*Barata, J., & Cunha, P. R. (2017). Synergies between quality management and information systems: a literature review and map for further research. Total Quality Management & Business Excellence, 28(3–4), 282–295.*

*Link for the published version https://doi.org/10.1080/14783363.2015.1080117*

# Synergies between quality management and information systems: a literature review and map for further research

João Barata*

*CTCV, Technological Centre for Ceramic and Glass; ISMT, Miguel Torga Institute; and CISUC, Department of Informatics Engineering, University of Coimbra*

Department of Informatics Engineering, University of Coimbra, Pólo II, 3030-290 Coimbra, Portugal
* Corresponding author. Email: barata@dei.uc.pt

Paulo Rupino da Cunha

*CISUC, Department of Informatics Engineering, University of Coimbra*

Department of Informatics Engineering, University of Coimbra, Pólo II, 3030-290 Coimbra, Portugal

# Synergies between quality management and information systems: a literature review and map for further research

We review existing work on synergies between information systems (IS) and quality management systems (QMS) and propose avenues to advance them further, leading to a whole that is greater than the sum of the two parts, moving away from current practice, where the lifecycle of the IS and the QMS are handled independently, by different teams, equipped with disconnected tools and methodologies. We start with a literature review that makes sense of a puzzle of 91 articles published since 1979. Three focal categories of papers are identified and discussed, namely, (1) IS in support of the QMS; (2) QMS in support of the IS; and (3) a shared view of the IS and QMS. As 80% of the papers address the limited perspective of one type of system being dominant, in the second part of the paper we propose a map for further research.

**Keywords**: information system, quality management system, TQM, ISO 9000, literature review, synergies

## 1. Introduction

The information system (IS) – consisting of technology, data, and people involved in delivering information and communication services (Davis, 2000) – and the Quality Management System (QMS) – concerned with the principles, policies, processes and procedures required for ensuring the quality objectives (Zhu & Scheuermann, 1999) – are two main pillars of effective organizations. Despite their distinct goals and functions, the IS and the QMS are mutually dependent. There is a considerable overlap in concerns and actions when planning, deploying, and operating these systems. For example, designing the business processes and their supporting documents, attending to user information requirements, and training staff on daily routines. The operation of these systems also calls for coordination, especially for managing organizational change and improvement (Spencer & Duclos, 1998).

When combined, the IS and the QMS are capable of significant positive organizational impact (Sánchez-Rodríguez & Martínez-Lorente, 2011). Paradoxically, the practice of designing and operating these two key systems is most frequently unconnected, leading to redundancies, inconsistencies, and inefficiencies, as explained in the empirical study conducted by Cunha and Figueiredo (2005). For these reasons, for over thirty-five years, researchers have been interested in how quality management systems and information systems can support each other. One of the first papers addressing the subject was published in 1979 (Wolfe & Tassé, 1979); however, the possibility of leveraging synergies between IS and QMS throughout their lifecycles remains a fragmented and fuzzy topic in the literature.

Given this background, the purpose of this paper is to (1) identify possibilities for synergies between the IS and the QMS; (2) explore how these two different systems can be jointly designed; and (3) understand how they can be operated in an articulated manner.

This explicit investigation of ways to materialize synergies between the IS and the QMS is needed, because, without specific determination, the adoption of either system does not automatically improve the other. On the one hand, Casadesús and Castro (2005) have shown that, in spite of implementing ISO 9000, companies did not adopt practices to enable and integrate IT. On the other hand, Perez-Arostegui et al. (2012) have shown that IT competence by itself does not improve quality performance. Both conclude for the need to explore in greater depth the IS/QMS relationship.

Regarding Quality, we have focused on Total Quality Management (TQM) and on standards such as the ISO 9000, which are globally accepted programs to implement a QMS (Zhu & Scheuermann, 1999). TQM is a philosophy that adopts a systemic view of the organization, focusing on continuous improvement of the processes. ISO 9000 is

a series of quality management standards, published by the International Organization for Standardization (ISO). Regarding IS, we have adopted a comprehensive perspective, encompassing not only technology but also data and people, across design, implementation, and operation (Davis, 2000). The abbreviations 'IS' and 'IT' will be applied interchangeably, accordingly to the original use of the cited author.

A systematic literature review (Webster & Watson, 2002) was conducted for documents that explore QMS and IS integration in EBSCO, Science Direct, and Google Scholar. Backward and forward searches for references and authors were performed for each relevant article. Given the generic nature of the terms 'information system' and 'quality management', the search keywords were refined to include 'TQM', 'ISO 9000' or 'ISO 9001', combined by boolean operators (e.g. 'information system' + ('9000' or '9001')). Another iteration of search refinement included convergent terms uncovered in previously found relevant literature, such as 'document management' or 'top management support'. Then, an overall analysis of top IS and quality journals was carried out, considering the period from January 2010 to March 2015. Each publication was tagged and annotated using the Mendeley free reference manager tool. Further, the pertinent papers were grouped by similar concepts into categories, using an iterative coding approach. According to Tranfield, Denyer, and Smart (2003, p. 220), 'for academics, the reviewing process increases methodological rigor. For practitioners/managers, systematic review helps develop a reliable knowledge base by accumulating knowledge from a range of studies'.

The next section of this paper presents the literature review, according to three focal categories of papers, namely, (1) IS in support of the QMS, (2) QMS in support of the IS, and (3) a shared view over the IS and QMS. In the second part of the paper we depart from the work of Forza (1995a, 1995b) and extend it to account for a synergistic

approach to the QMS and IS lifecycles. The forth and final section states our conclusions, the limitations of this work, and implications for theory and practice.

## 2. Making sense of the literature review

A systematic literature review aims to 'analyse the past to prepare the future' (Webster & Watson, 2002). In our classification of the papers, we used the most prevalent categories and concepts that they addressed, as described in the top and bottom rows of figure 1, respectively.

**<Figure 1 about here >**

Figure 1. Major categories and concepts in the IS – QMS literature.

