THE BODY OF KNOWLEDGE FOR HIGHER EDUCATION IN INDUSTRIAL ENGINEERING AND MANAGEMENT: EXPERIENCES FROM THE ERASMUS+ IE3 PROJECT

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Abstract

The ongoing fourth industrial revolution, also known as Industry 4.0 (I4.0), permeates the worldwide economies of most industrialized areas. From the shop floor to the research & innovation level, a critical mass of knowledge workers is required to benefit from the great, mostly unexplored, potentialities of I4.0 technologies.

Educating a critical mass of thousands of knowledge / talented workers is the most extensive higher education challenge Europe is facing.

An increasing qualitative and quantitative gap between demand and supply of knowledge workers is threatening the chance of success of the re-industrialization of Europe.

The main objective of the IE3 project is to design and test innovative courses in Industrial Engineering and Management (IE&M). By introducing cutting-edge learning techniques and tools, the project will support the future generation of knowledge workers. Testing and sharing pilot solutions by the IE3 project will systematically support the development, updating, or re-design of university courses/programs in IE&M throughout Europe.

The Body of Knowledge (BoK) for Higher Education in Industrial Engineering and Management is the reference document to support conceptual and implementation processes of designing, updating, or re-designing university master-level programs or course modules in IE&M.

The BoK defines Guidelines supporting the renewal processes of IE&M master-level education in Europe and disseminates IE3 project outcomes, giving value to practical experience carried out by project partners during the project development.

The BoK is not only a methodology, but it represents the foundation upon which Higher Education Institutions (HEIs) can develop their strategies, policies, procedures, and tools to renew courses and programs in an evolving environment. The Bok refers to contents and knowledge constantly evolving according to a rolling re-design approach.

Keywords: Body of Knowledge, Industrial Engineering and Management, Knowledge workers, Higher Education Institutions, IE3 Project.

1 INTRODUCTION

Today Europe is witnessing an unbelievable paradox: the number of technological investments in the Industry 4.0 (I4.0) sector grows while the number of Knowledge Workers (KWs) able to design and operate their declines. According to the New Skills Agenda for Europe, “Work in industry at all levels from operators to engineers and administrative staff will increasingly consist of designing, maintaining and supervising intelligent machines that assist in the performance of tasks. This will require different skill sets. Future jobs will require an appropriate mix of basic, soft and technical skills, notably the digital and business-specific skills that education and training systems are not yet fully addressing. Industry has an active role to play in the definition and training of the key skill sets and competences” [1]. Knowledge and skills of workers have to be consistent with the content of work and since the content changes continuously, workers have the solid background within their specialization but also ability to adapt and learn. Flexibility is a personal feature, which can be practiced and developed while solid

knowledge background needs to be provided by education institution [2]. Smart Human Resources 4.0 (SHR 4.0) is a new concept evolving as a part of I4.0, including innovations in digital technologies and smart manufacturing to improve the management of next-generation employees [3]. SHR is considered one of the primary sources to shape the skills, capabilities and behaviours of KWs to achieve the organization goals adopting the I4.0 technologies [4]. The future workers will need to develop also entrepreneurial skills (or "intrapreneurial", referring to employees), as they will be asked to react to more decision-making complicated problems.

The increasing mismatch of 'demand vs supply' of KWs has another explanation: the substantial divergences between the educational programs offered by different Higher Education Institutions (HEIs) are a considerable harness to working mobility and deprive fresh European graduates of the opportunity of selling their know-how to foreign job markets. Currently, the EU HEIs are not ready to face the new educational challenges. Nevertheless, time plays an important role since it is strictly connected to the financial costs that increase when the company lacks qualified employers [5]. Different training programs and initiatives have appeared in the last years to face the labour market educational request [6]. The programs are designed by combining the digital professional profiles request defined by the companies' needs and the education experience. HEIs answered the market demand by proposing new master-level degree courses and organizing many advanced courses to train Industry 4.0 professionals. But, in all cases, a coordinated program resulting from synergic efforts by different EU HEIs is missing. Many initiatives result from collaboration among business and education institutions at the national level [7]. Since the economic and cultural circumstances ruling today's job market make it impossible to overlook the opportunities offered by the I4.0 paradigm, it is needed that the EU HEIs must comply with the new sector needs. Under this perspective, small and medium enterprises (SMEs) require special attention since they hardly have the economic resources or the ability to update workers' knowledge.

