FIVE DIMENSIONS OF INFORMATION SYSTEMS: A PERSPECTIVE FROM THE IS AND QUALITY MANAGERS

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Abstract

We classify five key dimensions of information systems (IS): Context, People, Process, Information Technology (IT), and Information/Data. Subsequently, we propose a shared organizational view for quality information systems (QIS), in the context of ISO 9001. A multiple case study was conducted in fourteen ISO 9001 certified organizations. The QIS dimensions were validated with the cross-case comparison, focusing on the perspectives of the IS and quality managers. These management functions have distinct priorities, but should concentrate their efforts in a common mission: design and improve the QIS. The data suggests that a QIS is not a separate IS for quality, but rather that it is entwined with the organizational IS. We argue that five interrelated dimensions must be considered to create synergies between the IS and quality management systems. This study contributes to the discussion of how the IS should be addressed in the next release of ISO 9001.

Keywords: Information Systems, Quality Information Systems, ISO 9001, Case Studies.

1 INTRODUCTION

Quality information systems (QIS) may determine the success or failure of quality management approaches such as the ISO 9001 and TQM – Total Quality Management (Mathieson & Wharton, 1993; Sánchez-Rodríguez & Martínez-Lorente, 2011; Forza, 1995a; Forza, 1995b). In fact, quality management is an information intensive activity (Khalil, 1995; Matta et al., 1998), requiring a description of the business processes to ensure that the users always perform them consistently. However, the increase in bureaucracy caused by the quality documentation, and also a more demanding measurement system, are frequently reported problems for ISO 9001 (Withers & Ebrahimpour, 2000; Poksinska et al., 2006; Kumar & Balakrishnan, 2011).

The information system (IS) is a major concern of the quality managers, that have nowadays a multiple set of responsibilities (Addey, 2004). These professionals are central users of the QIS, daily searching for updated, reliable, and timely data, not always easy to get. Our research suggests that the time spent by the quality manager in information management may be up to 70%, which raises the question: "should this be a main task of the quality manager?".

The QIS combines the quality management system (QMS) and the IS, but there is no unanimous definition of QIS. Some authors use the expression to deal with the quality of the IS, such as Zahedi (1998), who defines a QIS as an IS in which TQM principles and techniques are applied. Other authors focus on the technological aspects of the QIS, for instance Ishizu (1996) defines QIS as a system that aims "to develop advanced TQM based on IT power". According to Juran and Gryna (1993), a QIS is a separate IS that processes quality information to support decision making, and should be integrated with management information systems. Each author needs to present their own definition of QIS depending on the purpose of the research (Gerber et al., 2004). Moreover, the

distinct dimensions of the QIS are studied independently, for example, Forza (1995a) associated IT and information flows, while Naveh and Halevy (2000) addressed quality information. There is a need to interrelate all the dimensions, but which are those dimensions?

Information technologies (IT) are a key dimension of the IS, but the mere adoption of IT may not be enough to develop a QIS (Morabito et al., 2010). The IS is a human activity system, involving socio-technical aspects (Davis, 2000), where IT requires a context, a purpose, and beneficiaries to make sense (Zhang et al., 2011). The positive impact of the IS on the QMS depends on information management, IT resources, and on the ability to make use of IT, thus making it a capability (Bharadwaj, 2000; Peppard & Ward, 2004; Zárraga-Rodríguez & Alvarez, 2013). Merging IS and quality theory, Mithas, Ramasubbu, and Sambamurthy (2011) found that information management capability has an important role in developing three quality capabilities: customer management, process management, and performance management. To prevent becoming an obstacle to quality, the IT needs to be complemented by well designed information flows, accordingly with the organizational processes, change, flexibility, and training (Morabito et al., 2010). These studies show that IT is only one piece of the QIS puzzle.

The QMS and the IS present synergies (Cunha & Figueiredo, 2005; Loukis et al., 2008), nevertheless, the adoption of one system does not automatically improve the other. On one hand, Casadesús and Castro (2005) have shown that in spite of ISO 9001 implementation, companies did not adopt practices to enable IT, and have not achieved an integration of the IT systems. On the other hand, Perez-Arostegui et al. (2012) have shown that IT competence by itself does not improve quality performance, but a positive impact occurs when the IT competence is combined with leadership, that is one of the core quality principles. Without purposeful integration in the design of both systems, there may be redundancies, inconsistencies, unnecessary costs, and inefficiencies (Cunha & Figueiredo, 2005). The daily operation of those two systems also calls for coordination, especially for managing organizational change and improvement, involving both quality and IS managers (Spencer & Duclos, 1998; Rademacher & Clark, 1993).

