ABSORPTION OF INFORMATION PROVIDED BY BUSINESS INTELLIGENCE SYSTEMS
The Effect of Information Quality on the Use of Information in Business Processes

Aleš Popovič[1], Pedro Simões Coelho[2] and Jurij Jaklič[1]
[1]*Department of Information Management, Faculty of Economics, University of Ljubljana*
Kardeljeva pl. 17, 1000 Ljubljana, Slovenia
[2]*Institute for Statistics and Information Management, Universidade Nova de Lisboa*
Campus de Campolide, 1070-312 Lisboa, Portugal

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Abstract: The fields of business intelligence and business intelligence systems have been gaining relative significance in the scientific area of decision support and decision support systems. In order to better understand mechanisms for providing benefits of business intelligence systems, this research establishes and empirically tests a model of business intelligence systems' maturity impact on the use of information in organizational operational and managerial business processes, where this effect is mediated by information quality. Based on empirical investigation from Slovenian medium and large-size organizations the proposed structural model has been analyzed. The findings suggest that business intelligence system maturity positively impacts both segments of information quality, yet the impact of business intelligence system maturity on information media quality is greater than the impact on content quality. Moreover, the impact of information content quality on the use of information is much larger than the impact of information media quality. Consequently, when introducing business intelligence systems organizations clearly need to focus more on information content quality issues than they do currently.

1 INTRODUCTION

For today's organizations, in order to succeed, it is important to understand how information technology can create substantial and sustainable competitive advantages. Peppard, Ward and Daniel (2007) suggest that "with their information technology investments, most organizations focus on implementing the technology rather than on realizing the expected business benefits". A similar pattern can be spotted in the field of business intelligence systems (Williams and Williams, 2007, Elbashir et al., 2008). This situation can be easily attributed to the lack of ability of organizations to view these investments in the context of the business value creation process, which is binding for organizations if they want benefits forthcoming.

The field of business intelligence shows very few empirical studies regarding the realization of benefits from business intelligence systems. Findings from Jourdan et al. (2008) suggest benefits derived from business intelligence systems have not been adequately researched and thus need further attention.

The quest for delivering business value via business intelligence systems can be seen as a matter of determining how an organization can use the information provided through business intelligence systems "to improve management processes (such as planning, controlling, measuring, monitoring, and/or changing) and/or to improve operational processes (such as sales, order processing, purchasing)" (Williams and Williams, 2007).

Decision-makers' information-processing characteristics contribute significantly in adopting business intelligence systems. The greater the capability of decision-makers to process the provided information, the higher the probability will be of the business intelligence systems being adopted. This all depends on the absorption capacity, which refers to the knowledge and ability of an organization to judge and process certain

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information in order to make as efficient as possible use of the information within the organization (Baldwin & Scott, 1987). It may be the case, especially for small companies, that an organization lacks the knowhow to process potentially valuable-information adequately (Frambach, 1993).

The purpose of this research is therefore to come up with a deeper understanding of the role of business intelligence systems for providing quality information and further on the impact of the information quality on the use of information in organizational business processes, i.e. on absorption of quality information.

The outline of the paper is as follows: In Section 2 we present our research model, Section 3 aims to present the methodological framework for the study, while Section 4 deals with the testing of the proposed research model and hypotheses. Section 5 concludes with a summary and a discussion of the main findings, limitations and direction for future work.

2 THE RESEARCH MODEL

Implementation of business intelligence systems first of all addresses information goals, namely providing high quality information for decision-makers. Similarly Brown (2005) argues the value of business intelligence systems is created by acting on the information delivered through these systems.

Assessment of an IT asset can be based upon a maturity model, also known as stages theory, not only to determine the current stage of implemented IT but also to show its next step (Nolan, 1979). There are many IT/IS maturity models dealing with different aspects of maturity, namely technological, organizational and process maturity. These maturity models are quite general and their focus is not on the key technological elements of business intelligence systems. Moreover, according to Becker et al. (2009) “maturity models inherently become obsolete because of changing conditions, technological progress or new scientific insights”. The fields of business intelligence and business intelligence systems are rapidly evolving thus requiring regular validation and constant changes of maturity models.

