The Impact of Quality Information Provided by Business Intelligence Systems on the Use of Information in Business Processes

Jurij Jaklič[1,2], Aleš Popovič[1,2], and Pedro Simões Coelho[1,2]

[1] Faculty of Economics, University of Ljubljana,
Kardeljeva pl. 17, 1000 Ljubljana, Slovenia
[2] Instituto Superior de Estatística e Gestão de Informação, University NOVA,
Campus de Campolide, 1070-312 Lisboa, Portugal
{jurij.jaklic,ales.popovic}@ef.uni-lj.si,
psc@isegi.unl.pt

Abstract. The main purpose of introducing business intelligence systems in a firm is to increase the quality of information available to knowledge workers at various organizational levels. However, quality information is of little value to firms if it has not been used in firm's business processes. Literature suggests the use of information mainly helps organizations in two ways, namely in managing their business processes and in making decisions. The quantitative analysis carried out on data from Slovenian medium and large organizations further shows that information quality differently impacts the two uses of information with impact on business process management being stronger.

Keywords: Business intelligence system, Information quality, Use of information, Decision making, Business process management, Structural equation modeling.

1 Introduction

The complexities of modern-day decisions are forcing firms to use information analysis tools to support their business decisions [1]. In a decision-support context, business intelligence systems emerged as a promising technological solution with a wide range of analytical capabilities to provide stakeholders at various organizational levels with valuable information for their decision-making [2]. Although the most often cited direct benefit of implementing a business intelligence system is improved quality of information for decision-makers [3], the business value of business intelligence systems can only result from changes and innovations in ways of working [4]. If we think of business intelligence systems as providing (quality) business information and business analysis in support of fact-based decisions in the context of business processes, it becomes clear that business intelligence systems are closely linked to business processes when delivering business value [5].

Firms today are repeatedly recognizing that making quality decisions depends upon the quality of information available to support these decisions [6], thus making the provision of quality information the key to gaining a competitive advantage [7; 8; 9].

M.M. Cruz-Cunha et al. (Eds.): CENTERIS 2011, Part I, CCIS 219, pp. 158–167, 2011.

Yet, simply acquiring or possessing information is not directly related to firm's performance, but it is rather the utilization of information (as reflected in the decision-making process) that is the key link between information acquisition and the firm's performance [10]. If firms want the available quality information to contribute to their performance it must be used within business processes to improve the decision-making [11], process execution [12] or ultimately to fulfill consumer needs [8].

With this research we aim to address the question of how does quality information provided by business intelligence systems affect different uses of information within firm's business processes. The purpose of the paper is therefore to explore the impact of information quality provided by business intelligence systems on different contexts of information use in business processes.

The outline of the paper is as follows: Section 2 introduces the fields of information quality and the use of information in business processes. Section 3 aims to present the methodological framework for the study, while Section 4 deals with the testing of the proposed research model and hypotheses. Section 5 concludes with a summary, a discussion of the main findings, and future work.

2 Information Quality and the Use of Information in Business Processes

In today's business environment quality information is a matter of primary interest. For more and more firms, information has increasingly become a critical resource and an asset in their business processes [13]. According to [14], for firms' "processes that depend on information, the quality of information is one of the key determinants of the quality of their decisions and actions". The contribution of high-quality information to firms is that it makes it easier to convert available information into knowledge, by helping to interpret and evaluate the information, by assisting the connection with prior knowledge, and by facilitating the application of the information to new contexts [15].

While it is broadly recognized that information plays a critical role in the success of firms [16; 17; 18], any information acquired by decision-makers will deliver little impact on final firm performance if it is not actually used in the making of decisions [19; 20]. In the view of [21], the value of information increases with the use of information. To contribute to firm performance information must be good quality and support decisions in those organizational processes whose results add value to firms. Many authors [11; 22; 23] suggest in quite a limited way that better information quality would improve firm performance, but provide no detailed explanations regarding this relationship. [24], however, maintains that better information and access to information per se do not affect firm performance; the key question is instead what firms do with such information [25].

Our research focus is presented in Figure 1. It has been previously established that business intelligence systems maturity [3] along with appropriate business knowledge for business intelligence initiatives [2] positively affects the quality of available information within firms. Moreover, information use is a critical aspect of information

processing since in this phase the acquired and disseminated information is applied to strategic and tactical outcomes to impact firm performance [26]. We thus focus in this paper on the relationship between information quality provided by business intelligence systems and the use of information in business processes.

