UDC 005.642:004.738.5
Original Scientific Paper

Benchmarking User Perceived Impact for Web Portal Success Evaluation

Daniel Delić *delic@zedat.fu-berlin.de*
Freie Universität Berlin, Germany
Institute of Production, Information Systems and Operations Research

Hans-J. Lenz *hjlenz@zedat.fu-berlin.de*
Freie Universtität Berlin, Germany
Institute of Production, Information Systems, and Operations Research

Abstract

We describe an approach for success evaluation of Web portals by benchmarking user perceived impact with Multiple-Criteria Decision Analysis (MCDA). For impact measurement a questionnaire is used. The method is applied in a case study of four e-government portals and results are discussed.
Keywords: Portal success evaluation, user perceived impact, benchmarking, MCDA

1. Introduction

Portals provide a variety of information, links to information sources, services, as well as productivity and community supporting features (e.g., news, calendar, e-mail, and forum) in one Web site. Web portals can be classified into community portals, business or market portals, information portals, entertainment portals etc. [21]. Subject of this study are portals whose main purpose is to provide information. For such portals it is not only important to contain high-quality information, but also that users can find and request the corresponding content pages easily.

Success evaluation is important in order to improve and optimize the quality of the provided services. User satisfaction questionnaires are common measurement instruments for such a task [24]. Usually, it is carried out within the framework of a goal-centered evaluation or an evaluation of improvement relative to past performance. However, goals may be unrealistic and/or there may be no exact knowledge about "good" performance; improvement measurement does not provide information about the performance level at all (e.g., compared to some "standard"). In such cases benchmarking, i.e., comparative analysis can be the better alternative. It also has proved to be suitable for identification of best practices, and improvement [8]. Benchmarking is a suitable approach for the interpretation of questionnaire survey results in particular because usually there do not exist standards that could be used for performance level assessment instead.

Although user satisfaction is the "most prevalent measure of IS success" [24], it is only a substitute for performance measurement. A more direct approach is measuring impact. We propose questionnaire items for measuring the users' perceived impacts as the main success criteria. The questionnaire is based on the IS success model of DeLone and McLean [6]. The benchmark task is carried out with Multiple-Criteria Decision Analysis (MCDA). MCDA enables consistent preference decision making on a set of alternatives (i.e., portals) with regard to multiple decision criteria and the specific preferences of the decision maker (i.e., portal provider). Thus, allowing performance assessment and identification of weak points from the specific perspective of a portal provider.

We conduct a case study of four e-government portals and discuss the results.

The paper is organized as follows: Section 2 contains a brief summary of related work. In Section 3 an introduction to the DeLone and McLean IS success model is given. In Section 4 the questionnaire is presented. Section 5 introduces the MCDA method applied. In Section 6 case study results are presented and discussed. Section 7 contains some conclusions and future work.

2. Related Work

The majority of the proposed questionnaire approaches focus on measuring (directly or indirectly) user satisfaction, as well as some form of perceived Web site quality [24].

Other studies consider consequences of Web use, such as trust, perceived risk, and loyalty [10, 16]. Normally, privacy and security are important to Web site visitors. Due to the impersonal nature of the online environment, its technological unpredictability, and uncertainty about provider behavior, trust and perceived risk are important factors. These factors play a vital role in a user's decision, whether or not and how to interact with a Web site [16]. Closely related to trust and perceived risk is loyalty [10, 18]. It is considered as one of the most important success factors in e-commerce [18]. Loyal customers are more profitable in the long term, produce ongoing revenues, and are willing to spend more money. They are also inclined to recommend the Web site to other people, increasing the firm's customer base at no extra cost.

A further study, by D'Ambra and Rice [4], identifies criteria for measuring individual performance of Web use, such as increase in knowledge, improved decision making, and improved quality of work.

MCDA methods for Web success evaluation with questionnaire surveys have been applied already [13, 20]. Grigoroudis et al. [13] measure and compare user perceived quality of Web sites, but they do not take explicitely impact into account. Sampson and Manouselis [20] do apply impact criteria (as defined in this paper). However, they do not compare results between several portals but between several stakeholder groups of one portal. Their evaluation framework is goal-oriented. They define a total performance of 60% of stakeholder satisfaction as a success threshold. In our approach, on the contrary, we focus on measuring and comparing user perceived impact for several similar portals. The performance of a portal is interpreted relative to the performance outcomes of the other portals. No thresholds as success level indicators have to be defined in advance.

3. IS Success

DeLone and McLean [6] (further referred to as D/M92) analyze 180 IS success studies and identify six major interdependent categories which they term as *dimensions* of IS success: information quality (INFQ), system quality (SYSQ), user satisfaction (USAT), use (USE), individual impact (IIMP), and organizational impact (OIMP) (Figure 1).

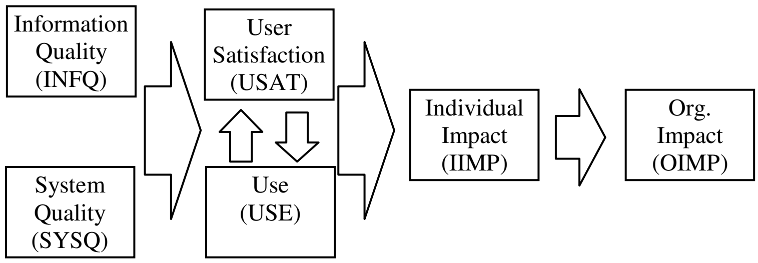

Figure 1. D/M92 IS Success model (Source: [6]).

