CHALLENGES OF STANDARDISING THE INNOVATION MANAGEMENT IN THE SPANISH CONSTRUCTION INDUSTRY

Eugenio Pellicer¹, Víctor Yepes², Christian L. Correa³
pellicer@cst.upv.es¹, vyepespi@cst.upv.es², chcorbe@doctor.upv.es³
School of Civil Engineering, Technical University of Valencia
Camino de Vera, s/n, 46022 Valencia, Spain

ABSTRACT

Construction industry is judged as non-innovative, even though, construction works are project-based and each project always needs to adapt procedures and materials. Spain is the fifth country in the European Union in terms of production in the construction industry, with figures very close to that of United Kingdom, France or Italy. In spite of that, the Spanish construction industry is particularly non-innovative: its investment in innovation is eight times less than the European average. In order to solve this problem, a new set of standards (UNE 166000) was issued to encourage the technological innovation in a continuous and methodical way. This normative implies a change of scenario where innovation can be regarded as any other business management process and, consequently, it can be standardised. Systematisation is performed through certification by a recognised body. Companies can attain certification applying UNE 166001 for R&D&i projects and UNE 166002 for R&D&i management systems. The later standard can also be integrated very easily with the quality management standard ISO 9001. Until now very few companies in the Spanish construction industry have obtained any certification. Nevertheless, this situation may change radically in the near future due to the companies’ needs to exhibit proof of their R&D&i progress in the bidding procedure for public works and services.

Keywords: Certification, Spain, Standardisation, Management

1. INTRODUCTION

The construction industry accounts for 10% of Gross Domestic Product (GDP), approximately, in developed countries (Crosthwaite, 2000). According to SEOPAN (2005), values for the European Union (EU-15) range from 6.7%, in Sweden, to 16.6%, in Ireland; production in construction accounted for more than one billion of euros ($10^{12}$ €) in 2004. Civil works represents only 21% of the total, whereas building renovation and maintenance, residential and non residential building complete the whole (SEOPAN, 2005).

Even though the construction industry has not been widely analysed as other sectors (agriculture in the past, and manufacturing and services nowadays), it is blamed as non innovative (Tucker and Borcherding, 1977; Shenhar and Dvir, 1996; Jones and Saad, 2003; Blayse and Manley, 2004). Despite that, other authors enlighten the characteristics of the industry as opportunities that could be used to enhance innovation in one way or another (Tatum, 1989; Groåk, 1994; Slaughter, 1998; Gann, 2000). Recently, some specific books, that highlight the importance of innovation in
the construction industry, were written by Gann (2000), Jones and Saad (2003), and Manseau and Shields (2005).

Instead of the construction industry, Gann and Salter (2000) use the concept of construction process. This process displays the five traditional phases of the facility life cycle: feasibility, design, construction, operation, and divestment. The tangible product is the built infrastructure. Nam and Tatum (1988) reveal the main features of this construction product: immobility, complexity, durability, costliness, and high degree of social responsibility. Gann and Salter (2000) also elaborate the idea of a project-based industry materialised by companies that work by projects. For each phase of the process different kinds of projects are needed and, consequently, specialised project-based companies appear.

Spain is one of the major countries in the European Union with respect to the volume of production in the construction industry, along with Germany, France, United Kingdom, and Italy. The main Spanish construction companies also get first-class contracts in Europe and America: the new semi-floating breakwater for Monaco Harbour, the Öresund bridge linking Denmark and Sweden, the Trakia motorway crossing Bulgaria from Serbia to the Black Sea, the Ting-Kan bridge in Hong Kong, the Trans-Texas corridor, and the east side access Manhattan tunnels, among others. In spite of that, the Spanish construction industry is especially non-innovative. Spanish spending on R&D&i activities, as percentage of GDP, is half of the EU-15 and one third of the United States (CICYT, 2003). When referred to construction, Spanish investment in innovation is approximately eight times less than the EU-15 average (Villar-Mir, 2001). 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 through the Latham (1994) and Egan (1998) reports, and the later Movement for Innovation (http://www.constructingexcellence.org.uk).

