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The Impacts of ERP Integration on Information Quality

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Abstract

The paper aims at analyzing the relationship between the level of integration of the ERP system and the information quality perceived by managers due to direct and indirect factors. In the latter model, the information quality is affected by the presence of specific features of information flow, defined as the information processing capacity, the frequency of meeting, and the information sharing. To test the research model, a PLS-SEM analysis was applied to a survey conducted in the Italian setting. Empirical results show that the level of integration of the ERP system positively affects the latent variable (features of information flow) and that the features of information flow positively affect the perceived quality of information. Empirical results also suggest that the level of integration of ERP systems can positively and indirectly affect the information quality seen by managers, by the effect of the features of information flow. Managers can benefit from this study for supporting their decision to achieve an optimal level of integration of their ERP systems to enhance the information quality within the firm.

Keywords: Erp Systems; Erp Integration; Information Quality; Information Flow; Pls-Sem.

1. Introduction

Nowadays, managers can easily find and store information. On the other hand, this hyper-amount of data does not allow them 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 challenging to acquire and store a huge "quantity" of data and information. Their problem is instead of obtaining 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 in the current information economy where data, information, and knowledge are strategic for companies. Therefore, information systems play an increasingly significant role in managing data and information and for providing effective decision support to managers.

The present study deals precisely with these issues: the paper aims at analyzing the relationship between the level of integration of the ERP system and the information quality perceived by the manager, by identifying direct and indirect effects. To test the research model, a PLS-SEM analysis was applied to a survey in the Italian context. Empirical results show that the level of integration of the ERP system positively affects the latent variable, represented by a set of specific features of information flow, defined as information processing capacity, frequency of meeting, and information sharing. The remainder of the paper is organized as follows: Section 2 analyzes the literature review and lays down the research hypotheses; section 3 describes the research method, section 4 presents the research findings, and section 5 discusses results, limitations and possible future research developments.



2. Literature review and research hypotheses

2.1 ERP integration systems and features of information flow

ERP systems may affect the information flow, both positively and negatively. An ERP system, in fact, brings integration into the company and favors a real-time sharing of information. Therefore, on one side, it may allow a smooth flow of information across the company, and, on the other side, it may cause a real-time sharing of possible data entry mistakes, which would influence other business units [1]. However, literature widely recognizes ERP the potentials to improve the information flow, which mainly refer to a) the capacity to improve data management and to allow data integration and sharing [5]; b) the possibility to share consistent information across different functional areas [6]; c) the capacity to improve reliability, timeliness, comparability and relevance of information [7], [8]; d) the possibility to achieve flexible information flows [2].

These potentials may also affect the reporting system, which is an essential element of the information flow. In the absence of ERP systems, business units work in silos, each of them managing its data. ERP-implementing companies, instead, take advantage of data integration, which could affect the reporting system management. A study of the relationship between external reporting and management accounting, suggests that the information system integration, made possible by technology 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 support, they do not need to wait for the periodic reports produced by management accountants [9]. Even if this study was not specifically focused on ERP systems, another research focused on ERP systems proposes a similar reasoning, suggesting that the introduction of ERP systems have important opportunities and impacts on management accounting and internal reporting [10]. The effects of ERP on internal reporting have also been studied by Sangster et al. (2009) [11]; in this research, the authors found a slight decrease in the time spent on internal reporting by management accountants. Furthermore, they found that management accountants spend significantly less time in 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 previously [11].

One of the main reasons why ERP is reckoned as a means to improve information flow, is that its implementation often requires a preliminary Business Process Reengineering (BPR) [2], which allows firms to assess, revise and reorganize the internal processes. In the context of business process optimization, ERP systems are adopted to achieve flexible information flows, to obtain short planning cycles, availability of up-to-date information, more timely communications, and elimination of data redundancy. As a result, ERP systems improve information processing capacity, enhance organizational communications and data visibility [3] and increase the productivity of work processes [4].

