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# Strengthening Competencies in Learning of Industrial Safety focused on Projects

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**Abstract**

The acquisition of the fundamentals to assess the importance of industrial safety needs tools to enhance practical learning of this subject. Evaluation techniques and risk prevention, the necessary protective measures, health and safety applicable to the industry and issues concerning the development of a Safety and Hygiene plan are aspects that must be integrated into the competencies of university technical degree. In a previous step, it will be obtained a panoramic of the degree of implementation of matters relating to industrial safety, limiting the study to equivalent degrees, to career of Industrial engineering, pre-Bologna, to provide data on the extent of this subject. It will check on which levels of degree, masters or doctoral studies, exists. The main objective, once obtained the above data, it will provide tools to strengthen practical learning through binding strategies university-industry based on the performance of different projects that satisfy the competences attached.


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*Keywords:* Industrial Engineering; Industrial Safety; Industrial Hygiene; University; Project.

## 1. Introduction

Industrial safety is a particularly relevant area for manufacturing engineering, because the indices of industrial accident in this field are high. Risks inherent to the production activity, exposure to environmental pollution and the level of training of workers, etc. constitute a potential danger to manufacturing activities. The cost of accidents and

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work-related diseases is quite substantial for an advanced society as current. Evaluation techniques and risk prevention, the necessary protective measures, safety and hygiene of industry and the aspects concerning the development of a safety and Hygiene plan in the workplace, are issues that must be integrated into the general and specific competences of the educational guides into university technical careers.

University system is structurally integrated into the whole social system, but should not be losing its identity, its specific role and autonomy [1]. It can be considered the learning process as the one by which a person incorporates information content, acquired skills or practical skills, adopt new strategies of knowledge and / or action, and it appropriates habits, attitudes and values [2]. In this sense, the acquisition of the fundamentals needed to assess the vital importance of industrial safety, needs tools to enhance practical learning of this subject.

The particular idiosyncrasies of engineering studies allows for integration into the social system, through relationships with companies. It´s possible establish binding university-industries strategies as a vehicle for channeling the strengthening of skills for the study of industrial safety. The preferred way of channeling that will be study shall be based on different kind of projects. Galeana [3] notes that "the process of designing and developing a project allows and encourages students to experiment, make discoveries based learning, learning from their mistakes and face and overcome difficult and unexpected challenges. In this regard, also it takes students to ask and investigate to solve the problems and challenges they faced.

We will focus on the previous career of industrial engineering, broken down into several branches of knowledge (from industrial technologies, mechanical engineering, etc.) following the Bologna process, to sample plans implanted study. It will analyze, through data from the main database of higher education, the current state of technical qualifications, offered in relation to industrial safety.

The analysis will provide relevant information to clarify the actions implemented by the universities for the incorporation of knowledge this subject in their educational offers. Useful formulas will be proposed of Linkage University and enterprise, through different types of projects to enhance the practical application of the knowledge required for the acquisition of competences in this area.

In a previous step it will be analyzed the current situation, derived from our membership of the European Higher Education in the wake of the signing of Bologna Agreement. The current framework for the different areas of education, specialization and research will be described as well as the major changes that have affected previous career in industrial engineering. In a next step, an approach will be made to limit the spread of subjects related to industrial safety, based on data obtained from databases such as TESEO, RUCT, etc. In the last step; it proposes strategies to enhance learning in the field of industrial safety based on the methods of projects.

## 2. Current Situation

The current situation of the Spanish University is derivative of the commitments acquired by signing the Bologna Agreement. Universities offering courses in industrial engineering have been subject to major changes affecting the profession. Let us focus on the current state to understand the current situation

### *2.1. About Bologna*

Since 1999, the Bologna Declaration was signed, which resulted in the creation of the European Higher Education Area, Spanish universities have been adapting their qualifications to this common framework, a process that ended in 2010 in accordance with the provisions of several royal decrees reflected in current academic levels:

- Official Master's and Doctoral Programs adapted to the European Higher Education Area (EHEA) and regulated by Royal Decree 1393/2007 [4], by which establishes the ordination of official university education, and Royal Decree 861/2010 [5], by which modifies to Royal Decree 1393/2007 of 29th October.
- Official University Degrees Postgraduate regulated by Royal Decree 56/2005, repealed by Royal Decree 1393/2007 [4], and issued under Order ECI/2514/2007 [6], on issue of certificates of master and doctor and is modified art. 5.2 and transitional provision 2 by Royal Decree 189/2007 [7], and the arts. 5, 6.1 and additional provision 8.1, by Royal Decree 1509/2005 [8].