The most direct approach of success measurement is to assess the effectiveness of a system by its impacts (represented by the IIMP and OIMP dimensions in the D/M92 model). However, in most cases it is difficult to assess such outcomes. A more common approach is to indirectly assess effectiveness via substitute measures, such as Web quality or user satisfaction (represented by the remaining dimensions in the D/M92 model). Although substitute measurement outcomes are closely associated with impacts, those relationships are not sufficiently strong to warrant their use as interchangeable measures of effectiveness [23]. Thus, impact measurement should be preferred if possible. However, as suggested by DeLone and McLean [7], impact cannot be fully understood without analysis of causing factors. Therefore, it is important to consider multiple success dimensions in order to get a (more) complete picture of success

4. Evaluation Questionnaire

The primary goal of the survey is to assess the user perceived (i.e., individual) impact of portal use. The proposed questionnaire is based on a simplified D/M92 model with the categories USE and OIMP omitted. USE does not measure opinions but behavior and OIMP is not considered in this study.

As mentioned in Section 2, trust, perceived risk, and loyalty are important Web success factors. These factors are influenced by perceptions of Web site quality, as well as user satisfaction [2, 10]. This indicates their suitability as impact measures in the D/M92 model. Another important factor in the context of information portals is the user perceived value of the provided information. It can be assessed as increase in the user's knowledge [4].

The proposed questionnaire items for impact measurement are adapted from the aforementioned studies. For the assessment of satisfaction, information quality, and system quality, commonly applied questions from [1, 15, 17] are used. The questionnaire consists of 21 items (Table 1). Answers are measured on a 5-point rating scale, ranging from 1 (strongly disagree) to 5 (strongly agree). RISK item scales are recoded, i.e., 1 means high perceived risk and 5 means low perceived risk.

Information Quality (INFQ)	
INFQ1	The provided information (incl. downloads) on the portal is up to date.
INFQ2	...is clear.
INFQ3	...is complete.
INFQ4	...is relevant.
INFQ5	...is exclusive.
System Quality (SYSQ)	
SYSQ1	The content is well structured and organized.
SYSQ2	The content is easy to read.
SYSQ3	This portal is easy to navigate through.
SYSQ4	The hyperlinks are valid.
SYSQ5	The single pages load fast.
SYSQ6	The portal's search function is helpful.
User Satisfaction (USAT)	
USAT1	Overall, I'm satisfied with this portal.
USAT2	Overall, this portal meets my expectations.
Individual Impact (IIMP)	
KNOW1	I'm better informed because of my portal use.
KNOW2	I make better decisions because of the information on the portal.
TRST1	xyz.com is competent in fulfilling it's task.
TRST2	Personal user data (e. g., e-mail address) are not misused.
RISK1+	It is unsafe to store personal user data on this portal (e.g., e-mail address for newsletter).
RISK2+	There is a significant risk in using this portal.
LOYA1	I intend to visit this portal regularly in the future.
LOYA2	I will recommend xyz.com to others.

+ recoded

Table 1. Evaluation questionnaire.

5. MCDA Approach

The proposed MCDA method here is *Simple Additive Weighting* (SAW) [9, 14]. SAW is applied to solve decision problems with respect to multiple alternatives and criteria. It allows consistent preference decision making on a set $A = \{a_1, a_2, ..., a_n\}$ of alternatives and a set $C = \{c_1, c_2, ..., c_m\}$ of criteria with their corresponding weights $W = \{w_1, w_2, ..., w_m\}$ ($w_j \geq 0, \sum_j w_j = 1$). The latter reflect the decision maker's preference for each criterion. SAW aggregates the criteria c_j based outcome values x_{ij} for an alternative a_i into an overall utility score $U^{\text{SAW}}(a_i)$. The goal is to obtain a ranking of the alternatives according to their utility scores. For that purpose the outcome values x_{ij} are normalized to the interval [0, 1] by applying a utility function $u(\cdot)$, i.e., partial utility values $u(x_{ij})$ are derived. Finally, the utility score for each alternative is calculated by summing up the partial utility values:

$$U^{\text{SAW}}(a_i) = \sum_{j=1}^{m} w_j \cdot u(x_{ij}), \ \forall a_i \in A. \quad (1)$$

To compare performances between alternatives, the results are stored in a decision matrix (Table 2).

In order to apply SAW the x_{ij} values must be at least of ordinal scale and the decision maker's preference order relation on them must be complete and transitive. In the case of ordinal scaled attributes the derived utility values only specify the ranking of different outcome values of that attribute. They do not indicate any distances between the different outcome values. For instance, a student with a grade B cannot be considered as double as good as a student with a D.

For a more detailed introduction to MCDA and the SAW method we refer to [9, 14].

	w_1 c_1	$\cdots$ $\cdots$	w_j c_j	$\cdots$ $\cdots$	w_m c_m	U^{SAW}
a_1	$u_1(x_{11})$		$\cdots$		$u_m(x_{1m})$	$U^{\text{SAW}}(a_1)$
$\vdots$	$\vdots$		$\vdots$		$\vdots$	
a_i	$u_1(x_{i1})$	$\cdots$	$u_j(x_{ij})$	$\cdots$	$u_m(x_{im})$	$U^{\text{SAW}}(a_i)$
$\vdots$	$\vdots$		$\vdots$		$\vdots$	
a_n	$u_1(x_{n1})$		$\cdots$		$u_m(x_{nm})$	$U^{\text{SAW}}(a_n)$

Table 2. SAW decision matrix.

