Contributions to Management Science

Carlo Caserio · Sara Trucco

Enterprise Resource Planning and Business Intelligence Systems for Information Quality

An Empirical Analysis in the Italian Setting

Springer

Contributions to Management Science

More information about this series at http://www.springer.com/series/1505

Carlo Caserio · Sara Trucco

Enterprise Resource Planning and Business Intelligence Systems for Information Quality

An Empirical Analysis in the Italian Setting

Springer

Carlo Caserio
Faculty of Economics
Università degli Studi eCampus
Novedrate
Italy

Sara Trucco
Faculty of Economics
Università degli Studi Internazionali di Roma
Rome
Italy

ISSN 1431-1941 ISSN 2197-716X (electronic)
Contributions to Management Science
ISBN 978-3-319-77678-1 ISBN 978-3-319-77679-8 (eBook)
https://doi.org/10.1007/978-3-319-77679-8

Library of Congress Control Number: 2018936625

Printed on acid-free paper

This Springer imprint is published by the registered company Springer International Publishing AG part of Springer Nature
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

To my family

Carlo Caserio

To my Mom and Dad

Sara Trucco

Preface

Nowadays, Information Technology (IT) innovations, the advent of the Internet, and the ease of finding and sharing information are all elements that contribute to obtaining overwhelming amounts of data and information. On the one hand, managers can now easily find and store information, and on the other hand, this hyper-amount of data does not allow us to distinguish between “good” and “bad” information. Furthermore, the data and information stored in enterprise databases may be obsolete, inaccurate, irrelevant, or partial. In other words, companies do not find it difficult to acquire and store a huge “quantity” of data and information. Their problem instead is to obtain an adequate level of “quality” of data and information. The point is that the increased volume of data and information can undermine the capacity of companies to discern quality from non-quality data and information, and this difficulty is even more crucial when we consider that we are living in an information economy where data, information, and knowledge become extremely strategic for companies. Therefore, the quality of information deserves particular attention.

Although IT has played a key role in bringing about information overload and underload, possible solutions to these phenomena are still being sought in the IT field. Integrated systems, data management systems, data warehousing, data mining, and knowledge discovery tools are some examples of IT solutions that companies are adopting to deal with information overload/underload. One of the most effective solutions seems to be the implementation of Enterprise Resource Planning (ERP) systems, which improve data quality, data integrity, and system integration.

In addition to improving data quality and system integration, companies also aim at improving their capacity to perform data analysis. As a matter of fact, in order to pursue the objective of improving the quality of information, companies need to pay attention both to the quality of incoming data and to the capacity to analyze it and deliver the resulting information to the right person, at the right time. Therefore, Business Intelligence (BI) systems are another important solution that companies use to improve their data analysis and processing capabilities and to recognize and select relevant data for a more effective decision-making process.

This manuscript will examine, through an empirical analysis, the role played by ERP and BI systems in reducing or managing information overload/underload and thus in improving the information quality perceived by the Italian manager. The research is based on the idea that the improvement of information systems, achievable by means of ERP and BI systems, may reduce or eliminate information overload/underload. We also investigate whether the combined adoption of ERP and BI systems is more effective in dealing with information overload/underload than would be the single adoption of ERP or BI systems. Furthermore, the research presented in this book examines the influence that ERP and BI systems may have on the features of information flow—such as information processing capacity, communication and reporting, the frequency of meetings, and information sharing—and, in turn, the influence of information flow features on information quality.

The research was made possible by the financial support of the Università degli Studi Internazionali di Roma (UNINT).

This study is part of a larger project on accounting information systems.

Novedrate, Italy Carlo Caserio
Rome, Italy Sara Trucco

Contents

Chapter 1
Introduction

Abstract The manuscript aims at analyzing the role played by ERP, BI systems and the combined adoption of ERP and BI in reducing or managing information overload/underload, and thus in improving the information quality perceived by Italian managers. Furthermore, the manuscript analyzes the effects of information flow on the perceived information quality. The analysis was carried out through a survey on a sample of 300 managers who work for Italian listed or non-listed companies of varying size. The participants—Chief Information Officers, Chief Technology Officers, Chief Executive Officers and Controllers—were randomly selected from the LinkedIn social network database, since some scholars have recently stressed the relevance and widespread use of this social media application. We received back 79 answers, with a 26% rate of response. A set of regression and t-test analyses was performed. The main practical implication of our research is that it helps managers understand the impacts an investment in ERP or BI systems could have on information management and on the decision-making process. Other practical implications pertain to the methodology used in our study: in fact, managers may conduct an internal survey similar to that used for this study to assess the pre-conditions for investing in ERP and/or BI systems by (a) examining the information quality perceived by employees and managers, (b) analyzing the employees' and managers' perception of information overload/underload, and (c) investigating the perception of employees and managers regarding the current IT.

1.1 A Brief Overview of the Book

Nowadays, Information Technology (IT) innovations, the advent of the Internet, and the ease of finding and sharing information are all elements that contribute to obtaining overwhelming amounts of data and information. The storage of terabytes of data and information is becoming commonplace (Abbott 2001), and this huge volume of easily available information is only apparently a benefit for companies. In fact, on the one hand, managers can now easily find and store information, and

C. Caserio and S. Trucco, *Enterprise Resource Planning and Business Intelligence Systems for Information Quality*, Contributions to Management Science,
https://doi.org/10.1007/978-3-319-77679-8_1

on the other this hyper-amount of data does not allow us to distinguish between "good" and "bad" information. The literature shows that organizations have far more information than they can possibly use, and at the same time they do not have the information they would actually need (Abbott 2001; Eckerson 2002). Furthermore, the data and information stored in enterprise databases may be obsolete, inaccurate, irrelevant, or partial. In other words, companies do not find it difficult to acquire and store a huge "quantity" of data and information. Their problem instead is to obtain an adequate level of "quality" of data and information (Al-Hakim 2007; Wang et al. 2005). The point is that the increased volume of data and information can undermine the capacity of companies to discern quality from non-quality data and information, and this difficulty is even more crucial when we consider that we are living in an information economy where data, information and knowledge become extremely strategic for companies (Eckerson 2002).

Therefore, information overload (and underload) deserves particular attention. Information overload arose in the 1970s as a consequence of the information age and its widespread use of organizational computing systems (Bettis-Outland 2012). The initial studies on information overload/underload recognized the lack of relevant information as one of the weaknesses of management information systems (Ackoff 1967). Other important studies emphasized that information overload happens every time the quantity of information surpasses an individual's information processing resources, whereas information underload occurs when managers receive less than the amount of information necessary for their job tasks (O'Reilly 1980). More recent studies confirm that information overload is still a critical issue affecting decision-making process in several business fields (Soucek and Moser 2010; Letsholo and Pretorius 2016; Ho and Tang 2001; Rodriguez et al. 2014).

Although IT has played a key role in bringing about information overload and underload, possible solutions to these phenomena are still being sought in the IT field. Integrated systems, data management systems, data warehousing, data mining and knowledge discovery tools are some examples of IT solutions that companies are adopting to deal with information overload/underload.

One of the most effective solutions seems to be the implementation of Enterprise Resource Planning (ERP) systems, which improve data quality, data integrity and system integration. As an example, Markus and Tanis (2000), Rajagopal (2002) and Karimi et al. (2007) recognize the following benefits from ERP systems:

(1) ERPs eliminate multiple data entry and concomitant errors;
(2) ERPs simplify data analysis;
(3) ERPs improve data integration, since they allow for the management and sharing of data related to products, services and business activities.

In addition to improving data quality and system integration, companies also aim at improving their capacity to perform data analysis. As a matter of fact, in order to pursue the objective of improving the quality of information, companies need to pay attention both to the quality of incoming data and to the capacity to analyze it and deliver the resulting information to the right person, at the right time (Agarwal and Dhar 2014; Herschel and Jones 2005). Therefore, Business Intelligence (BI) systems are another important solution that companies use to improve their data analysis and processing capabilities, and to recognize and select relevant data for a more effective decision-making process.

This manuscript will examine, through an empirical analysis, the role played by ERP and BI systems in reducing or managing information overload/underload, and thus in improving the information quality perceived by the Italian manager. The research is based on the idea that the improvement of information systems, achievable by means of ERPs and BI systems, may reduce or eliminate information overload/underload. We also investigate whether the combined adoption of ERP and BI systems is more effective in dealing with information overload/underload than would be the single adoption of ERP or BI systems.

ERP and BI systems may play a crucial role in improving the quality of data management and analysis. The combined use of both ERP and BI systems is expected to be more effective than the single use of one of them.

Furthermore, the research presented in this book also examines the influence that ERP and BI systems may have on the features of information flow—such as information processing capacity, communication and reporting, the frequency of meetings, and information sharing—and, in turn, the influence of information flow features on information quality.

1.2 Theoretical Contributions of the Present Work

From a theoretical standpoint, the present work contributes to shedding some light on:

- The relationship between ERP and information overload/underload and between ERP and features of information flow. The empirical results of our research show that ERP systems do not affect the perception of information overload/underload. However, some effects of the implementation of ERP systems is recognizable in other items, which are indirectly connected to the quality of information. For example, empirical results show that respondents adopting ERP perceive higher data accuracy and system reliability and, in general, a higher information processing capacity than do respondents not adopting ERP. Furthermore, the results show that companies adopting ERP have a more structured reporting system, as information is more frequently communicated on a monthly or a 6-month basis, with respect to companies that do not adopt ERP. These perceptions, though probably not connected to the perception of information overload/underload, indicate that the use of ERP has a positive impact on information system quality and information quality items. This supports that part of the literature which supports the idea that ERP improves data quality, information quality and information system quality in general

(Bingi et al. 1999; Dell'Orco and Giordano 2003; Chapman and Kihn 2009; Scapens and Jazayeri 2003).

- The relationship between BI and information overload/underload and between BI and features of information flow. Our results show that respondents adopting BI systems do not perceive a different level of information overload or underload than do respondents who do not adopt BI systems. However, a more detailed analysis shows that managers of companies adopting BI systems perceive a higher data accuracy, a higher level of information processing capacity, and a more regular reporting system, based on a systematic monthly frequency. Furthermore, our empirical results also show that respondents adopting BI systems perceive a higher information quality with respect to respondents that do not adopt BI. Therefore, the higher data accuracy and information quality perceived by BI system adopters can be due to the improvements that BI brings to the entire data-information-decision cycle. Regarding the perception of respondents pertaining to the more regular reporting system, this result is probably an effect of the capacities of BI systems, well-recognized by the literature, which consists in providing the right information at the right time to the right person (Burstein and Holsapple 2008). A regular and systematic reporting system could be, in fact, the effect of an accurate reporting design process carried out before implementing a BI system. A successful BI implementation should require managers to define the features of the information and reports they will need, including the frequency with which they wish to receive them (Eckerson 2005; Foshay and Kuziemsky 2014; Nita 2015). Moreover, respondents adopting BI perceive a better information processing capacity, due to the variety of opportunities provided by BI systems regarding data elaboration and information flow (Boyer et al. 2010; Brien and Marakas 2009; da Costa and Cugnasca 2010; Smith et al. 2012; Spira 2011).
- The relationship between the combined use of ERP and BI and information overload/underload and between the combined use of ERP and BI and features of information flow. The empirical results show that respondents adopting both an ERP and a BI system do not perceive higher or lower information overload or information underload than do the other respondents. This is partially aligned with the literature, which suggests that information problems, caused by a lack of systematic information collection and processing, make BI tasks more and more difficult (Li et al. 2009). In other words, this result suggests that in companies where information collection and processing are not appropriately managed from the beginning, the potential benefits of BI systems are weakly perceived or not perceived at all. Interestingly, our results also show that respondents who have implemented both ERP and BI systems perceive a higher level of information processing capacity than do respondents who adopt only ERP or BI. Therefore, despite the fact managers do not perceive that ERP and BI improve information overload/underload, they recognize that these systems improve the capacity of the company to process information. Our results are thus not fully supported by the literature, which suggests that the simultaneous use of ERP and BI systems should have more of an effect on the information

flow features than would the single adoption of ERP or BI (Berthold et al. 2010; Chapman and Kihn 2009; Horvath 2001; Scheer and Habermann 2000).
- The relationship between the information quality perceived by managers and features of information flow. Our empirical evidence reveals the features which can affect the information quality perceived by managers. In particular, we found that information processing capacity and communication and reporting affect, in different ways, the perceived information quality.

1.3 Managerial Implications of the Present Work

Some implications for practitioners emerge from both the theoretical and empirical analyses.

The main practical implication of our research is that it helps managers to understand the impacts an investment in ERP or BI systems could have on information management and on the decision-making process. The results of our research show, in fact, that the use of ERP and BI systems have indirect effects on information overload and underload.

Our study may also have implications for managers operating in sectors characterized by high uncertainty, since the use of ERP and BI systems is a possible solution to deal with the ambiguity arising from information overload.

As a consequence, other managerial implications are related to the possibility of adopting ERP and BI systems to improve information flow, increase information quality and support strategic decisions.

In addition, further useful insights are provided by our research from a theoretical perspective: first, managers could support their decisions to invest in BI based on the taxonomy of BI needs emerging from the literature and summarized in this study; second, the understanding of critical success factors for the implementation of ERP and BI systems may help managers to develop an effective implementation project; third, the acknowledgement of the effects of ERP and BI on information quality and on information overload and underload may support managers in selecting the system they need the most; fourth, the literature analysis presented in this study may help managers in evaluating the opportunity to maintain their legacy systems and to invest in ERP or in Extended-ERP and/or in BI systems, according to their particular needs, characteristics and objectives.

Other practical implications derive from the methodology used in our study: in fact, managers may conduct an internal survey similar to that used for this study in order to assess the pre-conditions for investing in ERP and/or in BI systems: (a) by examining the information quality and the information system quality perceived by employees and managers; (b) by analyzing the employees' and managers' perceptions of information overload/underload; (c) by investigating the perception of employees and managers regarding the appropriateness of information provided by the present systems.

1.4 Structure of the Book

The remainder of the book is divided into 5 chapters:

- Chapter 2 deals with the characteristics of ERP systems and their effects on information quality, according to the literature;
- Chapter 3 refers to BI systems and to the most important aspects which make these systems crucial for information quality and for companies' support;
- Chapter 4 presents the research design and the analysis of ERP and BI systems with respect to information quality;
- Chapter 5 shows the research methodology applied, the empirical analysis and the results obtained;
- Chapter 6 discusses the results and presents the conclusions of the study.

The conceptual path underlying the structure of the book is to first examine the characteristics and the usefulness of ERP and BI systems, with the aim of analyzing their potential capacities to reduce information overload and underload and to improve information quality. Subsequently, the empirical analysis investigates whether and how the ERP and BI systems play a role in improving the information quality for a sample of Italian managers.

Following this path, Chap. 2 analyzes the academic literature on ERP, with regard to the evolution of ERP systems, which started in the 1960s when the first reorder point systems were implemented by the companies. Material Requirements Planning (MRP) and Manufacturing Requirements Planning (MRP II) represent the next phase in this evolution (Ganesh et al. 2014). In the '90s, ERP was born, and from that year to the present the evolution of ERP has not stopped: Extended ERP (or ERP II) was developed around the year 2000 and ERP systems based on cloud computing technologies have been deployed beginning in the 2010s (Chaudhary 2017; Rashid et al. 2002). The evolution of ERP is useful for understanding how ERP systems have supported, over time, information systems quality and information quality. In fact, Chap. 2 also shows that ERP systems can positively impact information quality in two main ways: first, they are able to directly impact the quality of information by improving data management and eliminating (or dramatically reducing) information redundancy (Sumner 2013); second, ERP systems are also beneficial to many other characteristics of information systems (Karimi et al. 2007; Uwizeyemungu and Raymond 2005; Xu et al. 2002), which, indirectly, impacts the quality of information. Obviously, to obtain these benefits, it is necessary to implement an effective ERP system by following the critical success factors suggested by the literature. Chapter 2 proposes a list of success factors based on the main literature, regarding both ERP implementation (Finney and Corbett 2007; Somers and Nelson 2004) and ERP-post implementation (Nicolaou 2004; Zhu et al. 2010). Finally, Chap. 2 focuses on the managerial role of the Chief Information Officer, who is responsible for the IT system and the entire information flow within a firm.

Chapter 3 deals with BI systems, trying to follow the complete path of BI implementation and maintenance, based on the academic literature. Specifically, this chapter first summarizes the main needs which may lead companies to implement a BI system; second, it proposes a set of critical success factors which allow for the implementation of an effective BI system that can satisfy companies' needs; third, it presents the main maturity models of BI systems by paying particular attention to the life cycle of BI systems and the need to keep them up do date. Regarding the first part of the chapter, the summarization of companies' needs for BI includes management information system needs (Elbashir et al. 2008; Levinson 1994; Peters et al. 2016; Rud 2009; Sudarsanam 2003), strategic planning needs (Alkhafaji 2011; Giesen et al. 2010; Laszlo and Laugel 2000; Malmi and Brown 2008; Yeoh and Popovič 2016), commercial and marketing needs (Chau and Xu 2012; He et al. 2013; Olszak 2016; Park et al. 2012), regulation needs (Rutter et al. 2007; Trill 1993; Williams 1993; Wingate 2016; Yeoh and Popovič 2016) and fraud detection needs (Bell and Carcello 2000; Dorronsoro et al. 1997; Fanning and Cogger 1998; Kotsiantis et al. 2006; Ngai et al. 2011). Each category of company needs is thoroughly analyzed according to the literature and eventually broken down into sub-needs. The second part of this chapter pertains to the critical success factors of BI implementation; several authors have proposed a different set of factors, which allows companies to maximize the effectiveness of BI system implementation. This part of the chapter takes into account the main critical success factor studies in the literature and shows the key aspects that a company should consider for effective BI implementation (Hawking and Sellitto 2010; Vosburg and Kumar 2001; Yeoh and Koronios 2010; Yeoh and Popovič 2016). Included among these critical success factors are the ERP systems dealt with in Chap. 2. In addition to the critical success factors for BI implementation, the literature also recommends aligning the evolution of BI systems with that of business, considering the life-cycle of BI models as a driver which affects critical success factors. In this regard, the third part of the chapter refers to the BI maturity models (Hribar Rajterič 2010; Moss and Atre 2003; Tan et al. 2011; Watson 2010).

Chapter 4 presents the research design and the research questions of our empirical research. In particular, we analyze the possible relationships between ERP, BI and information overload/underload. Furthermore, we investigate whether ERP and BI systems may also affect information quality by influencing the information flow features (i.e., information processing capacity, communication and reporting, information sharing and frequency of meetings). In fact, the potentialities of ERP and BI systems may positively contribute to increasing information quality (and information system quality) by means of an improved management of information flow. This quality improvement may indirectly support management in counteracting, or at least reducing, the information overload/underload. Finally, we investigate the role played by the features of information flow in improving the information quality perceived by managers. After presenting the research design, the chapter describes the sample selection, the data collection, the variable measurement and the factor analysis carried out on the research variables.

Chapter 5 pertains to the results of the empirical research. This chapter presents the methodology applied to the research, the analyses carried out and the main results of the research. Empirical results from the entire datasets of respondents demonstrate that respondents adopting an ERP or a BI system—or both an ERP and a BI system—do not perceive higher or lower information overload or information underload. Furthermore, respondents who have implemented an ERP system perceive a higher level of information processing capacity, a higher level of communication and reporting, and a higher level of frequency of meetings than do respondents who have not implemented an ERP. Respondents who have implemented a BI perceive a higher level of information processing capacity than do respondents who have not implemented a BI. Respondents who have implemented both ERP and BI systems perceive a higher level of information processing capacity than do respondents who have not implemented an ERP or a BI system. Results from the regression analysis show that information processing capacity has a positive effect on the information quality perceived by managers; therefore, if the information processing capacity increases, the information quality perceived by respondents increases as well. Furthermore, results show that communication and reporting have a negative effect on the information quality perceived by respondents; as a result, if the communication and reporting increases, the information quality decreases.

Chapter 6 presents a discussion about the results of the theoretical and empirical analysis conducted in the manuscript. The chapter also discusses the limitations of the research and suggests further developments.

References

Abbott J (2001) Data data everywhere–and not a byte of use? Qual Mark Res Int J 4:182–192

Ackoff, RL (1967) Management misinformation systems. Manag Sci 14:B–147

Agarwal R, Dhar V (2014) Big data, data science, and analytics: the opportunity and challenge for IS research. INFORMS

Al-Hakim L (2007). Information quality management: theory and applications. IGI Global

Alkhafaji AF (2011) Strategic management: formulation, implementation, and control in a dynamic environment. Dev Learn Organ Int J 25

Bell TB, Carcello JV (2000) A decision aid for assessing the likelihood of fraudulent financial reporting. Audit J Pract Theory 19:169–184

Berthold H, Rösch P, Zöller S, Wortmann F, Carenini A, Campbell S, Bisson P, Strohmaier F (2010) An architecture for ad-hoc and collaborative business intelligence. In: Proceedings of the 2010 EDBT/ICDT workshops. ACM, p 13

Bettis-Outland H (2012) Decision-making's impact on organizational learning and information overload. J Bus Res 65:814–820

Bingi P, Sharma MK, Godla JK (1999) Critical issues affecting an ERP implementation. Manag 16:7–14

Boyer J, Frank B, Green B, Harris T, Van De Vanter K (2010) Business intelligence strategy: a practical guide for achieving BI excellence. Mc Press

Brien JA, Marakas GM (2009) Management information system. Galgotia Publications L994 3

Burstein F, Holsapple C (2008) Handbook on decision support systems 2: variations. Springer Science & Business Media

Chapman CS, Kihn L-A (2009) Information system integration, enabling control and performance. Account Organ Soc 34:151–169. https://doi.org/10.1016/j.aos.2008.07.003

Chau M, Xu J (2012) Business intelligence in blogs: understanding consumer interactions and communities. MIS Q 36

Chaudhary S (2017) ERP through cloud: making a difficult alternative easier. Int J Eng Sci 6079

da Costa RAG, Cugnasca CE (2010) Use of data warehouse to manage data from wireless sensors networks that monitor pollinators. In: 2010 eleventh international conference on mobile data management (MDM). IEEE, pp 402–406

Dell'Orco M, Giordano R (2003) Web community of agents for the integrated logistics of industrial districts. In: Proceedings of the 36th annual Hawaii international conference on system sciences, 2003. IEEE, p 10

Dorronsoro JR, Ginel F, Sgnchez C, Cruz CS (1997) Neural fraud detection in credit card operations. IEEE Trans Neural Netw 8:827–834

Eckerson WW (2005) The keys to enterprise business intelligence: critical success factors. TDWI Rep

Eckerson WW (2002) Data quality and bottom line: achieving business success through high quality data (TDWI Report Series). Data Warehouse Institute, Seattle, WA

Elbashir MZ, Collier PA, Davern MJ (2008) Measuring the effects of business intelligence systems: the relationship between business process and organizational performance. Int J Account Inf Syst 9:135–153

Fanning KM, Cogger KO (1998) Neural network detection of management fraud using published financial data. Int J Intell Syst Account Finance Manag 7:21–41

Finney S, Corbett M (2007) ERP implementation: a compilation and analysis of critical success factors. Bus Process Manag J 13:329–347

Foshay N, Kuziemsky C (2014) Towards an implementation framework for business intelligence in healthcare. Int J Inf Manag 34:20–27

Ganesh K, Mohapatra S, Anbuudayasankar SP, Sivakumar P (2014) Enterprise resource planning: fundamentals of design and implementation. Springer

Giesen E, Riddleberger E, Christner R, Bell R (2010) When and how to innovate your business model. Strategy Leadersh 38:17–26

Hawking P, Sellitto C (2010) Business Intelligence (BI) critical success factors. In: 21st Australian conference on information systems. pp 1–3

He W, Zha S, Li L (2013) Social media competitive analysis and text mining: a case study in the pizza industry. Int J Inf Manag 33:464–472

Herschel RT, Jones NE (2005) Knowledge management and business intelligence: the importance of integration. J Knowl Manag 9:45–55

Ho J, Tang R (2001) Towards an optimal resolution to information overload: an infomediary approach. In: Proceedings of the 2001 international ACM SIGGROUP conference on supporting group work. ACM, pp 91–96

Horvath L (2001) Collaboration: the key to value creation in supply chain management. Supply Chain Manag Int J 6:205–207

Hribar Rajterič I (2010) Overview of business intelligence maturity models. Manag J Contemp Manag Issues 15:47–67

Karimi J, Somers TM, Bhattacherjee A (2007) The impact of ERP implementation on business process outcomes: a factor-based study. J Manag Inf Syst 24:101–134

Kotsiantis S, Koumanakos E, Tzelepis D, Tampakas V (2006) Forecasting fraudulent financial statements using data mining. Int J Comput Intell 3:104–110

Laszlo C, Laugel J-F (2000) Large scale organizational change: an executive's guide. Routledge

Letsholo RG, Pretorius MP (2016) Investigating managerial practices for data and information overload in decision making. J Contemp Manag 13:767–792

Levinson NS (1994) Interorganizational information systems: new approaches to global economic development. Inf Manage 26:257–263

Li X, Qu H, Zhu Z, Han Y (2009) A systematic information collection method for business intelligence. In: International conference on electronic commerce and business intelligence, ECBI 2009. IEEE, pp 116–119

Malmi T, Brown DA (2008) Management control systems as a package—opportunities, challenges and research directions. Manag Account Res 19:287–300

Markus ML, Tanis C (2000) The enterprise systems experience-from adoption to success. Fram Domains IT Res Glimpsing Future Past 173:173–207

Moss LT, Atre S (2003) Business intelligence roadmap: the complete project lifecycle for decision-support applications. Addison-Wesley Professional

Ngai EWT, Hu Y, Wong YH, Chen Y, Sun X (2011) The application of data mining techniques in financial fraud detection: a classification framework and an academic review of literature. Decis Support Syst 50:559–569

Nicolaou AI (2004) Quality of postimplementation review for enterprise resource planning systems. Int J Account Inf Syst 5:25–49

Nita B (2015) Methodological issues of management reporting systems design. Wrocław University of Economics Prace Naukowe Uniwersytetu Ekonomicznego, We Wroclawiu

Olszak CM (2016) Toward better understanding and use of business intelligence in organizations. Inf Syst Manag 33:105–123

O'Reilly CA (1980) Individuals and information overload in organizations: is more necessarily better? Acad Manage J 23:684–696

Park S-H, Huh S-Y, Oh W, Han SP (2012) A social network-based inference model for validating customer profile data. MIS Q 36

Peters T, Işık Ö, Tona O, Popovič A (2016) How system quality influences mobile BI use: the mediating role of engagement. Int J Inf Manag 36:773–783

Rajagopal P (2002) An innovation—diffusion view of implementation of enterprise resource planning (ERP) systems and development of a research model. Inf Manage 40:87–114

Rashid MA, Hossain L, Patrick JD (2002) The evolution of ERP systems: a historical perspective

Rodriguez MG, Gummadi K, Schoelkopf B (2014) Quantifying information overload in social media and its impact on social contagions. arXiv:14036838

Rud OP (2009) Business intelligence success factors: tools for aligning your business in the global economy. Wiley

Rutter R, Lauke PH, Waddell C, Thatcher J, Henry SL, Lawson B, Kirkpatrick A, Heilmann C, Burks MR, Regan B, et al (2007) Web accessibility: web standards and regulatory compliance. Apress

Scapens RW, Jazayeri M (2003) ERP systems and management accounting change: opportunities or impacts? A research note. Eur Account Rev 12:201–233

Scheer A-W, Habermann F (2000) Enterprise resource planning: making ERP a success. Commun ACM 43:57–61

Smith G, Ariyachandra T, Frolick M (2012) Business intelligence in the bayou: recovering costs in the wake. Organ Appl Bus Intell Manag Emerg Trends Emerg Trends 29

Somers TM, Nelson KG (2004) A taxonomy of players and activities across the ERP project life cycle. Inf Manag 41:257–278

Soucek R, Moser K (2010) Coping with information overload in email communication: Evaluation of a training intervention. Comput Hum Behav 26:1458–1466

Spira JB (2011) Overload! How too much information is hazardous to your organization. Wiley

Sudarsanam S (2003) Creating value from mergers and acquisitions: the challenges: an integrated and international perspective. Pearson Education

Sumner M (2013) Enterprise resource planning: Pearson new international edition. Pearson Education Limited

Tan C-S, Sim Y-W, Yeoh W (2011) A maturity model of enterprise business intelligence. Commun IBIMA

Trill AJ (1993) Computerized systems and GMP—A UK perspective: part I: background, standards, and methods. Pharm Technol Int 5:12–26

Uwizeyemungu S, Raymond L (2005) Essential characteristics of an ERP system: conceptualization and operationalization. J Inf Organ Sci 29:69–81

Vosburg J, Kumar A (2001) Managing dirty data in organizations using ERP: lessons from a case study. Ind Manag Data Syst 101:21–31

Wang YR, Pierce EM, Madnik SE, Fisher CW, Zwass V (2005) Information quality. ME Sharpe

Watson HJ (2010) BI-based organizations. Bus Intell J 15:4–6

Williams MH (1993) Good computer validation practice is good business practice. Drug Inf J 27:333–345

Wingate G (2016) Pharmaceutical computer system validation: quality assurance. risk management regulatory compliance. pp 1–10

Xu H, Horn Nord J, Brown N, Daryl Nord G (2002) Data quality issues in implementing an ERP. Ind Manag Data Syst 102:47–58

Yeoh W, Koronios A (2010) Critical success factors for business intelligence systems. J Comput Inf Syst 50:23–32

Yeoh W, Popovič A (2016) Extending the understanding of critical success factors for implementing business intelligence systems. J Assoc Inf Sci Technol 67:134–147

Zhu Y, Li Y, Wang W, Chen J (2010) What leads to post-implementation success of ERP? An empirical study of the Chinese retail industry. Int J Inf Manag 30:265–276

Chapter 2
Enterprise Resource Planning Systems

Abstract The most advanced integrated Information Technology (IT) tools are represented by Enterprise Resource Planning systems (ERP). These systems can collect and integrate data using a common database, thereby representing a good basis for the overall accounting process. This chapter starts with an analysis of the literature on ERP, with a particular focus on the evolution of ERP systems. The evolution of ERP is, in fact, useful in understanding how ERP systems may affect, over time, the quality of information systems and of information. The chapter also shows that ERP systems can positively impact information quality in two main ways: first, they can directly impact the quality of information by improving data management; and second, ERP systems are also beneficial to many other features of information systems, which indirectly impacts the quality of information. To obtain these benefits, it is necessary to implement an effective ERP system by following the critical success factors suggested by the literature. Therefore, the chapter also proposes a list of success factors based on the main literature, regarding both ERP implementation and ERP post-implementation. Finally, the chapter focuses on the managerial role of the Chief Information Officer, who is responsible for the IT system and the entire information flow within a firm.

2.1 Introduction

The most advanced integrated Information Technology (IT) tools are represented by Enterprise Resource Planning systems (ERP)[1] (Granlund and Malmi 2002). These systems are able to collect and integrate data using a common database, and thus

---

[1]ERP could be defined as: "*enterprise wide packages that tightly integrate business functions into a single system with a shared database*" (Lee and Lee 2000; Quattrone and Hopper 2001; Newell et al. 2003; Grabski et al. 2011). In a similar vein, Kumar and Hillegersberg defined ERP as: "*information systems packages that integrate information and information-based processes within and across functional areas in an organization.*" Both the aforementioned definitions of ERP underline the relevance of integrated information across different functional areas of an organization (Kumar and van Hillegersberg 2000).

C. Caserio and S. Trucco, *Enterprise Resource Planning and Business Intelligence Systems for Information Quality*, Contributions to Management Science,
https://doi.org/10.1007/978-3-319-77679-8_2

they represent a good basis for the overall accounting process (Chapman and Kihn 2009).

For their potential benefits, ERPs became popular during the '90s in firms all over the world (Arnold 2006; Sutton 2006). Before that date, companies usually used different information systems for each functional area within the organization, which did not allow for an easy and timely exchange of information among managers. This also discouraged the comparability of accounting information (Rom and Rohde 2007). To solve these problems and to exploit the potentialities of the new Information System Integration (ISI), ERPs were introduced especially to facilitate the exchange of information among managers and, in general, to foster internal relationships (Davenport 1998a). Therefore, their use is generally justified by the need to share consistent information across different functional areas of a company (Robey et al. 2002).

ERP systems play a crucial role in integrating the several business functions and in improving the quality of data and, thus, of information. Therefore, this chapter has been divided into seven sections: Sect. 2.2 presents the evolution of ERP systems, from the first examples of inventory control systems (1960s) to the recent cloud ERP (2010s); Sect. 2.3 deals with the supporting role of ERP for information quality; Sects. 2.4 and 2.5 show the Critical Success Factors (CSFs) for ERP implementation and post-implementation, respectively; Sect. 2.6 highlights the advantages and disadvantages of ERP systems; Sect. 2.7 illustrates the role of ERP in aligning management accounting information with financial accounting information; and Sect. 2.8 shows the role of the Chief Information Officer (CIO).

2.2 The Evolution of ERP Systems

Enterprise Resource Planning (ERP) systems have evolved from software which supported companies in Material Requirements Planning (MRP) and Manufacturing Resource Planning (MRP II). In the '60s, only reorder point systems were developed to support managers in forecasting inventory demand on the basis of historical data. Attempts to integrate information systems started years before the birth of ERP; MRP and MRP II, in fact, represent two examples of information systems integration. MRP was born in the'70s and supported managers in production planning and inventory control through a master production schedule and a bill of materials. Its main aim was to ensure the availability of materials needed for production, in order to avoid the interruption of the production processes (Sumner 2013). The objectives of MRP are summarized by Ganesh et al. as follows (Ganesh et al. 2014):

- to ensure the availability of required input material for production;
- to make sure that required products are made from input material and provided to the customer;
- to maintain an optimal level of investors;

- to synchronize manufacturing activities with delivery schedules;
- to synchronize purchasing activities with manufacturing activities.

MRP evolved after about ten years into MRP II, which incorporated the financial accounting system, sales planning functions and customer order processing (Somers and Nelson 2003). MRP II resolved many of the problems of MRP, which were mainly due to the latter's incapacity to manage complex manufacturing business processes (Ganesh et al. 2014). The main difference between MRP and MRP II is that the former is a stand-alone software, whereas MRP II is an initial example of an enterprise-level system aimed at avoiding data duplication by promoting data integrity and forecast accuracy through customer feedback.

By the '90s, the first ERP systems were developed with the aim of integrating the main business functions and of aligning the business processes to the ERP software (Brown et al. 2003). For the first time, ERP systems made it possible to generate a seamless flow of information throughout the company, satisfying not only the needs of external customers but also those of internal customers (that is, information users); by doing so, it improved the effectiveness and the timeliness of the decision-making process (Ross et al. 2003; Ganesh et al. 2014).

From the '90s on, vendors added further modules and functions to the basic ERP modules, thus laying the bases for the "Extended ERPs", or ERP II (Rashid et al. 2002). By the 2000s, this "extended version" of ERP was made possible also by the proliferation of the Internet (Lawton 2000), which allowed the integration of ERP with other external business modules, such as CRM (Customer Relationship Management), SCM (Supply Chain Management), APS (Advanced Planning and Scheduling), BI (Business Intelligence), and e-business capabilities (Rashid et al. 2002). The extensions of ERP to CRM and SCM allowed for the effective management of the relationships among organizations, suppliers and customers, from the procurement of materials to the delivery of the products, thereby aligning the supply system with customer demand.

Thus, the evolution from ERP to ERP II has been driven by new business requirements and new information technologies. The latter do not necessarily represent an invention of ERP vendors but arise from the market and consist of single components, such as application frameworks, databases, Decision Support Systems (DSS), which, once incorporated into the enterprise system, increase considerably the business benefits (Møller 2005). BI and business analytics are other examples of IT tools—namely, DSS tools—which have become even more integrated with the ERP system, as they use ERP data for supporting managers' decisions. In addition, the eXtended Mark-up Language (XML) has been gradually implemented in the ERP infrastructures (Møller 2005).

As some studies suggest, ERP II provides benefits to the company only when the technology available on the market is well integrated in the enterprise system; hence, it is not sufficient that the technology exists; it also has to be effectively embedded in the information system (Akkermans et al. 2003; Weston 2003). In this regard, the definition of ERP II provided by the Gartner Research Group in 2000 states that the extended ERP (or ERP II) is a business strategy and a set of industry domain-specific applications which create value for customers and shareholders through collaborative operational and financial processes (Oliver 1999).

A study based on a survey shows that: (a) ERP II increases all the benefits of ERP, since resources are better managed, and (b) ERP II allows the decision-making process to be supported even more effectively than would be the case with a non-extended ERP, as the resources of the whole supply chain are made available (Wheller 2004).

The innovations explained so far mainly regard the need for data and information quality, the integration of ERP with other applications, and the improvement of the decision-making process. However, more recently, technology has provided another innovation for managing ERP, which consists in purchasing the system as a cloud computing service.

Cloud computing is a model of computing which provides access to a shared set of IT resources by means of the Internet. These resources consist in computer processing, storage, software, and other services provided in virtualization and accessible on the basis of an as-needed logic, from any device connected to the Internet and from any location (Laudon and Laudon 2015).

Cloud computing technology is characterised by the following essential features (Mell et al. 2011):

- on-demand self-service: consumers can obtain services as needed, automatically and on their own;
- ubiquitous network access: cloud resources can be accessed through any standard Internet device;
- location-independent resource pooling: computing resources are assigned to multiple users, according to their demand. Users do not know where the computing resources are located;
- rapid elasticity: computing resources are rapidly adapted to meet changing user demand;
- measured service: cloud resource fees are proportional to the amount of resources used.

Cloud computing consists of three different types of services: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS), and it can be private, public and hybrid (Elragal and El Kommos 2012).

Cloud ERP belongs to the SaaS category and allows companies to obtain ERP services in a cloud environment. The Internet has made it possible to introduce in the company's value chain many applications, which are not necessarily owned by the ERP vendors. Applications, in fact, reside on web servers to which anyone on the intranet has access using a connected device (from personal computers to smartphones or tablets). Following this logic, access to the system and to the information does not imply extra costs, and anyone who needs information can obtain it with ease. This architecture has advantages also in extending ERP, as it easily allows for a selective access of suppliers and customers by means of extranets

Table 2.1 Evolution of ERP (*Source* authors' presentation)

2010s	Cloud ERP
2000s	Extended ERP
1990s	ERP
1980s	MRP II
1970s	MRP
1960s	Reorder point systems and inventory control

or the public Internet (Chaudhary 2017). Scalability, easy upgrades and mobile access are consequent advantages of this architecture.

Regarding the differences between ERP in cloud and ERP on-premises, some studies show that cloud ERP requires no capital expenditure and no maintenance costs, as opposed to on-premises ERP; furthermore, the cloud solution is more flexible and more easily accessible (Ramasamy and Periasamy 2017).