The categories (1) '*IS in support of the QMS*' and (2) '*QMS in support of the IS*', are unidirectional perspectives of one type of system supporting the needs of the other. Category (3) '*IS and QMS shared view*' represents a synergistic relation, where both systems build on each other, thus enabling wider organizational gains. The expression 'shared view' comes from the work of Chen, Mocker, Preston, and Teubner (2010), who identify the 'shared view' of the IS role within the organization as one of the conceptions of IS strategy.

Regarding category (1), two main concepts emerge from the support role of the IS, namely IT solutions and quality information systems (QIS) that also includes information flows (Forza, 1995a). Another perspective – (2) – explores the QMS in support of the IS, addressing the adoption of quality principles (e.g., continuous improvement) and methods (e.g., audits) for the design and management of the IS. The shared view (3) addresses the potential benefits of the joint design and management of

the IS and the QMS. Papers that deal with evidences of organizational impact can be found across all three categories.

Figure 2 shows the distribution of the collected papers by (a) research type, (b) approach to quality management, (c) lifecycle phase, and (d) major categories.

**<Figure 2 about here >**

Figure 2. Paper distribution.

Empirical studies are frequently found (67%), when comparing with theoretical ones (33%). TQM is the most referenced approach to quality management when discussing its relation with the IS (65%), more than tripling the 20% figure for ISO 9000. There is more balance in the focus of the discussion in what regards the lifecycle. Papers addressing the design-time (e.g., development of IT and systems documentation) represent 41%, while the run-time (e.g., operation and management practices for audit and improvement) concerns 59%. At 46%, the area '*IS in support of the QMS*' represents the most significant share of the studies, followed by 34% that look into how the QMS can be used to support the IS. Only 20% of the papers deal with synergies. In the following sections we describe the state-of-the-art in the three categories of papers.

### *2.1. IS in support of the QMS*

The IS may determine the success or failure of the QMS (Mathieson & Wharton, 1993; Matta, Chen, & Tama, 1998; Wai, Seebaluck, & Teeroovengadum, 2011) and that impact is well documented. A stream of the literature addresses quality dimensions, concluding about the importance of IT in support of compliance, leadership (Ang, Davies, & Finlay, 2000, 2001; Keramati & Albadvi, 2009), quality awareness, and reduction of quality costs (Mjema, Victor, & Mwinuka, 2005; Pursglove & Dale, 1996;

Taylor & Wright, 2006).

There are several IT solutions to support quality efforts. For example, electronic data interchange (EDI), enterprise resource planning (ERP), and computer-aided design / computer-aided manufacturing (CAD/CAM) have a direct impact on related quality management capabilities: customer and supplier relations, product and process management, and workforce management (Sánchez-Rodríguez, Dewhurst, & Martínez-Lorente, 2006; Sánchez-Rodríguez & Martínez-Lorente, 2011). The use of groupware tools in process improvement groups, such as the workflow and decision support systems is suggested by Kock and McQueen (1998).

The positive effects cross the boundaries of the organization, extending to customer and supplier relationships (Anh & Matsui, 2011; Daghfous & Barkhi, 2009; Dewhurst, Martínez-Lorente, & Sánchez-Rodríguez, 2003; Kuei, Madu, & Lin, 2011; Ray, Muhanna, & Barney, 2005; Xu, 2011). The use of Internet technologies is popular in this area, with Tang and Lu (2002) specifying a QIS for the supply chain, while Shao, Wu, Deng, Li, and Feng (2006) present a web platform for collaboration with the suppliers, customers, and other partners. In the domain of organizational networks, Gerber, Dietzsch, and Althaus (2004) specify a QIS for non-hierarchic regional production, and Mahdavi, Shirazi, Cho, Sahebjamnia, and Ghobadi (2008) implement a QIS for distributed manufacturing shops. The web technologies can also assist quality inside the organization, by means of intranets (Hussain, Barber, & Hussain, 2009) and e-commerce (Tan, Lin, & Hung, 2003).

Other authors have studied IS support in the context of economic sectors; for example in construction (Love & Irani, 2003; Zeng, Lou, & Tam, 2007), agro-food (Schiefer, 1999), laboratorial (Schmitz & Boukhari, 2007), and manufacturing (Bandyopadhyay, 2003; Jiao, Pokharel, Kumar, & Zhang, 2007). Transversal studies

can be found in the work of Ulbrich and Woll (1993) and Li (2007), describing information modelling for product development. Other authors like X. Tang, Duan, and Chin (2007) have designed an integrated QIS, in a manner similar to software quality packages available in the market today. In the scope of ISO 9000, Sakthivel, Devadasan, Vinodh, Ramesh, and Shyamsundar (2007) describe an IS development and Lari (2002) points out areas where decision support systems could be used, for example, for corrective and preventive actions.

However, IT is only one part of the equation. A seminal model for studying the role of IS in quality management has been developed by Forza (1995a), and is presented in figure 3.

**<Figure 3 about here >**

Figure 3. Framework for studying the role of IS in supporting QMS (Forza, 1995b).

The model of figure 3 suggests the study of the QIS by its information flows and IT for quality. A subsequent publication by Forza (1995b) claims that information flows contribute to high quality performance, while the IT contribution requires further investigation. Although figure 3 suggests a mutual influence between the IS and the QMS (as denoted by the vertical bidirectional arrow), the author's findings mostly address the role of the IS in support of the QMS. This influential framework was selected by Sadeh, Arumugam, and Malarvizhi (2013) to show the supportive effect of QIS on TQM.

Later, other frameworks were developed, such as Valmohammadi (2011), to study the relation of IT with seven TQM principles; Kostagiolas (2006), for supporting ISO 9000 in healthcare; and Naveh and Halevy (2000) on using QIS as a basis for improvement programs. Au and Choi (1999) present a singular study that shares lessons

learned from a QIS design: early involvement of IT professionals; the importance of listening to employee feedback; and keeping the QIS aligned with continuous improvement. The IS plays an important role in QMS internalization, but the positive impact depends on the information management (Mithas, Ramasubbu, & Sambamurthy, 2011), IT resources and on the ability to make use of IT, thus building it into a capability (Zárraga-Rodríguez & Alvarez, 2013).

