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STANDARDIZING THE INNOVATION IN THE SPANISH CONSTRUCTION INDUSTRY

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Abstract

Innovation is the process that converts new knowledge into new products and services. It constitutes one of the two fundamental supports of the companies' competitiveness. Construction is a very important activity in Spain, but companies of the construction industry invest very little compared to other industrial activities. Due to this fact, the R&D&i's investment in the Spanish construction industry is eight times less than the average of the EU-15. One of the reasons that explicate this situation is the current systemization scarcity of innovation; however, when there is innovation, it concentrates mainly in the constructive procedures to solve specific problems.

Nowadays, innovation is not considered an art any more, but a manageable process. The standardization of innovation allows the increase of innovation's effectiveness and efficiency, reducing risks and supporting companies to recover their initial investments with high speed. Spain is positioned in an inflexion point produced by the beginning of standardization and certification of innovative projects and innovation management. This article describes the most important requirements related to innovation projects stated in the UNE 166001 standard, and those requirements of the UNE 166002 standard related to the management of R&D&i.

The most important conclusion is that the standardization of the innovation in the Spanish construction industry can be very effective in order to systemize new knowledge into new constructive procedures. This change can be enhanced because R&D&i management is being valued in public works' bids as an added factor to the traditional ones: price, duration and quality.

Keywords: Innovation, Construction, Standardization, Management

Resumen (NORMALIZANDO LA INNOVACIÓN EN EL SECTOR ESPAÑOL DE LA CONSTRUCCIÓN)

La innovación es el proceso que transforma nuevos conocimientos en nuevos productos y servicios. Constituye uno de los pilares fundamentales de la competitividad de las empresas. Sin embargo, y a pesar que la construcción es una actividad tremendamente importante en España, las empresas del sector invierten muy poco en relación con otras actividades industriales. Así, la inversión en I+D+i en la construcción en nuestro país es ocho veces menor que la media de la UE-15. Una de las razones que explican este hecho es la escasa sistematización de la innovación, que cuando existe, se centra principalmente en los procesos constructivos para resolver problemas concretos.

Hoy se entiende que la innovación ya no es un arte, sino un proceso que se puede gestionar. La normalización de la innovación permite aumentar la eficacia y eficiencia de la innovación, reduciendo riesgos y ayudando a las empresas a recuperar con mayor rapidez

sus inversiones iniciales. España se encuentra en un punto de inflexión producido por la normalización y la certificación de los proyectos y de la gestión de la innovación. El artículo describe los requisitos más importantes de la norma UNE 166001 en relación con los proyectos de innovación, y los de la norma UNE 166002 referidos a la gestión de la I+D+i.

La conclusión más importante es que la normalización de la innovación en el sector de la construcción en España puede ser muy efectiva para sistematizar la incorporación de nuevos conocimientos en nuevos procedimientos constructivos. Este cambio puede verse muy favorecido si empieza a valorarse la gestión de la I+D+i en los concursos de obras públicas, como un aspecto añadido al precio, al plazo y a la calidad de la oferta.

Palabras Clave: Innovación, Construcción, Normalización, Gestión

1. Innovation and construction

Innovation is a process of taking new ideas through to satisfied costumers. It is the transfer of new knowledge into new products and services. High competitive companies allow that their strategy of progress and economic growth is based on their innovation capability and their transformation in interesting products for their potential users or consumers. In spite of the importance of the construction activities, the innovation effort, made by the companies that work in this industry, is hardly known. There are no systematic records on innovation due to two main motives [1]: low diffusion of the innovation concept and little concern in the tax allowance. In general, research, development and innovation (R&D&i) shows lower levels in construction comparing to other industrial activities, even in countries of tradition in research as Germany, United Kingdom, France or United States. The Spanish scenario is not very different. Maybe Japan is the only exception; there, construction companies have a traditionally well-known research activity.

There are many specific features that hold back the implementation of R&D&i processes to the construction industry. Some of them can be pointed out: heterogeneous and fragmented sector that depends on many professional bodies; unique projects that produce prototypes most of the times; absolute dependence on the economic cycle; intensive and unqualified manpower; mobility of the construction operations; and high degree of subcontracting.