The disadvantages and concerns regarding cloud ERP are mainly related to: (1) data security (including privacy issues) and (2) integration. In terms of data security, business data is likely to be accessed from any smartphone or device, which potentially compromises data security (Chao Peng and Baptista Nunes 2009). Nevertheless, in this regard data security is completely controlled by the vendor, as the company only uses the services but does not own the servers where data is stored, and it has no control over who may access their business data (from the vendor side) (Peng and Gala 2014). In many cases, the company does not even know where servers are geographically located and how they are protected; this lack of transparency may introduce further data privacy concerns. For these reasons, Service Level Agreements have a crucial role in defining all the conditions, guarantees, actions and remedies between vendor and customer (Lenart 2011).

Regarding the second item, integration, it is quite difficult both for companies and for vendors to customise a cloud ERP and to integrate it with other applications. For their part, companies have limited control over the cloud and do not have sufficient freedom and rights to personalize a cloud ERP, whereas vendors, in trying to make integrations, would have to face the diversity of platforms and technologies used for developing applications. As a result, until now it has not been feasible for vendors to customise the ERP package and to provide a seamless integration between the system and the applications purchased by different client companies (Peng and Gala 2014).

Table 2.1 summarizes the evolution of ERP over the years, showing how rapidly information systems innovation is advancing. In fact, over about 50 years, technology and other drivers such as globalisation, hyper-competition and market changes have dramatically changed companies' needs with regard to the integration of information systems, data storage and elaboration, and decision-making support.

2.3 Information Quality and ERP

The attention paid to information systems quality has gradually increased over time, given the importance of information systems in providing information to management. From data acquisition and elaboration to the communication of information, several components are involved, since the information system consists of a set of technical resources, data, people and procedures which interact to produce information (Kroenke and Boyle 2016) and to generate knowledge (Wijnhoven 2009). The definitions of information systems make it clearly understood that they are composed of several dimensions. Therefore, the quality of information systems needs to be assessed through a multidimensional measure, or through frameworks which take into account the whole set of components (DeLone and McLean 1992). According to some studies, it is important that managers identify the most critical aspects of information system quality that can affect the business (Gorla et al. 2010).

The literature provides numerous studies aimed at analyzing how the quality of information systems could be obtained and measured under different perspectives and using different methods. The initial studies focused attention mainly on user satisfaction and system use (Lucas 1978; Ginzberg 1981; Hopelain 1982; Srinivasan 1985). Following the idea that productivity in the computer context is related to the sense of satisfaction in using the computer services, some studies measured user satisfaction through a list of factors identified through a review of the literature (Bailey and Pearson 1983; King and Epstein 1983), while others focused on the users' attitude towards the changes introduced by a system—specifically, by DSS—to the work environment (Barki and Huff 1985). Barki and Huff discovered that satisfaction is higher when DSSs bring changes to the work environment as opposed to when they do not result in substantial changes. Later studies examined service quality as a driver for information system quality; service quality refers to the fact that computer users are satisfied only if their expectations meet their perception of the quality they are getting (Pitt et al. 1995); the concept is thus very similar to that of user satisfaction.

Another study, based on an extensive survey conducted on a sample of 465 data warehouse users from seven companies, developed a model based on nine determinants of quality in an IT environment, four focused on the output of the system (i.e., the information quality), and five addressed to the information processing system needed to produce the output (i.e., the system quality) (Nelson et al. 2005). It is interesting to note that, according to the authors, information quality—consisting in the accuracy, completeness, currency and format of information—has a significant role in explaining information system quality—consisting in the accessibility of the system, its reliability, response time, flexibility and integration; these nine determinants are also predictive of the general information and system quality in data warehouse contexts.

Similarly, other studies identified the characteristics that give high quality to an information system. The literature review conducted by De Lone and McLean

(1992) identified six factors considered critical for information system quality: (a) system quality, intended as the information processing system itself; (b) information quality, that is, accuracy, timeliness, reliability, completeness, relevance, precision and currency; (c) information use; (d) user satisfaction; (e) individual impact; (f) organizational impact. After about 20 years, De Lone and McLean updated their study, proposing other determinants that can affect information system success, divided into four categories: task, user, project, organization (Petter et al. 2013).

As the more recent literature shows, there is no single determinant which can, on its own, explain the quality or the success of the information system; instead, it is necessary to include variables pertaining to the several aspects characterizing information systems, such as hardware and software quality, service quality, information quality, communication quality, while also considering that different, or more specific needs can arise depending on the business and on the evolution of technology (Xu et al. 2013; Bessa et al. 2016).

Because information systems produce information and knowledge starting from data and using processing capabilities, the quality of information is related to the quality of the entire data elaboration process: if the information system allows companies to acquire and store high quality data (with the support of high quality hardware), then the processing system will generate high quality information (with the support of high quality software). This, in turn, will effectively support the decision-making process, providing a high service quality. These considerations are recognizable in a wide stream of studies on the role of data and information in improving the quality of information systems (Redman and Blanton 1997; Kahn et al. 2002; Pipino et al. 2002; Xu et al. 2002; Madnick et al. 2009). Studies on the impact of data and information quality have been carried out to promote positive impacts and provide disincentives to negative ones. Poor data quality, in fact, could make the retrieval of business records more difficult (Mikkelsen and Aasly 2005), thereby not allowing the right information to be provided to the right stakeholder. This misalignment could be even more critical in the performance management field: as underlined by Redman (Redman 1998), poor data quality can compromise the achievement of strategic and tactical objectives. Other studies demonstrate that the quality of the decision-making process depends on the quality of data produced by the information system (Fisher et al. 2003; Calvasina et al. 2009; Caserio 2011) and on the coherence between data architecture and business architecture (Vasile and Mirela 2008). Studies on data quality also involve the Enterprise Architecture and the IT governance frameworks, both aimed at aligning the information systems with the business objectives on a strategic level (Schekkerman 2004; Weill and Ross 2004; Caserio 2017). This is evidence of how important data and information quality have become, and it explains why companies are investing in IT and information systems solutions such as ERP and BI systems. The following sections focus on these issues, in particular on the role that, according to the literature, ERP systems could play in information quality.

2.3.1 Information Quality

In the field of Management Information Systems, information quality and information systems quality are still the most discussed topics. The literature provides different interpretations of information quality, recognizing that information quality could be intrinsic, contextual, representational, and related to accessibility (Lee et al. 2002; Zmud 1978; Ballou and Pazer 1985; DeLone and McLean 1992; Goodhue 1995; Wand and Wang 1996; Wang and Strong 1996; Jarke and Vassiliou 1997).

Intrinsic information quality pertains to the accuracy, objectivity and precision of information; this interpretation derives from the initial theoretical grounds behind Gorry and Scott Morton's framework on the accuracy of information for structured problems (Gorry and Scott Morton 1971a).

The contextual characteristic of information quality refers to the capacity of information to be relevant, reliable and timely, capable of adding value, useful and complete. This interpretation refers to information being available in the right amount, sufficient and informative, and able to create value for the decision-making process.

The representational characteristic of information quality is related to the capacity of the information to be understood and effectively implemented in the decision-making process. Information must be understandable, concise, clear and meaningful; in other words, it has to be able to represent the problem to which it refers.

Regarding information accessibility, computer systems must permit an easy and secure access to the information.

According to other studies, information quality can be defined as the coherence of information with respect to the specifications of the product or the service to which it refers and as the capacity to satisfy (or to exceed) consumer expectations (Zeithaml et al. 1990; Reeves and Bednar 1994; Kahn et al. 2002). Based on this interpretation, high-quality information provides an accurate representation and meets the requirements of the final user. Naturally, the coherence and the usefulness of information also depend on the initial data quality (Piattini et al. 2012).

According to the literature, the quality of information depends on several attributes, divided into three main dimensions (Marchi 1993; O'Brien and Marakas 2006):

- time: the information must be timely, and thus provided when it is needed; it has to be up-to-date, provided with the needed frequency, and can refer to the past, present or future;
- content: the information must be accurate, without errors, relevant, complete, concise; it must also have a scope and be useful in revealing the performance obtained;
- form: the information must be clear, with the proper detail, ordered in a sequence as needed, composed of text, images, maps, graphics, etc., as required by the user in a digital or a printed paper version.

Information quality matters also for economic reasons, as both quality information and non-quality information have a cost. The costs of non-quality information involve, first of all, a waste of time for people trying to find the most appropriate information for their needs and to make the most reliable interpretation of inaccurate information. In addition, inaccurate information may cause several problems for the business activities depending on the type of error or inaccuracy of information (which could regard clients, orders, suppliers, internal processes, etc.), which results in costs. Moreover, data correction, the recovery of process failure, backup, recovery and other similar activities lead to the consumption of more computing resources than would be necessary if information were accurate. Similarly, because of non-quality information, redundant controls on data and information will need to be activated in order to prevent errors from negatively affecting the results (English 2002).

2.3.2 ERP System for Information Quality

The implementation of an ERP, when critical success factors are respected (see Sect. 2.4), has many implications for the information system. As a matter of fact, ERP is defined by the literature as an information system itself (Sheu et al. 2003; Li and Olorunniwo 2008; Parthasarathy 2012; Esendemirli et al. 2015). The greatest benefit of ERP implementation is the reduction of business process complexity, since ERP aims at integrating business functions, data and processes along the value chain (Broadbent et al. 1999; Karimi et al. 2007). In most cases, a successful ERP implementation requires a preventive Business Process Reengineering (BPR) (Broadbent et al. 1999; Holland and Light 1999; Palaniswamy and Frank 2000; Fui-Hoon Nah et al. 2001) which aims at revising and optimizing the business processes. BPR developed in companies with a high business process complexity has more of an impact and is more expensive because of the difficulty in carrying out standardization (Rosenkranz et al. 2010; Schäfermeyer et al. 2012). In this regard, Karimi et al. observe that "*the higher a firm's business process complexity, the higher the radicalness of its ERP implementation as a result of its potential to enable fundamental and radical changes in the firm's business processes and their outcomes*" (Karimi et al. 2007: 107). We can consequently deduce that the higher the business process complexity, the higher the business impact (and risk of failure) of ERP implementation. In fact, the literature confirms that the benefits of ERP for information systems can depend on the quality of BPR (Bingi et al. 1999) and that one of the motivations that lead companies to implement an ERP is to obtain business process standardization (Al-Mashari et al. 2003). From an opposing viewpoint, the literature also shows that a more impactful BPR may engender ERP dissatisfaction (Scheer and Habermann 2000).

In addition to business process complexity, organizational factors play a critical role in examining the benefits of ERP for information systems. Employees are a component of information systems, as well as being the end users of ERP; thus, to obtain information system benefits from an ERP implementation, people should accept the ERP and recognize its usefulness and support for their tasks. Therefore, as suggested by many authors, ERP benefits information systems when top management provides its support (Ein-Dor and Segev 1978; Grover et al. 1995; Grover and Segars 1996) and mediates between technology and business requirements, resolving eventual conflicts of interest among stakeholders (Grover et al. 1995). Furthermore, the alignment between the ERP and the organizational objectives and needs is a critical condition that enables the ERP to improve the information system (Cline and Guynes 2001; Gefen and Ragowsky 2005).

Along with business process complexity and organizational factors, another benefit that the ERP can bring to the information system is the improvement in information quality. Given the importance recognized by companies and scholars of the quality of information, the attention paid to the circumstances that may improve information quality has gradually increased. Moreover, the huge amount of data and information that companies need to manage has increased the attention on solutions which could improve the quality of the information system.

ERP systems directly and indirectly support information quality: for example, they lead to the integrity of the system and permit users to insert data only once (Xu et al. 2002; Uwizeyemungu and Raymond 2005).

The literature confirms that companies implement ERP systems in order to resolve information problems related to the legacy systems; in fact, poor productivity and performance are connected to the poor quality of information, specifically to the fragmentation of information (Davenport 1998b; Rajagopal 2002).

ERP systems reduce data integration problems as follows (Markus and Tanis 2000a; Rajagopal 2002; Karimi et al. 2007):

(1) by eliminating multiple data entry and concomitant errors;
(2) by simplifying the data analysis;
(3) by managing, integrating and sharing data related to products, services and business activities that create value.

Data integration improvement allows information to be consistent, thus ensuring that two (or more) separate systems do not generate two (or more) different versions of the same information. In other words, data integration allows each decision maker in the company, and in each subsidiary, to receive the same information; as a result, the decision-making process is faster (Shanks et al. 2003) and managers can exchange views on problems and business issues, even when the subsidiaries are located at a great distance.

As confirmation of this, the relational database on which ERP systems are built makes information representative throughout the company, which is even more perceived when a company migrates from legacy systems to an ERP system (Xu et al. 2002). In fact, legacy systems are built on separate subsystems, and thus the same data is located in several sources, thereby generating problems of information inconsistency. The resulting lack of integration makes it difficult for a subsystem to access data stored in another subsystem and makes the communication between different subsystems very problematic (Xu et al. 2002).

Literature shows several ERP benefits to the information system, wisely summarized by (Sumner 2013), who recognizes that ERP: (a) allows companies to move from a stand-alone to an integrated system solution; (b) makes possible a better internal coordination, particularly among the business functions; (c) improves the integration of database; (d) allows a more effective maintenance; (e) promotes common interfaces across the company's systems; (f) makes information consistent and available in real-time; (g) introduces a client-server model, more effective than legacy systems; (h) aligns business processes with an information model; (i) optimizes the number of applications required for managing business functions.

In addition to the benefits which can be obtained by the adoption of ERP, it is also important to take into consideration other drivers which may lead managers to implement ERP, specifically (Skok and Legge 2001):

- legacy systems and concerns about the Millennium Bug;
- globalization of the business;
- the more stringent national and international regulatory environment: e.g., the European Monetary Union;
- BPR and the attention paid to process standardization, such as ISO 9000;
- scalable and flexible emerging client/server infrastructures;
- trend towards collaboration among software vendors.

2.4 Critical Success Factor for ERP Implementation

The first important studies on Critical Success Factors (CSFs) and Critical Failure Factors (CFFs) of ERP were developed in the US, where the implementation of ERP occurred for the first time (Wylie 1990); subsequently, several studies have also been carried out in emerging economies, which has allowed researchers to draw up frameworks useful in understanding the weight of the several factors. Most of these studies followed a methodology aimed at: (a) identifying CSFs proposed by the literature; (b) submitting these CSFs to the attention of experts, professional operators and users to obtain their judgment; and (c) setting up a sort of ranking (Ganesh and Mehta 2010; Garg 2010). Other authors have dealt with some of the CSFs emerging from the literature by examining them on the basis of the industry, the size of the company and the country (Niu et al. 2011).

The classifications of CSFs proposed by the literature are frequently based on a study by Davenport (Davenport 1998b), which lays down the first relevant considerations about the complexity of ERP implementation. Markus et al. (2000) also show the different business strategies to be followed for an effective implementation of ERP. During the 2000s, two rich literature streams emerged, one aimed at examining the difficulties in implementing an ERP system and its CFFs (Markus et al. 2000; Umble and Umble 2002; Gargeya and Brady 2005; Shirouyehzad et al.

2011), the other at identifying the CSFs of ERP implementation (Brown and Vessey 1999; Parr and Shanks 2000; Fui-Hoon Nah et al. 2001; Al-Mashari et al. 2003; Somers and Nelson 2004; Nah and Delgado 2006; Finney and Corbett 2007). One of the first studies to summarize the CSFs on the basis of a rigorous literature review and a cross-sectional analysis carried out on 116 companies was by Somers and Nelson (Somers and Nelson 2004), which was later adopted as a reference in several studies. The authors identified 22 CSFs (shown in Table 2.2), whose order of importance changes according to the phase of ERP implementation (initiation, adoption, adaptation, acceptance, routinization, infusion).

For example, in the ERP initiation and ERP acceptance phases, the "use of steering committee" is recognized as the most important factor, whereas, during the ERP adoption and adaptation phases, the "change management" has the highest importance. Again, in the ERP routinization phase, the "user training on software" plays the most important role, whereas in the ERP infusion phase, the most critical factor is the "use of consultants".

Another important study, conducted after that by Somers and Nelson, extends the number of CSFs by identifying 26 items and classifying them into two categories: strategic and tactical CSFs (Finney and Corbett 2007). Carried out from the stakeholder perspective, this study underlines the strict connection between strategic CSFs (e.g., change management) and tactical ones (e.g., how to obtain the change management). The list of CSFs, collected through an analysis of the literature, includes the 22 CSFs proposed by Somers and Nelson (2004) and adds some new aspects, such as the relevance of the implementation strategy, the choice of the ERP, precautionary crisis management (of the implementation project), and a preliminary analysis of the existing legacy system.

With regard to the definition of CSFs, some studies have followed a different approach by identifying CSFs along the various steps of ERP implementation. However, the results of these studies are very similar to those of Finney and Corbett. Kronbichler et al. for example, identify CSFs along the three phases of planning, implementation and stabilization/improvement of an ERP (Kronbichler et al. 2009). Markus and Tanis considered the factors of success/failure of ERP implementation, which can occur along one or more of the following implementation phases (Markus and Tanis 2000b):

- project chartering: that is, the phase in which software, project manager, budget and scheduling are selected;
- project phase, in which the system is implemented, and thus data conversion is performed, users are trained, and testing is achieved;
- shakedown phase, where the system begins to run regularly, becomes stabilized, and is slightly customized;
- the onward-upward phase, consisting of a continuous improvement pursued through upgrades, the continuous training of users, and the evaluation of post-implementation benefits.

Table 2.2 Critical success factors according to Somers and Nelson

Critical success factors	
Use of steering committee	Interdepartmental cooperation
Change management	Interdepartmental communication
Top management support	Education on new BPR
Business process reengineering	Dedicated resources
Clear goals and objectives	Project management
Management of expectations	User training on software
Project champion	Vendor support
Project team competence	Minimal customization
Partnership with vendor	Use of consultants
Use of vendor tools	Architecture choices
Data analysis and conversion	Careful selection of package

Given the relevance of a successful ERP implementation and the great impact this has on the business, many studies have focused attention on the Critical Failure Factors (CFFs): that is, on the main causes of an ERP failure. One of the most common ideas is that an ERP implementation is likely to fail if its consequences on the business structure are not accurately evaluated (Markus et al. 2000; Umble et al. 2003).

Analysing the issue in more detail, the causes of the failure could be related to several aspects, such as ERP software modification: in other words, the tendency of companies to ask for tailored ERP systems by forcing the vendors to find customized solutions which turn out to be counter-productive for an effective functioning of ERP (Shanks et al. 2003). System integration may represent another risk of failure, as it could lead to technical difficulties related to the integration of the enterprise software with a package of hardware, software, database management systems and telecommunications systems appropriate to the size, structure and geographical dispersion of the company. Furthermore, companies may need to keep legacy systems which perform operations not included in the ERP package (Tsai et al. 2005); these systems have to be interfaced with ERP and could give rise to some complications (Yeo 2002; Shanks et al. 2003; Umble et al. 2003). Other problems could be due to the coordination of the several firms involved in the implementation process (applications developers, ERP vendors, vendors of ERP extensions) and to the turnover of project personnel possessing the necessary skills for managing ERP system (Shanks et al. 2003).

Other failure factors are related to the shakedown and the onward-upward phase. Regarding the shakedown, the most important problems are due to the implementation of ERP following an excessively functional perspective, a scarce definition of project scope, a poor consideration of end-user training needs, testing aspects, and problems concerning data quality and reporting needs.

Regarding the onward-upward phase, failure factors are mainly due to the lack of knowledge of the effects ERP investment has on business results, to the lack of end-user knowledge of the new system, and to the difficulties related to the upgrade and maintenance of the ERP system (Shanks et al. 2003). Post-implementation of ERP thus deserves special attention, since it influences the long-term success of the ERP system.

2.5 Critical Success Factors for ERP Post-implementation

The implementation stage of ERP has been largely studied by scholars and with different perspectives. The life of an ERP starts with its adoption and ends when the ERP has been replaced by a new one (Markus and Tanis 2000b).

One of the most relevant research perspectives is that related to critical success factors for the implementation of ERP systems. The post-implementation stage encompasses a number of activities which are pivotal for the success of ERP implementation (Gelinas et al. 1999). Therefore, the post-implementation success of ERP is a complex topic due to several dimensions such as organizational performance and the financial return on investment in ERP (Sedera and Gable 2004). An ERP may be considered successful if it can improve the overall performance of a firm by reducing organizational costs, increasing the firm's productivity, increasing employees and customer satisfaction, and so on (Sedera and Gable 2004).

The success of the post-implementation process is heavily affected by the quality of the phase of ERP implementation itself and by its effectiveness in carrying out changes and improvements in processes, systems, and the overall performance of the firm (Nicolaou 2004a). In particular, Zhu et al. argue that the quality of implementation and organizational readiness affect post-implementation success (Zhu et al. 2010).

Furthermore, successful business process changes can be considered as facilitators for achieving post-implementation performance gains (Guha et al. 1997).

Nicolaou (2004a) associated the critical dimensions of success in post-implementation with the critical success factors of ERP implementation. The author identified the following critical success factors for ERP implementation: (1) top management support and commitment to project and fit to business strategy; (2) the alignment of people, process, technology; (3) anticipated benefits from the ERP implementation project; (4) the motivation behind ERP implementation; and (5) the scope of user training. The author argues that the first factor can be linked to the following dimensions of success in post-implementation: "evaluation of fit with strategic vision; review of project planning effectiveness and evaluation of infrastructure development". The second one can be linked to the following dimensions of post-implementation: "review of fit resolution strategies; evaluation of system integration attainment and reporting and flexibility". The third factor can be linked to "evaluation of level of attainment of expected system benefits". The fourth factor can be linked to "review of driving principles for project and review of project justification practices". Finally, the fifth success factor may be linked to "review of user learning and evaluation of effective knowledge transfer (among project team members and other users)" (Nicolaou 2004a).

2.6 Advantages and Disadvantages of ERPs

This section analyzes potential benefits and disadvantages that may arise from ERP adoption within a firm. The literature has focused particular attention on the effects ERP adoption could produce on both financial and non-financial performance ratios (Sect. 2.6.1). Section 2.6.2 presents a discussion about the framework that can be used to classify the potential benefits of an ERP system. Finally, Sect. 2.6.3 analyzes the potential disadvantages linked to adopting an ERP system.

2.6.1 Potential Benefits of ERP Adoption

The literature about the potential benefits of adopting an ERP has focused on the effects this could produce on both financial and non-financial performance indicators. Some scholars have even analyzed this topic by referring to tangible and intangible benefits (Markus et al. 2000; Nicolaou 2004b; Fang and Lin 2006; Florescu 2007; Skibniewski and Ghosh 2009; Trucco and Corsi 2014).

The main studies focusing on the effects ERP adoption could produce on financial performance were carried out by Poston and Grabski 2001; Hunton et al. 2002; Hitt et al. 2002; Nicolaou 2004a. These authors found that the introduction of an ERP can produce important effects on the following financial performance indicators: (1) Return On Assets (ROA); (2) Return On Investment (ROI); (3) Return On Sales (ROS); (4) Cost of Goods Sold over Sales (CGSS); and (5) Employee to Sales (ES). Although they found controversial results, even if they used a similar method to carry out their studies, they all agreed that ERP adoption is able to produce all its effects after a certain time-lag (Poston and Grabski 2001; Hitt et al. 2002; Hunton et al. 2003; Zaino 2004; Nicolaou 2004b).

In particular, Poston and Grabski examined the effects of ERP adoption over a three-year period, finding no significant improvements in the main key financial performance indices. However, they found an improvement in the cost of goods to revenue three years after the ERP system implementation (but not in the first or second year after implementation). They also found a significant reduction in the ratio of employee to revenue for each of the three years they examined (Poston and Grabski 2001).

Nicolaou examined the effects of an ERP on the financial performance of a firm over four years after implementation. He found that ERP benefits on the firms' financial performance became evident and strong only after a lag of approximately two years from ERP implementation, and therefore after two years of continued use of ERP (Nicolaou 2004b). Hitt et al. found that firms that invest in ERPs have a higher performance in several ratios than firms with no investment in ERPs. In particular, they found that the ERP implementation phases take between one and three years, and the first significant benefits appear on average after 31 months. Some authors noted that in the first period of ERP implementation there is a discordant trend between internal and external performance indices; as a matter of fact, there is a reduction in performance ratios and in productivity and an increase in stock market evaluation (Hitt et al. 2002). In a similar vein, other authors argued that the market expects that an ERP implementation may allow firms to improve their competitive advantage (Stratman 2007). Hunton et al. examined the effects of ERP adoption on financial performance over a period of 3 years after ERP implementation, confirming the productivity paradox by comparing firm performance of adopters with those of non-adopters. They found that the financial performance for ERP adopters does not change significantly from pre- to post-adoption, although some performance ratios decline for non-adopters over the same time-period. They also found that large/unhealthy adopters can expect greater performance gains than can large/healthy adopters, and that the small/healthy adopters have better performance in terms of ROA, ROI, and Return On Sales (ROS) than do small/unhealthy adopters (Hunton et al. 2003). Zaino found that 60% of firms have financial benefits from ERP implementation, whereas the remaining 40% have a reduction in ROI (Zaino 2004). Other scholars have examined the immediate after-effects of ERP adoption, finding that investments due to ERP implementation might lead to productivity and profitability problems. These problems can be linked to a change in management during the implementation phases (Davenport 1998a; Hitt et al. 2002).

More recently, other scholars have studied the potential benefits ERP implementation may have on non-financial dimensions (Fang and Lin 2006; Qutaishat et al. 2012; Trucco and Corsi 2014). Fang and Lin investigated Taiwan public firms that adopted the ERP system to evaluate the effects on non-financial measures by exploiting the balanced scorecard and the dimensions of the balanced scorecard (financial, internal process, customer, innovation and learning). The authors examined whether different corporate ERP aims may affect performance after ERP implementation. The corporate aims of ERP adoption that they analyzed were re-engineering processes, performing supply chain management, implementing or supporting e-commerce, integrating ERP with other business information systems, reducing inventory costs, changing the existing legacy system, favoring the competitiveness of multinational enterprises, enhancing enterprise images, developing e-business. They found through a regression analysis that the balance scorecard's financial perspectives are closely related to non-financial perspectives (Fang and Lin 2006). Qutaishat et al. (2012), through users' interviews, underlined that ERP adoption could produce benefits in terms of customer satisfaction and employee productivity (Qutaishat et al. 2012). Trucco and Corsi found that ERP adoption can produce benefits for the classical financial indicators in terms of ROE and ROI, and for non-financial ratios such as corporate governance and social and organizational aspects (Trucco and Corsi 2014). In particular, they found a general benefit from ERP implementation to the corporate governance score in terms of a company's systems, processes and management practices. Furthermore, they found an improvement to a social ratio, which summarizes if and how the company describes the implementation of its training and development policy. Results from the study by Trucco and Corsi are in line with other studies that point out that ERP adoption can bring some improvements to social ratios linked to customer satisfaction and employee productivity (Markus et al. 2000; Cotteleer and Bendoly 2002; McAfee 2002).

Moreover, prior studies have investigated the market reaction to ERP implementation announcements, finding that stakeholders perceive the potential advantages of a new ERP system (Wah 2000; Hayes et al. 2001; Hunton et al. 2002). Specifically, Hunton et al. (2002) found that analysts reacted positively to ERP announcements. In fact, they found that analysts who participated in the experimental study perceived that a firm may have some benefits due to the use of an integrated Information Technology (IT) system. Even if most scholars agree that an integrated ERP produces its effects on financial statement disclosure and has advantages regarding accounting information, most of the literature focuses on the external perceptions (analysts and external users at large). Furthermore, Hunton et al. (2002) have pointed out that one of the main limitations of their study is its external validity, since they based their results on laboratory experiments. Therefore, they call for more research regarding the potential quality improvements correlated to ERP adoption (Hunton et al. 2002).

Another stream of literature on ERP has investigated the complex relationships between ERP and management control systems (Maccarone 2000; Booth et al. 2000; Granlund and Malmi 2002; Shang and Seddon 2002; Hartmann and Vaassen 2003; Caglio 2003; Scapens and Jazayeri 2003; Dechow and Mouritsen 2005; Sangster et al. 2009; Chapman and Kihn 2009; Granlund 2011; Kallunki et al. 2011). Most of the above-mentioned literature agrees that ERP systems can produce their effects on the organization as a whole. In this regard, Shang and Seddon (2000) emphasized that managerial benefits may arise from a better planning and management of resources, whereas Maccarone (2000) identified two main classes of benefits produced by adopting an ERP: (1) a reduction in the time needed to perform managerial activities, and (2) an improvement in the quality of data and control activities at large. Sangster et al. (2009) carried out a survey using a questionnaire addressed to 700 management accountants in large UK firms to identify the effect of the perceived success of ERP implementation upon the role of respondents, finding that ERP generally improves the quality of the role of management accountants if ERP adoption is successful.

Even if most scholars have emphasized the positive, even small, correlation between the use and implementation of an ERP within an organization and managerial controls (Quattrone and Hopper 2001; Spathis and Constantinides 2004; Kallunki et al. 2011), others have found a quite limited impact on the improvements in management control systems and practices due to ERP adoption. Booth et al. (2000) examined the Chief Financial Officers' (CFOs) perception about the impact of ERPs on the adoption of new accounting practices, finding little evidence.

Table 2.3 Literature review on the potential effects of ERP adoption (financial and non-financial dimensions)

Dimensions	Main items in each dimension	Literature streams
Financial	ROA, ROI, ROS, ROE, Cost of goods sold over sales, Employee to sales	Hitt et al. (2002), Hunton et al. (2003), Nicolaou (2004b), Poston and Grabski (2001), Zaino (2004)
Non-financial	Social ratios, corporate governance, customer satisfaction, employee satisfaction, employee productivity, internal process, innovation and learning	Cotteleer and Bendoly (2002), Markus et al. (2000), McAfee (2002), Fang and Lin (2006), Florescu (2007), Markus et al. (2000), Nicolaou (2004a), Skibniewski and Ghosh (2009), Trucco and Corsi (2014)

Specifically, they found that ERPs seem to open the way to data manipulation rather than lead to an easier collection and elaboration of management data.

According to other scholars, resistance to change on the part of controllers and the time lag between ERP adoption and the related effects on management control systems have a limited impact on the success of ERP (Granlund and Malmi 2002; Scapens and Jazayeri 2003).

Table 2.3 summarizes the literature review on the potential effects of ERP adoption (financial and non-financial dimensions).

2.6.2 A Framework for Classifying the Benefits of ERP Systems

Some authors have identified a framework to classify the potential benefits that ERP adoption can have on the financial and non-financial performance of a firm. In this regard, Shang and Sheddon (2002) proposed five dimensions to classify the benefits of ERP systems: (1) operational dimension; (2) managerial dimension; (3) strategic dimension; (4) IT infrastructure dimension; and (5) organizational dimension (Shang and Seddon 2002). The operational dimension refers to business processes and operation volumes (Brynjolfsson and Hitt 1996; Weill and Broadbent 1998). Within this dimension, an ERP adoption can bring about the following classes of benefits: (1) cost reduction; (2) cycle time reduction; (3) productivity improvement; (4) information quality improvement; and (5) customer service improvement. The managerial dimension pertains to senior managers of information systems (Gorry and Scott Morton 1971b). Within this dimension, an ERP adoption can bring about the following classes of benefits to the firm: (1) better resource management; (2) better decision-making and planning; and (3) better performance. The strategic dimension is related to competitive advantages (Porter and Millar 1991). Within this dimension, an ERP implementation can produce the following benefits for the firm: (1) strategic business growth plan; (2) support business alliance; (3) support business innovation; (4) support cost leadership; (5) support product differentiation; and (6) support external linkages. The IT infrastructure dimension refers to the architecture of the IT and produces the following benefits: (1) increased business flexibility; (2) IT cost reduction; and (3) increased IT infrastructure capability. The organizational dimension refers to organizational behavior (Baets and Venugopal 1998). Within this dimension, an ERP implementation can produce the following benefits: (1) support organizational changes; (2) facilitate business learning; (3) empowerment; and (4) build a common vision.

Within this framework, Gattiker and Goodhue proposed a model in which they identified the following organizational benefits due to the ERP implementations: better information quality, more efficient internal business processes, and better coordination among different units of the firm (Gattiker and Goodhue 2005).

Similarly, Markus et al. proposed different dimensions to analyze the benefits of ERP implementation, including economic, financial and strategic business ratios; business process aspects; the organization's managers; employee and customer aspects; and supplier and investor dimensions (Markus et al. 2000).

2.6.3 Potential Disadvantages of ERP Adoption

Despite these considerations about the potential positive effects of ERP adoption, some scholars have found some disadvantages linked to a new ERP.

Brazel and Dang (2005) found a decreased reliability of financial statements for external users in the years following the adoption of ERP; they measured this reliability through the value of discretionary accruals. According to their framework, a loss of financial statement reliability could happen because of a potential increase in the discretion managers have in the use of accounting information (Brazel and Dang 2008). In fact, ERPs allow managers greater access to and control over financial information (Dillon 1999).

Furthermore, Davenport and other scholars have revealed the disadvantages, risks and costs related to ERP adoption (Davenport 1998a). Some authors have stressed the potential risks that accounting integration due to ERP adoption could bring to the company. As a matter of fact, even if the ERP system is perceived as a strategic investment within the firm (Cooke and Peterson 1998), the most relevant risk related to this strategic investment is the failure of ERP implementation, which could even lead to firms' bankruptcy (Davenport 1998a; Markus et al. 2000). Despite this, an Advanced Market Research (AMR) revealed that firms invest huge amounts of money in ERP (around $79 billion in 2004), even if some implementations have failed (Carlino et al. 2000). Some scholars have estimated that only 34% of ERP implementation projects are successful (Nelson 2007). Costs which are associated with a new ERP may include the purchase of software, hardware, network investments and consulting fees (Beheshti and Beheshti 2010).

Furthermore, an ERP could be viewed as a limitation on the discretion of managers in changing managerial controls in the future, since it is difficult to forecast the long-term implications of ERP during its initial phase of implementation. To overcome this limitation a possible, but not sufficient, solution could be to adopt a strategic and long-term vision during the ERP implementation phase (Grabski et al. 2001; Quattrone and Hopper 2001; Grabski et al. 2011).

Hendricks et al. have argued that any or only a few of the financial benefits due to an IT adoption could depend on high implementation costs (Hendricks et al. 2007). Costs are both monetary and relative to the human resources required to implement and manage the ERP system and its integration within the organization (Granlund and Malmi 2002). However, researchers agree that a holistic view of the effects of ERP implementation is necessary (Jarrar et al. 2000; Markus et al. 2000; Gattiker and Goodhue 2005), since the long and deep process of ERP adoption affects the whole organization (Rose and Kræmmergaard 2006).

2.7 ERP as a Driver of Alignment Between Management Accounting Information and Financial Accounting Information

Another stream of literature has pointed out the important role that ERP can have in fostering the relationship between external financial information[2] and internal managerial information[3] (Innes and Mitchell 1990; Caglio 2003; Taipaleenmäki and Ikäheimo 2013). Some authors have argued that an ERP may represent a facilitator, motivator, even an enabler for the convergence between financial accounting and management accounting[4] (Innes and Mitchell 1990; Cobb et al. 1995; Booth et al. 2000; Lukka 2007). Booth et al. (2000) asserted that IT can set the premises for high levels of information integration.

[2]Financial accounting information is the product of corporate accounting and external reporting systems that measure and disclose quantitative and qualitative data concerning the financial position and the overall performance of the firm (Bushman and Smith 2001). Further, financial accounting information, whose main purpose is to meet the information requirements of external stakeholders, also fulfils the internal need of a company to correctly disclose information to the market about its performance, thereby reducing uncertainties for investors and, consequently, the cost of capital (Lambert and Verrecchia 2014).

[3]Management accounting information can be defined by Anthony as the flow of information used by management for internal purposes such as planning and control (Anthony 1965).

[4]The two areas of financial accounting information and management accounting information represent together the accounting; the existence of financial accounting and management accounting information tends to create two different circuits of information within a firm (Popa-Paliu and Godeanu 2007; Taipaleenmäki and Ikäheimo 2013). Even if some authors have pointed out that, in academia and from a theoretical viewpoint, there is a deep distinction between financial accounting and management accounting, they have highlighted that there are some practical overlapping areas between the two, which need to be explored and identified (Lambert 2006).

Taipaleenmäki and Ikäheimo state that ERP systems could be a useful basis for changes in the accounting system. As a matter of fact, they assert that integration between financial and management accounting information could be linked to the contemporary need to understand ERP systems and to decrease accounting resources (Ikäheimo and Taipaleenmäki 2010; Taipaleenmäki and Ikäheimo 2013).

In a similar vein, Caglio (2003) has theorized deep changes in accounting practices due to the introduction of an ERP system, and in this regard he has introduced a new hybrid figure of a manager who is somewhere between a financial accountant and the other professional managers, confirming, through a case study, the pivotal role of ERP in removing the barriers between financial accounting and management accounting. Within this framework, Trucco found that the high level of integration in ERP improves the level of integration of accounting systems (Trucco 2014, 2015).

2.8 The Managerial Role of the Chief Information Officer

The managerial role of the Chief Information Officer (CIO) was introduced in the 1980s, even if his or her tasks have increased in recent decades (Grover et al. 1993). The CIO label was created in order to recognize that the Information Systems function had become critical in many firms (Earl 1996).

The CIO is responsible for the enterprise IT system; indeed he/she covers technical and organizational areas, such as as IT-business alignment (Gottschalk 1999), IT investment decisions (Earl and Feeny 1994; Mithas et al. 2012), and IT system quality improvement and evaluation (Spewak and Hill 1993). Therefore, a CIO should ensure a cost-efficient enterprise IT system in order to create long-lasting value within the firm in which he/she operates (Gottschalk 1999; Li and Ye 1999; Sobol and Klein 2009; Lunardi et al. 2014). The CIO is thus a member of the firm's C-level executive team, assuming a strategic role and affecting the organizational and financial performance of the whole firm (Peppard 2007). Furthermore, the market positively perceives the presence of the new CIO and the appointment of the CIO as a firm's leader (Chatterjee et al. 2001).

Some scholars have identified different profiles of CIOs, namely architecture builder, partner, project coordinator, systems provider and technological leader, while others have proposed different features of CIOs, such as business visionary, business system thinker, value configure, entrepreneur, IT architect planner, organizational designer, relationship builder and informed buyer (Chen and Wu 2011; Guillemette and Paré 2012).

In accomplishing his/her tasks, the CIO interacts with other top managers, such as the Chief Executive Officer (CEO), the IT auditor and the Chief Financial Officer (CFO) (Banker et al. 2011). Other studies focus on the relationship between the CIO and the other top managers, especially with regard to the Chief Executive Officer and Chief Financial Officer. In particular, the CIO should report to the CEO or to the CFO: he/she should report to the CEO if the firm pursues IT initiatives in order to improve the differentiation strategy; otherwise, he/she should report to the CFO in order to lead IT initiatives in facilitating cost leadership strategy (Earl and Feeny 1994; Preston et al. 2006). The CIO should have both a technical background and managerial and leadership skills in order to support the firm's long-term goals (Bharadwaj 2000; Corsi and Trucco 2016).

