INFORMATION QUALITY INDICATORS AND THEIR USE IN INTEGRATED MANAGEMENT SYSTEM IMPLEMENTATIONS: A CASE STUDY

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Abstract:

The implementation of an integrated management system impacts on an organization in several dimensions: from organizational culture and climate changes to relationship changes with suppliers and clients. Broadening the group of suppliers and clients presupposes the availability of reliable information and the existence of business partners with access to such information. This paper highlights the readiness of reliable information via information quality indicators in integrated management system implementations.

Based on the theories of information quality elaborated by Huang, Lee and Wang (1999) and information quality assessment by Lee et al. (2002), this work aims at presenting a methodology for the assessment of integrated management system implementation success based on the use of information quality metrics or indicators. This study was guided by the following research question: does the assessment of success in the cycles of integrated

management systems implementation, with the use of information quality indicators, help the cyclic implementation process?

The case study described herein shows the use of the proposed methodology for an organization that finished the first cycle of an integrated management system implementation and that is currently studying the beginning of the second cycle. In this case study, information quality metrics related to the financial-accounting information were defined, and the phases that preceded and followed the first cycle of implementation were considered. The results for the studied organization are described; they highlight the easy understanding of the methodology, among other positive factors.

Keywords: information quality, quality assessment, integrated management systems, ERP systems, information system success

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1 Introduction

The implementation of integrated management systems presents challenges that involve different external and internal factors to the organization. Its study has been moving forward as new generations of integrated systems are developed, a process that started from the first of them represented by ERP (Enterprise Resource Planning) systems in the nineties, discussed by Manetti (2001) and Willis, Willis-Brown and McMillan (2001). Searching for a better insertion in their value chain, organizations that began the assimilation of integrating technologies with the implementation of ERP systems have been turning their attention to other tools, like SCM (Supply Chain Management) systems, CRM (Customer Relationship Management) systems and other systems, which intensively use the Internet and its communication infrastructure (James and Wolf, 2000; Brignall and Ballantine, 2004).

An integrated management system manages and integrates business processes in a horizontal way that surpasses the borders of the functional organization, demanding investments that vary from hundreds of thousands to millions of dollars.

A problem in the implementation of software packages is the alignment among the functionalities offered by the package and the functionalities required by the organization, a problem that was studied by Davenport (1998), by Scheer and Haberman (2000) and by Gattiker and Goodhue (2004).

Some organizations adapt the software to their operations, accomplishing different customization levels. The results of this decision imply in high consumption of resources, mainly when periodical changes in the packages occur (technological adaptations, inclusion of new functionalities, and so forth). Other organizations decide to implement, together with the package, significant organizational and process changes.

Beyond those internal factors to the organization, the implementation project of such a system is surrounded by external competitive pressures and by constant evolutions of information technology.

This brief presentation about the internal and external challenges in the management of the integrated management systems implementation project is good to outline the context of this study, whose focus, should be emphasized, is to help the management of the

implementation process by introducing performance indicators that measure local and restricted impacts directly related to the global impacts promoted by the implementation.

Based on the theoretical framework proposed by Huang, Lee and Wang (1999) and by Lee et al. (2002), this work has the main objective of presenting a model of assessment of implementation success based on the use of metrics or indicators of information quality that intends to contribute to the cyclic integrated management systems implementation process. This study was guided by the research question: does the assessment of success in the cycles of integrated management systems implementation, with the use of information quality indicators, help the cyclic implementation process?

2 Methodology

This work is an exploratory case study. According to Yin (2001), a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. It is exploratory because it aims to guide the development of research questions and hypotheses.

The case study was performed for the employment analysis of the model of success assessment in the first implementation cycle of an integrated management system in a medium-sized Brazilian organization. The chosen organization is a family firm whose annual revenue is about 22 million dollars. It has finished the first cycle of its implementation process, on which about one hundred thousand dollars were spent. After nearly one year, when the case study was applied, the organization had begun to prepare the second cycle of implementation. Interviews and questionnaires were applied to gather quantitative and qualitative data. The results of this work are obviously limited to the researched universe.