In summary, several studies addressed the impact of the IS on the QMS, in multiple contexts and with different IT solutions. However, there is a lack of methodologies to assist practitioners in the collaborative design and elicitation of the information requirements and IT support of business processes, according to QMS principles and requirements. As for run-time, guidance is missing on how to make sure that the information system is audit-friendly and prepared to evolve according to the principles that the QMS encloses. A plethora of IT solutions is already available as building blocks, leaving the organizational, social, and cultural issues involved in the synergistic design and evolution of the IS and the QMS as major challenges to tackle.

### *2.2. QMS in support of the IS*

We have seen why and how the IS is an important element in support of the QMS, but the reciprocal is also true (Delić, Radlovački, Kamberović, Vulanović, & Hadžistević, 2014).

Quality is a multi-dimensional concept in IS. Stylianou and Kumar (2000) sustain the idea of 'enterprise quality' as a holistic perception of IS and QMS in continuously improving the organization. Nevertheless, each view of IS quality is usually researched individually. For example, software engineers centre their attention on the quality attributes of the software, while managers are concerned with the way the

use of IS contributes to the profitability of the firm, and the impact on the performed work (Von Hellens, 1997).

TQM and ISO 9000 can be adopted for use in the entire IS lifecycle. Starting with the design, Wang (1998) proposes the Total Data Quality Management methodology, inspired by the Plan-Do-Check-Act (PDCA) cycle used for continuous improvement, while Worthington (2000) presents techniques to build an IS, starting with the selection of a quality system model such as ISO 9000. For the auditing phase, Chou et al. (1998) propose an integrated process designed with TQM and ISO 9000 requirements.

Some authors explored technological aspects to improve with quality; for example, Stylianou, Kumar, and Khouja (1997) exemplify how a TQM tool such as quality function deployment can be adopted for IS development, and Rothenberger, Kao, and Van Wassenhove (2010) demonstrated that quality is the key to cost-effective software production. Mandke and Nayar (2004) introduced the concept of information integrity.

A positive impact of TQM in ERP projects can be explained by the emphasis on customer satisfaction, top management support, and life-long learning (L. Li, Markowski, Xu, & Markowski, 2008; H.-F. Lin, 2010; Schniederjans & Kim, 2003). A field survey conducted by Prybutok, Zhang, and Ryan (2008) found that other principles, namely leadership, strategic planning, and customer focus, had a positive impact on the IS dimensions of information, system, and service quality. Moreover, Customer Relationship Management (CRM) has been shown to be positively influenced by ISO 9000 principles, such as customer focus (Ku, 2010; Su, Tsai, & Hsu, 2010). These examples illustrate how a purely technical perspective is insufficient and suggests that quality models should be linked to IS practice (Dahlberg & Jarvinen, 1997).

Other authors addressed social issues to bridge the user expectations gap in the IS lifecycle. By adopting TQM, the IS design is guided to satisfy potential expectations, uniting behavioural and technical aspects (Aggarwal & Rezaee, 1996; Chou, 2001; Zahedi, 1998). Hartman et al. (2002) reinforce this viewpoint, showing that, as the QMS maturity increases, the adoption of IS will be more user-centred and participative. The QMS is an opportunity for clarifying processes and for documenting know-how, therefore promoting knowledge transferability (Molina, Montes, & Fuentes, 2004). Furthermore, the quality assessment of computer information systems can be based in TQM and ISO 9000, as presented by the socio-technical approach of Palvia, Sharma, and Conrath (2001).

Both, technological and social aspects of IS, can improve with the QMS, but are organizations exploiting all the potential? According to Ravichandran and Rai (2000a), the IS departments should adopt a strategy that integrates all the dimensions of TQM. Top management support, stakeholder participation, product/service design, service quality, and quality information, are examples of dimensions with a direct and positive impact on their performance (Chow & Lui, 2003; DeJarnett, 1991; Siddiqui & Rahman, 2006). A pioneer study of TQM use in the IS function was developed by Pearson et al. (1995), revealing the benefits of improved customer satisfaction, enhanced quality of products and services, and flexibility in meeting customer demands. Afterwards, Paper and Rogder (1996) presented three case studies of TQM adoption, encouraging the involvement of the IS function with business process improvement. However, continuous improvement typical in quality requires constant changes in the process support systems, thus increasing IS pressure. On the other hand, failure to meet those demands may cause users to bypass the IT staff in the quality journey (Khalil, 1995).

The literature reveals several benefits in adopting quality principles and methods in IS design and management. As presented by Morabito, Themistocleous, and Serrano (2010), to improve the business value, the organization must combine IT with complementary resources such as training, process orientation, change, and flexibility orientation. However, the major challenge seems to be how to apply the values of a quality culture (Hildebrandt, Kristensen, Kanji, & Dahlgaard, 1991) to all the dimensions of the IS; for example, how to deal with continuous improvement as an opportunity for the IS teams to be proactive in improvement initiatives that ensure compliance and quality policy internalization via IT solutions.

### *2.3. IS and QMS shared view*

The third (minority) research strand that we have identified in the literature addresses synergies between the information system and the quality management system, instead of merely putting one at the service of the other. A need for deeper integration between the IS and the QMS is concluded by D'Souza and Sequeira (2011) in the context of the Malcolm Bridge National Quality Award, while Zárraga-Rodríguez and Alvarez (2013) found a link between information management capability and the European Foundation for Quality Management model. Other authors go further; for example, Jabnoun and Sahraoui (2004) advocate that QMS and IT plans should be developed simultaneously.

Although the QMS and the IS are different in nature, they may require similar organizational cultures (Fok, Fok, & Hartman, 2001). Philip and McKeown (2004) describe an example of business transformation and cultural changes developing managerial and organizational competencies, IS, and QMS. Increasing the TQM maturity also increases the users' perception of organizational performance and service quality (Hartman et al., 2002). C. Lin, Chuang, and Shih (2012) present a

correspondence between the development stages of TQM and IS. These studies acknowledge the potential of mutual impact, but once again their focus is unbalanced; the primary being the impact of quality principles on IS development, but missing emphasis on the role of the IS in fostering a quality culture.