In the context of this approach, we define portal success as follows:

Definition 1. *The success level of an information portal in providing information content w. r. t. given criteria and weights is determined by the value of its utility score relative to the utility scores of the other considered portals.*

According to Definition 1, the most successful portal, denoted as a^*, is the one with the highest utility score: $U^{\text{SAW}}(a^*) \geq U^{\text{SAW}}(a_i),\ a^* \neq a_i,\ \forall a_i, a^* \in A$.

6. Case Study

The proposed approach was applied in a case study on four German e-government portals, so called *education servers*. Each server is provided by a different German state. The contents and services are mainly related to state specific topics about schools, education, educational policy etc. In addition, various materials such as curricula for instruction can be downloaded. Furthermore, the portals offer services such as e-learning and collaboration support. One of their main target groups are teachers.

For reasons of confidentiality, we cannot uncover the portals' identities. However, they are quite similar both in types of content and in modes of navigation to other educational servers in Europe such as the Swiss Education Server (Figure 2).

Figure 2. Homepage of the Swiss Education Server (www.educa.ch).

The case study consisted of two phases. Firstly, an online survey on each portal was conducted. The results were used to validate and refine the proposed path model. Secondly, the survey results based on the validated and refined path model were used for the MCDA model.

6.1. Questionnaire Survey and Validation

On each portal a link to its questionnaire was provided at the homepage for (depending on the portal) a period of about four to eight weeks (late 2006/early 2007). In addition, the link was e-mailed to registered portal users. In total 526 users participated in the survey. However, only 223 ($N_{Portal1} = 63$, $N_{Portal2} = 61$, $N_{Portal3} = 32$, $N_{Portal4} = 67$) completed the questionnaire with no missing item. These data were used for the validation as well as for the MCDA modeling.

We apply Partial Least Squares (PLS) [22] for the validation task. PLS is suitable for studies with an exploratory nature, which is the case here. Although the hypothesized dependencies in the D/M92 IS success model are confirmed by several studies [7], to the best of our knowledge there exists no such study which applies the impact measures proposed in our work. The used software is SmartPLS 2.0 M3 [19].

Measurement validity, i.e., the validity of the model's constructs respectively latent variables, is assessed by analysis of discriminant and convergent validity of the measures (i.e., questionnaire items). In PLS this is done by Confirmatory Factor Analysis (CFA) [11, 12]: each item loading must be higher on its assigned construct than on any other construct, and the square root of the *Average Variance Extracted* (AVE) of each construct must be larger than its correlations with any other construct (the AVE reflects the overall variance in the measurement items accounted for by their corresponding latent variable; it is defined as $\mathrm{AVE} = (\sum \lambda_i^2)/((\sum \lambda_i^2) + (\sum (1-\lambda_i^2)))$, where λ_i is the amount of explained variance of measurement item i).

First measurement results indicate a weak model fit: the USAT items cross load heavily on the INFQ and SYSQ items; item INFQ5 has an exceptionally low loading; the loadings of the SYSQ items suggest splitting the system quality category into two subcategories.

After we removed the items INFQ5, USAT1, and USAT2, and after the SYSQ category was split into the subcategories PREQ ("presentation quality", items SYSQ1-SYSQ3) and TECQ ("technical quality", items SYSQ4-SYSQ6), the validation results for each portal indicate a good model fit: all items load correctly on their assigned constructs (Appendix A) and each construct's $\sqrt{\mathrm{AVE}}$ is larger than its correlations with any other construct (Appendix B).

Construct reliability is measured with Cronbach's alpha [11]. It is an indicator for the average level of inter-correlation of the items of a latent variable, defined as $\alpha = (\mathrm{N}/\mathrm{N}-1)((\sigma_X^2 - \sum_{i=1}^{\mathrm{N}} \sigma_{Y_i}^2)/\sigma_X^2)$ where N is the number of items, σ_X^2 is the variance of the observed total test scores, and $\sigma_{Y_i}^2$ is the variance of item i. For each latent variable, except for TRST, the value is above the suggested minimum in PLS of .70 [11] for each portal (Table 3). Moreover, for exploratory analysis a minimum value of .60 is acceptable [11]. However, the low alpha values for the portals P2, P3, and P4 indicate that the questions for the assessment of the TRST construct need to be reformulated for future surveys in order to be more reliable.

Cronbach's Alpha	P1	P2	P3	P4
INFQ	0,900976	0,851046	0,855400	0,870123
LOYA	0,935681	0,700677	0,822130	0,866676
PREQ	0,885059	0,879895	0,888505	0,851089
RISK	0,949150	0,918025	0,969217	0,832479
TECQ	0,808713	0,786584	0,837501	0,747164
TRST	0,738107	0,531842	0,351880	0,586694
KNOW	0,830617	0,845958	0,745331	0,889699

Table 3. Cronbachs alphas of the constructs for each portal.

Structural validity of the model is assessed by testing the significance of the paths and by calculating the R^2 values.

For significance testing the implemented bootstrapping algorithm in SmartPLS is used. The t-values for each portal are shown in Appendix C. The refined path model is depicted in Figure 3, with significant paths printed in black. The thickness of a path indicates by how many portals significance is supported.