References

Akkermans HA, Bogerd P, Yücesan E, Van Wassenhove LN (2003) The impact of ERP on supply chain management: exploratory findings from a European Delphi study. Eur J Oper Res 146:284–301

Al-Mashari M, Al-Mudimigh A, Zairi M (2003) Enterprise resource planning: a taxonomy of critical factors. Eur J Oper Res 146:352–364

Anthony RN (1965) Planning and control systems: a framework for analysis. Harvard Business School Division of Research, Boston

Arnold V (2006) Behavioral research opportunities: understanding the impact of enterprise systems. Int J Account Inf Syst 7:7–17

Baets W, Venugopal V (1998) An IT architecture to support organizational transformation. Inf Technol Organ Transform (Wiley) 195–222

Bailey JE, Pearson SW (1983) Development of a tool for measuring and analyzing computer user satisfaction. Manag Sci 29:530–545

Ballou DP, Pazer HL (1985) Modeling data and process quality in multi-input, multi-output information systems. Manag Sci 31:150–162

Banker RD, Hu N, Pavlou PA, Luftman J (2011) CIO reporting structure, strategic positioning, and firm performance. MIS Q 35:487–504

Barki H, Huff SL (1985) Change, attitude to change, and decision support system success. Inf Manag 9:261–268

Beheshti HM, Beheshti CM (2010) Improving productivity and firm performance with enterprise resource planning. Enterp Inf Syst 4:445–472

Bessa J, Branco F, Costa A, et al (2016) A multidimensional information system architecture proposal for management support in Portuguese higher education: The university of Tras-os-Montes and Alto Douro case study. In: 2016 11th Iberian conference on information systems and technology CISTI. IEEE, pp 1–7

Bharadwaj AS (2000) A resource-based perspective on information technology capability and firm performance: an empirical investigation. MIS Q 169–196

Bingi P, Sharma MK, Godla JK (1999) Critical issues affecting an ERP implementation. Manag 16:7–14

Booth P, Matolcsy Z, Wieder B (2000) The impacts of enterprise resource planning systems on accounting practice—the Australian experience. Aust Account Rev 10:4–18

Brazel J, Dang L (2005) The effect of ERP system implementations on the usefulness of accounting information. Available at SSRN: https://ssrn.com/abstract=815190

Brazel JF, Dang L (2008) The effect of ERP system implementations on the management of earnings and earnings release dates. J Inf Syst 22:1–21

Broadbent M, Weill P, St. Clair D (1999) The implications of information technology infrastructure for business process redesign. MIS Q 159–182

Brown C, Vessey I (1999) ERP implementation approaches: toward a contingency framework. In: Proceedings of 20th international conference on information systems, association for information systems, pp 411–416

Brown C, Vessey I et al (2003) Managing the next wave of enterprise systems: leveraging lessons from ERP. MIS Q Exec 2:45–57

Bryjolfsson E, Hitt L (1996) Paradox lost? Firm-level evidence on the returns to information systems spending. Manag Sci 42:541–558
Bushman RM, Smith AJ (2001) Financial accounting information and corporate governance. J Account Econ 32:237–333
Caglio A (2003) Enterprise Resource Planning systems and accountants: towards hybridization? Eur Account Rev 12:123–153
Calvasina R, Calvasina E, Ramaswamy M, et al (2009) Data quality problems in responsibility accounting issues. Inf Syst 48–57
Carlino J, Nelson S, Smith N (2000) AMR research predicts enterprise applications market will reach $78 billion by 2004. AMR Res
Caserio C (2011) Relationships between ERP and business intelligence: an empirical research on two different upgrade approaches. Inf. Technol Innov Trends Organ (Springer) 363–370
Caserio C (2017) IT governance in enterprise resource planning and business intelligence systems environment: a conceptual framework. Int J Manag Inf Technol 12:3041–3049
Chao Peng G, Baptista Nunes M (2009) Surfacing ERP exploitation risks through a risk ontology. Ind Manag Data Syst 109:926–942
Chapman CS, Kihn L-A (2009) Information system integration, enabling control and performance. Account Organ Soc 34:151–169
Chatterjee D, Richardson VJ, Zmud RW (2001) Examining the shareholder wealth effects of announcements of newly created CIO positions. Mis Q 43–70
Chaudhary S (2017) ERP through cloud: making a difficult alternative easier. Int J Eng Sci 6079
Chen Y-C, Wu J-H (2011) IT management capability and its impact on the performance of a CIO. Inf Manag 48:145–156
Cline MK, Guynes CS (2001) A study of the impact of information technology investment on firm performance. J Comput Inf Syst 41:15–19
Cobb I, Helliar C, Innes J (1995) Management accounting change in a bank. Manag Account Res 6:155–175
Cooke DP, Peterson WJ (1998) SAP implementation: strategies and results
Corsi K, Trucco S (2016) The role of the CIOs on the IT management and firms' performance: evidence in the Italian context strength. Inf Control Syst (Springer) 217–236
Cotteleer MJ, Bendoly E (2002) Order lead-time improvement following enterprise—IT implementation: an empirical study. Working Paper. Harvard Business School, Boston
Davenport TH (1998a) Putting the enterprise into the enterprise system. Harv Bus Rev 76:121–131
Davenport TH (1998) Putting the enterprise into the enterprise system. Harv Bus Rev 76
Dechow N, Mouritsen J (2005) Enterprise resource planning systems, management control and the quest for integration. Account Organ Soc 30:691–733
DeLone WH, McLean ER (1992) Information systems success: the quest for the dependent variable. Inf Syst Res 3:60–95
Dillon C (1999) Stretching toward enterprise flexibility with ERP. APICS Perform Advant 38–43
Earl MJ (1996) The chief information officer: past, present and future. Inf Manag 456–484
Earl MJ, Feeny DF (1994) Is your CIO adding value? Sloan Manag Rev 35:11
Ein-Dor P, Segev E (1978) Organizational context and the success of management information systems. Manag Sci 24:1064–1077
Elragal A, El Kommos M (2012) In-house versus in-cloud ERP systems: a comparative study. J Enterp Resour Plan Stud 2012:1
English LP (2002) Total quality data management (TQdM). Inf Database Qual 85–109
Esendemirli E, Turker D, Altuntas C (2015) An Analysis of interdepartmental relations in enterprise resource planning implementation: a social capital perspective. Int J Enterp Inf Syst IJEIS 11:27–51
Fang M, Lin F (2006) Measuring the Performance of ERP system—from the balanced scorecard perspectives. J Am Acad Bus 10:256–263
Finney S, Corbett M (2007) ERP implementation: a compilation and analysis of critical success factors. Bus Process Manag J 13:329–347

Fisher CW, Chengalur-Smith I, Ballou DP (2003) The impact of experience and time on the use of data quality information in decision making. Inf Syst Res 14:170–188
Florescu V (2007) TIC Et Performance De L'enterprise: Un Modèle General D'analyse. Rev Repères Econ Inform 2
Fui-Hoon Nah F, Lee-Shang Lau J, Kuang J (2001) Critical factors for successful implementation of enterprise systems. Bus Process Manag J 7:285–296
Ganesh K, Mohapatra S, Anbuudayasankar SP, Sivakumar P (2014) Enterprise resource planning: fundamentals of design and implementation. Springer
Ganesh L, Mehta A (2010) Critical success factors for successful enterprise resource planning implementation at Indian SMEs
Garg P (2010) Critical success factors for enterprise resource planning implementation in Indian retail industry: an exploratory study. arXiv:10065749
Gargeya VB, Brady C (2005) Success and failure factors of adopting SAP in ERP system implementation. Bus Process Manag J 11:501–516
Gattiker TF, Goodhue DL (2005) What happens after ERP implementation: understanding the impact of interdependence and differentiation on plant-level outcomes. MIS Q 29:559–585
Gefen D, Ragowsky A (2005) A multi-level approach to measuring the benefits of an ERP system in manufacturing firms. Inf Syst Manag 22:18–25
Gelinas UJ, Sutton SS, Oram AE (1999) Accounting information systems: south. Western College Publishing
Ginzberg MJ (1981) Early diagnosis of MIS implementation failure: promising results and unanswered questions. Manag Sci 27:459–478
Goodhue DL (1995) Understanding user evaluations of information systems. Manag Sci 41:1827–1844
Gorla N, Somers TM, Wong B (2010) Organizational impact of system quality, information quality, and service quality. J Strateg Inf Syst 19:207–228
Gorry GA, Scott Morton MS (1971a) A framework for management information systems
Gorry GA, Scott Morton MS (1971b) A framework for management information systems
Gottschalk P (1999) Strategic management of IS/IT functions: the role of the CIO in Norwegian organisations. Int J Inf Manag 19:389–399
Grabski S, Leech SA, Lu B (2001) Risks and controls in the implementation of ERP systems. Int J Digit Account Res 1:47–68
Grabski SV, Leech SA, Schmidt PJ (2011) A review of ERP research: a future agenda for accounting information systems. J Inf Syst 25:37–78
Granlund M (2011) Extending AIS research to management accounting and control issues: a research note. Int J Account Inf Syst 12:3–19
Granlund M, Malmi T (2002) Moderate impact of ERPS on management accounting: a lag or permanent outcome? Manag Account Res 13:299–321
Grover V, Jeong S-R, Kettinger WJ, Lee CC (1993) The chief information officer: a study of managerial roles. J Manag Inf Syst 10:107–130
Grover V, Jeong SR, Kettinger WJ, Teng JT (1995) The implementation of business process reengineering. J Manag Inf Syst 12:109–144
Grover V, Segars AH (1996) The relationship between organizational characteristics and information system structure: an international survey. Int J Inf Manag 16:9–25
Guha S, Grover V, Kettinger WJ, Teng JT (1997) Business process change and organizational performance: exploring an antecedent model. J Manag Inf Syst 14:119–154
Guillemette MG, Paré G (2012) Toward a new theory of the contribution of the IT function in organizations. Mis Q 36:
Hartmann FG, Vaassen EH (2003) The changing role of management accounting and control systems: accounting for knowledge across control domains. http://dare.uva.nl/record/1/215071
Hayes DC, Hunton JE, Reck JL (2001) Market reaction to ERP implementation announcements. J Inf Syst 15:3–18

Hendricks KB, Singhal VR, Stratman JK (2007) The impact of enterprise systems on corporate performance: a study of ERP, SCM, and CRM system implementations. J Oper Manag 25:65–82

Hitt LM, Wu XZD, Zhou X (2002) Investment in enterprise resource planning: business impact and productivity measures. J Manag Inf Syst 19:71–98

Holland CR, Light B (1999) A critical success factors model for ERP implementation. IEEE Softw 16:30–36

Hopelain DG (1982) Assessing the climate for change: a method for managing change in a system implementation. Syst Object Solut 2:55–65

Hunton JE, Lippincott B, Reck JL (2003) Enterprise resource planning systems: comparing firm performance of adopters and nonadopters. Int J Account Inf Syst 4:165–184

Hunton JE, McEwen RA, Wier B (2002) The Reaction of financial analysts to enterprise resource planning (ERP) implementation plans. J Inf Syst 16:31–40

Ikäheimo S, Taipaleenmäki J (2010) The divergence and convergence of financial accounting and management accounting–institutional analysis of the US, Germany and Finland. Betriebswirtschaft 70:349–368

Innes J, Mitchell F (1990) The process of change in management accounting: some field study evidence. Manag Account Res 1:3–19

Jarke M, Vassiliou Y (1997) Data warehouse quality: a review of the DWQ project. IQ 299–313

Jarrar YF, Al-Mudimigh A, Zairi M (2000) ERP implementation critical success factors-the role and impact of business process management. In: Proceedings of the 2000 IEEE international conference management of innovation technology—ICMIT 2000. vol. 1, pp 122–127

Kahn BK, Strong DM, Wang RY (2002) Information quality benchmarks: product and service performance. Commun ACM 45:184–192

Kallunki J-P, Laitinen EK, Silvola H (2011) Impact of enterprise resource planning systems on management control systems and firm performance. Int J Account Inf Syst 12:20–39

Karimi J, Somers TM, Bhattacherjee A (2007) The impact of ERP implementation on business process outcomes: a factor-based study. J Manag Inf Syst 24:101–134

King WR, Epstein BJ (1983) Assessing information system value: an experimental study. Decis Sci 14:34–45

Kroenke DM, Boyle RJ (2016) Experiencing MIS, Global Edition. Pearson Education Limited

Kronbichler SA, Ostermann H, Staudinger R (2009) A review of critical success factors for ERP-projects. Open Inf Syst J3

Kumar K, van Hillegersberg J (2000) Enterprise resource planning: introduction. Commun ACM 43:22–26

Lambert RA (2006) Agency theory and management accounting. Handbooks of management accounting research, 1:247–268

Lambert RA, Verrecchia RE (2014) Information, illiquidity, and cost of capital. Contemp Account Res

Laudon KC, Laudon JP (2015) Management information systems: managing the digital firm, 13th Global Edition. Pearson

Lawton G (2000) Integrating ERP and CRM via the Web. SW Expert 10:33–37

Lee YW, Strong DM, Kahn BK, Wang RY (2002) AIMQ: a methodology for information quality assessment. Inf Manag 40:133–146

Lee Z, Lee J (2000) An ERP implementation case study from a knowledge transfer perspective. J Inf Technol 15:281–288

Lenart A (2011) ERP in the cloud–benefits and challenges. Res Syst Anal Des Models Methods 39–50

Li M, Ye LR (1999) Information technology and firm performance: linking with environmental, strategic and managerial contexts. Inf Manag 35:43–51

Li X, Olorunniwo F (2008) An exploration of reverse logistics practices in three companies. Supply Chain Manag Int J 13:381–386

Lucas HC (1978) Unsuccessful implementation the case of a computer-based order entry system. Decis Sci 9:68–79

Lukka K (2007) Management accounting change and stability: loosely coupled rules and routines in action. Manag Account Res 18:76–101

Lunardi GL, Becker JL, Maçada ACG, Dolci PC (2014) The impact of adopting IT governance on financial performance: an empirical analysis among Brazilian firms. Int J Account Inf Syst 15:66–81

Maccarone P (2000) The impact of ERPs on management accounting and control systems and the changing role of controllers

Madnick SE, Wang RY, Lee YW, Zhu H (2009) Overview and framework for data and information quality research. J Data Inf Qual JDIQ 1:2

Marchi L (1993) I sistemi informativi aziendali. Giuffrè

Markus ML, Axline S, Petrie D, Tanis SC (2000) Learning from adopters' experiences with ERP: problems encountered and success achieved. J Inf Technol 15:245–265

Markus ML, Tanis C (2000a) The enterprise systems experience-from adoption to success. Fram Domains IT Res Glimpsing Future Past 173:173–207

Markus ML, Tanis C (2000b) The enterprise systems experience-from adoption to success. Fram Domains IT Res Glimpsing Future Past 173:173–207

McAfee A (2002) The impact of enterprise information technology adoption on operational performance: an empirical investigation. Prod Oper Manag 11:33–53

Mell P, Grance T, et al (2011) The NIST definition of cloud computing

Mikkelsen G, Aasly J (2005) Consequences of impaired data quality on information retrieval in electronic patient records. Int J Med Inf 74:387–394

Mithas S, Tafti AR, Bardhan I, Goh JM (2012) Information technology and firm profitability: mechanisms and empirical evidence

Møller C (2005) ERP II: a conceptual framework for next-generation enterprise systems? J Enterp Inf Manag 18:483–497

Nah FF-H, Delgado S (2006) Critical success factors for enterprise resource planning implementation and upgrade. J Comput Inf Syst 46:99–113

Nelson RR (2007) IT project management: infamous failures, classic mistakes, and best practices. MIS Q Exec 6

Nelson RR, Todd PA, Wixom BH (2005) Antecedents of information and system quality: an empirical examination within the context of data warehousing. J Manag Inf Syst 21:199–235

Newell S, Huang JC, Galliers RD, Pan SL (2003) Implementing enterprise resource planning and knowledge management systems in tandem: fostering efficiency and innovation complementarity. Inf Organ 13:25–52

Nicolaou AI (2004a) ERP systems implementation: drivers of post-implementation success. In: Decision support uncertain complex world: IFIP TC8WG8 3 international conference pp 589–597

Nicolaou AI (2004b) Firm performance effects in relation to the implementation and use of enterprise resource planning systems. J Inf Syst 18:79–105

Niu N, Jin M, Cheng J-RC (2011) A case study of exploiting enterprise resource planning requirements. Enterp Inf Syst 5:183–206

O'Brien JA, Marakas GM (2006) Management information systems. McGraw-Hill Irwin

Oliver RW (1999) ERP is dead! Long live ERP! Manag Rev 88:12

Palaniswamy R, Frank T (2000) Enhancing manufacturing performance with ERP systems. Inf Syst Manag 17:43–55

Parr A, Shanks G (2000) A model of ERP project implementation. J Inf Technol 15:289–303

Parthasarathy S (2012) Research directions for enterprise resource planning (ERP) projects. Int J Bus Inf Syst 9:202–221

Peng GCA, Gala C (2014) Cloud ERP: a new dilemma to modern organisations? J Comput Inf Syst 54:22–30

Peppard J (2007) The conundrum of IT management. Eur J Inf Syst 16:336–345

Petter S, DeLone W, McLean ER (2013) Information systems success: the quest for the independent variables. J Manag Inf Syst 29:7–62

Piattini MG, Calero C, Genero MF (2012) Information and database quality. Springer Science & Business Media

Pipino LL, Lee YW, Wang RY (2002) Data quality assessment. Commun ACM 45:211–218

Pitt LF, Watson RT, Kavan CB (1995) Service quality: a measure of information systems effectiveness. MIS Q 173–187

Popa-Paliu L, Godeanu IC (2007) Resemblances and differences between financial accounting and management accounting. Annals of the University of Petrosani Economics, 7

Porter M, Millar VE (1991) How information gives you competitive advantage, in revolution in real time: managing information technology in the 1990s. Harvard Business Review Press, Boston, pp 48–79

Poston R, Grabski S (2001) Financial impacts of enterprise resource planning implementations. Int J Account Inf Syst 2:271–294

Preston DS, Karahanna E, Rowe F (2006) Development of shared understanding between the chief information officer and top management team in US and French organizations: a cross-cultural comparison. IEEE Trans Eng Manag 53:191–206

Quattrone P, Hopper T (2001) What does organizational change mean? Speculations on a taken for granted category. Manag Account Res 12:403–435

Qutaishat FT, Khattab SA, Zaid MKSA, Al-Manasra EA (2012) The effect of ERP successful implementation on employees' productivity, service quality and innovation: An empirical study in telecommunication sector in Jordan. Int J Bus Manag 7:p45

Rajagopal P (2002) An innovation—diffusion view of implementation of enterprise resource planning (ERP) systems and development of a research model. Inf Manag 40:87–114

Ramasamy M, Periasamy J (2017) Explore the impact of cloud computing on ERP systems used in small and medium enterprises. Int J 5

Rashid MA, Hossain L, Patrick JD (2002) The evolution of ERP systems: a historical perspective

Redman TC (1998) The impact of poor data quality on the typical enterprise. Commun ACM 41:79–82

Redman TC, Blanton A (1997) Data quality for the information age. Artech House, Inc

Reeves CA, Bednar DA (1994) Defining quality: alternatives and implications. Acad Manag Rev 19:419–445

Robey D, Ross JW, Boudreau M-C (2002) Learning to implement enterprise systems: an exploratory study of the dialectics of change. J Manag Inf Syst 19:17–46

Rom A, Rohde C (2007) Management accounting and integrated information systems: a literature review. Int J Account Inf Syst 8:40–68

Rose J, Kræmmergaard P (2006) ERP systems and technological discourse shift: managing the implementation journey. Int J Account Inf Syst 7:217–237

Rosenkranz C, Seidel S, Mendling J, et al (2010) Towards a framework for business process standardization. In: Business Process Management Workshop. Springer, pp 53–63

Ross J, Vitale MR, Willcocks LP (2003) The continuing ERP revolution: sustainable lessons, new modes of delivery. Cambridge University Press

Sangster A, Leech SA, Grabski S (2009) ERP implementations and their impact upon management accountants. JISTEM J Inf Syst Technol Manag 6:125–142

Scapens RW, Jazayeri M (2003) ERP systems and management accounting change: opportunities or impacts? A research note. Eur Account Rev 12:201–233

Schäfermeyer M, Rosenkranz C, Holten R (2012) The impact of business process complexity on business process standardization. Bus Inf Syst Eng 4:261–270

Scheer A-W, Habermann F (2000) Enterprise resource planning: making ERP a success. Commun ACM 43:57–61

Schekkerman J (2004) How to survive in the jungle of enterprise architecture frameworks: creating or choosing an enterprise architecture framework. Trafford Publishing

Sedera D, Gable G (2004) A factor and structural equation analysis of the enterprise systems success measurement model. In: Proceedings of ICIS 2004, p 36

Shang S, Seddon PB (2000) A comprehensive framework for classifying the benefits of ERP systems. In: Proceedings of AMCIS 2000, p 39

Shang S, Seddon PB (2002) Assessing and managing the benefits of enterprise systems: the business manager's perspective. Inf Syst J 12:271–299
Shanks G, Seddon PB, Willcocks LP (2003) Second-wave enterprise resource planning systems: implementing for effectiveness. Cambridge University Press
Sheu C, Yen HR, Krumwiede D (2003) The effect of national differences on multinational ERP implementation: an exploratory study. Total Qual Manag Bus Excell 14:641–657
Shirouyehzad H, Dabestani R, Badakhshian M (2011) The FMEA approach to identification of critical failure factors in ERP implementation. Int Bus Res 4:254
Skibniewski MJ, Ghosh S (2009) Determination of key performance indicators with enterprise resource planning systems in engineering construction firms. J Constr Eng Manag 135:965–978
Skok W, Legge M (2001) Evaluating enterprise resource planning (ERP) systems using an interpretive approach. In: Proceedings of 2001 ACM SIGCPR conference computer personnel research. ACM, pp 189–197
Sobol MG, Klein G (2009) Relation of CIO background, IT infrastructure, and economic performance. Inf Manag 46:271–278
Somers TM, Nelson KG (2003) The impact of strategy and integration mechanisms on enterprise system value: empirical evidence from manufacturing firms. Eur J Oper Res 146:315–338
Somers TM, Nelson KG (2004) A taxonomy of players and activities across the ERP project life cycle. Inf Manag 41:257–278
Spathis C, Constantinides S (2004) Enterprise resource planning systems' impact on accounting processes. Bus Process Manag J 10:234–247
Spewak SH, Hill SC (1993) Enterprise architecture planning: developing a blueprint for data, applications and technology. QED Information Sciences, Inc
Srinivasan A (1985) Alternative measures of system effectiveness: associations and implications. MIS Q 243–253
Stratman JK (2007) Realizing benefits from enterprise resource planning: does strategic focus matter? Prod Oper Manag 16:203–216
Sumner M (2013) Enterprise resource planning: Pearson new international edition. Pearson Education Limited
Sutton SG (2006) Enterprise systems and the re-shaping of accounting systems: a call for research. Int J Account Inf Syst 7:1–6
Taipaleenmäki J, Ikäheimo S (2013) On the convergence of management accounting and financial accounting—the role of information technology in accounting change. Int J Account Inf Syst 14:321–348
Trucco S (2014) Linee evolutive del sistema di controllo interno a supporto della comunicazione finanziaria. Econ Aziend (Online) 4:215–227
Trucco S (2015) Financial accounting: development paths and alignment to management accounting in the Italian context. Springer
Trucco S, Corsi K (2014) The influence of ERP systems implementation on accounting, organizational and social improvements: evidence from Italy and the UK. In: Baglieri D, Metallo C, Rossignoli C, Iacono MP (eds) Information systems management organization and control. Springer International Publishing, pp 115–138
Tsai W-H, Chien S-W, Hsu P-Y, Leu J-D (2005) Identification of critical failure factors in the implementation of enterprise resource planning (ERP) system in Taiwan's industries. Int J Manag Enterp Dev 2:219–239
Umble EJ, Haft RR, Umble MM (2003) Enterprise resource planning: implementation procedures and critical success factors. Eur J Oper Res 146:241–257
Umble EJ, Umble MM (2002) Avoiding ERP implementation failure. Ind Manag 44:25–25
Uwizeyemungu S, Raymond L (2005) Essential characteristics of an ERP system: conceptualization and operationalization. J Inf Organ Sci 29:69–81
Vasile G, Mirela O (2008) Data quality in business intelligence applications. Analele Universitatii din Oradea 1359
Wah L (2000) Give ERP a chance. Manag Rev

Wand Y, Wang RY (1996) Anchoring data quality dimensions in ontological foundations. Commun ACM 39:86–95

Wang RY, Strong DM (1996) Beyond accuracy: What data quality means to data consumers. J Manag Inf Syst 12:5–33

Weill P, Broadbent M (1998) Leveraging the new infrastructure: how market leaders capitalize on information technology. Harvard Business Press

Weill P, Ross JW (2004) IT governance: how top performers manage IT decision rights for superior results. Harvard Business Press

Weston FT Jr (2003) ERP II: the extended enterprise system. Bus Horiz 46:49–55

Wheller S (2004) ERP II demystified. Technol Eval

Wijnhoven F (2009) Information management: an informing approach. Routledge

Wylie L (1990) A vision of next generation MRP II scenario. S-300–339

Xu H, Horn Nord J, Brown N, Daryl Nord G (2002) Data quality issues in implementing an ERP. Ind Manag Data Syst 102:47–58

Xu JD, Benbasat I, Cenfetelli RT (2013) Integrating service quality with system and information quality: an empirical test in the e-service context. Mis Q 37

Yeo KT (2002) Critical failure factors in information system projects. Int J Proj Manag 20:241–246

Zaino J (2004) ERP integration struggles to connect. Inf Week March 29

Zeithaml VA, Parasuraman A, Berry LL (1990) Delivering quality services. N Y Free Press Career Dev 11:63–64

Zhu Y, Li Y, Wang W, Chen J (2010) What leads to post-implementation success of ERP? An empirical study of the Chinese retail industry. Int J Inf Manag 30:265–276

Zmud RW (1978) An empirical investigation of the dimensionality of the concept of information. Decis Sci 9:187–195

Chapter 3
Business Intelligence Systems

Abstract This chapter deals with Business Intelligence (BI) systems, summarizing the main needs which may lead companies to implement a BI system and proposing a set of critical success factors which allow for an effective implementation of a BI system that can satisfy companies' needs. Finally, it presents the main maturity models of BI systems, focusing on the life cycle of BI systems and the need to keep them up-to-date. In the first part of the chapter, the summarization of companies' needs for BI includes management information system needs, strategic planning needs, commercial and marketing needs, regulation needs, and fraud detection needs. The second part of this chapter pertains to the critical success factors of BI implementation. Several scholars have proposed different sets of factors to allow companies to maximize the effectiveness of BI system implementation. This part of the chapter considers the main critical success factor studies in the literature and shows the key aspects a company should consider for an effective BI implementation. Among these critical success factors are the ERP systems dealt with in Chap. 2. In addition to the critical success factors for BI implementation, the literature also recommends aligning the evolution of BI systems with that of the business, considering the life-cycle of BI models as a driver which affects critical success factors. In this regard, the third part of the chapter discusses the BI maturity models.

3.1 Introduction

This chapter will analyze the main needs for Business Intelligence (BI) which lead companies to invest in BI solutions (Sect. 3.2). The need to implement a BI system can arise from very different situations and could depend on internal or external aspects: for example, BI investment could be achieved to meet information system needs (Sect. 3.3), strategic planning needs (Sect. 3.4), commercial and marketing needs (Sect. 3.5), or regulatory and fraud detection needs (Sect. 3.6). After underlining the companies' needs for BI, it is important to understand how to implement a BI system to ensure it will meet the companies' expectations. For this

C. Caserio and S. Trucco, *Enterprise Resource Planning and Business Intelligence Systems for Information Quality*, Contributions to Management Science,
https://doi.org/10.1007/978-3-319-77679-8_3

purpose, Sect. 3.7 examines the main literature on the Critical Success Factors (CSFs) for BI implementation.

The success of BI is also affected by the maturity model and by the lifecycle approach used by the company; these aspects are explained in Sect. 3.8 and supported by the main literature streams.

3.2 Business Intelligence and Companies Needs

The main aim of this section is to analyze the factors that lead companies to invest in BI solutions. The aim, therefore, is to identify the criteria that should be followed in guiding companies to choose the most suitable system to meet their needs.

The need to invest in BI systems is analyzed from both an academic and professional perspective (Yeoh and Popovič 2016). However, there have been few studies that analyze, in a systematic and in-depth approach, the several factors and motivations that determine the need for companies to adopt BI systems (Yeoh and Koronios 2010; Yeoh and Popovič 2016). Only a few studies have been carried out through surveys specifically aimed at highlighting companies' needs for BI: the most representative example is the study of Yeoh and Popovič (2016), which is aimed at enhancing the understanding of critical success factors in the implementation of BI systems by analyzing 7 case studies and interviewing 26 business actors involved in the use of BI tools. Their research proposes an analysis of the perceived users' needs at various organizational levels.

Another study that indirectly identifies the needs of companies to implement BI systems is by Rud (2009), which provides guidance on the many needs that companies may feel. This study presents evidence from BI professionals, CEOs and experts during their work experience on the main information and IT requirements perceived by companies and on aspects that increase (or would increase) such needs. The lack of studies addressed directly at the needs of BI has made it necessary to extend the analysis of the literature to articles that, although not directly focused on the analysis of companies' BI needs, indirectly deal with their BI requirements, both in empirical and theoretical studies.

A BI system, a term coined in the early twentieth century by Gartner, can be defined as an integrated set of tools and technologies used to gather, integrate, aggregate, select, validate, intelligently explore and analyze (structured and semi-structured) data and information from different sources, making them useful and usable in different decision-making processes (Reinschmidt and Francoise 2000; Olszak and Ziemba 2007).

Studies show a growing trend in the investments that companies have made in the latest generation of IT technologies, despite the difficulties associated with the recent financial crisis. Companies are now faced with the choice of alternative solutions. On the one hand, they can opt for more "traditional" IT-centric models, in which BI is controlled by Information Technology (IT). These models are based on complex technologies that require special skills, and thus the availability of IT experts who deliver all the reports, making the process lengthy and ineffective. On the other hand, companies can choose “more innovative” systems, also called “business-led analytics”, which, based on self-service and visual analytics tools, allow users to produce custom reports without the need for specific IT skills.

The analyses aimed at monitoring the market trends of BI solutions appear to show that the entire market is constantly growing at an annual rate of 7.9% and that the latest generation solution—”business-led”—is in rapid growth, with a rate of only 63.6% in 2015 (Gartner 2017). The latter market segment seems to be highly promising since the decision to invest in BI systems seems to be highly influenced today by the growing need for flexibility in use and the personalization of data and information.

Below is a list of the critical drivers which lead companies to invest in BI technologies and the major models that companies may choose to implement these (see Table 3.1).

Regarding the factors which affect a company’s decision to invest in BI, we can identify the following three main drivers:

(1) coercive isomorphism (DiMaggio and Powell 1983; Powell and DiMaggio 2012), related to the need to manage a growing amount of data and information. These needs can be determined by the increasingly stringent and complex management needs, and by the need to meet the requirements of compliance with general or sectoral norms (e.g., bank regulations). The diffusion of computer technology and communication tools has greatly increased the amount of data and information that companies are able to manage daily;
(2) mimetic isomorphism (Haveman 1993), related to the need to cope with an increasingly competitive, global, turbulent and disrupting environment where timeliness becomes more and more critical in responding rapidly to market demands;
(3) decision-making process, associated with the need to deal with more and more complex processes (Saaty 1990; Turban et al. 2014) due to highly competitive contexts that require the increasing use of advanced information technologies and sophisticated decision-making algorithms.

Table 3.1 Summarization of the main drivers of BI needs

Coercive isomorphism (DiMaggio and Powell 1983; Powell and DiMaggio 2012)	Mimetic isomorphism (Haveman 1993)	Decision-making process support (Saaty 1990; Turban et al. 2014)
Need to manage great amount of data	Need to compete on the market	Need for timeliness
Need to deal with complex environment	Need to deal with competitors	Need for data quality
Need to comply with regulations	Need to respond to market demands	Need for reliable information

As a consequence, companies need to invest in innovative BI models that can:

- meet the need of integrating and analyzing data from different applications or, more generally, from different sources;
- reduce the opacity of certain operations and business functions by increasing their transparency and sharing;
- increase the timeliness of data access and data processing;
- increase the number of users who have access to data and information while reducing the technical expertise needed;
- effectively and efficiently manage company-specific life stages (expansion of the business, mergers, acquisitions, and so forth).

To develop these capacities, companies need to have BI and information available for several business functions and areas. The main areas where BI needs are most felt are the following (see Table 3.2):

a. management information systems;
b. strategic planning;
c. marketing;
d. regulations and fraud detection.

The main literature regarding the needs of companies is reported in Table 3.3.

The following sections analyze each of the BI needs reported in Table 3.2 on the basis of the literature summarized in Table 3.3.

Table 3.2 Main BI needs of companies

Management information systems	Strategic planning	Marketing	Regulation and fraud detection
Alignment to group logics	Monitoring of environmental signals	Search new needs and consumers tastes	Comply with the law
Coordination and technical-organizational integration	Planning and control requirements	Profile new potential customers	Make the internal control system auditable
Improvement of data management and decision support information	Innovative tools for adapting to environmental dynamics	Enhance existing relationships with customers	Detect financial frauds
Improvement in communication		Support marketing strategies	

Table 3.3 Main literature on the BI needs of companies

Management information systems	Literature review
Alignment to group logics	Sudarsanam (2003), Levinson (1994), Robbins and Stylianou (1999), Roehl-Anderson (2013), Elbashir et al. (2008), Peters et al. (2016), Kirlidog (1996)
Coordination and technical-organizational integration	Hou (2012), Popovič et al. (2012), Sparks and McCann (2015), Raymond (1990), Dishman and Calof (2008), Isik et al. (2011), Hérault et al. (2005), Serain (2002); Bieberstein (2006), Mendoza et al. (2006), Marjanovic (2010)
Improvement of data management and decision support information	Gilad and Gilad (1986), Turban et al. (2014), Woodside (2011), Chen et al. (2012), O'Reilly (2009), O'Reilly and Battelle (2009), Da Xu et al. (2014), Palattella et al. (2016), Peters et al. (2016), Moss and Atre (2003), Checkland (1981), Rosenhead and Mingers (2001), Mackenzie et al. (2006)
Improvement in communication	Rud (2009), Krivda (2008), Coleman and Levine (2008), Caserio and Trucco (2016), Patel and Hancock (2005), Hribar Rajterič (2010), Burton (2009), Lahrmann et al. (2011)
Strategic planning	
Monitoring of environmental signals	Georgantzas and Acar (1995), Malaska et al. (1984), Bradfield et al. (2005), Rud (2009), Giesen et al. (2010), Mitchell and Bruckner Coles (2004), Lindgren and Bandhold (2009), Laszlo and Laugel (2000), Pearce et al. (1997), Pearce and Robinson (2005), Alkhafaji (2011), Carpenter and Sanders (2006), Bose and Mahapatra (2001), Liebowitz (2006), Bradfield et al. (2005)
Planning and control requirements	Anandarajan et al. (2004), Hannula and Pirttimaki (2003), Mancini and Marchi (2004), Yeoh and Popovič (2016), Williams and Williams (2010), Howard (2003), Williams and Williams (2010), Elbashir et al. (2011), Malmi and Brown (2008), Aronson et al. (2005), Brignall and Ballantine (2004), Carte et al. (2005), Robertson et al. (2007), Olszak (2016), Chaudhary (2004), Hawking et al. (2008), Davenport et al. (2010), Pranjić (2011)
Innovative tools for adapting to environmental dynamics	Laszlo and Laugel (2000), Rud (2009), Bäck (2002), Bose and Mahapatra (2001), Michalewicz et al. (2006), Bäck (2002), Wang (2005), Salehie and Tahvildari (2009)
Marketing	
Search for new needs and consumer tastes	Olszak (2016), He et al. (2013), Chau and Xu (2012), Park et al. (2012)
Profile new potential customers	Olszak (2016), He et al. (2013), Berthon et al. (2012), Hall (2004), Hočevar and Jaklič (2008), Ranjan (2009)

(continued)

Table 3.3 (continued)

Management information systems	Literature review
Enhance existing relationships with customers and support marketing strategies	Olszak (2016), He et al. (2013), Berthon et al. (2012), Ranjan (2009)
Regulation and fraud detection	
Comply with the law	Yeoh and Popovič (2016), Trill (1993), Williams (1993), Rutter et al. (2007)
Make the internal control system auditable	Wingate (2016), Yeoh and Popovič (2016), Trill (1993)
Detect financial frauds	Ngai et al. (2011), Dorronsoro et al. (1997), Fanning and Cogger (1998), Cerullo and Cerullo (1999), Bell and Carcello (2000), Owusu-Ansah et al. (2002), Spathis (2002), Viaene et al. (2004), Kotsiantis et al. (2006)

3.3 BI for Management Information Systems Needs

This section deals with the needs for BI in the information system. First of all, the needs for BI may emerge from mergers and acquisitions operations, as explained in Sect. 3.3.1. Another reason why companies perceive the need to invest in BI is to improve internal coordination and technical-organizational integration (Sect. 3.3.2). Furthermore, because information systems aim at supporting strategic, managerial and operational decisions, companies may invest in BI to satisfy the need for data management and decision support (Sect. 3.3.3) and to improve communications (Sect. 3.3.4).

3.3.1 Alignment to Group Logics

Extraordinary finance operations, in particular Mergers and Acquisitions (M&A), play an increasingly important role in the current economy, due in part to globalization; such operations effect different business areas, such as the financial structure of companies, equity ownership, the business model, size and organizational set-up. Therefore, given the increased frequency and scope of these operations, due diligence activities should highlight the key success factors of M&A, such as the competitive position of the company to be acquired, the system and production processes, the human resources available, the accounting, contractual and fiscal situation, organizational features and information systems (Sudarsanam 2003). This latter point is particularly relevant in the context of this study, as M&A involve the integration, and thus the alignment, of corporate information systems, with the aim of pursuing strategic and tactical objectives (Levinson 1994). The literature shows that such finance operations can fail if they are carried out by attributing excessive attention to financial variables at the expense of technical, informational and organizational ones. Empirical studies also suggest that accurate planning of M&A operations is crucial for their success (Robbins and Stylianou 1999). One of the most common causes of M&A failure is the scant attention paid to their effects on the integration of the IT resources of the companies involved (McKiernan and Merali 1995; Roehl-Anderson 2013).