This research aims to contribute to three research questions: (1) Identify the key IS dimensions, aiming at the creation of a shared domain knowledge (Reich & Benbasat, 2000), for IS and quality managers; (2) Propose a definition of QIS, in the context of ISO 9001; and (3) Validate and understand the characteristics of the QIS by the lens of the identified dimensions. Due to the exploratory nature of the research questions, we have conducted a literature review followed by multiple case studies (Dubé & Paré, 2003; Yin, 1994). The IS–QMS interface has received less attention than other organizational interfaces of the IS function, such as the commercial and marketing (focusing on CRM - Customer Relationship Management), financial and planning (e.g. ERP - Enterprise Resource Planning studies), or supply-chain management (SCM).

The paper is organized as follows: section 2 presents the background of research, introducing ISO 9001, the key dimensions of an IS, and the QIS. In order to provide an initial framework and guide the data collection, a thorough review of the IS and quality literature was performed. Next, we describe the research design, specify the case studies, and propose the a priori model for QIS. A total of 28 interviews were conducted with IS and QMS managers. Afterwards, we describe the cross-case comparison in section 4, and the results are discussed in section 5. The last section offers some conclusions, describes the limitations of this study, and suggests opportunities for future research.

2 BACKGROUND

2.1 ISO 9001

ISO 9001 is the most generalized model for QMS in the world (Sampaio et al., 2009). The first version of the standard was published in 1987, and it was later revised in 1994, 2000 and 2008. ISO 9001 guides companies to improve business quality and adopt continuous improvement as a strategy (Ward & Peppard, 2002; ISO, 2008). It is an important tool for organizations to demonstrate to their

customers that they have the capability to produce consistently to their requirements (Cianfrani et al., 2000).

When adopting ISO 9001, the organizations establish, document, implement, and optionally certify their QMS. The first clauses of the standard are a general introduction to the standard itself, making it evident that the adoption of a QMS must form part of a strategic decision, and must count on the support of management. It makes clear that the standard establishes requirements that each company must fulfil, even if there is freedom in the choice of systems and methodologies to adopt. The subsequent clauses are the interconnected requirements of the QMS, as Figure 1 represents.

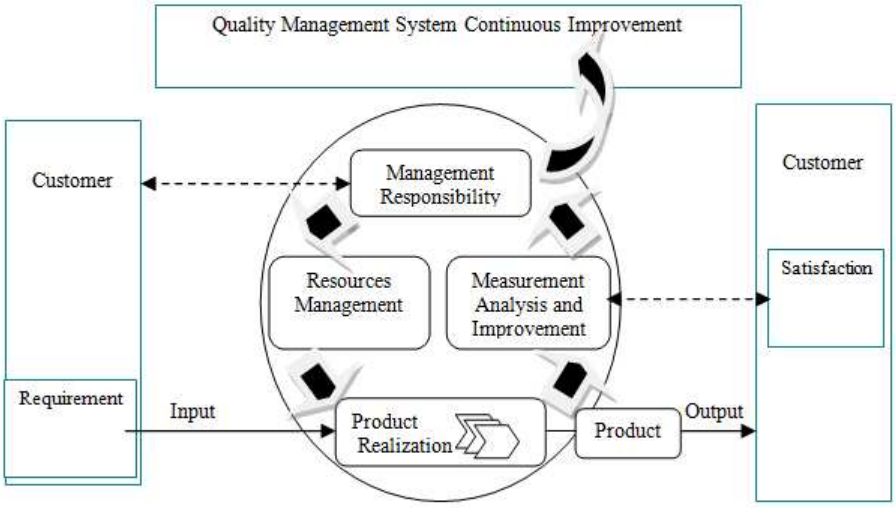

Figure 1. ISO 9001 model (adapted from ISO (2008)).

The standard suggests the PDCA "Plan–Do–Check–Act" approach for continuous improvement (ISO, 2008), and requires a documented quality system, consisting of defined procedures, work instructions, and specifications. These documents may be in any form or medium. In illustrative terms, a quality certification is about "writing down how things are to be done; doing things the way they were written; and providing evidence of both" (Cunha & Figueiredo, 2005).

2.2 Information systems and its dimensions

IS research addresses a variety of subjects related with information, technologies, and human aspects in organizational context (Hirschheim & Klein, 2012), however, "IS" may have different meanings to different people.

According to Carvalho (2000) "any definition of information system is inevitably a general statement that can fit different instances", and may cause confusion about the object of interest. For instance, Mason and Mitroff (1973) state that an IS "consists of, at least, a PERSON of a certain PSYCHOLOGICAL TYPE who faces a PROBLEM within some ORGANIZATIONAL CONTEXT for which he needs EVIDENCE to arrive at a solution, where the evidence is made available through some MODE OF PRESENTATION." Many other definitions exist, with varying degrees of influence from the underlying IT, suggesting a combination of dimensions (Carvalho, 2000; Alter, 2008; Laudon & Laudon, 2007).