The aim of this study is to examine whether ERP systems may affect the "information flow" of the company and if the level of ERP systems integration has some impacts on information quality. For "information flow," we refer to a set of features emerging from the literature, such as information processing capacity, communication, reporting, frequency of meeting, and information sharing. For the "level of ERP systems integration" we intend the number of ERP modules implemented and the number of external applications integrated with the ERP system. First ERP systems were developed with the aim of integrating the main business functions and of aligning the business processes to the ERP software [12], generating a seamless flow of information throughout the company [13], [14]. From the '90s on, vendors added further modules and functions to the basic modules of ERP, thus laying the bases for the "Extended ERPs" or ERP II [15]. Subsequently, the proliferation of the Internet 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). Literature shows that the increase of ERP integration brings many benefits to the companies: for example, fully integrated ERPs are more effective than ERPs not completely integrated, in satisfying the knowledge needs of a company [16], in allowing data integration and information sharing [17] and, thus, in improving the reporting quality [9]. Therefore, we formulate the first hypothesis as follows:



- Hp1: The level of integration of ERP systems affects the features of information flow.

2. 2 Features of information flow and information quality

Information quality has significant economic implications for a company because non-quality information generates costs. These costs mainly pertain to the waste of time for decision-makers, who try to find the most appropriate information for their needs. As a matter of fact, poor information quality forces decision-makers to interpret the inaccurate information, and inaccuracy may cause problems to the business activities [18]. Costs of non-quality information also consist of data correction, recovery of process failure, and other similar activities, which consume more computing resources than it 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 [19].

In this regard, the literature suggests that also information overload is one of the costs of poor information quality. In the presence of information overload, managers could be not able to effectively manage their decision-making process, as the information available are too much, or irrelevant. In these situations, managers are not able to prioritize their tasks, and thus, their decision-making process collapses [20]. Interestingly, some literature recognizes costs of information overload as similar to those of non-quality information; indeed, 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 coming from multiple sources on the same topic [18], [21]. When a manager receives (a lot of) irrelevant information, instead of (a few 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 for accomplishing their decision-making process and when they receive irrelevant instead of relevant information [20], [22]. Information overload often results from poor quality information, that is, uncertain, ambiguous, and complex information [23].

The link between information quality and information overload is also recognizable from the countermeasures suggested by some authors. For example, the study of Eppler and Mengis [24] proposes that, for avoiding information overload, companies should implement intelligent information management, e-tools, decision support systems, and information quality filters able to prioritize information and to reduce a wide set of alternatives to a more manageable size. This implies that improving some dimensions of information quality (such as relevancy, accessibility, credibility), information overload should 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 [25], [26]. Larkin and Simon [27] show that visualization techniques dramatically improve people capacity to recognize patterns, to distinguish various pieces of information, and to focus on the most relevant ones. The authors show that these systems allow people to process information like experts could, and the literature shows that experts are less subject to the information overload than novices, when facing the same volume of information [28], [29]. Taken together, these studies suggest that visualization is a possible countermeasure to information overload, as it increases the 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, also the reports would better signal the relevant information. As a confirm, the literature shows that information visualization techniques are able to improve the quality of information as they reduce information complexity and help to focus on the relevant details [30], [31].

Furthermore, another study states that to reduce information distortion and, thus, to improve the quality of information shared, it is necessary that information shared is as accurate as possible [32]. In other terms, 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: an effective information flow allows information system users to receive [33]: a) complete



information, that is the correct amount of information; b) information selected on the base of relevancy; c) timely information; d) up-to-dated information; e) information at the required time; f) accessible information.

Similarly, [34]– [36] emphasize the importance of information flow in improving the effectiveness of decision-making process. On this basis, we posit the following hypothesis:

- Hp2: Features of information flow affect the quality of information.

2. 3 ERP integration and information quality: direct effects

Some studies, which compare legacy systems with integrated ERP systems, confirm that ERP capacities could improve the data and information quality and counteract information overload and underload through the increase of system quality [37]. Integrated ERPs can also increase data quality, as they solve the typical problems of legacy systems, consisting in [17]: a) keeping the same data in different subsystems (i.e. in different sources); b) finding difficult and slow to access the data kept in another subsystem; c) a lack of communication capacity.

