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Alexander Maedche[1], Jan vom Brocke[2], Alan Hevner[3] (Eds.)

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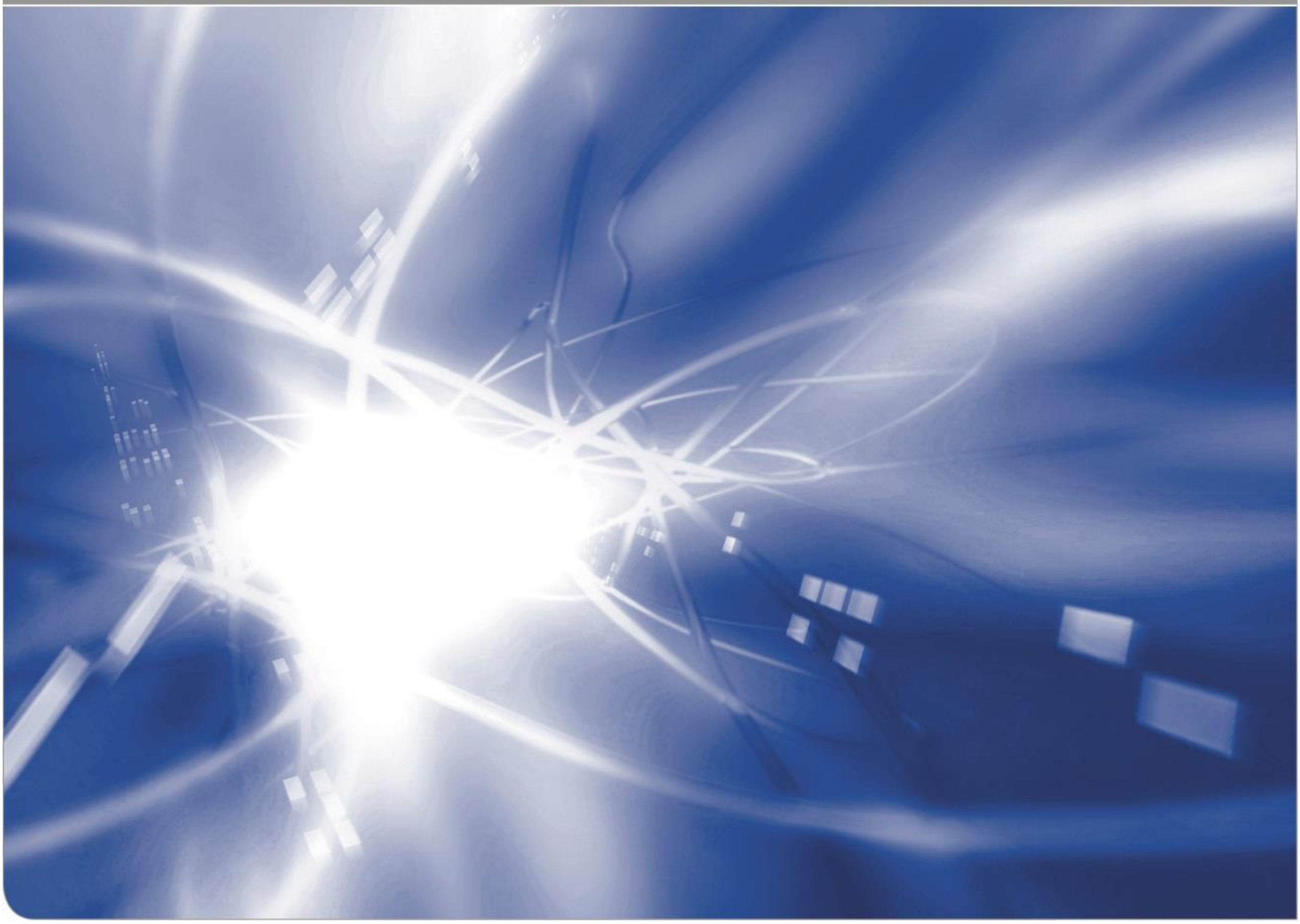

