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ICT Management and Compliance: An Action Research Project

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Abstract

This chapter presents an action research study for the integrated management of ICT and standards compliance. The case reports to a technological institute with multiple certifications. There are an increasing number of nonprofit organizations that adopt international standards such as ISO9001. ICT becomes critical in this context, must be integrated with the standards requirements, the stakeholders' needs and the organizational processes. Moreover, combining digital and paper based compliance brings challenges to the organizational users and to external auditors. The proposed approach guides ICT management in highly regulated contexts. In the practical case that we describe, ICT and compliance becomes two sides of a single coin. The findings may assist nonprofit organizations to deal with the increasing pressure of regulations worldwide.

Introduction

The nonprofit organizations must comply with a plethora of regulations. Those regulations may be enforced when concerning the law, but may also be voluntary, when a specific standard, guide, or procedure is adopted. One of the most widespread standards is the ISO9001, guiding companies in the implementation of quality management systems. When adopting ISO 9001, the organizations should place the customer as their main concern, adopt a process approach, and evidence a continuous

improvement effort (ISO, 2008). ISO 9001 is increasingly adopted by nonprofit organizations, for example, universities, health care, associations, and research institutions. An example of such cases is presented by White, Samson, Rowland-Jones, & Thomas (2009). The standard presents several benefits for management development and process improvement, for instance, identification of process weaknesses, task duplications, and ICT adoption to solve data duplication problems (White et al., 2009).

ICT is critical for compliance and must be integrated in early stages of the design (Bonazzi, Hussami, & Pigneur, 2010). The lack of alignment between ICT and regulations may lead to an increase of bureaucracy, non-conformities in process execution, additional costs for ICT changes, and communication difficulties between ICT managers and other business functions. Modern information systems (IS) are socio-technical (Laudon & Laudon, 2007). For this reason, ICT management must include the necessities of the systems users, the processes that an organization performs, and the context that shapes ICT requirements and goals (Laudon & Laudon, 2007). To take full advantage of ICT, the organizations must develop distinct competences (Morabito, Themistocleous, & Serrano, 2010). There are synergies in managing ICT and organizational management suggested by standards. For example, combining IT plans and quality plans (Jabnoun & Sahraoui, 2004), including ICT experts in the improvement teams (Keith, 1994; Spencer & Duclos, 1998), developing a process approach and managing continuous improvement (Garimella, 2006), exploring a similar culture required by quality and ICT (Fok, Fok, & Hartman, 2001).

In spite of the multiple benefits, there are obstacles in combining ICT management and compliance with quality standards. For example, the different vocabularies by ICT and quality managers, the processes documentation detail that ICT requires (Daghfous & Barkhi, 2009; Li, Markowski, Xu, & Markowski, 2008), the difficulties of managing changes in ICT, and process improvement initiatives (Spencer & Duclos, 1998). There are no approaches to guide companies in achieving the integration benefits (Cunha & Figueiredo, 2005). Moreover, implementing one system does not directly improve the other. A study by Casadesús and Castro (2005) found that in spite of ISO 9001 implementation, companies did not adopt practices to enable ICT, and did not achieved an integration of ICT. Inversely, Perez-Arostegui et al. (2012) have showed that ICT by itself does not improve quality.

This chapter addresses the problem of joint management of ICT and compliance, in the context of ISO 9001. Next section provides the background for the research, introducing ISO 9001 and the challenges for ICT management. An approach is presented to assist organizations in managing ICT and compliance, with an application in a technological institute. The approach is illustrated with a practical example for a core process of the institute, concerning design and development. One of the key aspects is the integration between process documentation and the technological tools. The chapter concludes with a discussion of future research and the study limitations.

Background

There are positive and negative aspects in adopting ISO 9001. Nevertheless, there is a consensus among the researchers: ICT is a key element for ISO 9001 adoption and organizational compliance.

The benefits and pitfalls of ISO 9001

Organizational standards such as the ISO 9001 are used worldwide to improve quality management (ISO, 2012). The first version of the standard was published in 1984, and the current version of 2008, is adopted by over one million organizations, in 180 countries. The standard has eight clauses of requirements, including scope; normative references; terms and definitions; general and documentation requirements of the quality management system; management responsibility and commitment; resource management; product realization; measurement, analysis and improvement. The PDCA is the suggested approach for continuous improvement (ISO, 2008), in four iterative steps: Plan – establish the objectives and processes, necessary to deliver results in accordance with customer requirements and the

organization's policies; Do – implement the process; Check – monitor and measure processes and product against policies, objectives and requirements for the product and report the results; and Act – take actions to continually improve process performance. The adoption of ISO 9001 requirements is voluntary, although in some sectors, holding an ISO 9001 certificate has become a basic requirement. To obtain certification, organizations must implement the quality management system (QMS) accordingly ISO 9001 international standard, and be recognized by a certification entity. An external audit evaluates the QMS conformance with the standard and the evidences of continuous improvement. In simple terms, a quality certification is about "writing down how things are to be done; doing things the way they were written; and providing evidence of both" (Cunha & Figueiredo, 2005).

The motivation to implement a QMS compliant with ISO 9001 may vary in nature. As presented by Heras-Saizarbitoria, Casadesús, and Marimón (2011), there are external motives such as client demand and improving public image. Internal motives are the improvements in systematization, efficiency, and internal control within the firm. A study by Pekovic (2010) has revealed that certification determinants in the public sector, may vary with firm characteristics between manufacturing and service firms. The probability of certification increases with firm size and if the firm belongs to a group. The existence of international activity and the experience with similar standards also have positive effect on the probability of certification. Although recognizing external arguments importance, several authors (Boiral & Amara, 2009; Brown, Wiele, & Loughton, 1998; Curkovic & Pagell, 1999; Gotzamani & Tsiotras, 2001; Pan, Lin, Tai, & Tseng, 2010; Rao, Ragu-Nathan, & Solis, 1997; Sampaio, Saraiva, & Rodrigues, 2009) suggests that to achieve a competitive advantage, companies must internalize the quality principles. Standards requirements may be easily copied by competitors and the differentiation advantage decrease its impact as other companies in the same industry achieve certification (Karapetrovic, Fa, & Saizarbitoria, 2010). As showed by Prajogo (2011), strengthening internal motives have a positive impact in ISO 9001 implementation and operational performance. Multiple studies have concluded that organizations achieve a distinct operating advantage from the standard when they accomplish to use it in daily practice (Naveh & Marcus, 2005; Sroufe & Curkovic, 2008) with customer focus and a continuous improvement strategy (Terziovski, Power, & Sohal, 2003).