This integration should instead be one of the primary objectives of M&A operations, as it would provide quality, accurate, useful and timely information (Buck-Lew et al. 1992) and an effective system with the characteristics of selectivity, flexibility, reliability, timeliness and acceptability (Marchi 1993) that can support decision-making at the operational, managerial and strategic levels (Anthony 1967; Mancini 2010). According to a slightly different analytical perspective, for M&A operations to be successful, an alignment should be pursued between the business strategy and the technological tools available in the company (Roehl-Anderson 2013). Therefore, the impact of M&A operations on BI systems is twofold: on the one hand, the success of the integration of information systems improves the effectiveness of BI systems, as these analyze and process data provided by the information systems (Elbashir et al. 2008; Peters et al. 2016); on the other hand, M&A operations should be carried out by aligning the company's strategic needs with its BI needs in order to create value (Henningsson and Kettinger 2016).

With regard to the alignment of information systems, the need to implement a BI system may derive from the need to align the purchasing company's BI system to that of the acquired company, in case the latter is considered more effective (Yeoh and Popovič 2016). In this context, the most recent literature clearly demonstrates that the effective integration of information and IT systems of companies involved in M&A operations is essential for the achievement of the expected benefits (Wijnhoven et al. 2006; Graebner et al. 2016; Henningsson and Kettinger 2016).

Globalization has undoubtedly favored the implementation of M&A operations, and therefore the need for companies to implement or update BI systems to align them with business strategies. The compatibility of the information and IT systems of companies is thus one of the most important success factors for M&A operations, as it influences the ability of BI systems to provide adequate decision support (Sudarsanam 2003).

In the case of company groups, the parent company may feel the need to implement or adapt its BI systems to make them available to other companies of the group that, for organizational, structural or budget reasons, are lacking in BI tools. On the contrary, the need to invest in BI systems may be perceived by companies belonging to the corporate group due to the implementation and transfer strategies of hardware and software pursued by the parent company (Kirlidog 1996).

3.3.2 Coordination and Technical-Organizational Integration

The need to improve internal, technical and organizational coordination is very commonly discussed in the literature on BI integration systems. One of the needs emphasized in some studies is that perceived by BI end-users, who feel that BI investment is creating value only if the tools meet their needs and improve their job performance (Hou 2012).

The literature shows that end users' needs generally require that BI tools (Popovič et al. 2012; Sparks and McCann 2015):

- support the end-users' job tasks;
- are well structured and integrated so as to facilitate the achievement of end-users' objectives;
- have intuitive interfaces;
- facilitate the access to data;
- increase the timeliness of data, information and communication.

In other words, BI systems should provide an adequate level of user satisfaction, which consists in the end-users perception of an acceptable alignment between the systems used and the perceived needs (Raymond 1990; Dishman and Calof 2008).

Such satisfaction can be achieved through the enhancement and integration of existing and/or new BI systems; but this improvement, in turn, generates the need to manage the technical issues underlying the integration. This latter mainly concerns two closely-related factors (Isik et al. 2011):

a. technical-IT integration of internal business applications, which involves data, information and people;
b. enhancement of the ability to provide the information and knowledge needed to support end-user decisions.

With reference to the first point, obtaining a satisfactory level of integration between the business applications has become increasingly complex over time, given the high heterogeneity of databases, information platforms, software and interfaces. Furthermore, the advent of the Internet has brought new problems related to public communications, communications security and interoperability: i.e., the ability of systems to interact reliably with other systems (Hérault et al. 2005).

To cope with these complexities and to foster a link between business applications, middleware solutions were designed, which consist in software systems and interfaces that act as mediators among a lot of different applications (Serain 2002; Bieberstein 2006).

With regard to point (b), namely, the ability of the system to provide decision support to end-users, it is still thanks to the integration (and the updating) of the systems that the decision makers can meet this need. In addition to allowing very different applications to interact, the integration of the systems also makes it possible to unify information and data management systems, thus improving the alignment of information flows with business needs (Markus 2000). Consequently, the integration of the system allows for the provision of "unified" information which supports managerial decision-making (Mendoza et al. 2006).

In addition to providing "unified" information, an effective decision support to end-users also requires the adoption of data mining and knowledge discovery tools to transform data into knowledge; in doing so, these tools allow management to obtain insights and to make interpretations regarding a vast amount of data (Shim et al. 2002; Chou et al. 2014).

System integration has not only technical but also organizational implications. Integration makes it necessary to identify the most appropriate and effective solutions for end-user training and the definition of rules and best practices that end-users could follow and share (Marjanovic 2010).

However, the need for information system coordination and integration can also be perceived by the same top management, especially in companies that have already implemented BI systems and used them to support key business processes. Companies of this type recognize a considerable strategic value for BI systems, and they are generally the most inclined to invest in new BI solutions, since they wish to derive the maximum possible value (Marjanovic 2010).

3.3.3 Improvement of Data Management and Decision Support Information

The implementation of BI systems inevitably responds to the need to obtain data and information that support the decision-making process. The main phases of a BI system are (Gilad and Gilad 1986; Turban et al. 2014):

a. collection of data;
b. evaluation of the validity and reliability of the data;
c. data analysis;
d. data storing and processing;
e. dissemination and communication.

Communication precedes the acquisition and use of the information by the recipients to support their decisions. Following this path, raw data will be converted into information and therefore into knowledge, which is useful in providing decision makers with the appropriate support for their strategic choices. The need to have a BI system is thus perceived even more intensely when information is critical and impacts the decision-making process (Woodside 2011). Companies' needs for BI to support decisions can be explored under two main aspects:

- technological, based on data and tools available for data analysis;
- informational, associated with the specific business-related decision-making needs.

Regarding the technological aspect, companies' needs for data processing tools have evolved in line with the evolution of data complexity. Consequently, these needs have led to an evolution in BI tools (Chen et al. 2012). According to this interpretation, the needs for BI can be correlated with the types of data that managers need to analyze. The more structured is the data—that is, the more it comes from corporate databases and management systems—the more companies will effectively use BI tools such as data warehousing, Extracting, Transforming and Loading technologies (ETL), On-Line Analytical Processing (OLAP) and reporting, which allow them to extrapolate useful information through statistical analyses such as regression, segmentation and clustering, and to visualize information using multidimensional tools such as scorecards and dashboards (Chen et al. 2012).

However, BI tools needed by companies may change according to the nature and to the characteristics of the data. For example, if the data to be analyzed comes from the web in very large amounts and is not structured, companies will need Big Data and Web 2.0 tools, which would allow managers to analyze large amounts of data —such as, sites, social media, forums, blogs, and online resources in general. These tools, through advanced analyses, can provide a measurement of relevant aspects, such as online user activity (through web analytics and web intelligence tools), the frequency of use of certain terms (text mining, web mining), and the "moods" emerging from the text analysis (tone analysis, sensitivity analysis) (O'Reilly 2009; O'Reilly and Battelle 2009; Chen et al. 2012).

Companies that rely particularly on innovative tools, such as the Internet of Things, or mobile web applications, may perceive the need for BI tools that have recently begun to spread on the market (Da Xu et al. 2014; Palattella et al. 2016; Peters et al. 2016).

In addition to relying on the data typology and tools, BI needs also depend on the specific decision-making requirements that managers must meet. Hence, investing in BI requires the identification of the company's real technical and informational needs to ensure the new BI resources are not acquired only to upgrade the processing capabilities, neglecting the alignment of technology to the business. Following this idea, the need for BI tools depends on the type of business activity, the industry, the complexity of the internal processes and the external environment. In other words, it depends on all those elements that contribute to creating the problems and, consequently, it affects the type of decision support needed to solve them (Moss and Atre 2003). The study by Mackenzie et al. (2006) is also in line with these ideas: the authors distinguish the DSSs according to the decision-making needs the company has to satisfy, recognizing two types of DSSs:

a. substantive systems, which provide support for the resolution of specific kinds of problems and the management of specific decisions through processing, calculation and design capabilities;
b. procedural systems, which instead provide support for the assessment of the consequences of a decision.

Therefore, substantive systems will be implemented by companies that need an "operational" decision-making support, and thus aid in understanding how to reach a certain goal that is already known (Checkland 1981). This type of support is based on providing the decision maker with a set of alternatives, mostly based on mathematical calculations and simulations.

On the other hand, procedural systems will be adopted by companies that need to understand why a specific action is required, or to look for the best alternative that could solve a particular problem. In these systems—unlike the previous ones—the problems to be solved are not known in advance and are generally strategic, unstructured and not well-documented (Rosenhead and Mingers 2001; Mackenzie et al. 2006).

3.3.4 Improvement in Communications

In addition to acquiring data and information needed to gain decision support, companies also perceive the need for BI tools to enhance their communicative skills (Rud 2009). BI tools, therefore, can be used to improve the frequency, clarity and timeliness of communication. In some cases, the choice to implement a BI system arises from the specific need to improve the effectiveness of communications between management and customers, with the aim of improving economic and financial performance (Krivda 2008). Of course, the tools that can be used for this purpose include those of Web 2.0.

Some factors that may affect a company's need for BI and the type of BI tools required are:

- the type of business activity;
- the number of sectors and/or markets in which the company operates;
- the structure of the reporting system;
- the maturity model of BI.

Regarding the first point, some companies may adopt tools useful for promoting internal real-time collaboration, setting up collaborative teams that can discuss and share ideas and solutions for several issues (Rud 2009). The type of business activity can also lead companies to prefer BI systems for synchronous communication or asynchronous communication: the first fulfills the need for quick comparison between the interested parties (both internal and external), while the latter is generally suitable for the resolution of less urgent problems (Coleman and Levine 2008).

As for the second point, a high number of sectors and/or markets in which the company operates may cause information overload, which could bring about a loss in decision-making accuracy, and low-quality and delayed communications (Rud 2009). In these cases, companies would need a high-quality information system (Caserio and Trucco 2016), which requires both an integrated transactional system (e.g. ERP systems) and a BI system well-aligned with business goals (Patel and Hancock 2005).

Concerning the third point—the structure of the reporting system—communication and collaboration needs can also be met through the implementation of a reporting system, which is one of the first investments that companies carry out in BI. Companies with this system ensure that they can select, represent and communicate data by choosing only the most relevant data and dividing it into multidimensional views. In other cases, companies invest in BI reporting systems because they are interested in analyzing trends and historical data, creating forecasts, and conducting scenario analysis (Hribar Rajterič 2010). If company feels the need to enhance the reporting system, it can introduce more advanced solutions, such as personalized Key Performance Indicators (KPIs) and scorecards, both of which are multidimensional tools that generate reports for performance measurement, control and monitoring.

Regarding the fourth point—the BI maturity model—the need for an upgrade in BI could be influenced by the maturity of BI and that of the company: in fact, according to the literature on the maturity model of BI systems—used to describe, explain and evaluate the life cycle of Business Intelligence—for a BI system upgrade to produce the benefits expected, the equilibrium between the level of maturity of BI and the level of maturity of the company has to be maintained (Burton 2009; Hribar Rajterič 2010; Lahrmann et al. 2011). Therefore, in investing in BI, a company could postpone or anticipate its purchase according to the condition of equilibrium (or disequilibrium) between the BI and the company maturity level.

3.4 BI for Strategic Planning Needs

As previously explained, BI systems support information system management by improving data and information management, data and system integration, and reporting systems. One of the most frequent needs companies try to satisfy by implementing a BI system is that of supporting strategic decisions, planning and control. Accordingly, this section deals with the following needs of companies:

- BI needs for monitoring weak environmental signals (Sect. 3.4.1); BI systems may allow companies to understand the environmental dynamics and to eventually anticipate strategic competitors;
- planning and control needs (Sect. 3.4.2); BI may aid companies in improving the management control system through dashboards, forecasting models, reward/compensation systems, and by aligning the various business functions objectives;
- needs for advanced tools which support the alignment between the business model and the changing environment (Sect. 3.4.3).

3.4.1 Monitoring of Environmental Signals

Environmental changes require companies to rapidly and effectively obtain the information needed to support the decision-making process. From this perspective, the implementation of BI systems can respond to the need for tools that can support the company in the strategic planning phases and in analyzing complex problems through planning, simulation and scenario analysis tools (Georgantzas and Acar 1995; Marchi 1997; Caserio 2015). The need to analyze unstructured problems, typically associated with environmental turbulence, has gradually been perceived since the 1970s, when the environmental complexity began to affect corporate decisions more intensely (Malaska et al. 1984; Bradfield et al. 2005).

According to the literature, companies which implement BI tools to support strategic planning and control activities seek to satisfy the following needs:

- obtain better monitoring of the external environment and recognize weak change signals (Rud 2009);
- periodic re-evaluations of the adopted business model (Giesen et al. 2010);
- identify and monitor over time the drivers which affect economic and financial results (Mitchell and Bruckner Coles 2004);
- create alternative scenarios for solving complex problems (Lindgren and Bandhold 2009);
- obtain a quick and coordinated decision-making process (Laszlo and Laugel 2000).

In these areas, an effective BI system would play a crucial role for companies, as it would provide environmental turbulence signals necessary to evaluate a possible revision of the business model. The analysis of the external environment is as crucial as it is difficult to carry out, considering that it examines several qualitative and quantitative factors of multiple resources, including elements that, in many cases, are not known beforehand. This could make it difficult for companies to adapt to the new environmental conditions in a timely manner (Pearce et al. 1997; Pearce and Robinson 2005).

In addition, external information, useful for analyzing the strategic problems and for supporting decisions, may be available only in certain limited periods of time; furthermore, its acquisition could be costly and time-expensive, and the time available for procuring it could be insufficient. Moreover, even in cases of easy information accessibility, it would still be unlikely to know, a priori and accurately, what information is needed to effectively support decisions; instead, it is much more common for management to become aware of the necessary information only when it is really needed, which usually happens when it is too late (Alkhafaji 2011).

In addition to the need for BI to anticipate potential changes in the external environment, companies also need to continuously align their business model to the environmental changes. Therefore, BI tools that help to recognize external change signals are as important as those that support management (Alkhafaji 2011):

- in understanding whether the alignment between the business model and the environment has been achieved (or is happening) effectively;
- in verifying if there are any inconsistencies between the desired change and the actual change;
- in providing alternatives that enhance alignment, minimizing the negative effects of external pressures.

However, the external environment consists of several forces and conditions related to the industry, the market and the economic system, some of which are not measurable. Thus, BI tools are useful for analyzing only measurable data, information and resources which pertain to the external environment. This analysis is usually based on the principles of SWOT analysis, which identifies the strengths, the weaknesses, the opportunities and the threats that characterize the company and its environment (Hunger and Wheelen 2010). Within a turbulent environmental system, BI can effectively support managers in identifying environmental elements that have changed, in recognizing which elements have a direct influence on business processes and which ones, instead, do not engender any modification of the business model (Carpenter and Sanders 2006).

In the absence of BI tools, it is likely that the difficulties in recognizing the weak signals of change will be perceived to the maximum extent possible, while an effective BI system could help to reduce them. BI tools, in fact, can support business management in several ways:

a. by providing in-depth data mining, which enables companies to acquire non-detectable knowledge (Bose and Mahapatra 2001);
b. by creating forecasts based on historical trends (Liebowitz 2006);
c. by acquiring and processing data in a timely fashion and visualizing it through multidimensional reporting systems (Chen et al. 2012);
d. by providing scenarios, simulating the effects of possible future decisions (Bradfield et al. 2005).

In addition to the support in recognizing environmental change signals, BI tools also allow companies to continuously monitor the ongoing process of alignment between the business model and the new, changed environmental conditions. These tools allow the company both to monitor external information that most likely will affect the business model and to monitor the internal key variables that are most sensitive to external influences.

A BI system capable of managing such continuous monitoring and controls provides undoubted benefits to business management, as it permits periodic reviews of strategic objectives and the alignment of business policies with environmental changes. The need to adapt to the changed external conditions forces companies to promptly change the business model. Consequently, there emerges the need for tools that guide and optimize business operations on a daily basis and that enable the monitoring of internal operations activities. These tools, called *operational BI*, allow instant visibility of the most critical business operations (Nesamoney 2004) and, in pursuing the aim of making the decision-making process as quick as possible, operational BI systems must be matched by the continuous, on-line monitoring of business operations (White 2005). BI systems are particularly suited for such operations because they are able to acquire information directly from original business processes, or during the process implementation, in a disaggregated form that allows managers to measure and monitor the performances in real-time, with a high level of detail (Alles et al. 2006). Because business processes are often a response to environmental turbulence, continuous monitoring of these processes must necessarily be coordinated with the constant monitoring of the external environment.

Therefore, BI systems satisfy the need to monitor the external signals of change, the need to assess the adherence of the business model to the mutable environmental conditions, and the need to promptly reveal any discrepancy.

3.4.2 Planning and Control Requirements

Originally, BI systems were defined as a collective term for data analysis tools (Anandarajan et al. 2004) that allow for timely, relevant and easy-to-use information (Hannula and Pirttimaki 2003). Today, this definition is still valid, as BI provides significant improvements to the traditional DSS (Mancini and Marchi 2004; Yeoh and Popovič 2016).

In addition to the support provided to the strategic level, BI systems are also helpful in enhancing the planning and control activities performed by firms. BI systems, in fact, refer to a set of systems for data analysis and reporting that provide decision support *at various levels* of the organization (Hannula and Pirttimaki 2003) through business applications that include scorecards, dashboards, customer analytics and supply chain analytics (Williams and Williams 2010).

With regard to planning and control activities, the main need that leads managers to acquire BI systems is to improve the effectiveness of Corporate Performance Management (CPM), which mainly consists in resource management, cost accounting, financial planning and budgeting (Howard 2003; Williams and Williams 2010; Elbashir et al. 2011). BI tools provide powerful capabilities which support planning, cybernetic controls, and administrative and reward/compensation controls (Elbashir et al. 2011). According to Malmi and Brown’s definition (2008):

- cybernetic controls provide quantitative measures for activities and processes, fix performance standards, and provide feedback on the business goals, assessing variances between goals and results;
- planning controls designate functional area goals, establish standards for assessing the business function results, and assure alignment between the various functional goals throughout the company;
- reward/compensation controls seek to motivate the individuals, thereby increasing their performance;

- administrative controls set organizational structures, lines of accountability, and establish policies and procedures.

Several planning and control activities are supported by the BI tools, since they help to monitor, scan and interpret the collected information. For example, BI tools allow firms to perform financial simulations, what-if analyses and scenario analysis before defining strategic (and tactical) goals (Mancini and Marchi 2004; Aronson et al. 2005; Marchi and Caserio 2010).

Hence, using BI solutions can dramatically improve the planning and control activities. In an integrated enterprise system, the solidity of databases is ensured by the set of relations that connect the data to each other; but in many cases the individual ability of end-users to extract relevant information without using specialized applications is quite limited. This plays against the need to effectively manage planning and control activities, which require a timely response of the system and accurate enterprise data, which is useful in making estimates, forecasts, simulations, and the like. In this sense, BI systems play a crucial role as they are specifically designed to facilitate users in performing detailed analyses of enterprise data (Brignall and Ballantine 2004; Carte et al. 2005; Robertson et al. 2007). Furthermore, the availability of timely and accurate information and data positively affect both cost management and the reporting system (Rud 2009). In fact, BI systems are able to produce, from the underlying enterprise databases, a wide range of pre-specified reports useful for supporting planning and control activities (Elbashir et al. 2011).

The importance of BI tools for planning and control activities is also confirmed by some empirical studies: a survey conducted by Olszak (2016), along with other case study analyses (Chaudhary 2004; Hawking et al. 2008; Davenport et al. 2010; Olszak 2015), reveal that BI systems can be acquired for:

- supporting demand forecasting;
- informing about the realization of enterprise goals;
- increasing the effectiveness of strategic, tactical and operational planning;
- improving the quality of information related to trends and the realization of plans;
- providing analyses of deviations from the realization of plans.

The benefits of BI for planning and control activities are sometimes neither directly measurable nor explicit. This happens when the improved strategic decisions and the increased information quality due to the adoption of BI tools allow managers to prevent losses, without the possibility of quantifying the effects (Pranjić 2011).

3.4.3 Innovative BI Tools for the Adaptation to Environmental Conditions

To support strategic decisions, companies need BI tools that are sufficiently innovative and capable of recognizing the signs of change. Some studies argue that traditional BI tools, as part of strategic planning, usually consist of applications that use historical trends to derive future values, supported by statistical models (Laszlo and Laugel 2000; Rud 2009). The same studies argue that the mathematical rigor of such models, although useful for the initial formulation of the strategy, may be an obstacle to the creativity which could be necessary for suggesting alternative scenario hypotheses and for proposing business model changes. Traditional BI tools are, therefore, likely to undermine the strategic adaptability of the company (Laszlo and Laugel 2000). This strategic adaptability should be supported by an equally *adaptable BI* infrastructure, or by adaptive BI tools (Bäck 2002). These systems inherit the features of expert systems and belong to the area of machine learning, which examines the ability to provide software with the capacity to learn without a specific programming. The learning process, in fact, derives from the recognition of patterns and algorithms which analyze source data to make predictions (Bose and Mahapatra 2001).

The goals of traditional BI systems are to access data from a variety of sources, transform them into information and, through data mining algorithms, into knowledge that supports decision-making. The knowledge is made available to the decision makers through user-friendly interfaces. Unlike these traditional systems, adaptive BI not only provides support for decisions but is also able to recognize the best decisions to take on the basis of the knowledge available (Michalewicz et al. 2006).

Therefore, in addition to transforming the data into information and information into knowledge, these systems elaborate the knowledge through optimization models and predictive algorithms, proposing decisions that are continuously updated based on the data and knowledge acquired in input. These tools are thus based on an iterative “input-output-output” logic, as shown in Fig. 3.1.

Over time, the adaptive BI system contributes to a self-learning process that gradually updates the knowledge about problems and proposes solutions aligned with the input data.

The adaptive BI system is based on a logic in which:

- the input is represented by the problem to be solved and its related data;
- the output consists of the additional knowledge that the system generates regarding the problem, utilizing the combination of optimization and prediction models;
- the generated output (i.e., the solution proposed for the problem) represents both a decision-making support and an internal data source which returns as a system’s input; this input is also composed of new updated data acquired from external sources;
- the process is repeated cyclically.

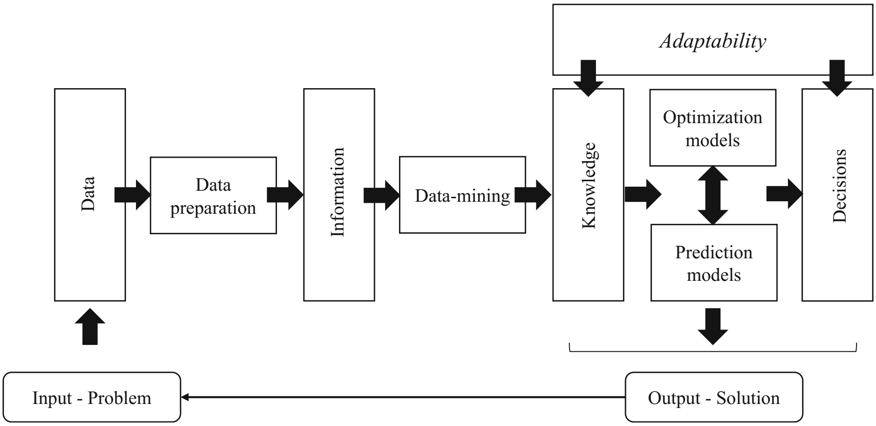

Fig. 3.1 Adaptive business intelligence (*Source* Adapted from Michalewicz et al. (2006))

The iterative approach of these systems allows companies to keep the knowledge of the problems up-to-date by taking into account the effects of environmental turbulence on the input data (Bäck 2002; Wang 2005; Salehie and Tahvildari 2009).

Therefore, companies which use traditional BI systems and operate in a turbulent environment perceive the need to adopt more innovative and flexible systems, thereby favoring the adaptability necessary to cope with mutable environmental dynamics (Rud 2009).

3.5 BI for Marketing Needs

One of the strongest needs that lead companies to invest in BI tools is to create new relationships with customers or to enhance existing relations (Olszak 2016). BI provides valuable support for processing large amounts of structured or unstructured data, thereby helping companies to analyze data related to active customers. Furthermore, BI tools may also be useful in identifying and profiling new potential customers through data analysis carried out, for example, on social media. Companies can thus invest in BI to meet several types of needs relating to the commercial and marketing fields (He et al. 2013; Olszak 2016):

- market analysis to search for new needs and consumer tastes;
- market analysis to identify the target audience and profile potential new customers;
- internal data analysis on existing customers to enhance existing relationships;
- classifying active customers based on common characteristics (creating clusters and segments);
- implementing targeted marketing strategies.

BI systems support companies in identifying new market opportunities in order to meet the needs of customers and increase their satisfaction levels (Chau and Xu 2012; Park et al. 2012). The combination of these tools with Web 2.0 can even improve customer analysis. Web 2.0 tools, in fact, provide valuable support to the management of business and marketing activities, since they enable managers to interact directly with effective or potential customers and to gain information about their preferences and interests. For example, through the combination of data-mining techniques—namely, the text-mining applied to social networks—and Web 2.0, it is possible to obtain information implicit in the exchange of messages and opinions expressed by social media users (He et al. 2013). These combined tools could also be used by companies operating in international markets; however, in these cases they should customize their global marketing strategy to meet the diverse needs of clients from many different countries (Berthon et al. 2012).

With regard to internal customers, data analysis can only be conducted where BI tools are closely related to Customer Relationship Management (CRM) systems. The latter, in fact, represent the source from which BI tools acquire customer data related to buying habits (channel used, quantity purchased, typology of products, and so on), degree of loyalty, customer age, and customer preferences. Once the data has been acquired, BI tools process it through statistical analysis, clustering and segmentation (Olszak 2016).

Therefore, from a commercial and marketing perspective companies invest in BI tools to meet the following needs (Hall 2004; Hočevar and Jaklič 2008):

- monitoring the market demand;
- deepening knowledge of clients (actual and potential);
- proposing solutions to maximize customer satisfaction and loyalty;
- consequently, increasing economic returns and competitive advantage.

Hence, the use of BI tools in the marketing field helps improve the customer experience as a whole by providing customers with the most timely and aligned responses to their problems and priorities (Ranjan 2009).

3.6 BI for Regulations and Fraud Detection Needs

The study conducted by Yeoh and Popovič (2016) suggests that one of the reasons why companies adopt BI systems is to comply with regulations. In certain cases, in fact, the peculiarities of the industry and the unique characteristics of the environment in which the company operates may lead managers to acquire BI systems that make business activities easy to audit. In these cases, companies require BI tools that can create auditable reporting (in support of institutional inspections performed by the control organisms) and perform business activities in compliance with regulations. In this regard, some studies conducted in the pharmaceutical sectors suggest that companies have to make sure that their software allows them to keep audit trails and to apply access restrictions to specific fields of the enterprise database (Wingate 2016). Therefore, the choice of BI tools and, more generally, of the BI model is sometimes influenced by the expectations of the regulatory authorities, which could require that (Trill 1993; Williams 1993):

- software be programmed and maintained under version and change control;
- companies use good programming practices;
- data integrity issues be well implemented in the database management systems.

In other cases, BI model modifications could arise from compliance with the changes in International Accounting Standards (IAS) and International Financial Reporting Standards (IFRS). For example, the passage from the IAS 39 to the IFRS 9—related to the evaluation of financial instruments—obliged companies to adopt new classification and measurement methodologies. These changes are likely to imply some modifications also in the business applications used in accounting information systems (Corsi and Mancini 2010; Trucco 2014, 2015).

In some cases, companies need to adopt BI tools to provide disabled people with the same quality of web services and the same effectiveness that other users receive. In such cases, Web accessibility tools, PDF accessibility tools and other specific technologies have to be adopted (Rutter et al. 2007).

Furthermore, the need for advanced BI tools is perceived by companies that have to perform Financial Fraud Detection (FFD) activities, mainly banks and insurance firms. In this area, data-mining plays an important role as it allows companies to extract and uncover the hidden information behind large amounts of data and identify interesting patterns in databases and useful knowledge from business data (Ngai et al. 2011). Fraud detection seems to be one of the most common and well-established applications of data-mining, as confirmed by the existence of several data-mining techniques such as neural networks (Dorronsoro et al. 1997; Fanning and Cogger 1998; Cerullo and Cerullo 1999), logistic regression (Bell and Carcello 2000; Owusu-Ansah et al. 2002; Spathis 2002), naïve Bayes methods (Viaene et al. 2004), and decision trees (Kotsiantis et al. 2006), among others.

3.7 Critical Success Factors of BI Implementation and Adoption

The previous sections summarized the main reasons that lead companies to adopt BI systems and BI tools. Once the needs for BI have been recognized, it is important to understand how BI systems are implemented within the company.

For this purpose, several authors propose a set of Critical Success Factors (CSF) considered essential for the successful implementation of BI. Yeoh and Koronios (2010), through a multiple case study analysis, distinguish three main aspects of BI implementation—organization, process and technology—recognizing the CSFs pertaining to each of them. Regarding organization, they identify "vision and business case related factors" and "management and championship related factors"; with regard to process, they find "team related factors", "project management and methodology related factors" and "change management related factors"; regarding technology, they identify "data related factors" and "infrastructure related factors". In their framework, the authors also consider the relevance of process performance, which includes the budget and time schedule, and infrastructure performance, represented by system quality, information quality and system use. A follow-up study by (Yeoh and Popovič 2016) suggests that organizational factors play the most crucial role in influencing the success of BI implementation.

According to Rud (2009), CSFs for BI are classifiable into five elements: effective communication, which could be obtained by sharing goals, knowledge and using different communication styles and different BI tools; collaboration, achievable through teamwork using specific tools, which allows people to exchange opinions about problems in a timely manner; innovation, which is the capability to develop creativity and propose new solutions to meet market needs; adaptability, attainable by keeping the organization open to change and by promoting flexibility in organizational structures and interactions; and leadership, a term which summarizes a wide range of characteristics that leaders should have to motivate personnel and to obtain the awareness of the internal needs (for example, empathy, attunement, organizational awareness, inspiration, among others). Other studies underline the fact that BI systems are an extension of ERP systems, and thus the presence of an effective ERP is one of the CSFs for BI implementation (Vosburg and Kumar 2001). In this regard, Hawking and Sellitto (2010) propose a list of CSFs for BI implementation in an ERP system environment, identified through a content analysis performed on presentations of industry practitioners involved in the implementation, use and maintenance of BI in an ERP environment. The most frequent CSFs found through this content analysis are: management support, resources, user participation, and team skills. Other factors, such as champion, source systems and development technology, had minor frequency and thus less importance.

Another qualitative study, carried out through a literature analysis and a set of interviews conducted with executives, managers and staff before, during and after the BI implementation, suggest there are two types of CSFs for BI: implementation CSFs—collaborative culture, customization, communication, project management, resources, top management support, training, vertical integration—and success factors related to the post-BI implementation phase—perceived success, timely implementation and satisfaction. (Woodside 2011). Other studies deal with the CSFs of BI implementation in specific industries or places. For example, Olszak and Ziemba (2012) examine the CSFs for BI implementation in small-medium enterprises in Poland, while Dawson and Van Belle (2013) focus on CSFs for Business Intelligence in South African financial services.

Table 3.4 summarizes the main CSFs related to BI implementation emerging from the literature.

Table 3.4 Main critical success factors for BI implementation

Yeoh and Koronios (2010)	Rud (2009)	Hawking and Sellitto (2010)	Woodside (2011)
Vision and business case related factors	Effective communication	Management support	Collaborative culture
Management and championship related factors	Collaboration	Resources	Customization
Team related factors	Innovation	User participation	Communication
Project management and methodology related factors	Adaptability	Team skills	Project management
Change management related factors	Leadership	Champion	Resources
Data related factors		Source systems	Top management support
Infrastructure related factors		Development technology	Training
Budget and time schedule			Vertical integration
System quality			Perceived success
Information quality			Timely implementation
System use			Satisfaction

It is also important to underline that several studies also recognize ERP systems as critical BI success factors, since ERP systems provide the starting data that are processed by BI systems. If the quality of data is high and the data comes from an integrated and reliable ERP system, then the BI system will also be able to provide effective decision support (Karim et al. 2007; Laudon et al. 2012).

In examining the CSFs of BI implementation, some authors also take into account the BI maturity model, which allows the position of the company along the BI development process to be identified. Consequently, the BI maturity model enables companies to understand which are the CSFs for upgrading BI, coherent with the maturity of the company (Hribar Rajterič 2010; Popovič et al. 2012). In other words, these studies consider the lifecycle of BI as one of the drivers that influence the CSFs.

3.8 BI Maturity Models and Lifecycle

Over time, the role of BI systems has gradually changed, from that of a single analytical application view to being an essential component of information systems which contributes to overall company success (Watson 2010). To make BI systems effective, it is necessary to follow its design and structure changes. To this end, the literature provides the concept of a maturity model, which consists in a sequence of multiple archetypal levels of maturity of a certain domain that can be used to assess the degree of the model development (Lahrmann et al. 2011).

Each level of maturity is very different from the others and composed of features that differ from those of the other levels. Key Process Areas (KPAs) are defined for each level of maturity and are distinctive for that particular level. KPAs represent phases that the company needs to complete in order to achieve a certain level of maturity (Hribar Rajterič 2010).

Maturity models allow companies to understand the overall development of a certain domain, and therefore are useful in understanding the characteristics needed by the company to evolve from one level to another. Regarding BI maturity models, the literature provides a series of examples, the main ones summarized by Lahrmann et al. (2010) and Hribar Rajterič (2010). An example of maturity model is shown in Fig. 3.2.

Figure 3.2 shows an example of a BI Maturity Model, developed by The Data Warehouse Institute (TDWI), mainly focuses on technical issues. Maturity levels are graded through eight key process areas: scope, sponsorship, funding, value, architecture, data, development and delivery.

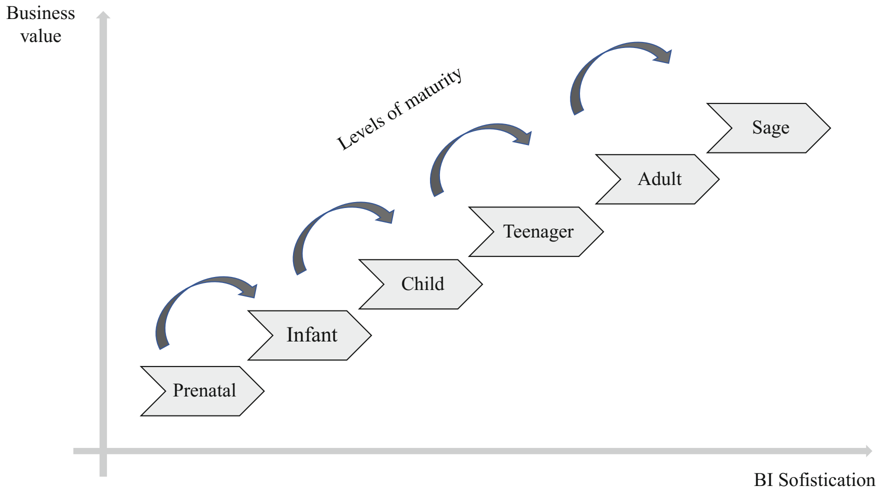

Fig. 3.2 TDWI's business intelligence maturity model (*Source* Adapted from Eckerson (2007))

The starting level, “prenatal”, represents the situation in which organizations have rigid management reporting systems, mainly based on standard static reports, distributed to employees on a regular time basis. Reports are hand-coded against legacy systems, therefore IT staff cannot satisfy rapidly the requests for custom reports.

The “infant” phase, represents the situation in which companies are faced with several partial and non-integrated data sources, which provide contrasting business views and do not allow for an effective decision-making process. When companies are at a “child” level, some data warehouse starts to be implemented in single business units, which, however, are not linked to each other. At the “teenager” level, companies recognize the importance of BI systems and of the centralized Data Warehouse (DW) for improving data integration and data quality. Companies make an extensive use of BI consultants to acquire BI tools that provide users with dashboards based on KPIs and with interactive reporting and analysis tools. At the “adult” level, companies implement centralized data management and standardize the architecture of DWs, the language and the metrics rules. The companies start using DWs integrated with data sources in real time. When the company reaches the “sage” level, the BI system capabilities are turned into technical services and an *ad hoc* information management group is responsible for managing the company’s entire data warehouse as a source for all enterprise information (Hribar Rajterič 2010). At this level, the BI system allows for the creation of customized reports, the monitoring of KPIs, and the provision of services with high added value.

The main aim of maturity models is to allow companies to assess their BI technologies: first, companies can understand what the BI maturity level of their system is and, second, ascertain the coherence between BI maturity and company maturity. Furthermore, maturity models support companies in comparing their system with those of competitors, in recognizing possible weak points in their BI system, and in identifying possible improvement strategies to achieve a certain maturity level (Tan et al. 2011). Therefore, the passage from one level to another is generally dictated by strategic alignment needs.

The maturity models also support the understanding of critical success factors for BI implementation since, according to Hawking and Sellitto (2010), success factors may vary depending on the life stage of BI in which the company is involved. Similarly, Dinter et al. (2011) suggest that a lifecycle-oriented approach allows companies to anticipate potential project risks in a timely fashion and to identify possible interventions in the early implementation stage.

This latter consideration introduces another analytical perspective, which also refers to the dynamics of BI systems over time. In addition to the maturity models, in fact, BI may also be analyzed from a lifecycle perspective. Moss and Atre (2003), for example, state that an integrated BI system needs considerable time to be deployed. Almost all the implementations of engineering projects need to follow these phases:

- justification, in which the developer analyses the business needs which gave rise to the project;

- planning, useful in defining strategies and examining how to achieve the objectives;
- business analysis, which deeply and analytically investigates the business requirements and the possible problems, in order to understand which product could fulfill the business needs;
- design, in which the developer defines the product features which could solve the problems and satisfy the business needs;
- construction, in which the product is created;
- deployment, which allows the company to implement the product and evaluate whether it meets the business needs.

However, this approach is effective only when the external (and internal) environment of the company is relatively static. Since BI models tend to evolve following continuous environmental changes, the traditional deployment process become inadequate for the continual support of business decisions and needs. An effective BI deployment approach should develop iterative releases, as each deployment is likely to give rise to new requirements for the next release (Moss and Atre 2003).