[1] Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany
[2] University of Liechtenstein, Liechtenstein
[3] University of South Florida, USA

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Institute of Information Systems and Marketing (IISM)
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An Assistance System for Business Information Visualization

Research-in-Progress

Michael Schelkle

University of Augsburg, Universitaetsstr.16, 86159 Augsburg, Germany
michael.schelkle@wiwi.uni-augsburg.de

Abstract. Business Information Visualization (BIV) is increasingly recognized in research and practice. Nevertheless, studies show that BIV is often inappropriately applied in business reporting, which may lead decision makers to wrong conclusions. Users who create these reports complain about difficulties to implement appropriate BIV due to insufficient software support. As a result BIV acceptance suffers. A promising approach to overcome this are user assistance systems (UAS). Hence, the overarching goal of our research project is to gain insight to what extent UAS affect the acceptance of BIV. Since we could not identify in literature a UAS that helps to apply appropriate BIV, we intend to develop such a UAS first. Based on design science research, the aim of this paper is to introduce a UAS prototype that may increase BIV acceptance. Besides evaluating UAS on acceptance, the artifact may help practitioners to adhere to appropriate BIV in their everyday work.

Keywords: User Assistance System · Self-Service Business Intelligence · Business Information Visualization · Guidelines · Design Science Research

1 Problem Identification and Motivation

The relevance of appropriate business information visualization (BIV) for decision support is supported by findings in literature [1] and is increasingly recognized by companies to avoid threats and realize opportunities [2]. A recent study shows that 78% of the respondents rate BIV important or very important due to the avoidance of misapprehensions and faster information transfer [2]. On the other hand, research shows that BIV is often not appropriately applied within business reporting [3, 4]. Such insufficient BIV may lead to selective or distorted perception [4]. For example, truncated axes exaggerate the magnitude of a trend, because the sizes of intervals on the vertical axis are unequal [5]. In consequence, these reports do not fulfil their central tasks: Creating business transparency and providing relevant information as basis for decision making [6] by drawing attention to critical areas and revealing needs for action. It is has been shown that this deficiency may guide decision makers to wrong conclusions [4, 5], which can lead to tremendous negative results. For instance, the German project Airport

Berlin Brandenburg wasted billions of euros [7] since managers relied on poorly visualized reports [8].

A technology, which is used to create management reports and is gaining importance in the field of Business Intelligence, is Self-Service Business Intelligence (SSBI) [9]. Here, users have a variety of personal decision support features (e.g. visualizing) to independently develop their own management reports in a timely manner [10]. One pitfall however is, that this technology often gears its visualizations towards what is technically feasible, but not towards what is visually reasonable [11]. Since SSBI users can be regarded as relative BIV layman, they complain about difficulties to implement appropriate BIV, which leads to a lack of BIV acceptance [2]. One reason for this is insufficient software support that fails to assist in creating reports based on predetermined BIV guidelines [2], such as the International Business Communication Standards (IBCS). Since user assistance systems (UAS) help users to perform their tasks better [12], it appears to be a promising approach to increase the perceived usefulness and perceived ease of use of BIV. This leads to enhanced acceptance, referring to the technology acceptance model [13]. According to the design science research (DSR) methodology proposed by Peffers et al. [14], this paper aims to introduce a prototypically implemented software artifact as preliminary result.

The following sections will outline the research objective and the design and development of the prototype. Its demonstration and proposed evaluation is outlined, before the paper closes with a preliminary conclusion and a plan for future research.

2 Objective of the Research Project

2.1 Research Objective

The project's overarching goal is to gain insight to what extent UAS affect the acceptance of BIV in management reporting, in particular in an SSBI environment. To evaluate this, UAS that analyze business charts for inadequate BIV and correct shortcomings according to scientific found guidelines have to be investigated. Since after a systematic search we could not identify such UAS in literature, in a first step a UAS for BIV has to be developed. Thus, the research objective of this article is:

Designing a software-based user assistance system that increases the acceptance of appropriate business information visualization.