The refined path model indicates that the proposed impact measures are valid in the context of the adapted D/M92 model, i.e., they are influenced by perceived system and information quality. From the model can be seen that INFQ has a main influence on KNOW and TRST. While TECQ is also an important influencing factor on TRST, PREQ is less. KNOW and TRST have the main influence on LOYA. The development of RISK is mainly dependent on TRST.

The relatively high R^2 values for KNOW, TRST, and LOYA indicate that these internal construct's variances are influenced to a considerable amount by the other constructs of the model. RISK is the only exception with a relative low R^2 value for each portal, indicating that this construct is influenced by some more factors than considered in this model, e.g., the user's predispositions (Table 4).

Comparing the users of the different portals with each other does only make sense if their profiles conform at least to some extend. We back this assumption on similarities in profession (mostly teachers), experience with internet and portal usage as well as topics of interest among those users. The corresponding data were gathered by the demographic part of the questionnaire. Further details are described in [5, Chapter 5].

6.2. MCDA Model

As described in the introduction, subject of this study is the assessment and comparison of individual impact. Thus, for the development of the MCDA model the questionnaire's impact measurement items are used. The remaining items are considered for the interpretation of impact measurement results.

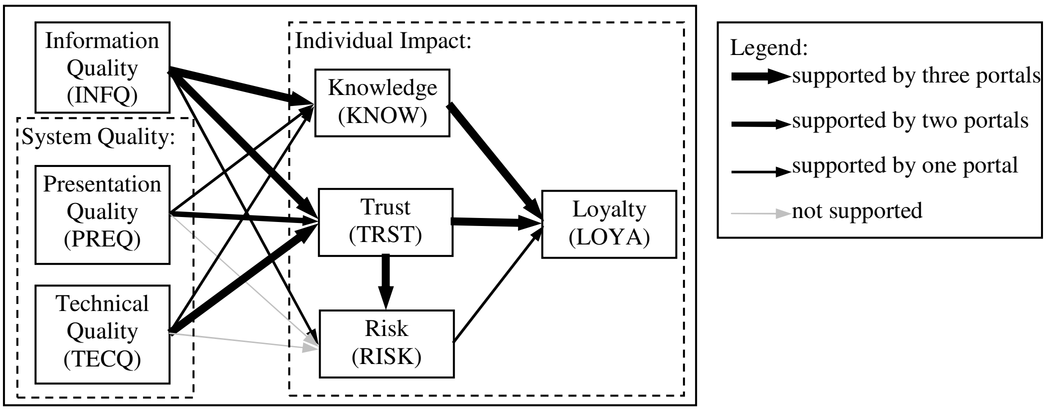

Figure 3. Refined path model.

The MCDA process consists of three steps: (1) the criteria based outcome values for each portal are assessed, (2) those values are normalized by applying a utility function, (3) the weights are set according to the preferences of the considered portal provider and the utility score for each portal is derived.

R^2	P1	P2	P3	P4
KNOW	.58	.44	.58	.68
TRST	.48	.45	.55	.57
RISK	.25	.24	.11	.31
LOYA	.73	.56	.59	.39

Table 4. R^2 values of the constructs for each portal.

Since the answers are measured on a 5-point rating scale, the data are completely ordinal. For ordinal data a mean value cannot be derived. Instead the median for each item is used. Additionally, the first and third quartiles are included for better diagnostic capability. The corresponding outcome matrix consists of three (Q1: 1st quartile, Q2: median, Q3: 3rd quartile) values for each questionnaire item (see example *a* in Fig. 4). The partial utility values are derived by the value function $u(x_{ijkl}) = x_{ijkl} / 5$, according to the maximum scale value 5 (see example *b* in Fig. 4). Finally, the partial utility values are weighted and summed up to an overall utility score. In the case at hand we have a three level criterion structure: (1) impact sub-category, (2) questionnaire item, and (3) quartile based outcome value (see example *b* in Fig. 4).

The corresponding utility score function is

$$U^{\text{SAW}}(a_i) = \sum_{j=1}^{4} w_j \cdot \left[\sum_{k=1}^{2} w_{jk} \cdot \left[\sum_{l=1}^{3} w_{jkl} \cdot \ u(x_{ijkl}) \right] \right] \tag{2}$$

with $\sum_j w_j = 1$, $\sum_k w_{jk} = 1$, $\sum_l w_{jkl} = 1$ and $w_j, w_{jk}, w_{jkl} \geq 0$.

6.3. Interpretation and Discussion of Results

In this paper the evaluation is carried out exemplarily from the perspective of portal provider 3. Thus, all weights are set according to the preferences of provider 3. The resulting decision matrix is shown in Table 5. For a better overview it is shown in an aggregated form (according to the two inner parts of equation 2). The aggregation consists of, firstly, summing up the partial utility values of the quartiles over each questionnaire item and, secondly, summing up those values over each impact sub-category (see example c in Fig. 4).

Example *a* (criteria and outcome values)

	KNOW					
	KNOW1			KNOW2		
	Q1	Q2	Q3	Q1	Q2	Q3
Portal 1	3	4	5	3	3	4

Example *c* (weight, criterion, and aggregated partial utility value)

w_j c_j	.242 KNOW
Portal 1	.7500

Example *b* (weights, criteria, and partial utility values)

w_j c_j	.242 KNOW					
w_{jk} c_{jk}	.625 KNOW1			.375 KNOW2		
w_{jkl} c_{jkl}	.33 Q1	.33 Q2	.33 Q3	.33 Q1	.33 Q2	.33 Q3
Portal 1	.6	.8	1	.6	.6	.8

Figure 4. From outcome to utility values; examples.

