ADAPTATION OF DELONE AND MCLEAN MODEL FOR ERP SYSTEM QUALITY EVALUATION

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Abstract

This paper aims to determine whether the DeLone and McLean information system success model (D&M model) can be used to evaluate the quality of Enterprise Resource Planning system (ERP system). The study examines the dimensions of the D&M model, adapted for empirical evaluation of ERP system quality by end-users of ERP systems in enterprises. The quality of ERP systems is measured by comparing answers to questions that serve to determine the degree of quality of each dimension of ERP system quality. The research was conducted on 335 medium and large companies in Bosnia and Herzegovina, for which it has been confirmed in the pilot research to have an ERP system that they have used for more than two years. A survey questionnaire is used to investigate the quality of the ERP system from the perspective of the middle and top management of the companies that use information from the ERP system for decision making. The empirical research has confirmed that the D&M model of information system success, with some adjustments, can be used to investigate the quality of ERP systems. The main limitation of the research is the lack of a database of companies using ERP systems that makes the data collection phase more difficult and more complex. Regardless of this, the proposed model can be used to evaluate the quality of ERP systems, but also some other types of information systems in future research, such as BI and CRM systems.

Keywords: ERP system, DeLone and McLean model, ERP system quality, ERP system dimensions

JEL: M15, M20

1. Introduction

In today's global economy, organizations face many challenges, particularly with increasing competition and higher customer expectations. Rapid changes in social, economic and political forces, in combination with the daily progress of technology, make business markets more competitive, which consequently has a strong impact on the way businesses operate. These changes in business have led to the creation of huge amounts of information in the business world, be it generated within the company or external. Some authors believe that the success of a company increasingly depends on timely information (internal and external) that is available to the right person at the right time for management decisions (Chen *et al*., 2006). Companies implement Enterprise Resource Planning system (ERP system) to improve the speed of decision-making and business costs control and to improve the distribution of information throughout the organization (Dezdar, 2012). ERP system is an information system that includes integrated software solutions and can be used to manage and integrate all business functions within the organization (Ross *et al*., 2006). The most important attributes of ERP system are: its ability to automate and integrate business processes, enabling the implementation of the best business practices, sharing common data and practices across the enterprise, and creating and accessing real-time information (Soh *et al*., 2000; Nah and Lau, 2001).

2. DeLone and McLean information system success model

DeLone and McLean (2003) argue that information system (IS) success measures should focus on the specific benefits arising from the IS project, and in the 1992 DeLone and McLean information system success model (D&M model) they provide the basis for measuring information systems performance from an end-user perspective (Figure 1).

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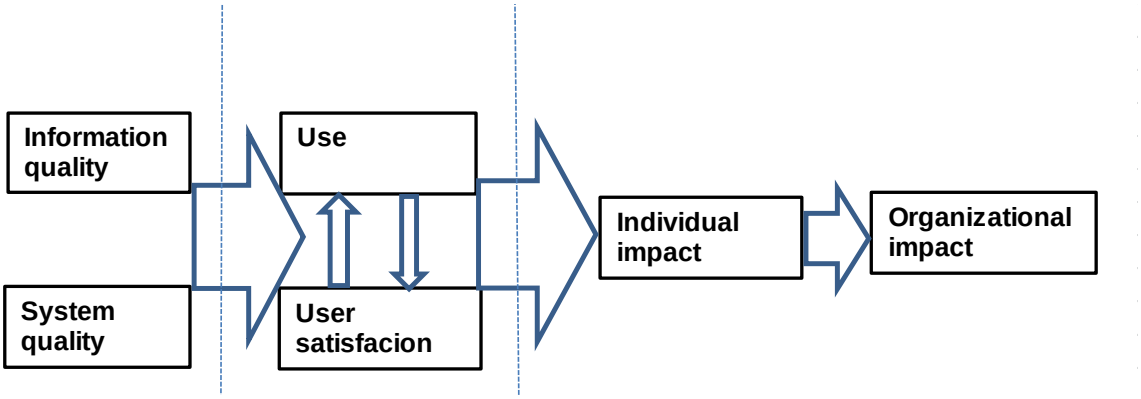