Business process management (BPM) is a common topic of discussion in the IS and QMS research. There are studies supporting the existence of a mutual benefit of the IS/QMS in the performance of specific processes; for example in purchasing, as shown by Hemsworth, Sánchez-Rodríguez, and Bidgood (2008). Nevertheless, Iden (2012) argues that process goals are insufficiently detailed in ISO 9000-based QMSs and don't lead to consistent process improvement practices. There are also critical factors for a fit of BPM and IS, namely the standardization of processes, IT, training, and empowerment of employees (Trkman, 2010). These findings suggest that, when working separately, QMS and IS practitioners may have difficulties in implementing effective BPM systems, so teams should be multidisciplinary (Keith, 1994; Spencer & Duclos, 1998).

In conclusion, a shared organizational view of the IS and the QMS is appealing and considered desirable in the literature, but there is a lack of practical guidance on how to do it. For example, how to synergistically: (1) plan, establishing the requirements and goals for the joint development, in a way that is accessible and useful to both QMS/IS teams; (2) do, putting the systems in action, ensuring compliance and adherence to daily practice; (3) check, the development outputs; and (4) act, improving both systems and continuously refining the plan. The endeavour is complex, since the synergistic design of the IS and the QMS must consider organizational, social, and technological aspects that interact and support each other (Gunasekaran, Arunachalam, & Devadasan, 2006; Jensen, 1991). Conversely, maintaining both systems as separate

entities increases a risk of overlaying a new bureaucratic system on top of an already existing one (Rivers & Bae, 1999). To achieve the desired synergies, Cunha and Figueiredo (2005) defend the need of more studies to investigate both constructs further.

## 3. Leveraging synergies across IS and QMS lifecycles

Given the scarce actionable advice in the literature on how to create and deploy highly synergistic information and quality management systems, we set out to extend the seminal framework of Forza (1995a, 1995b). Our goal is to identify research guidelines for both, design-time and for run-time, as represented in figure 4.

**<Figure 4 about here >**

Figure 4. A map for further research.

The factor (A) '*IS in support of the QMS*', holistically considers the organizational IS. Our review suggests the need to add other IS components besides the QIS component of the original framework. For instance, the IS management practices, business processes, and the socio-technical aspects of the IS. Factor (B) proposes the study of the QMS not only as a source of requirements for the IS but also as a source of principles and values, with the potential for dynamically contributing to IS design and management. Factors (C1) and (C2) assert that design-time and run-time have distinct challenges and are sources of potential synergies. The design-time is the stage of the 'to-be' and 'should be' models for the creation of artefacts and tools. The run-time considers the phase when IS and QMS are already implemented and continuous improvement becomes a central concern. Nowadays, at this stage, IS and QMS teams continue to work separately, in spite of the success in the improvement of both systems being closely interrelated. The two moments are dependent of each other: the run-time

is the result of the actions of design-time, and also the basis for new iterations of design, as recommended by the PDCA cycle.

We argue that new approaches should be developed, that include practical artefacts to assist its users. Examples of artefacts can be architectural documentation of both systems and patterns of action that IS and QMS practitioners can adopt. At run-time, there is a need to foster the emergence of a quality culture, guided by the principles of the QMS. A shared view will be less effective if the integration stops at the design phase.

## 4. Conclusions

Nowadays, virtually all organizations have information systems in place, to support their business processes and data requirements of the various stakeholders. An increasing number is also setting up quality management systems (e.g., based on TQM or ISO 9000 standards) to ensure that their products or services consistently meet defined quality criteria and that improvement opportunities are sought.

What we have found out in our extensive literature review is that those organizations are not realizing the full potential of having both systems in operation. Furthermore, we have found out that this is not merely caused by lagging practice, but that it stems from limitations in the extant body of knowledge. In fact, although it is known that the articulation of the IS and the QMS can deliver significant organizational benefits (Sánchez-Rodríguez & Martínez-Lorente, 2011), only 20% of the studies address a shared view of these two systems. Moreover, even fewer of these provide concrete guidance on how to design and operate both systems, so that synergies are leveraged and the result is more than the sum of the two parts.

Taking into account the shortcomings in the literature and our experience with theory and practice of IS and QMS, we have extended the seminal framework of Forza (1995a, 1995b) to map out avenues for further research.

Although we have used rigorous best practices to perform our literature review, there are three major limitations in our work: (1) despite the care taken, the selection of databases and of the search terms constrains the results that were obtained; (2) we have confined the scope of our study to quality management approaches based on TQM and ISO 9000; and (3) although our review identifies numerous studies regarding the IS in support of the QMS, only general insights for the other two perspectives have been provided by the literature.

The expected migration to ISO 9001:2015 is an opportunity for improving the adoption of quality principles in business processes and in IT, exploring the opportunities offered by the IS in context awareness and documented information. An IS and QMS shared view is one that defends that (1) IS/QMS managers understand the work of each other and how they can cooperate to improve organizational performance, (2) IS and QMS plans should be aligned, (3) IS and QMS documentation is coherent, not redundant, and adherent to daily practice, (4) IT sourcing involves the joint decision of IS/QMS managers, (5) training of process participants includes QMS principles adoption, managerial, and technological aspects, (6) IS/QMS experts participate in IS quality issues (e.g., software verification, data quality programs), and (7) improvement actions address sociotechnical dimensions, namely, the development of people competences and IT support tools.

In future work, besides proposing methods to guide de synergistic design and operation of the IS and QMS in its full socio-technical complexity, researchers can also expand our literature review to include additional quality management approaches, such

as the more vertical AS 9100 (from the aerospace industry), or complementary, for example, addressing environment, safety, and social responsibility.

**References**


Aggarwal, R., & Rezaee, Z. (1996). Total quality management for bridging the expectations gap in systems development. *International Journal of Project Management*, *14*(2), 115–120.

Ang, C.-L., Davies, M., & Finlay, P. (2000). Measures to assess the impact of information technology on quality management. *International Journal of Quality & Reliability Management*, *17*(1), 42–66.

Ang, C.-L., Davies, M., & Finlay, P. (2001). An empirical study of the use of information technology to support total quality management. *Total Quality Management*, *12*(2), 145–157.

Anh, P., & Matsui, Y. (2011). Relationship between quality management information and operational performance: International perspective. *Management Research Review*, *34*(5), 519–540.