Innovation is a pure managerial activity, because it is the entrepreneur who introduces the new ideas into the market; these ideas can be of any type, own or foreign, in the shape of services or products [2]. Figure 1 displays a new management model, where innovation is another operational business process that should be lead by top management [3]. In the construction industry, innovation is mainly focused in processes, directly linked to the construction site in order to solve the problems at hand. These kinds of innovation processes are quick responses to particular problems, and they hardly fit to the systematized development of the R&D&i processes. Besides, results from innovation are not usually patentable and they can be easily copied by other companies. Suppliers (equipments, machinery, products, etc.) are generally companies from the same multinational enterprise, thus R&D&i activities are developed in the native countries of these enterprises. Nevertheless, no difficulties should hide the companies' need to know the scientific and technological discoveries and the capability to apply them to the different phases of the construction process.

One of the biggest deficiencies in Spain is the low level of development in the innovation system [4]. Spanish spending on R&D&i activities, as percentage of GDP, is half of the EU-15 and one third of the United States [5]. Spanish construction industry is especially non-innovative. When referred to construction, Spanish investment in innovation is approximately eight times less than the EU-15 average [5]. Furthermore, until some months ago, no

initiative was taken to prompt the innovation in the industry, as it happened during last decade in United Kingdom [7,8], and the later Movement for Innovation [9].

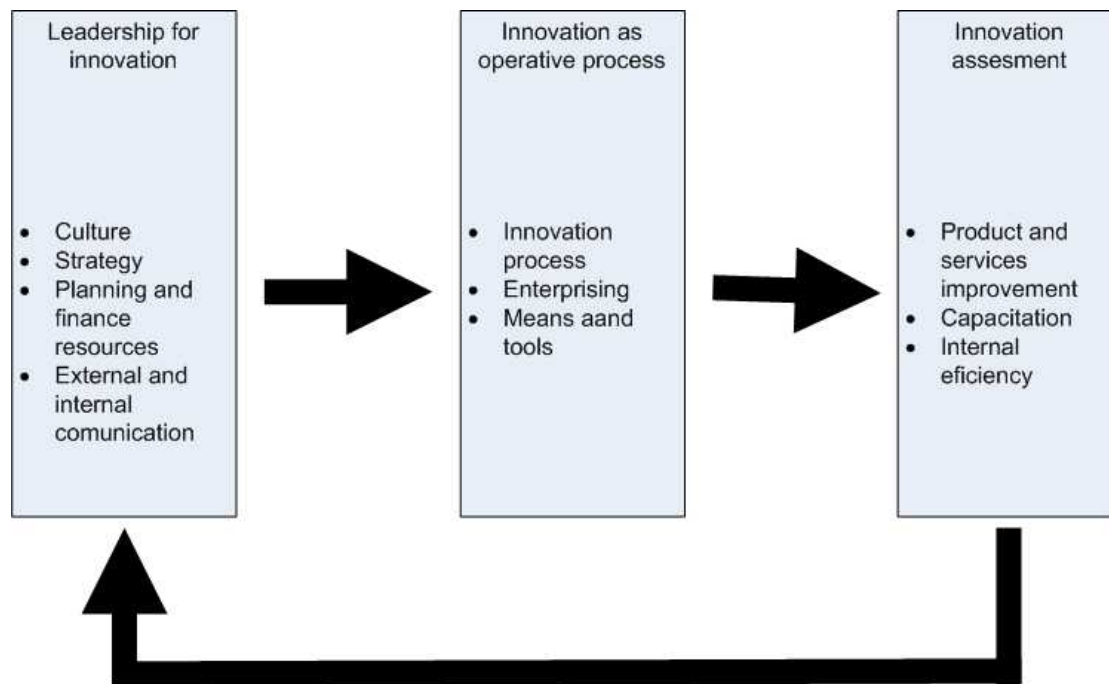


Figure 1: COTEC innovation model (adapted from [3])

Applying the commitments adopted by the European Union at Lisbon in 2000 [5], the Spanish government has just issued the program Inventiveness-2010 [10] to bridge the gap of R&D&i with the western economies. Fiscal incentives are given to enterprises that invest in R&D&i activities. Additionally, some public agencies are rewarding construction companies in the bidding process if these companies show up proof of their innovation; this reward can be up to 25% in the final score of the bidding [11].