Herewith we follow the call of Maedche et al. [12] to study the effects of assistance systems in the field of information systems research and provide a specific solution in the form of a prototype, based on DSR [15].

2.2 Related Work

Before a UAS for fostering the acceptance of adequate BIV is developed, we want to characterize the state of the art of UAS that help to avoid misleading BIV. Since studies in BIV are fundamentally multidisciplinary, literature from prior research in computer science, human visual perception, and an application domain (i.e., management accounting) [16] was included in our literature search. We conducted the search based on the term "user assistance system" in the databases IEEE Xplore, ACM digital library, AIS Electronic Library, and Emerald Insight to reflect the before mentioned multidisciplinarity. To complement the search, management accounting as well as information systems journals were included (i.e., HMD Praxis der Wirtschaftsinformatik, Decision Support Systems, Management Accounting Research, Journal of Management Accounting Research, Journal of International Financial Management and Accounting, Advances in Management Accounting, Management Accounting Quarterly). Even so UAS could be identified (e.g., UAS for: a ticketing process of an issue tracking system [17], remote experimentation [18], fostering multimedia skills [19]), none of the articles characterizes a UAS for BIV.

Since this first search did not reveal a specific UAS, which focuses on BIV guidelines, a further search comprising the terms "chart" and "misleading" and synonyms thereof was conducted. Here several publications [20–23] got identified that deal with the topic of misleading BIV and show a demand for user assistance. However, these articles do not describe or develop a concrete software application.

Referring to these reviews, no approach for implemented software that assists to reveal and amend misleading graphics based on scientific found guidelines could be identified. This shows a research gap that we want to bridge with our research project.

3 Design and Development

3.1 Theoretical Background

Business Information Visualization.

Information visualization can be considered as an aid of thought to assist managers in decision making [1]. When information visualization technologies are used to visualize business information (e.g., charts or tables) it is referred to as BIV [24]. Hence, BIV is the use of computer-supported interactive visual representations of business data to amplify cognition for improved decision making [25]. This involves defining graphical elements and their relationships to display relevant information [1]. Based on the approach of external cognition (i.e. the use of the external world to accomplish cognition), the main idea of BIV is, that visual representations provide information to amplify cognition [26] to support decision making.

Cognitive theories help to determine how information has to be visually presented to amplify cognition. For example, cognitive load theory refers to the total amount of mental effort being used in the limited working memory and gives guidance on how to design the presentation of information for improved intellectual performance [27]. Cognitive fit theory proposes that the match between task (e.g., detect relationships) and presentation format (e.g., diagram) leads to superior task performance [28].

One approach to comply with this knowledge are guidelines [16]. In the context of BIV, we define a guideline as a general rule, principle, instruction, or piece of advice for the use of computer-supported visual representations of business data to amplify cognition. There are several guidelines for information visualization in general (e.g.,

[29], [30]), which draw on those insights. A framework that refers to these guidelines and highlights the design of business reports and presentations are the IBCS [31]. Moreover, the IBCS are increasingly recognized by industry [32] and showcase comprehensively inadequate BIV examples alongside their proposed corrections [33], which is the reason why we use these guidelines for our UAS.

Technology Acceptance Model and User Assistance Systems.

The technology acceptance model (TAM) was developed to improve our understanding of user acceptance processes and to provide a theoretical basis for a practical user acceptance testing methodology [13]. The TAM posits that perceived usefulness and perceived ease of use determine an individual's intention to use a system [26]. Davis [13] defines perceived usefulness as the extent to which a person believes that using a particular system will enhance job performance. Perceived ease of use is defined as the degree to which a person believes that using a particular system will be free of physical and mental effort [13].