Figure 1. *DeLone and McLean information system success model from 1992*

Source: DeLone and McLean, 1992

The primary conclusions of the original paper were (DeLone and McLean, 1992):
1. The multidimensional and interdependent nature of information system success requires great care when defining and measuring each aspect of a dependent variable. It is important to measure possible interactions between dimensions of success to isolate the effect of different independent variables with one or more dependent dimensions of success.
2. The choice of dimensions of success and associated measures should depend on the objectives and context of the empirical research, but where possible, tested and proven measures should be used.
3. Despite the multidimensional and dependent nature of IS success, attempts should be made to significantly reduce many different measures used to measure IS success so that research results can be compared and findings confirmed.
4. More field research should also be conducted to explore and include measures of organizational impact.
5. This model needs further development and validation before it can serve as a basis for selecting appropriate IS measures.

After the D&M model was created, other researchers expanded, adapted, and empirically studied it. For example, Shang and Seddon (2000) concluded that the meaning of use as a dimension of an IS is ambiguous and should be defined differently in the D&M model.

Other researchers demonstrated through empirical research that service quality is also an important dimension of IS evaluation (Jiang and Klein, 1999). Taking into consideration new research and changes in the role of information systems in enterprises, DeLone and McLean in 2003 provided a new D&M model, shown in Figure 2. IS success dimensions in D&M model are (Petter *et al.*, 2008):

- System quality - measures desirable characteristics of the IS such as ease of use, adaptability, availability, reliability, response time.
- Information quality - means the desirable characteristics of the results obtained from the system such as managerial reports or websites, for example completeness, ease of understanding, personalization, relevance, security and accuracy.
- Service quality - refers to the support of internal or external IT staff towards the end-users of the system, and is reflected in the reliability of the service, speed of response, knowledge, empathy towards the end-user.
- Use or intention to use - is the level and manner in which employees and customers use the capabilities of the IS, for example frequency of use, schedule of use, number of accesses,

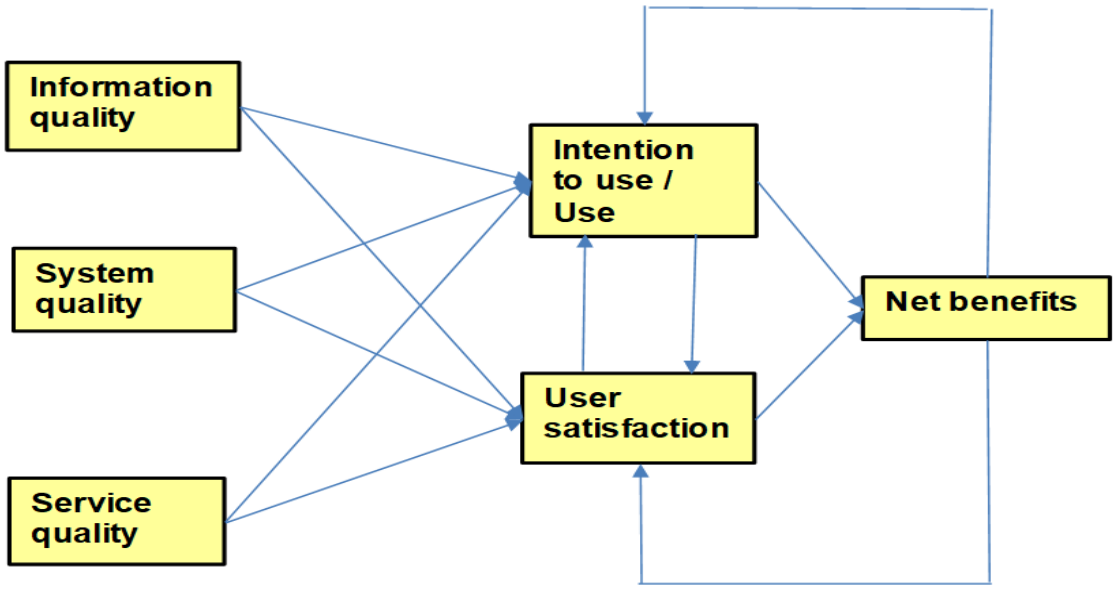

Figure 2. *DeLone and McLean information system success model*
Source: DeLone and McLean, 2003

- User satisfaction - means the level of customer satisfaction with reports, Internet sites, and support services.
- Net benefits - refers to the benefits of an IS for a company such as cost reduction, entering new markets, additional sales, and saving time in business processes.

