Triple “E” Value Circle – Measuring Information Systems´ Success with a Focus on Digital Technologies

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Summary

Digitalization penetrates the entire company. Thus, the need for updating information systems (IS) success models is obvious. They should go beyond “pure” efficiency criteria . But how to define such models and how to implement them? Well-known approaches will no longer work.

Zusammenfassung

Die Digitalisierung durchdringt das ganze Unternehmen. Es braucht daher überarbeitete Modelle zur Erfolgsmessung von Informationssystemen (IS). Diese sollten über die „reine“ Effizienzmessung hinausgehen. Wie aber definiert man solche Modelle und wie setzt man sie um? Bekannte Ansätze greifen nicht mehr.

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Stichwörter

Informationssysteme # Digitalisierung # Evaluierung von (IT)-Projekten # Finanzfunktion der Zukunft # IS Erfolgsmessung

Keywords

Information Systems # Digitalization # Evaluation of (IT) Projects # Finance Function of the Future # IS success measures

Implications for practice (key messages)

- **Digitalization** is on the agenda of almost all companies. Thus, the perspective on information systems (IS) is changing. Evaluating IS success must become more balanced.
- Applying the triad of efficiency, effectiveness, and experience, the **Triple „E“ Value Circle** serves as a balanced assessment of digital technologies.
- The approach on hand with its nine criteria is **easy to understand** and **applicable**, but always **distinct** in its individual criteria.

Key Take-Aways

- The Triple “E” Value Circle focuses on the **challenges of a digital transformation**. It covers a new – more balanced – assessment of digital technologies.
- The immanent **triad of the target categories** “efficiency, effectiveness, and experience” ensures a balanced assessment of digital technologies.

A first implementation shows that the approach and its application is **easy to understand**. The assessment criteria are **equally important** and **MECE** (mutually exclusive and collectively exhaustive).

1. Adopting Digital Technologies

Experiencing digital technologies in a "trial and error" mode was accepted in the last years of global economic prosperity. In the current economic uncertainty and especially the COVID-19 pandemic even **"digital technologies have to pay off."** This statement of a board member from a specialty glass and glass-ceramics manufacturer brings the present perspective on digital technologies to the point: Fancy storytelling of digital evangelists will receive no funding anymore!

Measuring **IS (information systems) success** is a popular research stream and it will be important for the years to come. However, different stakeholders have different definitions (cf. Grover 1996). Focusing on the perspective of IS users, we define IS as successful if they improve **a user's work satisfaction and performance** (cf. Seddon et al. 1999).

Today, four well-known approaches exist: (1) Starting in 1992, DeLone and McLean (1992) came up with an **IS success model**. It is a multidimensional approach covering six IS success categories. (2) The **Technology Acceptance Model (TAM)** explains user behavior with both its perceived usefulness as the degree to which a person believes that using a specific IS would enhance his/her job performance and its perceived ease-of-use as the degree to which a person believes that using IS would be free from effort (cf. Venkatesh and Davis 2000). (3) The **Integrated Model** by Wixom and Todd (2005) complements missing IS characteristics within TAM with external variables. (4) Finally, **list approaches** are a collection of assessment criteria which are derived from literature or the (individual) experience of the authors (cf. Young and Watson 1995).

Evaluating these approaches, the models #1-3 are scientifically sound. However, they are often not directly applicable in practice. In turn, list approaches are more relevant, but not particularly rigorous (cf. Mayer and Marx 2010). Furthermore, they run the risk of being too specific for a domain and lack generalizability.

IS success strongly depends on the **type of IS** that is evaluated (cf. Seddon et al. 1999). Whilst digital technologies such as automation, analytics, and digital enterprise platforms become more important, there is hardly any research measuring their success. Compared to enterprise resource planning (ERP) and business intelligence (BI) projects, the perceived ease-of-use of digital technologies is often not so high. Thus, digital technologies are often stuck in a proof-of-concept phase. However, companies see a huge potential to drive future gains (cf. Ransbotham et al. 2019). In other words: **Companies cherish digital technologies, but they currently do not use them so much.**

Complementing existing IS success models, the objective of this article is to lay out a **list approach focusing on how to measure IS success of digital technologies** properly. Accordingly, the evaluation criteria have to be derived in a more rigorous and transparent way than in existing (list) approaches. Aiming at that, we opted for a consortium research approach and took a Robotic Process Automation (RPA) implementation as our case study.