A synthesis of relevant interrelated IS dimensions that we found in the IS literature is presented in Table 1.

IS definition	IS dimensions
"… an integrated man/machine system for providing information to support the operations, management and decision making functions in an organisation. The system uses computer hardware, software, manual procedures, management and decision models and a data base." (Davis, 1974); An updated definition by Davis (2000): "[…] information technology infrastructure, application systems, and personnel that employ information technology to deliver information and communications services for transaction processing/operations and administration/ management of an organization. The system utilizes computer and communications hardware and software, manual procedures, and internal and external repositories of data. The systems apply a combination of automation, human actions, and user-machine interaction."	Context (organizational structure, operations and decision models), People, Processes (procedures), IT (hardware, software), Information/Data
"[…] can in effect be considered as the memorisation system of the organisation: the system which permits it to keep in memory: its transactions with its environment; the events in its environment which it wishes to recall easily for some period; the common rationale which its members gladly share, or those which are imposed by its environment." (Le Moigne, 1975)	Context (culture, history), Information/Data
"[...] a system which assembles, stores, processes and delivers information relevant to an organisation (or to society), in such a way that the information is accessible and useful to those who wish to use it, including managers, staff, clients and citizens. An information system is a human activity (social) system which may or may not involve the use of computer systems." (Buckingham et al., 1987)	People, IT, Information/Data
"an information system consists of five components: hardware, programs, data, procedures and people." (Kroenke, 2008)	People, Processes (procedures), IT (hardware, programs), Information/Data
"structural perspective: a collection of people, processes, data, models, technology and partly formalised language, forming a cohesive structure which serves some organizational purpose or function. functional perspective: technologically implemented medium for the purpose of recording, storing and disseminating linguistic expressions as well as for the supporting of inference making." (Hirschheim et al., 1995)	Context, People, Processes (procedures), IT, Information/Data
"what emerges from the usage that is made of the IT delivery system by users (whose strengths are that they are human beings, not machines). This usage will be made up of two parts: (1) First the formal processes, which are currently usually assumed to be pre-determinable with respect to decisions about what IT to use. y (2) Second, the informal processes, which are what the human beings who use the IT and the formal processes create or invent in order to ensure that useful work is done." (Paul, 2007)	People, Processes (the context does not appear clearly in this definition, although may be described by the formal and informal processes), IT
"An organizational system that consists of technical, organizational and semiotic elements which are all re-organized and expanded during ISD [information system development] to serve an organizational purpose." (Lyytinen & Newman, 2006)	Context, People, Processes, IT, Information/Data (technical, organizational, and semiotic elements)
"An organized collection of people, information, business processes, and information technology designed to transform inputs into outputs, in order to achieve a goal." (Huber et al., 2007)	People, Processes, IT, Information/Data
"is an integrated and cooperating set of software directed information technologies supporting individual, group, organizational, or societal goals." (Watson, 2008)	Context, People, IT

Table 1. Some IS definitions and key dimensions.

The selection of definitions presented in the left column of Table 1 were guided by the review of Carvalho (2000) and Alter (2008). To ensure that the dimensions in the right column of Table 1 were correctly extracted, we have analysed the IS definitions with NVIVO10, as Figure 2 illustrates.

Figure 2. IS dimensions extraction with NVIVO10.

After eliminating the meaningless terms (e.g. “made”; “may”), we have created associations between the relevant terms. For instance, the terms “human”, “people”, “participants” where grouped in the dimension “People”, while “environment”, “external”, “organizational” are encapsulated in the dimension “Context”. We have finally reached five interrelated key dimensions of an IS that are: Context, People, Process, IT, and Information/Data.

2.3 Quality, IS, and Quality Information Systems

Quality is a key research topic in IS (Huang et al., 1998). DeLone and McLean (1992, 2003) have proposed one of the core models in this field, suggesting that system quality, information quality, system use, and user satisfaction, are essential dimensions to evaluate the impact of the IS. Enterprise quality is an holistic concept, that includes both the quality of business processes and the quality of the IS, according distinct viewpoints, such as IT, service, and information/data (Stylianou & Kumar, 2000). These viewpoints are interrelated, but, nevertheless, they are usually researched individually (Salmela, 1997; Wang, 1998; Stylianou & Kumar, 2000; Ozkan, 2006). Salmela (1997) defines business quality “as the net value of an information system for the user organisation”. Information, system, and service quality have been researched, for example, regarding Internet and web applications (Albassam & Alshawi, 2010; Saatçıoğlu et al., 2006).