The majority of studies made so far attest the positive organizational impact of ISO 9001 (Karapetrovic et al., 2010). These impacts may also be clustered in internal and external to the organizations. Internal impacts are related with organizational improvements, such as the quality system, communication, service, competitiveness, financial performance, and human resource/organizational climate (Boiral, 2011; Cagnazzo, Taticchi, & Fuiano, 2010; Naveh & Marcus, 2005). Walgenbach (2001) reported that ISO 9001 was an opportunity for structuring and achieving a better clarity in the organizational processes: documenting know-how, systematization, the standardization and improvement of processes, procedures, and interdepartmental relations. These benefits are especially relevant for nonprofit organizations. External impacts are related with international trades, suppliers, customers, and stakeholders (Cagnazzo et al., 2010). According with Singh, Power, and Chuong (2011), ISO 9001 focuses on internal processes but also on the coordination with external stakeholders. Singh et al. (2011) purport that organizations use ISO 9001 as a holistic tool to manage organizational environment, involving the internal processes and external relationships with suppliers and consumers.

ISO 9001 is also a subject of criticism and problems. The most cited barriers are insufficient top management involvement, excessive documentation, implementation time and cost, system change, and standard interpretation (Poksinska, Eklund, & Dahlgaard, 2006; Withers & Ebrahimpour, 2000). Kumar and Balakrishnan (2011) identify four categories of problems:

- Leadership related issues (Inadequate Commitment by Top Management, Lack of Motivation, Recognition, Organizational learning , Strategic Planning and long term focus);

- Strategy Related Issues (Mission, Vision, Values, Strategic Planning, Strategy Mapping, Cascading down the line, KPIs and Initiatives);
- Quality System related issues (Weak PDCA cycle, generic system, internal audit not in depth, non value adding meetings/trainings and excessive paperwork);
- Society oriented gaps (Corporate Social Responsibility, Environmental Management, and Sustainability).

There is evidence that ISO 9001 perceived benefits decrease over time (Franceschini, Galetto, Maisano, & Mastrogiacomo, 2010; Karapetrovic et al., 2010). Longitudinal studies suggest that ISO 9001 benefits progressively tend to decline (Casadesús & Karapetrovic, 2005a, 2005b). Additionally, a phenomenon of "decertification" has emerged in some developed countries, as presented by Franceschini, Galetto, Maisano, and Mastrogiacomo (2011). For example, in the last five to six years, UK, Ireland, and Denmark have evidenced a tendency to reduce the number of certified companies (Marimon, Heras, & Casadesús, 2009; Sampaio, Saraiva, & Guimarães Rodrigues, 2009). Franceschini et al. (2011), present three possible causes for the saturation and initial decline in some countries: the perception of little incentive towards improvement; the bureaucratic burden in the application of ISO 9001 standards; and the apparent lack of advantages for organizations with a well-rooted quality culture.

There are a number of studies concerning the benefits and difficulties of ISO 9001, however, how to use ISO management systems in practice remains an opportunity for research (Boiral, 2011). A quality management strategy must be defined prior to the decision of certifying the company and should be combined with other technologies or systems to enhance firm performance.

ICT Management and ISO 9001 Compliance: Where are the Opportunities?

Regulations may be a burden to nonprofit organizations, but are also a chance for ICT adoption. Lobo and Ramanathan (2005) present a study on the role that ICT can play in quality management practices. The literature also present solutions for specific clauses of ISO 9001 such as clause 4 - Quality Management System (Sakthivel, Devadasan, Vinodh, Raman, & Sriram, 2008) and clause 5 - Management Responsibility (Sakthivel, Devadasan, Vinodh, Ramesh, & Shyamsundar, 2007). A number of authors suggest the benefits of ICT for quality management (Dewhurst, Martínez-Lorente, & Sánchez-Rodríguez, 2003; Gunasekaran, Arunachalam, & Devadasan, 2006; Sánchez-Rodríguez, Dewhurst, & Martínez-Lorente, 2006; Sánchez-Rodríguez & Martínez-Lorente, 2011; Zárraga-Rodríguez & Alvarez, 2013). The reported benefits include quality data and information, improving timely and correct decisions (Jiao, Pokharel, Kumar, & Zhang, 2007), allowing quality tracing and control (Zhao, Xu, Yao, & Qin, 2008). Table 1 summarizes a review of studies that address the mutual impact of some well known IT applications and quality management.

Table 1. IT and Quality Management Synergies

IT	**IT support to the QMS**	**QMS support to IT**
ERP - Enterprise Resource Planning (Foster, Wallin, & Ogden, 2011; Li et al., 2008; Lin, 2010; Lobo & Ramanathan, 2005; Sánchez-Rodríguez & Martínez-Lorente, 2011)	customer and supplier relations, product and process management, quality data, workforce management	user involvement, IS quality, top management support, process approach. QMS as a predecessor of Enterprise Resource

IT	IT support to the QMS	QMS support to IT
		Planning (ERP)
EDI - Electronic Data Interchange, **Groupware** (Kock & McQueen, 1997; Lobo & Ramanathan, 2005; Sánchez-Rodríguez & Martínez-Lorente, 2011)	customer and supplier relations, product and process management, quality data and workforce management, employee and stakeholders communication, system development, audit, training	
CAD/CAM - Computer-aided Design / Computer-aided Manufacturing (Foster et al., 2011; Hammer, 1990; Lobo & Ramanathan, 2005; Sánchez-Rodríguez & Martínez-Lorente, 2011)	customer and supplier relations, product and process management, quality data and workforce management, product development	
Intranet, Extranet, and Internet (Cunha & Figueiredo, 2005; Hussain, Barber, & Hussain, 2009; Lobo & Ramanathan, 2005; Silveira, Rodríguez, Casati, Daniel, D'Andrea, Worledge, & Taheri, 2009; Tang & Lu, 2002)	feedback for strategic planning, market research e-commerce	requirements evaluation
CRM- Customer Relationship Management (Bandyopadhyay, 2003; Daghfous & Barkhi, 2009; Ku, 2010; Lobo & Ramanathan, 2005; Su, Tsai, & Hsu, 2010)	customer focus, customer service	QMS as a predecessor of the Customer Relationship Management (CRM), QMS principles to improve CRM systems
Document Management Systems (Bandyopadhyay, 2003; Cunha & Figueiredo, 2005; Kasim, 2011; Rezaei, Çelik, & Baalousha, 2011; Yao, Trappey, & Ho, 2003)	process documentation, documenting the QMS, communication	strategic record management

Quality must be a priority to ICT management. According to Rademacher and Clark (1993, p.769) "the IT quality mission is likely to remain an issue for some time". In their study, the majority of the ICT managers (80%) are in a position of reacting to the QMS rather than taking a proactive attitude (20%). The authors continue by stating that "the ISO 9000 standard offers an excellent opportunity for IT to have a wide-reaching impact on parent organizations as well as an impact on organizations competing

for world markets. It would be refreshing, indeed, if this new quality initiative is viewed as a challenge and opportunity rather than simply a problem of compliance".