To create things that serve human purposes, finally, to create a better world, we follow Design Science Research (DSR) in IS. The publication schema by Gregor and Hevner (2013) gave us direction: We motivate this article in terms of measuring IS success with a focus on digital technologies ***(Sect. 1)***. Based on the state of the art, we highlight research gaps ***(Sect. 2)***. Addressing these gaps, we adopt a consortium research approach ***(Sect. 3)***. Relevant findings are captured in a Triple "E" Value Circle ***(Sect. 4)***. Emphasizing iterative "build" and "evaluate" activities, we test the model in a case study at a specialty glass and glass-ceramics manufacturing company ***(Sect. 5)***. Comparing the results with prior work and examining how they relate back to the article's objective and research questions, we end with a summary, limitations our work, and avenues for future research ***(Sect. 6)***.

2. Complementing Information System Success Models

Following Webster and Watson (2002), we started our literature review with (1) a **journal search** focusing on leading IS research journals complemented by proceedings from major IS conferences.

Since the subject of research is of practical interest as well, we even looked directly at MIS Quarterly Executive and Harvard Business Review. For the (2) **database search**, we used ScienceDirect, EBSCOhost, Springer Link, AIS eLibrary, and Google Scholar.

Assessing the publications by their titles, abstracts, and keywords, we performed an iterative (3) **keyword search**. We specified the term "IS success" by value assessment, IT/IS value, and evaluation as well as "digital technologies" with automation. This led to 46 relevant hits. Within the practitioners' perspective, we found six publications such as MIT Center for Information Systems Research (2019) and McKinsey & Company (2018). Finally, we conducted (4) a **backward and forward search**. With references from all relevant publications, we identified another five relevant articles such as Liere-Netheler et al. (2018) and ended with **57 relevant publications** in total. ***Fig. 1*** visualizes the search string with the number of relevant publications in the black ovals.

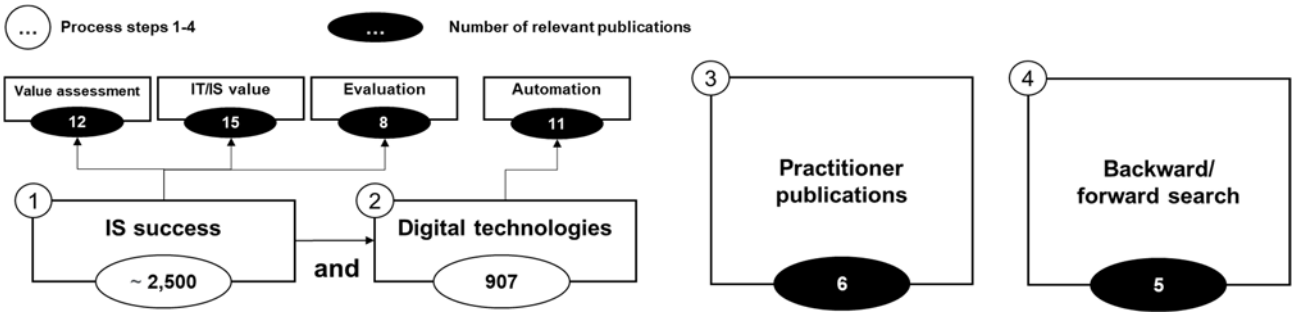

Fig. 1 Search Strategy Within the Citation Pearl Growing Approach

For the gap analysis, we structured the relevant publications in two clusters as follows: **(1)** The **focus area** exposes the topics of research: The DeLone & McLean IS success model received much attention from researchers who like to treat IS success as a **multidimensional construct** and also measuring it as such. Based on several comments, DeLone and McLean (2003) proposed an updated model and evaluate IS success with six interrelated dimensions: Three characteristics of quality, namely information, system, and service, affect a person's (a) **IS use** or (b) **intention to use IS**, their (c) **user satisfaction**, and (d) **net benefits** overall. The latter again will influence (e) **IS user satisfaction** and their (f) **effective use of IS**.

We detail this **multidimensional approach** in our model by three categories assessing digital technologies in terms of efficiency, effectiveness, and experience. Firstly, IS budgets are often granted if a business case in terms of efficiency is provided. We define **efficiency** as the measure of the extent to which input is used for an intended (typically) monetary output. Secondly, IS success should be measured also by better insights, higher data accuracy or speed in delivering information. Clustering such benefits in terms of **effectiveness**, we follow what DeLone and McLean (2003) label as "individual and organizational impact." None of the existing models we examined cover the intangible advantages of innovation, supporting (digital) change and transformation. Thus, we add a third category of IS success: **"Experience."** It supports efficiency and effectiveness as a leading driver as digital technologies are often still in a proof-of-concept phase and miss a focus on their perceived usefulness.