Although quality has been widely studied, especially from the engineering viewpoint (Von Hellens, 1997), little attention has been given to the QIS. A seminal study conducted by Forza (1995a, 1995b), proposed the dimensions of IT and information flows to support quality performance. Since then, a number of scholars have studied the impact of IT in quality management (Dewhurst et al., 1999; Dewhurst et al., 2003; Sánchez-Rodríguez et al., 2006; Sánchez-Rodríguez & Martínez-Lorente, 2011; Sadeh et al., 2013), however, these contributions have mostly focused on the impact of IT, in a perspective of one system (IS) supporting the other (QMS). There is a need to create synergies in their combined development (Barata & Cunha, 2013).

The Table 2 presents some QIS definitions found in the literature, and the related QIS dimensions.

QIS definition	QIS dimensions
"…sending the right quality information to the right point at the right time." (Tang et al., 2007)	Processes (information flows), Information/Data
"[is based on] three levels of information creation and analysis: process control, process evaluation and organizational assessment." (Naveh & Halevy, 2000)	Context, (not only quality) Processes (information flows), Information/Data
"capture quality information from both internal and external parties, and to facilitate the communication environment, in order to share quality information among enterprises, customers and suppliers." (Tang & Lu, 2002)	Processes (information flows), IT
"to support collaboration of member enterprises distributed in different regions to assure the efficiency and correctness of collaboration." (Zhao et al., 2008)	IT, Information/Data
"information flows and information technologies which support managers and workers in their activities in order to improve quality performance. Information technologies are separated from information flows since information flows can take place even without information technologies and the presence of information technologies does not necessarily guarantee the achievement of information flows." (Forza, 1995a)	Processes (information flows), IT
"applicability and superiority of the software in improving product quality and reducing production cost in a case study." (He, 2006)	IT
"necessary data to achieve and proof conformance with the specification of a product"; "logistics of QI". "[Present the development of a software tool] to build up quality control loops over and the complete production network." (Gerber et al., 2004)	Processes (information flows), IT, Information/Data
"[aims] to develop advanced TQM based on IT power […] may also contribute to information technology." (Ishizu, 1996)	IT, Information/Data (types of information)
"be better able to manage their quality-related knowledge." (Zeng et al., 2007)	People (barriers in information flows), Processes (information flows), Information/Data
"[sub-system of the Quality task system, associated with] designing and developing, operating, maintaining and auditing the quality system". The IT component is a part of the "quality technological subsystem." (Jensen, 1991)	IT, Information/Data
"help control manufacturing activities, analyze information, and support real-time policy making."; "requires gathering, processing, storage and the distribution of quality-related data." (Mahdavi et al., 2008)	Information/Data
"it will be an effective work if QIS is developed by integrating it with ISO 9001:2000 quality system based-model. Hence, if a QIS compatible to ISO 9001:2000 standard is implemented in a company, it will leverage the performance of ISO 9001:2000 standard and offer very powerful solutions towards achieving continuous quality improvement." (Sakthivel et al., 2008)	IT
"MIS department can take on this responsibility to link MIS with total quality management (TQM). The resulting quality information system (QIS) will focus less on technology and more on the business process." (Keith, 1994)	People, Processes, IT

Table 2. Literature contributions to define QIS.

The technological aspects are most prevalent in the literature, focusing on IT and the required Information/Data for quality purposes. The Context of QIS is predominantly confined to the requirements of the QMS, as an independent piece of the organizational IS. Although the dimensions of People and Processes can also be identified in Table 2, there is a lack of a holistic perspective of the QIS, from an organizational and managerial perspective.

3 RESEARCH DESIGN

This section describes the research method and offers details about the various case studies. An a priori conceptualization of QIS is developed.

3.1 Research method

We have conducted multiple case studies, researching the phenomena in its real context, which is especially suited when the frontiers between the phenomena and the context are not evident (Yin, 1981). Case studies are empirical descriptions of particular instances of a phenomena and may use qualitative or quantitative data sources (Yin, 1994). Multiple case studies usually allow the creation of a more robust theory than single research cases (Yin, 1994; Eisenhardt, 1991), enabling a broader exploration of the research questions and the focus of the researcher in cross case analysis (Eisenhardt & Graebner, 2007). With an exploratory purpose in distinct settings, the multiple cases have the potential to identify interesting aspects for the target organizations, promoting the reflection by the field professionals (Gill & Bhattacherjee, 2009).