ICT management and quality management have synergies. However, there is a gap in the literature concerning how ICT can be managed to ensure compliance in ISO 9001 contexts. For example, how ICT should be developed to assist the organizational users to comply with requirements, such as standards and laws. How to manage a combination of ICT, paper based evidences, and the regulatory context, to improve the auditing process. One of the problems is that the management of ICT and compliance is not integrated. Nonprofit organizations may have distinct types of audits, such as quality, financial, and contractual. With the increase of ICT adoption, the audit evidences are increasingly embedded in technological mediums, such as databases and specific applications. These are some challenges that we tackle in the next section.

Integrated Management of ICT and ISO 9001

In this section, we present the approach for the joint management of ICT and regulations, in the context of ISO 9001. The approach is composed by a sequence of steps in which the organizational users design the ICT requirements and the tools to manage its evolution. We extensively describe the case of ICT adoption in a process of D&D-Design and development. Technological institutes develops essential function in society, including innovating, and providing services (Kramer, 1987). Although the case is presented for ISO 9001, this is only one example of standard that involves compliance management and audits. The section also presents how to create practical internal and external audit tools. The purpose of those tools - matrixes and tables that any organization of any sector and size can internally develop - is to assist ICT management and provide evidence of compliance to auditors. The presented case shows how ICT and compliance management can be combined in a single approach.

Action Research: Connecting Researchers and Practitioners

Action research is an approach that simultaneously aims to improve a problem situation in the target organization, and contribute to scientific knowledge (Davison, Martinsons, & Kock, 2004). This approach is suitable for complex problems, involving multiple variables, where a solution is reached by collaboration, between researchers and practitioners. One of the most used forms is the Canonical Action Research (CAR), characterized by five phases of *Diagnosing*, *Action planning*, *Action taking*, *Evaluating*, and *Specifying learning* (Susman & Evered, 1978):

1. *Diagnosing*, identifying or defining the problematic situation, as a shared task by the researcher and practitioner. The actors holistic interpret the phenomenon and formulate working hypothesis to be used in the sub-sequent phases of the cycle;
2. *Action planning*, considering alternative courses of action for the problem;
3. *Action taking*, referring to the selection of the course of action and its implementation, causing change to occur and trying to create an improved situation;
4. *Evaluating*, studying the consequences of the actions, involving a critical analysis of the results;
5. *Specifying learning*, identifying the findings, documenting and defining the outcomes that will add to the body of knowledge. As mentioned by Cunha and Figueiredo (2002) although appearing last, this phase is a permanent activity.

The investigation requires that the client setting be clearly defined. While planning the action, both the researchers and practitioners create a frame of reference that will guide the development of a system. The objective is to improve the problematic situation, not necessarily to solve the problem due to the possible complexity involved. To ensure rigor and validity, there are five principles that we must consider in CAR (Davison et al., 2004):

1. Principle of the Researcher–Client Agreement: the client explicitly agrees with the research approach, and understands what will be developed and how is going to be evaluated;
2. Principle of the Cyclical Process Model: to ensure that the project follow the steps of the method or justify any deviation;
3. Principle of Theory: suggesting that is necessary to have a frame of reference for the action research to be executed and the theoretical model is used to evaluate the outcomes;
4. Principle of Change through Action: ensuring that the intervention aims to create change, properly documented;
5. Principle of Learning through Reflection: both the client and the researchers reflect about the results, producing new theory or providing valuable knowledge for future cycles.

Client Setting: Nonprofit Technological Institute

The research was developed in a private nonprofit technological institute, with the mission of providing services to their associates and promoting innovation. The external stakeholders are private associations and companies, and public institutions, creating a highly regulated environment. This is an interface institution, with close connection with the industry and with the university. The institute is certified by several standards and must comply with multiple contracts to support their mission. Additionally to the voluntary regulations, there is also an increasingly demanding context of legal requirements. On one hand, the recognition of public interest implicates a number of obligations, for top management and for each project that the institute develops. On the other hand, the institute also contributes for legal production, by technical studies and reports.

Compliance is a daily concern that involves the entire organization. The institute is now developing an action research project aiming the joint design and management of information systems and quality management systems. The case described next is for the most critical process of the institute mission: D&D - design and development. The objective of the organization is to ensure that ICT and processes are integrated managed for compliance, no duplications exist, and systems auditability may be improved. The institute has difficulties in managing both ICT and regulations with the current human resources and needs an improvement in the process. One of the objectives is that ICT becomes a part of compliance and every requirement is supported by ICT. The reverse is also true, that is to ensure that ICT comply with the regulations.

First Cycle: Managing the development

The first cycle of action research aimed the joint development of the IS and ISO 9001 D&D - Design and development process. At this stage, both the researchers and practitioners were involved in the process of implementing ICT and creating a process compliant with the standards and procedures.

Diagnosing: The D&D Process and Innovation

The D&D is central to technological institutes and is related with the design of new products and conducting innovation projects, for instance, the European co-funded projects. D&D is one of the most problematic processes of the institute. First, it is the core process for their innovation mission. Second, is expressly mentioned in the ISO 9001 standard, and a requirement for certification. This is one of the processes with higher number of nonconformities in the ISO 9001 audits. Third, due to the ISO/IEC 17025 certification, this process must also be followed when developing new laboratorial procedures. Forth, each D&D project must comply with distinct regulations, that may be customer agreements, laws concerning the product to be developed, regulations for co-funding of the project.

