

## Special Issue on Design Science in Organizations

### Research Article

# e-Qualifácil: Preparing Small Businesses for a Quality Management System

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## Abstract

More than 95 percent of all the businesses around the globe are small- and medium-sized (International Organization for Standardization [ISO], 2016). However, the limited resources of small businesses represent a difficulty in implementing a quality management system (QMS) complied with ISO 9001:2015, which is many times demanded by the supply chain of these companies. The object of this research was to develop an artifact, named e-Qualifácil, to access the current stage of the small business' QMS. Using the Design Science Research method, the artifact was built considering the seven guidelines of the Design Science and the five phases of research applied to development cycles of artifacts. e-Qualifácil was tested in three small businesses of discrete manufacturing. For each business, the artifact generated a prioritized list of activities that together represent an action plan for the adequacy of business' process to the requirements of the ISO 9001 standard. In addition, the application process of the artifact pointed out the lack of leadership in planning, formalization and control of quality processes, and technical processes in general. Design Science Research showed up as a good option to include rigor in organizational interventions and a practical tool to strengthening knowledge dissemination.

**Keywords:** design science research; quality management; ISO 9000 standards; small business; design science.

## Introduction

Small businesses are undeniably important for economic and social development not only in terms of employment and income generation, but also in decentralization of capital (Madi & Gonçalves, 2012; Serviço Brasileiro de Apoio às Micro e Pequenas Empresas [SEBRAE], 2017). As part of the entrepreneurial community, small businesses make an essential contribution to society's economic welfare, producing a considerable portion of total goods and services, stimulating innovation and competitiveness, and collaborating with big companies in the development of more efficient products (Longenecker, Moore, & Petty, 1997).

Like any other business, regardless of size, small businesses need to ensure high quality products and services as strategic competitive advantage factors. However, some specificities as informal management, low managerial skills, and scarcity of resources (Garófalo, 2009) compromise the formalization of technical and control processes that assure internal consistence and quality.

Despite the largely recognized benefits of quality-focused management, implementing a quality management system (QMS) is a challenge for small businesses because of the costs involved in creating and supporting such a system, a lack of specific knowledge, and restricted financial and human resources (Chatzoglou, Chatzoudes, & Kipraios, 2015; Yusof & Aspinwall, 2000), even when QMS is a requirement of ISO 9001 certified clients.

Considering this scenario, small businesses may need effective support to access and comprehend what is necessary to implement a QMS. Thus, the objective of this paper is to develop an organizational self-assessment artifact to analyze the current situation of the quality management system of small businesses and propose a prioritized list of actions to improve that system. It has to be a user-friendly artifact that reduces the business dependency on external resources and increase corporate knowledge. In a satisfactory way, the company could prepare itself for a future ISO 9001:2015 certification.

## Quality Management

Quality management as a formal organizational function is a recent development (Garvin, 1992). Quality management evolved alongside the development of industrialization (Carvalho & Miguel, 2012) and management theories (Maximiano, 2004). By incorporating other concepts, quality management became a systematic approach (Maximiano, 2004).

Encompassing products and services, users, and perceived value, quality has focused on inspection, control, guarantee, and management; currently the view on quality emphasizes the integration of management systems (Carvalho & Miguel, 2012; Evans, Foster, & Linderman, 2014; Garvin, 1992; Jasiulewicz-Kaczmarek, 2016). Through continuous improvement, quality management aims at organizational efficiency and effectiveness. Social, environmental, and economic dimensions are also considered (Garengo & Biazzo, 2013) in search of competitive advantages.

The choice of a quality management system model is a strategic decision (Associação Brasileira de Normas Técnicas [ABNT], 2015a; ISO, 2016), which depends on the firm's characteristics and goals (Maguad, 2006).

A standardized management system is a set of interrelated elements, which establishes policies, goals, and processes for achieving an organization's objectives (ABNT, 2015b). This system should be documented and established by a specialized organization for standardization (ABNT, n.d.). QMS requirements specify good management practices to achieve quality and customer satisfaction in any kind of product or service (ISO, 2016).

ISO is one of the main international organizations that establish standards to facilitate trade among nations and advance science and technology (Ferreira, 2012). ISO's QMS model, comprising the set of standards called ISO 9000 series, is based on the principle of continuous improvement. It is applicable to any type of organization (ISO, 2019) and it is largely used throughout the world (Ferreira, 2012). In addition to the benefits already mentioned, its implementation helps outline organizational risks and remedies (ISO, 2019).

ISO 9000:2015 - Quality management principles (Table 1) show how management may maximize resources and identify the actions needed to deal with the consequences of supplying products and services (ABNT, 2015b).

Table 1

#### Quality management principles: ISO 9000:2015

Quality management principles	Declaration	Justification
Customer focus	The main focus of quality management is to meet customer needs and to strive to exceed their expectations.	Sustainable success can only be achieved when an organization builds and retains customers' and other stakeholders' trust. Such trust is reinforced by understanding their current and future needs. Each aspect of customer interaction is an opportunity to create higher value.
Leadership	Leaders across the hierarchy establish unity of purpose and direction of the organization. They should create and maintain an internal environment in which people can become fully involved in achieving the organization's quality-related objectives.	Establishing unity of purpose and direction and engaging people help the organization align strategies, policies, processes, and resources to achieve objectives.
Engagement of people	Empowered, involved, competent people, at all levels in the organization, are essential to increase organizational capabilities to create and deliver value.	Managing an organization effectively and efficiently demands respecting and involving people at all levels. Recognition, accountability, and improving competencies facilitate people's involvement in fulfilling the organization's quality-related objectives.