3 Theoretical Framework

3.1 Cyclic vision of the integrated management system implementation process

According to the model of Esteves, Carvalho and Santos (2000), adapted in Gonçalves and Quintana (2001), the implementation process is composed of nine phases. Such phases contemplate the decision of adoption of the ERP system and the selection of the product (phases 1 and 2); the selection of the implementation partner (phase 3); the definition of the implementation project (phase 4); the initial implementation (phase 5); the use of the system (phase 6); the implementation of improvements (phase 7); the evolution (phase 8); and the

retirement (phase 9). Phase 5 corresponds to four sub-phases adapted from the model proposed by Bancroft, Seip and Sprengel (1998): the discovering of the current situation (as-is picture); the definition of the desired situation (to-be picture); the configuration (parameterization, customization and tests); and the beginning of the operation (go-live).

Phases 6, 7 and 8 can occur in a cyclic way, involving several stages according to the selected option. In general, they imply implementation of new modules or incremental changes occurring due to the evolution in the usage of the modules that had already been implemented. The evolution phase can mean the revision of business processes and the implementation of additional modules and/or complementary systems.

Souza's model of ERP system implementation (Souza, 2000) presents three main phases (Figure 1). The first phase contemplates the implementation decision, the choice of the vendor and the planning of the implementation. Second and third phases comprise the implementation of the ERP system modules and system use. "Both occur in successive iterations, many times simultaneously. Each of these iterations represents an implementation stage that drives, at its end, to a new phase in the use of the system where more functions are implemented and integrated" (Souza, 2000, p. 27).
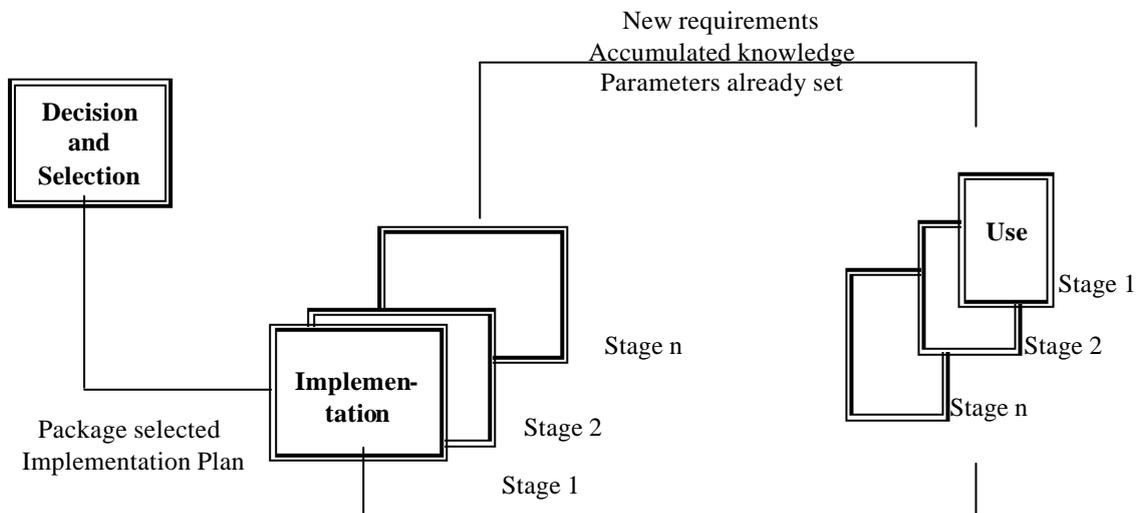

Figure 1 - Phases of the integrated management system implementation process according to Souza's model (2000).

Both models presented herein treat the implementation process as a cyclic process. Esteves, Carvalho and Santos (2000) decompose the cycle in use (phase 6), improvements implementation (phase 7) and evolution (phase 8). Souza (2000) considers that evolution occurs in two stages: implementation and use.

The concept of cyclic evolution reaffirms the applicability of the proposed model of success assessment based on information quality. In both models, the binomial implementation-use admits cycles of gradual implementation and continuous improvements. Continuous improvements were also studied by Nicolaou (2004) in the context of post-implementation review.

The use of information quality metrics is particularly useful in the control of those cycles. The idea is to measure the quality level of the information available in the system after each implementation-use cycle. The result of this assessment will be of major importance for the design of the new implementation-use cycle, because it will highlight where less quality exists, and consequently where the efforts should be concentrated on the process of cyclic incremental improvement.

