

P1138**Implementation of Quality Management System on architecture offices as a requirement for sustainable design***Case Studies*

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Abstract: The concern with quality management systems initiated on 1990 through ISO 9001 regulation. In Brazil, the improve of quality on civil construction industry have been stimulated after 1998 through the Federal Government PBQPh – Brazilian Program for Quality and Productivity in the habitat – which proposes the quality improvement of construction enterprises through the progressively compliance with the requirements of ISO 9001. The architecture offices were the last to join this initiative with the establishment, ten years later (on 2008), of a program created specifically for them. At the same time, during the last part of 20th century, design methods for sustainable buildings have emerged all over the world. Europeans have taken the sustainable construction as an important goal to be achieved, particularly considering the necessity of reducing energy consumption. Among the methodologies for sustainable design that have made their way to Brazil, the French one (HQE®) has been adapted, resulting in the AQUA Brazilian certification. The main contribution of this paper is to analyze the relation between the existence of an implemented quality management system on design offices and its influence on the design management process for sustainable buildings. Constructors and architects have been interviewed in order to get their opinion about this subject. Results obtained testify the relation between an organized quality management system as a requirement to produce sustainable buildings through the integrated design..

Key words: Sustainable Design, Design Management, Architecture management.

1. INTRODUCTION

The concern for quality during the development of the designs (architecture, structure, etc) initiated when the researchers proved that most of the problems identified during the construction were due to failures in the conception.

It would be necessary to develop a model that would help the design management process: a development plan where the main activities and their priorities - as well as roles and responsibilities of the main participants of the process and information flow - would be defined. It became necessary to map the design process and organize companies to ensure proper production flow in design management.

The quality management system created for help the organization of design offices must help the management of the information, thus making work easier and contributing indirectly to the quality of the designed building.

Unfortunately some aspects compromise the implementation of a quality management system in design companies. One of them is the resistance to complying with ISO 9001 requirements. Some professionals consider that the proposed model is not applicable to small companies, which are common in the building design sector. Despite of difficulties, architecture offices are organizing their management system and achieving best results on design management process.

At the end of 20th century architecture offices had to face a new challenge: the requirements for sustainable design. It is known that interoperability among professionals is a pre-requisite for sustainable design, and it demands the organization of procedures to guarantee the exchange of information among professionals during the design process and a documented management process. On the other hand, some authors suggested the concurrent engineering logic as an answer to integrate design process and, consequently, to sustainable design.

This paper highlights the contribution of a quality management system for sustainable design in architecture offices. Two case studies had been carried out. The first one presents the results obtained through a pilot-experience with a collaborative project among the researchers of Federal University of Rio de Janeiro - Brazil (Universidade Federal do Rio de Janeiro) and architecture offices. The firms have been selected considering their interest on quality management systems (SALGADO, 2010). The second case study analyse the French experience with the HQE® certification through interviewees with design offices, consulting firms and construction companies. Testimonies assure the contribution of ISO 9001 requirements for the organization of a design method to achieve high quality environmental design.

2. DESIGN MANAGEMENT SYSTEMS: FROM SEQUENTIAL MODELS TO CONCURRENT ENGINEERING

The design management process has sparked the interest not only in researchers, but also in professionals of the field, which see a possibility to improve their productivity with quality and efficiency.

Some architects had severely criticized management models for architecture offices, pointing out the importance of drawing the distinction between “*design process certification*” and “*product certification*” to avoid the use of the “*ISO 9001 quality seal*” as misleading advertisement, since the simple certification of an architecture office quality management system does not ensure the quality of the projects themselves.

This discussion confronts the two meanings of “design” (SALGADO, 2007):

- design as product – refers to the building or building complex to be built;
- design as process – refers to the sequence of activities that are required to turn the original construction idea (concept) into guidelines that have to be followed by the construction company in order to create the product, i.e. to build the building.

Brazilian Architecture Office Association (AsBEA - *Associação Brasileira dos Escritórios de Arquitetura*) prepared in 1992 a basic routine for the development of architecture designs with the objective of establishing information, subsidies, requirements and procedures for each phase or step of design process.