Considering the following structure applicable to almost all existing qualifications:

Title of degree: 240 ECTS (European Credit Transfer and Accumulation System) equivalent to 4 academic years (with exceptions).

Master's degree: 60 to 120 ECTS credits (from 1-2 academic years).

Doctorate: maximum variable duration, a criterion of each university.

In the EHEA (European Higher Education Area) the unit of measurement of the subjects will no longer be the old credit (based solely on teacher teaching time, for which 10 hours of class corresponded to one credit), it will be the ECTS credit. In this system will be assessed the hours that students engaged in study activity. In this activity, which will be between 25 and 30 credit hours, including the time devoted to teaching hours, hours of study, tutorials, seminars, workshops, internships or projects, as well as the requirements for the preparation and conduct of examinations and assessments. The great advantage of ECTS is that as the unit of measurement is equal in all universities of the new European Area, allows much more easily compare the workload of qualifications and facilitate student mobility and recognition of their studies.

Figure 1 show, the main lines of training, specialization and research proposed in European Higher Education, leading to a common goal, the job market.

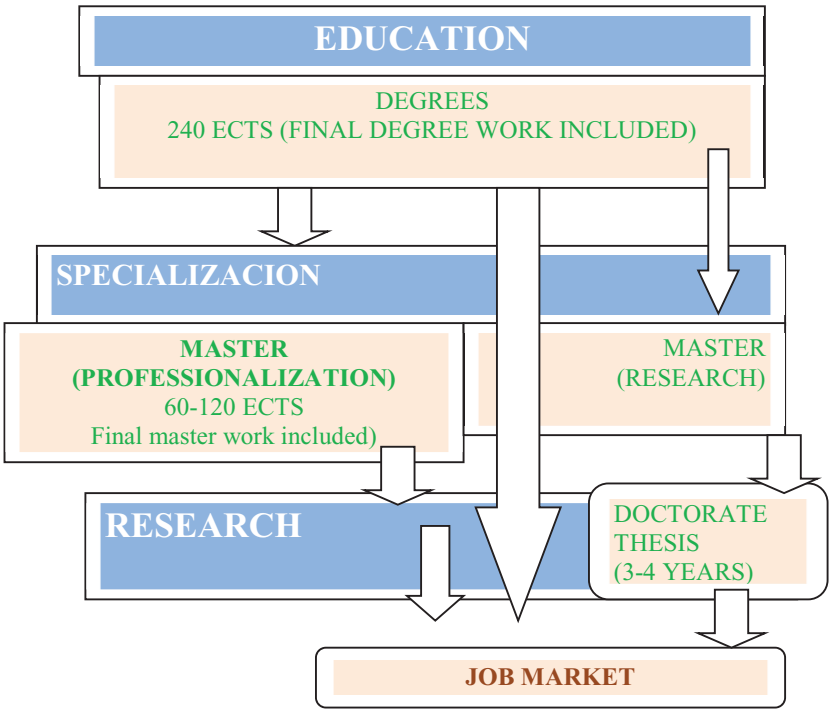


Fig 1. Main lines developed by European Higher Education.

*2.2. About the career of Industrial Engineering (ETSII) and subsequent derivatives degrees*

The major changes since the creation of the EHEA have meant the end to training for certification of Industrial Engineering Curriculum 1998. Instead, in Spanish universities can attend graduate studies in different branches and specialties of Engineering, followed or not for master's studies. Of these, the degree that leads most directly to previous industrial engineering degree is the degree in Engineering of Industrial Technologies because it has with the right planning for subsequent achievement of Master in Industrial Engineering, a title that gives full professional responsibilities for the exercise of the profession of industrial engineering [9].

Therefore, industrial engineering, broken down into several branches of knowledge (from industrial technologies, to industrial organization, etc.), after the Bologna process, it will be conceptually assimilated, for the sole purposes of training itinerary, with the master's degree in industrial technologies, without prejudice to other branches of specialization.

From the data provided by the Registry of Universities, Faculties and Degrees, RUCT [10], regarding graduate studies and masters in Spanish universities, it follows:
Degree in industrial technologies: a total of 25 records.
Master's degree in industrial engineering: a total of 44 records.
Master in industrial technologies: 4 records.

- Programs official postgraduate programs / PhD research in industrial technologies: 14 records.

The above date indicates that while some Universities offer master's degree; however still do not have graduate studies. To study the Master, it can come from other grades, but priority is given to degree in industrial technology, being the most appropriate curricular way.