The conclusions of the updated D&M model are (DeLone and McLean, 2003):

1. Many empirical studies confirmed the original model and its interrelationships, while other studies recommended improvements to the original model. Based on these contributions, an updated D&M model of information system performance was created, which serves as the basis for positioning and comparing empirical research of ISs. The model should continue to be tested and re-examined. The changes introduced in the D&M model are an example of continuous growth and refinement.
2. The updated D&M model is a useful model for developing comprehensive measures of e-commerce success.
3. It is recommended to add service quality as an important dimension of IS success given the importance of IS support, especially in an e-commerce environment where customer service is crucial.
4. The complex, multidimensional, and interdependent nature of IS success requires important to measure possible interactions between these dimensions of success to isolate the effect of different independent variables with one or more of these dependent dimensions of success. The updated D&M model in Figure 2 shows the interdependent relationships that still need to be considered and tested.
5. For each research undertaking, the selection of dimensions and measures of IS performance should be in line with the objectives and context of the empirical research, but where possible, tested and proven measures should be used.
6. Despite the multidimensional nature of IS success, attempts should be made to significantly reduce the number of measures used to evaluate IS success so that research results can be compared and findings confirmed. Where possible, it is better to apply the existing validated measures rather than developing the new ones.
7. With the development of management support systems and e-commerce systems, the voluntary use of the IS is more common today than before. Therefore, it is still necessary to include the use of the system as a critical dimension of measuring IS success. Actual use measures should be preferred to reported use measures. Also, use measures should include the richness of use as a system phenomenon, including the nature, level and suitability of

use, and should not exclusively measure, for example, the frequency of use.
8. More field research should explore and include net benefit measures. Yuthas and Young (1998, p. 120) support this conclusion, "Examination of satisfaction and use measures is not an acceptable alternative to direct performance measurement (i.e., net benefit). Although the three variables are correlated, the links between them are not strong enough to justify their use as a substitute for each other." Good progress has been made in developing and testing net benefit measures at the individual, group, organizational, industrial and national levels.

The practical application of the D&M model depends on the organizational context. A researcher who wants to apply the D&M model must have such knowledge to understand the IS and the organization they are researching. This will determine the types of measures to be used for each dimension of success. The choice of success dimensions and specific measures depends on the nature and purpose of the system being evaluated, so that, for example, an e-commerce application would have some similarities but also some different success measures compared to ERP systems. Both systems would measure the accuracy of the information, while only an e-commerce system would measure the personalization of information. The vendor-managed IS will measure the quality of the vendor's service, not the IS department's (Petter *et al*., 2008).

The D&M model has motivated many other researchers to measure IS performance from the other perspectives such as operational efficiency of the IS function, IS response, timeliness of information and accuracy of information (Cha-Jan Chang and King, 2005; Sharma and Bhagwat, 2006).

Impact of the ERP system was studied by McAfee (2002) based on a survey of 101 SAP R3 package implementers who reported performance improvements in some areas such as time cycles, time completion rates, and information quality. Wieder *et al*. conducted field research to determine the impacts of several aspects of ERP system implementation using IS measures, measuring business process performance, and measuring enterprise performance (Wieder *et al*., 2006).

All these studies have significantly contributed to the further development of IS performance measures because researchers have advocated for the importance of performance measurement to improve business activities and thus identified a number of ways to measure IS function. However, most of them have developed and tested general research instruments that measure IS performance, without focusing on the specific system being assessed and its purpose. It can be said that DeLone and McLean are right when they say that each IS project is different and that appropriate measures are applied for different systems (DeLone and McLean, 2003).

According to the research conducted by Petter, the D&M model has been cited in more than 300 scientific papers aimed at explaining the performance of an IS (Petter *et al*., 2008). Considerable research has focused on IS success over the years largely using the D&M models, so Jeyaraj's (2020) review presents 53 studies published between 1992 and 2019 using D&M models in the research of success of different ISs. The advantage of the DeLone and McLean models compared to the others is that they provide a scheme for categorizing a multitude of IS measures used in the research literature, and in addition propose a model of interdependence between categories (Stefanović *et al*., 2011). DeLone and McLean make it clear that their models neither create research, nor develop measures, nor interpret results. The model helps researchers to frame the data to make it easier to understand and explain (DeLone and McLean, 2003).

