Abstract

Several academic institutions from Brazil, Chile, Colombia, Mexico, Spain and Portugal work together to investigate and benchmark the management of occupational safety and health in the construction industry. The aims of this network are: (a) comparison of occupational safety and health among countries, emphasizing the legal and institutional frameworks; (b) analysis of management strategies and good practices used by industry leaders; (c) study of good practices and strategies in other sectors that can be adapted to the construction industry, such as resilience; (d) diffusion of knowledge to undergraduate and postgraduate students and to professionals form the industry. This paper presents, first, this ambitious international project. Later, it comments the different strategies used to share and expand the knowledge to the academic institutions, incorporating it into the syllabuses at postgraduate level. Some particular deliverables such as the website and the e-books are also discussed in detail. This kind of multi-cultural project allows for the interchange of experiences and ideas that can be transformed into knowledge for students at the Master degree level and into training for researchers at the Ph.D. level also. The paper presents and discusses some of these results.

Keywords: Construction, education, international, occupational, safety, training.

1 OCCUPATIONAL SAFETY AND HEALTH IN CONSTRUCTION

Occupational accidents are one of the major problems of the developed and developing countries. Even though the importance of the workers’ health is invaluable, these accidents suppose a huge economical cost. In many countries, construction industry has the highest occupational accident ratio, regarding the rest of productive sectors (Waehrer et al., 2007).

There are several reasons for this record. Initially, the magnitude of the industry: construction sector stands for 10% roughly of the Gross Domestic Product (GDP) in developed and developing economies (Crosthwaiite, 2000). By contrast, the construction industry has not been analyzed as broadly as other sectors (formerly agriculture, and now manufacturing and services). This may be because of several particularities of this sector that distinguishes it worldwide from other industries (Nam and Tatum, 1988; ILO, 2001):

- The work site is mobile.
- The work site is temporal.
- Many agents participate in the construction process.
- Most of the construction companies are small.
- The margin of profit is narrow, thus companies have cost reduction as their main objective.
- Workers that intervene in the process have scarce professional qualification, due to the employment temporality and the lack of training.

From the academic and research points of view, data are not optimistic either. For example, two of the authors of this paper were working with a group of professors from several European universities (Ireland, Lithuania, Poland, Portugal, Spain and United Kingdom) on the relationship between academic degrees and professional qualifications in construction management. One of the main conclusions drawn was that engineers and architects that manage the project life cycle had, commonly, a lack of specific education and training in occupational safety and health (Teixeira et al., 2006).
Research in occupational safety and health in construction industry is also pretty scarce (Carvajal and Pellicer, 2006). A deep analysis of the papers published in the Journal of Construction Engineering and Management, the oldest and one of the most reputable journals on construction management, shows that the ratio of papers regarding occupational safety and health issues are only 2.8% from 1983 to 2000 (Pietroforte and Stefani, 2004), and only 2.1% from 1985 to 2002 (Abudayyeh et al., 2004). Furthermore, Crawford et al. (2006) analyzed seven previous papers on trends in the field of project management. Only one of them (Morris et al., 2000) considered that occupational safety was an issue worth mentioning, out of forty four other issues.

The culture of construction safety is defined as the whole group of knowledge, habits and behaviors that drive to the application of approaches and procedures of construction safety and health, not only to design, but also to execution of projects in the construction industry (Geller, 1994; Molenaar et al., 2002; Pellicer and Molenaar, 2009). This deficit in knowledge regarding occupational safety and health in construction acquires more relevance taking into account that the culture of construction safety should be generated and impelled by the technical personnel that intervene in the design-construction cycle (mainly engineers and architects), jointly with legislative and governmental support (Pellicer et al., 2003).

In view of this scenario, a group of academics from six different countries interested in these issues agreed to take a small step ahead together in order to increase the culture of construction safety with the purpose of using this knowledge for improving education and training of engineers at undergraduate and postgraduate level.