Continues

**Table 1 (continued)**

Quality management principles	Declaration	Justification
Process approach	Consistent, predictable results can be achieved more efficiently and effectively when activities are seen and managed as interrelated processes working inside a consistent system.	QMS consists of interrelated processes. Understanding how this system yields results allows the organization to optimize the system and its performance.
Improvement	A successful organization has a permanent focus on improvement.	Improvement is essential to keep the current level of organizational performance, to respond to changes in both the internal and external environments, and to generate new opportunities.
Evidence-based decision-making	Decisions which are based on the analysis and evaluation of data and information are more likely to yield desired results.	Decision-making may be a complex process as it always involves some degree of uncertainty, and often various types and sources of input. Data interpretation may also be subjective. It is important to understand cause-effect relationships and potential unintended consequences. Analysis of facts, evidence, and data leads to greater objectivity and confidence in decision-making.
Relationship management	For sustainable success, organizations should manage their relationship with important stakeholders, such as providers.	Stakeholders influence organizational performance. An organization is more likely to achieve sustainable success when relationships with all stakeholders are managed to optimize their impact on performance. Managing relationships with networks of providers and partners is particularly crucial.

**Note.** Source: developed based on Associação Brasileira de Normas Técnicas. (2010). *ABNT NBR ISO 9004. Gestão para o sucesso sustentado de uma organização – Uma abordagem da gestão da qualidade* (pp. 39-43). Rio de Janeiro, Brazil: Author; and Associação Brasileira de Normas Técnicas. (2015b). *ABNT NBR ISO 9000: 2015 - Sistemas de gestão da qualidade - fundamentos e vocabulário* (pp. 3-9). Rio de Janeiro, Brazil: Author.

Quality management principles synthesize quality gurus' postulates (Paladini, 1998). These principles are also related to the external environment (customers and stakeholders) and to internal management (process approach, continuous improvement, and evidence-based decision-making). This set of principles should encompass all the organizational players, leaders, and employees, as well as all stakeholders. The work process is considered a flow under continuous scrutiny and control. The emphasis is on strategic thinking and acting (Chatzoglou et al., 2015; Maguad, 2006).

In terms of structure, ISO 9001:2015 combines quality management principles with Deming's (1990) PDCA (Plan-Do-Check-Act) cycle, defining ten requirements (seven of which are auditable). Table 2 describes the auditable requirements. The non-auditable requirements are #1 – Scope, #2 – Normative reference, and #3 – Terms and definitions.

Table 2

**ISO 9000:2015 Auditable requirements**

Requirement	Requirement scope
#4 – Context of the organization	Description and analysis of the environment and shareholder expectations, and definition of the QMS scope.
#5 – Role of leadership	Roles and responsibilities regarding the quality policy, clear understanding of the context, and relationship with employees.
#6 – Planning	Risk and opportunity analysis, definition of quality objectives, and planning for change.
#7 – Support	Clarification about resources, competencies, communication processes, and existing documented information.
#8 – Operation	Plan, control, and execution of product- and service-related activities.
#9 – Performance evaluation	Monitoring, auditing, and critical analysis by top management.
#10 – Continuous improvement	Solution of nonconformities and potential corrective actions.

**Note.** Source: developed based on Associação Brasileira de Normas Técnicas. (2015b). *ABNT NBR ISO 9000: 2015 - Sistemas de gestão da qualidade - fundamentos e vocabulário* (pp. 3-9). Rio de Janeiro, Brazil: Author.

Defining and assigning these requirements highlights the relationship between production and administrative support inside the organization (ABNT, 2010; Barros, Sampaio, & Saraiva, 2014; ISO, 2019). The requirements are translated into 269 questions that the company must answer, and provide evidence for, in quality certification procedures.

Certification is a process to ensure, by means of a written certificate, that the quality management system meets the requirements of a normative standard. It is issued by an independent certification organization (ISO, 2016; Shankar, 2003). Conformity to an international standard provides benefits such as recognition of an efficient management system and potential to break down commercial barriers. In some cases, it is a contractual requirement for selling or buying a product or service (ISO, 2016).

Specifically, these benefits are associated to stable, integrated processes, adequacy to customer needs and specifications, and a clear understanding of the organizational structure's operation (ABNT, n.d.; Maekawa, Carvalho, & Oliveira, 2013; Tarí, Molina-Azorin, & Heras, 2012; Yang, 2001).

Overrating certification often leads to minimizing difficulty in its implementation and maintenance. Some of these difficulties are: a lack of commitment or indifference by top management; paperwork burden in producing normative documents; restricted financial resources; inadequate culture; resistance to change; high costs with auditing, hiring consultants, and training (Maekawa et al., 2013). Regarding small businesses, Yamanaka (2008) summarized a list of studies showing difficulty related to a lack of time and resources to support certification activities, as well as an inexistent demand from the market.

## Small Business: Specificities and Management

Small businesses play a vital role in the world's economies. More than 95 percent of all the businesses around the globe are small- and medium-sized (ISO, 2016).

There are many criteria to define a small business (Robbins & Decenzo, 2004), including some considered arbitrary – such as its size (Longenecker et al., 1997). The most usual criterion is a combination of income (between R\$ 360 thousand and R\$ 4.8 million) (Lei n. 123, 2006) with the number of employees (industry: 20 to 99; commerce and services: 10 to 49) (SEBRAE, 2017). Therefore, 6.1% of the businesses in Brazil may be considered small – a total of 419,000 companies, which generate 28.49% of the country's formal, private-sector jobs outside agribusiness (SEBRAE, 2017).

Usually, a small business is private-owned, independently operated and funded. Typically, the small business segment is unequal in terms of productivity, access to funding, ownership of resources for investment, and innovation capabilities (Bateman & Snell, 2006; Kaufmann & Tödting, 2002; Robbins & Decenzo, 2004).

Leone (1999) defines three small business' specialties: organizational, decision-making, and individual. Organizationally, small businesses present scarcity of resources, weak market position, centralized management, and almost intuitive administrative circle. In terms of the decision-making process, those companies prioritize short-term horizon with absence of quantitative data. In addition, the owner-CEO is considered all-powerful and, many times, have a no-differentiated position from the company in terms of both assets and personal influence. According to Leone (1999), these specialties impose a specific managerial approach to small business.