To understand the process problems from the perspective of the users, we have deployed a questionnaire as suggested by the MUVE – Motivation, Understanding, Value, and Effort approach (Antunes & Cunha, 2013). The steps of the diagnosis for the D&D process is presented in Figure 1.

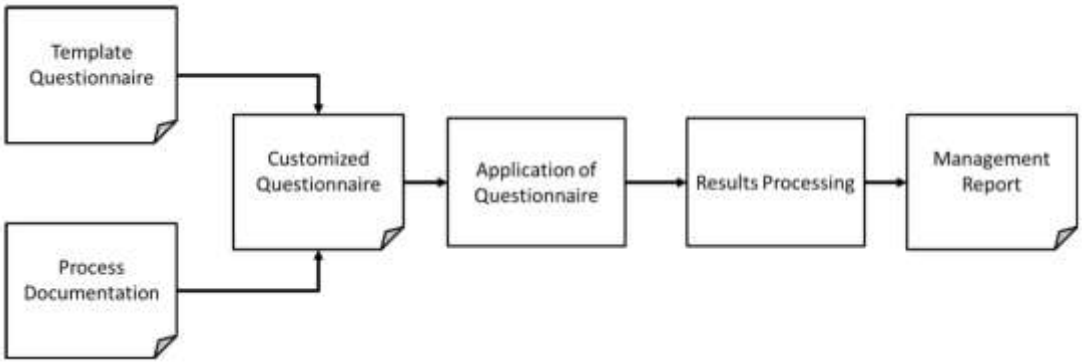

Figure 1 The MUVE approach (Antunes & Cunha, 2013)

The MUVE is an approach that suggests the users' participation in process management (the persons that develop the process in the field). A questionnaire is customized to the specific process by evaluating its documentation. The questionnaire analyzes four main aspects of the process users, that are: Motivation, Understanding, Effort and Value (Antunes & Cunha, 2013). A representation of each question score is presented with the colors green (ok), yellow (improvements needed), and red (problematic). An excerpt of the results for the D&D process is presented in Figure 2.

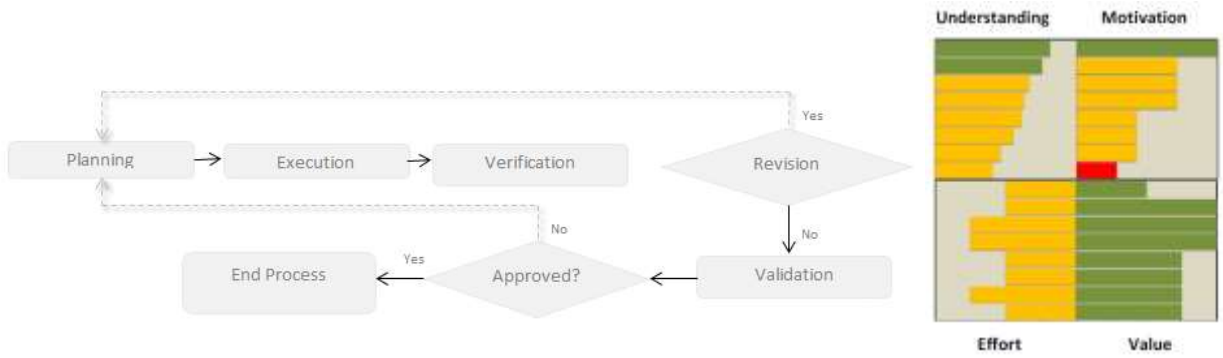

Figure 2 The D&D process blueprint with MUVE (Antunes & Cunha, 2013)

The process users recognize the value of the D&D process and the importance of new product developments for the future of the organization. However, we may observe in Figure 2 that the effort is classified with yellow, meaning that they think that the process is not efficient. The motivation to comply with the process rules is problematic. That questionnaire have identified that one of the problems were precisely the cumbersome spreadsheets that were used to support the process. Those files were not friendly, did not help the organizational users in accomplishing the requirements. The main problems were:

1. The process documentation was not used in practice - there was a procedure for D&D but no one reads it, as a consequence, the audits usually found non conformances in the process;

2. The spreadsheets did not protect the users from mistakes, for instance, the cells were not protected;
3. The users needed to fill different templates, one for the project, other for the project plan;
4. Each project also required a paper archive, to put the correspondence, related legislation, external reports;
5. The users thought that the process was designed in a way, but is executed differently – they were not listened for the process design.

Action Planning: ISO_2 Approach and the O_2 Framework

As a result of the diagnosis, we outlined a plan of action to address each main problem, as follows.

1. The process documentation was not used in practice: We had insights from the MUVE questionnaire that the documentation required redesign, to assist the process users in daily tasks;
2. The spreadsheets did not protect the users from mistakes: A new D&D process, effectively supported by ICT, must guide the users on what they should do, but also protect them from executing what they should not do. ICT can provide data validation functionalities, for instance, ensuring that specific fields are filled in an electronic form. To be user friendly, the new process workflow and rules must be incorporated in the organizational ICT solutions;
3. The users needed to fill different templates: Nonprofit organizations must ensure that ICT management and compliance are integrated. Some templates can be integrated with ICT, for instance reducing the number of forms or even by simplifying the process. At this stage, we do not know if all the templates are really needed to execute D&D, and ensure compliance with national and international regulations. The next steps may identify the information needs (requirements) and then, how they can be implemented;
4. Each project also required a paper archive: ICT can reduce paper use, with known advantages for information archive, such as physical space optimization, improving information search, and data confidentiality (e.g. to adopt data encryption techniques, ensuring that sensitive data are only accessible to the authorized users);
5. The users thought that the process was designed in a way, but is executed differently: Our intervention must involve all the users in the D&D process improvement. This participative development is also expected to have a positive effect in problem 1 (ensuring that documentation is useful for all the process users).

The first challenge is to manage ICT for the D&D process, and simultaneously deploy all the compliance documentation, procedures, records, and indicators required: the design stage. The second challenge is to create the conditions to manage ICT in the continuous improvement phase, or the run-time phase, after both the technological solution and the compliance structure is created and used in daily practice. The organization also wanted to include other regulatory needs for the process. Although the main source of requirements were the ISO 9001, contractual agreements, and law should be included in the D&D process development.

An approach was developed to guide the action among the participants of the project, with the seven steps illustrated in Figure 3.