2 CYTED PROGRAMME

The Ibero-American Development Programme for Science and Technology (CYTED) was created in 1984 through an International Framework Agreement signed by 19 Latin American countries, plus Spain and Portugal. The CYTED Programme is an intergovernmental multilateral science and technology cooperation programme, which aims to combine different perspectives and visions to promote cooperation in research and innovation for the development of the Latin America region (see its web site for additional information: http://www.cyted.org/?lang=en).

The functional framework is made up of research and development groups of universities, organizations and companies from the member states, which participate in different ways: thematic networks, research projects, consortium projects, transversal activities and innovation projects. Thematic networks are the associations of research groups of public and private bodies of the member states; their scientific and technological activities are brought together in an area of common interest. The CYTED Programme publicly calls for the presentation of proposals yearly. It has so far created 191 thematic networks; this small quantity of financed projects reflects the competitiveness and the difficulty of getting the funding.

The thematic networks aim to: enable stable and ongoing scientific interaction; facilitate the exchange of mutually important scientific and technical knowledge; maximize synergy and coordination along R+D lines; promote research staff exchange and mobility; provide human resources and technical and methodological training; propose potential research or innovation projects; and transfer technology between different groups or entities.

The thematic networks have to publish and disseminate, prior to completion, at least one monograph on the ‘state of the art’ of the theme or themes being dealt with. These networks are comprised of at least six participants from different countries, always aiming to cover the greatest possible geographical area, for a maximum duration of 4 years. Each thematic network has a coordinator who reports to the corresponding CYTED manager on their activity. The grant covers expenses regarding mobility, meetings, publications and training, generally.

3 OBJECTIVES AND OUTPUTS OF THE NETWORK GESST-IC

The thematic network 309RT0375 is focused on management of occupational safety and health in the construction industry through new approaches and benchmarking (GESST-IC). This subject is included in the thematic area 4: support of industrial development. The network is composed by six universities of six different countries: Brazil, Chile, Colombia, Mexico, Portugal and Spain, summing up a total of 21 researchers. Table 1 shows relevant data of the different participants. The network is coordinated by the Universidade Federal do Rio Grande do Sul at Porto Alegre (Brazil).
The specific objectives of this network, related to safety and health management in the construction industry at every participating country, are:

1. To perform a comparative analysis of the actual scenario, with emphasis on the legal and institutional framework.
2. To conduct a survey of strategies and good managerial and technological practices used by industry leaders.
3. To benchmark strategies and good managerial and technological practices from other industries that can be adapted to construction, using approaches such as resilience engineering.
4. To select a set of strategies and best practices, as well as to disseminate this knowledge to students at universities and to professionals at the construction site.

The expected outputs of the network, related to safety and health management in the construction industry, are:

1. To consolidate a network dedicated to teaching and research.
2. To strengthen the capacity of teaching and research of every participating group; this will be reflected in greater quantity and quality of the academic outputs.
3. To develop a web-site to be maintained by the institutions of the network; this will be available for publications (papers, dissertations, reports, etc.), best practices and benchmark indicators.
4. To produce an e-book compiling all the output; this will also be published at the end of the project.
5. To write and present four papers in international journals and conferences, disseminating the outputs of the network.
6. To train representatives of local industry, particularly with regard to strategies and best practices.

4 COMPARISON AMONG NETWORK COUNTRIES

In this section, some information about the six countries of the network is presented. It covers basic data regarding population, area, employees in the industry and deadly accidents in the construction industry. Table 2 shows the important differences among the countries, being Brazil almost 93 times bigger and 18 times more populated than Portugal.