Applying the commitments adopted by the European Union at Lisbon in 2000 (CICYT, 2003), the Spanish government has just issued the program Inventiveness-2010 (Ministerio de la Presidencia, 2005) to bridge the gap of research, development and innovation 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 (http://www.fomento.es).

In this paper, we are going to display a new scenario where innovation is seen as another business management process capable of being systematised; this way, innovation can undergo standardisation in accordance with an external certification body. First, the apparently exclusive terms of innovation and standardisation are evaluated. Later, the new Spanish normative UNE 166000 is deeply analysed, mainly from two approaches: R&D&i projects and R&D&i management systems; a comparison with the standard ISO 9001 is also provided. Finally, the main conclusions of our work are stated.
2. INNOVATION VERSUS STANDARDISATION

Currently, the construction industry is applying flexible processes and holistic methods (Jones and Saad, 2003). Project management is the usual way of managing work in design and construction companies; nowadays, this is viewed as an innovative way of management in other sectors too (Hobday, 2000). These features (flexibility, holistic and project-based approaches) encourage innovation, but they are rather opposed to standardisation. Thus, are they compatible? And, is it possible to standardise?

Kondo (2000) affirms that innovation and standardisation are not mutually exclusive. For this author, in order to achieve a good harmony between them, work standards have to clearly specify the “true aim of the work” and afford “freedom in the means and methods” (p. 9, Kondo, 2000). 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. (2004) present a case study of a British public agency that manages innovative solutions for the health sector by means of standardisation; standards offer the baseline for reliable performance, whereas significant elements of innovation are captured and added to the standards. No further literature was found relating innovation and standardisation.

Nevertheless, several papers were discovered about the relationship between innovation and quality management. Kanji (1996) displays a simple model where each kind of innovation undergoes the quality management process to become successful innovation; several examples are given to enhance the idea. Keogh and Bower (1997) present a case study to detect links between quality management and innovation in the oil and gas industry. Bossink (2002) investigates the supportive use of quality tools in the management of innovation; he finds that these quality tools, 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 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, organisation, 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 complementary support.

In western and developing economies most companies innovate, not only in the construction industry but also in other sectors. However, the core difficulty is 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, organised, directed and controlled, as
any other managerial activity (Pellicer and Yepes, 2005). 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 (Koehn and Datta, 2003).

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

- Efficient exploitation of resources and know-how.
- Improvement of organisational activities.
- Achievement of goals and objectives previously fixed.
- 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.

3. UNE 166000 STANDARDS

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:


Certification can be obtained for innovation 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.

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. CERTIFICATION FOR INNOVATION PROJECTS

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 systematisation of R&D&i projects. Thus, every type of organisation, 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. In these R&D&i projects, results may differ significantly from the initial goals; even though these results can be of better value if they get more innovative consequences. 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. Then, the R&D&i project is 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 summarised. Foreseen scientific and technical advances, intellectual property protection and laws and regulations affected are emphasised too.

Scope definition comprises the work breakdown structure and the product breakdown structure or, in other words, the organisational 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.
Figure 1 explains the certification process for R&D&i projects. The 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 analysed; the certification organisation 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 when it has already been implemented.

5. CERTIFICATION FOR INNOVATION MANAGEMENT SYSTEMS

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

A model of R&D&i process has to be established, documented, implemented and maintained by the organisation. 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 absolutely necessary to attain control of documents and records in a similar way as stated in ISO 9001 standard.

Principals and executive officers agree to develop, implement, improve and review the R&D&i management system. They have to analyse 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 organisational 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.
The certification process for R&D&i management systems is shown in figure 2. 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.

6. COMPARISON BETWEEN ISO 9001 AND UNE 166002

UNE 166002 is compatible and complementary with ISO 9001; both could merge
together in a common management system with different functions. Correspondence
and comparison between UNE 16602 and ISO 9001 is displayed in the next table.