According to the derived utility scores the following ranking is obtained: 1st portal 2, 2nd portal 1, 3rd portal 3, and 4th portal 4. Since all values are based on ordinal scale, the sizes of differences between the utility values are meaningless, as explained in Section 5. However, differences can serve at least as hints to levels. As can be seen from Table 5, there are only slight differences in the partial utility values as well as the overall utility scores between the portals. This indicates an almost equal level of performance.

w_j c_j	.242 KNOW	.273 TRST	.242 RISK	.242 LOYA	U^{SAW}
Portal 2	.8167	.8593	.9333	.8333	.86
Portal 1	.7500	.8222	.9000	.8333	.83
Portal 3	**.6833**	**.8963**	**.9000**	**.7667**	**.81**
Portal 4	.6833	.8222	.9000	.8000	.80

Table 5. Portal success decision matrix.

According to the weights all impact categories are almost equally important to provider 3, with the category TRST being most critical. Two slightly "weak" points can be identified: the

KNOW and the LOYA values are a little lower, compared to the other portals. As indicated by the path model (Fig. 3), LOYA is influenced by KNOW and TRST. The lower LOYA value thus could be explained, among others, by the lower KNOW value. Comparison of the outcome values for the KNOW category shows that the ratings for item KNOW2 are partially lower for portal 3 than for the portals 1 and 2 (Table 6). Comparison of the outcome values of the INFQ, PREQ, and TECQ categories, which are according to the path model (Figure 2) influencing factors on KNOW, shows no significant differences between the portals 1, 2, and 3. Thus, the only difference remains with the lower rated KNOW2 item for portal 3.

A manual inspection of pages on portal 3 shows that many pages do not contain much detailed information content. This could be an explanation for the fact that the users do not feel as if the information provided, helped them much with making better decisions (item KNOW2). In that case, providing a higher amount of information details could probably lead to an improvement.

	KNOW2		
	Q1	Q2	Q3
Portal 2	3	4	4
Portal 1	3	3	4
Portal 3	2	3	4
Portal 4	2	3	4

Table 6. KNOW2 outcome value matrix.

Concerning the questionnaire, a more differentiated result could possibly be derived if instead of a 5-point scale a 7- or 10-point scale is used for the questionnaire items.

Overall the results indicate an almost equal success level of the portals. The performance of portal 3 compared to the other portals can be considered as satisfactorily. No critical flaws were identified.

7. Conclusions

A MCDA model for success evaluation of information providing portals based on measuring user perceived impact is proposed. The objective is to estimate the performance, identify weak points, and derive possible approaches for improvement. The model allows a systematic, comparative analysis of the considered portals on basis of the defined criteria and the decision maker's preferences. Furthermore, it is very flexible. Criteria can be added or excluded according to the evaluation task at hand.

The development of knowledge, trust, perceived risk and loyalty through usage of a portal are proposed as impact measurement criteria. Their appropriateness was confirmed in the validation phase of the questionnaire.

The proposed MCDA model was applied in a case study of four e-government portals. The results indicate that this approach can be a useful tool to evaluate and improve the success of a Web portal compared to other similar portals. This is in particular suitable for areas where no common “market figures” or other success benchmarks exist.

A limitation of this study is the relatively small numbers of survey participants per portal, i.e., the relatively small sample sizes. Thus, the results may not completely reflect the opinions of all users of the portals.

A prerequisite for this approach is the existence of other similar portals which can serve as benchmarks. This is a limiting factor of the method, because (1) there simply may not exist similar portals or (2) other providers are not willing (e.g., due to competition) or able (e.g., due to capacity) to cooperate.

In a future work an extended MCDA model will be used. It additionally consists of a usage analysis component and a cost analysis component. The goal is to improve the evaluation by enhancing the diagnostics of the model.

Appendix A: Factor Loadings

The factor loadings of the measurement variables (i.e., items) on the latent variables (i.e., constructs) for the respecified path model are shown (Tables 7-10).

	INFQ	LOYA	PREQ	RISK	TECQ	TRST	KNOW
INFQ1	**0,877861**	0,679123	0,688288	0,311178	0,675050	0,649749	0,650169
INFQ2	**0,891532**	0,684861	0,686630	0,262565	0,666161	0,599228	0,592088
INFQ3	**0,883534**	0,599303	0,567827	0,219103	0,633056	0,479023	0,572923
INFQ4	**0,858084**	0,617916	0,483614	0,235467	0,682506	0,563844	0,584963
LOYA1	0,684068	**0,968411**	0,457976	0,396823	0,616147	0,744422	0,764642
LOYA2	0,745836	**0,970202**	0,491728	0,502294	0,686342	0,790911	0,729584
RISK1	0,271985	0,445722	0,126754	**0,974119**	0,306204	0,446022	0,231877
RISK2	0,304630	0,460274	0,137311	**0,976853**	0,359993	0,467835	0,269686
SYSQ1	0,629800	0,438616	**0,947344**	0,063337	0,643182	0,416972	0,569372
SYSQ2	0,664993	0,467409	**0,905290**	0,143858	0,617301	0,488009	0,559446
SYSQ3	0,584807	0,417785	**0,851604**	0,161652	0,534860	0,366798	0,509540
SYSQ4	0,709207	0,570250	0,593729	0,262312	**0,815450**	0,439767	0,569577
SYSQ5	0,565218	0,601954	0,521074	0,330916	**0,865610**	0,643308	0,640776
SYSQ6	0,678113	0,542401	0,593075	0,273413	**0,867950**	0,523998	0,645406
TRST1	0,717091	0,776774	0,462555	0,394460	0,647968	**0,917163**	0,718506
TRST2	0,420700	0,616932	0,369729	0,448334	0,468189	**0,859697**	0,554786
KNOW1	0,678382	0,754114	0,626391	0,220542	0,699568	0,705395	**0,934081**
KNOW2	0,585309	0,665950	0,486787	0,258380	0,647125	0,631515	**0,914814**

Table 7. Factor loadings of measurement variables for portal P1.