Nevertheless, we are in a point of inflexion towards a new scenario. Several circumstances favor the change of attitude towards innovation: subsidies and grants from the European Union; implementation of quality and environmental management systems (ISO 9001 and ISO 14001); and design-build projects and public-private partnerships where construction companies act as designers. Construction companies are just realizing that innovation plays a fundamental role to respond the necessities and expectations of their clients and stakeholders; they are also recognizing that innovation may be a key factor for their survival.

The significance of innovation in every sector is increasing widely. Firms cannot afford to rely upon flashes of brightness by individual researchers working alone. Very often, innovation comes from the planned and deliberate combination of ideas, people, and things from the past that glimmer new technological revolutions. Thus, construction companies need more than creativity; they need a consistent innovation process, just as they have processes leading all other aspects of their business. However, managers and technical staff often struggle to describe "innovation" accurately and find it difficult to detail which tasks can be considered innovative and which cannot. Nevertheless, from the management point of view, innovation is a process (a set of systematic activities) which intends to get competitive advantages by adding scientific, technological or organizational improvements, advances in knowledge or design of the company's products, services or procedures.

Summarizing, the aim of this paper is to present a new picture where innovation is perceived as another business management process able of systematization. In this fashion, innovation can endure standardization in compliance with an external certification body. First, the apparently exclusive terms of innovation and standardization are evaluated. Standards are part of the framework that holds efficient innovation processes. Hence, the new Spanish normative UNE 166000 is deeply analyzed. Finally, the main conclusions of our article are stated.

2. Standards and innovation

Standards embody technical knowledge and make them accessible to every business, allowing a more effective product and process development. Due to the accuracy of their specifications, standards let companies and their customers to save on capturing product information and on testing for reliability and compatibility. However, meeting standards and regulations can also be seen by firms as a restriction on their capacity to carry out some types of innovation.

It could be inferred that the purpose of standards is to suppress innovation in the area being standardized. Standardization means we no longer have to innovate in that area because it is already optimized. Thus, is it possible to standardize the innovation? There is a good debate about whether such constraints on companies reduce competition and innovation at market level or in the global economy. Many firms report that meeting standards and regulations are issues that impede innovation projects.

Kondo [12] affirms that innovation and standardization are not mutually exclusive. For this author, in order to achieve a good harmony between them, work standards have to specify clearly the “true aim of the work” and afford “freedom in the means and methods”. He proposes that manuals should be oriented to beginners for training or to experienced workers for know-how. In this same direction of thought, Edum-Fotwe *et al.* [13] present a case study of a British public agency that manages innovative solutions for the health sector by means of standardization; standards offer the baseline for reliable performance, whereas significant elements of innovation are captured and added to the standards.

Several papers were discovered about the relationship between innovation and quality management. Kanji [14] displays a simple model where each kind of innovation undergoes the quality management process to become a successful innovation; several examples are given to enhance the idea. Keogh and Bower [15] present a case study to detect links between quality management and innovation in the oil and gas industry. Bossink [16] investigates the supportive use of quality tools in the management of innovation; he finds that these quality tools, being ISO 9001 standard among them, are very useful for the management of innovation.

In 1989, BSI issued the standard BS 7000-1 “Design management systems: guide to managing innovation”; it was republished ten years later. This standard gives advice on “the development of innovative and competitive products that will satisfy customer’s perceived and talent needs in the long term future” (p. 1); it goes beyond design management, but it does not cover a continuous improvement. However, more than a typical standard, BS 7000-1 can be considered as an academic paper addressing key issues on managing innovation related to design: roles, types, processes, organization, tools and techniques. Another standard, BS 7000-4 (“Design management systems: guide to managing design in construction”, published in 1999 by BSI), deals with specific issues on managing design in construction. Three main features have to be highlighted from the analysis of these British Standards. First, their scope is product design (even the BS 7000-4 that is focused on

construction). Second, they provide a framework for managing innovation, but not in a systematic way. Finally, they rely on ISO 9001 standard as a complementary support.

In western and developing economies, most companies innovate, not only in the construction industry but also in other sectors. In Europe, large funds are expended in the development of standards, offering companies prospective competitive advantages under the right framework environment. Standards offer benefits throughout research and development, design and testing, avoiding the expensive and time-consuming business of starting from scratch. Spending less time and money reinventing the wheel means that efforts can be focused on developing new and innovative elements. The result is that products reach the market faster and more efficiently, decreasing investment risks and making possible that those companies recover initial investments much quicker.