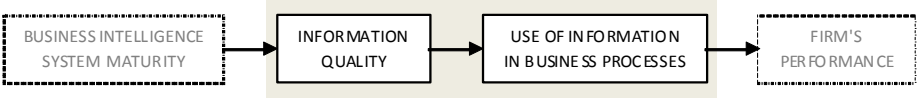

Fig. 1. Research focus

The relevance of information quality in the business process context has been previously acknowledged [27; 28], but its use and impact on processes rarely researched [29]. According to [30], quality information is a key element in business process management by enabling the follow up of results, online process analysis and control, and consecutively the dynamic adjustment of the firm. [31] similarly points out the link with business processes by asserting that information provided by business intelligence systems enable process analysis to help understand real-time and historical performance, enable users define and share best practices for the process, and help look for bottlenecks and drive real-time adjustments. Seen more broadly, the quest for delivering value to firms via business intelligence systems can be regarded as a matter of determining how a firm can use the information provided through business intelligence systems "to improve management processes (such as planning, controlling, measuring, monitoring, and/or changing) so that management can increase revenues, reduce cost, or both and/or to improve operational processes (such as sales, order processing, purchasing) so that the business can increase revenues, reduce costs or both" [5]. Literature on information and knowledge utilization [13; 16; 18; 32; 33; 34; 35; 36] suggests the use of information mainly helps organizations in two ways: 1) in managing their business processes; and 2) in making decisions.

With process orientation gaining importance [30; 37], the need to effectively manage business processes is of great importance resulting in new requirements for decision support. Supplying information related to business processes enables the measurement of process performance and helps firms identify opportunities for process improvement [18; 38]. With a broader view of their business processes, firms ensure that business processes provide maximum benefits to the firm. Many researchers have shown interest in exploring the relationship between the use of information and process management: [39], using Xerox as an example, explains how quality information was applied to improvement actions such as improving products, business processes, and improving the understanding of customer needs, [26] explore the effect of a firm's strategy type and the use of information on new product outcomes, and [40] explore how effective use of quality information affects quality performance and process performance to facilitate management of supplier relationship, product/service design, and process management.

Literature [16; 18; 41] suggests available information in organizational processes pinpoints problems regarding process execution and exposes them to managers and other users within the organization. Further, information actively supports continuous

process improvement programs [18], business process change initiatives [38; 41] and, as suggested by field experts, assessments against process standards (such as Six Sigma or the ISO 9001 standard). Several researchers moreover suggest that information motivates new innovations in firms' internal processes [18; 42] as well as external services [43].

The impact and use of information for decision-making has been extensively researched in the literature: [44] inspected how managers in publishing and telecommunication industries use information to make day-to-day decisions and formulate longer term strategies, [45] analyzed the impact of information usage on clinical decision-making, [32] studied the impact of information usage on decision-making in government departments, [36] researched the impact of information utilization on corporate decision-making in the UK banking sector, [46] researched this impact on the insurance sector whereas [47] analyzed this impact on the pharmaceutical industry. In a case study of Singapore's managers, [33] investigated how information is used as a tool for management decision-making.

According to [48], any attempt to value information within an organization has to be looked at in the context of the activity or decision it affects. The value of information depends on the information's relevance to the decision to be made, and on its precision, cost and reliability [49]. In an ideal situation, decision-makers would utilize information from those sources perceived to offer the highest quality information.

Regarding the use of information in decision-making processes literature suggests many potential beneficial effects for organizations, such as: reducing uncertainty [36; 50; 51; 52], enhancing confidence [22; 33], improving operational effectiveness [53; 54], reacting to business events [16; 48], performing proactive business planning, and supporting changes in corporate strategies and plans [55; 56].

Based on the extensive literature review of the fields in question we put forward the following two hypotheses:

H1: Information quality positively affects information use for business process management.

H2: Information quality positively affects information use for business decision making.

3 Methodology

This study employed a survey to obtain data measuring participants' perceptions of available information quality and perception about the use of information in business processes. The questionnaire was developed by building on the previous theoretical basis in order to ensure content validity. Pre-testing was conducted using a focus group involving academics interested in the field and semi-structured interviews with selected firms who were not interviewed later. This was also used to assure face validity. We used a structured questionnaire with a combination of 7-point Likert scales and 7-point semantic differentials.