Since UAS are defined as an intelligent and interactive information technology component that enables individuals to perform tasks better [12], it is a promising approach to improve the acceptance of adequate BIV. UAS guide users while performing a specific task [12] (e.g., creating visualizations), which may increase the perceived ease of use. Moreover, further determinants of perceived usefulness, such as job relevance, output quality or result demonstrability [34] may be positively affected. Job relevance is given as our UAS supports users (e.g., management accountants) in performing their task of creating visualizations for reports. The output quality may increase due to adherence to scientific found BIV guidelines. Since reports are a mean of communication and it can be measured if a visualization adheres to a set of predetermined guidelines, result demonstrability is given.

Since the TAM is a widely employed model of adoption and use and has shown to be highly predictive for these items [34], we are going to use it as theoretical background to evaluate our UAS on BIV acceptance.

3.2 Development Method

For the development of the prototype we draw on the human-centered design (HCD) process, that is frequently used in the domain of human computer interaction [35]. The four-staged iterative process comprises *specifying the context of use*, *specifying the user requirements*, *producing a design solution*, and *evaluating the artifact* [35].

The *context of use* is in our case SSBI, in which users widely generate and analyze relevant information without the support of reporting specialists [36]. These users are students of a management information system course. They can be regarded as prospective BIV professionals (e.g., information producer) as studies indicate that managers and students behave similarly [37]. In their role, they are confronted with management reports by either producing or consuming them or doing both.

The *user requirement* is to fulfill the specifications of predetermined BIV guidelines by using a UAS that helps to identify and correct inadequate BIV. As a result users may accept to adhere to adequate BIV.

With the subsequent step, *produce a design solution*, a prototype is developed, which follows the vertical prototyping concept since its system features are available in its final functionality, but limited in scope [38]. The final prototype will meet the requirements of the final application, but has not implemented all, but only a sample (e.g., truncated axis or inverted timelines) of the identified BIV guidelines.

The last step of the iterative part of the HCD process is the *evaluation of the artifact*. We use a two-staged approach for the evaluation. First we demonstrate the functionality of the prototype. In a second step we will evaluate the artifact on BIV acceptance referring to the TAM.

3.3 Design of the Software Prototype

Our UAS, the "BIV Assistant", analyzes graphics for inadequate BIV, e.g., a truncated axis that exaggerates the magnitude of a trend and therefore may lead to wrong decision making. In case the visualization shows inadequate BIV elements, the BIV Assistant will prompt a warning message based on the respective IBCS guideline. Being warned, users receive an explanation why the visualization is inappropriate. Hence, users may perceive adequate BIV as being useful for supporting decision making. In a next step, they may decide if the BIV Assistant should automatically amend the inadequate BIV by applying the relevant IBCS guideline. Herewith, the BIV Assistant helps the user to identify and correct inadequate BIV. Hence, it facilitates to adhere to the IBCS, which may result in an increased perceived ease of use and perceived usefulness.

The prototype of the BIV Assistant, is the result of the first iteration of the HCD process as described in the previous section. The current version of the BIV Assistant detects four different misleading visualization patterns, which refer to Courtis [39]. In his work, Courtis [39] graphically illustrates four misleading charts extracted from annual reports, together with a correct construction of each graph. The BIV Assistant addresses these visualizations and detects their inappropriateness by referring to specific guidelines from the IBCS.

The first is a truncated axis. Here, the BIV Assistant examines, if the starting value of the axis is zero. If not, based on the IBCS guideline CH 1.1, the warning message "Avoid truncated axes: Charts with value axes not starting at zero […] do not correspond to the numerical values upon which the chart is based. Therefore, value axes should generally start at zero" is displayed (see Figure 1). The user has the possibility to let the BIV Assistant automatically emend the inadequate BIV. Doing so, the BIV Assistant sets the starting value of the axis to zero.