We have adopted a research protocol for the phases of design, data collection, and data analysis (Benbasat et al., 1987; Dubé & Paré, 2003; Walsham, 1995; Walsham, 2006), followed by an iterative process of case evaluation and comparison (Eisenhardt, 1989; Klein & Myers, 1999). The IS and the QMS managers were selected to represent a tactical level of organizational alignment (Tarafdar & Qrunfleh, 2009). The data gathering techniques were the document collection, observation, and semi-structured interviews (Myers & Newman, 2007). The document analysis and observations have focused the documental structure of ISO 9001 certification, the processes, and the IT for quality support. A brief meeting with the IS and quality managers was initially conducted to present the research objectives. This introductory step helped us understand the existing QIS, collect documents, evaluate IT support, and prepare the interviews. These were carried out in a second phase, where we approached the IS and quality managers separately. Each session took approximately 45 minutes (a minimum of 30 minutes and a maximum of 60 minutes). We have used a smart pen (Livescribe, 2013), to record the interviews.

In all the cases there are IT applications to support quality directly, such as document management and complaints management. Some of these have been developed in-house while others have been acquired in the software market. We also asked about other general IT solutions that provided a significant support to quality. The CRM and the CMMS – Computerized Maintenance Management System, were the most cited, perhaps due to the focus of ISO 9001 in the areas of customer and asset management. Although IT is only one of the IS dimensions, we wanted to ensure that all the organizations could express their perspective in each of the five dimensions.

3.2 Research cases

The cases were selected from ISO 9001 certified organizations where we had contacts or where we had previously done contract work. The details are presented in Table 3.

Sector	Acronym	Company size	IT support for the QMS
Ceramics #1	CER1	Large (>250 employees)	QMS software(a); CRM
Ceramics	CER2	Large (>250)	QMS software
Ceramics	CER3	Medium (50-250)	QMS software

Sector	Acronym	Company size	IT support for the QMS
Batteries	BAT	Large (>250)	QMS software; process modeling software and statistical software
Agro food	AGR	Medium (50-250)	QMS, production control software and CMMS
Metal	MET1	Large (50-250)	QMS software; CRM
Metal	MET2	Small (<50)	QMS software
Paper	PAP	Medium (50-250)	QMS software; B2B platform
Institute	INS1	Medium (50-250)	QMS software
Institute	INS2	Large (>250)	QMS software; B2B platform
Environment	ENV	Large (>250)	QMS software; CMMS
Printer	PRI	Large (>250)	QMS software; CMMS
Automotive	AUT	Large (>250)	QMS software; CMMS
Plastics #14	PLA	Large (>250)	QMS and production software; ERP

(a) Software applications for ISO9001 requirements, such as document management systems, training management, complaints and non conformity, and action plans.

Table 3. Research cases.

3.3 A priori conceptualization of the QIS

We propose a comprehensive definition for QIS, guided by the literature review:

> A system that intertwines **people** and **IT**, in a **context** that is influenced by quality policies, procedures, and standards, the organizational infrastructure, and external environment, processing **information** in cycles of planning, execution, monitoring, measurement, and improvement of the organizational **processes**.

Information processing comprises the steps for collecting, processing, storing, and disseminating (Laudon & Laudon, 2007). By Process we adopt the definition provided by ISO 9001, representing a sequence of activities that converts inputs (e.g. materials, financial) in products, that are defined as the output of a process (ISO, 2008). The five main interrelated dimensions of the QIS are People (e.g. system participants and beneficiaries of the system), IT (e.g. hardware, software), Context (e.g. infrastructure, environment, regulations), Information/Data (required, processed and delivered by the QIS), and Processes (e.g. procedures, workflows).

4 RESULTS

First, we identified the interviewees' perception of the QIS, by questioning: "In your opinion, what is the definition of quality information system?" The answers are presented in section 4.1, followed by the cross-case perspective of the IS and QMS managers for each of the five interrelated QIS dimensions. The interview statements are identified by the acronym of the case study and the manager's area (IS or QMS), for example, CER1 IS, concerning the IS manager of company CER1.

4.1 QIS definition: An experts perspective

The data analysis provided two sets of QIS definitions. On one hand, organizations with a more recent QMS, with ongoing IT projects, or with a single (or few) products, tend to emphasise technology.

> *"Is a system that provides the quality documents,* and allows establishing and monitoring the improvement actions. Is an essential way of defusing quality information.*"* (CER2 QMS)

> *"Reliable data to be analysed. We spend too much time trying to find errors* and achieving the right information.*"* (PRI QMS)

> *"The quality documents and the quality set of software* tools that are required to process information for the certification requirements.*"* (PAP IS)

> *"Is an effort to reduce paper by electronic means, reducing quality burocracy […] improves* quality by reducing information errors, creating alerts and providing i*ndicators."* (BAT IS)

On the other hand, organizations with more mature QMSs, more IT solutions and integration needs, and multiple products or production by customer order, tend to focus on the social aspects of the QIS.