Au, G., & Choi, I. (1999). Facilitating implementation of total quality management through information technology. *Information Management*, *36*(6), 287–299.

Bandyopadhyay, J. (2003). A Total Quality Management Information System for Auto Parts Manufacturers in the United States. *International Journal of Management*, *20*(2), 187–193.

Casadesús, M., & Castro, R. (2005). How improving quality improves supply chain management: empirical study. *The TQM Magazine*, *17*(4), 345–357.

Chen, D., Mocker, M., Preston, D., & Teubner, A. (2010). Information Systems Strategy: Reconceptualization, Measurement, and Implications. *MIS Quarterly*, *34*(2), 233 – 259.

Chou, D. C. (2001). Integrating TQM into e-commerce. *Information Systems Management*, *18*(4), 31–39.

Chou, D. C., Yen, D. C., & Chen, J. Q. (1998). Analysis of the total quality management-based software auditing. *Total Quality Management*, *9*(7), 611–618.

Chow, W. S., & Lui, K. H. (2003). A structural analysis of the significance of a set of the original TQM measurement items in information systems function. *Journal of Computer Information Systems*, *43*(3), 81–91.

Cunha, P. R., & Figueiredo, A. D. (2005). Quality Management Systems and Information Systems: Getting More than the Sum of the Parts. In *Proceedings of the 11th Americas Conference on Information Systems (AMCIS)*. Omaha, USA.

D'Souza, S., & Sequeira, A. (2011). Information Systems and Quality Management in Healthcare Organization: *Journal of Technology Management for Growing Economies*, *2*(1), 47–60.

Daghfous, A., & Barkhi, R. (2009). The strategic management of information technology in UAE hotels: An exploratory study of TQM, SCM, and CRM implementations. *Technovation*, *29*(9), 588–595.

Dahlberg, T., & Jarvinen, J. (1997). Challenges to IS quality. *Information and Software Technology*, *39*(12), 809–818.

Davis, G. B. (2000). Information systems conceptual foundations: looking backward and forward. In R. Baskerville, J. Stage, & J. I. DeGross (Eds.), *Organizational and Social Perspectives on Information Technology* (pp. 61–82).

DeJarnett, L. R. (1991). What can Deming do for IS? *Information Strategy: The Executive's Journal*, *7*(3), 3–4.

Delić, M., Radlovački, V., Kamberović, B., Vulanović, S., & Hadžistević, M. (2014). Exploring the impact of quality management and application of information technologies on organisational performance – the case of Serbia and the wider region. *Total Quality Management & Business Excellence*, *25*(7-8), 776–789.

Dewhurst, F. W., Martínez-Lorente, A. R., & Sánchez-Rodríguez, C. (2003). An initial assessment of the influence of IT on TQM: a multiple case study. *International Journal of Operations & Production Management*, *23*(4), 348–374.

Fok, L. Y., Fok, W. M., & Hartman, S. J. (2001). Exploring the relationship between total quality management and information systems development. *Information & Management*, *38*(6), 355–371.

Forza, C. (1995a). Quality information systems and quality management: a reference model and associated measures for empirical research. *Industrial Management & Data Systems*, *95*(2), 6–14.

Forza, C. (1995b). The impact of information systems on quality performance: an empirical study. *International Journal of Operations & Production Management*, *15*(6), 69–83.

Gerber, A., Dietzsch, M., & Althaus, K. (2004). Information based, dynamic quality information system for non-hierarchic regional production networks. *Robotics and Computer-Integrated Manufacturing*, *20*(6), 583–591.

Gunasekaran, N., Arunachalam, V. P., & Devadasan, S. R. (2006). TISIT: a model for integrating TQM with software and information technologies. *The TQM Magazine*, *18*(2), 118–130.

Hartman, S. J., Fok, L. Y., Fok, W. M., & Li, J. (2002). Relationships among quality management, IS use and organizational performance in the health care and non-health care setting. *Total Quality Management*, *13*(7), 927–943.

Hemsworth, D., Sánchez-Rodríguez, C., & Bidgood, B. (2008). A structural model of the impact of Quality Management Practices and purchasing-related Information Systems on purchasing performance: A TQM perspective. *Total Quality Management & Business Excellence*, *19*(1-2), 151–164.

Hildebrandt, S., Kristensen, K., Kanji, G., & Dahlgaard, J. J. (1991). Quality culture and TQM. *Total Quality Management*, *2*(1), 1–16.

Hussain, Z., Barber, K., & Hussain, N. (2009). An Intranet based system as an enabler in effective project management and implementation of quality standards: A case study. *Journal of Engineering and Technology Management*, *26*(3), 196–210.

Iden, J. (2012). Investigating process management in firms with quality systems: a multi-case study. *Business Process Management Journal*, *18*(1), 104–121.

Jabnoun, N., & Sahraoui, S. (2004). Enabling a TQM structure through Information Technology. *Competitiveness Review: An International Business Journal Incorporating Journal of Global Competitiveness*, *14*(1/2), 72–81.

Jensen, T. J. (1991). A framework for quality system design in "one of a kind" manufacturing companies. *International Journal of Production Economics*, *22*(2), 121–130.

Jiao, R., Pokharel, S., Kumar, A., & Zhang, L. (2007). Development of an online quality information system for e-manufacturing. *Journal of Manufacturing Technology Management*, *18*(1), 36–53.

Keith, R. (1994). MIS+TQM=QIS. *Quality Progress*, *27*(4), 29–31.

Keramati, A., & Albadvi, A. (2009). Exploring the relationship between use of information technology in total quality management and SMEs performance using canonical correlation analysis: a survey on Swedish car part supplier sector. *International Journal of Information Technology and Management*, *8*(4), 442–462.

Khalil, O. (1995). Enabling Total Quality Management Through Information Systems. *Competitiveness Review: An International Business Journal Incorporating Journal of Global Competitiveness*, *5*(2), 48–58.

Kock, N., & McQueen, R. J. (1998). Groupware support as a moderator of interdepartmental knowledge communication in process improvement groups: an action research study. *Information Systems Journal*, *8*(3), 183–198.