The second misleading element, which can be detected by the BIV Assistant is an inverted timeline. Here the BIV Assistant examines if the values of the time axis are in descending order. In this case, the following message appears: "Your chart contains an inadequately visualized time series. In charts, horizontal axes visualize data series over time […] moving from left to right" [31]. This refers to the guideline UN 3.3-1 [31]. The BIV Assistant sorts the values to an ascending order to amend this chart.

Revealing filtered elements on the ordinate axis is the third deceptive element that prompts a warning, based on the IBCS guideline ST 3.2: “Your chart contains filtered values. If some important arguments […] are left out, the given answer will not be convincing” [31]. The correction of the element is done by clearing the filter.

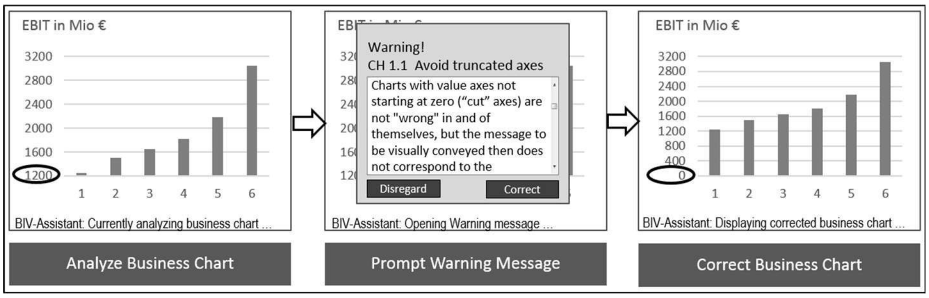

Fig. 1. BIV Assistant Prototype – Processing Steps

The last misleading element, which can be detected by the BIV Assistant are differently scaled axes in a combination chart. Referring to the IBCS guidelines CH4/ CH4.1, the following message appears: “Your chart contains differently scaled axes. Proper visual comparison requires the usage of identical scales […]. If presenting more than one chart […] on one page, use the identical scale for these charts” [31]. This distorted visualization is rectified by comparing the maximum values of the first and the second ordinate and adjusting the lower value to the higher.

4 Demonstration and Evaluation

Referring to Peffers et al. [14], a prototype has to demonstrate to solve one or more instances of the problem. Moreover it has to be evaluated how well the artifact supports a solution to the problem [14]. As suggested by Bucher et al. [40], the prototype got functionally evaluated by using a demonstration example. In our case, drawing on examples from Courtis [39], the prototype was successfully tested. The prototype demonstrated that it recognizes inadequate BIV, prompts a warning message in which the pitfalls of the diagram are described, and finally corrects the inadequate BIV to meet the respective requirements mentioned by Courtis [39].

Having finished the development of the prototype, it will be evaluated on BIV acceptance. The effect of the independent variable (i.e., assistance) on the dependent variable (i.e., acceptance of appropriate BIV) will be measured in a between-subject experimental design, where the subjects are randomly assigned into two groups. On a given business case, both groups will have to create or alter management reports using a SSBI tool while adhering to the IBCS. The treatment group may use the BIV Assistant, whereas the control group has to perform the task without any assistance. To evaluate the effect on acceptance, questionnaires with validated items from prior research from Venkatesh and Bala [34] will be used.

5 Discussion and Conclusion

BIV suffers from lack of acceptance due to insufficient software support. This unsatisfactory support can be confirmed by our study since no implemented software that assists to identify and correct misleading BIV could be found in literature. Even so, our prototype is a first approach to bridge this gap. At its current stage, it is limited with regard to the number of implemented guidelines. However, additional IBCS guidelines will be implemented during further development iterations. Although the prototype has demonstrated its functionality, the actual evaluation on BIV acceptance still has to be done. Therefore, in a next step the prototype will be evaluated in a between-subject experimental design, referring to validated items from prior research to test the BIV acceptance. Depending on the evaluation results, the overarching project's scientific contributions may be to underpin or disprove the relative importance of TAM constructs in the area of UAS for BIV. Generalizing our findings, we may contribute to how software-based UAS have to be designed to increase user acceptance. Practitioners who create management reports using SSBI (e.g., managers or management accountants) are addressed, as our artifact may assist in their everyday work.