> *"A QIS is many different things […] Is the concepts that we want to pass to people, their* feedback. Is a major responsibility of the QMS manager. The IT and train that helps people manage information. Is a systematization of quality in daily practices. Is also a control system, however, is mainly an improvement system.*"* (ALI QMS)

> *"It is a quality literacy tool. This is why is essential for auditors to understand if quality is a* reality or only something to achieve a few days before the audit. Includes several mediums such as papers and software, but what I am most concerned with is the use of those medium. Quality is not a state, is a daily effort.*"* (CER1 IS)

> *"*All the organizational information and tools to make it flow. I am the main responsible for it, but my main concern is to bring the others to that responsibility *[…].* Machines are working most of the time, people are different*, we can't force them for quality, we must help them to* contribute to quality.*"* (MET2 QMS)

> *"A QIS is a perspective of our organizational IS, involving quality* issues. Is a part of our IS, that includes what we could name quality data but in our case this does not happens. We have data and then there are perspectives and viewpoints concerning that data. The same data can be used for quality or any other purpose. My QMS colleague is one of my most demanding customers [*…], in fact I don't think that any other department has the same influence on the IS. I need to work constantly aligned with quality, this is a partnership."* (PLA IS)

We could also distinguish two perspectives when comparing the QIS with the organizational IS:

(1) The QIS as a separate IS that is "owned by quality", described as a set of tools to satisfy QMS requirements of the quality department (e.g. CER2). This concept was more common in centralized QMS, where quality managers have a higher responsibility in gathering, treating, and diffusing QMS information. The QMS managers did not report the situation as beneficial; on the contrary, it requires a higher percentage of work for information issues, and less time for process improvement.

(2) The QIS as inherent and inseparable from the organizational IS, was evidenced by four organizations (INS1, INS2, AUT, and PLA). In those cases, the IS manager seemed more involved with quality initiatives, and aware of the quality benefits. Both IS and QMS managers of these cases acknowledge that the main users of the QIS are not their own (as a mere tool to support their departments needs), but the entire organization, and external entities.

> *"We won't have success in including all the workers as QIS users, if we don't make the QIS something useful for their daily work. If the user does not need it, won't use it properly,* information will be incomplete and scarce, leading to errors and more processing after [for us]. We must create a situation in witch both quality and the IS are daily practice, not an additional system to deal with.*"* (PLA QMS)

4.2 Context

We observed from the collected documents that quality indicators addressed a number of different sources of information, such as product quality; departments' objectives; process monitoring; and financial information. The QIS context is internal and external to the organization, involving different stakeholders. A statement from INS2 QMS manager illustrates this broad perspective of QIS context:

> *"*The QIS allows two main goals: (1), to understand if we actually can achieve organizational improvement, and (2) to be a communication tool with all the organization stakeholders. With our workers because quality requires constant meetings and we can use those meetings to

communicate about the organizational context [e.g. information about competitors, to know best practices, improvement suggestions]. Other stakeholders are also addressed, for instance, to provide information to our customers concerning our product quality, to give our suppliers feedback about their products [e.g. shared quality control], and to communicate with *stockholders, because we use quality indicators in our administrations meetings."* (INS QMS)

4.3 People

We asked the managers (1) who were the main users of the QIS; (2) how did the IS and QMS managers communicate on a daily basis; and (3) who was the fundamental responsible of the QIS.

The interviewees present the QIS as a holistic system that involves everyone, inside and outside the organization. The IS managers recognize that their specific QIS activities are mostly internal to the organization (IT support, information quality), when compared with the QMS managers. The latter can balance their internal (e.g. training employees in quality, improving processes) and external activities (e.g. relations with the suppliers, customers, and auditors), expressing a higher perception of the external customer, when compared with the IS managers.

Regarding the direct communication between the IS and QMS manager, the opinions diverge. The majority of the QMS experts said that the IS manager was one of the most important tactical functions to allow quality to work. In fact, they have expressed some dependence on the IS function. Contrarily, the IS managers were almost unanimous in saying that they could perform their work without the quality managers' collaboration. However, they also stated that the QMS affected their tasks more significantly than other functions, such as the financial, marketing or production managers (example: PLA IS). This occurs because they need to align their practices with the QMS documents.

Who owns the QIS? According to a QMS manager of INS1 "I am the owner of the QIS, but I don't want it!". Owning the QIS means being responsible for making it work, ensuring that information is complete and reliable, data is evaluated, and used in decision-making. This is a burden reported by the majority of quality managers. We found that a QMS manager spends, on average, 70% of his/her time with information related tasks. This value must be carefully analysed, because each interviewee may interpret their information related tasks differently. But what becomes clear is that the QMS managers' perception is that they spend too much time with the QIS, thus compromising their mission.