Five years later, the Building Technology Center (*Centro de Tecnologia de Edificações*), in partnership with the Union of Construction Industry of São Paulo (*Sindicato da Indústria da Construção Civil de São Paulo* SINDUSCON-SP), prepared a “Quality Management Program in Design Development for the Construction Industry” that intended to gradually self-implement improvements to the design process, by understanding the flow of design process activities, mainly the need to develop the strategic planning of design companies (TZORZOPOULOS, 1999).

The Brazilian Architecture Office Association (AsBEA, 2006) focused again on the topic of the design management process, when published, in 2006, a series of manuals, whose objective was to establish the scope of the services related to the development and coordination of projects. Discussed topics range from the hiring of services to the scope of the projects to be presented. AsBEA does not

suggest any specific management model, but points out the issues that the companies have to consider when organizing their way of operation.

According to Koskela (2007) the evolution of design management practice can be grouped into three different periods:

- design as a craft,
- sequential engineering and
- concurrent engineering (a systematic approach to the integrated concurrent design of products and their related processes, including manufacturing and support).

Traditionally design and engineering has been viewed as transformation, whereas concurrent engineering is based on mostly intuitive understanding of design and engineering as flow and value generation. This author concludes that the tools and methods of concurrent engineering derive from new conceptualization of design, which thus provides the seed towards further development of the theory of design as well as new design management methods.

3. FIRST CASE STUDY: QUALITY MANAGEMENT SYSTEM APPLIED TO BRAZILIAN ARCHITECTURE OFFICES

Brazilian Federal Government addressed the concerns of the Brazilian construction industry, specifically the design sector, by creating in 2008 the Compliance Evaluation System for Companies that are specialized in preparing projects (SiAC-Projetos) (PBQPh, 2008). This system was created within the Brazilian Program for Quality and Productivity in the Habitat (PBQP-H) and has the following main properties:

- Four implementation stages;
- Four standard guidelines – one for each stage;
- **STAGE 1** – Statement of Adhesion to Standard Guideline of Stage 1;
- **STAGES 2, 3 and 4** – Certification by Certification Bodies (CO) or Authorized Certification Bodies (CCO) with *in loco* audits

On previous paper (SALGADO, 2010) have been presented the results obtained with the experience of following up on SiAC-Projetos implementation in design companies located in the city of Rio de Janeiro. Table 1 show the characterization of the design offices that had participated to this project. This experience had highlighted some important aspects to be considered related with the implementation of a quality management system as follows:

- The **TIME** dedicated to organizing the company's management system: the implementation of a quality management system cannot be done in your spare time. The company should allocate some time to perform this task;
- the implementation of the system has to become a **PRIORITY**: if it is not perceived as a priority, it ends up ranking second and being forgotten;
- a professional of the company has to be assigned to be **EXCLUSIVELY** dedicated to follow up the tasks that are required for the organization of the quality management system.

The first phase of the discussion on design management process at Brazilian architecture offices has relativized the importance of aspects such as the quality in the design conception of the building, user satisfaction, among others. This happened due to the urgency in reducing design errors, such as incompatibilities between the different specialties, the discrepancies between the last reviewed version

of the design and the one that is actually being executed on the construction site, and the problems in tracking design team decisions.

Table 1 – Characterization of offices that participated to this pilot experience.(SALGADO, 2010)

<i>Companies</i>	<i>A</i>	<i>B</i>	<i>C</i>
<i>Foundation year</i>	<i>1987</i>	<i>2006</i>	<i>1986</i>
<i>Number of employees</i>	<i>6</i>	<i>33</i>	<i>39</i>
<i>Activity</i>	<i>Architecture projects, including all phases, and coordination of residential and business projects.</i>	<i>Real estate, schools, special projects (dealers, stands, squares, etc)</i>	<i>. Architecture projects: coordination and development of executive projects . Engineering projects: infrastructure for developments and groups (implementation, earthwork, drainage, sewage system, drink water, power supply, lightening, etc).</i>
<i>What do you expect from implementing a quality management program at your company?</i>	<i>To improve the company's performance; record the adopted operation and organization; improve the workflow and information management.</i>	<i>To organize the company's management system by establishing routines in order to comply with contracts, reduce errors and rework.</i>	<i>To standardize the procedures used by the company (from internal administrative processes to the services rendered to clients) in order to ensure the quality (deadlines, costs and technical quality) of the services we render to our clients.</i>

NOTE: Data obtained on December 2008.