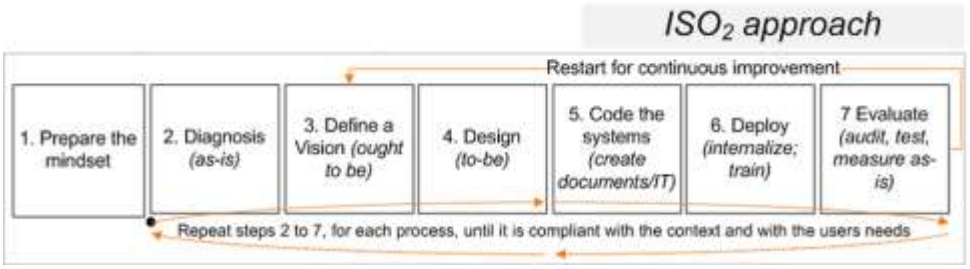

Figure 3 The ISO₂ Approach (Barata & Cunha, 2013a)

The ISO_2 suggest a continuous improvement approach for the process, combining efforts of ICT experts and other management experts. The ISO_2 focus all the participants in collaboration for the process vision, ICT development and management, process documentation, training, and compliance assessment. When following the steps of the approach, the project participants are asked to think about five main elements that must be considered when developing an information system, presented in Figure 4.

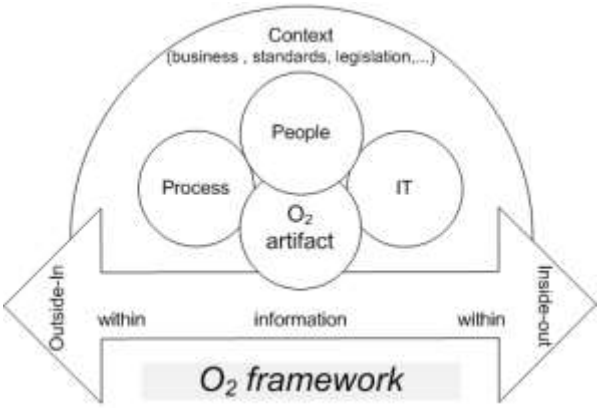

Figure 4 The O2 Framework (Barata & Cunha, 2013a)

The O_2 framework suggest that for developing an IS, there must be considered the interrelated components of *context, people, process, information, and IT* (Barata & Cunha, 2013b). It is necessary to identify the information entering the system (inside-out), processed by the system (within), and provided by the system (outside-in). These three perspectives are essential when dealing with regulations, because there are requirements, expressed by goals and rules (outside-in), must be internalized in daily practice (within), and finally, evidence must be provided to external entities (inside-out). Managing external interfaces is even more critical for nonprofit organizations, having multiple communities and stakeholders. These ISO_2 and the O_2 artifacts are the frame of reference for the action taking, presented in the next section.

Action Taking: Joint Design of IS and ISO 9001

The project team in the technological center was the IS manager and the Quality manager, that has the responsibility of the several institutional certifications, and protocol collaborations with associations and public entities. The first part of the approach is to create the idea of a partnership, not a customer – supplier relation, that could occur by the idea of IS as the supplier of ICT solutions and the QMS identifies the requirements for ICT, as the customer. Our diagnosis of ISO_2 approach was already executed with the questionnaire, so as the vision of the new compliant process.

One of the difficulties of managing ICT design is the different backgrounds of the project participants. The team may include ICT developers, ICT managers, different organizational management functions, other process participants, and even outside elements such as consultants. To make design more sufficient and effective, the ISO_2 approach suggest the use of matrixes to identify requirements (goals and rules) for the IS development. The matrix for the D&D process is presented in Table 2.

Table 2. The goals and rules for the D&D process

D&D Process		Outside-in	Within	Inside-out
Context [Standards, Company functions and politics, legislation, Scientific developments]	Current	✓Product color and dimensional specification	✓Translate requirements in new product specifications	✓Provide information to the customer regarding the production status
	⇩			
	Planned	✓Regulatory product constraints ✓Company politics about innovation and new product development ✓Universities and R&D institutes communication	✓Compliance management ✓Risk management ✓Financial management and project time sheets ✓V&V ISO 9001 requirement ✓Project revision ISO 9001requirement	✓Marketing and commercial diffusion ✓Product technical specification
People [New product participants, Customers, Suppliers]	Current	~~D&D department is the interface with new product development*~~	✓D&D department creates order production	✓Commercial department provides information to the customer
	⇩			
	Planned	✓All the company workers must participate in new D&D ✓Promote access to scientific and technical publications ✓Training in innovation ✓Record customer suggestions	✓Diffuse new ideas and opportunities ✓Idea selection ✓Improve communication of ideas and project status ✓Project management ✓Indicators of process success	✓Newsletter contributions ✓Seminar participations ✓International project developments co-funded by EU ✓Evaluate ideas with potential partners ✓Evaluate customer satisfaction
ICT [Network communications, software]	Current	✓Web portals to obtain information about technological developments ✓Newsletters input	~~✓Excel*~~ ✓~~Production records (paper)*~~	✓E-mail
	⇩			
	Planned	✓Competitors use of ICT	✓Platform for managing ideas ✓Project management software	✓Website interface ✓B2B with project partners
Process [Tasks, responsible and performance indicators]	Current	✓Customer order entry	✓Product specification ✓Production order	✓Product Shipment
	⇩			
	Planned	✓Knowledge management about product, process and marketing innovation	✓Idea management (record – evaluate – decide to implement/discard) ✓Project management (Record project, define teams and plan, define objectives – develop – training – evaluate)	✓Project report to external entities ✓Product catalog / commercial presentation ✓Financial and quality indicators: % success, margin, detailed costs

* eliminated for the improved process compliance

The matrix represents the goals and rules that the information system should consider for the D&D process. There are lines for the goals and rules currently implemented (as-is, step 3) and the planned goals and rules (to-be), that are agreed by the project participants. The next step is to group goals and rules by colors. Each color represents an ICT development project, and the black color represents a shared requirement, that is not specific to an ICT project but must be considered for all the projects. In the

example of D&D, there are blue and orange requirements. The blue represent an innovation management platform to be developed and the orange, a project management solution. A positive aspect of using this approach is that the project participants do not forget to consider the inputs and the outputs of the ICT. When we combine the goals and rules of the same color in a unique table, we have the requirements for that ICT application (in the case to be developed, but could also be acquired to external entities), as presented in Table 3.