Industrial and Engineering Management (IE&M) is an inter-disciplinary discipline concerned with optimising complex processes, systems, or organizations by developing and implementing relations between productive units to improve the coordination and performance of workers, materials, and machines. This transfer of knowledge becomes fundamental to develop I4.0 initiatives, all of them pertaining to the fields of IE&M. Thus, the most efficient solution to reduce the gap between what students know and can do and what hiring firms want from them is re-designing the educational offer of IE&M provided by HEIs starting from the actual needs of the business sector. Consistent with this end, a joint action including HEI, companies, and trade consortium (e.g., students associations, industrial confederations, etc.) is required to restructure the current educational offer in IE&M, re-designing the courses in line with the new market needs and the innovation technologies at European level.

To this purpose, the Industrial Engineering and management of European higher Education (IE3) project designs and tests innovative courses in IE&M by introducing cutting-edge learning techniques and tools to support the future generation of KWs. In this paper, The Body of Knowledge (BoK) for Higher Education is introduced to support conceptual, and implementation processes of designing, updating, or re-designing university master-level programs or course modules in IE&M [8]. Consistent with the aim of the paper, guidelines supporting the renewal processes of IE&M master-level education in Europe are described to provide value to practical experience carried out by project partners during the project development. The BoK aims at:

1 Identifying education and training convergences and divergences between IE&M courses along with the training needs required by companies to IE&M students and collect results in a structured document;

2 Aligning knowledge, skills and competences with contents, learning–teaching methods and assessment of the educational activities offered by Higher Education Institutions (heis) throughout Europe;

3 Supporting the development and testing IE&M university programs, courses and e-learning modules based on the findings as per point (i) and (ii).

The rest of this paper is organized as follows. Standards for course/program renewal in IE&M are in Section 2. Guidelines and use cases for planning course renewal in Section 3. Section 4 presents the key knowledge and the learning tools to be adopted. Finally, Section 5 shows the conclusion and future research.

2 STANDARDS FOR COURSE/PROGRAM RENEWAL IN IE&M

2.1 The framework

The general reference conceptual framework of the BoK is based on the continuous improvement approach of the 'Quality System' of a Higher Education Institution.

The approach is process-oriented and built upon multiple iterations of the PDCA (Plan-Do-Check-Act) cycle also known as 'Deming cycle'. The PDCA process will be applied to courses and programs referable to the Industrial Engineering & Management Higher Education with focus on Industry 4.0 paradigm. The five main processes of the cycle (Initiating, Planning, Executing, Monitoring and Controlling, Continuous Improvement) are detailed in the next subsections according to the scheme in figure 1.

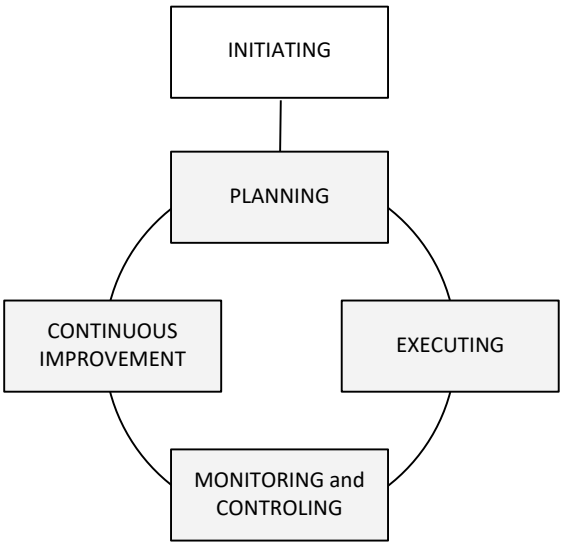


Figure 1 – The continuous improvement approach for Course / Program renewal in Industrial Engineering and Management Higher Education.