3. ERP system quality

There is a difference in understanding the concept of quality by different people. In the manufactured product, the customer, as a user, recognizes the quality of appearance, function, and performance. The quality of the service can be evaluated based on the degree of satisfaction of the user who receives the service. In general, quality can be defined as the level of excellence at which a company chooses to satisfy its target customers and, at the same

time, the extent to which it manages to reach this level (Leite *et al*., 2009).

Customer needs must be translated into measurable product or service characteristics, and once specifications are developed, ways to measure and monitor characteristics need to be found (Chandrupatla, 2009). This provides a basis for continuous improvement of a product or service. Quality can be seen as consistent compliance with customer expectations. This concept accepts user's definition of quality, respectively user perception. Perceived quality is the judgment of users about the overall excellence or superiority of a product or service (Leite *et al*., 2009).

When it comes to the quality of ERP systems, it is difficult to determine the specifications by which quality would be monitored because the expectations of users are different. Since these are complex ISs that cover the entire company and consist of many dimensions, it is not possible to determine a unified system of characteristics which an ERP system should satisfy to be considered high quality. Therefore, various models for the evaluation of ISs and ERP systems have been developed in scientific papers, and one of them is the D&M model.

In this paper, the following dimensions and appropriate measures for measuring the quality of the ERP system will be used:

- System performance quality - to clarify this dimension, instead of "system quality" the term "system performance quality" will be used, and the measures for its evaluation are adaptability, availability, reliability, and response time.
- Quality of information - means completeness, ease of understanding, and relevance of information.
- Quality of service - refers to the support of internal or external IT staff to the end-users of the system, and in this research it is measured through the reliability of the service, response speed, and level of knowledge.
- Use of the system - at the operational level, the use of the ERP system is mandatory to perform operational tasks, so it is necessary to assess the quality of use. DeLone and McLean (2003) suggest that researchers must consider the nature and appropriateness of system usage because, at higher hierarchical levels of the organization, the continuous adoption and use of the system is completely voluntary. Therefore, the research is focused on middle and top management in companies, and the use of systems in this research is considered one of the dimensions of the quality of ERP systems. The measures for evaluating the use of ERP systems in this paper are the use of reports in everyday tasks and the use of reports for decision-making.
- Customer satisfaction - based on IS papers (DeLone and McLean, 2003; Petter *et al*., 2008; Petter and McLean, 2009; Eldrandaly *et al*., 2015; Urbach and Müller, 2011; Jaafreh, 2017), this research will accept general satisfaction with the system as a unique measure of customer satisfaction and as the most frequently used parameter of customer satisfaction in IS studies. Taking into account the above definition of perceived quality, the dimension of "customer satisfaction" will also be considered as one of the dimensions of ERP system quality.

4. Research hypothesis and model

This study aims to determine whether the D&M model can be used to evaluate the quality of an ERP system. The study examined the dimensions of the D&M model, adapted for empirical evaluation of ERP system quality by end-users of ERP systems in enterprises, as it is shown in Figure 3.

In this paper, the quality of ERP systems is measured by comparing the answers to the questions that serve to determine the degree of quality of each dimension of ERP system quality.

Based on the above, the research hypothesis can be postulated as follows:

H: The D&M model can be used to evaluate the quality of ERP systems.