Therefore, the process to be followed, shown in Fig. 3.3, requires that initially—the justification phase—the business opportunities have to be clearly identified and the problems that the (new) BI application release could solve and/or the benefits that it could bring to the company highlighted; subsequently, the planning stage

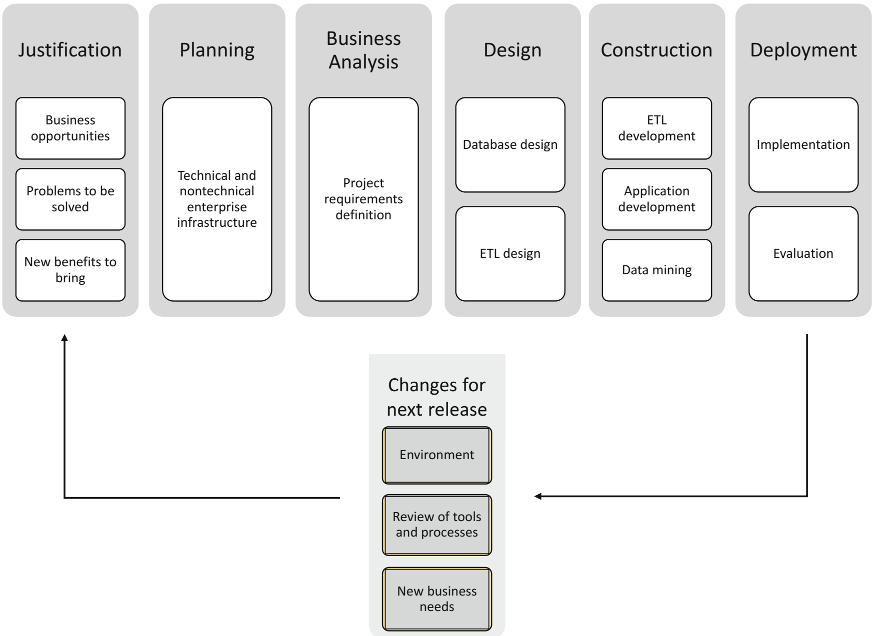

Fig. 3.3 Lifecycle of BI applications (*Source* Adapted from Moss and Atre (2003))

evaluates the technical and nontechnical enterprise infrastructure, after which the business needs are analyzed in detail to identify the requirements of the company regarding data, information, tools and internal processes. After the design and construction have been accomplished, the release is deployed. This iterative approach is important for two main reasons: (a) it keeps the functionalities of new releases constantly aligned with business needs, and (b) it learns from the previous releases, as every tool, technique and process which was not helpful in the previous project will be modified or discarded in the next one.

References

Alkhafaji AF (2011) Strategic management: formulation, implementation, and control in a dynamic environment. Dev Learn Organ Int J 25

Alles M, Brennan G, Kogan A, Vasarhelyi MA (2006) Continuous monitoring of business process controls: A pilot implementation of a continuous auditing system at Siemens. Int J Account Inf Syst 7:137–161

Anandarajan A, Srinivasan CA, Anandarajan M (2004) Historical overview of accounting information systems. In: Business intelligence techniques. Springer, pp 1–19

Anthony RN (1967) Planning and control systems (It. trans., Sistemi di pianificazione e controllo: schema d'analisi, Etas Libri, Milan)

Aronson JE, Liang T-P, Turban E (2005) Decision support systems and intelligent systems. Pearson Prentice-Hall

Bäck T (2002) Adaptive business intelligence based on evolution strategies: some application examples of self-adaptive software. Inf Sci 148:113–121

Bell TB, Carcello JV (2000) A decision aid for assessing the likelihood of fraudulent financial reporting. Audit J Pract Theory 19:169–184

Berthon PR, Pitt LF, Plangger K, Shapiro D (2012) Marketing meets Web 2.0, social media, and creative consumers: implications for international marketing strategy. Bus Horiz 55:261–271

Bieberstein N (2006) Service-oriented architecture compass: business value, planning, and enterprise roadmap. FT Press

Bose I, Mahapatra RK (2001) Business data mining—a machine learning perspective. Inf Manag 39:211–225

Bradfield R, Wright G, Burt G et al (2005) The origins and evolution of scenario techniques in long range business planning. Futures 37:795–812

Brignall S, Ballantine J (2004) Strategic enterprise management systems: new directions for research. Manag Account Res 15:225–240

Buck-Lew M, Wardle CE, Pliskin N (1992) Accounting for information technology in corporate acquisitions. Inf Manag 22:363–369

Burton B (2009) Toolkit: maturity checklist for business intelligence and performance management. Gart Res

Carpenter MA, Sanders WG (2006) Strategic management: a dynamic perspective, concepts and cases, United States, ed edn. Prentice Hall, Upper Saddle River, N.J.

Carte TA, Schwarzkopf AB, Shaft TM, Zmud RW (2005) Advanced business intelligence at cardinal health. MIS Q Exec 4:413–424

Caserio C (2015) Modelli d'azienda per il supporto decisionale e la generazione della conoscenza. G Giappichelli Editore

Caserio C, Trucco S (2016) Relationship between information system and information overload. A preliminary analysis. Int J Manag Inf Technol 11:3040–3050

Cerullo MJ, Cerullo V (1999) Using neural networks to predict financial reporting fraud: part 2. Comput Fraud Secur 1999:14–17

Chau M, Xu J (2012) Business intelligence in blogs: understanding consumer interactions and communities. MIS Q 36:

Chaudhary S (2004) Management factors for strategic BI success. In: Business intelligence in the digital economy: opportunities, limitations and risks. IGI Global, pp 191–206

Checkland P (1981) Systems thinking, systems practice

Chen H, Chiang RH, Storey VC (2012) Business intelligence and analytics: from big data to big impact. MIS Q 36

Chou H-W, Lin Y-H, Lu H-S et al (2014) Knowledge sharing and ERP system usage in post-implementation stage. Comput Hum Behav 33:16–22

Coleman D, Levine S (2008) Collaboration 2.0: technology and best practices for successful collaboration in a Web 2.0 world. Happy About

Corsi K, Mancini D (2010) The impact of law on accounting information system: an analysis of IAS/IFRS adoption in Italian companies. In: Management of the interconnected world. Springer, pp 483–491

Da Xu L, He W, Li S (2014) Internet of things in industries: a survey. IEEE Trans Ind Inform 10:2233–2243

Davenport TH, Harris JG, Morison R (2010) Analytics at work: smarter decisions, better results. Harvard Business Press

Dawson L, Van Belle J-P (2013) Critical success factors for business intelligence in the South African financial services sector. South Afr J Inf Manag 15:1–12

DiMaggio P, Powell WW (1983) The iron cage revisited: collective rationality and institutional isomorphism in organizational fields. Am Sociol Rev 48:147–160

Dinter B, Schieder C, Gluchowski P (2011) Towards a life cycle oriented business intelligence success model. In: AMCIS

Dishman PL, Calof JL (2008) Competitive intelligence: a multiphasic precedent to marketing strategy. Eur J Mark 42:766–785

Dorronsoro JR, Ginel F, Sgnchez C, Cruz CS (1997) Neural fraud detection in credit card operations. IEEE Trans Neural Netw 8:827–834

Eckerson W (2007) TDWI benchmark guide: interpreting benchmark scores using TDWI's maturity model. TDWI Res 3–14

Elbashir MZ, Collier PA, Davern MJ (2008) Measuring the effects of business intelligence systems: the relationship between business process and organizational performance. Int J Account Inf Syst 9:135–153

Elbashir MZ, Collier PA, Sutton SG (2011) The role of organizational absorptive capacity in strategic use of business intelligence to support integrated management control systems. Account Rev 86:155–184

Fanning KM, Cogger KO (1998) Neural network detection of management fraud using published financial data. Int J Intell Syst Account Finance Manag 7:21–41

Gartner (2017) Gartner says worldwide business intelligence and analytics market to reach $18.3 billion in 2017. Gartner, Inc. Retrieved March 5, 2017

Georgantzas NC, Acar W (1995) Scenario-driven planning: learning to manage strategic uncertainty. Praeger

Giesen E, Riddleberger E, Christner R, Bell R (2010) When and how to innovate your business model. Strategy Leadersh 38:17–26

Gilad T, Gilad B (1986) SMR forum: business intelligence-the quiet revolution. Sloan Manag Rev 1986–1998(27):53

Graebner M, Heimeriks K, Huy Q, Vaara E (2016) The process of post-merger integration: a review and agenda for future research. Acad Manag Ann Annals–2014

Hall J (2004) Business intelligence: the missing link in your CRM strategy. Inf Manage 14:36

Hannula M, Pirttimaki V (2003) Business intelligence empirical study on the top 50 Finnish companies. J Am Acad Bus 2:593–599

Haveman HA (1993) Follow the leader: mimetic isomorphism and entry into new markets. Adm Sci Q 593–627
Hawking P, Foster S, Stein A (2008) The adoption and use of business intelligence solutions in Australia. Int J Intell Syst Technol Appl 4:327–340
Hawking P, Sellitto C (2010) Business intelligence (BI) critical success factors. In: 21st Australian conference on informafion systems. pp 1–3
He W, Zha S, Li L (2013) Social media competitive analysis and text mining: a case study in the pizza industry. Int J Inf Manag 33:464–472
Henningsson S, Kettinger WJ (2016) Understanding information systems integration deficiencies in mergers and acquisitions: a configurational perspective. J Manag Inf Syst 33:942–977
Hérault C, Thomas G, Lalanda P (2005) Mediation and enterprise service bus: a position paper. In: Proceedings of the first international workshop on mediation in semantic web services (MEDIATE 2005), pp 67–80
Hočevar B, Jaklič J (2008) Assessing benefits of business intelligence systems—a case study. Manag J Contemp Manag Issues 13:87–119
Hou C-K (2012) Examining the effect of user satisfaction on system usage and individual performance with business intelligence systems: an empirical study of Taiwan's electronics industry. Int J Inf Manag 32:560–573
Howard P (2003) Analytics volume 1: an evaluation and comparison. In: Smithson B (ed). Milton Keynes, UK Bloor Res
Hribar Rajterič I (2010) Overview of business intelligence maturity models. Manag J Contemp Manag Issues 15:47–67
Hunger JD, Wheelen TL (2010) Essentials of strategic management, 5th edn. Pearson, Upper Saddle River
Isik O, Jones MC, Sidorova A (2011) Business intelligence (BI) success and the role of BI capabilities. Intell Syst Account Finance Manag 18:161–176
Karim J, Somers TM, Bhattacherjee A (2007) The impact of ERP implementation on business process outcomes: a factor-based study. J Manag Inf Syst 24:101–134
Kirlidog M (1996) Information technology transfer to a developing country: executive information systems in Turkey. Inf Technol People 9:55–84
Kotsiantis S, Koumanakos E, Tzelepis D, Tampakas V (2006) Forecasting fraudulent financial statements using data mining. Int J Comput Intell 3:104–110
Krivda C (2008) Dialing up growth in a mature market: Vodafone New Zealand Ltd. combines Teradata and powerful analytics to optimize customer communications and improve retention. Teradata Mag-March
Lahramnn G, Marx F, Winter R, Wortmann F (2010) Business intelligence maturity models: an overview. In: ItAIS. Springer Naples
Lahrmann G, Marx F, Winter R, Wortmann F (2011) Business intelligence maturity: development and evaluation of a theoretical model. In: 2011 44th Hawaii international conference on system sciences (HICSS). IEEE, pp 1–10
Laszlo C, Laugel J-F (2000) Large scale organizational change: an executive's guide. Routledge
Laudon KC, Laudon JP, Brabston ME, et al (2012) Management information systems: managing the digital firm, Seventh Canadian Edition. 7th Pearson
Levinson NS (1994) Interorganizational information systems: new approaches to global economic development. Inf Manage 26:257–263
Liebowitz J (2006) Strategic intelligence: business intelligence, competitive intelligence, and knowledge management. CRC Press
Lindgren M, Bandhold H (2009) Scenario planning—revised and updated: the link between future and strategy. Springer
Mackenzie A, Pidd M, Rooksby J et al (2006) Wisdom, decision support and paradigms of decision making. Eur J Oper Res 170:156–171
Malaska P, Malmivirta M, Meristö T, Hansen S-O (1984) Scenarios in Europe—who uses them and why? Long Range Plann 17:45–49

Malmi T, Brown DA (2008) Management control systems as a package—Opportunities, challenges and research directions. Manag Account Res 19:287–300

Mancini D (2010) Il sistema informativo e di controllo relazionale per il governo della rete di relazioni collaborative d'azienda. Giuffrè Editore

Mancini D, Marchi L (2004) Gestione informatica dei dati aziendali. FrancoAngeli

Marchi L (1993) I sistemi informativi aziendali. Giuffrè

Marchi L (1997) Un modello informatico per le simulazioni economico-finanziarie. Il Borghetto, Pisa

Marchi L, Caserio C (2010) Generating knowledge by combining prediction models with information technology. Manag Interconnected World 307–314

Marjanovic O (2010) Business value creation through business processes management and operational business intelligence integration. In: 2010 43rd Hawaii international conference on system sciences (HICSS). IEEE, pp 1–10

Markus ML (2000) Paradigm shifts-E-business and business/systems integration. Commun Assoc Inf Syst 4:10

McKiernan P, Merali Y (1995) Integrating information systems after a merger. Long Range Plann 28:454–562

Mendoza LE, Pérez M, Grimán A (2006) Critical success factors for managing systems integration. Inf Syst Manag 23:56–75

Michalewicz Z, Schmidt M, Michalewicz M, Chiriac C (2006) Adaptive business intelligence. Springer Science & Business Media

Mitchell DW, Bruckner Coles C (2004) Business model innovation breakthrough moves. J Bus Strategy 25:16–26

Moss LT, Atre S (2003) Business intelligence roadmap: the complete project lifecycle for decision-support applications. Addison-Wesley Professional

Nesamoney D (2004) BAM: event-driven business intelligence for the real-time enterprise. Inf Manage 14:38

Ngai EWT, Hu Y, Wong YH et al (2011) The application of data mining techniques in financial fraud detection: a classification framework and an academic review of literature. Decis Support Syst 50:559–569

o'Reilly T (2009) What is web 2.0. O'Reilly Media, Inc

Olszak CM (2016) Toward better understanding and use of business intelligence in organizations. Inf Syst Manag 33:105–123

Olszak CM (2015) Business intelligence and analytics in organizations. In: Advances in ICT for business, industry and public sector. Springer, pp 89–109

Olszak CM, Ziemba E (2007) Approach to building and implementing business intelligence systems. Interdiscip J Inf Knowl Manag 2

Olszak CM, Ziemba E (2012) Critical success factors for implementing business intelligence systems in small and medium enterprises on the example of upper Silesia, Poland. Interdiscip J Inf Knowl Manag 7:129–150

O'Reilly T, Battelle J (2009) Web squared: web 2.0 five years on. O'Reilly Media, Inc

Owusu-Ansah S, Moyes GD, Babangida Oyelere P, Hay D (2002) An empirical analysis of the likelihood of detecting fraud in New Zealand. Manag Audit J 17:192–204

Palattella MR, Dohler M, Grieco A et al (2016) Internet of things in the 5G era: enablers, architecture, and business models. IEEE J Sel Areas Commun 34:510–527

Park S-H, Huh S-Y, Oh W, Han SP (2012) A social network-based inference model for validating customer profile data. MIS Q 36

Patel S, Hancock J (2005) Strategy deployment, aligning business intelligence with performance management. Axon Solutions plc

Pearce JA, Robinson RB (2005) Strategic management formulation, implementation, and control, 9th edn. Mass McGraw-Hill, Boston

Pearce JA, Robinson RB, Subramanian R (1997) Strategic management: formulation, implementation, and control. Irwin Chicago, Illinois

Peters T, Işık Ö, Tona O, Popovič A (2016) How system quality influences mobile BI use: the mediating role of engagement. Int J Inf Manag 36:773–783
Popovič A, Hackney R, Coelho PS, Jaklič J (2012) Towards business intelligence systems success: effects of maturity and culture on analytical decision making. Decis Support Syst 54:729–739
Powell WW, DiMaggio PJ (2012) The new institutionalism in organizational analysis. University of Chicago Press
Pranjić G (2011) Influence of business and competitive intelligence on making right business decisions. Ekon Misao Praksa 271–288
Ranjan J (2009) Business intelligence: concepts, components, techniques and benefits. J Theor Appl Inf Technol 9:60–70
Raymond L (1990) Organizational context and information systems success: a contingency approach. J Manag Inf Syst 6:5–20
Reinschmidt J, Francoise A (2000) Business intelligence certification guide. IBM Int Tech Support Organ
Robbins SS, Stylianou AC (1999) Post-merger systems integration: the impact on IS capabilities. Inf Manage 36:205–212
Robertson B, Boehler A, Hansel J (2007) Sustainable performance improvement through predictive technologies. Strateg Finance 88:56
Roehl-Anderson JM (2013) M&A Information technology best practices. Wiley
Rosenhead J, Mingers J (2001) Rational analysis for a problematic world revisited. Wiley
Rud OP (2009) Business intelligence success factors: tools for aligning your business in the global economy. Wiley
Rutter R, Lauke PH, Waddell C, et al (2007) Web accessibility: web standards and regulatory compliance. Apress
Saaty TL (1990) Decision making for leaders: the analytic hierarchy process for decisions in a complex world. RWS publications
Salehie M, Tahvildari L (2009) Self-adaptive software: landscape and research challenges. ACM Trans Auton Adapt Syst 4:14:1–14:42. https://doi.org/10.1145/1516533.1516538
Serain D (2002) Middleware and enterprise application integration: the architecture of e-business solutions. Springer Science & Business Media
Shim JP, Warkentin M, Courtney JF et al (2002) Past, present, and future of decision support technology. Decis Support Syst 33:111–126
Sparks BH, McCann JT (2015) Factors influencing business intelligence system use in decision making and organisational performance. Int J Sustain Strateg Manag 5:31–54
Spathis CT (2002) Detecting false financial statements using published data: some evidence from Greece. Manag Audit J 17:179–191
Sudarsanam S (2003) Creating value from mergers and acquisitions: the challenges: an integrated and international perspective. Pearson Education
Tan C-S, Sim Y-W, Yeoh W (2011) A maturity model of enterprise business intelligence. Commun IBIMA
Trill AJ (1993) Computerized Systems and GMP—a UK perspective: part I: background, standards, and methods. Pharm Technol Int 5:12–26
Trucco S (2014) Linee evolutive del sistema di controllo interno a supporto della comunicazione finanziaria. Econ Aziend (Online) 4:215–227
Trucco S (2015) Financial accounting: development paths and alignment to management accounting in the Italian context. Springer
Turban E, Sharda R, Delen D (2014) Decision support and business intelligence systems. Pearson Education Limited
Viaene S, Derrig RA, Dedene G (2004) A case study of applying boosting Naive Bayes to claim fraud diagnosis. IEEE Trans Knowl Data Eng 16:612–620
Vosburg J, Kumar A (2001) Managing dirty data in organizations using ERP: lessons from a case study. Ind Manag Data Syst 101:21–31
Wang Q (2005) Towards a rule model for self-adaptive software. ACM SIGSOFT Softw Eng Notes 30:8

Watson HJ (2010) BI-based organizations. Bus Intell J 15:4–6
White C (2005) The next generation of business intelligence: operational BI. Inf Manage 15:34
Wijnhoven F, Spil T, Stegwee R, Fa RTA (2006) Post-merger IT integration strategies: an IT alignment perspective. J Strateg Inf Syst 15:5–28
Williams MH (1993) Good computer validation practice is good business practice. Drug Inf J 27:333–345
Williams S, Williams N (2010) The profit impact of business intelligence. Morgan Kaufmann
Wingate G (2016) Pharmaceutical computer system validation: quality assurance. Risk Manag Regul Compliance 1–10
Woodside J (2011) Business intelligence best practices for success. In: International conference on information management and evaluation. academic conferences international limited, p 556
Yeoh W, Koronios A (2010) Critical success factors for business intelligence systems. J Comput Inf Syst 50:23–32
Yeoh W, Popovič A (2016) Extending the understanding of critical success factors for implementing business intelligence systems. J Assoc Inf Sci Technol 67:134–147

Chapter 4
ERP and BI as Tools to Improve Information Quality in the Italian Setting: The Research Design

Abstract This chapter presents the research design and the research questions of our empirical research. We specifically analyze the possible relationships between ERP, BI and information overload/underload. Furthermore, we wonder whether ERP and BI systems may also affect the information quality by influencing the information flow features (i.e., information processing capacity, communication and reporting, information sharing and frequency of meeting). In fact, the potentialities of ERP and BI systems may positively contribute to increasing the information quality (and the information system quality) by means of an improved management of information flow. This quality improvement may indirectly support management in counteracting, or at least reducing, the information overload/underload. Finally, we investigate the role played by the features of information flow in improving the information quality perceived by managers. After discussing the research design, the chapter describes the sample selection, the data collection, the variable measurement, and the factor analysis carried out on the research variables.

4.1 Introduction

The present section analyzes the literature review on information quality, information overload, information underload, and the features of information flow, along with the research design and the research questions of our research.

We provide the research design of this study in Sect. 4.2, the sample selection and data collection in Sect. 4.3, the variable measurement in Sect. 4.4, and the factor analysis carried out on our research variables in Sect. 4.5.

C. Caserio and S. Trucco, *Enterprise Resource Planning and Business Intelligence Systems for Information Quality*, Contributions to Management Science,
https://doi.org/10.1007/978-3-319-77679-8_4

4.2 Literature Review Supporting the Research Design

4.2.1 Literature Review on Information Overload and Information Underload

The initial studies on information overload and information underload were conducted in the '70s. Ackoff (1967) described the weaknesses of management information systems, stating that managers usually operate under a system deficiency: the lack of relevant information (Ackoff 1967). Prior studies on information overload were conducted in the '80s by O'Reilly (1980), who realized that information overload happens every time the quantity of information surpasses the individual's information processing resources (O'Reilly 1980). Galbraith (1977), Tushman and Nadler (1978) laid down the theoretical bases of information overload, asserting that companies facing uncertainty need to adjust their information processing capacities to adapt successfully to the different environments. However, when the information processing capacity is not aligned anymore to the information processing requirements, companies enter into a condition of information overload (Galbraith 1977; Tushman and Nadler 1978). More recent research supports the basic assumptions of information overload, both from a theoretical and an empirical perspective. With regard to the theoretical perspective, scholars have analyzed the main literature on information overload by highlighting the features, causes, consequences, and possible solutions to information overload (Edmunds and Morris 2000; Eppler and Mengis 2004a; Melinat et al. 2014). According to these studies, the solutions to information overload would be the adoption of personal information management strategies, the selection of only relevant information, a reduction in the amount of information selected for the decision-making process, the use of push technology solutions and intelligent agents, and the use of value-added information. The initial empirical research on information overload confirms the theories about the effects of information overload on managerial decisions (Duncan 1973; Tushman 1977). More recent empirical studies have analyzed different aspects of information overload, such as its effect on email communication (Soucek and Moser 2010), on the decision-making process (Letsholo and Pretorius 2016), and on social media communication (Ho and Tang 2001; Rodriguez et al. 2014). Both theoretical and empirical studies suggest the following actions for preventing information overload and underload: (a) avoid assuming that more information is always needed by managers; (b) do not provide more information to managers but make better use of information already available; (c) consider that, while a larger amount of relevant information leads to better decision making process, a larger amount of irrelevant information reduces the manager's capacity to recognize the problem and thus to carry out an effective decision-making process; (d) make a better use of technology in order to select only relevant and quality information.

As the literature shows, many authors recognize the cause of information overload in the amount of information (Hiltz and Turoff 1985; Miller 1994), while others believe that information overload is due to the lack of information processing capacity needed to manage the information load (Eppler and Mengis 2004a; Tushman and Nadler 1978). Information processing capacity is, in turn, affected by information quality and format (Stvilia et al. 2005).

However, the literature shows that information overload could be due to several causes, such as the use of technology, the decision-making approach and the characteristics of the tasks performed. With regard to technology, managers tend to invest in Information Technology (IT) and in Business Intelligence (BI) to meet workers' needs and increase their productivity, but they do not realize that technology itself could give raise to "technology overload", which is a combination of information, communication and system feature overload (Karr-Wisniewski and Lu 2010). Investing in technology beyond a certain level might not increase productivity; on the contrary, it could lead to a loss of productivity.

In terms of the decision-making approach, managers sometimes tend to produce information overload by seeking more information than they need and, at the same time, not using the information that they already possess (Feldman and March 1981). This behavior could depend on two main reasons: first, more available information reduces the perception of uncertainties and increases the manager's feeling of having better control of the situation (Milliken 1987, 1990); second, managers feel more confident and satisfied if they collect more information, even when it causes overload (Connolly 1977). The paradox, as explained by O'Reilly (1980), is that, on the one hand, managers lose decision-making accuracy as a consequence of the information overload, while on the other they feel more confident and secure. Therefore, beyond a certain level of information load, further information does not provide any improvement in decision-making accuracy; on the contrary, the performance tends to decrease. Some studies focus attention on the decision-making approach. For example, Bettis-Outland (2012) asserts that incremental decision-making produces less information overload than does comprehensive decision making, as the former considers fewer alternatives in solving a problem, whereas the latter by nature leads managers to seek for all the possible alternative solutions (Bettis-Outland 2012). However, it is very difficult for companies operating under uncertain conditions to benefit from the advantages of an incremental decision-making style.

The problem of information overload might not depend only on the accumulation of information; managers, in fact, could feel information overloaded because of the time pressure to accomplish their tasks and the inability to prioritize tasks optimally (Kock 2000a). Moreover, communication is another relevant aspect which could give rise to information overload. In fact, as shown by Meglio and Kleiner (1990), in many cases information users contribute to information overload, since their communication is not effective enough (Meglio and Kleiner 1990); this point supports the idea that information overload could depend on the individuals (knowledge base, decision style) and on task-related factors (amount of information processes, task complexity, number of information exchange interactions) (Kock 2000a). Another study on task-related factors shows that tasks characterized by frequent interruptions are more likely to produce information overload than are uninterrupted tasks (Speier et al. 1999).

There is broad agreement in the literature on the fact that managers, in pursuing the aim of feeling more confident in solving problems or making decisions, seek more information than they need, a behavior favored by the emergence of the Internet (Kiley 2005). Nowadays, in fact, acquiring, communicating and storing huge amounts of information is much easier and faster than in the past. Hence, whereas IT can help managers to support their decisions, it could also be used improperly (overused or misused), and by doing so increasing the information overload/underload.

4.2.2 Links Between Information Overload/Underload and ERP Systems

Following the literature, it seems quite clear that the capacity of companies to efficiently manage data and information—which is a possible cause of information overload and information underload—largely depends on the quality of Information Systems (IS) (Bera 2016; Melchor and Julián 2008; Petter et al. 2013a; Simperl et al. 2010). Even though an IS represents a symbiotic relationship between system users and the system itself (Chandler 1982; Taylor 1982) aimed at processing information to support decisions, the literature shows that very often managers are faced with the paradoxical situation of having a lot of information available but finding it difficult to select the information which is useful for supporting decisions (Edmunds and Morris 2000).

To our knowledge the literature does not provide specific studies on the relationship between ERP systems and information overload/underload; however, considering the main causes of information overload/underload described above, and taking into consideration the results of a preliminary study which partially confirms that IS quality could affect information overload (Caserio and Trucco 2016), we can hypothesize that a well-integrated IS based on an ERP system can also play an important role in dealing with information overload and underload. As a matter of fact, from an analysis of the literature we can deduce that information overload/underload could be managed through an effective system which: (a) allows for the collection and integration of data in a single database (Chandler 1982; Chapman and Kihn 2009); (b) permits consistent information to be shared across different functional areas of a company (Robey et al. 2002a); (c) improves the reliability, timeliness, comparability and relevance of accounting information for external and internal users (Hitt et al. 2002; Mauldin and Richtermeyer 2004; Poston and Grabski 2001), enhancing the capacity to plan and manage the resources, thereby reducing the time needed to perform managerial activities and bringing benefits to the quality of data and control activities in general (Caglio 2003; Quattrone and Hopper 2001); and (d) meets the users' expectations, improving job performance and increasing job satisfaction (Morris and Venkatesh 2010; Thatcher et al. 2002).

The aforementioned points are all made possible by the capacities of an ERP system. Some studies, which compare legacy systems with ERP systems, confirm that ERP capacities could improve data and information management, and thus counteract information overload and underload through:

- an increase in system quality, as ERP systems allow companies to manage several business functions with a comprehensive software, using shared information and data flows (Lee and Lee 2000) and replacing legacy systems characterized by incompatible software;
- an increase in data quality, as ERP systems solve the typical problems of legacy systems (Xu et al. 2002a): (a) keeping the same data in different subsystems (i.e., in different sources); (b) difficulties and slowness in accessing the data kept in another subsystem; (c) a lack of communication capacity.

Considering that ERP systems are implemented to improve data accuracy and data management through a comprehensive relational database which connects all aspects of the business and allows data and information to be shared inside the company, these systems could play an important role in reducing or in managing information overload and underload. Thus, our first research question is:

- RQ 1a: "Do ERP systems matter to information overload and information underload?"

4.2.3 Links Between Features of Information Flow and ERP Systems

In addition to the possible relationship between ERP and information overload/underload, ERP systems may also affect the information flow. In fact, an ERP system brings integration into the company, favoring a real-time sharing of information. However, while ERP solutions ensure a smooth flow of information across the company, they also cause a real-time sharing of possible data entry mistakes, which would have a domino effect that impacts other business units (Bingi et al. 1999).

Another reason why ERP might improve information flow is that its implementation often requires a preliminary Business Process Reengineering (BPR) (Scheer and Habermann 2000), which allows firms to assess, revise and reorganize their internal processes. In the context of business process optimization, ERP systems are generally adopted to achieve flexible information flows, obtain short planning cycles, make available up-to-date information and more timely communications, and eliminate data redundancy. As a result, they improve information processing capacity, enhance organizational communications and data visibility (Dell'Orco and Giordano 2003), and increase the productivity of work processes (Gupta and Kohli 2006).

The most important potentialities of ERP emerging from the literature pertaining to information flow refer to: (a) the capacity to improve data management and permit data integration and sharing (Chapman and Kihn 2009); (b) the possibility to share consistent information across different functional areas (Robey et al. 2002b); (c) the capacity to improve the reliability, timeliness, comparability and relevance of information (Mauldin and Richtermeyer 2004; Poston and Grabski 2001); (d) the possibility to achieve flexible information flows (Scheer and Habermann 2000). These potentialities may also affect the reporting system, which is part of the information flow. In the absence of ERP systems, business units work in silos, each of them managing its own data. ERP-implementing companies instead take advantage of data integration, which could affect reporting system management. Joseph et al. (1996), in a study of the relationship between external reporting and management accounting, suggest that information system integration, made possible by technological innovation, allows managers to have online access to the information required for carrying out control tasks. Because managers can access a huge amount of information for both control and decision-making support, they do not need to wait for the periodic reports produced by management accountants. Even if this study did not specifically focus on ERP systems, Scapens and Jazayeri (2003) propose using the same line of reasoning: they suggest that the introduction of ERP systems may have important implications for the nature of management accounting, and thus of internal reporting.

The effects of ERP on internal reporting have also been studied by Sangster et al. (2009), who found a slight decrease in the time spent on internal reporting by management accountants. Furthermore, they found that management accountants spend significantly less time on data collection when the ERP has been successfully implemented. In these circumstances, management accountants have more time for data analysis, performance issues, control activities, and more time to produce a larger amount of reports than before (Sangster et al. 2009).

Based on the above considerations, we pose the following research question, which aims at understanding whether the ERP system may (and in what way) affect the information flow of the company. For "information flow" we refer to a set of features emerging from the literature cited above, such as information processing capacity, communication and reporting, frequency of meeting, and information sharing.

- RQ1b: "Do ERP systems matter to the features of information flow?"

4.2.4 Links Between Information Overload/Underload and Business Intelligence Systems

In addition to studies on ERP, legacy or integrated systems in general, scholars have also investigated the role of Business Intelligence (BI) system in counteracting information overload. In fact, while ERP systems may help to prevent information overload/underload by assuring data quality and system integrity, BI systems could contribute to the solution of information overload/underload by addressing the right information to the right decision maker at the right time (Burstein and Holsapple 2008).

Unlike ERP systems, the literature provides several studies which analyze the link between information overload/underload and BI, supporting the idea that an effective BI system may allow companies to manage, counteract or eliminate information overload/underload. Boyer et al. (2010), for example, recognizes the use of analytics, BI and performance management systems as a solution to this problem (Boyer et al. 2010). Similarly, Spira (2011) proposes a solution based on the use of data mining, digital mapping, geographical information systems and online preservations to reveal patterns that would otherwise remain undiscovered (Spira 2011). O'Brien and Marakas (2009) attribute great importance to the reporting system, stating that to reduce information overload/underload, companies should adopt exception reports, issued only when exceptional conditions occur, instead of periodical standard reports (Brien and Marakas 2009).

Other studies recognize the critical role of BI in reducing these anomalies on the Web. In particular, they recognize the role of knowledge discovery tools on the Web, which would help managers who need to analyze business data on the Internet, such as the competitive environment of their company, the market situation, or the competitors that most resemble their company (Chung et al. 2005). In the Web research field, several studies support the relevance of visualization techniques in reducing information overload and supporting managers in exploring the knowledge on the Web (Lin 1997) by means of Web-mining and webpage clustering (Hartigan 1985; Marshall et al. 2004), while other studies support the importance of social media analytics. The attention paid to social media analysis has increased considerably in recent years given the growing importance of Web 2.0, which provides a great source of information about consumer preferences, opinions, behavior and market trends (Stieglitz and Dang-Xuan 2013; Zeng et al. 2010).

According to other studies, information overload/underload could be counteracted using an effective corporate portal, which allows companies to easily access all the digital enterprise information and knowledge by integrating structured with unstructured information through the Intranet (Detlor 2000; Dias 2001).

However, the idea that BI could represent a solution is not unanimously shared by the literature. Li et al. (2009), for example, believe that information problems caused by a lack of systematic information collection and processing makes BI tasks more and more difficult (Li et al. 2009). Following this idea, information overload and underload can be prevented rather than solved, and this prevention would be obtained by collecting proper data or information and applying data mining for the succeeding elaborations. Similarly, another study underlines that BI studies often ignore the importance of information selection and pay too much attention to the capacity of BI to gather and elaborate data and to exhaustively define information requirements (Blanco and Lesca 1998). According to this study, information overload and underload could be reduced by selecting the early warning signals, that is, information which is anticipatory in nature and thus has the ability to inform managers about future environmental and business changes.

The above literature about the role of BI in reducing, counteracting or managing information overload and underload allows us to define our second research question:

- RQ 2a: "Does Business Intelligence matter to information overload and information underload?"

4.2.5 Links Between Features of Information Flow and Business Intelligence Systems

The literature on BI systems shows that BI tools are also able to improve the information flow within the company. In fact, the features of information flow—information processing capacity, communication and reporting, frequency of meeting and information sharing—have often been examined in the literature. BI tools play an important role in improving both internal and external information flow.

Regarding the latter, the study by Rud (2009) suggests that BI systems allow companies to shift from a reactive to a proactive management of customer needs. Unlike traditional BI tools, which forecast yearly demand and then plan the production, most recent BI solutions enable firms to achieve a real-time monitoring of customer needs, which, in turn, allows for a more effective and timely communication between the market and the company.

Regarding the internal information flow, there are many studies in the literature which demonstrate that BI makes it possible to facilitate real-time interactions between team members (Berthold et al. 2010; Horvath 2001; Matei 2010; Rizzi 2012; Rud 2009). The role of collaborative ad hoc BI solutions is crucial for developing infrastructures which permit an information self-service for final users and, consequently, a collaborative decision-making process (Berthold et al. 2010).

Collaboration is vital for creating business value: according to Horvath (2001), in the context of Supply Chain Management (SCM), intelligent e-business networks provide the competitive advantage which allows the participants in a value chain to predominate and grow. Technological solutions applied to promote collaboration among the actors involved in the value chain are the key driver for the effectiveness of SCM, since they allow companies to follow the demand chain and to respond to the changing needs of customers (Horvath 2001).

The effectiveness of the information flow has also been improved by the impact of Web 2.0 platforms and of collaborative BI solutions. The former has changed the knowledge management paradigm from the "conventional" to the "conversational" (Lee and Lan 2007) by means of synchronous and asynchronous technologies that enhance the collaboration among people and allow information to be easily shared. The latter is a set of tools which promotes cooperation and data sharing not only within a company but also with other companies by means of more flexible warehouse approaches (Rizzi 2012).

The literature suggests that BI systems improve information flow also through OLAP (On-Line Analytical Processing) reporting technologies, which are able to extract pertinent information based on data analysis and to turn it into knowledge and rapidly-generated reports (Ranjan 2009). The above considerations lead to the following research question:

- RQ 2b: "Does a Business Intelligence system matter to the features of information flow?"

4.2.6 The Combined Use of ERP and Business Intelligence: Information Overload/Underload and Features of Information Flow

Summarizing the analysis performed so far, there are four different situations, as shown in Table 4.1: some companies may decide to adopt both an ERP system and a BI system (case 1); other companies can adopt an ERP system but not a BI system (case 2); conversely, other companies may decide to adopt a BI system but not an ERP system (case 3); others may adopt neither of the two systems (case 4).

With reference to the above table, we wonder whether companies that adopt both an ERP and a BI system (case 1) are better able to handle the information overload and information underload than are companies that adopt only an ERP system or a BI system. The idea is that the combined use of the two systems may provide greater support to the information overload and underload problems. Thus, we formulate our third research question as follows:

- RQ 3a: "Does the combined adoption of ERP and BI systems matter more to information overload and information underload than does the single adoption of an ERP or BI system?"

Similarly, the simultaneous use of ERP and BI systems is expected to be more impactful on the information flow features than the single adoption of ERP and BI would be. In fact, ERP systems may affect information flow through:

Table 4.1 Possible cases of ERP and BI system adoption (*Source* Our presentation)

Case 1	Case 2	Case 3	Case 4
Adopting ERP system	Adopting ERP system	Non-adopting ERP system	Non-adopting ERP system
Adopting BI system	Non-adopting BI system	Adopting BI system	Non-adopting BI system

(a) the BPR needed for the ERP implementation (Scheer and Habermann 2000), since BPR allows firms to restructure the internal processes and thus the internal and external communication flow;
(b) the enhancement of organizational communications, data visibility and the productivity of work processes (Dell'Orco and Giordano 2003; Gupta and Kohli 2006);
(c) the capacity to improve data management and allow data integration and sharing (Chapman and Kihn 2009);
(d) the possibility of sharing consistent information across different functional areas (Robey et al. 2002b);
(e) the capacity to improve information quality (Mauldin and Richtermeyer 2004; Poston and Grabski 2001);
(f) the achievement of flexible information flows (Scheer and Habermann 2000);
(g) the improvement of data integration and reporting systems (Scapens and Jazayeri 2003).

On the other hand, BI systems can improve the information flow within the company because they:

(a) support companies in proactively managing customer needs (Rud 2009);
(b) provide tools for real-time monitoring of customer needs;
(c) allow real-time interactions among team members (Berthold et al. 2010; Horvath 2001; Matei 2010; Rizzi 2012; Rud 2009);
(d) support a collaborative decision-making process (Berthold et al. 2010);
(e) promote business value creation by enabling collaboration among the actors involved in the value chain;
(f) allow companies to adapt the demand to the changing needs of customers (Horvath 2001);
(g) improve knowledge management and the knowledge repository (Lee and Lan 2007; Rizzi 2012);
(h) improve the information flow through OLAP reporting technologies (Ranjan 2009).

Based on the above considerations, we pose the following research question:

- RQ 3b: "Does the combined adoption of ERP and BI systems matter more to the features of information flow than does the single adoption of an ERP or BI system?"