In order to assess information quality we adopted previously researched and validated indicators provided by Eppler [57]. We included 11 of the information quality criteria from Eppler's framework in the research instrument (Table 1).

For measuring use of information in business processes we used indicators available in the reviewed literature and those obtained from the pilot study. Since there were no previously validated indicators generally applicable to this study, we made some modifications to existing indicators and added ones derived from the pilot study (see Table 1). The pool of indicators for measuring the use of information corresponds to previously established uses of information in business processes (see Chapter 2).

This study's target population were Slovenian medium and large size firms (at the time of data gathering 1,329 met the criteria according to the Slovenian Agency of Public Records and Related Services). Empirical data for this research were collected by means of paper and Web-based survey. Questionnaires were addressed to CIOs and senior managers estimated as having adequate knowledge about the quality of available information for decision-making and the use of information in business processes. The final response rate was near 14%.

Table 1. Indicators for the constructs.

Construct	Label	Indicator (description)
		(1 = Strongly Disagree … 7 = Strongly Agree)
Information Quality	IQ1	The scope of information is adequate (neither too much nor too little).
	IQ2	The information is not precise enough and not close enough to reality.
	IQ3	The information is easily understandable by the target group.
	IQ4	The information is to the point, without unnecessary elements.
	IQ5	The information is contradictory.
	IQ6	The information is free of distortion, bias or error.
	IQ7	The information is up-to-date and not obsolete.
	IQ8	The information provision corresponds to the user's needs and habits.
	IQ9	The information is processed and delivered rapidly without delay.
	IQ10	The background of the information is not visible (author, date etc.).
	IQ11	Information consumers cannot interactively access the information.
		The available information within our organization's processes …
Use of information for BPM	UI1	… exposes the problematic aspects of current business processes and makes stakeholders aware of them.
	UI2	… provides valuable input for assess business processes against standards, for continuous process improvement programs, and for business process change projects.
	UI3	… stimulates innovation in internal business processes and external service delivery.
Use of information for decision making	UI4	Information reduces uncertainty in the decision-making process, enhances confidence and improves operational effectiveness.
	UI5	Information enables us to rapidly react to business events and to perform proactive business planning.
	UI6	We are using the provided information to make changes in corporate strategies and plans, modify existing KPIs and analyze newer KPIs.

4 Results

We analyzed the gathered data using a form of structural equation modeling ('SEM'). For the estimation of the model we employed SEM-PLS (Structural Equation Models by Partial Least Squares) [58].

We first examined the reliability and validity measures for the constructs in the model. In the initial model not all reliability and convergent validity measures were satisfactory. Once all the items that did not load satisfactorily had been removed, the model was rerun. Figure 2 shows the results of testing the measurement model in the final run. In the final model all Cronbach's Alphas exceed the 0.70 threshold and were above to 0.80. Without exception, latent variable composite reliabilities are higher than 0.80, and in general near 0.90, showing a high internal consistency of indicators measuring each construct and thus confirming construct reliability. The average variance extracted ('AVE') is mostly around or higher than 0.60, indicating that the variance captured by each latent variable is significantly larger than variance due to measurement error, and thus demonstrating a convergent validity of the constructs. Reliability and convergent validity of the measurement model was also confirmed by computing standardized loadings for indicators and bootstrap *t*-statistics for their significance. All standardized loadings exceed (or were very marginal to) the 0.70 threshold and they were found, without exception, significant at 0.1% significance level, thus confirming a high convergent validity of the measurement model.

To assess discriminant validity, the following two procedures were used: 1) a comparison of item cross loadings to construct correlations, and 2) determining whether each latent variable shares more variance with its own measurement variables or with other constructs. The first procedure for testing discriminant validity was to assess the indicator loadings on their corresponding construct. All the item loadings met the requirements of the first procedure in the assessment of discriminant validity. For the second procedure we compared the square root of the AVE for each construct with the correlations with all other constructs in the model. All the constructs show evidence for acceptable validity.

A bootstrapping with 1,000 samples has been conducted to test the hypothesized relationships between the constructs. As shown in Figure 2, the standardized path coefficients range from 0.562 to 0.620 while the R^2 is moderate, i.e. between 0.316 and 0.385, for both endogenous constructs. We can see that about 39% of the variance in use of information for business process management is explained by the influence of information quality, while about 32% of the variance in use of information for decision making is explained by the influence of information quality.