Table 3. The innovation management platform: main goals and rules

D&D Process	Outside-in	Within	Inside-out
New ICT solution: Innovation Management Platform	✓Web portals to obtain information about technological developments ✓Newsletters input ✓Regulatory product constraints ✓Company politics about innovation and new product development ✓Universities and R&D institutes communication ✓All the company workers must participate in new D&D ✓Promote access to scientific and technical publications ✓Training in innovation ✓Record customer suggestions ✓Competitors use of IT ✓Knowledge management about product, process and marketing innovation	✓Compliance management ✓Diffuse new ideas and opportunities ✓Idea selection ✓Platform for managing ideas ✓Project management software ✓Idea management (record – evaluate – decide to implement/discard) ✓	✓E-mail ✓Seminar participations ✓International project developments co-funded by EU ✓Evaluate ideas with potential partners ✓Website interface ✓Product catalog / commercial presentation ✓Financial and quality indicators: % success, margin, detailed costs

The approach provides a high-level perspective of the requirements for the future solution, which may now be detailed with the IT team. Table 3 has the key issues to consider as inputs, processing, and outputs of the platform. Simultaneously, the process documentation needed revision to be integrated with the digital medium. Table 4 present the solution that was used to detail each goal/rule of the O_2 matrix.

Table 4. Detailing goals and rules - Innovation Management Platform (2 examples)

O_2 goal/rule	Type	Why	Who	When	Where	What
Web portals to obtain information about technological developments	Outside-in	Innovation requires obtaining outside information from several sources. Requirement of NP 4457 and ISO 9001	Any user of the process	New information is identified by external stakeholder or internally by research	ICT menu for knowledge management – form for technological vigilance	Websites, papers, articles, notes about ideas
Regulatory product constraints	Outside-in	New products must comply with regulations to be used in the market	Project manager	Product specification phase	Project form: grid of project objectives; product restrictions field	Standards, law, sector regulations, customer requirements

The objective of this table is to provide additional information about each goal/rule and identify the reasons (why), persons involved (who), when the goal/rule occurs or events that trigger that goal/rule (when), the implementation aspects (where), and the type of information that is needed for compliance. This is an approach to facilitate communication between ICT experts and non-experts, from the specification of the project to the validation. After this level of abstraction, each participant may detail even further as needed, for instance, the ICT developer will perhaps need use cases or database diagrams. That is when we enter a detail that is not required for cooperation but for individual work. The O_2 framework does not address that level of detail.

The O_2 matrix was detailed for the coding process, so is simpler to validate if the output solution complies with the standard and the organizational regulations, which were used as foundations for the requirements. There was also a purpose of reducing the D&D process documentation to a single document, smaller, and friendlier (there were several documents for that process such as procedures, form templates, and instructions): removing rules from the document and include every rule in ICT; removing definitions and include those definitions in ICT; and removing all the references to external documents. ICT should provide the tools to develop the process, for that reason, excessive documentation should be avoided. The process documentation changes are presented in Figure 5.

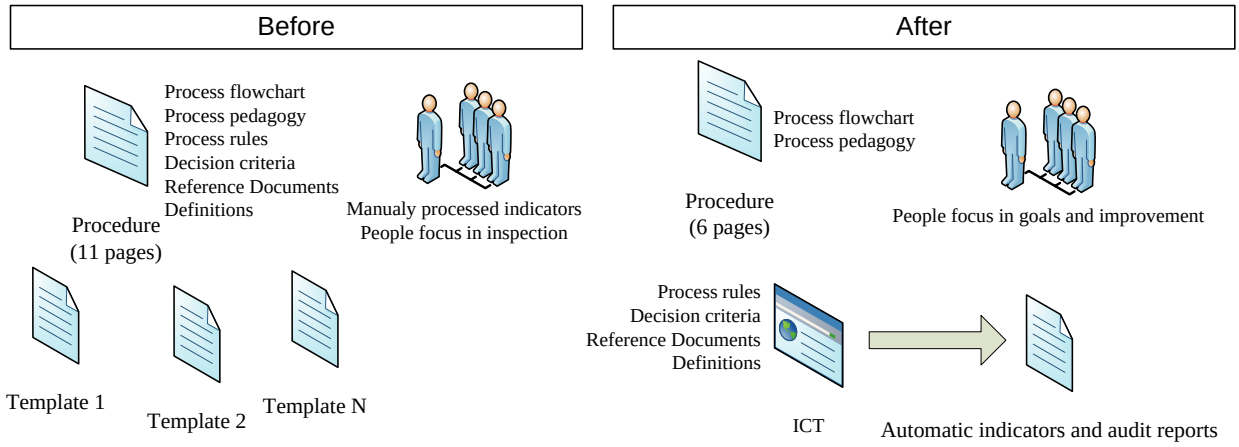

Figure 5 Process documentation changes with ICT

A single document explaining the process and the main goals of D&D was enough. All the rules was removed from the process documentation and included in the web platform. Example of sentences that were removed from the D&D procedure:

- "The responsibilities of this procedure are presented in the next section": This is not needed, because the platform permissions allow knowing who does what in the process. The ICT should have a report that presents all the platform users and respective permissions (e.g. who can add new projects, who validates the project, who is the administrator);
- "When a new project is created, the manager must develop a plan using form XYZ": This type of sentence should not be in a procedure if ICT and the process are integrated. First, the project plan form XYZ must be a part of the ICT functionality. Second, if it is required, the user did not even have to think about it, the platform must require the user to fill the plan (required fields in the platform). And third, form XYZ must be eliminated and included as web forms;

- "When an idea for a new product is identified, must be evaluated the relevance to create a new project of D&D. The criteria to evaluate an idea are… [criteria 1], [criteria 2], […]": This is a functionality that must be included in the platform, and the criteria must be defined in the ICT platform, not in a procedure. First, there is the risk of changing one (the process procedure or the ICT) without changing the other. Second, is not adequate that the user needs to read a procedure to know the criteria to evaluate new ideas, those should be presented directly in the platform;
- "The identification of the D&D project risks must be done by": Another example of what must be a platform rule. If the platform does not allow mistakes, then we are truly helping the users of the process;
- "Definitions; Innovation means the implementation of new […]": Definitions must be present where needed. ICT has means of providing definitions as tool tips or in user manuals, directly accessible while filling the forms.

This is not an exhaustive list; the aim is to illustrate what needs to be integrated in ICT. There is now only one single document for D&D process, and has been compacted in 50% (from 11 to 6 pages), mostly containing flowcharts, and explanation about the process impact in the organization (pedagogy).