Kostagiolas, P. (2006). Information Services for Supporting Quality Management in Healthcare. *Journal On Information Technology In Healthcare*, *4*(3), 137–146.

Ku, E. C. (2010). The impact of customer relationship management through implementation of information systems. *Total Quality Management & Business Excellence*, *21*(11), 1085–1102.

Kuei, C., Madu, C., & Lin, C. (2011). Developing global supply chain quality management systems. *International Journal of Production Research*, *49*(15), 4457–4481.

Lari, A. (2002). An integrated information system for quality management. *Business Process Management Journal*, *8*(2), 169–182.

Li, J.-W. (2007). Modelling a quality assurance information system for product development projects with the UML approach. *International Journal of Computer Integrated Manufacturing*, *20*(4), 370–386.

Li, L., Markowski, C., Xu, L., & Markowski, E. (2008). TQM—A predecessor of ERP implementation. *International Journal of Production Economics*, *115*(2), 569–580.

Lin, C., Chuang, H., & Shih, D. (2012). Development Stage and Relationship of MIS and TQM in the E-business ERA. *International Journal of Electronic Business Management*, *10*(1), 50–60.

Lin, H.-F. (2010). An investigation into the effects of IS quality and top management support on ERP system usage. *Total Quality Management & Business Excellence*, *21*(3), 335–349.

Love, P. E., & Irani, Z. (2003). A project management quality cost information system for the construction industry. *Information & Management*, *40*(7), 649–661.

Mahdavi, I., Shirazi, B., Cho, N., Sahebjamnia, N., & Ghobadi, S. (2008). Modeling an e-based real-time quality control information system in distributed manufacturing shops. *Computers in Industry*, *59*(8), 759–766.

Mandke, V. V, & Nayar, M. K. (2004). Beyond Quality: the Information Integrity Imperative. *Total Quality Management & Business Excellence*, *15*(5-6), 645–654.

Mathieson, K., & Wharton, T. J. (1993). Are information systems a barrier to total quality management ? *Journal of Systems Management*, *44*(9), 34–38.

Matta, K., Chen, H.-G., & Tama, J. (1998). The information requirements of total quality management. *Total Quality Management*, *9*(6), 445–461.

Mithas, S., Ramasubbu, N., & Sambamurthy, V. (2011). How Information Management Capability Influences Firm Performance. *MIS Quarterly*, *35*(1), 237–256.

Mjema, E. A. M., Victor, M. A. M., & Mwinuka, M. S. M. (2005). Analysis of roles of IT on quality management. *The TQM Magazine*, *17*(4), 364–374.

Molina, L. M., Montes, F. J. L., & Fuentes, M. D. M. F. (2004). TQM and ISO 9000 Effects on Knowledge Transferability and Knowledge Transfers. *Total Quality Management & Business Excellence*, *15*(7), 1001–1015.

Morabito, V., Themistocleous, M., & Serrano, A. (2010). A survey on integrated IS and competitive advantage. *Journal of Enterprise Information Management*, *23*(2), 201–214.

Naveh, E., & Halevy, A. (2000). A hierarchical framework for a quality information system. *Total Quality Management*, *11*(1), 87–111.

Palvia, S. C., Sharma, R. S., & Conrath, D. W. (2001). A socio-technical framework for quality assessment of computer information systems. *Industrial Management & Data Systems*, *101*(5), 237–251.

Paper, D., & Rogder, J. A. (1996). Quality information systems through people. *Journal of High Technology Management Research*, *7*(2), 269–282.

Pearson, J. M., McCahon, C. S., & Hightower, R. T. (1995). Total Quality Management. Are information systems managers ready? *Information & Management*, *29*(5), 251–263.

Perez-Arostegui, M. N., Benitez-Amado, J., & Tamayo-Torres, J. (2012). Information technology-enabled quality performance: an exploratory study. *Industrial Management & Data Systems*, *112*(3), 502–518.

Philip, G., & McKeown, I. (2004). Business Transformation and Organizational Culture: The Role of Competency, IS and TQM. *European Management Journal*, *22*(6), 624–636.

Prybutok, V. R., Zhang, X., & Ryan, S. D. (2008). Evaluating leadership, IT quality, and net benefits in an e-government environment. *Information & Management*, *45*(3), 143–152.

Pursglove, A. B., & Dale, B. G. (1996). The influence of management information and quality management systems on the development of quality costing. *Total Quality Management*, *7*(4), 421–432.

Ravichandran, T., & Rai, A. (2000). Total Quality Management in Information Systems Development: Key Constructs and Relationships. *Journal of Management Information Systems*, *16*(3), 119–155.

Ray, G., Muhanna, W. A., & Barney, J. B. (2005). Information Technology and the Performance of the Customer Service Process: A Resource-Based Analysis. *MIS Quarterly*, *29*(4), 625–652.

Rivers, P. A., & Bae, S. (1999). Aligning information systems for effective total quality management implementation in health care organizations. *Total Quality Management*, *10*(2), 281–289.

Rothenberger, M. A., Kao, Y.-C., & Van Wassenhove, L. N. (2010). Total quality in software development: An empirical study of quality drivers and benefits in Indian software projects. *Information & Management*, *47*(7-8), 372–379.

Sadeh, E., Arumugam, V. C., & Malarvizhi, C. A. (2013). Integration of EFQM framework and quality information systems. *Total Quality Management & Business Excellence*, *24*(1-2), 188–209.

Sakthivel, M., Devadasan, S. R., Vinodh, S., Ramesh, A., & Shyamsundar, S. (2007). ISO 9001:2000 based Quality Information Management Responsibility System. *International Journal of Business Information Systems*, *2*(2), 217–237.

Sánchez-Rodríguez, C., Dewhurst, F. W., & Martínez-Lorente, A. R. (2006). IT use in supporting TQM initiatives: an empirical investigation. *International Journal of Operations & Production Management*, *26*(5), 486–504.

Sánchez-Rodríguez, C., & Martínez-Lorente, A. R. (2011). Effect of IT and quality management on performance. *Industrial Management & Data Systems*, *111*(6), 830–848.

Schiefer, G. (1999). ICT and quality management. *Computers and Electronics in Agriculture*, *22*(2), 85–95.