Advancing on Leone's (1999) arguments, Garófalo (2009) classifies these specificities along three dimensions: informal management, low managerial skills, and scarcity of resources. Informal management implies low usage of managerial tools (Almeida, Pereira, & Lima, 2016) generating information asymmetry, which is also caused by a paternalistic culture (Silva & Scheffer, 2015). Small business managers lack knowledge of and interest in management techniques (Yusof & Aspinwall, 2000). In addition to less access to financial resources, human resources are limited in both number and qualifications (Garófalo, 2009). Under a different perspective, these conditions favor a more flexible, context-adaptable management style (Grossi & Oliveira, 2009; Kaufmann & Tödting, 2002).

Quality management is important to help small businesses grow and compete on a worldwide basis (Solis, Rao, & Ragu-Nathan, 2001). However, implementing such a system in a small business is more challenging due to creation and maintenance costs, an absence of formal planning, leadership issues, a lack of a process approach to management, and insufficient risk assessment (ISO, 2016; Maekawa et al., 2013; Yamanaka, 2008). Therefore, a small business needs to establish specific criteria to implement a formal quality management system, such as stepwise, monitored implementation; realistic goals; manager and employee training; support

from external consultants; managerial involvement; and effective monitoring of the results (Assarlind & Gremyr, 2014).

Studies on quality management in small businesses demonstrate that formal knowledge on its related concepts is often precarious; that an inward outlook rather than on customer needs tends to minimize results; and that implementing quality management should be supported by simple, uncomplicated, easily-learned processes (Agusti & Deschamps, 2013; Assarlind & Gremyr, 2014; Aziz & Ahmad, 2013; Zimon, 2016). ISO 9000 certifications are rare. When they exist, their potential benefits are curbed for a lack of strategic thinking and operational and managerial skills, as well as difficulty in hiring specialized support (Chatzoglou et al., 2015; Kaufmann & Tödting, 2002; Nwankwo, 2000; Yusof & Aspinwall, 2000).

## Methodological Design

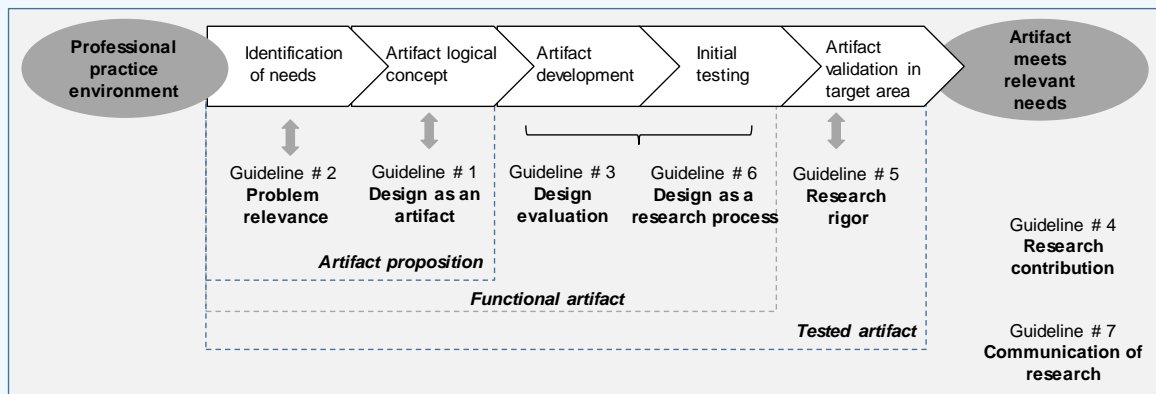
Design Science, which epistemologically pertains to a pragmatic research perspective (Creswell, 2007; De Sordi, Azevedo, & Meireles, 2015), aims to solve a problem, or build something still non-existing, by shortening the distance between theory and practice (Dresch, Lacerda, & Antunes, 2015a; Simon, 1996; Van Aken, 2004; Van Aken & Romme, 2009).

The present study used design-science research (Dresch et al., 2015a; Dresch, Lacerda, & Miguel, 2015b; Hevner & Chatterjee, 2010) to develop an organizational self-assessment artifact (software) to analyze the current situation of the quality management system of small businesses and propose a prioritized list of actions to improve that system. The assessment is based on ISO 9001:2015 standard requirements. The artifact's development and testing took into consideration the seven Design-Science Research Guidelines (Hevner, March, Park, & Ram, 2004), combined with the five-step cycle of technological artifact development (De Sordi et al., 2015).

The seven guidelines proposed by Hevner, March, Park and Ram (2004) guide the research process. The artifact has to be viable (#1 - design as an artifact) as a technology-based developed solution to a relevant business problem (#2 - problem relevance). In addition, its efficacy has to be assured (#3 - design evaluation) as well as its clear contributions (#4 - research contribution). The method to construct and evaluate the design artifact has to be rigorous (#5 - research rigor) and it has to be tested (#6 - design as a search process). The research needs to be effectively presented (#7 - communication of research).

The phases in the technological artifact development cycle (De Sordi et al., 2015) are in line with the guidelines of Hevner et al. (2004). The two initial phases, identification of needs and artifact logical concept, correspond to guidelines 2 and 1, respectively; they constitute the artifact proposition. Phases 3 and 4, artifacts development and initial testing, correspond to guidelines 3 and 6 (design-science approach carried out in a laboratory). Phase 5, artifact validation in the target area, corresponds to guideline 5. Following this process, guidelines 4 and 7 (contribution and communication) can be gauged. Figure 1 depicts the research process.





**Figure 1.** Research process

Source: Developed based on De Sordi, Azevedo, M. C., & Meireles, M. A. (2015). A pesquisa Design Science no Brasil segundo as publicações em Administração da Informação (p. 171). *Revista de Gestão da Tecnologia e Sistemas de Informação*, 12(1), 165-186. <http://dx.doi.org/10.4301/S1807-17752015000100009>

## Problem relevance (Guideline #2)

Assessing problem relevance encompassed three types of investigation: research in the academic literature; search for a currently available similar artifact; and evaluation of small businesses' potential interest in one artifact.