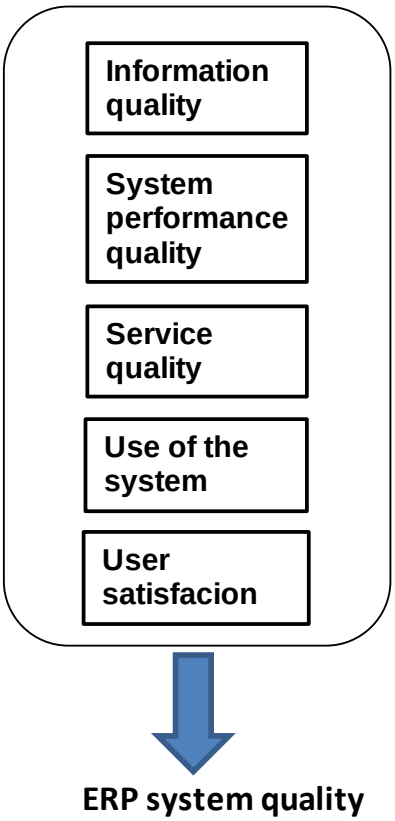

Figure 3. *ERP system quality research model*
Source: Authors' work

5. Research methodology

The empirical research was conducted on medium and large enterprises in Bosnia and Herzegovina (BiH) because they have two or more business processes that need to be supported and harmonized using an appropriate ERP system. According to the Law on Accounting and Auditing of the Federation of BiH (2010), medium-sized companies are those that meet at least two of the following conditions on the date of preparation of financial statements:

- the average number of employees during the year is between 50 and 250
- the average value of business assets at the end of the business year is between BAM 1,000,000 and 4,000,000
- the total annual income is between BAM 2,000,000 and 8,000.000.

Companies are also classified as medium-sizes companies if one of three specified conditions exceeds its upper limit. Large companies are those in which at least two of three specified conditions exceed their upper limit. (FBiH Law on Accounting and Auditing, 2010).

The data from a database owned by the renowned international company Bisnode were used as the basic set for the empirical research. For companies inBiH, Bisnode obtains the official data from two basic sources: the FIA (Financial Information Agency) and the CBBH (Central Bank of Bosnia and Herzegovina), so it has the official data for all active legal entities in BiH (www.boniteti.com). According to Bisnode, there are currently 3,089 medium-sized and 1,648 large companies in BiH, which is the basic set of 4,737 companies for research purposes. The research was conducted on 335 medium and large companies inBiH, for which it has been confirmed in the pilot research to have an ERP system that they have used for more than two years. The total number of 87 survey questionnaires was collected or 26% of the statistical set, while 8 questionnaires were filled in incorrectly. Finally, 79 companies represented the sample for further analysis. A survey questionnaire was used to investigate the quality of the ERP system. The research aimed to examine the quality of ERP system use and not the operational use that is mandatory, so the survey questionnaire was aimed at middle and top management of the companies that use information from the ERP system for decision-making.

6. Results of empirical research

The survey questionnaire was used to examine the attitudes of the respondents about the quality of the ERP system, and Table 1 shows how many questions were related to each dimension of the quality of the ERP system.

The Likert scale with five degrees of intensity was used to evaluate the statements (1 - I do not agree at all, 2 - I do not agree, 3 - I neither agree nor disagree, 4 - I agree, 5 - I completely agree). Tables from 2 to 6 list the values obtained in the survey for individual claims in the survey questionnaire.

Table 1. *Question structure in the questionnaire*

Dimensions of ERP system quality	Questions in the questionnaire from-to	Number of questions
Information quality	1 – 9	9
System performance quality	10 – 17	8
Service quality	18 – 26	9
Use of the system	27 – 32	6
User satisfaction	33 – 39	7
Total questions		**39**

Source: Authors' work

Table 2. *Values per claim for the "information quality" dimension*

Statement from the questionnaire	Average value	Standard deviation	Minimum value	Maximum value	Mod
Information from the ERP system are updated daily.	4.17	0.73	2	5	4
ERP reports contain all the necessary information.	3.94	0.75	2	5	4
ERP reports are easily accessible from menus /dashboards.	3.98	0.77	2	5	4
ERP reports are clear and concise.	3.91	0.84	2	5	4
ERP reports are tailored to the needs of the organization.	3.77	0.92	1	5	4
ERP provides control reports to verify the data.	3.91	0.78	2	5	4
ERP reports can only be accessed by authorized users.	4.37	0.66	2	5	5
ERP increases the level of information sharing in the enterprise.	4.03	0.79	2	5	4
I have no doubt about the accuracy of the information obtained from the ERP.	3.90	0.90	2	5	4
Total „information quality“	**4.00**	**0.81**	**1**	**5**	**4**

Source: Authors' work

The respondents gave the highest score to the statement "ERP reports can only be accessed by authorized users", and the lowest score to the statement "ERP reports are tailored to the needs of the organization".