It is important to add that design valorization should consider conferring a higher priority to aspects related to the quality of the designed spaces, which shall not be surpassed by the needs of the companies' design management system.

4. RECOVERING THE QUALITY IN THE DESIGN CONCEPTION THROUGH THE PRINCIPLES OF SUSTAINABLE DESIGN

It is generally accepted the current era of rating tools commenced in 1990 with the introduction of the BREEAM (UK) rating tool. This was followed by the French system HQE® and then by the U.S. LEED™ in 2000. Further analysis of, confirms that the evolution of rating systems into different countries is largely based on the initial rating systems (REED et al, 2009)

BREEAM (Building Research Establishment's Environmental Assessment Method) sets the standard for best practice in sustainable design. Credits are awarded in ten categories according to performance. Where a performance target has been achieved the number of available BREEAM credits can be awarded. The majority of BREEAM issues are tradable, meaning that a design team/client can pick and choose which to comply with in order to build their BREEAM performance score. As a certification body accredited by the UK Accreditation Service (UKAS) BRE Global Limited maintains an open and accountable governance structure. The operation of BREEAM (and indeed all our assurance activities) is overseen by an independent Governing Body and a Standing Panel for Peer & Market Review (BREEAM Offices 2008, 2010).

The Leadership in Energy and Environmental Design (LEED™) Green Building Rating System represents the U.S. Green Building Council's effort to provide a national standard for what constitutes a "green building". Through its use as a design guideline and third-party certification tool, it aims to improve occupant well-being, environmental performance and economic returns of buildings using established and innovative practices, standards and technologies. To earn LEED™ certification, the applicant project must satisfy all the prerequisites and qualify for a minimum number of points to

attain the established project ratings as listed. Having satisfied the basic prerequisites of the program, applicant projects are then rated according to their degree of compliance within the rating system. All prerequisites must be achieved in order to qualify for certification. Points add up to a final score that relates to one of four possible levels of certification. (SALGADO and LEMOS, 2005)

In France, the HQE® – *Haute Qualité Environnementale* (High Environmental Quality) association – was created to develop environmental quality management in the building construction industry. This association produced a report containing recommendations in the form of environmental targets to be pursued by architects and engineers. Among the targets, it is important to highlight: Eco-Construction; Eco-Management; Comfort (thermal, acoustic, visual); and Health (air and water quality, among others). This report led to the methodology for support of the high environmental quality design, where each target should be divided into several requirements and recommendations which should be reviewed for each building, it is not possible to establish a single formula for all types of construction.

The development of projects that consider the principles of the High Environmental Quality (HQE®) method may be divided into two phases: the first phase may be called "setting parameters" and the second "the design concept." The "setting parameters" phase can be divided into:

- The study of the environmental potential of the land - specifically related to the parameters set by the HQE® method
- The Pre-programming HQE® - with the ranking of the 14 targets set by the methodology;

Table 2 presents the 14 targets of HQE® methodology.

Table 2: 14 HQE® Targets

OUTDOOR ENVIRONMENT
ECO CONSTRUCTION
Target 1: Harmonious relation of the constructions with their immediate surroundings
Target 2: Integrated choice of construction processes
Target 3: Building site with few disturbances
ECO MANAGEMENT
Target 4: Energy Management
Target 5: Water Management
Target 6: Management of waste from the activities
Target 7: Technical Assistance and Maintenance
INDOOR ENVIRONMENT
COMFORT
Target 8: Hygrothermic Comfort
Target 9: Acoustic Comfort
Target 10: Visual Comfort
Target 11: Olfactive Comfort
HEALTH
Target 12: Sanitary Conditions
Target 13: Air Quality
Target 14: Water Quality