Regarding **list approaches**, we examined that they vary in terms of their number and level of abstraction (cf. Mayer and Marx 2010). We found just a few list approaches such as Gurbaxani and Dunkle (2019) assessing digital technologies more in detail. Yet, all the examined models lack the digital learning perspective.

Focusing on digital technologies many companies currently address automating processes. **Automation** is defined as machines, tools, devices, installations, and IS performing a set of activities without human intervention. While **RPA** covers rule-based activities such as routine tasks with structured data and deterministic outcomes (cf. Willcocks and Lacity 2016), cognitive-based automation performs activities which are managed by humans and, thus, require cognitive capabilities such as situational assessment, sensing, and monitoring (cf. Fast-Berglund et al. 2013). We focus on RPA as it is a mature digital technology including multiple case studies to be evaluated in terms of IS success.

(2) The **research approach** can either be empirical or non-empirical: The first one covers publications that investigate phenomena in the real world such as case studies, surveys, and experiments. All other publications like literature reviews are subsumed under non-empirical research. We followed a **consortium research** approach, as we wanted the participants to be highly involved in the process of model creation. Furthermore, we propose a **case study** which provides in-depth information and enables us to learn from practice. For IS success there is a good coverage of models. However, **instantiations** for these models are missing. Based on that, we will demonstrate how the proposed list approach on hand can be implemented in practice. Summarizing our findings, we specify the objective of this article to lay out a **list approach for evaluating digital technologies by triangulating efficiency, effectiveness, and experience in one and the same model**.

3. Applying Consortium Research

Based on the findings from the literature review, we opted for a **consortium research** with **25 managers from 11 different companies** covering the manufacturing, utilities, financial services, telecommunications, and other industries. Most of the managers are from the Finance department, however, they have a strong interest in IS design and they are tech-savvy due to education and/or experience. They meet twice a year to discuss digital transformation topics (cf. Schmalenbach-Gesellschaft für Betriebswirtschaftslehre e.V. 2020).

Starting with a **one-day workshop**, we presented the results of the literature research which were iteratively improved by the managers. Only this way, we could guarantee that the participants are highly involved in the topic of interest, how to structure relevant valuation criteria in a model, share their experience of what is different in assessing IS success of digital technologies, and give ideas and further recommendations in a personal atmosphere.

Furthermore, we took a **multinational specialty glass and glass-ceramics manufacturing company** as the case study reference. In 2019, the company had sales of 2.08 bn EUR, 15,500 employees. From January to September 2019, one researcher (author of this paper) participated in the project. Compared to surveys, case studies provide more in-depth information (especially company-internal data). To discuss **validity** and **utility**, Eisenhardt (1989) gave us direction: (1) We gathered information about the handling of the model, crafted observations, and, finally, conducted two **manager expert interviews**.

4. Developing an Alternative IS Success Model: The “Triple E” Value Circle

We started the manager focus group session laying out the goal of the one-day workshop. Then, we summarized the findings of the literature research and asked for a feedback about the three categories of measuring IS success: **(A) Efficiency:** As IS budgets are often granted if a tangible business case is provided, the managers agreed on **cost savings** assuming equal product, process, and service quality as the first category of measuring IS success. In doing so, the managers argued to honor direct EBIT impact by 100 percent and additional net sales by 10 percent. Cost savings were detailed by **reducing full time equivalents** (1, FTE, cf. Couto et al. (2017)) or (2) **lowering cost.** The latter covers the OPEX/CAPEX (short-term/long-term) impact or other cost cutting opportunities (cf. Crew and Parker 2006).

(B) Effectiveness: Furthermore, the managers were aligned that “there is more than efficiency when measuring IS success.” The examined effectiveness criteria of better insights (cf. Kiron and Shockley 2015), speed (cf. Davenport and Snabe 2011), and data accuracy (cf. Belhiah et al. 2015) were received very well. The managers added flexibility and security as other criteria. Discussing the content, the result of this second category of measuring IS success was as follows: **(3) Better insights** cover the degree to which new information (reports, analyses, key performance indicators) fit the requirements of the recipients. **(4) Speed** covers the time it takes for faster information delivery, system interactions, and decision making. **(5)** The ability to react to new, but mainly anticipated requirements

is covered by **flexibility** (cf. Bock et al. 2012). **(6) Accuracy** covers the provision of correct and up-to-date information (cf. Belhiah et al. 2015). **(7)** Last, but not least, **security** comprises data reliability even in heterogeneous ERP/BI architectures or in the cloud (cf. Takabi et al. 2010).