2.2 Initiating

The main expected output is to identify stakeholders and to define strategic goals.

The process aims to identify the stakeholders relevant to the course /program renewal processes, the relevant needs and requirements of these stakeholders and the consequent strategic goals. A rolling program must be implemented to systematically analyse needs and identify gaps between knowledge needs and educational offers to align the up-to-date technologies, skills, methods, expectations of the stakeholders, and the course's contents.

2.3 Planning

The expected output is to identify national regulations and European standards, define objectives, and a Performance Evaluation System (PES).

To ensure the effectiveness of the process for the renewal of courses/programs, the HEI must identify the compliance obligations relating to the specific national laws and regulations as well as to rules or guidelines from regulatory agencies (i.e. QA certification bodies like European Association for Quality Assurance in Higher Education (ENQA), European Network for Accreditation of Engineering Education (ENAEE)) and assess how compliance requirements apply to the design, implementation, maintenance and continuous improvement of new courses/programs.

The objectives for the renewal of the course/program must be defined by considering knowledge requirements stemming from 'demand vs offer' gap analysis while meeting the compliance obligations. Knowledge requirements pertain to both hard and soft skills. The objectives shall be consistent with the strategic goals and monitored and updated consistently with the PDCA loop. Moreover, in planning how to achieve its objectives, the HEI shall determine "what" will be done, "which" kind of resources will be required, "who" will be responsible for carrying out actions and results' achievement and "how" the results will be evaluated, including indicators for monitoring.

The HEI shall implement a Performance Evaluation System (PES) defining the performance variables needed to be monitored and measured, the appropriate set of indicators (KPIs) and the criteria against which to evaluate the course/program performance. Moreover, the effective monitoring methods, the frequency of monitoring, and when performance should be analysed and evaluated shall be defined.

2.4 Executing

The main expected output of the phase is to develop and manage the course/program.

The course/program shall be designed to comply with the objectives set in the planning phase. Explicit learning outcomes, teaching methodologies, and expected student workload (in ECTS) need to be defined. The syllabus will result from the 'composition' of bricks of knowledge and teaching methods to ensure the consistency of course modules with the needed student's competence and skills.

The course should be delivered according to the Student-centered approach in their entire life cycle (learning, teaching and intermediate/final assessment), encouraging students to take an active role in creating the learning process and assuring that the assessment reflects this approach [9].

In these phases, the Stakeholder engagement and the public dissemination of course/programs goals, structure, and expected and achieved results have a crucial role. They will be planned and executed in the whole process through direct interviews, meetings, public workshops and surveys.

2.5 Monitoring and Controlling

The aim of the process is the evaluation of the compliance of performance achieved with planned objectives. The process consists of four phases: monitoring, measurement, analysis, and evaluation. The HEI must define the results to be monitored and measured and the criteria for evaluating the performance of the courses/modules against the target KPIs defined in the planning phase.

Moreover, the HEI shall plan, implement, and maintain internal audit and review programs, including methods, responsibilities, and reporting requirements. To this aim, the HEI shall define the audit criteria and scope for each audit, conduct the audit, ensure the objectivity and impartiality of the audit process and maintain documented information on the audit program and results.

2.6 Continuous Improvement

In the last phase, finally, shall be defined the Corrective actions for continual improvement.

According to the review plan, HEI shall review the performance to ensure the course/program suitability, adequacy, and effectiveness and implement the needed corrective actions.

The Corrective actions shall include considerations of the degree of achievement of the planned objectives, information on the course/program performance (including trends on the results of monitoring and measurement, the fulfilment of its compliance obligations, third party (or external) audit results), the status of actions resulting from previous reviews. Other relevant criteria for defining corrective actions could be external and internal factors like changes in stakeholders' needs and expectations, including technological evolution and compliance obligations, the adequacy of resources, and decisions on opportunities for continuous improvement.

3 GUIDELINES AND USE CASES FOR PLANNING COURSE RENEWAL SULTS OF IE3 PROJECT

For the planning phase of the IE&M course/program renewal process guidelines have been defined. They are discussed in this section. To clarify their guidelines, use cases from IE3 project are provided.