ERP systems aim at improving data accuracy and data management through a comprehensive enterprise relational database which allows sharing data and information inside the company [17]; therefore, it is plausible to think that the higher the ERP integration, the higher the information quality improvement. This is also confirmed by the literature, which shows that some of the main benefits of ERP adoption are the possibility to achieve a database integration which allows data to have the same meaning across the company, and the possibility to have an information system integration able to connect and coordinate business functions [38]. Furthermore, as suggested by Percin (2008) [16], although significant benefits are gained by an existing ERP system, a new, fully integrated ERP system could satisfy the knowledge requirements pertaining any business activity, including information quality, among the others. Therefore, we posit the following hypothesis:

- Hp3: The level of integration of ERP systems directly affects the information quality.

2. 4 ERP integration and information quality: indirect effects

On the basis of prior literature, we can deduce that an Information System based on an ERP system can play an important part in promoting information quality. As a matter of fact, from the literature analysis we find out that information quality could be favored by ERP systems as they allow the collection and integration of data in a single database [39], permit to share consistent information across different functional areas of a company, improve the reliability, timeliness, comparability, and relevance of accounting information for external and internal users [7]. Furthermore, they enhance the capacity to plan and manage the resources by reducing the time needed to perform managerial activities and, as a consequence, bringing benefits to the quality of data and control activities in general [40]. Moreover, when ERP systems meet the users' expectations, they improve job performance and increase job satisfaction [41].

Literature also shows that an integrated ERP avoids disorder in production planning, improves production capacity, and standardizes the order fulfillment process [42] by doing so, improving information sharing among the enterprise, which is one of the features of information flow.

- Hp4: The level of integration of ERP systems indirectly affects the information quality, through the features of information flow.

3. Research method

3. 1 Survey analysis

The survey results were analyzed through a Partial Least Squares-Structural Equation Modeling (PLS-SEM), applied to the research model. PLS-SEM is a method of modeling a causal network of latent variables, aimed at maximizing the explained variance of the endogenous latent variables [43]–[45]. The PLS-SEM provides



estimates of the relations between variables and constructs (measurement model) and among constructs (structural model) [46]. The use of this statistical model has been widely documented across some disciplines, such as strategic management [47], marketing [45], accounting [48], and information system research [49]. Prior studies that have used PLS-SEM have pointed out the strengths of this statistical approach. In particular, PLS-SEM is suitable for analyzing: 1) complex relationships with multiple dependent variables; 2) issues with a scarcity of prior theoretical literature; 3) small sample size; 4) non-normal data, and 5) formative measures of latent variables [49]. Furthermore, the PLS-SEM approach seems to be particularly useful in measuring the reflective relations between research constructs and variables, which are believed to reflect the unobserved construct [50]. The PLS-SEM analysis was conducted using the SmartPLS software package [49].

3.2 Sample selection and data collection

To test the hypotheses, we conduct 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 – are randomly selected from the LinkedIn social network database, since some scholars have recently stressed the relevance and widespread use of these social media applications [51]. The main aim of the survey is to test the research design and to elicit preliminary evidence from our study. As the empirical analysis is based on a survey, most of the research variables measure the managers' perception, which could be interpreted as managers' satisfaction with the survey issues [52]. We received back 79 answers, with a 26% rate of response.

A test on an early-late response has been conducted on the control variables gender and type of firm, to check for differences in the two groups following a wave analysis proposed by Rogelberg and Stanton [53]. The results of a two-sample t-test with equal variances show that the mean differences of the variables are not statistically significant, therefore the hypothesis of bias between early and late respondents in the surveyed sample can be rejected.

3.3 Variable measurement

Surveys are useful to define the research and control variables. In our study, the survey allows us to detect the ERP integration: we assign value 0 if the respondent does not adopt ERP, value 1 if respondent adopts ERP with 1 module, value 2 if he/she adopts ERP with 2 modules, and so forth, till 13, if the respondent adopts ERP with 13 modules, which is the maximum value registered in the survey. Concerning the features of information flow (latent variable), we use the following research variables: Information Processing Capacity, Frequency of Meeting and the Information Sharing.