	INFQ	LOYA	PREQ	RISK	TECQ	TRST	KNOW
INFQ1	**0,867156**	0,539906	0,510259	-0,028516	0,496851	0,497405	0,565556
INFQ2	**0,801112**	0,437615	0,645433	-0,049087	0,562938	0,483570	0,409689
INFQ3	**0,792619**	0,257847	0,453929	-0,243734	0,361741	0,355655	0,387579
INFQ4	**0,858752**	0,500165	0,466780	-0,081485	0,312487	0,482541	0,693385
LOYA1	0,312273	**0,828533**	0,318881	0,198552	0,094871	0,478560	0,465815
LOYA2	0,587241	**0,918344**	0,555798	0,118142	0,448407	0,713219	0,590021
RISK1	-0,132347	0,143567	0,087277	**0,966453**	0,058771	0,342040	0,028287
RISK2	-0,076230	0,190052	0,212110	**0,955939**	0,083701	0,271629	0,085941
SYSQ1	0,620228	0,490560	**0,909466**	0,172791	0,506434	0,566578	0,477771
SYSQ2	0,521431	0,469524	**0,919503**	0,125145	0,539758	0,541575	0,489309
SYSQ3	0,521647	0,437428	**0,864413**	0,106693	0,673738	0,527119	0,412991
SYSQ4	0,449618	0,321636	0,524924	0,044715	**0,853836**	0,470359	0,311694
SYSQ5	0,449287	0,323340	0,595076	0,097807	**0,833682**	0,466778	0,206656
SYSQ6	0,389463	0,212134	0,472634	0,042758	**0,823463**	0,448415	0,240483
TRST1	0,593182	0,714761	0,573213	0,231599	0,550204	**0,906501**	0,616553
TRST2	0,248228	0,371958	0,401045	0,330278	0,316398	**0,721910**	0,251544
KNOW1	0,589028	0,511443	0,472012	0,033369	0,261607	0,460686	**0,924029**
KNOW2	0,600865	0,621562	0,483565	0,071720	0,302817	0,597431	**0,937400**

Table 8. Factor loadings of measurement variables for portal P2.

The factor loadings matrix for portal P3 shows two cases of considerable cross loading (fields with grayed background). This result is probably caused by the very small sample size (N = 32, see Section 6.1) for P3.

	INFQ	LOYA	PREQ	RISK	TECQ	TRST	KNOW
INFQ1	**0,905657**	0,542255	0,415319	-0,294899	0,404218	0,579408	0,612045
INFQ2	**0,811986**	0,406857	0,544274	-0,093057	0,601325	0,616327	0,594292
INFQ3	**0,766838**	0,249387	0,331258	-0,239639	0,303677	0,424137	0,603614
INFQ4	**0,854576**	0,421569	0,585324	-0,202509	0,476793	0,436091	0,511354
LOYA1	0,322083	**0,909633**	0,458925	-0,171150	0,531177	0,629451	0,506675
LOYA2	0,564440	**0,932390**	0,576386	-0,430082	0,597768	0,718422	0,449292
RISK1	-0,237602	-0,331113	-0,217163	**0,983979**	-0,183924	-0,292545	-0,103996
RISK2	-0,252001	-0,330555	-0,185247	**0,985901**	-0,115039	-0,295874	-0,080874
SYSQ1	0,532658	0,550127	**0,922457**	-0,289742	0,746319	0,573421	0,528921
SYSQ2	0,546148	0,585713	**0,911177**	-0,144055	0,817333	0,596083	0,589631
SYSQ3	0,420291	0,376372	**0,877680**	-0,107870	0,657171	0,418699	0,539730
SYSQ4	0,534945	0,663196	0,734580	-0,076441	**0,932007**	0,687069	0,647992
SYSQ5	0,458065	0,538055	0,809132	-0,062474	**0,894715**	0,616164	0,527998
SYSQ6	0,390422	0,363256	0,598132	-0,295553	**0,774902**	0,433375	0,453491
TRST1	0,512941	0,647909	0,582273	-0,344982	0,580250	**0,848818**	0,495725
TRST2	0,455143	0,479270	0,306243	-0,084605	0,465399	**0,697721**	0,210670
KNOW1	0,737922	0,591437	0,638030	-0,067175	0,691912	0,558710	**0,958524**
KNOW2	0,410365	0,208703	0,379635	-0,121995	0,324539	0,168126	**0,798680**

Table 9. Factor loadings of measurement variables for portal P3.