References

1. Al-Kassab, J., Schiuma, G., Ouertani, M.Z., Neely, A.: Information Visualization to Support Management Decisions. International Journal of Information Technology and Decision Making 13, 407–428 (2014)
2. Riedner, T., Janoschek, N.: Information Design 2014. Status quo, Nutzen und Herausforderungen von Information-Design-Initiativen in der DACH-Region. Würzburg (2014)
3. Eisl, C., Losbichler, H., Falschlunger, L., Grabmann Elisabeth, Hofer, D., Greil, A.: Information Design in den Geschäftsberichten der Dax 30-Unternehmen. Eine empirische Studie der FH Oberösterreich und von KPMG (2015)
4. Eisl, C., Losbichler, H., Fischer, B., Hofer, P.: Reporting Design – Status quo und neue Wege in der internen und externen Berichtsgestaltung (2013)
5. Arunachalam, V., Pei, B.K.W., Steinbart, P.J.: Impression management with graphs: Effects on choices. Journal of Information Systems 16, 183–202 (2002)
6. Weide, G.: Management Reporting. CON 21, 5–12 (2009)
7. Timmler, V.: BER-Sprecher gibt zu ehrliches Interview - und fliegt, http://www.sueddeutsche.de/wirtschaft/flughafen-berlin-brandenburg-ber-sprecher-gibt-zu-ehrliches-interview-und-fliegt-1.2943897
8. Bullion, C. von and Ott, K.: Blamage mit Ansage, http://www.sueddeutsche.de/wirtschaft/probleme-beim-berliner-flughafen-lange-bekannt-blamage-mit-ansage-1.1367491
9. Bange, C., Bitterer, A., Derwisch, S., Fuchs, C., Grosser, T., Iffert, L., Janoschek, N., Keller, P., Seidler, L., Vitsenko, J.: BI Trend Monitor 2016 (2016)

10. Poonnawat, W., Lehmann, P.: Using Self-service Business Intelligence for Learning Decision Making with Business Simulation Games. In: Zvacek, S., Restivo, M.T., Uhomoibhi, J.O., Helfert, M. (eds.) CSEDU 2014 - Proceedings of the 6th International Conference on Computer Supported Education, Volume 2, pp. 235–240 (2014)
11. Griesfelder, R.: Eine vergessene Disziplin: Business Information Design (Teil 1). Controlling & Management Review, 66–68 (2014)
12. Maedche, A., Morana, S., Schacht, S., Werth, D., Krumeich, J.: Advanced User Assistance Systems. Business & Information Systems Engineering 58, 367–370 (2016)
13. Davis Jr, F.D.: A technology acceptance model for empirically testing new end-user information systems: Theory and results (1986)
14. Peffers, K., Tuunanen, T., Rothenberger Marcus A., Chatterjee, S.: A Design Science Research Methodology for Information Systems Research. Journal of Management Information Systems 24, 45–77 (2007)
15. Hevner, A.R., March, S.T., Park, J., Ram, S.: Design Science in Information Systems Research. MIS Quarterly 28, 75–105 (2004)
16. Ware, C.: Information Visualization: Perception for Design. Elsevier (2012)
17. Haake, P., Morana, S., Schacht, S., Zhou-Hartmann, L., Maedche, A.: Designing an End User Participation and Involvement Assistant for Continuous IS Development (2016)
18. J. Harkin, M. J. Callaghan, T. M. McGinnity, L. P. Maguire: Intelligent User-Support in Learning Environments for Remote Experimentation. In: Third International Conference on Information Technology and Applications (ICITA'05), 2, pp. 119–124 (2005)
19. Di Valentin, C., Emrich, A., Werth, D., Loos, P.: Assistance System for Personalized Learning in Vocational Education (2014)
20. Harding, B.A., Widener, E.R.: Lies, damn lies and statistics . . .: the use and abuse of business graphics. In: Frontiers in Education Conference, 1988., Proceedings, pp. 363–367 (1988)
21. Raschke, R.L., Steinbart, P.J.: Mitigating the Effects of Misleading Graphs on Decisions by Educating Users about the Principles of Graph Design. Journal of Information Systems 22, 23–52 (2008)
22. Beattie, V., Jones, M.J.: Measurement distortion of graphs in corporate reports: an experimental study. Accounting, Auditing & Accountability Journal 15, 546–564 (2002)
23. Woller-Carter, M.M., Okan, Y., Cokely, E.T., Garcia-Retamero, R.: Communicating and Distorting Risks with Graphs: An Eye-Tracking Study. Proceedings of the Human Factors and Ergonomics Society Annual Meeting 56, 1723–1727 (2012)
24. Tegarden, D.P.: Business Information Visualization. Communications of the AIS 1, 1–38 (1999)
25. Bačić, D., Fadlalla, A.: Business information visualization intellectual contributions: An integrative framework of visualization capabilities and dimensions of visual intelligence. Decision Support Systems 89, 77–86 (2016)