However, the core difficulty becomes continuous and methodical innovation; random efforts and intermittent brainwaves are not enough. Innovation has achieved a critical point where it is not a gift anymore but a professional feature; thus, it has to be planned, organized, directed and controlled, as any other managerial activity [17]. ISO 9000 standards series can serve as a basis for it; nowadays, many companies are applying these standards to their business processes in the construction industry [18].

There is confirmation [19] to suggest that well implemented standards may contribute to the innovation process and consequently to economic growth. The challenge lies in increasing consciousness on how standards may be used by economic stakeholders to carry out innovative new products and services and more efficient business processes. Standards are a core part of the framework that holds efficient innovation. They outline an important part of the framework conditions for business and induce the possible routes to market. As a policy instrument for technology, diffusion standards are both effective and efficient. Hence, standards may be considered as a catalyst for innovation.

Systematic innovation presents many advantages for project-based companies in the construction industry:

- Efficient exploitation of resources and know-how.
- Improvement of organizational activities.
- Achievement of goals and objectives previously fixed.
- Spreading knowledge to comply with the requirements of market acceptability.
- Reducing uncertainty for producers and customers.
- Differentiating factor for competitiveness and business status.
- Technology transfer.
- Tax deduction.
- Enhancement of employees' motivation.
- Enrichment of stakeholders' satisfaction.
- Identification of changes and new opportunities through technological watch.
- Integration with other ISO standards.

For a company to start managing innovation in a systematic way there must be a commitment to dedicate economic, financial, material, human and managerial resources to it, an the direct involvement of management and stakeholders. It is very important to convey a sense of urgency when it comes to fine-tuning the company and organizing the innovation

process. Innovation has to be seen as a process that saturates the whole company, crosses the boundaries of functional departments and involves different players simultaneously.

3. UNE 166000 Standards

The 4th Research Technological Development and Demonstration European Frame Program, corresponding to the period 2002-2006, and the European Area of Research and Innovation are part of the European activities of R&D&i. In this field the sustainable economic development, as well as the employment encouragement and the social cohesion is promoted in order to obtain, in 2010, a very competitive area that may be able to generate useful knowledge. The Spanish Ministry of Science and Education has supported the project of standardizing the R&D&i activities and interested parties are participating in it: several public agencies, universities, technological institutions and research centers, networks of technology transference, enterprise associations, and significant companies.

In order to induce the systematic innovation in the Spanish economy, the experimental standards UNE 166000 were issued in 2002 by AENOR (the responsible body for developing Spanish standards). This year, the main standards have been edited in a definitive version. This new normative aims to enhance managing the methodical innovation, especially in medium and small enterprises. These standards comprise:

- UNE 166000: 2006. "R&D&i management: terminology and definitions of R&D&i".
- UNE 166001: 2006. "R&D&i management: requirements for R&D&i projects".
- UNE 166002: 2006. "R&D&i management: requirements for R&D&i management systems".
- UNE 166003 EX: 2003. "R&D&i management: competence and evaluation of R&D&i projects auditors".
- UNE 166004 EX: 2003. "R&D&i management: competence and evaluation of R&D&i management systems auditors".
- UNE 166005 IN: 2004. "R&D&i management: application guide of UNE 166002: 2002 EX to equipment sector".
- UNE 166006 EX: 2006. "R&D&i management: technological watch system".

Certification can be obtained for innovative projects (UNE 166001) and for innovation management systems (UNE 166002). The former can focus on planning or execution. The latter is thought to develop the integration of R&D&i within the quality management systems ISO 9001. Nowadays, these standards are mainly used in Spain; recently, they have also been introduced in Mexico, Brazil, Italy and Portugal.

Developing these standards, AENOR responds to the conception of new products and services, which become R&D&i activities. This scenario improves the quality of the companies, its products and services, in order to protect the environment and the well-being of the society. These standards will assist Spanish companies with R&D&i activities, to systematize their R&D&i projects; they will allow identifying their contents in these activities in order to anticipate tax allowances according to the Spanish Law.