4.2.7 Literature Review on Information Quality

The literature shows several contributions involving information quality: part of the literature considers information quality as a feature—or a driver—of information systems quality (DeLone and McLean 1992a; Nelson et al. 2005), whereas other contributions in the literature attempt to assess the information quality by proposing frameworks or methodologies (Bovee et al. 2003; Lee et al. 2002; Stvilia et al. 2005). Lee et al. (2002), for example, try to identify the business areas which have a need for information quality improvements by analyzing five major organizations. The aim of their research is to propose a methodology for assessing and improving information quality within a company. Stvilia et al. (2005) propose an information quality assessment framework by considering several typologies of information quality problems, related activities, and a taxonomy of information quality.

DeLone and McLean (1992a), along with Nelson et al. (2005), are instead examples of studies which involve information quality as an item affecting information system quality. Nelson et al. (2005) conducted a study on data warehouse users, developing a model based on nine determinants of IT environment quality, four of which were related to information quality. The interesting thing is that the information quality features—accuracy, completeness, currency and format of information—are believed to play a significant role in explaining information system quality. Other studies, aimed at identifying the characteristics that make an information system of high-quality, emphasize the crucial role played by information quality (DeLone and McLean 1992b, Petter et al. 2013b).

Bessa et al. (2016) and Xu et al. (2013), examine the determinants of information system quality, including among these information quality, also underlining that different, or more specific, needs can arise depending on the business and on the evolution of technology. Therefore, they indirectly suggest that information quality, along with information system quality, is a contingent factor.

These considerations are recognizable in a wide stream of studies on the role of data and information quality in improving the quality of information systems (Kahn et al. 2002; Madnick et al. 2009; Pipino et al. 2002; Redman and Blanton 1997; Xu et al. 2002b). Studies on the impacts of data and information quality have been carried out to trigger positive impacts and disable negative ones. Scant data quality could, in fact, cause difficulties in the retrieval of business records (Mikkelsen and Aasly 2005), as it obstructs the possibility of providing the right information to the right stakeholder. Other studies underline that information quality is the basis for a quality decision-making process (Calvasina et al. 2009; Caserio 2011; Fisher et al. 2003).

Information quality is thus a key factor for several reasons. The literature suggests several definitions of information quality, which, for example, could be considered as the fitness of user needs, as defined by Juran (1992) and Strong et al. (1997). Other studies, in proposing a definition of information quality, focus attention on information users by considering that information quality is the capacity to meet or exceed information users' expectations (Evans and Lindsay 2002; McClave et al. 1998). Information quality can also be defined as the coherence of information with regard to the specifications of the product or the service to which it refers (Kahn et al. 2002; Reeves and Bednar 1994; Zeithaml et al. 1990). According to this interpretation, high-quality information provides an accurate representation and meets the requirements of the final user. Naturally, the coherence and the usefulness of information also depend on the initial data quality

(Piattini et al. 2012). The importance of the information user perspective is also confirmed by the theory of information use environments suggested by Taylor (1991), which states that the long-term information needs of users are directly linked to their professional activities. The focus of Redman (1992) is still on the information user, even though he uses a more structured definition: information is of higher quality if it is more satisfactory than other information the user needs. In an earlier work, Eppler (2003) defines information quality under a subjective and an objective dimension; the former is the fitness of user expectations and the latter is the satisfaction of activity requirements.

In addition to the definitions of information quality, the literature provides some interpretations and dimensions of information quality. Information quality could be intrinsic, contextual, representational and related to accessibility (Lee et al. 2002; Ballou and Pazer 1985; DeLone and McLean 1992b; Goodhue 1995; Jarke and Vassiliou 1997; Wand and Wang 1996; Wang and Strong 1996; Zmud 1978). The intrinsic information quality includes dimensions related to the accuracy, objectivity and precision of information; this interpretation derives from the initial theoretical bases of Gorry and Scott Morton's (1971) framework regarding the information features of structured problems. Information quality could be contextual, as it depends on the capacity of information to be relevant, useful, complete, reliable and timely, able to add value and to meet users' expectations, despite the continuous changes in the (external and internal) context. Information quality could be representational, that is, related to the capacity of the information to represent the problem to which it refers; information has to be understood and effectively implemented in the decision-making process.

According to some authors, the quality of information depends on several attributes, which could be summarized in three main dimensions (Marchi 1993; O'Brien and Marakas 2006):

- time: the information must be provided when it is needed;
- content: information must be accurate, correct, relevant, complete, concise, and reveal knowledge about what it refers to;
- form: the information must be clear, detailed, formatted as required, and ordered in a sequence as needed.

Following another study, the dimensions of information quality could be listed in a more detailed manner, as shown in Table 4.2, which is adapted from Kahn et al. (2002).

Interesting to note among the features of information quality are "appropriate amount of information", "completeness" and "concise representation", which, in a certain way, pertain to the information overload/underload issues. For our purposes, we will consider information quality as the capacity of information the meet the decision-maker's needs.

Table 4.2 Features of information quality (*Source* Adapted from Kahn et al. 2002)

Features	Definitions
Accessibility	The possibility to easily retrieve the information
Appropriate amount of information	The coherence between the amount of information and the task to be carried out
Believability	The truthfulness of the information
Completeness	The capacity of information to provide all the details useful for the task
Concise representation	The correct synthesis/analysis level of information
Consistent representation	The capacity of information to be provided in the same format
Ease of manipulation	The possibility to use the same information for different tasks
Free of error	The correctness and reliability of information
Interpretability	The information is represented using an appropriate format, language, symbols
Objectivity	The information is unbiased, neutral, impartial
Relevancy	The helpfulness of information for the tasks
Reputation	The information is highly regarded in terms of its source or content
Security	The access restrictions to information are appropriately managed
Timeliness	The capacity of information to be up-do-date
Understandability	The capacity to easily comprehend the information
Value-added	The capacity of information to be beneficial and to bring advantages from its use

4.2.8 *Links between Features of Information Flow and Information Quality*

Information quality has significant economic implications for a company since non-quality information generates costs. These costs mainly pertain to the waste of time for decision makers trying to find the most appropriate information for their needs. Poor information quality forces decision makers to interpret the inaccurate information, and inaccuracy may cause problems for the business activities (Farhoomand and Drury 2002). The magnitude of the problem depends on the type of errors that inaccuracy may cause.

The costs of non-quality information also consist in data correction, the recovery of process failure and other similar activities, which consume more computing resources than would be necessary if the information were accurate. Similarly, because of non-quality information, redundant controls on data and information will need to be activated to prevent decision-making errors (English 2002).

In this regard, the literature suggests that information overload is also one of the costs of poor information quality. In the presence of information overload, managers might not be able to effectively manage their decision-making process, as the information available is too abundant, or irrelevant. In these situations, managers are not able to prioritize their tasks, and thus their decision-making process collapses (Kock 2000b). Interestingly, some studies recognize the costs of information overload as similar to those of non-quality information; in fact, information overload is considered as a phenomenon which affects individuals, organizations and decision-making processes because it causes a waste of time in processing redundant information from multiple sources on the same topic (Farhoomand and Drury 2002; Yang et al. 2009). When a manager receives (a lot of) irrelevant information instead of (a small amount of) relevant information, he/she is not able to accomplish his/her job. Therefore, a situation of information underload happens when managers receive less than the amount of information they would need to accomplish their decision-making process and when they receive irrelevant instead of relevant information (Kock 2000b; O'Reilly 1980). Information overload often results from poor quality information; that is, uncertain, ambiguous and complex information (Schneider 1987).

The link between information quality and information overload is also recognizable from the countermeasures suggested by some authors. For example, Eppler and Mengis (2004b) propose that, to avoid information overload, companies should implement intelligent information management, e-tools, decision support systems and information quality filters that can prioritize information and reduce a wide set of alternatives to a more manageable size. This implies that by improving some dimensions of information quality (such as relevancy, accessibility, credibility), information overload should also decrease. Other authors belong to this line of thought: they suggest that information overload could be reduced by investing in information visualization systems, which simplify the retrieval, recognition, processing and recall of information (Strother et al. 2012; Chen and Yu 2000). Larkin and Simon (1987) show that visualization techniques dramatically improve people's capacity to recognize patterns, distinguish various pieces of information, and focus on the most relevant ones. The authors show that these systems allow people to process information as experts could. The literature also reveals that experts are less subject to information overload than novices are when facing the same volume of information (Agnew and Szykman 2005; Swain and Haka 2000). Taken together, these studies suggest that visualization is a possible countermeasure to information overload, as it increases information quality and the features of information flow. Information processing capacity would increase by means of the synthetic and systemic representation of information; communication would improve because messages would be more selective and, consequently, reports would better signal the relevant information. As a confirmation of this, the literature shows that information visualization techniques can improve the quality of information, as they reduce information complexity and help to focus on the relevant details (Burkhard and Meier 2005; Shneiderman 1996).

Furthermore, another study states that to reduce information distortion, and thus to improve the quality of shared information, it is necessary that the information shared be as accurate as possible (Li and Lin 2006). In other words, this confirms that features of information quality (such as accuracy) are linked to the features of information flow (such as the sharing of information). Other authors consider the information flow as an important dimension of information quality; in fact, an effective information flow allows information system users to receive (Al-Hakim 2007):

- complete information; that is, the correct amount of information;
- information selected on the base of relevancy;
- timely information;
- up-to-date information;
- information at the required time;
- accessible information.

Similarly, Bosset (1991), Evans and Lindsay (2002) and Fadlalla and Wickramasinghe (2004) emphasize the importance of information flow in improving the effectiveness of the decision-making process. Based on these considerations, we posit the following research question:

- RQ4: "Do the features of information flow affect the information quality perceived by managers?"

4.3 Sample Selection and Data Collection

To answer the research questions, we conducted a survey on a sample of 300 Italian managers of Italian listed and non-listed companies of different size. The participants—Chief Information Officers, Chief Technology Officers, Chief Executive Officers and Controllers—were randomly selected from the LinkedIn social network database, since some scholars have recently stressed the relevance and widespread use of this social media application (Albrecht 2011). Furthermore, the growing interest paid to LinkedIn by practitioners has also been documented by the Association of Accounting Marketing (AAM 2011).

The main aim of the survey is to test the research design and elicit preliminary evidence from our study (Gable 1994). The survey was divided into 6 sections as follows: (1) personal data of the interviewees; (2) features of the firms; (3) the quality features of the accounting information system; (4) communication and reporting; (5) information overload and underload; and (6) overall judgement on IS and suggestions. Since the empirical analysis is based on a survey, most of the research variables measure the managers' perceptions, which could be interpreted as their satisfaction with the survey issues (Dillman 2008). We received back 79 answers, with a 26% rate of response.

A test on an early-late response was conducted on the control variables "gender", "type of firms" and "sector" to check for differences in the two groups following a wave analysis proposed by Rogelberg and Stanton (Rogelberg and Stanton 2007). The results of a two-sample t test with equal variances showed that the mean differences of the variables were not statistically significant, and therefore the hypothesis of bias between early and late respondents in the surveyed sample can be rejected. All the statistical analyses were performed with SPSS 20.0.

4.4 Variable Measurement

4.4.1 *Research Variable Measurement*

Surveys are useful in defining the research and control variables. In our study, the survey allows us to detect:

- ERP adoption (the survey question is "Does your firm adopt an ERP system?" 1 = Yes; 0 = No); and
- Business Intelligence adoption (the survey question is "Does your firm use systems of Business Intelligence?" 1 = Yes, 0 = No).

We created the research variable "ERP and Business Intelligence", which assumes a value of 1 when respondents adopt both ERP and Business Intelligence and a value of 0 when respondents do not adopt any of the two systems.

With reference to information processing capacity (Tables 4.3 and 4.4), we use the following items:

- Data accuracy (the survey question is "What is your perception of the accuracy of data to perform your tasks?" 1 very low,…, 7 very high);
- Timeliness of data; (the survey question is "What is your perception of the timeliness of data to perform your tasks?" 1 very low,…, 7 very high);
- System reliability (the survey question is "What is your perception of the capacity of the information system to address the right choice to the right person at the right moment?" 1 very low,…, 7 very high).

Regarding communication and reporting (Tables 4.5 and 4.6), the items are:

- Monthly reporting frequency (the survey question is "What is, on average, the number of reports issued in one month? 1 very low,…, 7 very high);
- 6-month reporting frequency (the survey question is "What is, on average, the number of reports issued over a six-months period? 1 very low,…, 7 very high);
- Annual reporting frequency (the survey question is "What is, on average, the number of reports issued annually?, 1 very low,…, 7 very high);

Table 4.3 Items included in the information processing capacity research variable

Research variable	Items in the research variable
Information processing capacity	Data accuracy
	System reliability
	Timeliness of data

Table 4.4 Measurement of the items included in the information processing capacity research variable

Items in the research variable	Scale of measurement
Data accuracy	Value on a scale of 1–7
System reliability	Value on a scale of 1–7
Timeliness of data	Value on a scale of 1–7

Table 4.5 Items included in the communication and reporting research variable

Research variable	Items in the research variable
Communication and reporting	Flash reporting frequency
	Monthly reporting frequency
	6-month reporting frequency
	Annual reporting frequency

Table 4.6 Measurement of the items included in the communication and reporting research variable

Items in the research variable	Scale of measurement
Flash reporting frequency	Value on a scale of 1–7
Monthly reporting frequency	Value on a scale of 1–7
6-month reporting frequency	Value on a scale of 1–7
Annual reporting frequency	Value on a scale of 1–7

- Flash reporting frequency (the survey question is “How often are flash reports issued? 1 very low,…, 7 very high).

With regard to Information Sharing (Tables 4.7 and 4.8), we consider the following items:

- Satisfaction about the sharing of information with colleagues at the same hierarchical level (the survey question is “What is your satisfaction about the information sharing with colleagues at the same hierarchical level?” 1 very low, …, 7 very high);
- Satisfaction about the sharing of information with colleagues at higher hierarchical levels (the survey question is “What is your satisfaction about the information sharing with colleagues at higher hierarchical levels?” 1 very low, …, 7 very high).

With regard to Frequency of Meeting (Tables 4.9 and 4.10), the items are:

Table 4.7 Items included in the information sharing research variable

Research variable	Items in the research variable
Information sharing	Satisfaction about the sharing of information with colleagues at the same hierarchical level
	Satisfaction about the sharing of information with colleagues at higher hierarchical levels

Table 4.8 Measurement of the items included in information sharing research variable

Items in the research variable	Scale of measurement
Satisfaction about the sharing of information with colleagues at the same hierarchical level	Value on a scale of 1–7
Satisfaction about the sharing of information with colleagues at higher hierarchical levels	Value on a scale of 1–7

- Frequency of meetings with colleagues at the same hierarchical level (the survey question is “How often do you have meetings with colleagues at the same hierarchical level?” 1 very rarely,…, 7 very often);
- Frequency of meetings with colleagues at higher hierarchical levels (the survey question is “How often do you have meetings with colleagues who belong to higher hierarchical levels?” 1 very rarely,…, 7 very often).

The perception of information overload and underload is measured according to the prior literature (O’Reilly 1980; Karr-Wisniewski and Lu 2010). In particular, information underload is measured through the following items (Tables 4.11 and 4.12):

- Less information (the survey question is “How often do you realize you have less than the amount of information you would need to make the best possible decision? 1 very rarely,…, 7 very often);
- Fewer IT resources (the survey question is “How often do you realize you have fewer than the amount of IT resources you would need to make the best possible decision? 1 very rarely,…, 7 very often);
- No information (the survey question is “How often do you feel you are not receiving all the information you need? 1 very rarely,…, 7 very often).

The information overload is measured through the following items (Tables 4.13 and 4.14):

- More information (the survey question is “How often do you realize you have more than the amount of information you would need?” 1 very rarely,…, 7 very often);
- Too many IT resources (the survey question is “How often do you realize you have too many alternative technologies to use for the same problem?” 1 very rarely,…, 7 very often);
- Too much information (the survey question is “How often do you realize you are receiving too much information with respect to the amount you would need? 1 very rarely,…, 7 very often);

Table 4.9 Items included in the frequency of meeting research variable

Research variable	Items in the research variable
Frequency of meeting	Frequency of meetings with colleagues at the same hierarchical level
	Frequency of meetings with colleagues at higher hierarchical levels

Table 4.10 Measurement of the items included in the frequency of meeting research variable

Items in the research variable	Scale of measurement
Frequency of meetings with colleagues at the same hierarchical level	Value on a scale of 1–7
Frequency of meetings with colleagues at higher hierarchical levels	Value on a scale of 1–7

Table 4.11 Items included in the information underload research variable

Research variable	Items in the research variable
Information underload	Fewer IT resources
	Less information
	No information

Table 4.12 Measurement of the items included in the information underload research variable

Items in the research variable	Scale of measurement
Fewer IT Resources	Value on a scale of 1–7
Less Information	Value on a scale of 1–7
No Information	Value on a scale of 1–7

Table 4.13 Items included in the information overload research variable

Research variable	Items in the research variable
Information overload	More IT resources
	More information
	Too many IT resources
	Too much information

Table 4.14 Measurement of the items included in the information overload research variable

Items in the research variable	Scale of measurement
More IT resources	Value on a scale of 1–7
More information	Value on a scale of 1–7
Too many IT resources	Value on a scale of 1–7
Too much information	Value on a scale of 1–7

- More IT resources (the survey question is “How often do you realize you have more IT resources than you would need?” 1 very rarely,…, 7 very often);

We also use another research variable that measures the perception of respondents about the absence of both information overload and information underload. This variable is called “Perceived Information Quality” (the survey question is “To what extent do you perceive that the amount of information you receive is appropriate to allow you to optimally execute your tasks?)”1 very low,…, 7 very high). Therefore, we assume that this variable measures the respondents’ perception of information quality (Table 4.15).

Table 4.15 Measurement of the perceived information quality research variable

Items in the research variable	Scale of measurement
Perceived information quality	Value on a scale of 1–7

4.4.2 Variable Measurement: Control Variables

The control variables, shown in Tables 4.16 and 4.17, regard either respondents' features or firms' features. The control variables for the former are the following:

- Role (1 if the respondent is a controller, 2 if the respondent is a Chief Information Officer, 3 if the respondent is a Chief Executive Officer, 4 if the respondent is head of the accounting information system, 5 if the respondent is Chief Technology Officer, and 6 if the respondent is a Chief Financial Officer);
- Education (1 if the respondent has only a secondary school diploma, 2 if the respondent has a bachelor or master degree, 3 if the respondent has a post-master degree, 4 if the respondent has a PhD).
- Gender (0 if the respondent is a male and 1 if the respondent is a female).

The control variables for the firms' features are:

- Firm size (1) if the respondent works in a small firm, (2) if the respondent works in a medium firm, (3) if the respondent works in a medium/large firm, and (4) if the respondent works in a large firm);
- Sector (1) if the firm belongs to the service sector, (2) if the firm belongs to the industrial sector, (3) if the firm belongs to the financial sector, and (4) if the firm belongs to the public sector);
- Type of firm (1) if the firm is listed, (2) if the firm is non-listed, (3) if the firm is non-profit, and (4) if the firm is public).

Table 4.16 Control variables

Dimensions	Control variables
Respondents' features	Role
	Gender
	Education
Firms' features	Firm size
	Sector
	Type of firm

Table 4.17 Measurement of the control variables

Control variables	Scale of measurement
Role	Value on a scale of 1–6
Gender	Dichotomous variable
Education	Value on a scale of 1–4
Firm size	Value on a scale of 1–4
Sector	Value on a scale of 1–4
Type of firm	Value on a scale of 1–4

4.5 Factor Analysis

The first step in our empirical analysis was to perform a principal component analysis (Tables 4.18, 4.19, 4.20, 4.21, 4.22 and 4.23) to construct the research variables and their components (Williams et al. 2012). A principal component analysis is a statistical procedure which uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components (Niculescu et al. 2016).

To test the validity and reliability of the factor analysis, we performed a Keiser-Meyer-Olkin (KMO) test to determine the sampling adequacy (Kaiser 1960), a Bartlett's sphericity test (Snedecor and Cochran 1989), and we used the analysis of Cronbach's alpha to assess the scale reliability (Nunnally and Bernstein 1994). We also checked for the eigenvalue of each item in order to determine how many factors should be retained in the analysis (Hayton et al. 2004).

Eigenvalues greater than 1 are associated with retained factors (Kaiser 1960). As shown in Tables 4.18, 4.19, 4.20, 4.21, 4.22 and 4.23, the reliability of the factor analysis is satisfactory for each item. The KMO measure of sampling adequacy

Table 4.18 Factor analysis for the information processing capacity research variable

Item	Factor loading	Communality	Eigen value	% of variance	Cronbach's alpha	Bartlett's sphericity test	KMO
Data accuracy	0.912	0.832	2.363	78.754	0.865	Chi2 = 113.570 p-value = 0.000***	0.719
Timeliness of data	0.897	0.804	0.398	13.263			
System reliability	0.853	0.727	0.239	7.983			

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

Table 4.19 Factor analysis for the communication and reporting research variable

Item	Factor loading	Communality	Eigen value	% of variance	Cronbach's alpha	Bartlett's sphericity test	KMO
Monthly reporting frequency	0.788	0.622	2.537	63.432	0.803	Chi2 = 137.257 p-value = 0.000***	0.628
6-month reporting frequency	0.921	0.847	0.785	19.626			
Annual reporting frequency	0.789	0.622	0.520	12.989			
Flash reporting frequency	0.668	0.446	0.158	3.954			

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

Table 4.20 Factor analysis for the information sharing research variable

Item	Factor Loading	Communality	Eigen value	% of variance	Cronbach's alpha	Bartlett's sphericity test	KMO
Satisfaction about the sharing of information with colleagues at the same hierarchical level	0.868	0.754	1.508	75.412	0.674	Chi2 = 22.860 *p*-value = 0.000***	0.500
Satisfaction about the sharing of information with colleagues at higher hierarchical levels	0.868	0.754	0.492	24.588			

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

Table 4.21 Factor analysis for frequency of meeting research variable

Item	Factor Loading	Communality	Eigen value	% of variance	Cronbach's alpha	Bartlett's sphericity test	KMO
Frequency of meetings with colleagues at the same hierarchical level	0.898	0.807	1.615	80.727	0.761	Chi2 = 36.281 p-value = 0.000***	0.500
Frequency of meetings with colleagues at higher hierarchical levels	0.898	0.807	0.385	19.273			

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

Table 4.22 Factor analysis for the information overload research variable

Item	Factor loading	Communality	Eigen value	% of variance	Cronbach's alpha	Bartlett's sphericity test	KMO
More information	0.649	0.421	2.454	61.361	0.648	Chi2 = 104.011 *p*-value = 0.000***	0.784
Too much information	0.824	0.678	0.752	18.793			
More IT resources	0.733	0.538	0.585	14.622			
Too many IT resources	0.904	0.817	0.209	5.224			

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

Table 4.23 Factor analysis for the information underload research variable

Item	Factor loading	Communality	Eigen value	% of variance	Cronbach's alpha	Bartlett's sphericity test	KMO
No information	0.905	0.820	2.347	78.226	0.860	Chi2 = 103.028 *p*-value = 0.000***	0.714
Fewer IT resources	0.841	0.707	0.419	13.966			
Less information	0.906	0.820	0.234	7.808			

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

achieves satisfactory levels, as it is higher than 0.5 (Hair et al. 2006) in all cases. Similarly, the Bartlett's test reports a satisfactory level of goodness-of-fit for each component of the research variables (Snedecor and Cochran 1989). Communality values are consistently higher than the threshold level of 0.50. The only two items showing a communality value below the threshold level are Flash Reporting Frequency, inside the research variable Communication and Reporting, and More Information, inside the research variable Information Overload. Both items are considered important in the accounting information literature: daily flash reports are of increasing importance, especially in sectors when managers need to constantly track sales performance and related trends in order to define appropriate marketing policies (Bog et al. 2011) and when management requires a quick presentation of the overall financial strength of the company (Basile et al. 2002). The item "more information" represents the situation in which managers feel they need to receive more information than they would need to accomplish their tasks; this situation is considered by the literature as a condition of information overload to be avoided (Galbraith 1974; Wärzner et al. 2017). However, searching for more information makes managers feel more confident and secure about the problems to be solved (O'Reilly 1980).

Moreover, the scale reliability for each component is very good, achieving a level of 0.865 for Information Processing Capacity, 0.803 for Communication and Reporting, 0.674 for Information Sharing, 0.761 for Frequency of Meeting, 0.648 for Information Overload, and 0.860 for Information Underload.

The factor analysis confirms the previous literature and frameworks by identifying which items could be encompassed in each research variable.

References

AAM (2011) Association of accounting marketing, association for accounting marketing social media survey, August 2010. Retrieved 23 Feb, 2011, from http://www.accountingmarketing.org/pdfs/2010/08162010_social_media_survey_results.pdf

Ackoff RL (1967) Management misinformation systems. Manag Sci 14:B–147

Agnew JR, Szykman LR (2005) Asset allocation and information overload: The influence of information display, asset choice, and investor experience. J Behav Finance 6:57–70

Albrecht WD (2011) LinkedIn for accounting and business students. Am J Bus Educ AJBE 4:39–42

Al-Hakim L (2007) Information quality management: theory and applications. IGI Global

Ballou DP, Pazer HL (1985) Modeling data and process quality in multi-input, multi-output information systems. Manag Sci 31:150–162

Basile A, Papa LJ, Johnston R (2002) Leading low-end accounting software. CPA J. 72:40

Bera P (2016) How colors in business dashboards affect users' decision making. Commun ACM 59:50–57

Berthold H, Rösch P, Zöller S, Wortmann F, Carenini A, Campbell S, Bisson P, Strohmaier F (2010) An architecture for ad-hoc and collaborative business intelligence. In: Proceedings of the 2010 EDBT/ICDT workshops. ACM, p 13

Bessa J, Branco F, Costa A, Martins J, Gonçalves R (2016) A multidimensional information system architecture proposal for management support in Portuguese higher education: the university of Tras-os-Montes and Alto Douro case study. In: 2016 11th Iberian conference on information systems and technologies (CISTI). IEEE, pp 1–7

Bettis-Outland H (2012) Decision-making's impact on organizational learning and information overload. J Bus Res 65:814–820

Bingi P, Sharma MK, Godla JK (1999) Critical issues affecting an ERP implementation. Manag 16:7–14

Blanco S, Lesca H (1998) Business intelligence: integrating knowledge into the selection of early warning signals. In: Workshop on knowledge management

Bog A, Plattner H, Zeier A (2011) A mixed transaction processing and operational reporting benchmark. Inf Syst Front 13:321–335

Bosset LJ (1991) Quality function deployment. ASQC Quality Press, Milwaukee

Bovee M, Srivastava RP, Mak B (2003) A conceptual framework and belief-function approach to assessing overall information quality. Int J Intell Syst 18:51–74

Boyer J, Frank B, Green B, Harris T, Van De Vanter K (2010) Business intelligence strategy: a practical guide for achieving BI excellence. Mc Press

Brien JA, Marakas GM (2009) Management information system. Galgotia Pubn L994 3

Burkhard RA, Meier M (2005) Tube map visualization: evaluation of a novel knowledge visualization application for the transfer of knowledge in long-term projects. J UCS 11:473–494

Burstein F, Holsapple C (2008) Handbook on decision support systems 2: variations. Springer Science & Business Media

Caglio A (2003) Enterprise resource planning systems and accountants: towards hybridization? Eur Account Rev 12:123–153. https://doi.org/10.1080/0963818031000087853

Calvasina R, Calvasina E, Ramaswamy M, Calvasina G, Cedar City UT (2009) Data quality problems in responsibility accounting. issues. Inf Syst 48–57

Caserio C (2011) Relationships between ERP and business intelligence: an empirical research on two different upgrade approaches. In: Information technology and innovation trends in organizations. Springer, pp 363–370

Caserio C, Trucco S (2016) Relationship between information system and information overload. A preliminary analysis. Int J Manag Inf Technol 11:3040–3050

Chandler JS (1982) A multiple criteria approach for evaluating information systems. MIS Q.61–74

Chapman CS, Kihn L-A (2009) Information system integration, enabling control and performance. Account Organ Soc 34:151–169. https://doi.org/10.1016/j.aos.2008.07.003

Chen C, Yu Y (2000) Empirical studies of information visualization: a meta-analysis. Int J Hum-Comput Stud 53:851–866

Chung W, Chen H, Nunamaker JF Jr (2005) A visual framework for knowledge discovery on the web: an empirical study of business intelligence exploration. J Manag Inf Syst 21:57–84

Connolly T (1977) Information processing and decision making in organizations. New Dir Organ Behav 205:234

Dell'Orco M, Giordano R (2003) Web community of agents for the integrated logistics of industrial districts. In: Proceedings of the 36th annual Hawaii international conference on system sciences, 2003. IEEE, p 10

DeLone WH, McLean ER (1992a) Information systems success: the quest for the dependent variable. Inf Syst Res 3:60–95

DeLone WH, McLean ER (1992b) Information systems success: the quest for the dependent variable. Inf Syst Res 3:60–95

Detlor B (2000) The corporate portal as information infrastructure: towards a framework for portal design. Int J Inf Manag 20:91–101

Dias C (2001) Corporate portals: a literature review of a new concept in information management. Int J Inf Manag 21:269–287

Dillman DA (2008) Mail and internet surveys: the tailored design method. Wiley, New York

Duncan, R.B., 1973. Multiple decision-making structures in adapting to environmental uncertainty: The impact on organizational effectiveness. Hum. Relat

Edmunds A, Morris A (2000) The problem of information overload in business organisations: a review of the literature. Int J Inf Manag 20:17–28

English LP (2002). Total quality data management (TQdM). Inf Database Qual 85–109

Eppler MJ (2003) Managing information quality: increasing the value of information in knowledge-intensive products and processes. Springer Science & Business Media

Eppler MJ, Mengis J (2004a) The concept of information overload: a review of literature from organization science, accounting, marketing, MIS, and related disciplines. Inf Soc 20:325–344

Eppler MJ, Mengis J (2004b) The concept of information overload: a review of literature from organization science, accounting, marketing, MIS, and related disciplines. Inf Soc 20:325–344

Evans JR, Lindsay WM (2002) The management and control of quality. South-Western, Cincinnati, OH

Fadlalla A, Wickramasinghe N (2004) An integrative framework for HIPAA-compliant I* IQ healthcare information systems. Int J Health Care Qual Assur 17:65–74

Farhoomand AF, Drury DH (2002) Overload. Commun ACM 45:127

Feldman MS, March JG (1981) Information in organizations as signal and symbol. Adm Sci Q 171–186

Fisher CW, Chengalur-Smith I, Ballou DP (2003) The impact of experience and time on the use of data quality information in decision making. Inf Syst Res 14:170–188

Gable GG (1994) Integrating case study and survey research methods: an example in information systems. Eur J Inf Syst 3:112–126

Galbraith JR (1977) Organization design. Addison Wesley Publishing Company

Galbraith JR (1974) Organization design: an information processing view. Interfaces 4:28–36

Goodhue DL (1995) Understanding user evaluations of information systems. Manag Sci 41:1827–1844

Gorry GA, Scott Morton MS (1971) A framework for management information systems

Gupta M, Kohli A (2006) Enterprise resource planning systems and its implications for operations function. Technovation 26:687–696

Hair JF, Black WC, Babin BJ, Anderson RE, Tatham RL et al (2006) Multivariate data analysis. Pearson Prentice Hall, Upper Saddle River, NJ

Hartigan JA (1985) Statistical theory in clustering. J Classif 2:63–76

Hayton JC, Allen DG, Scarpello V (2004) Factor retention decisions in exploratory factor analysis: a tutorial on parallel analysis. Organ Res Methods 7:191–205

Hiltz SR, Turoff M (1985) Structuring computer-mediated communication systems to avoid information overload. Commun ACM 28:680–689

Hitt LM, Wu DJ, Z X (2002) Investment in enterprise resource planning: Business impact and productivity measures. J Manag Inf Syst 19:71–98

Ho J, Tang R (2001) Towards an optimal resolution to information overload: an infomediary approach. In: Proceedings of the 2001 international ACM SIGGROUP conference on supporting group work. ACM, pp 91–96

Horvath L (2001) Collaboration: the key to value creation in supply chain management. Supply Chain Manag Int J 6:205–207

Jarke M, Vassiliou Y (1997) Data warehouse quality: a review of the DWQ Project. In: IQ. pp 299–313

Joseph N, Turley S, Burns J, Lewis L, Scapens R, Southworth A (1996) External financial reporting and management information: a survey of UK management accountants. Manag Account Res 7:73–93

Juran JM (1992) Juran on quality by design: the new steps for planning quality into goods and services. Simon and Schuster

Kahn BK, Strong DM, Wang RY (2002) Information quality benchmarks: product and service performance. Commun ACM 45:184–192

Kaiser HF (1960) The application of electronic computers to factor analysis. Educ Psychol Meas

Karr-Wisniewski P, Lu Y (2010) When more is too much: operationalizing technology overload and exploring its impact on knowledge worker productivity. Comput Hum Behav 26:1061–1072

Kiley K (2005) The cyberspace database information overload. Cat Age 12:56–59

Kock N (2000a) Information overload and worker performance: a process-centered view. Knowl Process Manag 7:256

Kock N (2000b) Information overload and worker performance: a process-centered view. Knowl Process Manag 7:256

Larkin JH, Simon HA (1987) Why a diagram is (sometimes) worth ten thousand words. Cogn Sci 11:65–100

Lee MR, Lan Y (2007) From Web 2.0 to conversational knowledge management: towards collaborative intelligence. J Entrep Res 2:47–62

Lee YW, Strong DM, Kahn BK, Wang RY (2002) AIMQ: a methodology for information quality assessment. Inf Manag 40:133–146

Lee Z, Lee J (2000) An ERP implementation case study from a knowledge transfer perspective. J Inf Technol 15:281–288

Letsholo RG, Pretorius MP (2016) Investigating managerial practices for data and information overload in decision making. J Contemp Manag 13:767–792

Li S, Lin B (2006) Accessing information sharing and information quality in supply chain management. Decis Support Syst 42:1641–1656

Li X, Qu H, Zhu Z, Han Y (2009) A systematic information collection method for business intelligence. In: International conference on electronic commerce and business intelligence, ECBI 2009. IEEE, pp 116–119

Lin X (1997) Map displays for information retrieval. JASIS 48:40–54

Madnick SE, Wang RY, Lee YW, Zhu H (2009) Overview and framework for data and information quality research. J Data Inf Qual JDIQ 1:2

Marchi L (1993) I sistemi informativi aziendali. Giuffrè

Marshall B, McDonald D, Chen H, Chung W (2004) EBizPort: collecting and analyzing business intelligence information. J Am Soc Inf Sci Technol 55:873–891

Matei G (2010) A collaborative approach of business intelligence systems. J Appl Collab Syst 2:91–101

Mauldin EG, Richtermeyer SB (2004) An analysis of ERP annual report disclosures. Int J Account Inf Syst 5:395–416. https://doi.org/10.1016/j.accinf.2004.04.005

McClave JT, Benson PG, Sincich T (1998) A first course in business statistics

Meglio CE, Kleiner BH (1990) Managing information overload. Ind Manag Data Syst 90:23–25

Melchor MQ, Julián CP (2008) The impact of the human element in the information systems quality for decision making and user satisfaction. J Comput Inf Syst 48:44–52

Melinat P, Kreuzkam T, Stamer D (2014) Information overload: a systematic literature review. In: International conference on business informatics research. Springer, pp 72–86

Mikkelsen G, Aasly J (2005) Consequences of impaired data quality on information retrieval in electronic patient records. Int J Med Inf 74:387–394

Miller D (1994) What happens after success: the perils of excellence. J Manag Stud 31:325–358

Milliken FJ (1990) Perceiving and interpreting environmental change: an examination of college administrators' interpretation of changing demographics. Acad Manage J 33:42–63

Milliken FJ (1987) Three types of perceived uncertainty about the environment: state, effect, and response uncertainty. Acad Manage Rev 12:133–143

Morris MG, Venkatesh V (2010) Job characteristics and job satisfaction: understanding the role of enterprise resource planning system implementation. Mis Q 143–161

Nelson RR, Todd PA, Wixom BH (2005) Antecedents of information and system quality: an empirical examination within the context of data warehousing. J Manag Inf Syst 21:199–235

Niculescu M, Irimia C, Rosca IC, Grovu M, Guiman MV (2016) Structural dynamic applications using principal component analysis method. In: International congress of automotive and transport engineering. Springer, pp 90–99

Nunnally JC, Bernstein IH (1994) Psychometric theory. McGraw-Hill, New York

O'Brien JA, Marakas GM (2006) Management information systems. McGraw-Hill, Irwin

O'Reilly CA (1980) Individuals and information overload in organizations: is more necessarily better? Acad Manage J 23:684–696

Petter S, DeLone W, McLean ER (2013a) Information systems success: the quest for the independent variables. J Manag Inf Syst 29:7–62

Petter S, DeLone W, McLean ER (2013b) Information systems success: the quest for the independent variables. J Manag Inf. Syst 29:7–62

Piattini MG, Calero C, Genero MF (2012) Information and database quality. Springer Science & Business Media

Pipino LL, Lee YW, Wang RY (2002) Data quality assessment. Commun ACM 45:211–218

Poston R, Grabski S (2001) Financial impacts of enterprise resource planning implementations. Int J Account Inf Syst 2:271–294. https://doi.org/10.1016/S1467-0895(01)00024-0

Quattrone P, Hopper T (2001) What does organizational change mean? Speculations on a taken for granted category. Manag Account Res 12:403–435. https://doi.org/10.1006/mare.2001.0176

Ranjan J (2009) Business intelligence: Concepts, components, techniques and benefits. J Theor Appl Inf Technol 9:60–70

Redman TC (1992) Data quality: management and technology. Bantam Books, Inc

Redman TC, Blanton A (1997) Data quality for the information age. Artech House, Inc

Reeves CA, Bednar DA (1994) Defining quality: alternatives and implications. Acad Manage Rev 19:419–445

Rizzi S (2012) Collaborative business intelligence. Bus Intell 186–205

Robey D, Ross JW, Boudreau M-C (2002a) Learning to implement enterprise systems: an exploratory study of the dialectics of change. J Manag Inf Syst 19:17–46

Robey D, Ross JW, Boudreau M-C (2002b) Learning to implement enterprise systems: an exploratory study of the dialectics of change. J Manag Inf Syst 19:17–46

Rodriguez MG, Gummadi K, Schoelkopf B (2014) Quantifying information overload in social media and its impact on social contagions. arXiv:14036838

Rogelberg SG, Stanton JM (2007) Introduction understanding and dealing with organizational survey nonresponse. Organ Res Methods 10:195–209

Rud OP (2009) Business intelligence success factors: tools for aligning your business in the global economy. Wiley

Sangster A, Leech SA, Grabski S (2009) ERP implementations and their impact upon management accountants. JISTEM-J Inf Syst Technol Manag 6:125–142

Scapens RW, Jazayeri M (2003) ERP systems and management accounting change: opportunities or impacts? a research note. Eur Account Rev 12:201–233

Scheer A-W, Habermann F (2000) Enterprise resource planning: making ERP a success. Commun ACM 43:57–61

Schneider SC (1987) Information overload: causes and consequences. Hum Syst Manag 7:143–153

Shneiderman B (1996) The eyes have it: a task by data type taxonomy for information visualizations. In: Proceedings of IEEE symposium on visual languages, 1996. IEEE, pp 336–343

Simperl E, Thurlow I, Warren P, Dengler F, Davies J, Grobelnik M, Mladeni D, Gomez-Perez JM, Moreno CR et al (2010) Overcoming information overload in the enterprise: the active approach. IEEE Internet Comput 14:39–46

Snedecor GW, Cochran WG (1989) Statistical Methods, 8th edn. Iowa State University Press, Ames

Soucek R, Moser K (2010) Coping with information overload in email communication: evaluation of a training intervention. Comput Hum Behav 26:1458–1466

Speier C, Valacich JS, Vessey I (1999) The influence of task interruption on individual decision making: an information overload perspective. Decis Sci 30:337–360

Spira JB (2011) Overload! How too much information is hazardous to your organization. Wiley

Stieglitz S, Dang-Xuan L (2013) Social media and political communication: a social media analytics framework. Soc Netw Anal Min 3:1277–1291

Strong DM, Lee YW, Wang RY (1997) Data quality in context. Commun ACM 40:103–110

Strother JB, Ulijn JM, Fazal Z (2012) Information overload: an international challenge for professional engineers and technical communicators. Wiley

Stvilia B, Twidale MB, Smith LC, Gasser L (2005) Assessing information quality of a community-based encyclopedia. In: IQ

Swain MR, Haka SF (2000) Effects of information load on capital budgeting decisions. Behav Res Account 12:171

Taylor RS (1991) Information use environments. Prog Commun Sci 10:55

Taylor RS (1982) Value-added processes in the information life cycle. J Am Soc Inf Sci 33:341–346

Thatcher JB, Stepina LP, Boyle RJ (2002) Turnover of information technology workers: examining empirically the influence of attitudes, job characteristics, and external markets. J Manag Inf Syst 19:231–261

Tushman ML (1977) Technical communication in research and development laboratories: the impact of project work characteristics. In: Academy of management proceedings. Academy of Management, pp 433–437

Tushman ML, Nadler DA (1978) Information processing as an integrating concept in organizational design. Acad Manag Rev 3:613–624

Wand Y, Wang RY (1996) Anchoring data quality dimensions in ontological foundations. Commun ACM 39:86–95

Wang RY, Strong DM (1996) Beyond accuracy: what data quality means to data consumers. J Manag Inf Syst 12:5–33

Wärzner A, Hartner-Tiefenthaler M, Koeszegi ST (2017) Working anywhere and working anyhow? Remote Work Collab Breakthr Res Pract Breakthr Res Pract 305
Williams B, Brown T, Onsman A (2012) Exploratory factor analysis: a five-step guide for novices. Australas J Paramed 8:1
Xu H, Horn Nord J, Brown N, Daryl Nord G (2002a) Data quality issues in implementing an ERP. Ind Manag Data Syst 102:47–58
Xu H, Horn Nord J, Brown N, Daryl Nord G (2002b) Data quality issues in implementing an ERP. Ind Manag Data Syst 102:47–58
Xu JD, Benbasat I, Cenfetelli RT (2013) Integrating service quality with system and information quality: an empirical test in the e-service context. Mis Q 37
Yang X, Procopiuc CM, Srivastava D (2009) Summarizing relational databases. Proc VLDB Endow 2:634–645
Zeithaml VA, Parasuraman A, Berry LL (1990) Delivering quality services. N Y Free Press Career Dev 11:63–64
Zeng D, Chen H, Lusch R, Li S-H (2010) Social media analytics and intelligence. IEEE Intell Syst 25:13–16
Zmud RW (1978) An empirical investigation of the dimensionality of the concept of information. Decis Sci 9:187–195

Chapter 5
ERP and BI as Tools to Improve Information Quality in the Italian Setting: Empirical Analysis

Abstract This chapter presents the results of our survey. Empirical results from the entire datasets of respondents demonstrated that respondents adopting an ERP or a BI system—or both an ERP and a BI system—do not perceive higher or lower information overload or information underload. Furthermore, respondents who have implemented an ERP perceive a higher level of information processing capacity, a higher level of communication and reporting, and a higher level of frequency of meeting than do respondents who have not implemented an ERP. Respondents who have implemented a BI perceive a higher level of information processing capacity compared to respondents who have not implemented a BI. Respondents who have implemented both an ERP and a BI system perceive a higher level of information processing capacity than do respondents who have not implemented an ERP or a BI. Results from the regression analysis show that information processing capacity has a positive effect on the information quality perceived by managers; therefore, if the information processing capacity increases, the information quality perceived by respondents increases as well. Furthermore, results show that communication and reporting has a negative effect on the information quality perceived by respondents, so that if communication and reporting increases, the information quality decreases.