3.2 Use of information quality indicators in the study of integrated management system implementation success

According to Davenport (1998), Willis, Willis-Brown and McMillan (2001) and Stair and Reynolds (2002), the benefits of the integrated management system implementation, particularly of an ERP system can be associated to the business process reengineering due to processes integration and standardization; to the substitution of inefficient processes, to the improvement of processes and to the implementation of new processes. The authors also emphasize that ERP systems provide the integration of information, improving information visibility and favoring its intra-organizational flow. The readiness of information with greater quality allows the centralization of functions, such as accounting and payrolls; and allows improvements in the decision-making process yielding to a more agile and flexible organization.

Table 1 brings a summary of positive impacts reported in recent Brazilian publications based on case studies about ERP system implementations.

As can be observed in Table 1, there are several mentions to impacts of ERP system implementation in the perspective of the quality of information. The focus of this work is the analysis under this perspective. Other perspectives of ERP system implementation success analysis were studied by Poston and Grabski (2001), Kawalek and Wood-Harper (2002), and Gattiker and Goodhue (2004).

3.3 Huang, Lee and Wang's information quality model

In this work, the model of implementation success assessment is built on the conceptual information quality model of Huang, Lee and Wang (1999, p. 33). The model, defines information quality based on two macro-dimensions: the first contains objective or intrinsic dimensions, and the second contains subjective dimensions that are related to usage and refers to perceived information quality.

The model proposed herein uses the empirical approach of analysis that prioritizes consumer viewpoint, which is quality as the extent it fits to use. Three analysis categories were applied, and only one of them, the Intrinsic Category, contained objective dimensions, the other two, Contextual and Accessibility Categories, contained subjective dimensions related to use.

Intrinsic category

The intrinsic category contains dimensions related to the internal quality of information. Intrinsic quality information dimensions assess the conformity between the vision of the real world obtained through direct observation and the vision of the real world inferred through its representation contained in the information system. Therefore, information with intrinsic quality should minimize imprecision, be objective and correct. Its dimensions are accuracy, objectivity, believability, and reputation.

Author	Impacts on Informational and Processes Reorganization	Impacts on Information Quality
Cardoso (2000) – Case study about the implementation and use of an ERP system as an instrument for financial management	- processes integration and standardization among different units of the organization (p. 174). - substitution of different processes for common processes to all the units (p. 200).	- it has identified users' satisfaction related to the readiness of information (p. 153). - users' satisfaction related to the accuracy (p. 163), usefulness (p. 164), conciseness (p. 165), relevance, ease of understanding, consistency and contents of information (p. 167-169).
Souza (2000) – Multi-case study about ERP system implementations accomplished in eight organizations.	- the integration among the activities allows the "elimination of mistakes and inefficiencies that can be hidden within the departments" (p. 244).	- activities linked on-line allow "information generated by those activities [pass] to be used immediately as entrances for the following activities in a process" (p. 244). - "improvement in the quality and in the precision of the available information" (p. 244). - "reduction of the necessary time for the closing of the accounting" (p. 246).
Saccol, Macadar and Soares (2001) – Multi-case study about the use of ERP systems in two organizations.	- it facilitated "larger participation in problem solution" (p. 5). - synchronization among operations and "the accounting records and controls" (p. 6).	- "it unified the information" avoiding "mistakes due to contradictory data" (p. 5). - In one of the cases, "access to the data is faster, information are more detailed and more reliable..." (p. 5). - "integration of organizational information" (p. 7). - it increased the "concern with the truthfulness and precision of data" (p. 8). - "facilitated access to information" and readiness of "information in real time" (p. 8-9).
Dias, Castro and Medeiros (2002) – Case study about the implementation and use of the Materials module of an ERP system.		- readiness of safer information and instantaneous updates" (p. 6). - readiness of "more consistent data" (p. 7). - readiness of information "in real time" (p. 9).
Sünderman (2004) – Case study about the implementation of an ERP system in one organization	- "the system changed the way the job is executed and controlled" (p. 89).	- the system changed the scope and volume of information entered in many business processes (p. 93-96).

Table 1 – Positive impacts of integrated management system implementation.