In the current business environment, there is no lack of business intelligence or business intelligence systems maturity models (Williams & Williams, 2007), yet they are relatively few compared to maturity models from other disciplines. What is more, none of the models found in the literature were empirically supported. Based on the reviewed business intelligence and business intelligence system maturity models we found no evidence of an agreement on the business intelligence systems’ maturity concept (Popovič, Coelho and Jaklič, 2009). However, we can derive two main emphasizes from the reviewed models. First, there is an awareness of the importance of integrating large amounts of data from disparate sources (Elbashir et al., 2008) and an awareness of the need to cleanse the data extracted from the sources (Bouzeghoub and Lenzerini, 2001) within the field of business intelligence systems. Second, organizations are focusing on technologies (e.g. querying, online analytical processing, reporting, data mining) for the analysis of business data integrated from heterogeneous source systems (Negash, 2004). On this basis, we propose the first hypothesis:

H1: Business intelligence system maturity is determined by data integration and analytics.

Petrini and Pozzebon (2009) suggest the role of business intelligence systems is to create an informational environment in which gathered operational data can be analyzed to provide quality information relevant to the decision-making process. Although the field of information quality evaluation has already been extensively researched (e.g. Slone, 2006, Lee et al., 2002), most of the proposed information quality frameworks don’t address the issue of information quality evaluation comprehensively enough. For evaluating information quality we adopted Eppler’s (2006) information quality framework since it provides one of the broadest and most thorough analyses of the information quality evaluation criteria. The framework in essence divides its criteria into two segments: a) criteria dealing with information content quality, which relates to actual information itself, and b) criteria addressing information media quality, which relates to whether delivery process and infrastructure are adequate in quality. Eppler (2006) further argues that technology mainly influences media quality and has limited possibilities of influencing content quality. Thus, we propose the concept of information quality as involving two dimensions that are both positively, yet differently affected by the maturity of business intelligence systems. In this context, hypotheses 2a, 2b and 2c are put forward:

H2a: Business intelligence system maturity has a positive impact on content quality.

H2b: Business intelligence system maturity has a positive impact on media quality.

H2c: Business intelligence system maturity has a different positive impact on content quality and media quality, with larger impact on media quality.

Mere availability of information does not guarantee the information's ultimate use (Diamantopoulos et al., 2003). The limited previous research suggests a positive relationship between information quality and information use (Low and Mohr, 2001, Deshpande and Zaltman, 1982), yet we are not aware of any previous study empirically analyzing separately the impact of content quality and media quality on the use of information. Moreover, while the use of information is closely linked to the value that the available information provides to knowledge workers for solving their decision problems content quality appears to be of greater importance than it is providing access to information. Thus we put forward hypotheses 3a, 3b and 3c:

H3a: Quality of information content has positive impact on the use of information.

H3b: Quality of information media has positive impact on the use of information.

H3c: Quality of information content and quality of information media have different positive impacts on the use of information.

3 METHODOLOGY

This study used a survey to obtain data measuring business intelligence systems maturity, participants' perceptions of information quality, and perception about the use of information within business processes. The questionnaire was developed by building on the previous theoretical basis in order to ensure content validity. Pre-testing was conducted using a focus group involving 3 academics interested in the field and 7 semi-structured interviews with selected CIOs who were not interviewed later. This was also used to assure face validity. We used a structured questionnaire with a combination of 7-point Likert scales and 7-point semantic differentials.

Based on the reviewed business intelligence and business intelligence systems' maturity models we modeled the business intelligence system maturity concept as a second-order construct formed by two first-order factors: data integration and analytics. The data integration construct is supported by the findings of Lenzerini (2002). Within the analytics construct we look at the different types of analyses the business intelligence system enables. We selected those indicators most used in previous works: paper reports (TDWI, 2005), ad-hoc reports (Claraview, 2005), online analytical processing ('OLAP') (Davenport and Harris, 2007), data mining (TDWI, 2005), dashboards, key performance indicators ('KPIs') and alerts (Davenport and Harris, 2007).

To measure information quality we adopted 11 previously validated information quality criteria indicators from the Eppler's framework (Eppler, 2006).