"I need to behave as a policeman to ensure that procedures are followed and people have the right information*."* (MET1 QMS)

"I have to report the top manager the quality indicators, but I am too much dependant from the others to complete this task*."* (PRI QMS)

4.4 Process

The standard suggests a process approach; therefore, process design and documentation are typical tasks of QMS managers. But when we asked the IS managers about those processes, twelve of them identified problems. One of them is that process descriptions were too vague and generic to be useful from an IT perspective. For example, the requirements of an IT application could not be extracted from the quality processes. Another problem is that, in the majority of the cases, those processes did not fit practice as they should.

The IS managers of cases CER1 and CER3 have stated that processes are usually changed without their knowledge, leading to difficulties in aligning IT changes. According to their point of view, this lack of alignment can create a wrong image of the IS effectiveness.

"sometimes the problem is not the delay in IS development, is in lack of communication and negotiation between systems managers*."* (CER1 IS).

Conversely, the quality managers also pointed to weaknesses on the IS side. For instance, there was a complaint that the IS staff could participate more in process improvement supported by IT. Interestingly, the case that revealed more integration between the IS and QMS function (PLA), also revealed that process improvement was not possible without the IS involvement.

4.5 IT

Although the majority of IS managers considers the quality software packages as the primary IT support of quality, the QMS managers reported the need of information from all the organizational IT portfolio. According to the QMS managers, quality involves the entire organization and IT should be effectively integrated. For instance, CRM solutions were reported as critical for the quality principles of customer satisfaction and complaints management. Interestingly, the ERP were only mentioned in two cases (PLA and AUT, that have developed their own specific modules). In the other cases, the ERP was one of the less used IT solutions for quality purposes, except if quality modules existed. We found out that the ERP solutions, in these cases, did not have quality functionalities as a priority. One of the managers has reported that quality required constant improvements, and having this type of dynamic in the ERP was not financially feasible. The in-house development or the acquisition of modules that are external to the ERP was the preferable solution in the researched cases.

We found three common problems in the cases we analysed:

- Poor alignment between IT and process documentation. There was a suggestion that some process documents could be eliminated if the IT was properly developed. "Why do we need an instruction to perform some process if the IT that supports the process can guide the user with the required information? Process documentation and IT must be developed together." (INS1 IS). Also, the QMS managers should not change documents and processes without considering the existing or potential IT solutions.
- IT validation. "We have to validate IT, but I do not know how! This should not be a task of the IS [function]" (CER3 QMS).
- IT should be more "audit-friendly". When an auditor looks for evidences of quality conformance, the IT becomes part of the audit. But information is difficult to connect: "we can't directly know which IT [component] supports which process, which IT [component] provides which quality indicator. This problem required a map to navigate between IT and processes." (ENV QMS).

4.6 Information/Data

Due to the principles of "doing right at the first time" and to give the organizational workers the tools to be autonomous in their tasks, information is essential for quality. This is a dynamic need that depends on the processes to be improved or changed to comply with the customer demands.

> *"I*nformation of the QIS is the set of information from the global IS that we require in some time frame*."* (AUT IS)

> *"Quality is not a subset of the organization, is a way of seeing the organization as a continuous* improvement system*."* (PLA QMS)

The list of quality indicators included very different types of data, from product characteristics to financial indicators. The indicators can change over time and the auditors may ask for any source to assess quality. For instance, we found information concerning product quality (e.g. defects), process performance (e.g. delays), innovation (e.g. new products developed), and even financial aspects. Financial information was intriguing for us, because the quality literature especially focuses the non-quality costs (such as defects and rework). However, we could find arguments that quality is also "a way of meeting stakeholders concerns, not only the customer concerns" (INS2 IS). As a result, to integrate quality indicators with the business, we could also see financial information as "quality information" in the QIS.

> *"Contrarily to CRM systems or some ERP modules that we can more or less describe the types* of functionalities and information, that is not possible with the QIS, because quality is everywhere, and all the information is potential quality information*."* (INS1 IS)

5 DISCUSSION

The cross-case comparison confirms the a priori conceptualization for the QIS, although not all the organizations express the same priorities in each of its dimensions. Organizations with more mature QMS and IT management practices do not put the emphasis in the technological aspects, but rather focus on the development of other interrelated dimensions, especially social aspects. Inspired by the work of Chen et al. (2010), we identify three possible conceptions: the QIS as a mere support of quality; the QIS as a mere support for the IS function to comply with quality; and the most potentially valuable: the QIS as a shared view of the IS role in the organization.