The most common reasons of problems in intrinsic category of information quality are multiple sources of the same data and judgments involved in data production. In the first case, the existence of more than one data source increases the possibility of divergences among them. In the second case, judgments and subjectivity in data production, such as, coded or interpretated data, results in data of questionable believability and reputation.

Over time, the lack of intrinsic quality, translated by the accumulation of divergent or subjective data, leads to data being viewed as having little added value to the organization, thus resulting in its reduced use.

Contextual category

Contextual category is based on quality aspects within the context of the task in which information is used. Its dimensions are: relevancy, value-added, timeliness, completeness, and amount of information. The lack of contextual quality is characterized, for example, by the generation of incomplete information, by information inadequately defined in its level of detail, or information delivered with a delay.

The main sources of contextual problems are: operational data production problems, changing data users' requirements and distributed computing. Operational data production problems happen when users do not supply complete data. This situation is very common when filling the data is not mandatory, given a certain perspective of the business. Changes in data users' requirements are characterized when they need new data or need to aggregate data based on attributes that do not exist in the data. Finally, the use of different technologies and heterogeneous systems for data management many times impedes a consistent data representation.

The three presented causes generate incomplete or inconsistent data, thus leading to data viewed as having little added value to the organization, and resulting in its reduced use.

Accessibility category

The accessibility category contemplates dimensions related to easiness of access to information and to the security issues involved in this access. The easiness of access embraces dimensions initially classified as representational and that reveal the easiness of understanding and the conciseness and consistency of information representation.

Metrics for information quality analysis

To determine whether information possesses quality it is necessary to use a measure system as basis. However, there is no universal system of measures for information quality assessment. Huang, Lee and Wang (1999, p. 61) present a model to measure subjective metrics of information quality. The most common way for this assessment is the use of questionnaires where people's perception of quality, based on their intuition and previous experiences, is collected.

4 Indicators of the information quality-based model for success assessment in the cycles of implementation

This model consists on the elaboration of questionnaires related to information quality assessment that should be applied in the posterior stages to each of the implementation-use

cycles. It is expected that the application of those questionnaires should assess the success of the recently finished cycle, and should help drive the incremental improvements that would be necessary in the next cycles.

The elaboration of the questionnaires follows two basic guidelines. Firstly, they should measure the information quality attributes defined in Huang, Lee and Wang's model. In second place, measures should be made locally, with the focus on users that directly access the system. Their operational requirements must be considered, such as time saving, better and more abundant information requirements, and the needs associated to decision-making. According to Ward and Peppard (2002) (Figure 2), local impact measures are accomplished more easily.
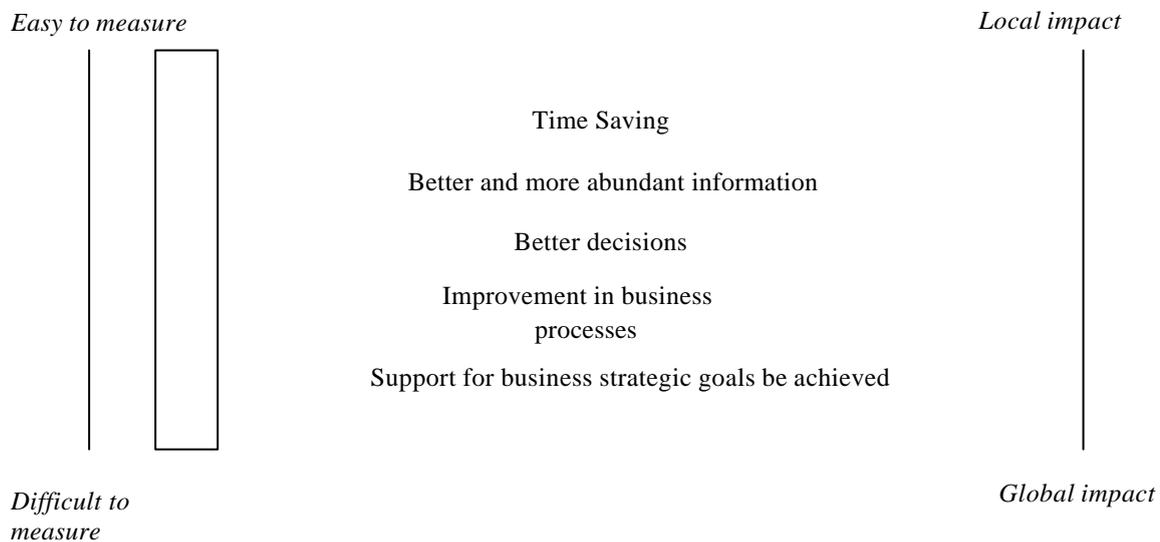