26. Card, S.K., Mackinlay, J.D., Shneiderman, B.: Readings in Information Visualization: Using Vision to Think. Morgan Kaufmann (1999)
27. Sweller, J.: Cognitive load theory. The psychology of learning and motivation: Cognition in education 55, 37–76 (2011)
28. Vessey, I.: Cognitive Fit: A Theory-Based Analysis of the Graphs Versus Tables Literature*. Decision Sciences 22, 219–240 (1991)
29. Few, S.: Show me the Numbers. Designing Tables and Graphs to Enlighten. Analytics Press, Burlingame, Calif. (2012)
30. Tufte, E.R.: Visual Explanations: Images and Quantities, Evidence and Narrative. Graphics Press (1997)
31. Hichert, R., Faisst, J.: International Business Communication Standards. IBCS Version 1.0 (2015)
32. Proff, D.U., Schulz, A.-K.: Visualisierungsgemeinschaft. Die Erstellung aussagekräftiger Berichte bekommt neuen Schub. Business Intelligence Magazine, 46–49 (2016)
33. Grund, C.K., Schelkle, M.: Developing a Serious Game for Business Information Visualization. In: Proceedings of the 22nd Americas Conference on Information Systems (AMCIS) (2016)
34. Venkatesh, V., Bala, H.: Technology Acceptance Model 3 and a Research Agenda on Interventions. Decision Sciences 39, 273–315 (2008)
35. Earthy, J., Jones, B.S., Bevan, N.: The improvement of human-centred processes—facing the challenge and reaping the benefit of ISO 13407. International Journal of Human-Computer Studies 55, 553–585 (2001)
36. Taschner, A.: Wie Management Reporting 2020 aussehen könnte. Controlling & Management Review, 8–15 (2014)
37. Gary E. Bolton, Axel Ockenfels, Ulrich W. Thonemann: Managers and Students as Newsvendors. Management Science 58, 2225–2233 (2012)
38. Floyd, C.: A Systematic Look at Prototyping. In: Budde, R., Kuhlenkamp, K., Mathiassen, L., Züllighoven, H. (eds.) Approaches to Prototyping, pp. 1–18. Springer Berlin Heidelberg, Berlin, Heidelberg (1984)
39. Courtis, J.K.: Corporate annual report graphical communication in Hong Kong: effective or misleading? Journal of Business Communication 34, 269–284 (1997)
40. Bucher, T., Riege, C., Saat, J.: Evaluation in der gestaltungsorientierten Wirtschaftsinformatik-Systematisierung nach Erkenntnisziel und Gestaltungsziel (2008)