Schmitz, V., & Boukhari, M. (2007). Information systems as a quality management tool in clinical laboratories. *Journal of Physics: Conference Series 90 012005*, *1*, 1–7.

Schniederjans, M. J., & Kim, G. C. (2003). Implementing enterprise resource planning systems with total quality control and business process reengineering: Survey results. *International Journal of Operations & Production Management*, *23*(4), 418–429.

Shao, X.-Y., Wu, J., Deng, C., Li, P.-G., & Feng, C.-X. J. (2006). A web-enabled collaborative quality management system. *Journal of Manufacturing Systems*, *25*(2), 95–107.

Siddiqui, J., & Rahman, Z. (2006). TQM for Information Systems: Are Indian Organizations Ready? *Interdisciplinary Journal of Information, Knowledge, and Management*, *1*, 125–136.

Spencer, M. S., & Duclos, L. K. (1998). TQM Stress MIS. *American Journal of Business*, *13*(1), 59–64.

Stylianou, A. C., & Kumar, R. L. (2000). An integrative framework for IS quality management. *Communications of the ACM*, *43*(9), 99–104.

Stylianou, A. C., Kumar, R. L., & Khouja, M. J. (1997). A total quality management-based systems development process. *ACM SIGMIS Database*, *28*(3), 59–71.

Su, C.-H., Tsai, A., & Hsu, C.-L. (2010). The TQM extension: Total customer relationship management. *Total Quality Management & Business Excellence*, *21*(1), 79–92.

Tan, B., Lin, C., & Hung, H. (2003). An ISO 9001:2000 quality information system in e-commerce environment. *Industrial Management & Data Systems*, *103*(9), 666–676.

Tang, X., Duan, G., & Chin, K.-S. (2007). Development and implementation of an integrated quality information system-a China experience. *International Journal of Advanced Manufacturing Technology*, *32*(5-6), 608–616.

Tang, X.-Q., & Lu, Q.-L. (2002). Intranet/Extranet/Internet-Based Quality Information Management System in Expanded Enterprises. *International Journal of Advanced Manufacturing Technology*, *20*(11), 853–858.

Taylor, W. A., & Wright, G. H. (2006). The contribution of measurement and information infrastructure to TQM success. *Omega*, *34*(4), 372–384.

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management*, *14*(3), 207–222.

Trkman, P. (2010). The critical success factors of business process management. *International Journal of Information Management*, *30*(2), 125–134.

Ulbrich, A., & Woll, R. (1993). Methods for Quality-Driven Product Development. *CIRP Annals - Manufacturing Technology*, *42*(1), 151–154.

Valmohammadi, C. (2011). An empirical research on the relation between IT and TQM Practices. *International Journal of Academic Research*, *3*(1), 874–880.

Von Hellens, L. A. (1997). Information systems quality versus software quality a discussion from a managerial, an organisational and an engineering viewpoint. *Information and Software Technology*, *39*(12), 801–808.

Wai, L., Seebaluck, A., & Teeroovengadum, V. (2011). Impact of information technology on quality management dimensions and its implications. *European Business Review*, *23*(6), 592–608.

Wang, R. Y. (1998). A product perspective on total data quality management. *Communications of the ACM*, *41*(2), 58–65.

Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare the future. *MIS Quarterly*, *26*(2), xiii–xxiii.

Wolfe, P., & Tassé, S. (1979). Development of a quality assurance management information system. *International Journal of Production Research*, *17*(3), 169–180.

Worthington, J. C. (2000). Two data bases in every garage: information quality systems. *Quality Assurance: Good Practice, Regulation, and Law*, *8*(3-4), 225–44.

Xu, L. Da. (2011). Information architecture for supply chain quality management. *International Journal of Production Research*, *49*(1), 183–198.

Zahedi, F. (1998). Quality information systems: a unifying framework. *International Journal of Technology Management*, *16*(4-6), 446–465.

Zárraga-Rodríguez, M., & Alvarez, M. J. (2013). Exploring the links between information capability and the EFQM business excellence model: the case of Basque Country Quality award winners. *Total Quality Management & Business Excellence*, *24*(5-6), 539–560.

Zeng, S. X., Lou, G. X., & Tam, V. W. Y. (2007). Managing information flows for quality improvement of projects. *Measuring Business Excellence*, *11*(3), 30–40.

Zhu, Z., & Scheuermann, L. (1999). A comparison of quality programmes: Total quality management and ISO 9000. *Total Quality Management*, *10*(2), 291–297.

## Figures

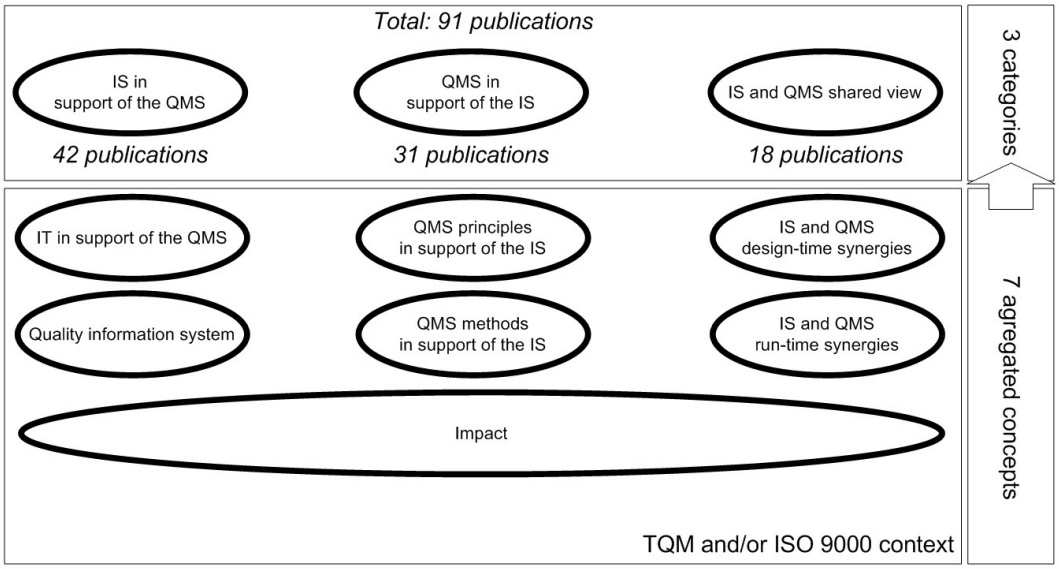


Figure 1. Major categories and concepts in the IS – QMS literature.