For measuring use of information in business processes we used indicators available in reviewed literature and those obtained from the pilot study. Davenport (1993) and Choo (1996) suggest available information in organizational processes pinpoints problems regarding process execution. Furthermore, information actively supports continuous process improvement programs (Davenport, 1993) and business process change initiatives (Davenport and Short, 2003).

The target population for this study were Slovenian medium and large size organizations (1,329). Empirical data for this research were collected by means of paper and Web-based survey. Questionnaires were addressed to CIOs and senior managers estimated as having adequate knowledge of business intelligence systems, the quality of available information for decision-making and the use of information in business processes. The final response rate was 13.6%.

4 RESULTS

Data analysis was carried out using a form of structural equation modelling ('SEM'). For the estimation of the model we employed SEM-PLS (Structural Equation Models by Partial Least Squares) (Ringle, Wende and Will, 2007), also known as PLS Path Modelling ('PLS').

Figure 1 shows the results of testing the measurement model in the final run. Without exception, latent variable composite reliabilities show a high internal consistency of indicators measuring each construct and thus confirming construct reliability. The average variance extracted ('AVE') demonstrates a convergent validity of the constructs. Reliability and convergent validity of the measurement model was also confirmed by computing standardized loadings for indicators and bootstrap *t*-statistics for their significance. All standardized loadings confirmed a high convergent validity of the measurement model.

To assess discriminant validity, the following two procedures were used: 1) a comparison of item cross loadings to construct correlations, and 2) determining whether each latent variable shares more variance with its own measurement variables or with other constructs. All the item loadings met the requirements of the first procedure in the assessment of discriminant validity and all the constructs showed evidence for acceptable validity.

A bootstrapping with 1,000 samples has been conducted to test the hypothesized relationships between the constructs. As shown in Figure 1, the standardized path coefficients range from 0.198 to 0.674 while the R^2 is moderate, i.e. between 0.205 and 0.349 (Chin, 1998), for all endogenous constructs. We can see that 30% of the variance in media quality is explained by the influence of business intelligence system maturity, while 20% of the variance in content quality is explained by the influence of business intelligence system maturity. Moreover, the influence of media quality and content quality explain about 35% of the variance in the use of information in business processes.

As indicated by the path loadings, business intelligence system maturity has significant direct and different positive influences on content quality ($\hat{\beta}$ = 0.453, $p< 0.001$) and media quality ($\hat{\beta}$ = 0.549, $p < 0.001$). The *t*-statistic for the difference of the two impacts is 2.2 with $p < 0.05$ hence confirming that the two hypothesized impacts are indeed different. These results thus confirm our theoretical expectation and provide support for *H2a*, *H2b*, and *H2c*. To derive additional relevant information, sub-dimensions of the second-order construct (business intelligence system maturity) were also examined. As evident from the path loadings of data integration and analytics, each of these two dimensions of business intelligence system maturity is significant ($p < 0.001$) and of moderate to high magnitude ($\hat{\beta}$ = 0.488 and $\hat{\beta}$ = 0.674), supporting *H1* as conceptualization of the dependent construct as a second-order structure.

Results also showed content quality ($\hat{\beta}$ = 0.440, $p < 0.001$) and media quality ($\hat{\beta}$ = 0.198, $p < 0.05$) have direct and different positive impact on the use of information, with the content quality impact on the use of information to be significantly larger than the one originated by media quality. The *t*-statistic for the difference of the two impacts is 2.14 with $p < 0.05$ thus confirming that the two hypothesized impacts are different. These results hence support *H3a*, *H3b*, and *H3c*.