With reference to the area of Information Processing Capacity, we use the following items: a) 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); b) 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); c) system reliability (the survey question is "What is your perception of the capacity of information system to address the right choice to the right person at the right moment?" 1 very low, ..., 7 very high).

With regard to the area of Information Sharing, we consider the following items: a) satisfaction on the sharing of information with colleagues of the same hierarchical level (the survey question is "What is your satisfaction on the information sharing with colleagues of the same hierarchical level?" 1 very low, ..., 7 very high); b) satisfaction on the sharing of information with colleagues of higher hierarchical levels (the survey question is "What is your satisfaction on the information sharing with colleagues of higher hierarchical levels?" 1 very low, ..., 7 very high).

With regard to the area of Frequency of Meeting, the items are a) frequency of meetings with colleagues of the same hierarchical level (the survey question is "How often do you have meeting with colleagues of the same hierarchical level?" 1 very rarely, ..., 7 very often); b) frequency of meetings with colleagues of higher hierarchical

levels (the survey question is "How often do you have meeting with colleagues which belong to higher hierarchical levels?" 1 very rarely, ..., 7 very often).

To create the following research variables: Information Processing Capacity, Frequency of Meeting and Information Sharing, we carried out a principal component analysis, which 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 [54]. After that, we created the research variables, by using the mean value scores of items (see Tables 1a, 1b, 2a, 2b, 3a and 3b).

Table 1a – Factor analysis for the information processing capacity research variable (part 1)

| Item | Factor Loading | Communalit y | Eigen Value |
|--------------------|----------------|--------------|-------------|
| Data Accuracy | 0,912 | 0,832 | 2,363 |
| Timeliness of Data | 0,897 | 0,804 | 0,398 |
| System Reliability | 0,853 | 0,727 | 0,239 |

Table 1b – Factor analysis for the information processing capacity research variable (part 2)

| Item | % of variance | Cronbach's alpha | Bartlett's sphericity test | KMO |
|--------------------|---------------|------------------|----------------------------|-------|
| Data Accuracy | 78,754 | 0,865 | Chi2 = 113,570 | 0,719 |
| Timeliness of Data | 13,263 | | p-value = 0,000*** | |
| System Reliability | 7,983 | | | |

*, **, *** indicate a significance degree between 0,10 and 0,05, 0,05 and 0,01, and 001 and 0, respectively.

We also use another research variable that measures the perception of respondents about information quality. This variable is called Perceived Information Quality (the survey question is "In which measure do you perceive that the amount of the information that you receive is appropriate to allow you to optimally execute your tasks?" 1 very low, ..., 7 very high).

Control variables regard either respondents' features or firms' features. About the first, the control variable is the 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 a responsibility of accounting information system, 5 if the respondent is Chief Technology Officer and 6 if the respondent is a Chief Financial Officer). About the second, the control variable is Type of firm (1 if the firm is listed, 2 if the firm is no-listed, 3 if the firm is no-profit one and 4 if the firm is a public one).

Table 2a – Factor analysis for the information sharing research variable (part 1)

| Item | Factor Loading | Communalit y | Eigen value |
|---|----------------|--------------|-------------|
| Satisfaction with the sharing of information with colleagues at the same hierarchical level | 0,868 | 0,754 | 1,508 |

| | | | |
|--|-------|-------|-------|
| Satisfaction with the sharing of information with colleagues at higher hierarchical levels | 0,868 | 0,754 | 0,492 |
|--|-------|-------|-------|

Table 2b – Factor analysis for the information sharing research variable (part 2)

| Item | % of variance | Cronbach's alpha | Bartlett's sphericity test | KMO |
|---|---------------|------------------|-------------------------------------|-----|
| Satisfaction with the sharing of information with colleagues at the same hierarchical level | 75,412 | 0,674 | Chi2 = 22,860 p-value = 0,000*** | 0,5 |
| Satisfaction with the sharing of information with colleagues at higher hierarchical levels | 24,588 | | | |

*, **, *** indicate a significance degree between 0,10 and 0,05, 0,05 and 0,01, and 0,01 and 0, respectively.

