{yy}) are the reliability of variable x (y) [29]. Cronbach's α is a lower limit of (statistical) reliability and substitution of reliability by α will result in an overestimate of the effect size.

claim that US is an adequate proxy for the contribution of IS to organizational performance is correct. However, the US instrument still needs some improvement. The ease of use component of the instrument consists of only two items and is relatively unreliable. Furthermore, reliabilities of the instrument may have been overestimated as a consequence of the tendency of respondents to give consistent answers. Thus the correlations between the subdimensions of US and the total US score are better estimates of reliability than the diagonal αs.

The correlations between US and performance may be inflated by two artifacts of the research design. First, self-reports of performance were used. Second, the correlations may have been inflated by the fact that this study focused on IS only; organizations that build better IS are likely to perform better in other areas, too. All those areas contribute to organizational performance. As only IS success is assessed, the relation between IS success and organizational performance will partially reflect the contribution to performance of the other areas in which the organization performs better.

It should also be acknowledged that US is less suited to assess the success of an IS that is used indirectly. However, in survey research it may not be obvious whether a manager is a user of the IS or uses it only indirectly.

Finally, the low and insignificant correlations between usage measures and performance measures add weight to the doubts that already exist about the validity of usage as a success criterion. However, the results of this study should not be generalized to other kinds of systems. For some systems (e.g. Internet sites or other information systems aimed at a general public) usage may remain the most appropriate and most easily assessed success measure; for IS, US measurement is more appropriate.[8]

[8] In a similar vein, the results of Chan, Huff, Baclay and Copeland indicate that using US as a success measure may underestimate systems' strategic importance: ''The seven dimensions of IS effectiveness formed two separate clusters – UIS [user information satisfaction] and strategic impact – suggesting that IS satisfaction measures were not just another way of assessing IS strategic importance; these factors were very different. This in turn implies that studies investigating organizational IS effectiveness may be well-advised not to rely solely on UIS-based measures.''

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References

[1] American Accounting Association, Report of the committee on management information systems, 1977.
[2] James E. Bailey, Sammy W. Pearson, Development of a tool for measuring and analyzing computer user satisfaction, Management Science 29(5) 530–545, May 1983.
[3] Henri Barki, Sid L. Huff. Change, attitude to change, and decision support system success, Information and Management 9(5) 261–268, December 1985.
[4] Lloyd W. Belcher, Hugh Watson, Assessing the value of Conoco's EIS, MIS Quarterly 239–253, September 1993.
[5] Robert P. Cerveny, G. Lawrence Sanders, Implementation and structural variables, Information and Management 11, 1986, pp. 191–198.
[6] Wynne W. Chin, Peter R. Newsted, The importance of specification in causal modeling: The case of end-user computing satisfaction, Information Systems Research 6(1), 1995, pp. 73–81.
[7] David W. Conrath, Olivier P. Mignen, What is being done to measure user satisfaction with EDP/MIS, Information and Management 19, 1990, pp. 7–19.
[8] William H. DeLone, Ephraim R. McLean, Information systems success: The quest for the dependent variable, Information Systems Research 3(1), 1992, pp. 60–95.
[9] Gary W. Dickson, James C. Wetherbe, The Management of Information Systems, McGraw-Hill, 1985.
[10] William J. Doll, T.S. Raghunathan, Jeen-Su Lim, Yash P. Gupta, A confirmatory factor analysis of the user information satisfaction instrument, Information Systems Research 6(2), 1995, pp. 177–188.
[11] William J. Doll, Gholamreza Torkzadeh, The measurement of end-user computing satisfaction, MIS Quarterly 12 259–274, June 1988.
[12] William J. Doll, Weidong Xia, Gholamreza Torkzadeh, A confirmatory factor analysis of the end-user computing satisfaction instrument, MIS Quarterly 453–461, December 1994.
[13] Philip Ein-Dor, Eli Segev, Organizational context and the success of management information systems, Management Science 24(10) 1064–1077, June 1978.
[14] Jamshid Etezadi-Amoli, Ali F. Farhoomand, On end-user computing satisfaction, MIS Quarterly 1–5, March 1991.

[15] Jamshid Etezadi-Amoli, Ali F. Farhoomand, A structural model of end user computing satisfaction and user performance, Information and Management 30(2) 65–73, May 1996.
[16] Charles A. Gallagher, Perceptions of the value of a management information system, Academy of Management Journal 17(1) 46–55, March 1974.
[17] Amy W. Gatian, Is user satisfaction a valid measure of system effectiveness?, Information and Management 26, 1994, pp. 119–131.
[18] Maarten Gelderman, Factors affecting the success of management support systems: Analysis and meta-analysis. Paper presented at the IS/MAS forum of the Annual Conference of the American Accounting Association, Orlando, FL, August 1995.
[19] Maarten Gelderman, Translation and validation of the Doll and Torkzadeh end user computing satisfaction instrument, In: Hugh J. Watson (Ed.), Proceedings of HICSS 31, vol. VI, IEEE Computer Press, January 1998, pp. 537–546.
[20] W.J. Haga, M. Zviran, Information systems effectiveness: Research designs for causal inference, Journal of Information Systems 4, 1994, pp. 141–166.
[21] M. Igbaria, M. Tan, The consequences of information technology acceptance on subsequent individual performance, Information and Management 32(3) 113–121, March 1997.
[22] Magid Igbaria, Sidney A. Nachman, Correlates of user satisfaction with end user computing: An exploratory study, Information and Management 19, 1990, pp. 73–82.
[23] Juhani Iivari, Irja Ervasti, User information satisfaction: IS implementability and effectiveness, Information and Management 27, 1994, pp. 205–220.
[24] Blake Ives, Margrethe H. Olson, User involvement and MIS success: A review of research, Management Science 30(5) 586–603, May 1984.
[25] Blake Ives, Margrethe H. Olson, Jack J. Baroudi, The measurement of user information satisfaction, Communications of the ACM 26(10) 785–793, October 1983.
[26] Mo Adam Mahmood, Janet A. Sniezek, Defining decision support systems: An empirical assessment of end-user satisfaction, INFOR Canada 27(3) 253–271, August 1989.
[27] M. Lynne Markus, Daniel Robey, The organizational validity of management information systems, Human Relations 36(3), 1983, pp. 203–226.
[28] Nancy Paule Melone, A theoretical assessment of the user-satisfaction construct in information systems research, Management Science 36(1) 76–91, January 1990.
[29] Jum C. Nunnally, Psychometric Theory. McGraw-Hill, 1967.
[30] Margrethe H. Olson, Blake Ives, User involvement in systems design: An empirical test of alternative approaches, Information and Management 4(4), 1981, pp. 183–195.
[31] Daniel Robey, User attitudes and management information system use, Academy of Management Journal 22(3), 1979, pp. 527–538.
[32] Detmar W. Straub, Validating instruments in MIS research, MIS Quarterly, June 1989.
[33] Ashok Subramanian, Sree Nilakanta, Measurement: A blueprint for theory-building in MIS, Information and Management 26, 1994, pp. 13–20.
[34] Andrew H. Van de Ven, Diane L. Ferry, Measuring and Assessing Organizations, Series on Organizational Assessment and Change, Wiley, 1980.

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