3.1 Guidelines

The planning of the course/program renewal process should be articulated into four main steps:

- Analysis of the educational offers in the knowledge areas identified
- Analysis of training needs of stakeholders
- Evaluation of knowledge gaps
- Definition of the competence matrix

- *Analysis of the educational offer*

A preliminary interaction with relevant stakeholder is required to identify their needs and requirements, and strategic goals to be set consistently. The Higher Education Institution's offer in the knowledge macro-area of interest shall be evaluated. Geographical scale (*Regional, National, International*) of the research shall be defined before starting the evaluation. HEI's offer evaluation can be carried out at Master program level and at course level. Appropriate key-words shall be defined in order to focus the research on strategic goals. A top-down approach could be adopted to identify courses consistent with strategic goals identified: Master (Second level) programs; courses in the set of Master (Second level) programs; syllabi of courses. Sources of information could be institutional web sites (Governmental agencies websites, Universities websites) and/or Academics (*Professors, Dean, Program Coordinators*) involved in programs of interest.

- *Training needs analysis*

A preliminary evaluation of training needs shall result from discussion among representatives of University and Stakeholders in the Steering Committee (SC) (planned meetings, seminars, special events). A further evaluation shall be based on the knowledge acquired by Academics in their research activities. This evaluation should be generalized through an analysis of scientific literature in the knowledge macro-area (i.e. Industry 4.0) related to strategic goals. To validate the training needs identified in the preliminary evaluation, stakeholders will be asked to provide their opinion. The involvement shall be based on surveys (interviews and/or questionnaires). Surveys could be designed at different level of details and spread on different geographical scales (regional, national, and multi-national). Surveys could be adopted for both training needs and educational offer analysis. When Academics are involved in the evaluation of HEI's offer, they shall be involved also in the training needs evaluation.

- *Gap analysis*

Results of surveys shell be adopted to identify knowledge areas in which the demand of knowledge of relevant stakeholder is greater than the offer of HEIs. The same kind of evaluation shell be done for knowledge transfer methodologies.

- *Competence matrix*

A Cross Analysis could be formalized in a 'Competence Matrix' (CM) which will synthesize most ranked Needs/Gap vs. Resource Availability (see Fig. 2). Resources may include human resources, infrastructure, technology and financial resources. Possible guidelines to be adopted in builting-up the CM are:

Granularity of Knowledge, Skill, and Competence (KSC): a de-composition of general KSC topics into more specific subjects could be performed. A proper level of granularity should be agreed within the SC searching for a trade-off between simplicity and precision in identifying subjects. Subjects could be identified also according to their nature and possible human/facility resources available. As an example, Operations Management could be split in specific subjects belonging to both theoretical models (e.g. inventory management) and software tools (e.g. ERP software modules).

Flexibility of KSC: subjects' assignment should be based on nature and availability of resources. (e.g.: Human Resource Management could be assigned to an industry professor; Team Project could be assigned provided that project management software platform is available).

Rolling approach: CM is conceived to dynamically fit contingencies emerging from the Need/Gap Analysis and resources available at a given time (e.g.: availability of a new university industry professor; instalment of a new educational lab; a new topic with high Need/Gap level of interest).

	Knowledge Skill Competence (i)			Knowledge Skill Competence (j)		
Resources	Subject 1,i	Subject 2,i	…	Subject 1,j	Subject 2,j	…
HEI professor						
Uni Labs						
Industry professor						
Company Labs						
Internship opportunities						

Figure 2. Example of Competence Matrix.

3.2 Use case: the IE3 project

✦ *Analysis of the educational offer*

In the development of the IE3 Project, the analysis of HEI's offer consists of:

- *Collection, analysis, and evaluation of syllabi of courses in IE&M*
- *Survey on HEIs' offer in IE&M.*

The educational offer of HEIs in IE&M involved the four project's partners (from Sweden, Spain, Poland, and Italy) as well as two associate partners: European Academy for Industrial Management (AIM) and the European Students of Industrial Engineering and Management (ESTIEM)). All partners were asked:

a) To identify HEIs in the Country offering Master (second level) programs in the field of IE&M;

b) To identify IE&M programs offered in the Country;

c) To collect syllabi of courses related to I4.0 topics offered in the IE&M programs in the Academic Year 2019/2020.