The implementation of R&D&i management systems will let the companies to generate their own technology and to systematize the creation of new products and services. This way, their performance can be enhanced and their market position improved in the next future.

In the Spanish construction industry, following the Inventiveness-2010 program, public agencies are evaluating innovation through the bidding process for works and services

contracts issued by the central government; the measurement of innovation is based on UNE 166000. The pace for innovation in the industry is increasing, even though it is going to take some time to reach the EU-15 average. For instance, at the end of 2005 only one out of 42 certified companies was a construction firm. At the beginning of this year, there were 32 application forms on administrative queue waiting for a positive decision to obtain certification; 10 out of those 32 forms were from firms in the construction industry.

4. R&D&i project certification

Project management is the engine for implementing new ideas; many tools and techniques can make this process more effective. In most organizations, there is a relatively high level of competence in project management. However, the understanding of how to manage an innovation project is not always clear. Figure 2 shows some types of innovations projects.

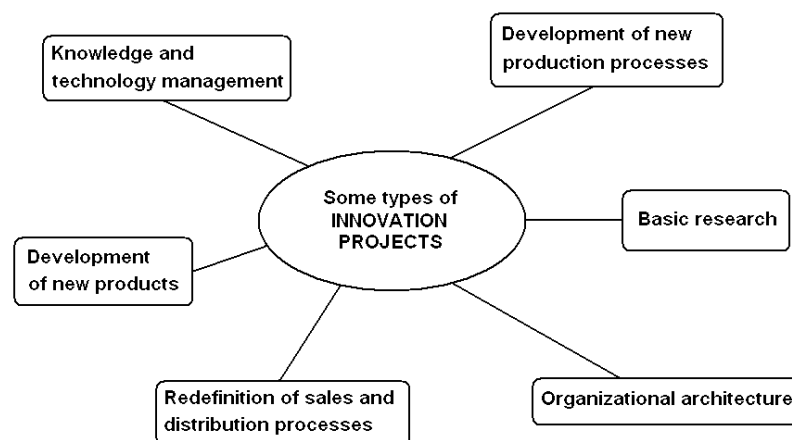


Figure 2: Some types of innovation projects (adapted from [20])

In most companies, innovation is, doubtless, one of the least structured processes; this is especially true in the case of small and medium enterprises [20]. Standard UNE 166001 is a reference for defining, documenting and developing R&D&i projects. It includes the relevant aspects of managing the project and exploiting its results. This standard aims to facilitate the systematization of R&D&i projects. Thus, every type of organization, especially medium and small enterprises, can identify innovative activities, develop and document them in a methodical way to obtain a sound and well regarded achievement in innovation. Furthermore, this innovation can be certified and displayed for acknowledgment, whenever it is necessary. Companies particularly pursue fiscal and tax incentives in order to improve its resources, products and processes.

Innovation projects never aim at providing solutions for the standard corporate business cycle, or meeting day-to-day demands; their purpose is maintaining or significantly improving the business's medium-term results. The results may vary from the initial aims, but this does not make them any less valuable. Innovative outcomes could be: incremental or radical; modifications of something existent or completely new; products or processes; or oriented to consumption, industry or management.

A potential innovative project needs a person in charge, with well-defined tasks. Therefore, it is imperative to manage and document R&D&i projects efficiently. Then, these projects are documented as follows: (1) main report; (2) scope of work; (3) budget; (4) document control; (5) project monitoring; and (6) exploitation plan. The main report includes: summary,

methodology, goals and planning to measure them, impact and opportunity regarding R&D&i. The current state of the art of the product, process and technology is also summarized. Foreseen scientific and technical advances, intellectual property protection, laws and regulations affected are also emphasized.

Scope definition comprises the work breakdown structure and the product breakdown structure or, in other words, the organizational hierarchy of project tasks and project results, respectively. It also includes: allocation of human resources, identification of critical milestones, assessment of risks, supervision of project tasks and results. It is recommended to display flowcharts: either bar charts or network charts.

The project budget is based on cost estimating and previous scheduling. Resources, task duration and their relation through the work breakdown structure are needed to obtain actual costs; cost traceability is also essential. Document control and project monitoring close the project management cycle. Project monitoring, according to this standard, demands regular reports to explain results, costs and deviations.