As indicated by the path loadings, information quality has significant direct and different positive influences on information use for process management ($\hat{\beta} = 0.620$, $p < 0.001$) and use for decision making ($\hat{\beta} = 0.562$, $p < 0.001$). The *t*-statistic for the difference of the two impacts is 2.4 with $p = 0.003$ hence confirming that the two hypothesized impacts are indeed different. These results thus confirm our theoretical expectation and provide support for *H1* and *H2*.

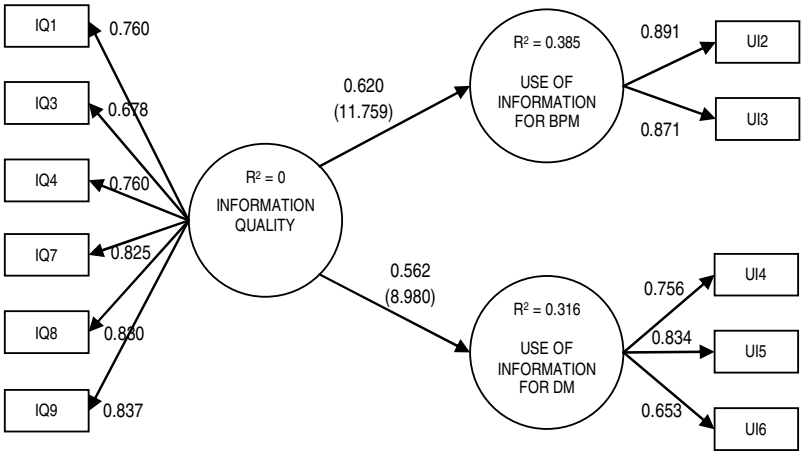

Fig. 2. Final model of information quality impact on different uses of information in business processes

5 Conclusions, Limitations and Future Work

One of the most important characteristics determining the degree to which information is used is its quality. This study analyses the relationship between information quality and the use of information in business processes. The use of information construct, as conceptualized in our model, reflects the role of information for managing business processes and for decision-making in business processes. For managing business processes information provides valuable input for business process assessment against standards, for continuous process improvement programs, and for process change projects. In decision-making, information reduces uncertainty, enables organizations to rapidly react to business events, and supports firms in making changes in corporate strategies, plans and performance indicators.

While it is widely recognized that information plays a critical role in the success of firms, information acquired by decision-makers will bear little impact on ultimate firm performance if it is not actually put to use in the making of decisions. Nevertheless, decision-making use of information appears to be less important than the relevance of information use in the business process management context. It seems as firms primarily seek to improve business process management practice through the generated information that help analysts tune the processes to serve their purposes better. The less intensive use of information for decision-making might be the result of less developed fact-based decision-making culture in firms.

A limitation of this research is the cross-sectional nature of the data gathered. In fact, although the research and measurement model are well supported by theoretical assumptions and previous research findings, the ability to draw conclusions through our causal model would be strengthened with the availability of longitudinal data. For this reason, in future research other designs such as experimental and longitudinal designs should be tested. Moreover, future research could also focus on testing the

proposed model on individual industries and comparing results between them. Last but not least, it would also be useful to validate the proposed model in an international setting with comparable firms, since due to cultural differences we can expect different impact in our model.