Listing provided by CGCOII (General Council of Engineers Industrial Engineers) of Spain, it is clear that Universities that teach currently related studies with previous degree in Industrial Engineering are a total of 35, scattered throughout the Spanish panorama, including both public and private universities.

The above data reveals that some of the universities that offer master's degree in industrial engineering that are integrated into a professional association that encompasses a broader territory. Indeed, the territorial organization of the professional association corresponds to 21 geographical areas scattered throughout the Spanish territory.

## 3. Technical University Degrees Related to the Industrial Safety

In 2011, there were just over 2.7 million serious accidents that resulted in more than three days of absence from work and 3, 691 fatal accidents in the EU-28. These figures marked a considerable reduction in relation to 2008, when there had been approximately 550 000 more serious accidents and nearly 850 more fatal accidents (based on time series for the EU-27) [11].

An alternative way to analyze the information on accidents at work is to express the number of accidents in relation to the number of persons employed (called 'incidence rate'). Across the EU-28 there were, on average, 1.94 fatal accidents per 100,000 persons employed in 2011 while there were 1,601 serious accidents at work per 100,000 persons employed.

In this regard, several organizations are working to provide a comprehensive and integrated view of industrial safety which to plan, promote and advance the research, technological development and innovation (R + D + i). For example, in Spain, the Spanish Technology Platform for Industrial Security (ISSP), established in October 2005, is one of these organizations led by the industry with the support of the different administrations. Its aim is to involve companies, technology centers and universities in R & D at European or national level in industrial safety, with its own peculiarities in the definition of its Strategic Research Agenda, management structure and operational deployment.

With these fundamental objectives devised by ISSP, would have to be allied learning policies of university education in engineering, to focus the practical learning of the subject. Specifically in the following areas:
The safety of products and facilities.
Safety and health at work.
The environmental safety.
The property security company.

In university education learning by competencies is a necessity, in the sense of acquiring knowledge, skills and attitudes necessary to perform the functions of higher level professionals in the prevention of occupational risks and acquire a specialization in the different areas preventive nonmedical, allowing updating of technological knowledge and access, where appropriate, to doctoral studies [12]. The competencies frequently collect the following proposals:
1. Ability to develop the necessary knowledge to understand the complexity, interrelationships and dynamics of the preventive action of occupational risks in companies, based on an integrated basis to their prospects legal, economic,

organizational, psychological, and sociological health, generating a process of continuous and autonomous learning of new knowledge and techniques.
2. Ability to perform analysis and diagnostics, support, advice and make decisions in their own subjects of preventive action of occupational risks in the company.
3. Ability to develop, coordinate and control the preventive action plans of occupational risks in business, understood as a social fact in a complex institutional framework, subject to constant change and the impact of technology and information society.
4. Ability to develop technical activities related to prevention in the company: promoting prevention, risk assessment, definition of corrective measures, establishing control measures and guidance and supervision of the activities of the technical persons who are employed basic or intermediate level, and the application of new information technologies and communication in different policy areas.
5. Ability to performing of training activities and information workers in prevention and realization of teamwork within the organization and networking with other external agents, using the terms, concepts and techniques appropriate in different communication channels.
6. Ability to develop critical analysis, according to ethical criteria of the decisions of the participants in the field of security and their impact on preventive action of occupational risks agents.
7. Ability to promote and disseminate a culture of prevention through behaviour, habits and customs.

The practical application of these competences is summarized in acquiring the fundamentals of industrial safety, to prevent and avoid accidents, valuing the conceptual importance of risk prevention. Knowledge of the laws that regulate industrial safety and risk prevention is another cornerstone previous driving skills to more advanced levels that are introduced in the professional field.

### *3.1. Data from technical university degrees related to the subject Industrial Safety*

To know the current state of higher technical qualifications related to the subject of industrial safety offered by Spanish universities, first use the database: RUCT [10]. We will focus solely on the branch of Engineering and Architecture, because our study is limited to qualifications derived from the previous industrial engineering and the search will be for the Titles section.

Regarding the information to collect the number of theses produced in Spain in relation to the subject we are dealing, we will use TESEO [13], data at values from the year 1990/91 to 2013/14.