Source : ADEME, 2002

A comparison among those three rating systems is presented on Table 3

Table 3 – Comparison among BREEAM, LEED™ and HQE®

Criteria	BREEAM	HQE®	LEED™
Energy	X	X	X
CO ₂	X	X	
Ecology	X	X	X
Economy		?	
Health and Wellbeing	X	X	
Indoor environmental quality	X	X	X

<i>Innovation</i>	X	?	X
<i>Land use</i>	X	X	X
<i>Management</i>	X	?	
<i>Materials</i>	X	?	
<i>Pollution</i>	X	X	X
<i>Renewable Technologies</i>	X	?	X
<i>Transport</i>	X	?	X
<i>Waste</i>	X	X	
<i>Water</i>	X	X	X

Source: Adapted from REED et al, 2009

About the certification methods, it is relevant to add that BRE Global, CSTB and CERTIVEA have signed a MoU to initiate joint programme with the overall objective of aligning the certification schemes delivered by the two institutes in the countries in which they operate. This will ultimately allow the development and promotion, at the European level, of a common assessment method and a common brand run by a European council.

The building production life cycle extends from the stage of preliminary study to construction. The possibility of changing the characteristics of the building to satisfactorily meet all the HQE requirements may vary, depending on the stage of this cycle. According to PLATZER (2009, p.67), the building production life cycle occurs within six phases: Programme needs - which can be divided into environmental needs and user needs; building design; materials and methods; construction; post-occupancy activities (including the use, operation and maintenance of the building) and demolition. According to this author, most part of the goals defined by HQE® must be accomplished during the two first phases. So, to achieve high quality environmental performance in building construction it is important to incorporate the sustainable solutions since the beginning of design process.

Currently, Brazilian's architecture offices are initiating their search for methods that could give some orientation about the design process for sustainable construction. LEED™ and HQE® have made their way to Brazil. The French methodology has been adapted, resulting in the AQUA Brazilian certification. It is assumed that Brazilian architecture offices must though organize their management system in order to accomplish the sustainable requirements along the design management process.

5. QUALITY MANAGEMENT FOR SUSTAINABLE DESIGN IN FRANCE

At the same moment design sector had faced the sustainable challenge, the discussion over design management process had been intensified. Architects and engineers are not interested on ISO 9001 certification but they understand that to achieve best design solutions (particularly considering the environmental goals) it is necessary to integrate the design solutions and also the professionals involved (architects, engineers, etc).

French experience with HQE® method had lead professionals to rethink design management process in order to integrate the new environmental goals into architecture solutions. For this reason, AFAQ AFNOR, *Fédération des Promoteurs Constructeurs de France* and CERTIVEA (a subsidiary of French Building Research Centre – CSTB) proposed the referential QUALIPROM® created precisely to be applied by a constructor that needs to integrate the HQE® goals into all its operations and demonstrate their capacity to accomplish the client's necessities and regulations related, answering positively to the environmental requests. (QUALIPROM, 2007).

This methodology is based on ISO 9001 requirements and also the exigencies of HQE®. Table 4 presents a comparison among different regulations about quality and environmental management.

Table , References texts about quality and environment management in France

Document	Editor	Goals	Methods	Note:
ISO 14001	AFNOR	Organize environment management	General regulations, not specific for construction sector. The certification has international validity.	Possibility to obtain a third part certification emitted by an independent organism
ISO 9001	AFNOR	Organize quality management		
SME HQE	Association HQE	Apply the environmental management to an specific real state operation	Report of "l'Association HQE" working group that proposed principles for adaptation of ISO 14001 requirements to building construction industry.	No possibility to obtain an associate certification (with ISO 14001). Can be applied to new constructions or rehabilitated buildings.
GA P 01-030	AFNOR	Adapt ISO 14001 to architects, engineers and constructors	AFNOR Guide that correlates SME HQE referential requirements according to ISO 14001 structure	
QUALIMO	Certivéa	Apply quality criteria to rental housing operations	Quality certification reference specific for rental management, considering the concepts of ISO 9000	Owners rental, including social structures for QUALIMO, real estate developers for QUALIPROM. Both benchmarks are dedicated to the certification by a particular agency: Certivéa
Référentiel QUALIPROM	Certivéa	Apply quality standards to the operations of housing for ownership	Quality certification reference specific for project management in home ownership considering the concepts of ISO 9000	

Font. : Adapted from PLATZER, 2009

In order to accomplish the necessary requirements to produce sustainable building, it is important to understand the design phase (which is pointed out to be the most impacting), and also the selection of building materials, components and processes.