References

1. Nemati, H.R., Steiger, D.M., Iyer, L.S., Herschel, R.T.: Knowledge warehouse: an architectural integration of knowledge management, decision support, artificial intelligence and data warehousing. Decision Support Systems 33(2), 143–161 (2002)
2. Coelho, P.S., Popovič, A., Jaklič, J.: The Role of Business Knowledge in Improving Information Quality Provided by Business Intelligence Systems. In: Quintela Varajão, J.E., Cruz-Cunha, M.M., Putnik, G.D., Trigo, A. (eds.) ENTERprise Information Systems, vol. 110, pp. 148–157. Springer, Heidelberg (2010)
3. Popovič, A., Coelho, P.S., Jaklič, J.: The impact of business intelligence system maturity on information quality. Information Research 14(4) (2009)
4. Peppard, J., Ward, J., Daniel, E.: Managing the Realization of Business Benefits from IT Investments. MIS Quarterly Executive 6(1), 1–11 (2007)
5. Williams, S., Williams, N.: The Profit Impact of Business Intelligence. Morgan Kaufmann, San Francisco (2007)
6. Ge, M., Helfert, M.: A theoretical model to explain effects of information quality awareness on decision making, Funchal, Portugal (June 12-16, 2007)
7. English, L.P.: Information Quality and Management Transformation (2007), http://www.b-eye-network.com/view/5679 (retrieved January 5, 2008)
8. Salaun, Y., Flores, K.: Information quality: Meeting the needs of the consumer. International Journal of Information Management 21(1), 21–37 (2001)
9. Ruževičius, J., Gedminaitė, A.: Business Information Quality and its Assessment. Engineering Economics 52(2), 18–25 (2007)
10. Souchon, A.L., Diamantopoulos, A.: A Conceptual Framework of Export Marketing Information Use: Key Issues and Research Propositions. Journal of International Marketing 4(3), 49–71 (1996)
11. Raghunathan, S.: Impact of information quality and decision-maker quality on decision quality: a theoretical model and simulation analysis. Decision Support Systems 26(4), 275–286 (1999)
12. Najjar, L.: The Impact of Information Quality and Ergonomics on Service Quality in the Banking Industry. University of Nebraska, Lincoln (2002)
13. Kirk, J.: Information in organisations: directions for information management. Information Research 4(3) (1999), retrieved from http://informationr.net/ir/4-3/paper57.html
14. Stvilia, B., Gasser, L., Twidale, M.B., Smith, L.C.: A framework for information quality assessment. Journal of the American Society for Information Science and Technology 58(12), 1720–1733 (2007)
15. Eppler, M.J., Wittig, D.: Conceptualizing Information Quality: A Review of Information Quality Frameworks from the Last Ten Years. Paper presented at the Fifth Conference on Information Quality, University of St. Gallen (2000)
16. Choo, C.W.: The knowing organization: How organizations use information to construct meaning, create knowledge and make decisions. International Journal of Information Management 16(5), 329–340 (1996)

17. Puffer, S.M., McCarthy, D.J.: A framework for leadership in a TQM context. Journal of Quality Management 1(1), 109–130 (1996)
18. Davenport, T.H.: Process Innovation: Reengineering Work Through Information Technology. Harvard Business School Press, Boston (1993)
19. Davenport, T.H., Beers, M.C.: Managing information about processes. Journal of Management Information Systems 12(1), 57 (1995)
20. Diamantopoulos, A., Souchon, A.L.: Measuring Export Information Use: Scale Development and Validation. Journal of Business Research 46(1), 1–14 (1999)
21. Liautaud, B.: e-Business Intelligence: Turning Information into Knowledge into Profit. McGraw-Hill, New York (2001)
22. Al-Hakim, L.: Information Quality Management: Theory and Applications. Idea Group Pub., USA (2007)
23. Slone, J.P.: Information Quality Strategy: an Empirical Investigation of the Relationship between Information Quality Improvements and Organizational Outcomes. Capella University, Minneapolis (2006)
24. Collins, J.: Good to Great: Why Some Companies Make the Leap ... and Others Don't. HarperCollins, New York (2001)
25. Howson, C.: Successful Business Intelligence: Secrets to Making BI a Killer App., 1st edn. McGraw-Hill Osborne Media, New York (2007)
26. Citrin, A.V., Lee, R.P., McCullough, J.: Information Use and New Product Outcomes: The Contingent Role of Strategy Type. Journal of Product Innovation Management 24(3), 259–273 (2007)
27. Davenport, T.H., Short, J.E.: The New Industrial Engineering: Information Technology And Business Process Redesign. Sloan Management Review 31(4), 11–27 (1990)
28. Kettinger, W.J., Grover, V.: Special section: toward a theory of business process change management. Journal of Management Information Systems 12(1), 9–30 (1995)
29. Grover, V., Kettinger, W.J.: Process Think: Winning Perspectives for Business Change in the Information Age. Idea Group Inc. (IGI), USA (1999)
30. Kovačič, A., Bosilj-Vukšić, V.: Management poslovnih procesov: prenova in informatizacija poslovanja s praktičnimi primeri. GV založba, Ljubljana (2005)
31. Cunningham, D.: Aligning Business Intelligence with Business Process (2005), http://www.tdwi.org/Publications/WhatWorks/display.aspx?id=7728 (retrieved December 30, 2007)
32. Winterman, V., Smith, C., Abell, A.: Impact of information on decision making in government departments. Library Management 19(2), 110–132 (1998)
33. de Alwis, S.M., Higgins, S.E.: Information as a tool for management decision making: a case study of Singapore. Information Research 7(1) (2001), retrieved from http://informationr.net/ir/7-1/paper114.html
34. Hicks, B.J.: Lean information management: Understanding and eliminating waste. International Journal of Information Management 27(4), 233–249 (2007)
35. Hicks, B.J., Culley, S.J., McMahon, C.A.: A study of issues relating to information management across engineering SMEs. International Journal of Information Management 26(4), 267–289 (2006)
36. Reid, C., Thomson, J., Wallace-Smith, J.: Impact of information on corporate decision making: the UK banking sector. Library Management 19(2), 86–109 (1998)
37. Gartner: Meeting the Challenge: The 2010 CIO Agenda. Gartner Executive Programs, Stamford (2010)