The research in the academic literature was based on articles published in top journals (A1 to B1). SPELL (Scientific Periodicals Electronic Library) was used for its coverage and availability of Brazilian articles. The search included 12 keywords related to the method and research objective. Out of the 22 articles found, none had the aim to develop an artifact to evaluate quality management systems.

A Google search was done to search for an existing software or device with a similar purpose to the proposed artifact. Twelve keywords in Portuguese and English were used, as well as variations of the term "self-diagnosis". This research found 30 software solutions developed by companies in Brazil, USA, Portugal, England, Finland, and Canada. Table 3 shows the findings. The most significant difference between the existing software solutions and the proposed artifact relates to their core purpose. Most software offers the QMS support after certification, whereas the proposed artifact supports pre-certification activities.

Table 3

**Specifications of quality management software found**

Number of occurrences	Scope	Purpose
23	Managing quality-related processes	Maintenance, automation, recording, and management of quality processes to meet post-certification requirements
2	Industry-specific certification	Adequacy to certification in a specific industry: textile industry quality seal and quality processes in construction
1	Usage of technical standards	Assessment of SME entrepreneurs' knowledge on usage and application of technical standards
1	Self-assessment questionnaire—ISO 9001:2015	Simplified analysis of standard requirements with potential help from consultants
1	Quality audit	Automation of quality audit processes
1	Diagnostics on management maturity	Managers' self-assessment for award giving
1	List of documents	Percentage of the required QMS documents existing and adequate

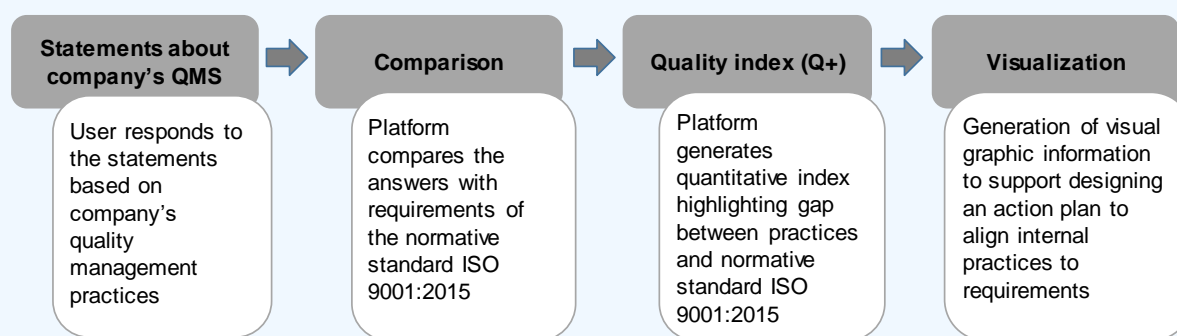
**Note.** Developed by the authors.

To evaluate small businesses' potential interest in one self-assessment artifact (software) that analyzes the current situation of the quality management, twenty-one businesses were contacted (some convenience-selected and other through snowball). Out of those, managers from six businesses answered a questionnaire to assess potential usage of an artifact. It was mainly a closed questions questionnaire around ISO 9001, certification, quality management tools (11 questions), and an open question on QMS: how do you will implement/upgrade your quality management system? The companies, in both manufacturing and services, are located in Greater São Paulo. Time of operation varies from 7 to 35 years. Four of the companies know ISO 9000 and one of them is certified because of client demand. Four of them stated that a QMS is important, but they lack the sufficient resources, external requirement, and knowledge to implement it – the same arguments found by Maekawa, Carvalho and Oliveira (2013) and Yamanaka (2008). Four companies admit that a QMS would improve their market image. They saw that any sort of quality tool might help the implementation process.

Those three investigations together justify the developing of an artifact.

**Design as an artifact (Guideline #1)**

The e-Qualifácil software was developed using Excel in order to simplify small business access to it. The artifact name was chosen to transmit two information: e (electronic), and Qualifácil (quality made ease, demystifying quality management). The Excel was selected for being a well-known and common computational resource, used by individuals and all sized companies. Users do not necessarily have to be quality specialists. The software's concept is simple, user-friendly, and self-explanatory. Figure 2 depicts the software's process flow.



**Figure 2.** Software process flow

Source: Developed by the authors.

The statements about the business's quality management were based on questions from the ISO 9001:2015 standard. The standard's language is very technical, but the statements' wording was simplified. The 269 questions referring to the 7 auditable requirements were transformed into 130 statements. Two quality experts and two non-experts validated the statements to ensure, respectively, conformity with the requirements and easy comprehension. Two rounds with the experts and three rounds with the non-experts were conducted alternately. Table 4 shows some excerpts of the findings to clarify some of the software statements.

Table 4

#### Deployment of statements about QMS (examples of statements)

Normative requirements (ISO 9001:2015)	Requirements/checklist for quality audit	Statements about QMS
5/ 5.2/ 5.2.2	Is the quality policy  Q35: documented and updated? Q36: communicated and understood? Q37: available to stakeholders?	A19: The quality policy is written, updated, and the company's employees know, understand, and apply its concepts on a daily basis.  ADDITIONAL EXPLANATION <b>Quality Policy</b> is a written statement about management's intentions regarding quality foundations and objectives.
6/ 6.2/ 6.2.1	Does the organization plan:  Q46: actions needed to address risks and opportunities? Q47: how to integrate and implement actions into its QMS processes and evaluate the effectiveness of actions?	A24: The organization plans actions to improve quality taking into consideration business risks and opportunities.