6. SECOND CASE STUDY: IMPLEMENTATION OF ISO 9001 REQUIREMENTS IN FRENCH OFFICES AS AN APPROACH TO ACCOMPLISH HQE® EXIGENCIES

In France, based on their concern with the energy performance of their buildings, professionals have started to rethink the design and construction process. A survey was conducted with some professionals that work in large French firms in order to understand the relation between a quality management system and an architecture process that could allow the accomplishment of the design with sustainable principles. Eight firms have been contacted:

- four architecture offices – one of them close to obtain ISO 9001 certification and one certified;
- two consulting firms specialized in acoustic projects;
- two construction firms certified by ISO 9001

It sought to identify not only their opinion with respect to the HQE® method but also concerning sustainable construction in France in general. Those surveyed were also asked about possible modifications incorporated into their design process, as a result of high environmental quality requirements for their building design.

The results obtained had shown that, with respect to design process management, in the opinion of those interviewed, it is not possible to achieve any design that takes the environmental issue into account, without preparing a system to help managing the necessary data for executing the design. In this area, all those interviewed claimed that they have a specific control system for documents and data.

It is important to point out, however, that specifically in relation to certification according to ISO 9001 standards, although all the companies recognise the importance of establishing a working

method, this does not have to be formalised in the manner set forth as being required by the standards. Furthermore, some of those interviewed did not see their companies as being sufficiently large to implement an organized management system.

In the four companies where the quality management system exists and is certified, the professionals confess that they would no longer know how to work without the documental base required by that system. It was stressed that all those interviewed should recognise the potential of a quality management system in handling designs with high environmental quality. As said by one of interviewed professionals:

“The HQE® has a qualitative approach, therefore the organization of the firm on the requirements of the standard ISO 9001 for quality management, makes it easier to have some organization for the environmental approach, because professionals are already accustomed to work with the procedures, with documents.”

7. DOCUMENT MANAGEMENT FOR SUSTAINABLE DESIGN

Two difficulties are been faced by Brazilian and French architecture offices in order to organize their management systems: the document management and the functional structure formalization – particularly on small offices. Amor and Clift (2007) had established a list with the standard documents in a construction project. Traditionally those documents are generated and stored in paper form. Table 5 presents a list of those documents.

The document management is a challenge because normally architects cannot predict the whole design management process and, consequently, they don't know how many types (and versions) of documents must be prepared in order to execute the complete task of producing a new building. The result of this situation is that, sometimes when a new document is produced, it is nominated without any specific pattern and archived without obeying a determined logic. Consequently, to find a document sometimes professionals spend a lot of time. This wasted time is subtracted from the working time and the result is the loss of productivity.

By discussing document and data control, some doubts came up regarding document management, which includes the creation, nomination, classification and archiving process. Routines have to be established for the following situations:

- 1) Control of technical documents and data (projects) – it is necessary to define the nomination (codes) to be used and the archiving procedure, and to establish the security level of each document (if anyone at the office can open and make changes/reviews or if only the design team can open and alter the archive).
- 2) Control of administrative documents and data (payroll, issued invoices, delivery receipts, etc) – the nomination (codes) must be related with the type of data to facilitate users to find when necessary. It is very important to discuss the process with all the collaborators in the office (not only architects and engineers)..
- 3) Control of Quality Management System documents and data – ISO 9001 indicates several new procedures to be discussed, produced (formally registered), validated and implemented by offices in order to allow the accomplishment of the requirements to a quality management system. These procedures must also be controled and archived.
- 4) Backup of documents and data (digital and printed) – Design offices are made of “ideas”. Those ideas are registered in several different documents that form the portfolio of the architecture (or engineering) office. It is not possible to conceive an office without an appropriate system to

- protect those several documents (printed or digital). The backup process can be automated or manual. It depends on the type of the documents to be protected.
- 5) Registration of system users (access to the network) – Different phases of design are developed by different professionals. So it is necessary to develop a system to define which professionals must have full access to all documents (“full access” in this context, means the possibility to open the digital archives, make changes and save with another code considering the reviewing process) and which professionals will only be authorized to see documents, but not to change them.
 - 6) Time of disposal – As offices normally do with printed documents, digital documents must also be deleted after a time. Not defining disposal time will lead to slowness in processing data from over-stored documents.