After the lunch break, we discussed if our model needed another category including the "learning" perspective of the organization. The manager focus group proposed another category named **(C) experience** which has to comprise the (intangible) learning effect when implementing digital technologies. In other words: It covers the freedom to, finally, set up future economies of scale. To give experience a clear direction, we came up with two sub criteria: (1) The use of the digital technology paves the way for future cost and/or FTE reduction **(efficiency)**. (2) Enabling **effectiveness** addresses how digital technologies shape the organization by better insights, more speed, flexibility, accuracy, and security. Finally, the model was documented (***Fig. 2)***. It covers the three categories of efficiency, effectiveness, and experience. All categories were detailed with nine criteria in total measuring IS success of digital technologies comprehensively.

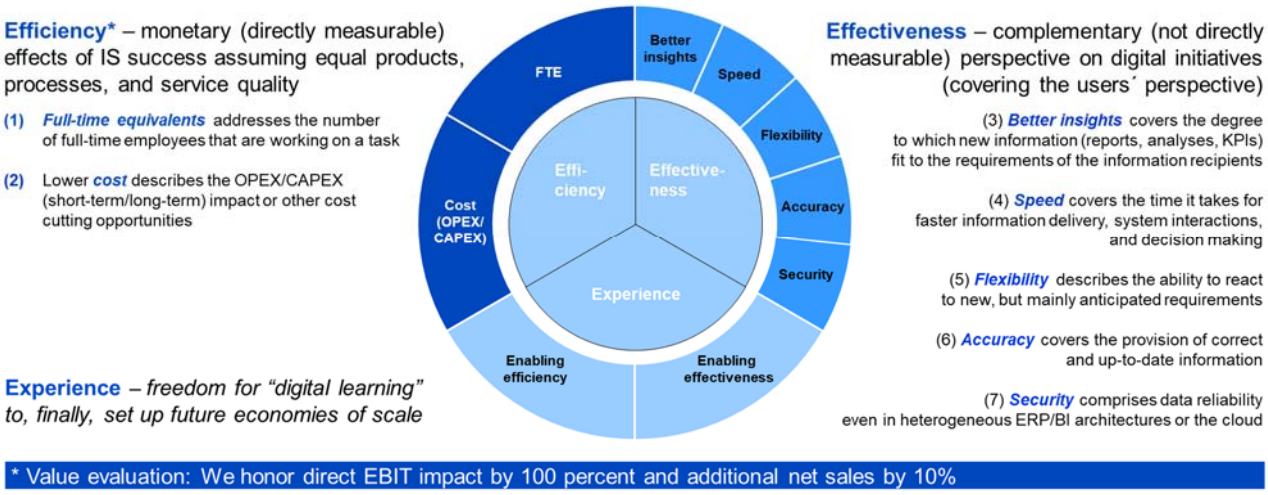

Fig. 2: Triple "E" Value Circle.

5. Making Digital Technologies a Success

Following our mixed method approach, we discussed the results from the manager focus group with practice. For the evaluation, we organized **two manager interviews** with the Head of the Digital Acceleration Team (DAT) and the Head of Finance at the reference company. Two researchers (authors of the paper) started the discussion by asking about the completeness of the model and went through the Triple "E" categories and the nine sub-criteria one after the other.

The interviewees agreed that they did not miss any important criteria and came up with three major conclusions as follows: **(1) Besides efficiency, effectiveness and experience should be complementing pillars of IS success models:** The Head of DAT expressed that the model is rigor in its foundation of the triple "E" categories. The model is more balanced (collectively exhaustive) and easier to understand compared to the "classical" approaches such as TAM he remembered from university. Furthermore, all single evaluation criteria are understandable and distinct (mutually exclusive). Thus, the model is MECE and helped the project exposing the value of RPA for the company "beyond pure efficiency." The Head of Finance agreed that the benefits of RPA were clearer after applying the valuation approach than the "pure" return-on investment (RoI) calculation. Both interviewees agreed that the Triple "E" Value Circle gives digital use cases a sound basis beyond "pure" efficiency.