	INFQ	LOYA	PREQ	RISK	TECQ	TRST	KNOW
INFQ1	**0,869909**	0,481344	0,673233	0,376015	0,573955	0,703071	0,681230
INFQ2	**0,851558**	0,462189	0,613852	0,365800	0,646210	0,542277	0,620094
INFQ3	**0,795155**	0,354181	0,433723	0,030564	0,280958	0,395591	0,612188
INFQ4	**0,871210**	0,477510	0,684788	0,312382	0,546101	0,586002	0,741059
LOYA1	0,519638	**0,932810**	0,454530	0,165196	0,438631	0,460683	0,545101
LOYA2	0,478223	**0,945547**	0,535589	0,302102	0,469837	0,532990	0,592153
RISK1	0,302530	0,181229	0,270471	**0,904983**	0,346220	0,439608	0,204754
RISK2	0,325572	0,274890	0,410128	**0,943576**	0,432208	0,545238	0,330267
SYSQ1	0,667923	0,559685	**0,903507**	0,335616	0,560151	0,621983	0,726078
SYSQ2	0,638247	0,428169	**0,877396**	0,309387	0,640459	0,613344	0,621703
SYSQ3	0,597057	0,397911	**0,852184**	0,347046	0,612917	0,612458	0,605516
SYSQ4	0,428163	0,262994	0,471569	0,297552	**0,771365**	0,456718	0,381219
SYSQ5	0,580895	0,436589	0,549695	0,410795	**0,883996**	0,511456	0,476975
SYSQ6	0,496041	0,461241	0,642392	0,325990	**0,786327**	0,551812	0,528919
TRST1	0,718548	0,492103	0,761665	0,451848	0,625239	**0,899643**	0,777998
TRST2	0,352068	0,387787	0,349786	0,462573	0,389754	**0,770689**	0,319897
KNOW1	0,779581	0,599066	0,697136	0,319442	0,538663	0,731206	**0,952070**
KNOW2	0,710505	0,550769	0,715080	0,242250	0,549981	0,590403	**0,945898**

Table 10. Factor loadings of measurement variables for portal P4.

Appendix B: Correlation matrices

The correlation matrices for the path model's constructs are shown. $\sqrt{\text{AVE}}$ values of the constructs are presented in the diagonal in boldface. Insignificant correlations ($p \le .05$, $df = N - 2$, two-tailed test) have a grayed background (Tables 11-14).

$\sqrt{\text{AVE}}$ and Correlation	INFQ	LOYA	PREQ	RISK	TECQ	TRST	KNOW
INFQ	**0,88**						
LOYA	0,738039	**0,97**					
PREQ	0,696207	0,490132	**0,90**				
RISK	0,296002	0,464569	0,135494	**0,97**			
TECQ	0,757842	0,672378	0,665281	0,342216	**0,85**		
TRST	0,658308	0,792309	0,472964	0,468701	0,638109	**0,89**	
KNOW	0,686141	0,770500	0,606334	0,257607	0,729654	0,725079	**0,92**

Table 11. $\sqrt{\text{AVE}}$ values and correlation matrix of constructs for portal P1.

$\sqrt{\text{AVE}}$ and Correlation	INFQ	LOYA	PREQ	RISK	TECQ	TRST	KNOW
INFQ	**0,83**						
LOYA	0,537219	**0,87**					
PREQ	0,618552	0,519418	**0,90**				
RISK	-0,110406	0,171868	0,151349	**0,96**			
TECQ	0,513654	0,342734	0,633904	0,073220	**0,84**		
TRST	0,552825	0,699133	0,607221	0,321548	0,551797	**0,82**	
KNOW	0,639319	0,611229	0,513474	0,057398	0,304151	0,571678	**0,93**

Table 12. $\sqrt{\text{AVE}}$ values and correlation matrix of constructs for portal P2.

$\sqrt{\text{AVE}}$ and Correlation	INFQ	LOYA	PREQ	RISK	TECQ	TRST	KNOW
INFQ	**0,84**						
LOYA	0,489995	**0,92**					
PREQ	0,557620	0,565994	**0,91**				
RISK	-0,248768	-0,335873	-0,203762	**0,98**			
TECQ	0,535723	0,614867	0,823918	-0,150654	**0,87**		
TRST	0,622435	0,734460	0,592695	-0,298753	0,677341	**0,77**	
KNOW	0,697397	0,516370	0,611785	-0,093474	0,632571	0,477511	**0,88**

Table 13. $\sqrt{\text{AVE}}$ values and correlation matrix of constructs for portal P3.

$\sqrt{\text{AVE}}$ and Correlation	INFQ	LOYA	PREQ	RISK	TECQ	TRST	KNOW
INFQ	**0,85**						
LOYA	0,529937	**0,94**					
PREQ	0,723308	0,529132	**0,88**				
RISK	0,340447	0,252401	0,376614	**0,92**			
TECQ	0,620179	0,484328	0,686641	0,425789	**0,82**		
TRST	0,672249	0,530787	0,701353	0,538484	0,624981	**0,84**	
KNOW	0,786093	0,606516	0,743717	0,297114	0,573353	0,698449	**0,95**

Table 14. $\sqrt{\text{AVE}}$ values and correlation matrix of constructs for portal P4.