The QIS context goes beyond the ISO 9001 requirements. Different factors, at distinct levels, must be considered (Piotrowicz & Irani, 2008). Compliance with ISO 9001 also requires complying with other standards and regulations, creating a wider context for the QIS. We could identify three complementary perspectives, namely:

- Outside-in, considering the external influence in the organizational QIS. This perspective refers to the QIS information from the "outside world", about competitors, customer requirements, best practices, and applicable regulations;
- Within, concerning the organizational structure and internal processes. In this perspective, the managers are focused in understanding and developing the quality culture, removing barriers to the processes, improving layouts, and workflows. Ensuring that the quality requirements are applied in daily practice;
- Inside-out, because quality requires that evidences be provided to stakeholders. This may occur, for example, in a quality audit or required by a customer.

All the organizational stakeholders are simultaneously contributors and beneficiaries of the QIS, but the IS and the QMS managers have a central responsibility in its design and management. These two endeavours may be unsuccessful if the managers see the QIS as a mere support for certification. One of the interesting aspects in the IS and QMS interface is the need to develop an holistic view of the organization. The IS manager could benefit from following the QMS manager's example in cross functional relations, and with the firm customers, for instance, to improve innovation (Saldanha & Krishnan, 2011).

The process dimension should be a common concern of the IS and QMS managers. If IS managers have a higher participation in process management and modelling, from the onset, then both functions will benefit (Garimella, 2006). ISO 9001 process maps require improvement and additional tools, to be useful for the IS. The problems found in the process dimension are consistent with previous studies, sustaining that ISO 9001 does not lead to a process approach (Iden, 2012). More mature QIS have revealed that both the IS and QMS managers must combine their efforts in process management.

There are differences in how the IS and QMS managers see the IT dimension. While the IS managers focus on the IT that directly supports quality (e.g. quality software packages), the majority of QMS managers report that all the organizational IT must be considered to support the QIS. In most cases, the IS managers see the QMS manager as an "IT customer", rather than an "IT partner". As a partner, also the QMS managers should be involved in early phases of IT development. If the QMS is not a primary concern, IT changes and improvements may become unaligned with processes or standards requirements. In addition, IT validation, as required by quality standards, should not be an exclusive responsibility of the QMS manager. IS managers are in a position to lead the critical aspects of data, information, and system quality. As evidenced by the literature and by interviewees, business and IS quality are two faces of a single coin.

We couldn't find in these cases a strict definition of "quality information" (Juran & Gryna, 1993), concerning the information that is exclusive to the QIS. Similarly to the IT dimension, where the entire IT portfolio is, potentially, relevant to support the QIS, also all the organizational information is, potentially, QIS information. The case studies suggest that the five QIS dimensions considerably overlap the holistic organizational IS.

6 CONCLUSIONS

We present five key interrelated dimensions of the QIS: Context, People, Process, IT, and Information/Data. Although recognizing the interest of researching each of these dimensions separately, we argue that an IS must be holistically understood by, at least, the combination of these five dimensions. A definition for QIS is provided in this paper, not as a separate IS, but rather as a shared organizational view of the IS (Chen et al., 2010). Our study provides a clearer perspective of the IS-quality interface, thus contributing to the discussion of the next revision of ISO 9001, expected to 2016.

The case studies have provided insights to define a QIS, from a management and organizational perspective. The context dimension is wider than the strict vision of the ISO 9001 requirements. The QIS is responsible for allowing information to flow outside-in, within, and inside-out of the QMS. We found that the people dimension is a major concern for both quality and IS, although lacking approaches to involve all the organizational users with the QIS. Process management has limitations in some of the cases, such as the detail of the documentation and coherence with practice. Finally, the IT dimension is a challenge in a continuous changing environment, where all the organizational information is potential quality information.

This research has limitations that are important to acknowledge. First, we present exploratory cross case comparison, so results could vary with distinct cases, representing distinct sectors and perspectives. Second, we have selected the tactical level of the IS and the QMS managers, while other organizational functions could be addressed. Third, we have only focused on the ISO 9001 certification context, researched by five key IS dimensions. Forth, the selection of core papers creates a natural limitation for the dimensions of the study.

Future research may address methods and tools to improve the QIS design and improvement. The IS and QMS managers must be partners in the development of the QIS, but the literature does not present guidance in this joint endeavour. For instance, how could IT be developed to achieve a better support of the quality requirements, not only by specific quality modules but as a concern in all IT solutions of the organizations. Additionally, how can the IS and QMS managers work together to reduce the operational responsibilities of information processing, gaining more time to their priority of designing and managing the QIS.

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