Table 3. *Values per claim for the "system performance quality" dimension*

Statement from the questionnaire	Average value	Standard deviation	Minimum value	Maximum value	Mod
ERP is fully tailored to the needs of the enterprise.	3.51	0.93	1	5	3
The ERP system has never been completely inaccessible (out of function).	3.41	1.21	1	5	4
The response time of an ERP system is generally satisfactory.	3.87	0.81	2	5	4
The response time of the front module (e.g., cash register module or module in which invoices are created) of the ERP system is satisfactory.	4.00	0.80	2	5	4
The ERP system can only be accessed by authorized users.	4.45	0.62	2	5	5
The ERP system did not crash due to hacker attacks.	4.44	0.62	3	5	5
Errors/problems in the operation of the ERP system are rare.	3.74	0.79	2	5	4
The ERP system can also be accessed via mobile devices, tablets, *etc*.	2.77	1.32	1	5	2
Total „system performance quality“	**3.77**	**1.06**	**1**	**5**	**4**

Source: Authors' work

Out of the claims related to the dimension "system performance quality", the best rated is "the ERP system can be accessed only by authorized users", and the worst-rated is "the ERP system can be accessed via mobile tablets, *etc*." (Table 3).

Table 4. *Values per claim for the "service quality" dimension*

Statement from the questionnaire	Average value	Standard deviation	Minimum value	Maximum value	Mod
The ERP provider has provided a help desk service.	4.13	0.84	1	5	4
Over 80% of ERP problems are solved through the help desk.	3.82	0.93	1	5	3
The ERP provider corrects minor reported errors in erp operation within 4 hours at the latest.	3.28	0.97	1	5	3
IT professionals working on ERP maintenance instill confidence that they are fully trained to solve problems.	3.77	0.77	1	5	4
IT professionals working on ERP maintenance quickly solve problems and failures.	3.64	0.69	1	5	4

Statement from the questionnaire	Average value	Standard deviation	Minimum value	Maximum value	Mod
IT professionals working on ERP maintenance have good personal communication with end users.	3.78	0.72	2	5	4
IT professionals working on ERP maintenance understand the needs of users and businesses.	3.57	0.85	1	5	3
The ERP provider is continuously working to improve the performance of the ERP.	3.97	0.61	2	5	4
The ERP provider suggests introducing solutions that have proven to be good for other users.	3.60	0.79	1	5	4
Total „quality of service“	**3.73**	**0.84**	**1**	**5**	**4**

Source: Authors' work

In the part of the questionnaire related to the "service quality" dimension, the first claim "the ERP supplier has an established help desk" received the best average score, and the worst average score was registered for the statement "the ERP provider corrects minor reported errors in ERP operation within 4 hours at the latest" (Table 4).

Table 5. *Values per claim for the "use of the system" dimension*

Statement from the questionnaire	Average value	Standard deviation	Minimum value	Maximum value	Mod
I use ERP reports daily in my work.	4.38	0.68	2	5	5
ERP reports significantly facilitate my daily work	4.39	0.63	3	5	5
ERP reports increase my productivity.	4.38	0.61	3	5	4
I use ERP reports to make every business decision.	3.77	0.80	2	5	4
ERP reports make it easier for me to work and communicate with other colleagues within the company.	4.10	0.61	3	5	4
ERP reports make it easier for me to work and communicate with colleagues from other companies, banks, the tax administration and other public organizations.	3.71	0.95	1	5	4
Total “use of the system“	**4.12**	**0.78**	**1**	**5**	**4**

Source: Authors' work

In the part of the questionnaire related to the "use of the system" dimension, the respondents rated the statement "ERP reports significantly facilitate my daily work" the best. They rated the statement "ERP reports make it easier for me to work and communicate with colleagues from other companies, banks, tax administrations and other organizations" the worst (Table 5).

Table 6. *Values per claim for the "user satisfaction" dimension*

Statement from the questionnaire	Average value	Standard deviation	Minimum value	Maximum value	Mod
Work on the ERP system is pleasant to me.	3.89	0.65	3	5	4
I am satisfied with the functionality /possibilities offered by the ERP system.	3.90	0.63	2	5	4
I am satisfied with the ERP user interface.	3.84	0.73	2	5	4
I am satisfied with the price /quality ratio for the ERP system.	3.74	0.84	1	5	4
I would recommend this ERP system to others.	3.66	0.84	2	5	3
I would buy an ERP system from the same supplier again.	3.44	1.01	2	5	3
The competition offers a better price /quality ratio for its ERP system.	2.83	0.83	1	5	3
Total "satisfaction with the system"	**3.61**	**0.87**	**1**	**5**	**4**

Source: Authors' work

For the "user satisfaction" dimension, the statement "I am satisfied with the functionality/possibilities offered by the ERP system" was rated the best, and "the competition offers a better price/quality ratio for its ERP system" was the worst-rated (Table 6).