5.1 Introduction

This chapter presents descriptive statistics and a correlation analysis of the research and control variables for the entire dataset (Sect. 5.2). Section 5.3 proposes the research method, the t-test and the regression analysis; Sect. 5.4 presents empirical results from the regression analysis and the t-test applied to the entire dataset of respondents. These analyses allow us to answer the research questions presented in Chap. 4. Section 5.5 presents the empirical results for the sub-sample of Chief Information Officers. Finally, Sect. 5.6 presents the summary results for the whole dataset of respondents and for the dataset of CIOs.

C. Caserio and S. Trucco, *Enterprise Resource Planning and Business Intelligence Systems for Information Quality*, Contributions to Management Science,
https://doi.org/10.1007/978-3-319-77679-8_5

5.2 Descriptive Statistics and Correlation Analysis

Table 5.1 shows the frequency distribution of the dichotomous research variables (ERP Adoption, Business Intelligence Adoption, and ERP and Business Intelligence); Table 5.2 shows some descriptive statistics of the research variables. In particular, Table 5.1 indicates that 78.5% of respondents declare they adopt ERP in their firms, 68.4% of respondents adopt Business Intelligence, and 60.7% of respondents adopt both ERP and Business Intelligence in their firms.

Table 5.2 shows that the highest mean value is linked to Information Sharing, whereas the lowest mean value is linked to Information Overload.

Furthermore, we ranked research variables according to their mean value in a descending order, applying a one-sample t-test (Table 5.3) to determine whether the mean response was significantly different from the indifference level (whose value is 4). Table 5.3 shows that, among the research variables, Information Sharing and Information Overload show a significant mean difference from the indifference level.

Table 5.4 shows the descriptive statistics for the items included in the Information Processing Capacity variables. Regarding the items included in this variable, the highest mean value is linked to Data Accuracy, whereas the lowest mean value is linked to Timeliness of Data. Table 5.5 shows the descriptive statistics for the items included in the Communication and Reporting variable. For items included in this variable, the highest mean value is linked to Flash Reporting frequency, whereas the lowest mean value is linked to 6-month reporting frequency.

Table 5.1 Frequency distribution of the dichotomous research variables (Number of observations: 79)

Research variables	Frequency distribution for survey questions (in %)	
	0	1
ERP adoption	21.5	78.5
Business intelligence adoption	31.6	68.4
ERP and business intelligence	39.2	60.8

Table 5.2 Descriptive statistics of the research variables (Number of observations: 79)

Research variables	Minimum	Maximum	Mean	Standard deviation
Information processing capacity	1	7	4.215	1.501
Communication and reporting	1	7	4.003	1.484
Information sharing	1	7	4.455	1.474
Frequency of meeting	1	7	4.000	1.494
Information underload	1	7	3.900	1.591
Information overload	1	5.25	2.493	1.082
Perceived information quality	2	7	4.18	1.326

Table 5.3 One-sample t-test on the research variables (Number of observations: 79)

Research variables	Minimum	Maximum	Mean	Standard deviation
Information sharing	1	7	4.455***	1.474
Information processing capacity	1	7	4.215	1.501
Perceived information quality	2	7	4.18	1.326
Communication and reporting	1	7	4.003	1.484
Frequency of meeting	1	7	4.000	1.494
Information underload	1	7	3.900	1.591
Information overload	1	5.25	2.493***	1.082

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

Table 5.4 Descriptive statistics of items included in the information processing capacity variable (Number of observations: 79)

Research variables	Minimum	Maximum	Mean	Standard deviation
Data accuracy	1	7	4.43	1.707
System reliability	1	7	4.18	1.623
Timeliness of data	1	7	4.04	1.743

Table 5.5 Descriptive statistics of items included in the communication and reporting variable (Number of observations: 79)

Research variables	Minimum	Maximum	Mean	Standard deviation
Flash reporting frequency	1	7	4.32	2.01
Monthly reporting frequency	1	7	4.13	1.793
6-month reporting frequency	1	7	3.75	1.815
Annual reporting frequency	1	7	3.82	1.893

Table 5.6 shows the descriptive statistics for the items included in the Frequency of Meeting variable. For items included in this variable, the highest mean value is linked to Frequency of meetings with colleagues at the same hierarchical Level.

Table 5.7 shows the descriptive statistics for the items included in the Information Sharing variable. Regarding items included in this variable, the highest mean value is linked to Satisfaction about the sharing of information with colleagues at higher hierarchical levels.

Table 5.8 shows the descriptive statistics for the items included in the Information Underload variable. The highest mean value for items included in this variable is linked to Fewer IT resources, whereas the lowest mean value is linked to No information.

Table 5.6 Descriptive statistics of items included in the frequency of meeting variable (Number of observations: 79)

Research variables	Minimum	Maximum	Mean	Standard deviation
Frequency of meetings with colleagues at the same hierarchical level	1	7	4.16	1.589
Frequency of meetings with colleagues at higher hierarchical levels	1	7	3.84	1.735

Table 5.7 Descriptive statistics of items included in the information sharing variable (Number of observations: 79)

Research variables	Minimum	Maximum	Mean	Standard deviation
Satisfaction about the sharing of information with colleagues at the same hierarchical level	1	7	4.28	1.632
Satisfaction about the sharing of information with colleagues at higher hierarchical levels	1	7	4.63	1.763

Table 5.8 Descriptive statistics of items included in the information underload variable (Number of observations: 79)

Research variables	Minimum	Maximum	Mean	Standard deviation
Fewer IT resources	1	7	4.14	1.946
No information	1	7	3.7	1.793
Less information	1	7	3.86	1.669

Table 5.9 shows the descriptive statistics for the items included in the Information overload variable. The highest mean value for items included in this variable is linked to More information, whereas the lowest mean value is linked to Too much information.

Table 5.10 shows the frequency distribution of the control variables.

Results from the zero-order correlation analysis of the research variables are presented in Table 5.11. Information Processing Capacity has moderate positive correlations with Communication and Reporting, Information Sharing, Frequency of

Table 5.9 Descriptive statistics of items included in the information overload variable (Number of observations: 79)

Research variables	Minimum	Maximum	Mean	Standard deviation
More information	1	7	2.67	1.395
More IT resources	1	6	2.51	1.324
Too many IT resources	1	7	2.45	1.395
Too much information	1	7	2.34	1.436

Table 5.10 Frequency distribution of the control variables (Number of observations: 79)

Control variables	Frequency distribution for survey questions (in %)						
	0	1	2	3	4	5	6
Gender	96.2	3.8					
Role		10.1	46.8	8.9	10.1	16.5	7.6
Education		21.5	49.4	24.1	5.1		
Type of firm		24.1	65.8	5.1	5.1		
Firm size		8.9	36.7	25.3	29.1		
Sector		58.2	38.0	1.3	2.5		

Meeting, and Perceived Information Quality. Furthermore, Information Processing Capacity has moderate negative correlations with Information Underload and Gender. Communication and Reporting has moderate positive correlations with Information Sharing, Frequency of Meeting and Firm Size. Information Sharing has moderate positive correlations with Frequency of Meeting, Perceived Information Quality and Firm Size, and a negative moderate correlation with Information Underload. Frequency of Meeting has moderate positive correlations with Perceived Information Quality and Firm Size and a negative moderate correlation with Gender. Information Underload has a moderate negative correlation with Perceived Information Quality. Information Overload has positive moderate correlations with Perceived Information Quality and Sector. Firm Size has a positive moderate correlation with Sector and a negative moderate correlation with Type of Firms.

The zero-order correlation analysis demonstrates that our results are not affected by issues of collinearity (Cohen et al. 2013).

5.3 Research Models

5.3.1 T-Test

We used non-parametric tests (Beattie and Pratt 2003; Beattie and Smith 2012) to answer our research questions and performed a t-test analysis to check for any differences between the perception of respondents (1) who adopted ERP and those who did not; (2) who adopted Business Intelligence and those who did not; and (3) who adopted both Business Intelligence and ERP and the other respondents. By doing so, we were able to answer RQ1a, RQ1b, RQ2a, RQ2b, RQ3a and RQ3b.

5.3.2 Regression Analysis for Research Variables

Furthermore, to answer research question 4 (RQ4) we performed a regression analysis on the research variables (identified in Chap. 4) created based on the factor analysis (Chap. 4).

Table 5.11 Correlation matrix of the research variables (79 observations)

	Information processing capacity	Communication and reporting	Information sharing	Frequency of meeting	Information underload	Information overload	Perceived informa-tion quality	Gender	Education	Role	Firm size	Sector	Type of firm
Information processing capacity	1												
Communication and reporting	0.336** 0.002	1											
Information sharing	0.633** 0.000	0.238* 0.035	1										
Frequency of meeting	0.564** 0.000	0.329** 0.003	0.562** 0.000	1									
Information underload	−0.484** 0.000	−0.130 0.274	−0.337** 0.004	−0.175 0.139	1								
Information overload	0.038 0.751	0.086 0.470	0.184 0.119	0.132 0.267	0.090 0.451	1							
Perceived information quality	0.579** 0.000	0.104 0.380	0.426** 0.000	0.392** 0.001	−0.384** 0.001	0.286* 0.014	1						
Gender	−0.265* 0.018	−0.113 0.323	−0.197 0.081	−0.223* 0.048	0.064 0.592	0.001 0.993	−0.150 0.205	1					
Role	0.185 0.102	0.174 0.126	0.181 0.110	0.081 0.477	−0.099 0.403	−0.124 0.294	0.260* 0.027	−0.216 0.056	0.188 0.097	1			
Education	−0.182 0.109	−0.057 0.620	−0.195 0.086	−0.117 0.304	0.050 0.673	−0.084 0.479	−0.164 0.166	0.051 0.654	1				
Firm size	0.142 0.212	0.269* 0.016	0.187 0.098	0.328** 0.003	−0.064 0.591	0.171 0.149	0.083 0.483	−0.084 0.460	0.090 0.432	−0.130 0.253	1		
Sector	−0.046 0.690	−0.080 0.481	−0.097 0.396	0.065 0.568	0.076 0.521	0.273* 0.019	0.028 0.816	0.056 0.621	0.05 0.968	−0.172 0.129	0.231* 0.040	1	
Type of firm	−0.112 0.328	−0.092 0.419	−0.128 0.262	−0.122 0.283	0.123 0.301	−0.048 0.685	−0.086 0.469	−0.086 0.469	−0.139 0.223	0.035 0.761	−0.350** 0.002	0.121 0.287	1

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

p values are in brackets

(1) $Y = \beta_0 + \beta_1$ Information Processing Capacity + β_2 Communication and Reporting + β_3 Information Sharing + β_4 Frequency of Meeting + β_5 Information Underload + β_6 Information Overload + β_7 Gender + β_8 Role + β_9 Education + β_{10} Sector + β_{11} Type of firms + β_{12} Firm Size + ε

The dependent variable (Y) is the Perceived Information Quality and represents the information quality perceived by respondents; the independent variables are the research variables identified in Chap. 4, which represent the features of the information flow. These variables are: Information Processing Capacity, Communication and Reporting, Information Sharing and Frequency of Meeting. The control variables are: Information Underload, Information Overload, Gender, Education, Role, Sector, Type of Firms, and Firm Size.

5.4 Empirical Results

The following sub-sections present the t-test analysis (Sect. 5.4.1) and the empirical results (Sect. 5.4.2).

5.4.1 T-Test: Empirical Results

We performed a t-test analysis to check for any differences between the perception of respondents (1) who adopted ERP and those who did not; (2) who adopted Business Intelligence and those who did not; and (3) who adopted both Business Intelligence and ERP and the other respondents. We carried out the same analysis for the research variables identified in Chap. 4 (Sect. 5.4.1.1) and for the survey items (Sect. 5.4.1.2).

5.4.1.1 T-Test: Empirical Results for the Research Variables

Regarding the research variables, Table 5.12 shows that respondents who implemented an ERP perceived a higher level of Information Processing Capacity than those who did not (t-test is statistically significant, *p* value = 0.051). Furthermore, respondents adopting an ERP perceived a higher level of Communication and Reporting than did respondents who did not adopt an ERP (t-test is statistically significant, *p* value = 0.028) and a higher level of Frequency of Meeting compared to respondents who did not adopt an ERP (t-test is statistically significant, *p* value = 0.099). These results allow us to answer *RQ 1b: "Do ERP systems matter to the features of information flow?"*

With regard to *RQ 1a: "Do ERP systems matter to information overload and information underload?",* the results demonstrated that respondents adopting an

Table 5.12 Results of the t-test analysis for research variables comparing respondents who adopted ERP and those who did not

Item	Number of observations	Mean	Standard deviation	T-test (p value)
Information processing capacity (with ERP)	62	4.38	1.455	0.051*
Information processing capacity (without ERP)	17	3.58	1.543	
Communication and Reporting (with ERP)	62	4.19	1.452	0.028**
Communication and reporting (without ERP)	17	3.31	1.427	
Information sharing (with ERP)	62	4.48	1.417	0.748
Information sharing (without ERP)	17	4.35	1.712	
Frequency of meeting (with ERP)	62	4.14	1.412	0.099*
Frequency of meeting (without ERP)	17	3.47	1.700	
Information underload (with ERP)	57	3.83	1.623	0.487
Information underload (without ERP)	16	4.15	1.495	
Information overload (with ERP)	57	2.43	0.976	0.383
Information overload (without ERP)	16	2.70	1.415	
Perceived information quality (with ERP)	57	4.26	1.330	0.304
Perceived information quality (without ERP)	16	3.88	1.310	

*. **. *** indicate a significance degree between 0.10 and 0.05. 0.05 and 0.01. and 0.01 and 0, respectively

ERP did not perceive higher or lower information overload or information underload compared to the other respondents (t-test for both research variables, information overload and information underload, are not statistically significant) (Table 5.12).

Table 5.13 shows that respondents who have implemented a BI perceive a higher level of Information Processing Capacity than do respondents who have not implemented a BI (t-test is statistically significant, p value = 0.075). These results allow us to answer *RQ 2b: "Does a Business Intelligence system matter to the features of information flow?"*.

With regard to *RQ 2a: "Does Business Intelligence matter to information overload and information underload?"*, the results demonstrate that respondents

Table 5.13 Results of the t-test analysis for the research variables comparing respondents who adopt BI and those who do not

Item	Number of observations	Mean	Standard deviation	T-test (p value)
Information processing capacity (with BI)	54	4.42	1.443	0.075*
Information processing capacity (without BI)	25	3.77	1.560	
Communication and reporting (with BI)	54	4.10	1.427	0.411
Communication and reporting (without BI)	25	3.80	1.610	
Information sharing (with BI)	54	4.60	1.340	0.197
Information sharing (without BI)	25	4.14	1.717	
Frequency of meeting (with BI)	54	4.12	1.352	0.295
Frequency of meeting (without BI)	25	3.74	1.762	
Information underload (with BI)	50	3.71	1.592	0.128
Information underload (without BI)	23	4.32	1.542	
Information overload (with BI)	50	2.58	1.015	0.288
Information overload (without BI)	23	2.29	1.215	
Perceived information quality (with BI)	50	4.44	1.280	0.012**
Perceived information quality (without BI)	23	3.61	1.270	

*. **. *** indicate a significance degree between 0.10 and 0.05. 0.05 and 0.01. and 0.01 and 0, respectively

adopting a BI do not perceive higher or lower information overload or information underload compared to the other respondents (t-test for both research variables, information overload and information underload, are not statistically significant) (Table 5.13). Moreover, respondents using Business Intelligence perceive a higher level of Perceived Information Quality than do those who do not use Business Intelligence systems (t-test is statistically significant, p value = 0.012).

Table 5.14 shows that respondents who have implemented both ERP and BI perceive a higher level of Information Processing Capacity than do respondents who have not implemented an ERP or a BI (t-test is statistically significant, p value = 0.058). These results allow us to answer *RQ 3b: "Does the combined*

Table 5.14 Results of the t-test analysis for the research variables comparing respondents who adopted both business intelligence and ERP and the other respondents

Item	Number of observations	Mean	Standard deviation	T-test (p value)
Information processing capacity (with ERP and business intelligence)	48	4.47	1.437	0.058*
Information processing capacity (without ERP or business intelligence)	31	3.81	1.534	
Communication and reporting (with ERP and business intelligence)	48	4.18	1.404	0.197
Communication and reporting (without ERP or business intelligence)	31	3.73	1.585	
Information sharing (with ERP and business intelligence)	48	4.60	1.337	0.268
Information sharing (without ERP or business intelligence)	31	4.23	1.662	
Frequency of meeting (with ERP and business intelligence)	48	4.13	1.324	0.319
Frequency of meeting (without ERP or business intelligence)	31	3.79	1.726	
Information underload (with ERP and business intelligence)	44	3.69	1.592	0.166
Information underload (without ERP or business intelligence)	29	4.22	1.564	
Information overload (with ERP and business intelligence)	44	2.52	1.250	0.818
Information overload (without ERP or business intelligence)	29	2.46	0.969	
Perceived information quality (with ERP and business intelligence)	44	4.39	1.351	0.099*
Perceived information quality (without ERP or business intelligence)	29	3.86	1.246	

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

adoption of ERP and BI systems matter more to the features of information flow than does the single adoption of an ERP or BI system?”.

With reference to *RQ 3a: “Does the combined adoption of ERP and BI systems matter more to information overload and information underload than does the single adoption of an ERP or BI system?”,* the results demonstrate that respondents who adopted an ERP and a BI do not perceive higher or lower information overload or information underload than do the other respondents (t-test for both research variables, information overload and information underload, are not statistically significant) (Table 5.14). Finally, respondents who adopted both ERP and Business Intelligence perceive a higher level of Perceived Information Quality than do the other respondents (t-test is statistically significant, p value = 0.099).

5.4.1.2 T-Test: Empirical Results for Survey Items

Regarding the survey items related to ERP system adoption, Table 5.15 shows that respondents who have implemented an ERP perceive a higher level of data accuracy than do respondents who have not (t-test is statistically significant, p value = 0.013). Furthermore, respondents adopting an ERP perceive a higher level of System reliability than do respondents who have not (t-test is statistically significant, p value = 0.017) and a higher frequency of monthly reports, 6-month reports and flash reports than those who do not adopt an ERP (t-test are statistically significant, p value = 0.063, 0.078 and 0.049, respectively). Finally, respondents who have adopted an ERP perceive a higher level of frequency of meetings with colleagues at the same hierarchical level compared to respondents who have not (t-test is statistically significant, p value = 0.062). In terms of the other survey items, Table 5.15 shows that there are no statistically significant differences in the perception of respondents who have or have not adopted an ERP system.

Table 5.16 shows that respondents who adopt a Business Intelligence system in their firms perceive a higher level of data accuracy than do respondents who do not use Business Intelligence (t-test is statistically significant, p value = 0.025). Furthermore, respondents who adopt Business Intelligence perceive a higher level of monthly reports than do respondents who have not (t-test is statistically significant, p value = 0.040) and attribute a lower score to the No information variable with respect to respondents who have not adopted a Business Intelligence system (t-test is statistically significant, p value = 0.035). Therefore, respondents who adopt Business Intelligence perceive they are not receiving all the information they need more rarely than do those who do not adopt Business Intelligence. Regarding the other survey items in Table 5.16, the results show that there are no statistically significant differences in the perception of respondents who adopt or do not adopt Business Intelligence systems.

Table 5.17 shows that respondents who adopt both an ERP and a Business Intelligence system perceive a higher level of data accuracy than do the other respondents in the sample (t-test is statistically significant, p value = 0.012) and a higher level of system reliability (t-test is statistically significant, p value = 0.076). Additionally, respondents adopting both ERP and Business Intelligence perceive a higher number of reports issued in one month than do the other respondents (t-test is statistically significant, p value = 0.029) and a lower level of no information (t-test is statistically significant, p value = 0.089). The results show that there are no other statistically significant differences in the perception of respondents regarding the other survey items.

Table 5.15 Results of the t-test analysis for items comparing respondents who adopt ERP with those who do not

Item	Number of observations	Mean	Standard deviation	T-test (p value)
Data accuracy (with ERP)	62	4.68	1.647	0.013**
Data accuracy (without ERP)	17	3.53	1.663	
Timeliness of data (with ERP)	62	4.08	1.692	0.68
Timeliness of data (without ERP)	17	3.88	1.965	
System reliability (with ERP)	62	4.4	1.573	0.017**
System reliability (without ERP)	17	3.35	1.579	
Monthly reporting frequency (with ERP)	62	4.32	1.818	0.063*
Monthly reporting frequency (without ERP)	17	3.41	1.543	
6-month reporting frequency (with ERP)	62	3.94	1.854	0.078*
6-month reporting frequency (without ERP)	17	3.06	1.519	
Annual reporting frequency (with ERP)	62	3.97	1.89	0.196
Annual reporting frequency (without ERP)	17	3.29	1.863	
Flash reporting frequency (with ERP)	62	4.55	1.964	0.049**
Flash reporting frequency (without ERP)	17	3.47	2.004	
Satisfaction about the information sharing with colleagues at the same hierarchical level (with ERP)	62	4.37	1.591	0.339
Satisfaction about the information sharing with colleagues at the same hierarchical level (without ERP)	17	3.94	1.784	
Satisfaction about the information sharing with colleagues at higher hierarchical levels (with ERP)	62	4.6	1.684	0.73
Satisfaction about the information sharing with colleagues at higher hierarchical levels (without ERP)	17	4.76	2.078	
Frequency of meetings with colleagues at the same hierarchical level (with ERP)	62	4.34	1.536	0.062*
Frequency of meetings with colleagues at the same hierarchical level (without ERP)	17	3.53	1.663	
Frequency of meetings with colleagues at higher hierarchical levels (with ERP)	62	3.95	1.634	0.258
Frequency of meetings with colleagues at higher hierarchical levels (without ERP)	17	3.41	2.063	
Less information (with ERP)	57	3.75	1.714	0.297
Less information (without ERP)	16	4.25	1.483	
Fewer IT resources (with ERP)	57	4.11	1.934	0.795
Fewer IT resources (without ERP)	16	4.25	2.049	
No information (with ERP)	57	3.63	1.867	0.55
No information (without ERP)	16	3.94	1.526	
More information (with ERP)	57	2.63	1.345	0.65

(continued)

Table 5.15 (continued)

Item	Number of observations	Mean	Standard deviation	T-test (*p* value)
More information (without ERP)	16	2.81	1.601	
More IT resources (with ERP)	57	2.51	1.283	0.982
More IT resources (without ERP)	16	2.5	1.506	
Too much information (with ERP)	57	2.25	1.272	0.28
Too much information (without ERP)	16	2.69	1.922	
Too many IT resources (with ERP)	57	2.35	1.203	0.245
Too many IT resources (without ERP)	16	2.81	1.94	

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

5.4.2 Empirical Results for Regression Analysis

The results of the regression analysis for the entire dataset of respondents are reported in Table 5.18. This analysis allows us to answer RQ4 (*Do the features of information flow affect the information quality perceived by managers?*).

Empirical results from the entire datasets of respondents show that the Information Quality perceived by respondents (Perceived Information Quality) is affected by Information Processing Capacity, Communication and Reporting, Information Underload, Information Overload and Education. In particular, the results show that Information Processing Capacity has a positive effect on the information quality perceived by managers (β: 0.467, *p* value: 0.001); therefore, if the information processing capacity increases, the information quality perceived by respondents increases as well. Furthermore, results show that Communication and Reporting has a negative effect on the information quality perceived by respondents (β: −0.169, *p* value: 0.096), so that if Communication and Reporting increases, the information quality decreases.

Among the control variables, Information Underload has a negative effect on perceived information quality; therefore, if the Information Underload increases, the perceived information quality decreases. Moreover, results show that Information Overload has a positive effect on the information quality perceived by managers, so that if the information overload increases the perceived information quality increases as well.

Results from the regression analysis allow us to answer RQ4 (*Do the features of information flow affect the information quality perceived by managers?*). We found that some features of information flow can affect the information quality perceived by managers; specifically, that Information Processing Capacity and Communication and Reporting affect the perceived information quality differently. The power of the model fit is high (R^2 = 51.9%).

Table 5.19 presents a multicollinearity check for the regression analysis carried out in this section. The Variance Inflation Factor (VIF) allows us to check for the presence of multicollinearity. Low values for the VIF index (VIF < 10) and the correlation matrix entries allow us to reject the hypothesis of multicollinearity for the entire dataset of non-financial firms (Cohen et al. 2013).

5.5 Additional Analysis: Empirical Results on the Chief Information Officer Dataset

We carried out an additional analysis on Chief Information Officers (CIOs), since this professional figure is responsible for the company's IT system, and thus of the entire information flow within a firm (Gottschalk 1999). The relevance of his/her role has particularly increased over the last few years (Bharadwaj 2000; Corsi and Trucco 2016). Furthermore, CIOs represent the majority (46,8%) of respondents within our dataset. Therefore, we carried out the regression and the t-test analysis specifically on this category of interviewees, adopting the same model shown above.

5.5.1 Regression Analysis for Chief Information Officers

To deepen our research, we performed a regression analysis on the research variables for CIOs. The regression model can be expressed as follows:

$Y = \beta_0 + \beta_1$ Information Processing Capacity + β_2 Communication and Reporting + β_3 Information Sharing + β_4 Frequency of Meeting + β_5 Information Underload + β_6 Information Overload + β_7 Gender + β_8 Education + β_9 Sector + β_{10} Type of firms + β_{11} Firm Size + ε

The dependent variable (Y) represents the Perceived Information Quality, whereas the independent variables are the research variables identified in Chap. 4, which represent the features of the information flow. These variables are: Information Processing Capacity, Communication and Reporting, Information Sharing, and Frequency of Meeting. The control variables are: Information Underload, Information Overload, Gender, Role, Sector, Type of Firms, and Firm Size.

5.5.2 Empirical Results of the Regression Analysis on Chief Information Officers

The results of the regression analysis on CIOs are reported in Table 5.20. This analysis allows us to provide a more in-depth answer to RQ4 (*Do the features of information flow affect the information quality perceived by managers?*).

Table 5.16 Results of the t-test analysis for items comparing respondents who adopt business intelligence with those who do not

Item	Number of observations	Mean	Standard deviation	T-test (p value)
Data accuracy (with business intelligence)	54	4.72	1.583	0.025**
Data accuracy (without business intelligence)	25	3.8	1.826	
Timeliness of data (with business intelligence)	54	4.19	1.661	0.273
Timeliness of data (without business intelligence)	25	3.72	1.904	
System reliability (with business intelligence)	54	4.35	1.544	0.161
System reliability (without business intelligence)	25	3.8	1.756	
Monthly reporting frequency (with business intelligence)	54	4.41	1.775	0.040**
Monthly reporting frequency (without business intelligence)	25	3.52	1.711	
6-month reporting frequency (with business intelligence)	54	3.74	1.855	0.965
6-month reporting frequency (without business intelligence)	25	3.76	1.763	
Annual reporting frequency (with business intelligence)	54	3.74	1.875	0.575
Annual reporting frequency (without business intelligence)	25	4	1.958	
Flash reporting frequency (with business intelligence)	54	4.5	1.901	0.235
Flash reporting frequency (without business intelligence)	25	3.92	2.216	
Satisfaction about the information sharing with colleagues at the same hierarchical level (with business intelligence)	54	3.93	1.588	0.499
Satisfaction about the information sharing with colleagues at the same hierarchical level (without business intelligence)	25	3.64	2.039	
Satisfaction about the information sharing with colleagues at higher hierarchical levels (with business intelligence)	54	4.31	1.503	0.219
Satisfaction about the information sharing with colleagues at higher hierarchical levels (without business intelligence)	25	3.84	1.748	
Frequency of meetings with colleagues at the same hierarchical level (with business intelligence)	54	4.31	1.503	0.219
Frequency of meetings with colleagues at the same hierarchical level (without business intelligence)	25	3.84	1.748	

(continued)

Table 5.16 (continued)

Item	Number of observations	Mean	Standard deviation	T-test (p value)
Frequency of meetings with colleagues at higher hierarchical levels (with business intelligence)	54	3.93	1.588	0.499
Frequency of meetings with colleagues at higher hierarchical levels (without business intelligence)	25	3.64	2.039	
Less information (with business intelligence)	50	3.72	1.703	0.284
Less information (without business intelligence)	23	4.17	1.586	
Fewer IT resources	50	4	1.969	0.379

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

Empirical results from the dataset of respondents among the CIOs demonstrate that the Information Quality perceived by CIOs is affected by Information Processing Capacity and Communication and Reporting, confirming results which refer to the entire dataset of respondents. In particular, the results show that Information Processing Capacity has a positive effect on the information quality perceived by CIOs (β: 0.380, p value: 0.093); therefore if the information processing capacity increases, the information quality perceived by respondents increases as well. Furthermore, results show that Communication and Reporting has a negative effect on the information quality perceived by respondents (β: −0.330, p value: 0.038), and thus if the Communication and Reporting increases, the information quality decreases.

Results allow us to better answer RQ4 (*Do the features of information flow affect the information quality perceived by managers?*). We found that some features of information flow can affect the information quality perceived by managers, specifically that Information Processing Capacity and Communication and Reporting affect the Perceived Information Quality differently. Similar considerations could arise from an analysis of the entire dataset of respondents. The power of the model fit is high ($R^2 =$ 55.1%).

Table 5.21 presents a multicollinearity check for the regression analysis carried out in this section. The Variance Inflation Factor (VIF) allows us to check for the presence of multicollinearity. Low values for the VIF index (VIF < 10) and the correlation matrix entries allow us to reject the hypothesis of multicollinearity for the entire dataset of non-financial firms (Cohen et al. 2013).

Table 5.17 Results of the t-test analysis for items comparing respondents who adopt both Business Intelligence and ERP with those who single adopted an ERP or BI system

Item	Number of observations	Mean	Standard deviation	T-test (p value)
Data accuracy (with ERP and business intelligence)	48	4.81	1.58	0.012**
Data accuracy (without ERP or business intelligence)	31	3.84	1.753	
Timeliness of data (with ERP and business intelligence)	48	4.17	1.667	0.418
Timeliness of data (without ERP or business intelligence)	31	3.84	1.864	
System reliability (with ERP and business intelligence)	48	4.44	1.515	0.076*
System reliability (without ERP or business intelligence)	31	3.77	1.726	
Monthly reporting frequency (with ERP and business intelligence)	48	4.48	1.798	0.029**
Monthly reporting frequency (without ERP or business intelligence)	31	3.58	1.669	
6-month reporting frequency (with ERP and Business Intelligence)	48	3.79	1.89	0.787
6-month reporting frequency (without ERP or business intelligence)	31	3.68	1.72	
Annual reporting frequency (with ERP and business intelligence)	48	3.85	1.868	0.856
Annual reporting frequency (without ERP or business intelligence)	31	3.77	1.961	
Flash reporting frequency (with ERP and business intelligence)	48	4.58	1.866	0.143
Flash reporting frequency (without ERP or business intelligence)	31	3.9	2.181	
Satisfaction about the information sharing with colleagues at the same hierarchical level (with ERP and business intelligence)	48	4.46	1.57	0.225
Satisfaction about the information sharing with colleagues at the same hierarchical level (without ERP or business intelligence)	31	4	1.713	
Satisfaction about the information sharing with colleagues at higher hierarchical levels (with ERP and business intelligence)	48	4.75	1.551	0.466
Satisfaction about the information sharing with colleagues at higher hierarchical levels (without ERP or business intelligence)	31	4.45	2.063	

(continued)

Table 5.17 (continued)

Item	Number of observations	Mean	Standard deviation	T-test (p value)
Frequency of meetings with colleagues at the same hierarchical level (with ERP and business intelligence)	48	4.35	1.48	0.189
Frequency of meetings with colleagues at the same hierarchical level (without ERP or business intelligence)	31	3.87	1.727	
Frequency of meetings with colleagues at higher hierarchical levels (with ERP and business intelligence)	48	3.92	1.514	0.608
Frequency of meetings with colleagues at higher hierarchical levels (without ERP or business intelligence)	31	3.71	2.053	
Less information (with ERP and business intelligence)	44	3.66	1.711	0.201
Less information (without ERP or business intelligence)	29	4.17	1.583	
Fewer IT resources (with ERP and business intelligence)	44	4	1.953	0.463
Fewer IT resources (without ERP or business intelligence)	29	4.34	1.951	
No information (with ERP and business intelligence)	44	3.41	1.808	0.089*
No information (without ERP or business intelligence)	29	4.14	1.706	
More information (with ERP and business intelligence)	44	2.82	1.419	0.271
More information (without ERP or business intelligence)	29	2.45	1.352	
More IT resources (with ERP and business intelligence)	44	2.59	1.3	0.508
More IT resources (without ERP or business intelligence)	29	2.38	1.374	
Too much information (with ERP and business intelligence)	44	2.2	1.25	0.315
Too much information (without ERP or business intelligence)	29	2.55	1.682	
Too many IT resources (with ERP and business intelligence)	44	2.45	1.229	0.985
Too many IT resources (without ERP or business intelligence)	29	2.45	1.639	

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

Table 5.18 Results of the regression analysis (the dependent variable is perceived information quality)[a]

	β	*p* value	Standard error	T
Information processing capacity	0.467	0.001***	0.139	3.352
Communication and reporting	−0.169	0.096*	0.100	−1.691
Information sharing	−0.134	0.317	0.132	−1.010
Frequency of meeting	0.156	0.194	0.119	1.314
Information underload	−0.191	0.074*	0.105	−1.820
Information overload	0.334	0.001***	0.099	3.392
Gender	−0.064	0.912	0.572	−0.111
Role	0.278	0.268	0.098	2.831
Education	−0.106	0.006**	0.095	−1.118
Sector	−0.039	0.701	0.102	−0.386
Type of firms	0.009	0.931	0.109	0.087
Firm size	0.046	0.683	0.111	0.410

[a]R^2 = 51.9%, F-test (F) = 5.385, *p* value = 0.000, Number of observations (N) = 72
*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

Table 5.19 Multicollinearity check

	Y = perceived information quality
Information processing capacity	2.393
Communication and reporting	1.285
Information sharing	2.280
Frequency of meeting	1.810
Information underload	1.366
Information overload	1.212
Gender	1.100
Role	1.246
Education	1.192
Sector	1.350
Type of firms	1.387
Firm size	1.633
Mean of VIF	1.521

Table 5.20 Results of the regression analysis on CIOs (the dependent variable is the Information Quality perceived by CIOs)[a]

	β	*p* value	Standard error	T
Information processing capacity	0.380	0.093*	0.217	1.754
Communication and reporting	−0.330	0.038**	0.150	−2.206
Information sharing	−0.010	0.953	0.173	−0.060
Frequency of meeting	0.180	0.283	0.164	1.099
Information underload	−0.222	0.195	0.167	−1.335
Information overload	0.193	0.144	0.192	1.343
Gender	−0.533	0.486	0.754	−0.708
Education	−0.112	0.405	0.132	−0.849
Sector	−0.151	0.281	0.137	−1.104
Type of firms	−0.109	0.431	−0.802	0.136
Firm size	0.041	0.807	0.166	0.247

[a]R^2 = 55.1%, F-test (F) = 2.569, *p* value = 0.027, Number of observations (N) = 34
*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

Table 5.21 Multicollinearity check

	Y = Perceived information quality
Information processing capacity	2.782
Communication and reporting	1.462
Information sharing	1.781
Frequency of meeting	1.465
Information underload	1.463
Information overload	1.351
Gender	1.313
Education	1.333
Sector	1.519
Type of firms	1.264
Firm size	2.248
Mean of VIF	1.635

5.5.3 T-Test: Empirical Results of the Analysis of Chief Information Officers

We also performed a t-test analysis on CIOs to provide more in-depth results from the analysis of the entire dataset of respondents. Therefore, with regard to RQ 1a: "*Do ERP systems matter to information overload and information underload?*", the

Table 5.22 Results of the t-test analysis for research variables comparing CIOs who adopt ERP with those who do not

Item	Number of observations	Mean	Standard deviation	T-test (p value)
Information processing capacity (with ERP)	28	4.51	1.142	0.414
Information processing capacity (without ERP)	9	4.11	1.616	
Communication and reporting (with ERP)	28	4.03	1.140	0.107
Communication and reporting (without ERP)	9	3.22	1.684	
Information sharing (with ERP)	28	4.54	1.146	0.986
Information sharing (without ERP)	9	4.55	1.648	
Frequency of meeting (with ERP)	28	4.39	1.083	0.147
Frequency of meeting (without ERP)	9	3.72	1.460	
Information underload (with ERP)	26	3.96	1.273	0.717
Information underload (without ERP)	9	3.78	1.384	
Information overload (with ERP)	26	2.39	0.855	0.010**
Information overload (without ERP)	9	3.33	1.000	
Perceived information quality (with ERP)	26	4.00	1.020	0.594
Perceived information quality (without ERP)	9	4.22	1.202	

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

results demonstrate that CIOs who adopt an ERP perceive lower information overload than those who do not (t-test is statistically significant, p value = 0.010) (Table 5.22).