Table 5 – Standard documents in a construction project – the UK viewpoint.(AMOR and CLIFT, 2007)

<i>Type</i>	<i>Author</i>	<i>Legal/contractual status</i>
<i>Brief</i>	<i>Client/owner</i>	<i>High</i>
<i>Contract/commission</i>	<i>Client</i>	<i>High</i>
<i>Drawings</i>	<i>Designer/contractor</i>	<i>High</i>
<i>Specifications</i>	<i>Designer</i>	<i>High</i>
<i>Bills of quantities</i>	<i>Quantity surveyor</i>	<i>Medium</i>
<i>Tender documents</i>	<i>Designer</i>	<i>High</i>
<i>Valuations</i>	<i>Quantity surveyor</i>	<i>Medium</i>
<i>Payment certificates</i>	<i>Designer</i>	<i>High</i>
<i>Program/schedules</i>	<i>Contractor</i>	<i>High</i>
<i>Calculations</i>	<i>Designer/contractor</i>	<i>Medium</i>
<i>Site diaries</i>	<i>Supervisor/contractor</i>	<i>Medium</i>
<i>Change orders</i>	<i>Client/designer/contractor</i>	<i>High</i>
<i>Progress records</i>	<i>Supervisor/contractor</i>	<i>Low</i>
<i>Claims/compensation events</i>	<i>Contractor</i>	<i>High</i>
<i>Letters</i>	<i>All</i>	<i>High</i>
<i>E-mail</i>	<i>All</i>	<i>Low</i>
<i>Fax</i>	<i>All</i>	<i>Low</i>
<i>Request for information</i>	<i>Contractor</i>	<i>Medium</i>
<i>Confirmation of instruction</i>	<i>Designer</i>	<i>Medium</i>
<i>Notices</i>	<i>Client</i>	<i>High</i>

It is clear that, in construction industry, physical documents will not disappear, however, as pointed by Amor and Clift (2007, p.186) the short term benefits which could be realised by utilization of DMS (document management system) are mostly in the automation of non-value adding processes, for example, automatic forwarding of documents to a set of team members on completion of a particular process or activity. Standards functions could also automate many of the tracking and verification activities required for dispute resolution by recording who received what documents, at what time, and by recording when the recipient opened the document. Standard function will also allow security to be implemented though digital signatures to ensure that original versions can be identified and encryption should be used to ensure that unauthorized access to documents can be controlled.

8. CONCLUSIONS

The implementation of a document management system is the main challenge Brazilian and French design offices have to face in order to achieve sustainable design goals. It have been noticed in France some offices that decided to create their own software for document management and it has been considered the first step not only for the certification ISO 9001 but also (and mostly) for helping to

accomplish the requirements of HQE® methodology – particularly on registering the QEB (Quality Environmental of the Building) goals and the design decisions to achieve the desired results.