Evaluating the Development

This section studies the consequences of action. First consequence is the integration of ICT and compliance by design. With increasing regulations, ICT cannot become a system that is added to other existing system. ICT must be embedded in daily practices, helping the users in achieving compliance. Second, by incorporating rules in ICT, the process documentation become friendlier, and decrease the risk of inconsistencies between process documentation and ICT practice. The third aspect was that the process users found the new process simpler. The developed tool has useful functionalities such as notifying the users of some actions, managing all the project documentations, and providing the process indicators automatically. Table 5 present a synthesis of major changes with the approach.

Table 5. What changed in the design-time?

Before	**After**
Regulations used as a basis for developing process documentation	Regulations incorporated in ICT
Semi-structured documents as a support of process pedagogy and daily use, difficult to maintain	Semi-structured documents as a support of process pedagogy
Quality manager is responsible for developing and ensuring process support	Teamwork for developing the process, including managers and process users. ICT must ensure process support
Lack of coherence between procedure and practice	Practice is executed with ICT assistance
Users complaints: the process is complex, leads to errors	Users acknowledge that ICT prevents errors.
Impossible to connect regulations with the process	Regulations, processes, people IT and information are interrelated
Difficult to audit compliance	ICT is the main support for audit

When we applied again the same questionnaire of step 2, the users expressed that finally the process was helping their work, not creating obstacles. One of the most important contributions was to put the rules of the process, the definitions and references directly in the platform. One of the users told us that "now the ICT has the burden of non conformities, not us! If some field is not filled and is required, if some step of the process is not executed, that is because the tool does not protect the users from error. Formerly we had all the responsibility of process problems. The procedure said one thing, the practice another. Now we can combine both advantages of going digital: efficiency and efficacy".

Lessons Learned for the First Cycle

ICT development can be a result of a cooperative effort between different organizational experts, with distinct vocabularies, but focused in finding the best solution. The use of a simple approach can help the project participants in knowing the steps of the process, and using similar tools. This approach provides a high level of design, which may be then detail by each expert, for example, the IT developer converting the matrix lines in specific functionalities. Although we have created a matrix for the entire D&D process, is also possible to create the matrix for activities or even tasks, in complex processes. If managed properly, ICT can decrease process documentation and provide a friendlier process that prevents users' mistakes. Hopefully, this will also improve the image of regulations in the organization: not as a source of problems but as a source of requirements to better accomplish the organizational mission.

The integration of goals and rules in ICT presents a new challenge: how to manage change in a digital environment. This problem was the motivation for a sequent cycle of action research at the institute. We planned to use the same approach and tools, but now for managing the entire ICT portfolio. The next section presents the results of that cycle.

Second Cycle: Managing Change

Regulations and procedures change over time. ICT cannot freeze or the problems that were solved in the development phase will soon appear. Lacking a proper management of change in organizational processes can create inconsistencies between ICT, process documentation, and practice. The first challenge is to identify those changes and the impacts in people (that requires training), and in our ICT portfolio. Therefore, the organization needs to have *inside-out* information to be aware of the context changes, *within* information to bring changes to daily practice, and *outside-in* information to provide evidences of compliance to the new situation. This is a dynamic process, involving the entire organization.

Managing ICT in regulatory environments requires having a map to link all the aspects of the information system: *context, people, process, information, and IT*. With such a map, when a regulation changes, ICT managers know which IT is affected, who uses those systems, the affected processes, the information that is now necessary inside-in, within, and inside-out of the system. Our plan was to design such a map that could guide the relationship between each element of the O_2 framework. The first task was the creation of an inventory of regulations, IT, processes, and users, as illustrated in Table 6.

Table 6. The O_2 inventory

Regulations	IT	Processes	People
✓ISO 9001 ✓ISO/IEC 17025 ✓Law N1/2013 ✓Law N2/2013 ✓Associative Contract X ✓…	✓ERP ✓CRM ✓Web Site ✓Innovation Platform ✓Spreadsheet Z ✓…	✓Human Resources ✓Provisioning ✓Quality Management ✓Design and Development ✓…	✓Function 1 ✓Function 2 ✓Association A ✓Association B ✓Customer

Then we asked the IS and the QMS managers to connect each element that had any type of connection, in their point of view. For instance, the element ISO 9001 with the element CRM, ISO 9001 with the quality management process, Provisioning with User 2. This was similar to a game, and quite easy to achieve. However, we found that the map was yet too high level, as exemplified in the Figure 6.

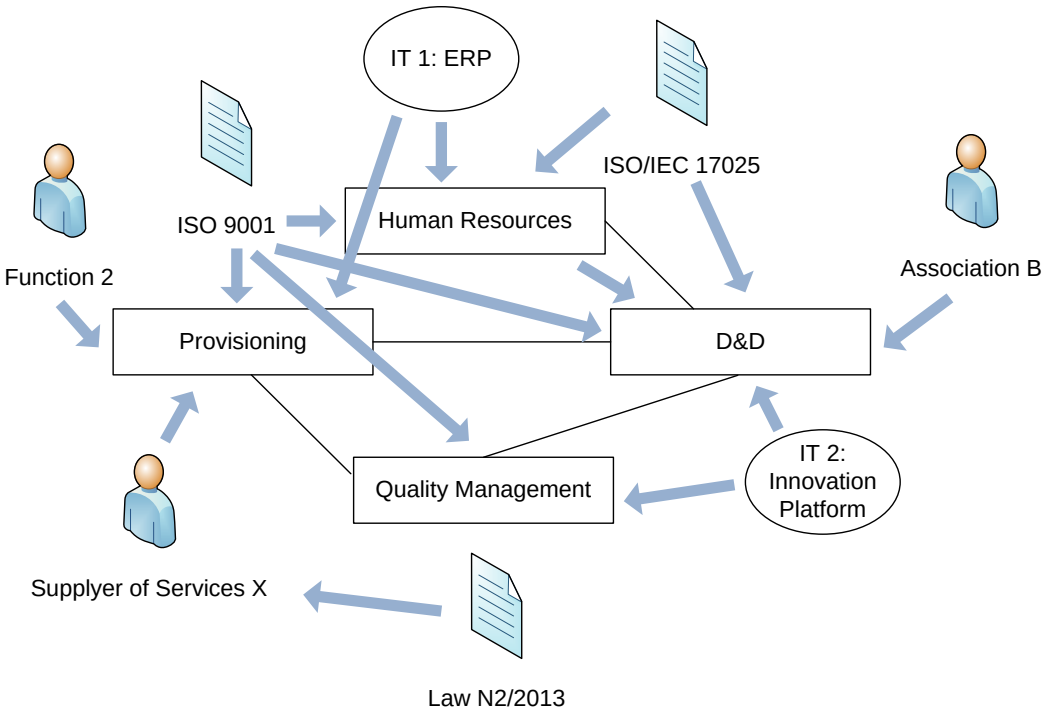

Figure 6 The O_2 map of the Technological Institute (excerpt)