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>AREA (km²)</th>
<th>POPULATION (2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>8,514,876</td>
<td>191,480,630</td>
</tr>
<tr>
<td>Chile</td>
<td>756,096</td>
<td>16,763,470</td>
</tr>
<tr>
<td>Colombia</td>
<td>2,070,408</td>
<td>41,468,384</td>
</tr>
<tr>
<td>Spain</td>
<td>505,992</td>
<td>46,745,807</td>
</tr>
<tr>
<td>Mexico</td>
<td>1,964,375</td>
<td>107,550,697</td>
</tr>
<tr>
<td>Portugal</td>
<td>92,090</td>
<td>10,647,300</td>
</tr>
</tbody>
</table>

Table 2. Area and population from countries in the network

COUNTRY | CITY | UNIVERSITY | WEB PAGE
---|---|---|---
Brazil | Porto Alegre | Universidade Federal do Rio Grande do Sul | www.ufrgs.br
Chile | Santiago | Pontificia Universidad Católica de Chile | www.puc.cl
Colombia | Bogotá | Universidad de Los Andes | www.uniandes.edu.co
Mexico | Monterey | Instituto Tecnológico y de Estudios Superiores de Monterrey | www.itesm.mx
Portugal | Lisbon | Universidade Técnica de Lisboa | www.ist.utl.pt
Spain | Valencia | Universidad Politécnica de Valencia | www.upv.es

Table 1. Basic data from participants in the network

The specific objectives of this network, related to safety and health management in the construction industry at every participating country, are:

1. To perform a comparative analysis of the actual scenario, with emphasis on the legal and institutional framework.
2. To conduct a survey of strategies and good managerial and technological practices used by industry leaders.
3. To benchmark strategies and good managerial and technological practices from other industries that can be adapted to construction, using approaches such as resilience engineering.
4. To select a set of strategies and best practices, as well as to disseminate this knowledge to students at universities and to professionals at the construction site.

The expected outputs of the network, related to safety and health management in the construction industry, are:

1. To consolidate a network dedicated to teaching and research.
2. To strengthen the capacity of teaching and research of every participating group; this will be reflected in greater quantity and quality of the academic outputs.
3. To develop a web-site to be maintained by the institutions of the network; this will be available for publications (papers, dissertations, reports, etc.), best practices and benchmark indicators.
4. To produce an e-book compiling all the output; this will also be published at the end of the project.
5. To write and present four papers in international journals and conferences, disseminating the outputs of the network.
6. To train representatives of local industry, particularly with regard to strategies and best practices.
Figure 1 displays the number of workers in the construction industry per country. It is visible the high number of workers in the Spanish construction industry comparing to more populated countries such as Brazil and Mexico. Regarding this latter country, it is also very noticeable that the number of construction workers is less than in the Portuguese construction industry.

Figure 1. Number of workers in the construction industry

Figure 2 exhibits the number of deadly accidents per country (as an absolute value). This figure also follows the same trends as the previous one, with the same highlighting issues.

Figure 2. Number of deadly accidents per country

These data allows highlighting some findings:

- Construction industry is singular, differentiating from other sectors, as stated previously (Nam and Tatum, 1988; ILO, 2001).
Discrepancies and inconsistencies appear in the statistics data; this is a problem previously stated (Pellicer et al., 2009). Sometimes accessing relevant information in some countries is very hard. Furthermore, there is the additional problem of the multiple sources of data, coming from different countries with different regulations and standards for obtaining the data.

Thus, comparison among countries is difficult, especially in the construction industry with additional problems of fragmentation in very small companies, informal economy, subcontracting, etc. (ILO, 2001; Pellicer et al., 2009).

This issue is trickier regarding occupational safety and health: workday, accident definition, time for recovery, accident record, etc.

5 EXPECTED LEARNING AND TEACHING OUTCOMES

This section explains the different strategies used to share and expand the knowledge to the academic institutions, incorporating it into the syllabuses at postgraduate level. This kind of multicultural project allows for the interchange of experiences and ideas that can be transformed into knowledge for students at the Master degree level and into training for researchers at the Ph.D. level also. First, some particular deliverables such as the website and the electronic book (e-book from now on) are discussed in detail.