As a survey questionnaire was used to assess the quality of the ERP system, Cronbach's alpha was used to check the validity of the questionnaire by groups of questions, as well as by the complete questionnaire. Cronbach's alpha measures the reliability or internal consistency of questionnaires. It tests whether multiple questions and questionnaires using the Likert scale are reliable (Tavakol and Dennick, 2011).

Cronbach's alpha values range from 0 to 1. A value of the coefficient above 0.7 indicates that the internal consistency of a set of claims can be considered acceptable (Tavakol and Dennick, 2011). Table 7 lists the results of Cronbach's alpha for the ERP system quality survey questionnaire and it can be seen that all groups of claims for the stated ERP system quality dimensions, as well as the survey as a whole, meet the internal consistency criteria. MS Excel was used for this analysis.

Table 7. *Testing the internal consistency of the questionnaire using Cronbach's alpha*

Set of claims	Number of claims	Cronbach's alpha
Information quality	9	0-89
System performance quality	8	0-77
Service quality	9	0.85
Use of the system	6	0.83
User satisfaction	7	0.72
Total questionnaire	**39**	**0.94**

Source: Authors' work

Further testing of the hypothesis was performed using factor analysis in which the factors are selected according to the questionnaire. Factor analysis is a common name for several methods that aim to condense many of manifest variables among which there is a correlation to a smaller number of latent dimensions (factors) that are the source of this connection (Mejovšek, 2003). Factor analysis is, except for the calculation of the results of entities in latent dimensions, also used for getting insight into the structure of the interconnection of several manifest variables. Using the principal components method, m latent dimensions that are linearly independent of each other are calculated from a set of m manifest variables based on an unreduced correlation matrix. The main components are linear combinations of manifest variables calculated in a way that the first main component explains the maximum possible part of the total variance of the manifest variables. The second as well as each subsequent main component, explains most of the remaining variance of the manifest variables, i.e., most of the variance of the manifest variables that is not explained by the previous main components (Dizdar, 2006).

In this case, 5 factors were chosen because 5 dimensions of ERP system quality were assumed. Table 8 shows the factor structure matrix for 39 variables (questions in the survey questionnaire) after the varimax factor rotation was performed.

Table 8. *The contribution of survey questions to individual factors*

	Factor1	Factor2	Factor3	Factor4	Factor5
Question1	0.334	0.212	0.320	0.153	0.302
Question2	**0.557**	0.268		0.281	
Question3	0.443	0.297	0.264	0.202	0.233
Question4	0.470	0.293	0.367	0.247	0.322
Question5	0.451	0.320	0.365	0.161	0.321
Question6	**0.587**	0.303		0.165	
Question7	0.299		-0.194	0.191	**0.648**
Question8	**0.713**	0.175	0.186		
Question9	**0.658**	0.187	0.251	0.303	0.339
Question10	0.412	0.386	**0.578**		0.220

	Factor1	Factor2	Factor3	Factor4	Factor5
Question11	0.245	0.102	0.477	0.148	**0.515**
Question12	**0.701**	-0.120	0.434	0.211	0.165
Question13	**0.709**		0.321		0.370
Question14	0.214		-0.106	0.145	**0.780**
Question15	0.191			**0.714**	
Question16	0.286	0.354	0.202	0.249	0.167
Question17	0.198	0.181	0.191	-0.201	
Question18	0.426	0.158	-0.205		0.237
Question19	0.227	**0.525**	0.238		
Question20	0.430	**0.508**	0.132		-0.364
Question21	0.163	**0.640**	0.406		0.185
Question22	0.122	**0.726**	0.378		
Question23		**0.722**	0.297	0.193	0.247
Question24	0.197	**0.753**		0.197	0.201
Question25	0.215	0.421	-0.104	0.246	0.107
Question26		0.325			-0.105
Question27	0.202		**0.815**	0.266	
Question28	0.351			**0.895**	
Question29	0.376	0.222		**0.750**	
Question30			0.339	**0.577**	0.343
Question31	-0.151	0.110	0.241	**0.610**	0.218
Question32		0.254		0.262	**0.521**
Question33	0.353	0.239	0.380	0.411	0.147
Question34	0.200	0.204	0.297	0.434	
Question35	0.393	0.179	0.463	0.381	
Question36	0.284	0.166	0.202	0.142	-0.145
Question37	0.138	0.336	**0.814**	0.311	-0.175
Question38		0.369	**0.771**	0.170	-0.256
Question39			0.448		