(2) Consider effectiveness and experience as equal to efficiency when measuring IS success: With its categories efficiency (monetary benefits), effectiveness (not directly tangible), and experience (intangible effects), the approach on hand is balanced. Applying this triad, the Head of DAT shed light on a common misconception: As opposed to efficiency improvements in terms of FTE and

OPEX, the true value of the RPA implementation is effectiveness as it strongly improved data accuracy. Furthermore, the Finance bots are much faster in execution than human work. These value proposals were the arguments starting the RPA project. They underline that effectiveness and experience are more than just add-ons to the efficiency category.

(3) Support digital transformation explicitly with an experience category: Finally, the DAT Head said that applying the value circle is straight-forward, but it was not easy to explain the "experience" category. Today, the implementation of our Triple "E" model has started in another company assessing analytics for net sales prediction. As organizational changes are becoming more important, he pointed out that the experience category is needed to drive the engagement of employees early in the project by digital learning targets. This is the major difference compared to "classic" SAP ERP roll outs and their well-proven RoI value assessments. We consider utility as satisfied and the importance of the experience category in supporting digital transformations became obvious.

6. The Future of Efficiency, Effectiveness, and Experience

With a consortium research approach and taking an RPA implementation as a case study, the objective of this paper was to lay out a **list approach updated to measure IS success with a focus on digital technologies**. Compared to existing approaches, we examined differences in assessing digital technologies by exposing both effectiveness criteria such as data accuracy or speed and the experience category with its digital learning and change within the organization in focus. These two categories complement the "pure" efficiency criteria perfectly. We started to demonstrate validity and utility of the Triple "E" Value Circle with an RPA case study.

For practice, the balanced mix of nine valuation criteria clustered in three "E" categories should help to measure IS success beyond efficiency with **completeness and distinctiveness**. As the Triple "E" Value Circle was created in a consortium approach, it is more **transparent and traceable** than list approaches we examined. Compared to structural models, the **handling** of the Triple "E" Value Circle is easier. More important, a significant statistically sound sample is not needed to define its structure.

For **research purposes**, the work on hand updates IS success research in a new setting of implementing digital technologies. A **literature review** to derive evaluation criteria, followed by **a workshop with practitioners** helped us to develop a more rigorous model than other list approaches. The efficiency category was complemented by effectiveness and experience criteria. Whereas Shang and Seddon (2002) developed a list of benefits based on a literature review in combination with an empirical study, we iteratively designed the model in cooperation with practitioners. An instantiation complemented work on hand.

Our research reveals **several avenues for future research**. A broader literature research should cover more **"grey" literature**. Furthermore, future research should examine the **weight of impact** for each criterion. In doing so, the experience category should be considered more thoroughly – neither structural models nor list approaches currently do that. The other side of not using huge samples to generate findings, case studies entail subjectivity. So, future research should cover more **(single) case studies and/or a comprehensive multiple case study**. Finally, digitalization may lead to unforeseeable (technical) developments so that the approach on hand needs to be updated. Nevertheless, assessing digital technologies with updated list approaches should be a rising topic in a company's digital agenda and may give researchers a push to drive established IS success models forward.

References

Belhiah, M./Bounabat, B./Achchab, S., The Impact of Data Accuracy on User-Perceived Service's Quality, in: Álvaro Rocha (ed): 10th Iberian Conference on Information Systems and Technologies, 2015, Águeda, Portugal, S. 1-4.

Bock, A. J./Opsahl, T./George, G./Gann, D. M., The Effects of Culture and Structure on Strategic Flexibility during Business Model Innovation, in: Journal of Management Science 49. Jg. (2012), H. 2, S. 279-305.

Crew, M./Parker, D., International Handbook on Economic Regulation: Edward Elgar Publishing, 2006.

Couto, V./Wiley, E./Plansky, J./Caglar, D., Fit for Growth: A Guide to Strategic Cost Cutting, Restructuring, and Renewal. Hoboken, NJ: John Wiley & Sons, 2017.

Davenport, T. H./Snabe, J. H., How Fast and Flexible do you want your Data, Really, in: MIT Sloan Management Review 52. Jg. (2011), H. 3, S. 57-67.

DeLone, W. H./McLean, E. R., Information Systems Success: The Quest for the Dependent Variable, in: Information Systems Research, 3. Jg. (1992), H. 1, S. 60-95.

DeLone, W. H./McLean, E. R./Ephraim, R., The DeLone and McLean Model of Information Systems Success: A Ten-Year Update, in: Journal of Management Information Systems, 19. Jg. (2003), H. 4, S. 9-30.