The map represents the distinct elements and their links. Each arrow represents information flows across the distinct elements. The O_2 map is only a high-level representation. The advantage of the map is to provide a better understanding of the impact that a change in one element can have in other elements. For instance, if a new person assumes the Function 2, we know which regulations and IT are applicable, and provide proper training; if a regulation change, we can quickly find processes and IT that will possible be affected. Then we can use the O_2 matrix details to identify the current scenario of the process, and plan the necessary changes.

The next task was to create metadata for each element of the map. This is simple because we have that information in the O_2 matrixes. For instance, the D&D process has an arrow from the IT 2, the Innovation Platform: when a user "click" on that arrow of the map, a popup shows the goals and rules of that connection, presented in Table 3. This is a multidimensional map that identifies the characteristics of each link between elements. To know all the regulatory goals and rules that some organizational function must acknowledge, we just have to add all the information in the arrows that link to the function: identifying training needs. The same is valid for IT applications: identifying requirements. If there is a need to know the entire impact of a regulation in our organization, we need to add all the information of the arrows that connect the legislation with other elements. The O_2 map is an analysis tool and guidance for change. When new regulations are created, we just need to update the map and complete the arrows.

Evaluating Change

A complete simple solution for such a complex problem is not yet achieved. The O_2 map is a high-level presentation and can guide the organization in the identification of links between IS components, relating ICT and regulations. The main problem with the map is that we cannot see details easily. For instance, which requirements of ISO 9001 affect provisioning? Which functionalities of IT2 are related with the process D&D and which ones are related with process Quality management? To answer the questions we must look at the O_2 matrixes that have the details of each process (add the information in each arrow of the map). This task could be automatic with a software tool. Nevertheless, important advances could be found with this approach, listed in Table 7.

Table 7. What changed in the run-time?

Before	**After**
Regulations are a burden to ICT management	Regulations are an essential component of ICT management
Ad-hoc management of regulations, without involving ICT as a critical aspect	Integrated management of change
Difficult to identify the impact of change	The O_2 map allows identifying the main elements that are affected by changing processes or regulations
Regulations seen as a problem of others, not the ICT management function	Regulatory compliance, minimizing errors, and non conformances is also a responsibility of ICT management
Difficult to gather evidences of compliance in audit	Compliance may be evidenced by the meta data of the O_2 map and ICT use in daily practice

A map that only includes processes could not represent the interrelated connections of an information system. The proposed approach enables ICT management in regulatory contexts, having the priority of people in the process of achieving compliance.

Lessons Learned for the Second Cycle

Managing ICT and regulations is complex and simple solutions may not be possible. However, there are tools that we can create to assist the organization in dealing with the problem. At the run-time phase, the O_2 map provides a high-level visualization of the distinct components of the organizational information system. From our experience of over 15 years in ICT management, the organizations do not have simple way of identifying these relations. With the O_2 map and the O_2 matrix, the information becomes integrated concerning each process, regulation, people, and IT.

Moreover, the O_2 map and the O_2 matrixes can be used for auditing purposes. An internal or external audit may use the map to see which persons to interview, which IT to address for process indicators or how the organization implement regulations in the daily practice: who implements, in which processes, by which IT. We suggest that organizations try to identify the links between the most important elements of their information system, or an integrated ICT management will not be effective in a highly regulated context. Then, for each process, more than creating too complex procedures, the

organizations must understand all the goals and rules that affect them, using tools such as the O_2 matrix. This is the first step for managing ICT and regulations in a way that both complement each other.

As regulatory compliance becomes entwined with ICT, organizational managers and auditors must be aware of the importance of data and information quality, software quality, infrastructure quality, ICT administration, and service quality. To ensure that ICT is compliant with local policy standards along as international standards, ICT must be audited and continuously improved. Regulatory compliance is a result of continuous efforts. An example of a practical checklist is presented by Barata, Cunha, and Costa (2013), aiming to audit and develop an information systems quality culture, in the context of ISO 9001.

Conclusion

This chapter provides an approach for the integrated management of ICT and standards compliance. The approach is validated throughout action research, in the context of ISO9001. A practical case is provided for a technological institute, exemplifying how the organizations can develop ICT as an enabler of compliance. The modern nonprofit organizations must be prepared to manage ICT in an increasing regulatory context. The regulations may include ISO standards, that are voluntary, but also the requirements imposed by laws, politics, internal, and external procedures. Either way, ICT must not only comply with those regulations, but also assist the internalization in daily practice. The presented approach is now being tested in distinct settings, in sectors such as the agro-food (ISO 22000) and the aeronautical (AS 9100).

The first step for managing ICT and compliance is to identify all the components of the information system: context, people, process, information, and IT. Then, the goals and rules that shape the compliant behavior of each process. Only then ICT can be developed, with people as a priority. The O_2 artifacts that are created in the development stage are also useful for sequent phases of ICT management, when change is the main focus. The matrixes will be used to check compliance with the regulations, identify the impact, and create a portfolio of goals and rules, connected with the distinct elements of ICT portfolio.

The research has limitations that are important to identify. First, the approach was successfully applied to a technological institute, but the positive results may not occur in all the possible organizational settings. Second, although a solution for proposed for managing ICT and compliance, the map is still incomplete to represent details of all the relations. A software tool could be developed to assist the practitioners in this task. For instance, with a functionality of “drill-down” that could see deeper connections at more detailed levels (clicking in a regulation opens its rules and for each rule or goal we could create links with IT, people, processes, and with other regulations). Such an application would create a multi-layered network of ICT and compliance, with the possibility of multiple visualizations (for instance, only seeing the links of a specific law and hiding other links and components). Future research may include different standards, with the potential to contribute to standards integration, as happens with the ISO management systems for environment, health and safety, and energy.

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