38. Davenport, T.H., Short, J.E.: Information technology and business process redesign. Operations Management: Critical Perspectives on Business and Management 1, 1–27 (2003)
39. Zhang, Q.: Quality dimensions, perspectives and practices. International Journal of Quality & Reliability Management 18(7), 708–722 (2001)
40. Zu, X., Fredendall, L.D., Douglas, T.J.: The evolving theory of quality management: The role of Six Sigma. Journal of Operations Management 26, 630–650 (2008)
41. Hammer, M., Champy, J.: Reengineering the Corporation: A Manifesto for Business Revolution. Harper Business, New York (1993)
42. Cohen, W.M., Levinthal, D.A.: Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly 35(1), 128–152 (1990)
43. McFarlan, F.W.: Information technology changes the way you compete. Harvard Business Review 62(3), 98–103 (1984)
44. Auster, E., Choo, C.W.: How senior managers acquire and use information in environmental scanning. Information Processing & Management 30(5), 607–618 (1994)
45. Wood, F., Wright, P.: The impact of information on clinical decision making by General Medical Practitioners. Information Research 2(1) (1996), retrieved from http://informationr.net/ir/2-1/paper11.html
46. Smith, C., Winterman, V., Abell, A.: The impact of information on corporate decision making in the insurance sector. Library Management 19(3), 154–173 (1998)
47. Bouchet, M.L., Hopkins, T., Kinnell, M., McKnight, C.: The Impact of Information Use on Decision Making in the Pharmaceutical Industry. Library Management 19(3), 196–206 (1998)
48. Badenoch, D., Reid, C., Burton, P., Gibb, F., Oppenheim, C.: The value and impact of information. In: Feeney, M., Grieves, M. (eds.) The Value and Impact of Information. Bowker-Saur., London (1995)
49. Feldman, M.S., March, J.G.: Information in Organizations as Signal and Symbol. Administrative Science Quarterly 26(2), 171–186 (1981)
50. Chengalur-Smith, I.N., Ballou, D.P., Pazer, H.L.: The impact of data quality information on decision making: anexploratory analysis. IEEE Transactions on Knowledge and Data Engineering 11(6), 853–864 (1999)
51. Frishammar, J.: Information use in strategic decision making. Management Decision 41(4), 318–326 (2003)
52. Sjöberg, L.: Intuitive vs. analytical decision making: which is preferred? Scandinavian Journal of Management 19(1), 17–29 (2003)
53. Nutt, P.C.: The formulation process and tactics used in organizational decision making. Organization Science 4(2), 226–251 (1993)
54. Wijnberg, N.M., van den Ende, J., de Wit, O.: Decision Making at Different Levels of the Organization and the Impact of New Information Technology: Two Cases from the Financial Sector. Group Organization Management 27(3), 408–429 (2002)
55. Al-Mashari, M., Zairi, M.: BPR implementation process: an analysis of key success and failure factors. Business Process Management Journal 5(1), 87–112 (1999)
56. Sen, K.: Does the measure of information quality influence survival bias? International Journal of Quality and Reliability Management 18(9), 967–981 (2001)
57. Eppler, M.J.: Managing Information Quality: Increasing the Value of Information in Knowledge-Intensive Products and Processes, 2nd edn. Springer, Heidelberg (2006)
58. Ringle, C.M., Wende, S., Will, A.: SmartPLS 2.0 M3. University of Hamburg (2007)