Eisenhardt, K. M., Building Theories from Case Study Research, in: Academy of Management Review, 14. Jg. (1989), H. 4, S. 532-550.

Fast-Berglund, Å./Fässberg, T./Hellman, F./Davidsson, A./Stahre, J., Relations Between Complexity, Quality and Cognitive Automation in Mixed-Model Assembly, in: Journal of Management Studies, 32. Jg. (2013), H. 3, S. 449–455.

Gregor, S./Hevner, A. R., Positioning and Presenting Design Science Research for Maximum Impact, in: Management Information Systems Quarterly, 37. Jg. (2013), H. 2, S. 337-355.

Grover, V./Seung, R. J./Segars, A. H., Information Systems Effectiveness: The Construct Space and Patterns of Application, in: Information & Management, 31. Jg. (1996), H. 4, S. 177-191.

Gurbaxani, V./Dunkle, D., Gearing Up For Successful Digital Transformation, in: Management Information Systems Executive, 18. Jg. (2019), H. 3, S. 209-220.

Kiron, D./Shockley, R., Creating Business Value with Analytics, https://sloanreview.mit.edu/article/creating-business-value-with-analytics, Stand: 15.10.2020.

Liere-Netheler, K./Vogelsang, K./Packmohr, S./Hoppe, U., Towards a Framework for Digital Transformation Success in Manufacturing, in: Bednar, P./Frank, U./Kautz, K. (Eds): Beyond Digitization – Facets of Socio-Technical Change. European Conference on Information Systems, 2018, Portsmouth, S. 1-17.

Mayer, J. H./Marx, F., Systematic Development of Business-Driven Requirements – Using Next-Generation EIS Design as an Example, in: Global Perspectives on Design Science Research. International Conference on Design Science Research in Information Systems and Technology, 2010, St. Gallen, Switzerland, S. 506–521.

McKinsey & Company, Unlocking success in digital transformations, https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Organization/Our%20Insights/Unlocking%20success%20in%20digital%20transformations/Unlocking-success-in-digital-transformations.pdf, 2018, Stand: 15.10.2020.

MIT Center for Information Systems Research, Digital Success Requires Breaking Old Rules, https://sloanreview.mit.edu/ article/digital-success-requires-breaking-rules, 2019, Stand: 15.10.2020.

Ransbotham, S./Khodabandeh, S./Fehling, R./LaFountain, B./Kiron, D., Winning With AI, in: MIT Sloan Management (2019), https://sloanreview.mit.edu/projects/winning-with-ai, Stand: 15.10.2020.

Schmalenbach-Gesellschaft für Betriebswirtschaftslehre e.V., Arbeitskreis Digital Finance – Kurzinfo, https://www.schmalenbach. org/index.php/arbeitskreise/finanz-und-rechnungswesen-steuern/digital-finance, Stand: 15.10.2020.

Seddon, P. B./Staples, S./Patnayakuni, R./Bowtell, M., Dimensions of IS Success, in: Communications of the Association for Information Systems, 2. Jg. (1999), H.1, S. 2-61.

Shang, S./Seddon, P. B., Assessing and Managing the Benefits of Enterprise Systems: The Business Manager's Perspective, in: Information Systems Journal, 12. Jg. (2002), H.4, S. 271-299.

Takabi, H./Joshi, J. B. D./Ahn, G.-J., Security and Privacy Challenges in Cloud Computing Environments, in: Institute of Electrical and Electronics Engineers, 8. Jg. (2010), H. 6, S. 24-31.

Venkatesh, V. /Davis, F. D., A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies, in: Management Science, 46. Jg. (2000), H. 2, S. 186-204.

Webster, J./Watson, R. T., Analyzing the Past to Prepare for the Future: Writing a Literature Review, in: Management Information Systems Quarterly, 26. Jg. (2002), H. 2, S. xiii-xxiii.

Willcocks, L. P./Lacity, M. C., Service Automation - Robots and the Future of Work. Warwickshire: Steve Brookes Publishing, 2016.

Wixom, B. H./Todd, P. A., A Theoretical Integration of User Satisfaction and Technology Acceptance, in: Information Systems Research, 16. Jg. (2005), H. 1, S. 85-102.

Young, D./Watson, H. J., Determinates of EIS Acceptance, in: Information & Management, 29. Jg. (1995), H. 3, S. 153-164.