To search all databases mentioned, it will be used the following descriptive terms related values inherent to industrial safety shown in table I:

Table 1. Degree/Master offered by Universities of technical branch and completed Thesis.

| Descriptive Values | Grade (number) | Masters (number) | PhD Thesis (number) |
|---|---|---|---|
| Industrial Safety | 0 | 2 | 2 |
| Integral Safety | 0 | 5 | 2 |
| Industrial Regulatory | 0 | 0 | 0 |
| Risks Evaluation | 0 | 0 | 18 |
| Risks Management | 0 | 2 | 22 |
| Prevention Management | 0 | 2 | 6 |
| Risks Prevention | 0 | 14 | 45 |
| Health and Safety | 0 | 2 | 26 |
| Occupational Safety | 0 | 2 | 17 |
| Safety and Hygiene | 0 | 0 | 9 |
| Industrial Hygiene | 0 | 0 | 2 |

It is noted that in relation to the descriptors, safety and hygiene / industrial hygiene / risk assessment, data show that in the field of engineering and architecture, there are no studies on the matter, however if data appears in branches of other degrees nontechnical related to the psychosocial aspects of security, which are not objects of this study.

## 4. Strategies of Linking University-Industry to the Practical learning of Industrial Safety

The competency-based education has been in recent decades the movement has had the greatest impact on the global higher education. The development of professional skills from the university brought up the challenge of designing models in which the student might deal with situations or problems necessitated the development and implementation of knowledge and know-how efficient [14].

In this regard, learning through projects, it states that the subject builds knowledge from their interaction with the learning objects and appears as a model of active education that involves the student. Some authors [15], proposing it as a method of great potential for higher education, based on their ability to integrate different types of skills:
Specific skills, those relating to expertise or field of knowledge specific to the project.
Methodological skills.
Social skills.

Others authors [16] and [17], recognize that face real problems it encourages that students acquire an apprenticeship more connected to the world outside the classroom that occurs not fragmented way, but holistic and, in turn, allows them to increase their interests and career options. The projects can be worked on different levels regarding the experience or practice: those whose development requires merely documentary inquiry or consultation; curricular projects developed in the laboratory or workshop, and those in real contexts (companies, communities, hospitals, industry, etc.). To enhance learning in industrial safety imparted in the various grades of atomized industrial engineering, it will raise Industry-University collaboration, located in a real context.

Strategies of linking University-Industry, as a means of strengthening the practical learning of industrial safety matters, by the following formulas:
Business projects: This is a modality consultancy focused on where groups led by a tutor working on a project of the company. The tutor has a role of facilitator and reporter on the progress of results, being the link between the company and the university. Projects must be real and must pursue a concrete and achievable goal.
Projects subject: academic work to be performed under the provisions of the teaching guide for the course, can be done by students on projects or research carried out in the company. These projects must be related to what has been learned in the course, to be valued and appropriately qualified.
Project-practices in the company: This mode is unusual in that students have to participate in a selection process in order to qualify for participation in a series of projects or real jobs in the company. The teacher plays the role of tutor and is the liaison with the company; seek information about the degree of participation of selected students and the quality of work performance.
Research projects: they are research on common problems that encompasses several companies in the industrial safety sector. The participation of companies in these investigations is crucial for the actual data and expertise that can provide. The scope of these projects can be very varied due to the large number of issues involving industrial safety.

The theme of the projects must necessarily cover the following areas: Evaluation techniques and risk prevention, the necessary protective measures, health and safety applicable to the industry and issues concerning the development of a Safety and Hygiene plan.

## 5. Conclusion

The industrial engineering has been identified for the purpose of training itinerary, with the degree plus the Masters in Industrial Technologies, without prejudice to other branches of specialization. Data extracted from the databases used, it can be emphasize that the degree in industrial technology, is available in a total of 25 universities.

As for the master's level, a total of 44 are offered in industrial engineering and a total of 4 in industrial technologies. As for official postgraduate or doctoral research in industrial technologies, are offered a total of 14.

Regarding the implementation of industrial safety in the degrees mentioned, it is verified that the results obtained, none of engineering colleges object of our study offer a title specific grade on industrial safety engineering. However at master's offer studies in this field are higher, highlighting those related to risk prevention. The health-related and industrial hygiene are the subject of other branches outside engineering. Regarding the completion of doctoral theses related to industrial safety, values consulted from the year 1990/91 to the present, indicate that except in the prevention of risks, whose amount is more significant, the number of completed thesis is scarce.

Learning through projects, it states that the subject builds knowledge from their interaction with the learning objects and appears as a model of active education that involves the student. To promote the implementation of knowledge regarding industrial safety are proposed linking strategies university company as a vehicle for strengthening the practical learning of industrial safety matters, by developing different projects, related with evaluation techniques and risk prevention, protective measures, health and safety applicable to the industry and issues concerning the development of a Safety and Hygiene plan.

A further study of the technical degrees, focusing on the training itinerary of courses, detailing the levels specified in the teaching guides may provide additional and more accurate information complementary to the current study.

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