Finally, UNE 166001 asks for exploitation of results in order to use, disseminate and protect them. The plan includes: identification of the new product or process, definition of stakeholders and markets interested in their use, protection of outcomes (if appropriate), economic exploitation of results, foreseen costs according to several scenarios, and benefits of the project related to business competitiveness.

The certification process starts when the applying company sends an application form and documentation to the certification body. The next steps follow: the application is processed and the documents are analyzed; the certification organization reports on compliance with UNE 166001; an external expert is selected (if adequate). This expert evaluates the project and hands out a technical report; if it is positive, the certification body issues a proposal for certification.

This standard classifies innovation projects into two types: based on content and budget; or based on content and execution. The first focuses on projects that have not been implemented yet, but the company is interested in showing its innovative contents to clients or any other stakeholder affected. The second kind of projects underlines the actual budget spent while the project is under execution or it has already been implemented.

5. R&D&i management systems certification

Standard UNE 166002 sets up the bases for systematization of R&D&i in companies. It also acknowledges certification by an independent organization. This normative is designed to integrate R&D&i management systems with other management systems that already exist in the company: quality (ISO 9000 standards), environment (ISO 14000 standards) or safety and health (OHSAS 18000 standards). The requirements of UNE 166002 are based on process management, using the well-known PDCA ("plan-do-check-act") methodology; these requirements are general and applicable to every enterprise, whatever its type or size. Figure 3 shows an innovation process based on the PDCA methodology.

Five major features are developed in the standard: R&D&i management system and model; stakeholders responsibility; resources management; R&D&i activities; and measurement, analysis and improvement. A model of R&D&i process has to be established, documented, implemented and maintained by the organization. A management system is also needed to improve the effectiveness following the requirements of UNE 166002. Documentation includes statements of R&D&i policies and goals, internal procedures and control records. Procedures comprise planning, operation and monitoring of R&D&i activities. It is necessary to attain control of documents and records in a similar way as stated in ISO 9001 standard.

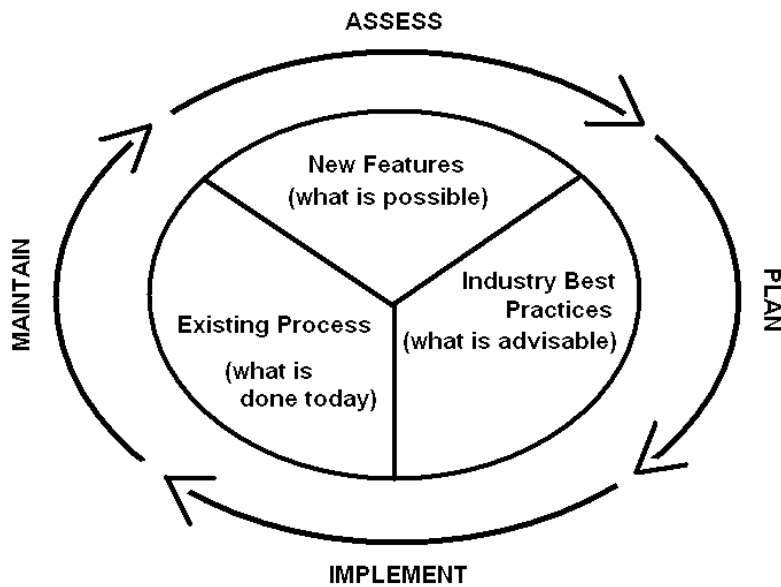


Figure 3. Innovation process (developed by the authors)

Principals and executive officers agree to develop, implement, improve and review the R&D&i management system. They have to analyze and meet the expectations and necessities of the different stakeholders: suppliers, clients, employees, shareholders, regulation bodies, etc. R&D&i policies, planning and responsibilities are put into action with reliable communication channels and a sound organizational hierarchy. The R&D&i management unit is defined to run the system and the R&D&i projects; in some circumstances other subordinate R&D&i units can function for executing specific projects, developing new technologies or generating knowledge.

R&D&i management needs skilled resources that have to be properly allocated. Personnel motivation and training are essential to achieve the goals. Material resources and infrastructure are also important parts of this scheme.