<table>
<thead>
<tr>
<th>UNE 166002</th>
<th>ISO 9001</th>
</tr>
</thead>
</table>
| R&D&i management system | 4.1 | 4.1.1 | Quality management system
| General | 4.1.1 | 4.1 | General requirement
| Documentation | 4.1.2 | 4.2.1 | General
| - | - | 4.2.2 | Quality manual
| Control of documents | 4.1.2.1 | 4.2.3 | Control of documents
| Control of records | 4.1.2.2 | 4.2.4 | Control of records
| Management responsibility | 4.2 | 5 | Management responsibility
| Management commitment | 4.2.1 | 5.1 | Management commitment
| Stakeholders focus | 4.2.2 | 5.2 | Customer focus
| R&D&i policy | 4.2.3 | 5.3 | Quality policy
| Planning | 4.2.4 | 5.4 | Planning
| Responsibility & authority | 4.2.5 | 5.5 | Responsibility & authority
| Management review | 4.2.6 | 5.6 | Management review
| Resources management | 4.3 | 6 | Resources management
| Provision of resources | 4.3.1 | 6.1 | Provision of resources
| Human resources | 4.3.2 | 6.2 | Human resources
| Infrastructure | 4.3.3 | 6.3 | Infrastructure
| Work environment | 4.3.4 | 6.4 | Work environment
| R&D&i activities | 4.4 | - | -
| Tools | 4.4.1 | - | -
| Identification and analysis of problems | 4.4.2 | - | -
| Analysis and selection of R&D&I ideas | 4.4.3 | 7.2.1&2 | Determination & review of requirements related to product
| - | - | 7.2.3 | Customer communication
| Planning & control of project portfolio | 4.4.4 | - | -
| Technology transfer | 4.4.5 | - | -
| R&D&i product | 4.4.6 | 7.3 | Design and development of product
| Purchasing: process, information and verification | 4.4.7 | 7.4 | Purchasing: process, information and verification
| - | - | 7.5 | Production and service provision
| - | - | 7.6 | Control of monitoring devices
| R&D&i process results | 4.4.8 | 8.2.3&4 | Processes & product
| Protection and exploitation of R&D&I activities results | 4.4.9 | - | -
| Measurement, analysis & improvement | 4.5 | 8 | Measurement, analysis & improvement
| - | - | 8.2.1 | Customer satisfaction
| Internal audit | 4.5.2 | 8.2.2 | Internal audit
| Monitoring and measurement of R&D&i processes | 4.5.3 | 8.2.3 | Monitoring and measurement of R&D&i processes
| Monitoring and measurement of results | 4.5.4 | 8.2.4 | Monitoring and measurement of R&D&i processes
| Control of results deviation | 4.5.5 | 8.3 | Control of nonconforming product
7. CONCLUSIONS

A spontaneous and random approach to innovation is not worthy any more; on the contrary, a systematic attitude to innovate is foreseeable. Standardisation and innovation are compatible concepts. Two styles of standardisation are analysed in the paper: BS 7000 and UNE 166000. On one hand, BS 7000-1 standard clarifies terms related to innovation and gives details on methodology; although, it is only a guide to manage innovation and it does not go further. On the other hand, UNE 166000 series establish a certification procedure for companies; requirements are defined and steps fixed, not only for specific projects but also for management systems. An additional feature of UNE 166002 is its compatibility with ISO 9001, thus both management systems (R&D&i and quality) can be combined together.

These UNE 166000 standards can also be applied to the construction industry. In fact, the Spanish government uses them as a tool to measure the innovation in the companies that bid contracts (works or services) for public agencies. These standards at a slow pace are certifying companies in the construction industry; nevertheless the number of application forms has escalatd in the last few months. Hence, companies perceive the risk of not obtaining the certification for their near future.

It would be important that principals of medium and small enterprises in the construction industry did not regard these standards as an additional cost for the organisation and another barrier for achieving better contracts. However, this is pretty difficult to achieve because most of the firms in the construction industry do not consider innovation as a priority for business. The “old-fashioned” way of thinking by the main stakeholders in the industry is still an obstacle for innovation.

8. ACKNOWLEDGMENTS

The research described in this paper is funded by the company LUBASA through the contract UPV-2005-0921. The authors also want to thank AENOR for its support.

9. REFERENCES