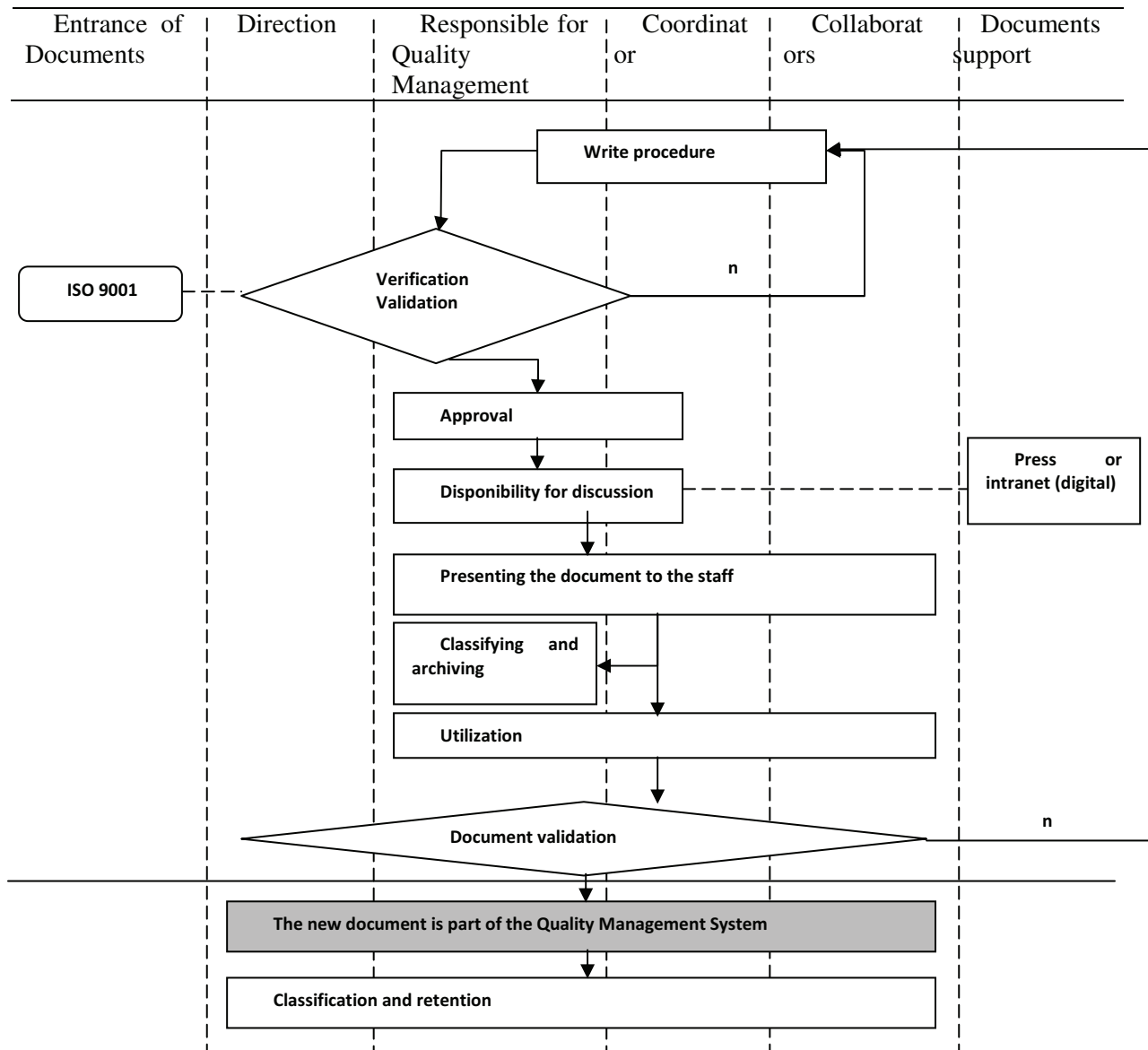


Figure 1, Workflow of ISO 9001 document management (proposed by a French construction enterprise interviewed)

Figure 1 presents a proposal for the workflow for ISO 9001 document management. It is important to highlight that the “validation” is considered an important phase not only for the control of ISO 9001 document management but also for design document management.

An information system becomes important for acquiring, structuring and exchanging information during the design process. The intrinsic complexity of the information during the architecture design process has become yet more complex with the adoption of environmental goals. The interoperability during the building conception process is necessary in order to select, among the set of possible solutions, the most accurate in terms of high quality environmental.

Considering that a quality management system organized according to ISO 9001 requirements must define procedures to document management, we can conclude that an office organized by this

regulation will, at least, have the necessary structure to rethink the design conception process considering the sustainability principles.

However, although the first steps had been taken, there is still too much work to be done. The new possibilities offered by BIM – Building Information Modeling – for example, have not been totally explored by the construction sector. The parametric design allows decisions to be done by different authors simultaneously, with the on-line discussion about the best solution for the building. On the other hand, professionals have to be trained on these new possibilities, which demand a new workflow for the design process, and represents a new challenge for document management process.

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