There are several tools provided by the standard in order to develop the R&D&i activities: technological watch, technological forecast, creativity, and internal and external analysis, among others. Additional activities proposed are: identification and analysis of problems and opportunities; analysis and selection of R&D&i ideas; planning, monitoring, and control of project portfolio; technology transfer; R&D&i products; purchasing; R&D&i process results; and protection and exploitation of R&D&i activities results.

Finally, the company schedules, plans and implements the monitoring process. It includes the measurement, analysis and continuous improvement of the R&D&i management system and the execution of its activities. They can be perfectly integrated in the quality management processes described by the standard ISO 9001.

Once the applying company sends the application form, the certification body analyses the documentation, visits the company's headquarters and performs a preliminary audit of the system. If the requirements are not met, then an extraordinary audit will be proposed to the company. Otherwise, the company gets the certificate; annual audits will monitor the system that will be renewed each three years.

Figure 4 summarizes the relationships among quality, innovation and knowledge as the basic elements in business management. Quality and innovation management processes can be

improved with the help of standardization, but knowledge management is not a standardized process yet. Thus, construction companies have tools that allow them to improve business management in order to enhance their competitiveness. However, even though companies have enough experience managing quality processes, it is decisive for them to deepen their innovation and knowledge management processes.

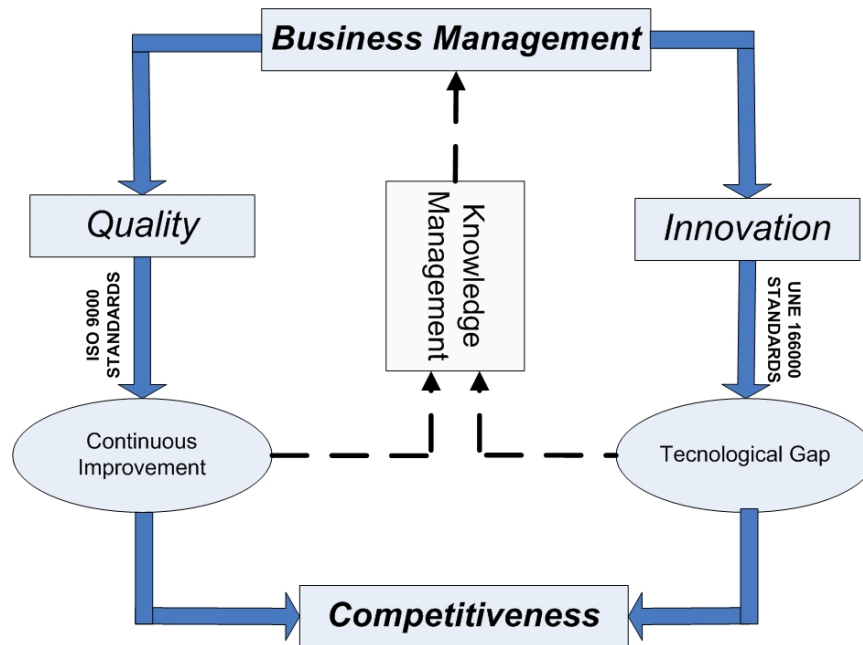


Figure 4: Quality, innovation and knowledge relationship within the company (developed by the authors)

7. Conclusions

A spontaneous and random approach to innovation is not worthy any more; on the contrary, a systematic attitude to innovate is foreseeable. Standardization and innovation are compatible concepts. Standards play a crucial role in the definition of market conditions in many industrial sectors, accelerating technological and organizational change and improving innovation performance. They also perform a major role in promoting innovative products and services, by providing stable references for the development of new innovative solutions and by creating large-scale markets.

Innovation is also a process, thus it can be standardized as any other business process. In Spain, a change of attitude towards innovation is just happening in the construction industry. R&D&i management is being valued in public works' bids as an added factor to the traditional ones: price, duration and quality. In fact, Spanish government uses UNE 166000 standards as a tool to measure the innovation in the companies. These standards at a slow pace are certifying companies. Thus, standardization of the innovation in the Spanish construction industry can be very effective in the near future to systemize new knowledge into new constructive procedures.

For construction companies, it is critical to improve business management in order to enhance their competitiveness. Quality, innovation and knowledge management processes can be enhanced with the help of standardization. This way, competitiveness can be attained through improvement in quality and steps up through the technological gap. To complete the

cycle, knowledge management should also be standardized and merged with the other processes of the company.

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