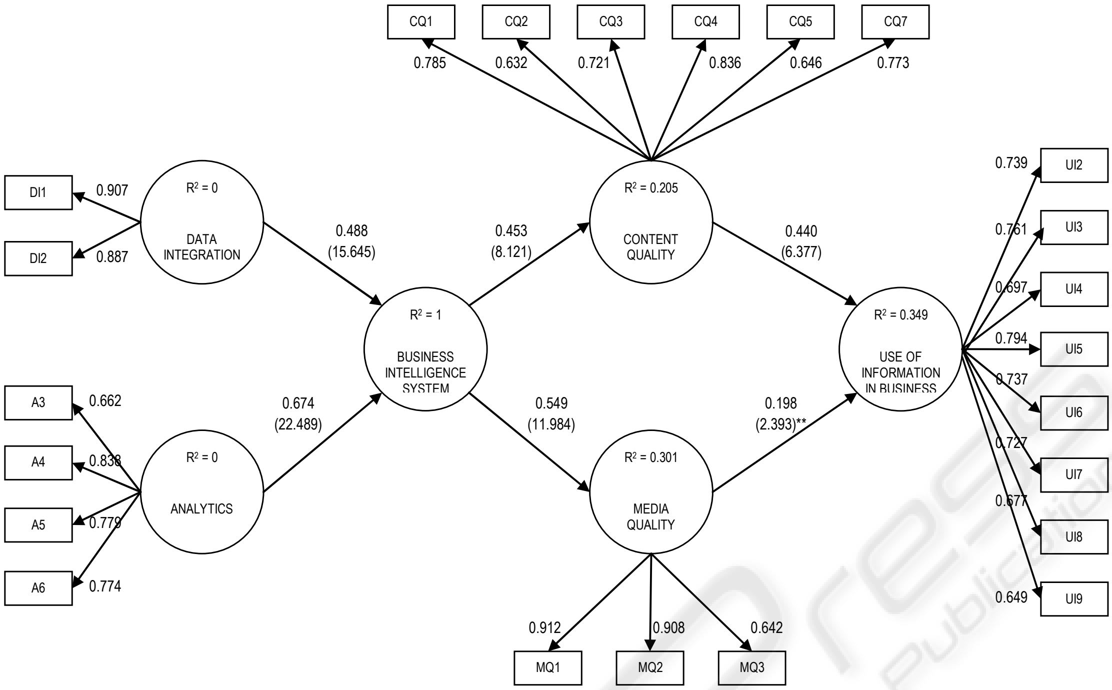
5 CONCLUSIONS AND LIMITATIONS

This study suggests business intelligence systems maturity positively impacts information quality. More precisely, results reveal that a higher level of business intelligence system maturity has a significant positive impact on both segments of information quality, namely information content quality and information media quality, as they were conceptualized in our model.

Even if both information quality segments are obviously addressed with the implementation of business intelligence systems, one may expect that projects dealing with implementation of business intelligence systems are focused more on issues related to the main information quality issues in knowledge-intensive activities, i.e. content quality issues. This means that the implementation of such systems should affect more content quality than media quality. The results show that the implementation of business intelligence systems indeed differently impacts the two dimensions of information quality: business intelligence systems maturity affects media quality more than content quality. It appears as organizations implementing business intelligence systems give less emphasis to the quality of information content and rather call attention to the information media quality. It seems that organizations avoid more demanding data management approaches that would lead to the higher content quality of the information provided by their business intelligence systems (Popovič et al., 2009).

Literature (e.g. Khalil and Elkordy, 2005) suggests that information of higher perceived quality will be used more frequently than will those of lower perceived quality. The results of this study conform to the above literature and additionally provide two important insights into the impact of the two information quality segments on the use of information as they were conceptualized in our model. First, considering the impacts of content quality and media quality on the use of information as proposed in the model it shows that both information quality segments have positive impact on the use of information. From the results it also appears that quality of information content is substantially more important to the use of information than it is the information media quality.

This is an interesting finding since it shows the gap between the media quality provided by business intelligence systems and the information quality needs of knowledge workers when using informa-



Note: All values significant at p<.001 level (N=181), except ** (significant at p<.05 level (N=181)). Values in parenthesis are bootstrap *t*-values.

Figure 1: Final baseline model of business intelligence system maturity impact on the use of information.

tion. While the implementation of business intelligence systems contributes above all to faster access to information, easier querying and analysis, and a higher level of interactivity, it is important to understand that the major problems of providing quality information for knowledge-intensive activities relate to information content quality, not media quality. Thus it is necessary to define as accurately as possible knowledge workers' needs. This is a difficult task due to the non-routine and creative nature of knowledge workers' work. However, contemporary managerial concepts, such as business performance management, enable better definition of information needs in managerial processes by connecting business strategies with business process management.

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

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