Easy to measure   *Local impact*

Time Saving

Better and more abundant information

Better decisions

Improvement in business
processes

Support for business strategic goals be achieved

*Difficult to
measure*   *Global impact*

Figure 2 – Comparison between the types of impacts and easiness of measurement.

The model allows the use of different questionnaires, examples of which were discussed in Gonçalves, Canhette and Clara (2003). This work, however, presents the questionnaires specially elaborated for the exploration of the users' viewpoint related to financial-accounting information quality. In order to measure user perceived quality, the questionnaires should be applied at the end of each implementation-use cycle. Each question applied considers the situation before and after the recently finished cycle.

Table 2 presents the issues related to information quality measurement for dimensions of the intrinsic information quality category. Questions 1(a), 1(b), 1(c) are applied in two moments: one refers to the situation before the recently finished cycle (were there?) and the other refers to the situation after the cycle is finished (are there?).

Question	Possible Answers
1(a) Were/Are there stages for re-checking data related to purchasing invoices? 1(b) Were/Are there stages for re-checking data related to sales invoices? 1(c) Were/Are there stages for re-checking data related to cash flow?	1. I totally disagree 2. I disagree partially 3. Neutral or Indifferent 4. I agree partially 5. I totally agree

Table 2: Questionnaire about information quality for the dimensions of the intrinsic category.

Table 3 presents the issues related to information quality measurement for dimensions of the contextual category. Questions 2(a) to 2(d) and 4(a) to 4(d) are applied in two moments: one refers to the situation before the recently finished cycle (was it?) and the other refers to the situation after the cycle is finished (is it?). Question 3 is unfolded in: (i) how many days have elapsed (before) and (ii) how many days elapse (after).

Question	Possible Answers
2(a) which was/is the periodicity of information consolidation about revenue (across branches and head office)? 2(b) which was/is the periodicity of information consolidation about cash flow? 2(c) which was/is the periodicity of information consolidation about markup for product line? 2(d) which was/is the periodicity of information consolidation about costs of the products?	1. Daily 2. Weekly 3. Monthly 4. Quarterly 5. Half-yearly
3) how many days elapsed/elapse between the closing of the calendar month and the accounting closing of the month?	1. 1 2. between 2 and 3 3. between 4 and 8 4. between 8 and 16 5. more than 16
4(a) was/is the amount of historical information available insufficient for decision making about receivables? 4(b) was/is the amount of historical information available insufficient for decision making about accounts payable? 4(c) was/is the amount of historical information available insufficient for decision making about accounting? 4(d) was/is the amount of historical information available insufficient for decision making about costs?	1. I totally disagree 2. I disagree partially 3. Neutral or Indifferent 4. I agree partially 5. I totally agree

Table 3: Questionnaire about information quality for the dimensions of the contextual category.

Table 4 presents the issues related to information quality measurement for dimensions of the accessibility category. Questions 5(a) to 5(d) are applied in two moments: one refers to the situation before the recently finished cycle (wasn't there?) and the other refers to the situation after the cycle is finished (isn't there?). Questions 6(a) to 6(d) are unfolded in: (i) was it easy to understand? (before) and (ii) is it easy to understand? (after).

Question	Possible Answers
5(a) wasn't/isn't there access control to information about receivables using user authentication and/or passwords? 5(b) wasn't/isn't there access control to information about accounts payable using user authentication and/or passwords? 5(c) wasn't/isn't there access control to information about accounting using user authentication and/or passwords? 5(d) wasn't/isn't there access control to information about costs using user authentication and/or passwords?	1. I totally disagree 2. I disagree partially 3. Neutral or Indifferent 4. I agree partially 5. I totally agree
6(a) wasn't/isn't the format of information presentation in the screen easy to understand in the modules about receivables? 6(b) wasn't/isn't the format of information presentation in the screen easy to understand in the modules about accounts payable? 6(c) wasn't/isn't the format of information presentation in the screen easy to understand in the modules about accounting? 6(d) wasn't/isn't the format of information presentation in the screen easy to understand in the modules about costs?	1. I totally disagree 2. I disagree partially 3. Neutral or Indifferent 4. I agree partially 5. I totally agree

Table 4: Questionnaire about information quality for the dimensions of the accessibility category

5 Case Study

This section describes the results obtained from the application of questionnaires for measuring perceived information quality in two moments: before and after the first cycle of the integrated management system implementation in a medium-sized organization in the nutrition industry.