With regard to RQ1b: "*Do ERP systems matter to the features of information flow?*, the results demonstrate that there is no differences in the perception of the features of information flow between CIOs who adopt ERP with those who do not.

Regarding RQ2b: "*Does a Business Intelligence system matter to the features of information flow?",* Table 5.23 shows there is no differences in the perception of the features of information flow between CIOs who adopt a BI with those who do not.

Table 5.23 Results of the t-test analysis for research variables comparing respondents who adopt BI with those who do not (dataset of CIO respondents)

Item	Number of observations	Mean	Standard deviation	T-test (p value)
Information processing capacity (with BI)	29	4.36	1.269	0.601
Information processing capacity (without BI)	8	4.62	1.29	
Communication and reporting (with BI)	29	3.96	1.295	0.267
Communication and reporting (without BI)	8	3.37	1.369	
Information sharing (with BI)	29	4.52	1.214	0.834
Information sharing (without BI)	8	4.62	1.506	
Frequency of meeting (with BI)	29	4.22	1.25	0.958
Frequency of meeting (without BI)	8	4.25	1.069	
Information underload (with BI)	27	3.93	1.409	0.923
Information underload (without BI)	8	3.87	0.796	
Information overload (with BI)	27	2.67	0.934	0.735
Information overload (without BI)	8	2.53	1.145	
Perceived information quality (with BI)	27	4.15	1.064	0.356
Perceived information quality (without BI)	8	3.75	1.035	

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

In terms of RQ 2a: "*Does Business Intelligence matter to information overload and information underload*?", the results demonstrate that respondents who adopt a BI do not perceive a higher or lower information overload or information underload compared to the other respondents (t-test for both research variables, information overload and information underload, are not statistically significant) (Table 5.23).

With regard to RQ 3b: "*Does the combined adoption of ERP and BI systems matter more to the features of information flow than does the single adoption of an ERP or BI system?",* Table 5.24 shows that CIOs who have implemented both BI and ERP do not perceive greater differences in the features of information flow than do the other CIOs.

With regard to RQ 3a: "*Does the combined adoption of ERP and BI systems matter more to information overload and information underload than does the single adoption of an ERP or BI system?*", the results demonstrate that respondents adopting an ERP and a BI system do not perceive a higher or lower information overload or information underload than do the other CIOs (t-test for both research variables, information overload and information underload, are not statistically significant) (Table 5.24).

Table 5.24 Results of the t-test analysis for research variables comparing respondents who adopted both Business Intelligence and ERP systems with those who single adopted an ERP or BI system (dataset of CIO respondents)

Item	Number of observations	Mean	Standard deviation	T-test (p value)
Information processing capacity (with ERP and business intelligence)	24	4.41	1.193	0.988
Information processing capacity (without ERP or business intelligence)	13	4.41	1.428	
Communication and reporting (with ERP and business intelligence)	24	4.08	1.888	0.109
Communication and reporting (without ERP or business intelligence)	13	3.36	1.453	
Information sharing (with ERP and business intelligence)	24	4.56	1.182	
Information sharing (without ERP or business intelligence)	13	4.5	1.443	0.888
Frequency of meeting (with ERP and business intelligence)	24	4.33	1.148	0.483
Frequency of meeting (without ERP or business intelligence)	13	4.04	1.314	
Information underload (with ERP and business intelligence)	22	4	1.338	0.615
Information underload (without ERP or business intelligence)	13	3.77	1.228	
Information overload (with ERP and business intelligence)	22	2.49	0.84	0.25
Information overload (without ERP or business intelligence)	13	2.88	1.157	
Perceived information quality (with ERP and business intelligence)	22	3.95	1.09	0.463
Perceived information quality (without ERP or business intelligence)	13	4.23	1.013	

*, **, *** indicate a significance degree between 0.10 and 0.05, 0.05 and 0.01, and 0.01 and 0, respectively

5.6 Summary Results

5.6.1 Summary Results for the Entire Dataset of Respondents

Table 5.25 summarizes the research questions outlined in Chap. 4. Chapter 6 will discuss the results of this study.

Table 5.25 Summary results for the entire dataset of respondents

Research questions	Summary results for research variables
RQ 1a: "Do ERP systems matter to information overload and information underload?"	Results demonstrated that respondents adopting an ERP do not perceive higher or lower information overload or information underload (t-test for both research variables, information overload and information underload, are not statistically significant)
RQ 1b: "Do ERP systems matter to the features of information flow?"	Respondents who have implemented an ERP perceive a higher level of Information Processing Capacity than do respondents who have not implemented an ERP (t-test is statistically significant, p value = 0.051). Furthermore, respondents adopting an ERP perceive a higher level of Communication and Reporting than do respondents without an ERP (t-test is statistically significant, p value = 0.028), as well as a higher level of Frequency of Meeting (t-test is statistically significant, p value = 0.099)
RQ 2a: "Does Business Intelligence matter to information overload and information underload?"	Results demonstrated that respondents adopting a BI do not perceive higher or lower information overload or information underload compared to the other respondents (t-test for both research variables, information overload and information underload, are not statistically significant)
RQ 2b: "Does a Business Intelligence system matter to the features of information flow?"	Respondents who have implemented a BI perceive a higher level of Information Processing Capacity than do respondents who have not implemented a BI (t-test is statistically significant, p value = 0.075)
RQ 3a: "Does the combined adoption of ERP and BI systems matter more to information overload and information underload than does the single adoption of an ERP or BI system?"	Results demonstrated that respondents adopting an ERP and a BI do not perceive higher or lower information overload or information underload compared to the other respondents (t-test for both research variables, information overload and information underload, are not statistically significant)
RQ 3b: "Does the combined adoption of ERP and BI systems matter more to the features of information flow than does the single adoption of an ERP or BI system?"	Respondents who have implemented both ERP and BI perceive a higher level of Information Processing Capacity than do respondents who have not implemented an ERP or a BI (t-test is statistically significant, p value = 0.058)

(continued)

Table 5.25 (continued)

Research questions	Summary results for research variables
RQ 4: "Do the features of information flow affect the information quality perceived by managers?"	Results show that Information Processing Capacity has a positive effect on the information quality perceived by managers (β: 0.467, p value: 0.001); therefore, if the information processing capacity increases, the information quality perceived by respondents increases as well. Furthermore, results show that Communication and Reporting has a negative effect on the information quality perceived by respondents (β: −0.169, p value: 0.096), so that if Communication and Reporting increases, the information quality decreases

Table 5.26 Summary results for chief information officers

Research Questions	Summary results for research variables
RQ 1a: "Do ERP systems matter to information overload and information underload?"	Results demonstrated that respondents adopting an ERP perceive lower information overload than do the other respondents (t-test is statistically significant, p value = 0.010)
RQ 1b: "Do ERP systems matter to the features of information flow?"	Results demonstrated that CIOs adopting an ERP do not perceive greater differences in the features of information flow than do the other CIOs
RQ 2a: "Does Business Intelligence matter to information overload and information underload?"	Results demonstrated that respondents adopting a BI do not perceive a higher or lower information overload or information underload compared to the other respondents (t-test for both research variables, information overload and information underload, are not statistically significant)
RQ 2b: "Does a Business Intelligence system matter to the features of information flow?"	CIOs who have implemented a BI do not perceive greater differences in the features of information flow compared to the other CIOs
RQ 3a: "Does the combined adoption of ERP and BI systems matter more to information overload and information underload than does the single adoption of an ERP or BI system?"	Results demonstrated that respondents adopting an ERP and a BI do not perceive a higher or lower information overload or information underload than do the other CIOs (t-test for both research variables, information overload and information underload, are not statistically significant)
RQ 3b: "Does the combined adoption of ERP and BI systems matter more to the features of information flow than does the single adoption of an ERP or BI system?"	CIOs who have implemented both BI and ERP do not perceive greater differences in the features of information flow than do the other CIOs

(continued)

Table 5.26 (continued)

Research Questions	Summary results for research variables
RQ 4: "Do the features of information flow affect the information quality perceived by managers?"	Results show that Information Processing Capacity has a positive effect on the information quality perceived by CIOs (β: 0.380, p value: 0.093); therefore, if the information processing capacity increases, the information quality perceived by respondents increases as well. Furthermore, results show that Communication and Reporting has a negative effect on the information quality perceived by respondents (β: −0.330, p value: 0.038), so that if Communication and Reporting increases, the information quality decreases

5.6.2 Summary Results for Chief Information Officers

Table 5.26 summarizes the research questions outlined in Chap. 4 for a sub-sample of respondents, namely CIOs. Chapter 6 will discuss the results of this study.

References

Beattie V, Pratt K (2003) Issues concerning web-based business reporting: an analysis of the views of interested parties. The British Accounting Review 35.2: 155–187

Beattie V, Smith SJ (2012) Evaluating disclosure theory using the views of UK finance directors in the intellectual capital context. Accounting and Business Research 42.5: 471–494

Bharadwaj AS (2000) A resource-based perspective on information technology capability and firm performance: an empirical investigation. MIS Q 169–196

Cohen J, Cohen P, West SG, Aiken LS (2013) Applied multiple regression/correlation analysis for the behavioral sciences. Routledge

Corsi K, Trucco S (2016) The Role of the CIOs on the IT management and firms' performance: evidence in the Italian context, in: strengthening information and control systems. Springer, pp 217–236

Gottschalk P (1999) Strategic management of IS/IT functions: the role of the CIO in Norwegian organisations. Int J Inf Manag 19:389–399

Chapter 6
Concluding Remarks

Abstract This chapter discusses the results of the theoretical and empirical analysis presented in the previous chapters of the manuscript. The limitations and further developments of the research were also presented. In general, our results show that information overload is less perceived than information underload in all the comparisons performed in the research. The empirical results of our research concerning the relationship between ERP systems and information overload/underload show that ERP systems do not affect the perception of information overload/underload. However, the empirical results show that respondents who adopt ERP perceive higher data accuracy, system reliability and, in general, a higher information processing capacity than do respondents who do not adopt an ERP. Furthermore, our results show that respondents who adopt BI systems do not perceive a different level of information overload/underload compared with respondents who do not adopt. However, a more detailed analysis shows that managers of companies adopting BI systems perceive a higher data accuracy, a higher level of information processing capacity, and a more regular reporting system, based on more systematic frequency. Empirical evidence on the effects of the simultaneous adoption of ERP and BI on information overload/underload and on the features of information flow show that respondents adopting both an ERP and a BI system do not perceive higher or lower information overload or information underload than do the other respondents. Finally, our results confirm prior studies on information processing capacity and information quality and suggest that reporting is one of the drivers of information quality.

6.1 Introduction

This section presents the results of the theoretical and empirical analysis conducted in the previous chapters of this manuscript.

Information overload and information underload could represent a serious limit for a company, as they can compromise the effectiveness of the decision-making process. The literature shows quite clearly that information overload and underload

C. Caserio and S. Trucco, *Enterprise Resource Planning and Business Intelligence Systems for Information Quality*, Contributions to Management Science,
https://doi.org/10.1007/978-3-319-77679-8_6

reduce decision accuracy (Eppler and Mengis 2004) and, consequently, the performance of managers. Information overload happens whenever the quantity of information the individual receives surpasses her/his capacity to process it (O'Reilly 1980); therefore, it happens more frequently in companies which face high environmental uncertainty, as they would need to adapt their information processing capacity to the changing conditions of the environment. Information underload occurs when the individual receives less information than she/he would need to accomplish a task (O'Reilly 1980; Eppler and Mengis 2004). Information underload may also occur when managers receive a large amount of irrelevant information. In this case, both information overload and information underload may occur as, on the one hand, the amount of information does not allow managers to perform their actions in a timely and effective manner, and on the other irrelevant information does not provide managers with the solutions to their problems, thereby causing information underload (Melinat et al. 2014; Letsholo and Pretorius 2016).

Information overload and information underload are also related to the time pressure managers feel in performing their job and to their possible incapacity to prioritize tasks optimally (Kock 2000). According to the literature, information overload and underload may even be due to the wrong use of technology (Lee et al. 2016). In fact, two contrasting types of behavior have been observed: on the one hand, companies invest in powerful IT tools in order to look for data, elaborate data, extract information, and undertake data mining, and in doing so produce plenty of data and information. On the other hand, companies invest in IT tools to deal with the information overload caused by the huge amount of data and information they need to manage. Therefore, if not appropriately used and not well-aligned with the management information needs and strategic goals, technology may even worsen the information overload and underload (Karr-Wisniewski and Lu 2010).

The literature shows that managers' perception of information overload/underload may represent a signal of poor information quality and, consequently, a signal of low quality of information flow (Kock 2000; Farhoomand and Drury 2002; Yang et al. 2009).

There have been several studies on information quality: part of the literature considers information quality as a feature—or a driver—of the quality of information systems (DeLone and McLean 1992; Nelson et al. 2005), whereas other contributions attempt to assess the information quality by proposing frameworks or methodologies (Lee et al. 2002; Bovee et al. 2003; Stvilia et al. 2005). Furthermore, the literature suggests several definitions of information quality, which, for example, could be considered as the fitness of user needs, as defined by Juran (1992) and Strong et al. (1997). Other studies, in proposing a definition of information quality, focus attention on information users by viewing information quality as the capacity to meet or exceed information users' expectations (McClave et al. 1998; Evans and Lindsay 2002). Information quality can also be defined as the coherence of information with regard to the specifications of the product or the service to which it refers (Zeithaml et al. 1990; Reeves and Bednar 1994; Kahn et al. 2002). According to this interpretation, high-quality information provides an accurate representation and meets the requirements of the final user. Naturally, the coherence and the usefulness of information also depend on the initial data quality (Piattini et al. 2012).

According to some authors, the quality of information depends on several attributes, which could be summarized in three main dimensions (Marchi 1993; O'Brien and Marakas 2006): time, content and form.

Our research provides an investigation of information overload and underload, information quality and features of information flow conducted through a survey on a sample of 79 Italian managers. Special focus is given to Chief Information Officers (CIOs), since this role is responsible for a company's IT system, and thus for the entire information flow within a firm (Gottschalk 1999). The role of the CIO has noticeably increased in the last few years (Bharadwaj 2000; Corsi and Trucco 2016). Furthermore, among our respondents, CIOs represent the majority of our dataset, with 46.8% of respondents.

In general, our results show that the information overload is less perceived than is information underload in all the comparisons performed in our research (i.e., (a) between respondents working in companies which adopt ERP systems and those working in companies that do not; (b) between respondents working in companies which adopt BI systems and those working in companies that do not; (c) between respondents working in companies which adopt both ERP and BI systems and the other respondents).

6.2 ERP, Information Overload/Underload and Features of Information Flow

The empirical results of our research on the relationship between ERP systems and information overload/underload show that ERP systems do not affect the perception of information overload/underload. The research variables used to measure the perception of information overload and underload are defined on the basis of previous studies (O'Reilly 1980; Karr-Wisniewski and Lu 2010) and aim at investigating whether managers perceive a lack of information—or even an absence of information—or a lack of IT resources. T-test analyses demonstrate that the perceptions of managers regarding these variables does not change whether or not they adopt ERP systems. The same is also true for research variables which investigate whether managers perceive information overload and whether they perceive having received appropriate information. It thus seems thus that the presence of an ERP system within the company does not alter the perception of managers about the quantity and the quality of information they receive to accomplish their tasks.

However, some effects of the implementation of ERP systems is recognizable in other items, which are indirectly connected to the quality of information. For example, empirical results show that respondents adopting ERP perceive higher data accuracy and system reliability and, in general, a higher information processing capacity than do respondents who have not adopted ERP. Furthermore, the results show that companies adopting ERP have a more structured reporting system, as information is more frequently communicated on a monthly or a 6-month basis, than do companies that do not adopt ERP.

These perceptions, although probably not connected to the perception of information overload/underload, reveal that the use of ERP has a positive impact on information system quality and on the information quality items. This confirms that part of the literature which supports the idea that ERP improves data quality, information quality and information system quality in general (Bingi et al. 1999; Dell'Orco and Giordano 2003; Chapman and Kihn 2009; Scapens and Jazayeri 2003).

For respondents adopting ERP, the perception that they are using a more reliable system may be due to the impact that a comprehensive software like ERP has on data and system quality, as suggested by Lee and Lee 2000; Xu et al. 2002. In addition, empirical results show that flash reporting is more frequently used in companies adopting ERP than in firms that do not; this is in line with the idea that in the presence of ERP systems management accountants can dedicate more time to data analysis and performance measurement, and thus have more time to produce a larger amount of reports (Sangster et al. 2009).

Another significant perception arising from our results is that respondents adopting an ERP perceive better internal job coordination, probably because the implementation of an ERP often requires a thorough reorganization (along with a Business Process Reengineering), which may result in more frequent meetings with colleagues at the same hierarchical level. This effect is also confirmed by the literature, under different perspectives (Scheer and Habermann 2000). Respondents' perceptions on the quality of information flow are also useful in understanding the effects of ERP implementation on information issues. In fact, respondents adopting ERP perceive a better capacity to process information, along with better communication; these results are in line with the literature on the impacts of ERP on information flow issues (Sangster et al. 2009; Poston and Grabski 2001; Mauldin and Richtermeyer 2004; Scheer and Habermann 2000).

Interestingly, the empirical results described above show that, in general, respondents adopting ERP perceive a general improvement in several items directly or indirectly connected to information quality (such as data accuracy, system reliability, information processing capacity, and reporting system quality) compared with those who do not adopt ERP; but at the same time, respondents who adopt ERP do not perceive either an information overload or an information underload. Consequently, these results allow us to speculate that the absence of a perception of information overload or underload could be due to the improved information and reporting quality brought about by the ERP system.

Similar results were also obtained in the sub-sample of CIOs.

Table 6.1 reports our research questions regarding the relationships between ERP systems and information overload/underload and between ERP and information flow, our empirical evidence, and the results from the main literature, which either confirm or contradict our results.

Table 6.1 ERP, information overload/underload and information flow: empirical evidence and the main literature

Research questions	Empirical evidence	Main literature
RQ 1a: "Do ERP systems matter to information overload and information underload?" *RQ 1b: "Do ERP systems matter to the features of information flow?"*	• No information overload/ underload perceptions either for respondents adopting ERP or for those not adopting ERP • Respondents adopting ERP perceive higher information quality and better communication and information flow	The results are in line with the main literature on the effects of ERP on data and information quality issues (Chandler 1982; Chapman and Kihn 2009; Robey et al. 2002; Hitt et al. 2002; Mauldin and Richtermeyer 2004; Poston and Grabski 2001; Lee and Lee 2000; Xu et al. 2002)

6.3 BI, Information Overload/Underload and Features of Information Flow

The empirical evidence of our research on the relationship between BI systems and information overload/underload show that BI systems do not affect the perception of information overload/underload. Our results show that respondents adopting BI systems do not perceive a different level of information overload or underload than do respondents who do not adopt BI systems. However, a more detailed analysis shows that managers of companies adopting BI systems perceive higher data accuracy, a higher level of information processing capacity and a more regular reporting system, based on a systematic monthly frequency.

Regarding data accuracy, the literature shows that BI systems allow companies to collect data in data warehouses, to manage and analyse it, and to carry out data cleansing to improve data accuracy and completeness by supporting managers in selecting only the relevant data, and thus in providing appropriate information (Boyer et al. 2010; Brien and Marakas 2009; da Costa and Cugnasca 2010; Smith et al. 2012). In terms of the capacity of BI systems to provide appropriate information, our empirical results also show that respondents who adopt BI systems perceive a higher information quality than do respondents who do not adopt BI.

Therefore, the higher data accuracy and information quality perceived by BI system adopters may be due to the improvements BI brings to the entire data-information-decision cycle.

Regarding the perception of respondents pertaining to the more regular reporting system, this result is probably an effect of BI system capacities, well-recognized by the literature, which consist in addressing the right information at the right time to the right person (Burstein and Holsapple 2008). In fact, a regular and systematic reporting system could be the effect of an accurate reporting design process carried out before implementing a BI system. Successful BI implementation should, in fact, require managers to define the features of information and reports they will need,

Table 6.2 Business Intelligence, information overload/underload and information flow: empirical evidence and the main literature

Research questions	Empirical evidence	Main literature
RQ 2a: "Does Business Intelligence matter to information overload and information underload?" *RQ 2b: "Does a Business Intelligence system matter to the features of information flow?"*	• No information overload/ underload perceptions either for respondents who adopt BI or those who do not • Respondents adopting BI perceive higher data accuracy, better information processing capacity, higher information quality, and a more structured reporting system	Results are not aligned with the main literature: BI was expected to improve information overload, as suggested by the literature (Boyer et al. 2010, Brien and Marakas 2009) At the same time, the results confirm the literature regarding the role of BI in improving data accuracy, information processing capabilities, and information quality (Burstein and Holsapple 2008; Foshay and Kuziemsky 2014; Nita 2015; Eckerson 2005; Smith et al. 2012)

including the frequency with which they wish to receive them (Eckerson 2005; Foshay and Kuziemsky 2014; Nita 2015).

Another interesting result of our research is that respondents who do not adopt BI systems perceive more frequently that they are not receiving all the information they would need to accomplish their tasks. This probably occurs because, without a BI system, respondents are not provided with support in collecting, selecting, managing and analysing data. As a result, business data is probably disseminated in the company, but because it is not well-organized, collected and stored, managers perceive that data does not exist at all, or is insufficient to meet their decision-making needs. This is confirmed by some studies which assert that without BI, obtaining information would require a long manual process (Kelly 2005); furthermore, other studies state that companies, because of environmental turbulence, are obliged to use business information more effectively than before, which is not possible without systematic information management (Imran and Tanveer 2015).

As a confirmation of the above result, on the other hand, respondents adopting BI perceive a better information processing capacity due to the various opportunities BI systems provide for data elaboration and information flow (Brien and Marakas 2009; Boyer et al. 2010; da Costa and Cugnasca 2010; Spira 2011; Smith et al. 2012).

Table 6.2 summarizes our research questions pertaining to the role of BI in affecting information overload/underload and information flow, the empirical evidence obtained and the main literature, which confirms or contradicts our results.

6.4 The Combination of ERP and BI for Information Overload/Underload and Features of Information Flow

The empirical evidence on the effects of the simultaneous adoption of ERP and BI on information overload/underload and on the features of information flow show that respondents adopting both an ERP and a BI system do not perceive higher or lower information overload or information underload than do the other respondents. Similar considerations arise from the analysis of the CIO dataset. This is partially aligned with the literature, suggesting that information problems caused by a lack of systematic information collection and processing make BI tasks more and more difficult (Li et al. 2009). In other words, this result suggests that in companies where information collection and processing are not appropriately managed from the beginning, the potential benefits of BI systems are weakly perceived or not perceived at all.

Interestingly, our results also show that respondents who have implemented both ERP and BI systems perceive a higher level of information processing capacity than do respondents who adopt only ERP or BI. Therefore, although managers do not perceive that ERP and BI improve information overload/underload, they recognize that these systems improve the capacity of the company to process information. This evidence suggests that: either information overload and information underload are not perceived as problems, even if the benefits of ERP and BI are clearly recognized, or information overload and underload are indeed problems, but remain implicit in the perception of managers, who instead find it easier to recognize the improvement in a more tangible aspect such as information processing capacity.

Our results are thus not fully supported by the literature, which argues that the simultaneous use of ERP and BI systems is expected to have more influence on the information flow features than would the single adoption of ERP or BI (Scheer and Habermann 2000; Horvath 2001; Chapman and Kihn 2009; Berthold et al. 2010) (Table 6.3).

6.5 Information Quality and Features of Information Flow

The literature on this topic suggests that features of information flow are relevant for improving information quality (Swain and Haka 2000; Agnew and Szykman 2005). In particular, information processing capacity would increase by means of the synthetic and systemic representation of information, and communication would improve by means of more selective messages (Shneiderman 1996; Burkhard and Meier 2005). Other authors consider the information flow as an important dimension of information quality; in fact, an effective information flow allows information

Table 6.3 The simultaneous use of ERP and BI for information overload/underload and information flow: empirical evidence and the main literature

Research questions	Empirical evidence	Main literature
RQ 3a: "Does the combined adoption of ERP and BI systems matter more to information overload and information underload than does the single adoption of an ERP or BI system?" *RQ 3b: "Does the combined adoption of ERP and BI systems matter more to the features of information flow than does the single adoption of an ERP or BI system?"*	• The results demonstrated that respondents adopting an ERP and a BI do not perceive higher or lower information overload or information underload than do the other respondents • Respondents who have implemented both ERP and BI perceive a higher level of Information Processing Capacity than do respondents who have not implemented an ERP or a BI system	Results are partially aligned with the literature, suggesting that information problems caused by a lack of systematic information collection and processing make BI tasks more and more difficult (Li et al. 2009). BI studies often ignore the importance of information selection and pay too much attention to the capacity of BI to gather and elaborate data (Blanco and Lesca 1998) Results confirm those in the literature concerning the role of ERP and BI systems in improving information processing capacity (Lee and Lan 2007; Ranjan 2009; Chapman and Kihn 2009)

system users to receive complete, relevant, timely, up-to-date and accessible information (Al-Hakim 2007).

Our empirical evidence on the relationship between information quality and the features of information flow show which of these features are able to affect the information quality perceived by managers. In particular, we found that information processing capacity and communication and reporting affect, in different ways, the perceived information quality. In fact, the results reveal that information processing capacity has a positive effect on the information quality perceived by managers; therefore, if the information processing capacity increases, the information quality perceived by respondents increases as well. On the contrary, the results show that communication and reporting has a negative effect on the information quality perceived by respondents; therefore, if the communication and reporting increases, the information quality decreases. This result shows a reduction in the quality of information due to an increase in reporting frequency. However, it would be necessary to carry out more in-depth investigations to understand the type of reporting that leads to a reduction in the perceived quality. For example, an increase in flash reporting frequency denotes greater timeliness of communication; instead, an increase in the frequency of annual reports could mean a lack of timeliness (but a greater level of accuracy). In spite of this, the results are useful in understanding that reporting frequency is actually one of the drivers of information quality (Table 6.4).

Similar considerations arise from an analysis of the dataset of CIOs.

Table 6.4 Information quality and features of information flow

Research questions	Empirical evidence	Main literature
RQ 4: "Do the features of information flow affect the information quality perceived by managers?"	Results show that Information Processing Capacity has a positive effect on the information quality perceived by managers; therefore, if the information processing capacity increases, the information quality perceived by respondents increases as well Furthermore, results show that Communication and Reporting has a negative effect on the information quality perceived by respondents; therefore, if the Communication and Reporting increases, the information quality decreases	Our results confirm prior studies on information processing capacity and information quality (Shneiderman 1996; Burkhard and Meier 2005) Our results suggest that reporting is one of the drivers of information quality (Al-Hakim 2007; Sangster et al. 2009)

6.6 Limitations and Further Development

This section presents some limitations of our research. The first limitation is related to the choice of the manager sample, which is not based on the industry. The literature actually suggests that firms belonging to industries characterized by high uncertainty are more likely to face information overload and underload compared with companies operating in more stable industries (Ho and Tang 2001). Another limitation is linked to the small number of observations: the perception of respondents about information overload and underload and about information quality in general may depend on several endogenous factors such as the size of the company, the experience of the interviewees, and their role inside the company.

In addition to extending the sample, it would be useful for future research to submit the survey to companies at two different moments: immediately before and immediately after the company makes an ERP/BI investment. By doing so, it would be possible to compare the management perception of information overload/underload before and after the adoption of the new software. This would allow for a better perception of the effects of ERP and BI on the topic we have investigated. Furthermore, a more in-depth analysis of the relationship between the reporting system and information quality could be carried out by analyzing the role played by the single items of our research variable "Communication and Reporting" on information quality.

Acknowledgements The authors gratefully acknowledge the anonymous reviewers for the insightful suggestions provided to enhance the quality of this manuscript.

The authors also acknowledge the assistant editor of this book series, Maria Cristina Acocella, along with the editorial staff of Springer for their professional and proficient involvement in the production of this book.

The authors also gratefully acknowledge the Università degli Studi Internazionali di Roma (UNINT), which has made this study possible by providing financial support.

This study is part of a larger project on accounting information systems.

References

Agnew JR, Szykman LR (2005) Asset allocation and information overload: the influence of information display, asset choice, and investor experience. J Behav Finance 6:57–70

Al-Hakim L (2007) Information quality management: theory and applications. IGI Global

Berthold H, Rösch P, Zöller S, et al (2010) An architecture for ad-hoc and collaborative business intelligence. In: Proceedings of the 2010 EDBT/ICDT workshops. ACM, p 13

Bharadwaj AS (2000) A resource-based perspective on information technology capability and firm performance: an empirical investigation. MIS Q 169–196

Bingi P, Sharma MK, Godla JK (1999) Critical issues affecting an ERP implementation. Manag 16:7–14

Blanco S, Lesca H (1998) Business intelligence: integrating knowledge into the selection of early warning signals. In: Workshop on knowledge management

Bovee M, Srivastava RP, Mak B (2003) A conceptual framework and belief-function approach to assessing overall information quality. Int J Intell Syst 18:51–74

Boyer J, Frank B, Green B, et al (2010) Business intelligence strategy: a practical guide for achieving BI excellence. Mc Press

Brien JA, Marakas GM (2009) Management information system. Galgotia Pubn L994 3

Burkhard RA, Meier M (2005) Tube map visualization: evaluation of a novel knowledge visualization application for the transfer of knowledge in long-term projects. J UCS 11:473–494

Burstein F, Holsapple C (2008) Handbook on decision support systems 2: variations. Springer Science & Business Media

Chandler JS (1982) A multiple criteria approach for evaluating information systems. MIS Q 61–74

Chapman CS, Kihn L-A (2009) Information system integration, enabling control and performance. Account Organ Soc 34:151–169. https://doi.org/10.1016/j.aos.2008.07.003

Corsi K, Trucco S (2016) The role of the CIOs on the IT management and firms' performance: evidence in the Italian context. In: Strengthening information and control systems. Springer, pp 217–236

da Costa RAG, Cugnasca CE (2010) Use of data warehouse to manage data from wireless sensors networks that monitor pollinators. In: 2010 Eleventh international conference on mobile data management (MDM). IEEE, pp 402–406

Dell'Orco M, Giordano R (2003) Web community of agents for the integrated logistics of industrial districts. In: Proceedings of the 36th annual Hawaii international conference on system sciences, 2003. IEEE, p 10

DeLone WH, McLean ER (1992) Information systems success: the quest for the dependent variable. Inf Syst Res 3:60–95

Eckerson WW (2005) The keys to enterprise business intelligence: critical success factors. TDWI Rep

Eppler MJ, Mengis J (2004) The concept of information overload: a review of literature from organization science, accounting, marketing, MIS, and related disciplines. Inf Soc 20:325–344

Evans JR, Lindsay WM (2002) The management and control of quality. South-Western, Cincinnati, OH

Farhoomand AF, Drury DH (2002) OVERLOAD. Commun ACM 45:127
Foshay N, Kuziemsky C (2014) Towards an implementation framework for business intelligence in healthcare. Int J Inf Manag 34:20–27
Gottschalk P (1999) Strategic management of IS/IT functions: the role of the CIO in Norwegian organisations. Int J Inf Manag 19:389–399
Hitt LM, Wu DJ, Z X (2002) Investment in enterprise resource planning: Business impact and productivity measures. J Manag Inf Syst 19:71–98
Ho J, Tang R (2001) Towards an optimal resolution to information overload: an infomediary approach. In Proceedings of the 2001 international ACM SIGGROUP conference on supporting group work, September, pp 91–96
Horvath L (2001) Collaboration: the key to value creation in supply chain management. Supply Chain Manag Int J 6:205–207
Imran M, Tanveer A (2015) Decision support systems: creating value for marketing decisions in the pharmaceutical industry. Eur J Bus Innov Res 3:46–65
Juran JM (1992) Juran on quality by design: the new steps for planning quality into goods and services. Simon and Schuster
Kahn BK, Strong DM, Wang RY (2002) Information quality benchmarks: product and service performance. Commun ACM 45:184–192
Karr-Wisniewski P, Lu Y (2010) When more is too much: operationalizing technology overload and exploring its impact on knowledge worker productivity. Comput Hum Behav 26:1061–1072
Kelly D (2005) Business Intelligence: the smart way to track academic collections. Educ Q 28:48
Kock N (2000) Information overload and worker performance: a process-centered view. Knowl Process Manag 7:256
Lee AR, Son S-M, Kim KK (2016) Information and communication technology overload and social networking service fatigue: a stress perspective. Comput Hum Behav 55:51–61
Lee MR, Lan Y (2007) From Web 2.0 to conversational knowledge management: towards collaborative intelligence. J Entrep Res 2:47–62
Lee YW, Strong DM, Kahn BK, Wang RY (2002) AIMQ: a methodology for information quality assessment. Inf Manag 40:133–146
Lee Z, Lee J (2000) An ERP implementation case study from a knowledge transfer perspective. J Inf Technol 15:281–288
Letsholo RG, Pretorius MP (2016) Investigating managerial practices for data and information overload in decision making. J Contemp Manag 13:767–792
Li X, Qu H, Zhu Z, Han Y (2009) A systematic information collection method for business intelligence. In: International conference on electronic commerce and business intelligence, ECBI 2009. IEEE, pp 116–119
Marchi L (1993) I sistemi informativi aziendali. Giuffrè
Mauldin EG, Richtermeyer SB (2004) An analysis of ERP annual report disclosures. Int J Account Inf Syst 5:395–416. https://doi.org/10.1016/j.accinf.2004.04.005
McClave JT, Benson PG, Sincich T (1998) A first course in business statistics
Melinat P, Kreuzkam T, Stamer D (2014) Information overload: a systematic literature review. In: International conference on business informatics research. Springer, pp 72–86
Nelson RR, Todd PA, Wixom BH (2005) Antecedents of information and system quality: an empirical examination within the context of data warehousing. J Manag Inf Syst 21:199–235
Nita B (2015) Methodological issues of management reporting systems design. Res Pap Wroclaw Univ Econ Nauk Uniw Ekon We Wroclawiu
O'Brien JA, Marakas GM (2006) Management information systems. McGraw-Hill, Irwin
O'Reilly CA (1980) Individuals and information overload in organizations: is more necessarily better? Acad Manage J 23:684–696
Piattini MG, Calero C, Genero MF (2012) Information and database quality. Springer Science & Business Media
Poston R, Grabski S (2001) Financial impacts of enterprise resource planning implementations. Int J Account Inf Syst 2:271–294. https://doi.org/10.1016/S1467-0895(01)00024-0

Ranjan J (2009) Business intelligence: concepts, components, techniques and benefits. J Theor Appl Inf Technol 9:60–70

Reeves CA, Bednar DA (1994) Defining quality: alternatives and implications. Acad Manage Rev 19:419–445

Robey D, Ross JW, Boudreau M-C (2002) Learning to implement enterprise systems: an exploratory study of the dialectics of change. J Manag Inf Syst 19:17–46

Sangster A, Leech SA, Grabski S (2009) ERP implementations and their impact upon management accountants. JISTEM-J Inf Syst Technol Manag 6:125–142

Scapens RW, Jazayeri M (2003) ERP systems and management accounting change: opportunities or impacts? A research note. Eur Account Rev 12:201–233

Scheer A-W, Habermann F (2000) Enterprise resource planning: making ERP a success. Commun ACM 43:57–61

Shneiderman B (1996) The eyes have it: a task by data type taxonomy for information visualizations. In: Proceedings of IEEE symposium on visual languages, 1996. IEEE, pp 336–343

Smith G, Ariyachandra T, Frolick M (2012) Business intelligence in the bayou: recovering costs in the wake. Organ Appl Bus Intell Manag Emerg Trends Emerg Trends 29

Spira JB (2011) Overload! How too much information is hazardous to your organization. Wiley

Strong DM, Lee YW, Wang RY (1997) Data quality in context. Commun ACM 40:103–110

Stvilia B, Twidale MB, Smith LC, Gasser L (2005) Assessing information quality of a community-based encyclopedia. In: IQ

Swain MR, Haka SF (2000) Effects of information load on capital budgeting decisions. Behav Res Account 12:171

Xu H, Horn Nord J, Brown N, Daryl Nord G (2002) Data quality issues in implementing an ERP. Ind Manag Data Syst 102:47–58

Yang X, Procopiuc CM, Srivastava D (2009) Summarizing relational databases. Proc VLDB Endow 2:634–645

Zeithaml VA, Parasuraman A, Berry LL (1990) Delivering quality services. N Y Free Press Career Dev 11:63–64