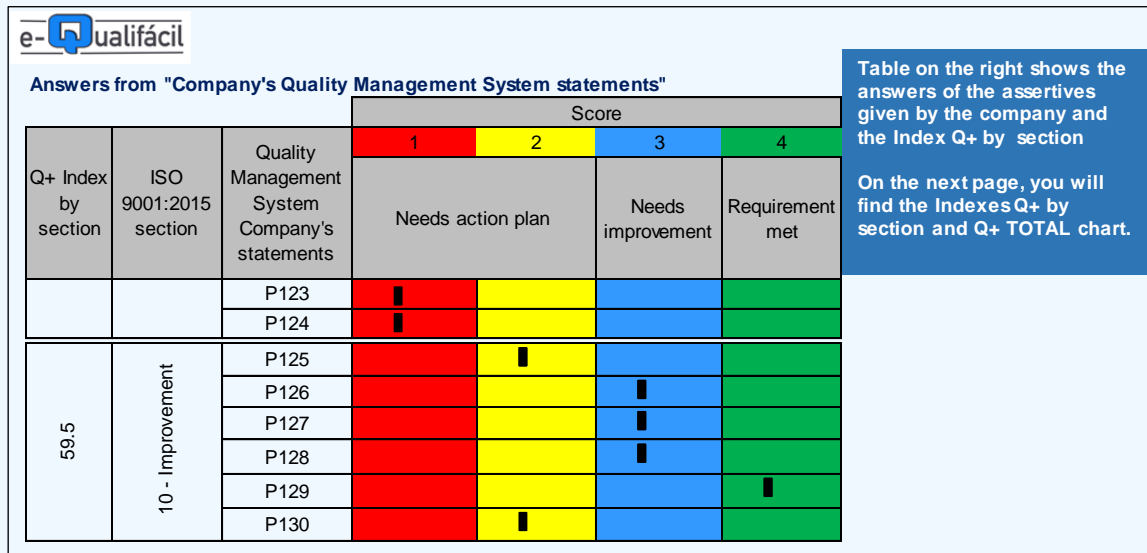
**Note.** Developed by the authors. The content was originally written in Portuguese.

The answers use a value scale as follows: (1) item neither implemented nor documented; (2) item implemented but not documented; (3) item implemented and partially documented; and (4) item fully implemented and documented. The four values were defined in order to avoid a midpoint.

Two types of Q<sup>+</sup> indices are calculated – a specific one for each section of the standard (Table 2) and a Total Q<sup>+</sup> index considering all the sections together. Both the individual scores attributed

to each statement and the statement’s weight are considered in calculation. Some statements have different weights in function of the number of requirements in the standard, as shown in Table 4. Individual scores given to the statements serve as input in prioritizing potential activities in the action plan.

Figure 3 depicts one of the artifact’s screens with inputs for defining an action plan.



**Figure 3.** e-Qualifácil screen with inputs for action plan  
 Source: e-Qualifácil artifact results page (Company C). The content was originally written in Portuguese.

### Design evaluation (Guideline #3)

“The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods” (Hevner et al., 2004, p. 85). The five types of evaluation methods proposed (Dresch et al. 2015a; Hevner et al., 2004) were used to ensure research rigor. Table 5 specifies researcher’s options for each method.

Table 5

#### Evaluation methods used with e-Qualifácil

Evaluation method	Selection	Justification
<b>Observational</b>	Field study	The application was monitored in three different businesses in a four-stage process.
<b>Analytical</b>	Dynamic analysis	The researchers were present during software use. Without interfering, they would observe usability, user reaction, and accuracy of responses.
<b>Experimental</b>	Controlled experiment	Despite on-site, real-life usage, the experiment may be considered controlled.
<b>Testing</b>	Functional test	The researchers performed some testing protocols (themselves as well as outside partners).
<b>Descriptive</b>	Scenarios	The artifact was analyzed in a real-life environment.

**Note.** Source: Developed based on Hevner, A. R., March, S., Park, J., & Ram, S. (2004). Design science in information systems research (p. 86). *MIS Quarterly*, 28(1), 75-105; and Dresch, A., Lacerda, D. P., & Antunes, J. A. V., Junior. (2015a). *Design science research: Método de pesquisa para o avanço da ciência e tecnologia* (p. 97). Porto Alegre, Brazil: Bookman.

The choice of evaluation methods grounded the research option of performing an improvement (Gregor & Hevner, 2013) or exploration (Gregor & Hevner, 2014), that is, a new solution to a known problem.

Thus, the observational method used was the field study. The preference was to monitor the use of artifact in multiple environments instead of only one business case. This option emphasizes the portability analysis of the artifact. In terms of analyses, the preference was for dynamic analysis, which enables a more comprehensive approach when compared to static or architecture analysis that privileges only one dimension like functionality or architecture of the artifact.

The use of controlled experiment enabled a view of a real situation, assuming variables other than just the data entered in the artifact, like usability, knowledge, user self-pressure. The white-box test was more effective, enabling the test of all functionality and not only failures and defects. It is noteworthy that the researchers performed the black-box test a priori. Finally, scenarios were not constructed but real-life environments brought more insights than theoretical arguments.

### **Design as a search process (Guideline #6)**

After being tested for functionality and interface, the artifact was evaluated in three small discrete manufacturing Brazilian businesses without QMS certification. The three small businesses are suppliers of an ISO 9001:2015-certified American company that helped the researchers make contact with them. A fourth small business was contacted but did not agree to participate in the process.

The artifact was evaluated in four stages. First, the company would choose a professional to receive the software, answer the statements, and verify the Q+ index results. Next, the respondent received a written copy of ISO 9001:2015 standard to check whether the artifact's statements helped understand the standard. During this stage, there was interaction with the researchers. In the third stage, the company's professionals would fill out a questionnaire to evaluate the e-Qualifácil software. Finally, the researchers would perform an on-site audit in order to check response accuracy and, ultimately, artifact functionality.

### **Design rigor (Guideline #5)**

The users and researchers were involved in evaluating confidence in the artifact and in the results from its usage (Dresch et al., 2015a).

After using the software, each user received a copy of the ISO 9001 standard and was asked to comment on its requirements and sections (content, understanding, competitiveness). Respondents were also asked to relate each statement of the artifact to a standard requirement to verify to what extent the statement duly explained and represented the standard.

Additionally, each user received a questionnaire to evaluate e-Qualifácil. The questionnaire comprises 34 statements across five sections (Table 6), using a 5-point agreement scale (1—I totally disagree to 5—I totally agree). Software performance was considered good when each statement got at least a 4 score (I partially agree) and the questionnaire's total score reached 136. The questionnaire also has a space for comments, suggestions, recommendations, problems, or report experience with the use of the application.