One of the major factors in the selection of the organization for the case study was the magnitude of investments in the ERP system. The investment corresponded approximately to hundreds of thousand of dollars, representing a minimum investment volume in such systems, to be used in other comparative studies. Another factor was the readiness to obtain authorization for applying the questionnaires and the readiness of data, although under the restriction of non-identification of the organization.

The organization, from now on called Alpha, has acted in the nutrition industry for more than four decades. Its product lines include morning meals and snacks for kids, and it is a sales leader in its main market product. The organization is located in the Southeast of Brazil and is composed by two factories and branches located in that same area. Its annual revenue in 2000 was approximately 44 million Reais (Brazilian currency). The organization is a family firm and its chief executive officer is its founder. Other family members occupy positions in the management board.

Prior to the ERP system implementation, the organization used IT solutions provided by a small bureau, including the following modules: Receivables (partially integrated),

Accounts Payable (isolated) and Accounting (isolated). Cost Procedures were not part of the computerized solution. The modules stored their data in Cobol data files, with the exception of Accounts Payable, which used an SQL Server database manager.

In spite of being partially computerized, the systems used by the organization were not integrated, they did not possess appropriate documentation and they did not accompany the growth of the company appropriately. These deficiencies together with new needs such as consolidated information, process integration and agility in the assessment of results showed that the company's systems were no longer adequate.

Due to those needs, IT management, with total support from the CEO, had the initiative of making a cost/benefit study in order to select an integrated solution (an ERP system) that contemplated all the necessary functionalities to the management of the organization. After a survey of several existing ERP systems in the market – their adherence to the processes in the organization analyzed – it was verified that all the products would require some degree of customizations. The major points taken into consideration in the choice of the ERP system were: customers' profile of the ERP system users, implementation and training costs, and the availability of good professionals who were able to implement the solution.

Having defined to the implementation of the ERP system provided by Datasul, with its Progress database management system, the implementation began with modules for accounting, finance, materials, manufacturing, human resources and payroll. Integration among the two factories and the branches was also achieved.

Application of questionnaires with information quality metrics

Questionnaires aimed at obtaining perceived information quality metrics before and after the implementation of the integrated management system were applied to different groups of users and were answered in a simple and direct way.

Basically, two groups of respondents were chosen: one group with the personnel responsible for the financial, accounting and costs areas; the other group was formed by more operational users, who are responsible for a larger number of direct interactions with the ERP system. The answers presented great homogeneity throughout the groups.

For intrinsic quality dimensions (Table 2), answers demonstrated that, regarding the purchase invoices, there were re-checking data stages, and after the first cycle of implementation, they were eliminated. The re-checking of data related to sales invoices was eliminated partially. The re-checking of data related to cash flow still remains. The little improvement on information quality achieved suggests that new implementation cycles

should be conducted and should focus on the increase of information reliability and the consequent elimination of the persistent re-checking stages, mainly for the information related to cash flow control.

For contextual quality dimensions, answers to question 2 (Table 5) show that information is consolidated more quickly after this cycle of implementation, except for production costs that are still consolidated monthly.

Still in the contextual dimension, the answer to question 3 (Table 3) indicated that, in the previous situation, accounting closing happened more than 16 days after the end of the month. After the first cycle of implementation of the system, this period varied from one to two weeks. The nearly one week gain in the timeliness of accounting information presentation was judged insufficient by the personnel responsible for the implementation process,

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2. Which was/is the periodicity of information consolidation about:

a) revenue (across branches and head office)?

	1. Daily	2. Weekly	3. Monthly	4. Quarterly	5. Half-yearly
Before ERP		X			
After ERP	X				

b) cash flow?