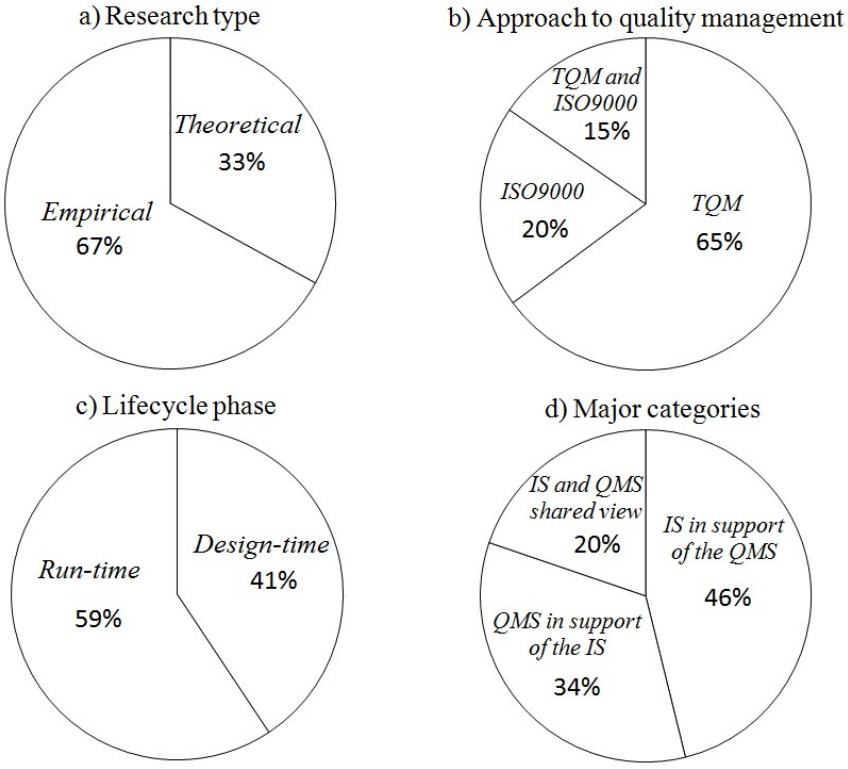

Figure 2. Paper distribution.

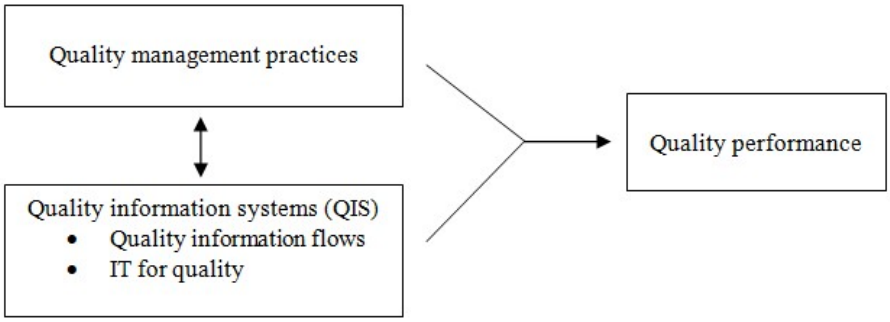


Figure 3. Framework for studying the role of IS in supporting QM practices (adapted from Forza, 1995b).

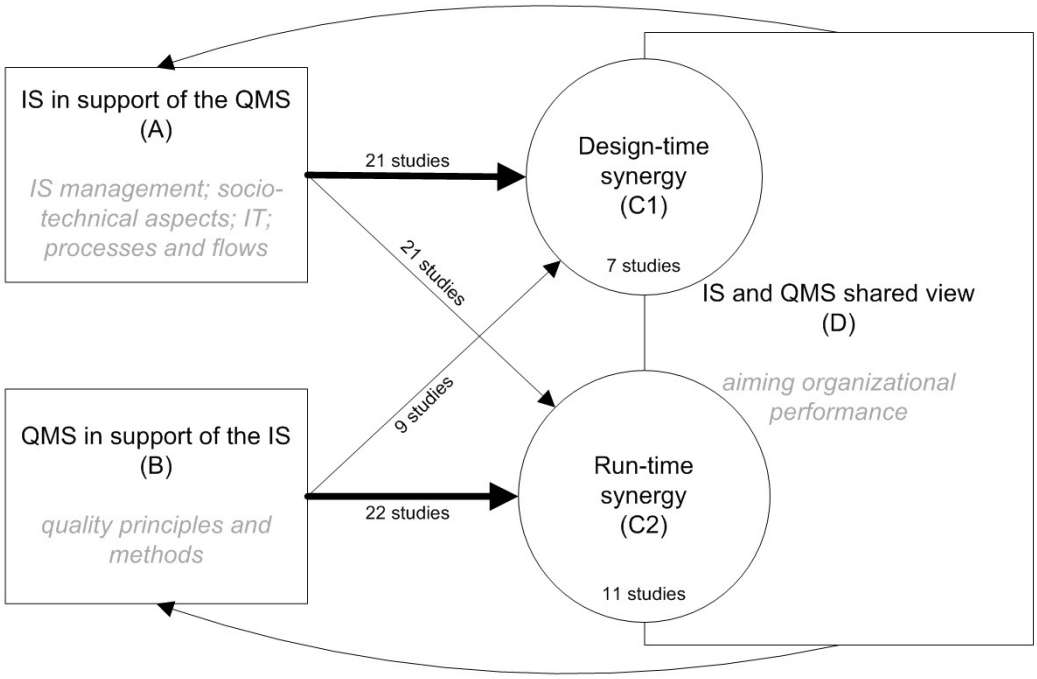


Figure 4. A map for further research.