Table 6

### Questionnaire to evaluate e-Qualifácil

Section	Number of statements	Content
<b>Operation and control</b>	12 statements	Operational aspects of the software such as easy installation, aesthetics, navigation, layout, operation, and control.
<b>Language</b>	5 statements	Clarity, comprehension, and objectivity of the statements, instructions, and results.
<b>Quality index</b>	4 statements	Comprehension, scores, and analysis of Q+ index usage.
<b>Priority graphic scale for action plan</b>	5 statements	Clarity, comprehension, objectivity, and level of profiting from generated information about operational aspects of QMS.
<b>Expectations</b>	8 statements	Desires fulfilled by using the software: relationship to QMS, benefits for the business, increase in individual knowledge, recommendations for other businesses.

**Note.** Developed by the authors.

After this process, the researchers checked the reliability of the results generated by the artifact via on-site auditing using a checklist with the standard requirements and related e-Qualifácil statements (see Table 4). Each requirement was received a score ranging from 0 to 3 (3 = conformity; 2 = room for improvement; 1 = minor non-conformity; and 0 = major non-conformity). The sum of scores given by the researcher was compared to the standard's total score (all requirements in conformity) and translated into a percentage of conformity. The AQI (Audited Quality Index) was compared to the Q+ index to check for discrepancies and, consequently, for reliability of the e-Qualifácil result.

## e-Qualifácil Evaluation and Results

Each evaluation process is described in detail. Company names were omitted and the businesses are referred to as companies A, B, and C. Artifact outputs are partially described in each case to express the experiments.

### Company A

Company A is family-owned. It was founded by three partners in Greater São Paulo, Brazil, just over thirty years ago. There are nineteen employees, of which eleven are in operations. There is no formal quality management position in the organizational structure. Their main product are

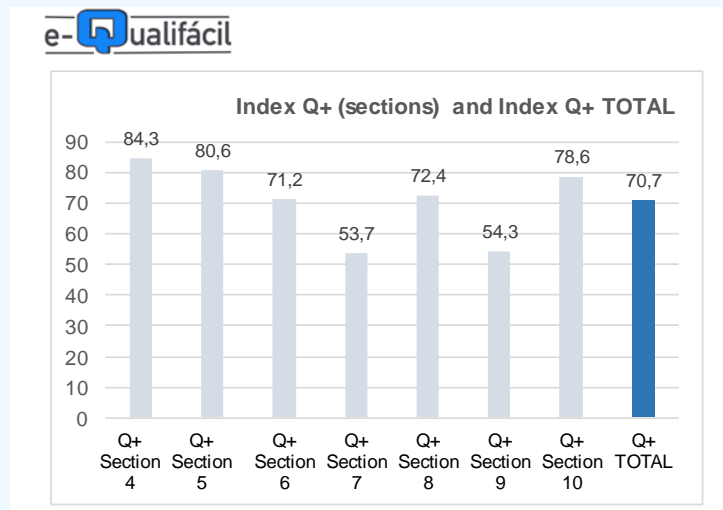
seals for metallic and plastic belts. They subcontract for some clients in raw material processing and they outsource administrative services and one industrial process (galvanization).

One of the founding partners was the user of e-Qualifácil. It took him approximately four hours to fill out all the statements. During this process, he would comment on product specifications, reliable production processes, re-inspection, and so on. Clearly, his perspective on quality was based on product quality rather than on quality management. Only when he was filling out section 8 (Operation) (see Table 2) did the concept become clearer.

After finishing evaluating all statements and receiving the printout of ISO 9001:2015 standard, the respondent spontaneously established relations between the statements of the artifact and the standard. In his opinion, the artifact helped to explain more clearly both quality management and the standard requirements – which he finds very complex.

The Q+ indices generated by the artifact (Figure 4) show that the processes implemented in the company have a 70.7% adherence to the ISO standard's requirements. Sections 7 (Support) and 9 (Performance evaluation) need greater focus in order to design an action plan.

Regarding section 7 (Support), the shortage reported is in human resources and process monitoring and tracking. Only five out of eighteen statements do not require improvement. Regarding section 9 (Performance evaluation), there is a demand for monitoring tools for specific groups: customers, auditors, and leaders.



**Figure 4.** Outputs from e-Qualifácil – Company A's quality indices

Source: e-Qualifácil artifact results page (Company A). The content was originally written in Portuguese.

After the completion of the artifact, the user filled the evaluation questionnaire. The user gave the artifact a 169 score. His only rate below 5 was for A8 – the software does not require someone else's help to be used.

During the researcher's on-site audit, three standard requirements were considered non-applicable for the company (Q 64, Q 165, Q 187—statements of the artifact). The AQI (38.4%) was 47.9% deviant from the Q+ index.

Some considerations on Company A:

- The founding partner's view on quality as product-centered (the initial stage of quality management) and his self-appointed position as artifact user are in line with what Leone (1999) and Garófalo (2009) call small business specificities.
- The respondent's perspective on quality probably biased his responses up to section 8 (Operation), inducing the considerable discrepancy between the Q+ and AQI indices. The lack of total integration between production and administrative support as prescribed in the standard (Barros et al., 2014; ISO, 2019) is perceived as an aspect that the company needs to improve.
- The user seemed satisfied with the artifact, especially as simple way of increasing knowledge on quality management. He also recognized the value of prioritizing needs in devising an action plan to improve their QMS.

## Company B

Two partners founded company B in 1999. It is located in São Carlos, Brazil, and it has 60 employees. They have a quality management manager that also handles a laboratory for control activities. Their QMS is partially structured according to ISO 9001, but it is not certified. Their main products are super-washed PET flakes and food-grade post-condensed PET resin.