Appendix C: T-Values for Model Paths

The t-values indicating the significance of the dependencies between the constructs for the respecified path model are shown. The values are obtained by bootstrapping with parameters (1) cases = N_{Portal} and (2) samples = N_{Portal} * 10 (two-tailed t-test, df = N_{Portal} * 10 – 1). Significant values are shown in boldface (Table 15).

t-value	P1	P2	P3	P4
INFQ → KNOW	1.60	**4.26****	**3.11****	**4.50****
INFQ → TRST	**2.90****	1.60	**2.61****	**2.31***
INFQ → RISK	.01	**2.82****	.45	.53
PREQ → KNOW	1.03	1.65	.47	**2.93****
PREQ → TRST	.46	**2.22***	.10	**2.45***
PREQ → RISK	1.33	1.12	.76	.28
TECQ → KNOW	**3.54****	1.19	1.19	.03
TECQ → TRST	**2.34***	**2.27***	**2.24***	1.75
TECQ → RISK	1.05	.60	.86	1.23
KNOW → LOYA	**4.39****	**2.73****	1.67	**3.44****
TRST → LOYA	**3.68****	**4.95****	**5.39****	1.24
TRST → RISK	**2.03***	**2.65****	1.15	**3.02****
RISK → LOYA	**2.24***	.13	1.29	.03

Table 15. T-values for model paths for each portal ($^{*}p \le .05$, $^{**}p \le .01$).

Acknowledgement

We thank an anonymous reviewer for valuable hints to improve our conclusions.

References

[1] Aladwani, A.M; Palvia, P.C. Developing and validating an instrument for measuring user-perceived web quality. *Information & Management*, 39:467-476, 2002.

[2] Bart, Y; Shankar, V; Sultan, F; Urban, G.L. Are the drivers and role of online trust the same for all web sites and consumers? A large-scale exploratory empirical study. *Journal of Marketing*, 69:133-152, 2005.

[3] Cameron, K.S. Critical questions in assessing organizational effectiveness. *Organizational Dynamics*, 9(2):66-80, 1980.

[4] D'Ambra, J; Rice, R.E. Emerging factors in user evaluation of the world wide web. *Information & Management*, 38:373-383, 2001.

[5] Delić, D. Ein Multiattributives Entscheidungsmodell zur Erfolgsbewertung Nicht-Kommerzieller Webportale. PhD thesis, Freie Universität Berlin, Berlin, Germany, forthcoming.

[6] DeLone, W.H; McLean, E.R. Information system success: The quest for the dependent variable. *Information Systems Research*, 3(1):60-95, 1992.

[7] DeLone, W.H; McLean, E.R. The DeLone and McLean model of information system success: A ten-year update. *Journal of Management Information Systems*, 19(4):9-30, 2003.

[8] Elmuti, D; Kathawala, Y; Lloyed, S. The benchmarking process: Assessing its value and limitations. *Industrial Management*, 39(4):12-19, 1997.

[9] Figueira, J; Greco, S; Ehrgott, M, editors. *Multiple Criteria Decision Analysis: State of the Art Surveys*. Springer, Boston, 2005.

[10] Gefen, D. Customer Loyalty in e-commerce. *Journal of the Association for Information Systems*, 3:27-51, 2002.

[11] Gefen, D.; Straub, D. A Practical Guide to Factorial Validity using PLS-Graph: Tutorial and Annotated Example. *Communications of the Association for Information Systems*, 16:91-109, 2005.

[12] Gefen, D; Straub, D.W; Boudreau, M.-C. Structural equation modeling and regression: Guidelines for research practice. *Communications of the Association for Information Systems*, 4(7):1-77, 2000.

[13] Grigoroudis, E; Litos, C; Moustakis, V.A; Politis, Y; Tsironis, L. The assessment of user-perceived web quality: Application of a satisfaction benchmarking approach. *European Journal of Operational Research*, 187(3):1346-1357, 2008.

[14] Lenz, H.-J; Ablovatski, A. MCDA -multi-criteria decision making in e-commerce. In Riccia, G.D; Dubois, D; Kruse, R; Lenz, H.-J, editors. *Decision Theory and Multi-Agent Planning*, Springer, Vienna, 2006.

[15] Liu, C; Arnett, K.P. Exploring the factors associated with web site success in the context of electronic commerce. *Information & Management*, 38:22-33, 2000.

[16] McKnight, D.H; Choudhury, V; Kacmar, C. Developing and validating trust measures for e-commerce: An integrative typology. *Information Systems Research*, 13(3):334-359, 2002.

[17] Negash, S; Ryan, T; Igbaria, M. Quality and effectiveness in web-based customer support systems. *Information & Management*, 40:757-768, 2003.

[18] Reicheld, F; Schefter, P. E-Loyalty: Your secret weapon on the web. *Harvard Business Review*, July-August, 2000.

[19] Ringle, C.M; Wende, S; Alexander, W. SmartPLS 2.0 M3. http://www.smartpls.de, downloaded: June, 1st 2008, University of Hamburg, Hamburg, Germany, 2006.

[20] Sampson, D; Manouselis, N. A flexible evaluation framework for web portals based on multi-criteria analysis. In Tatnall, A, editor. *Web Portals: The New Gateways to Internet Services*, Idea Group Publishing, London, 185-210, 2005.

[21] Tatnall, A. Portals, portals everywhere. In Tatnall, A, editor. *Web Portals: The New Gateways to Internet Services*, Idea Group Publishing, London, 1-14, 2005.

[22] Tenenhaus, M; Vinzi, V.E; Chatelin, Y.-M; Lauro, C. PLS path modelling. *Computational Statistics & Data Analysis*, 48:159-205, 2005.

[23] Yuthas, K; Young, S.T. Material matters: Assessing the effectiveness of materials management IS. *Information & Management*, 33:115-124, 1998.

[24] Zviran, M; Erlich, Z. Measuring IS user satisfaction: Review and Implications. *Communications of the Association for Information Systems*, 12, 2003.