	1. Daily	2. Weekly	3. Monthly	4. Quarterly	5. Half-yearly
Before ERP			X		
After ERP		X			

c) markup for product line?

	1. Daily	2. Weekly	3. Monthly	4. Quarterly	5. Half-yearly
Before ERP				X	
After ERP			X		

d) costs of the products?

	1. Daily	2. Weekly	3. Monthly	4. Quarterly	5. Half-yearly
Before ERP			X		
After ERP			X		

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suggesting that special attention should be directed to this item in the next improvement cycles.

Table 5: Answers to the questions about periodicity of consolidation – contextual perspective.

Answers to question 4 (Table 6) show that there is space for incremental improvements in informational processes directly related to sales (receivables) and purchases

(accounts payable). Answers to question 5 (Table 4) have indicated that the first implementation-use cycle has solved the previous problem of lack of passwords.

4. Was/is the amount of historical information available insufficient for decision making about:					
a) bills to receive?					
	1. I Totally disagree	2. I disagree Partially	3. Neutral or Indifferent	4. I agree Partially	5. I Totally agree
Before ERP				X	
After ERP		X			
b) bills to pay?					
	1. I Totally disagree	2. I disagree Partially	3. Neutral or Indifferent	4. I agree Partially	5. I Totally agree
Before ERP				X	
After ERP		X			
c) accounting?					
	1. I Totally disagree	2. I disagree Partially	3. Neutral or Indifferent	4. I agree Partially	5. I Totally agree
Before ERP					X
After ERP	X				
d) costs?					
	1. I Totally disagree	2. I disagree Partially	3. Neutral or Indifferent	4. I agree Partially	5. I Totally agree
Before ERP					X
After ERP	X				

Table 6: Answers to the questions about the amount of historical information - contextual perspective.

Analysis of the Table 7, with answers related to the format of information presentation on the screen (accessibility dimension), shows that, according to the personnel responsible for the cyclic implementation process, expressive improvements were verified in the access to the information, but there was still room for improvements.

The case study was concluded at the end of 2003, occasion in which the company accomplished studies for another implementation-use cycle that should incorporate several improvements. The implementation team concluded that there were several benefits brought about by the use of the model of assessment of success to the first implementation cycle. The model was useful to help define the improvements that should be pursued in the second implementation-use cycle.

6. Wasn´t/isn´t the format of information presentation in the screen easy to understand in the modules about:

a) bills to receive?

	1. I Totally disagree	2. I disagree Partially	3. Neutral or Indifferent	4. I agree Partially	5. I Totally agree
Before ERP					X
After ERP		X			

b) bills to pay?

	1. I Totally disagree	2. I disagree Partially	3. Neutral or Indifferent	4. I agree Partially	5. I Totally agree
Before ERP					X
After ERP		X			

c) accounting?

	1. I Totally disagree	2. I disagree Partially	3. Neutral or Indifferent	4. I agree Partially	5. I Totally agree
Before ERP					X
After ERP		X			

d) costs?

	1. I Totally disagree	2. I disagree Partially	3. Neutral or Indifferent	4. I agree Partially	5. I Totally agree
Before ERP					X
After ERP		X			

Table 7: Answers to the questions related to the format of information presentation – accessibility category.

5 Conclusions

This work has presented the application of a model for the assessment of information quality to measure the success of an integrated management system implementation in its several cycles. The case study focused on the application of this model in an organization of the nutrition industry that had recently concluded an implementation cycle, and that was preparing itself to begin another cycle.

The process designed to obtain the perceived quality metrics included the elaboration of questions and the application of questionnaires to different groups of users. There were no difficulties that discouraged the use of the metric. On the contrary, easiness of use was observed in obtaining the metrics, a fact that is attributed to the construction of simple and easy to understand questions. The answers that were obtained did not vary across different groups of users, and have been treated in an aggregated manner.

The whole implementation team emphasized the importance of the model application for the evaluation of the finished implementation-use cycle and for the definition of improvements that should be pursued in the second implementation-use cycle.

The need for more comprehensive future research should be clear. Case studies are useful due to their exploratory value, particularly in the investigation of the applicability of a theoretical framework in a specific domain; however, a validation of the specific theoretical relationships present in the studied model requires further confirmatory studies.

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