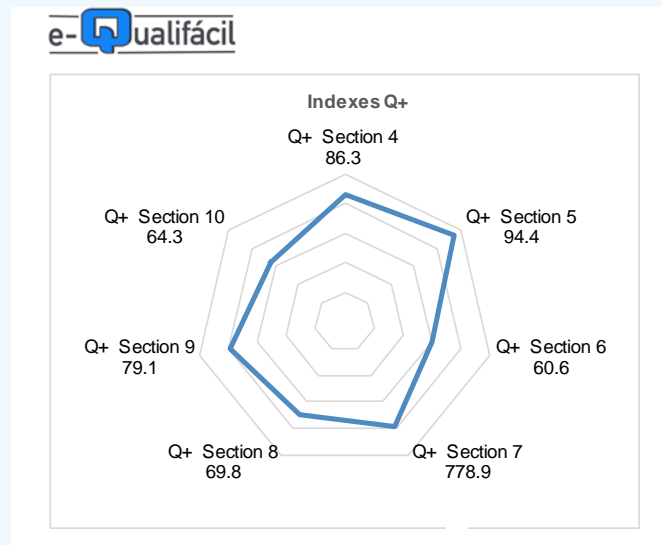
The user of e-Qualifácil was the quality manager. The process took about one hour. Forty-two requirements concerning projects, outsourcing, and customer property were left out due to the nature of the company's processes (it is a condition of ISO 9001:2015 standard that include sections not fully applicable for all companies). Therefore, the user suggested that the artifact be customized to include a non-applicable response to some items. The user was advised to give maximum scores to these statements to minimize response bias.

As the respondent already knew the ISO 9001 standard, it was not necessary to give her the print version for analysis. According to her, the artifact enabled understanding of the standard's new requirements. This may facilitate the migration to the newer ISO version because the actions were prioritized for a future action plan.

The Q+ indices generated by the artifact confirm that the processes implemented in the company had a 76.2% (Q+ TOTAL) adherence to the standard's requirements. Figure 5 highlights the level of adherence to the requirements in each section. Note that Figure 4 e Figure 5 have different representations. Both bar chart and radar chart are available as artifact's outputs.



The almost total adherence to the requirements in section 5 (Leadership) may be explained by the partial implementation of a QMS. Section 6 (Planning) proved to be the most challenging in terms of adherence, especially concerning risks, indicators, and planning for change. It should be stressed that, although the items left out belong to section 8 (Operation), this section's Q+ index was not one of the highest.



**Figure 5.** Outputs from e-Qualifácil – Company B's quality indices

Source: e-Qualifácil artifact results page (Company B). The content was originally written in Portuguese.

The user gave the artifact a 162 score. Seven statements got a score of 4. The user stressed the need for a non-applicable option and for pop-up windows relating the statement's number to its content on the screen for action plan prioritizing. In the "expectations" section of the questionnaire, she specifically commented on the artifact's goal to help implement a QMS: "The user needs to be able to interpret the standard, but the software makes an excellent link between the requirement and its interpretation."

The on-site audit disregarded the 42 items previously mentioned. The company does have a structured QMS based on ISO 9001, although some specific requirements were missing, such as top management critical analysis, quality-related objectives, and all the requirements from the new version of the standard. The audit's AQI was 74.3%, very close to the Q+ yielded by e-Qualifácil (a 2.5% difference).

Some considerations on Company B:

- The quality manager stated that e-Qualifácil served as a self-directed training tool, which reinforces Yamanaka's (2008) findings on the creative use of quality management resources in small business.
- A more contemporary view on quality concepts is important for using the artifact adequately. The small discrepancy between AQI and the Q+ index reinforces that.

- Although its usage and applicability are considered universal, ISO 9001:2015 deals with some specificities that are considered by auditors and managers. The artifact should also offer such flexibility.
- Despite having an implemented QMS, the user appreciated e-Qualifácil outputs' value in supporting internal auditing and future implementation.

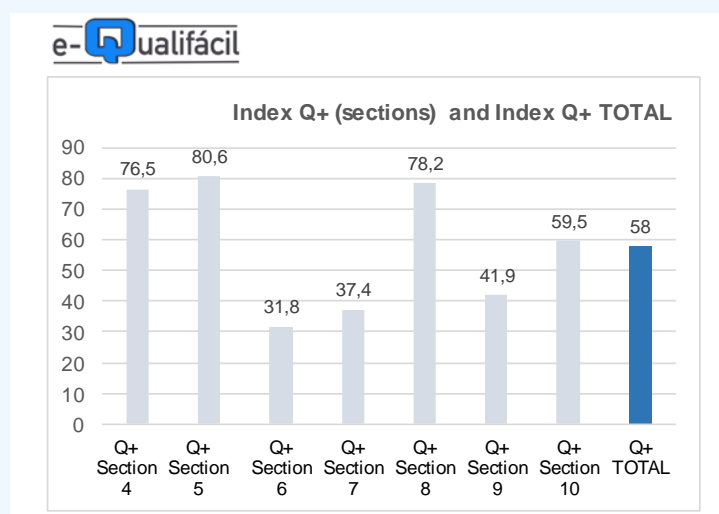
## Company C

Company C was founded in 2007 in Itupeva, Brazil. The number of employees is twenty-six. There is a quality department also controlling a laboratory that performs control activities. The company has a non-certified QMS with focus on product warranty. A large part of their manufacturing processes is automatically monitored. Their main products are super-washed PET flakes and PET preforms grinded and washed.

The quality supervisor evaluated e-Qualifácil. The process took a little longer than one hour. Again, the 42 requirements concerning projects, outsourcing, and customer property were left out. The same recommendation was made on giving maximum scores for the statements related to these issues.

After finishing the evaluation and reading the ISO 9001:2015 standard, the user was able to establish relationships between the artifact statements and the standard. In his opinion, the artifact's outputs help to design a future action plan, show how to improve their QMS, and direct creation of new internal procedures.

The Q+ indices generated by the artifact (Figure 6) show that the processes implemented in the company had a 58% adherence to the standard's requirements. However, sections 6 (Planning), 7 (Support), and 9 (Performance evaluation) need better focus to help design an action plan.



**Figure 6.** Outputs from e-Qualifácil – Company C's quality indices

Source: e-Qualifácil artifact results page (Company C). The content was originally written in Portuguese.