Table 3a – Factor analysis for the frequency of meeting research variable (part 1)

| Item | Factor Loading | Communalit y | Eigen value |
|--|----------------|--------------|-------------|
| Frequency of meetings with colleagues at the same hierarchical level | 0,898 | 0,807 | 1,615 |
| Frequency of meetings with colleagues at higher hierarchical levels | 0,898 | 0,807 | 0,385 |

Table 3b – Factor analysis for the frequency of meeting research variable (part 2)

| Item | % of variance | Cronbach's alpha | Bartlett's sphericity test | KMO |
|--|---------------|------------------|-------------------------------------|-----|
| Frequency of meetings with colleagues at the same hierarchical level | 80,727 | 0,761 | Chi2 = 36,281 p-value = 0,000*** | 0,5 |
| Frequency of meetings with colleagues at higher hierarchical levels | 19,273 | | | |

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

Finally, we standardized each research variable, and we substituted missing values with the mean or the mode of the series.

4. Research findings

The PLS-SEM approach requires assessing the reliability and validity of both the outer (measurement model) and the inner (structural) model [55]. This analysis was performed for the whole dataset of respondents and for the other two datasets (controllers dataset and financial accountants dataset). To assess the outer model, the following measures were evaluated: 1) composite reliability (internal consistency reliability); 2) the factor loading for each indicator included in the latent variable, and 3) the cross-validated commonality [56]. As shown in Table

4, the composite reliability values and Cronbach's alpha of features of information flow achieve satisfactory levels for each dataset (> 0.7) [57].

Table 4 – Reliability and validity of constructs and the goodness-of-fit of the structural model

| Research variable | AVE (Average Variance Extracted) | Composite Reliability | Chronbach's Alpha |
|------------------------------|-------------------------------------|-----------------------|-------------------|
| Features of information flow | 0,722 | 0,886 | 0,810 |

The convergent validity for the latent construct was measured by the Average Variance Extracted (AVE). As shown by Götz et al. (2010) [58], AVE for the latent construct should be higher than 0,50. Therefore, it is possible to conclude that the quality of the outer model is satisfactory. The empirical results of PLS-SEM analysis are reported in Table 5 and Figure 1.

Table 5 – SEM-PLS results

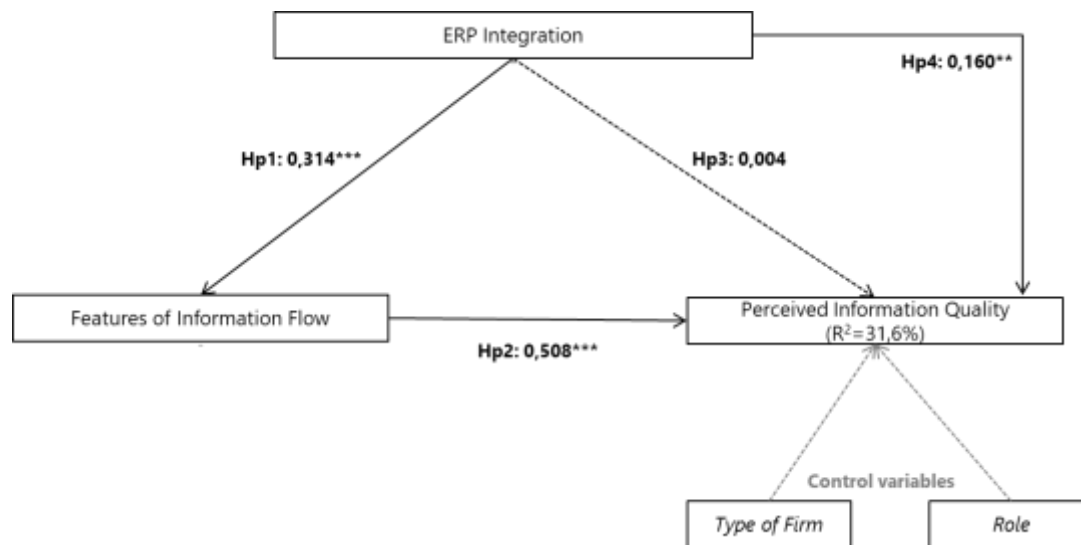
| General model | n = 79 |
|---|---|
| Variable (Y) | R square |
| <i>Perceived Information Quality</i> | 31.6% |
| | Direct Path Coefficient (P-value) |
| <i>ERP integration → Features of Information Flow</i> | 0,314 (0,001***) |
| <i>Features of Information Flow → Perceived Information Quality</i> | 0,508 (0,000***) |
| <i>ERP integration → Perceived Information Quality</i> | 0,004 (0,970) |
| <i>Type of Firms → Perceived Information Quality</i> | -0,001 (0,994) |
| <i>Role → Perceived Information Quality</i> | 0,162 (0,108) |
| | Indirect Path Coefficient (P-value) |
| <i>ERP integration → Perceived Information Quality</i> | 0,160 (0,011**) |