The e-book is a text and image-based publication in digital form. Its target audience is professionals and students related to the construction industry. The general contents are structured as follows: introduction (background, project and participants’ description, and objectives), state of the art per country (including differences among countries and causes), best practices per country (showing the impact measured and evidence of their effectiveness and presented in a standard format for comparison), work proposals per stakeholder, and conclusions.

On the topic of the web page, the sitemap presents the following interfaces:

- “Home” includes a brief summary on the network, logos of the participant institutions and the promoter, the main menu, updates, announcements and shortcuts.
- “Network” contains an in-depth presentation, history and project stages.
- “Research Groups” takes account the following issues, for each of the participating institutions: research lines, members of the group and contact information.
- “Publications” incorporates reports, papers, thesis (M.Sc. and Ph.D.), etc.
- “Products” has information regarding the e-Book and brochures.

Other expected outcomes come from the authors’ previous experience in other network projects that worked out on the relationship between academic degrees and professional qualifications in construction management (Teixeira et al., 2006; Pellicer et al., 2008; Minasowicz et al., 2009). The network also looks for preparation of a base of didactic modules, complementing technical knowledge of construction engineers with practical experience in occupational safety and health. This issue is complemented with supplementary education of professional engineers. Five seminars are foreseen; two of them already took place in Porto Alegre and Valencia during the first two years of the project.

The activities developed by this network will also make a contribution towards the development of innovative approaches for teaching the management of health and safety in engineering courses. The aim is to make health and safety management as part of construction and industrial management courses, rather than teaching it as a specific topic, mostly based on regulations and standards, as traditionally is done in many engineering courses. In fact, health and safety should be considered as a key requirement in the design and management of production system. For that reason it is topic that should be included in several different courses, such as production management, quality management, and construction technology.

Another important innovation is the search for a more robust conceptual framework for health and safety management, in order to understand the causes of accidents and effective actions for preventing them. In this respect one of the aims of this project is to understand a set of health and safety practices based on Resilience Engineering concepts and principles. This approach stresses understanding how people and organizations learn and adapt, and thus create safety in an environment with hazards, trade-offs and multiple goals (Hollnagel et al., 2006). A key idea is that resilience is more than the ability to continue operating when there is stress and disturbances; the
ability to adjust how systems function is, by far, more important from the Resilience Engineering point of view (Hollnagel, 2009). Although many studies on Resilience Engineering place an emphasis on complex socio-technical systems that involve intensive use of automation, such as aviation and power plants, previous studies have shown the benefits of applying RE to other industries, such as those of construction and electricity distribution (Mitropoulos and Cupido, 2009; Saurin et al., 2008).

6 CONCLUSIONS

This paper describes a research network, financed by CYTED, involving professors of six countries from Brazil, Chile, Colombia, Mexico, Spain and Portugal. The general focus of this project is the management of occupational safety and health in the construction industry; it seeks five specific objectives: (a) comparison of occupational safety and health among countries, emphasizing the legal and institutional frameworks; (b) analysis of management strategies and good practices used by industry leaders; (c) study of good practices and strategies in other sectors that can be adapted to the construction industry, such as resilience engineering; and (d) diffusion of knowledge to undergraduate and postgraduate students and to professionals form the industry.

Management and exploitation of statistical data from several sources was pointed out as an important problem during the exploration phase of this project. Data comes from different countries with different regulations and standards; thus, comparison among countries is difficult, especially in the construction sector.

The project is currently developing several activities, including a website and also an e-book. They will help to carry out innovative approaches for teaching the management of occupational safety and health in engineering courses. The aim is to make occupational safety and health management a part of construction and industrial management courses, rather than teaching it as a specific topic based on regulations and standards.

As a result of this, the paper highlights the benefits of an international project aiming to standardize knowledge, definitions and databases related to occupational safety and health in construction. It is particularly important the social benefits expected from these results: on the one hand, progress in scientific research, on the other hand, collection of best practices in safety management, production of papers and manuals (e-books), development of a website, as well as improving the education of undergraduate and postgraduate engineering degrees.

REFERENCES