The combined dearth of resources, risk analysis, planning for change, and attention to stakeholders may be analyzed as a consequence or result from the focus of their current QMS. Note the difference in the score for requirement 8 (Operation) – high to the focus on product.

The user gave the artifact a 169 score. The only score below 5 was given for A17. The “additional explanation” helps answer the statements by improving understanding. According to the respondent, clarifying terms in e-Qualifácil was unnecessary.

The on-site audit disregarded the 42 standard requirements that were non-applicable to the business (the same items as for Company B). The resulting AQI (39.5%) was 31.9% inconsistent with the Q+ index. No evidence was found in the field research for several items stated as implemented and documented (e.g., non-conforming product identification, segregated area for non-conforming products).

Some considerations on Company C:

- The information asymmetry between the supervisor’s responses and the on-site audit is representative of small business’s typical low usage of management tools (Almeida et al., 2016), which causes difficulty in implementing a formal QMS.
- The respondent apparently knows ISO 9001, since he could adequately justify using the artifact’s outputs. However, either the company’s informal managerial style or the respondent’s tendency to overestimate his own job prompted more overrated, positive responses. This is in line with the artifact’s purpose of generating a priority list for adjusting the QMS, but it minimizes the value of the Q+ index.

## Comparing the three experiences

Table 7 summarizes the key results of each experience of e-Qualifácil usages, comparing them. These results highlight differences in quality management maturity – general knowledge and personal work self-evaluation and in management in general to be further discussed.

Table 7

**e-Qualifácil experiences**

Company	Artifact usage	Q+ Index	ISO 9001 most adherent requirement	ISO 9001 less adherent requirement	AQI (Audit Quality Index)	Deviation Q+ /AQI
<b>A</b>	Complex and time-consuming process. User did not have knowledge of TQM.	70.7%	#4 Context #5 Leadership	#7 Support #9 Performance evaluation	38.4%	47.9%
<b>B</b>	Ease process, also well related to ISO 9001. User found some statements not applicable.	76.2%	#4 Context #5 Leadership	#6 Planning #10 Continuous improvement	74.3%	2.5%
<b>C</b>	Ease process. User values the artifact output for action plan elaboration.	58%	#5 Leadership #8 Operations	#6 Planning #7 Support	39.5%	31.9%

**Note.** Developed by the authors.

## Discussion and Conclusion

Evaluating e-Qualifácil in the three companies supports reflections not only on quality management and small business management, but also on the artifact itself and on the research method utilized.

Undoubtedly, a systemic view on quality management may highly benefit a business and help to organically insert it in the competitive market. In this sense, standardized systems are important facilitators – especially ISO 9001:2015, as it delimitates the scope (competitive scenario and stakeholders), form (process approach and continuous improvement) and assessment mechanisms (controls and measurement) to structure and execute quality management.

However, in building the artifact and using it, the standard was shown to be bureaucratic and complex. Considering the representativeness of small business in the global scenario – attested by data from Brazil, where 99% of the companies are small-sized (SEBRAE, 2017) –, it is worth reflecting whether simplified versions of the standard and evolving certification processes would not make sense to maximize gains for businesses and global competition. Considering the diversity of business segments, this need could be even higher.

The three applications of e-Qualifácil highlighted important issues related to small business management. The emphasis on quality assurance showed that such companies still hold an inward outlook, rather than worry about the competitive environment. Their scarcity of resources, measurement, and control tools, coupled with informal management, keeps actions focused on the present time and disconnected from the continuous improvement view prescribed by standardized quality management systems. In this way, the present study evidenced small business specificities that are reflected both in the business and in quality management literature.

It is important to highlight that the role of leadership dimension appeared to be a well-solved dimension in all businesses, but as any other self-diagnosis tool this response can be a bias.

The artifact was proven valid. It was able to prescriptively assess the company's current quality management situation and provide guidelines to adequate the system to ISO 9001:2015 in a satisfactory way. Even when quality management is not totally integrated, the artifact provides access to requirements in a simpler way and it even guides execution of a work plan. In technical terms, it becomes clear that, given ISO standard characteristics, a more modern view on quality management will help companies generate more precise quality indices.

Customization of the software (e.g., including a “non-applicable” option in some items) to render it more flexible and more widely applicable may further improve calculating the quality index. Another possibility is to make small businesses' organizational customers use the artifact as a tool for supplier evaluation and development. It is worth mentioning, however, that every self-diagnosis tool embodies potential response bias due to the respondent's personal characteristics.

As a research method, Design Science proved to be very adequate for solving organizational problems. Rigor in developing a solution and analyzing its validity and performance is related to both research contribution and communication.

While evaluating e-Qualifácil, the three small businesses representatives learned about global concepts such as the contemporary view on quality management, standards and certifications, and ISO 9001:2015 characteristics. The artifact promoted self-awareness and reflections on the company's management status and on potential new organizational demands. Finally, theory and practice were brought together through applied reflection – Research Contributions (Guideline #4).

In addition to the interaction with the three companies in the field research, the client company received the consolidated results from the three cases. It was also informed that a fourth company had declined to participate in the research. The client company's quality department discussed and validated the results and compared them to their own supplier assessments. Another venue to communicate this research is academia, whose interest is less in the specific research findings and more in detailing how the method was used – Research Communication (Guideline #7).

Despite the clear distinction between action research and Design Science (Dresch et al., 2015b) in terms of objective, work process, results, and type of knowledge generated, a suggestion for future studies is to use method triangulation and include action research (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011). In this case, both the researchers and the organization should participate in defining the problem, and constructing and evaluating the artifact. This is a step beyond technical action research (Wieringa, 2014) by not only testing a newly designed artifact but also including the organization in the design process, looking for a better fit to the organizational context by building an artifact that better meets specific needs. In the case of preparing small businesses to adjust to ISO 9001:2015, this is a valid reflection.

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1<sup>st</sup> author: conceptualization (lead), formal analysis (lead), methodology (lead), supervision (lead), writing-original draft (lead), writing-review and editing (lead).

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