*, **, *** indicate a significance degree between 0,10 and 0,05, 0,05 and 0,01, and 0,01 and 0, respectively.

Table 5 shows regression weights for the path analysis, with direct and indirect effects, whereas Figure

1 summarizes the research model and the direct and indirect path coefficients.

Figure 1 – Path analysis



In particular, PLS-SEM analysis shows that the level of Integration of ERP systems positively affects the latent variable (features of information flow). Thus, the HP1 is confirmed (the level of integration of ERP systems affects the features of information flow). Furthermore, the HP2 is also confirmed (Features of information flow affects the quality of information). As a matter of fact, PLS-SEM results show that features of information flow positively affect the perceived quality of information. On the other hand, the Hp3 is not confirmed (The level of integration of ERP systems directly affects the information quality). Finally, the Hp4 is confirmed (The level of integration of ERP systems indirectly affects the information quality, through the features of information flow). Indeed, results demonstrate that the level of integration of ERP systems can positively and indirectly affect the information quality perceived by respondents. This effect is possible through the features of information flow composed of the following research variables: information processing capacity, frequency of meeting and sharing of information.

5. Discussion and conclusions

Empirical results of this study show interesting insights on the relationship between the level of integration of ERP system and information quality. They show that the level of ERP systems integration may directly and indirectly influence the information quality perceived by managers and that this quality is affected by some specific features of information flow – information processing capacity, frequency of meeting, and information sharing. From a theoretical standpoint, this study contributes to the literature on information quality and accounting information system.

First, the results suggest that higher ERP integration leads to greater influence on the features of information flow. This result is in line with that part of the literature which found several potentials of ERP system, such as a) the capacity to improve data management and to allow data integration and sharing [5]; b) the possibility to share consistent information across different functional areas [6]; c) the capacity to improve reliability, timeliness, comparability, and relevance of information [7], [8]; d) the possibility to achieve flexible information flows [2].

Second, this research shows that better quality in the features of information flow positively affects the information quality perceived by managers. These results are supported by that part of the literature, which maintains that information shared must be as accurate as possible for reducing information distortion and, thus, for improving information quality [32].

Third, this study demonstrates that a higher level of ERP integration indirectly leads to a higher level of perceived information quality, through the improvements that it brings on the features of information flow. On the other

hand, the direct relationship between ERP integration and information quality is not supported. This is particularly interesting as it allows to point out that managers perception of information quality can be directly affected by the features of information flow, thereby opening interesting research avenues on the mediating role played by these features in the relationship between ERP integration and information quality.

Managers can benefit from this study since they can set up the level of integration of their ERP systems with the aim to enhance the information quality within their company. However, some limitations of this study have to be pointed out; first, the choice of the manager sample is not based on the industry; second, the number of observations is not big enough, and the perception of respondents about information quality may depend on several endogenous factors, such as the size of the company, the experience of the interviewees and their role. Future research can be addressed to apply the same research model specifically on Chief Information Officers (CIOs), who are professional figures mainly involved in the information flow issues. Further studies can be focused on the mediating role of the features of information flow on the relationship between the level of ERP integration and the information quality. Furthermore, it could be interesting to analyze other antecedents which may affect the information quality perceived by managers, such as the adoption of a Business Intelligence system and the combined adoption of Business Intelligence and ERP systems.

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