Source: Authors' work

In Table 8, the questions whose contribution to the factors is greater than or equal to 0.5 are marked because these are considered significant (Fazlić and Đonlagić, 2016). Table 9 shows that factors 1 and 5 are actually the first two dimensions of ERP system quality (information quality and system performance quality) because the questions related to these two dimensions contribute the most to factors 1 and 5 (questions 1 to 17). The questions related to the first dimension contribute to both, factor 1 and factor 5, but the questions related to the second dimension also contribute to these factors (1 and 5). It is obvious that the respondents did not sufficiently distinguish these two dimensions in the survey questionnaire and there was an overlap in the answers. Questions 18 to 26 contribute the most to factor 2, which refers to the third dimension - service quality. Questions 27 to 32 contribute the most to factor 4, which is the fourth dimension - the use of ERP systems. Questions 33 to 39 contribute to factor 3 and this is the fifth dimension in the survey questionnaire - user satisfaction with the ERP system.

Table 9. *The contribution of survey questions to the dimensions of research*

Extracted factors	**Ordinal number of question**	**Dimension in research**
Factor 1	1 – 9, 10 – 17	Information quality
Factor 2	18 – 26	Service quality
Factor 3	33 – 39	User satisfaction
Factor 4	27 – 32	Use of the system
Factor 5	10 – 17, 1 – 9	System performance quality

Source: Authors' work

The sum of the eigenvalues of these five factors shows what percentage of the variance of the manifest variables is explained by the extracted factors. From Table 10 it can be seen that 82.46% of the variance of the manifest variables was explained using the five selected factors.

Table 10. *The share of factors in explaining the variance of manifest variables*

	Eigenvalues	% of variance	Cumulative percentage of variance
Factor 1 - information quality	5.154	19.86%	19.86%
Factor 2 - service quality	4.308	16.60%	36.47%
Factor 3 – user satisfaction	4.185	16.13%	52.60%
Factor 4 - use of the system	4.120	15.88%	68.48%
Factor 5 - system performance quality	3.629	13.99%	82.46%
TOTAL	21.396	82.46%	
Total variance of manifest variables	25.946		

Source: Authors' work

7. Discussion

The dimensions in this research were set based on the D&M model, as well as the survey questionnaire. The research showed the consistency of the survey questionnaire both in terms of dimensions and the overall survey.

Factor analysis showed that 82.46% of the variance of the manifest variables was explained by the five selected factors, and most of the questions significantly contributed to one of the selected factors. Based on the above, the hypothesis can be fully accepted as true, and it is confirmed that the D&M model, with some adjustments, can be used to investigate the quality of ERP systems.

8. Conclusion

The lack of a database of companies using ERP systems can be pointed out as a limitation of the research. Therefore, a pilot survey was conducted to identify such companies. After the results of the pilot research were collected, a statistical set for the main empirical research was obtained, which made the data collection phase more difficult and more complex. This is the reason why the survey questionnaire was not previously piloted because the authors wanted to avoid surveying the same companies three times in a short period.

Testing the survey questionnaire might help to better conceptualize the questions for the main research. In that way, there might be more questions that contribute significantly to the factors and the mixing of contributions between the first two dimensions might be avoided. Regardless of this, the proposed model can be used to evaluate the quality of ERP systems, but also some other types of ISin future research, such as BI and CRM systems. The statements used in the survey questionnaire can be used to form a questionnaire for future research on the quality of business ISs.

Also, once the proposed ERP system quality evaluation model is validated, it can be used in future research to relate the quality of an ERP system, BI or CRM system with net benefits for the enterprise, as suggested by the original D&M model.

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