The following keywords were adopted for identifying (a, b) programs in the IE&M knowledge area: Industry / Industrial & Management; Engineering & Management; Production & Management; Manufacturing & Management. Appropriate Industry 4.0-related keywords (based on a scientific literature analysis) were adopted to identify relevant courses (point c).

The total number of collected syllabi was 352 from 16 Countries (mainly EU Countries).

The syllabi analysis on the data received was conducted with text mining methodology. The database of syllabi of identified courses was created and the search for clusters and most frequently mentioned words and terms was performed.

✦ *Training needs analysis*

In the IE3 project, semi-structured interviews were carried out to preliminary investigate companies training needs in IE&M knowledge area with focus on Industry 4.0. A semi-structured interview with companies was designed and carried out by project partners. The aim of the interviews was to collect companies' opinion on knowledge and skills required by young workers with an academic IE&M CV as well as in identifying their main knowledge areas of interest. The answers of the interview allowed to qualitatively evaluate the training needs of a significant sample (30 companies) of companies.

In the next step, quantitative questionnaires were designed on the base of:

- Results of the semi-structured interviews;
- Topics covered by the sample of 352 courses identified in the heis' offer analysis;
- Results of a scientific literature review on Industry 4.0.

Questionnaires was developed for different stakeholders (Academics, Students, Alumni, and Companies) with the aim evaluating the companies' training needs in implementing I4.0 paradigm and the educational offer in Master (second level) Academic Programs in the field of IE&M offered by European Universities. They were tuned thanks to the answers obtained from the qualitative interviews and discussions among all partners of the project (both academic and industrial) (see Fig. 3).

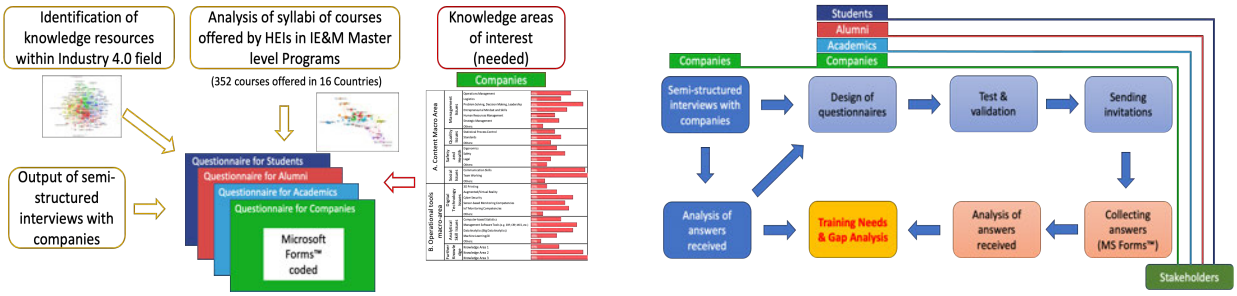


Figure 3. Training needs analysis in the IE3 Project.

The core part of the questionnaires was divided into main subsections, named “A. Learning skills and competencies” and “B. Learning environment”. The former section was designed to investigate on knowledge, skills and competencies, both in “traditional” knowledge areas on IE&M and in digital and analytical knowledge areas. The latter section was designed to investigate on knowledge transfer methodologies and learning activities. This section was introduced in order to achieve useful information on learning methodologies to be implemented in renewed courses to be offered by HEIs in the IE&M area.

For each topic investigated in both sections A and B, in order to make easier for the responder the selection of the appropriate answer and to obtain comparable and computable (by means of a Likert scale adoption) answer from different responders, pre-defined answers and instructions were provided at the beginning of each section.

Stakeholders were asked to assess the degree at which each competence investigated in Section A and each knowledge transfer methodology investigated in Section B were addressed in the courses offered by the selected Study Program(s) (OFFER) and to estimate its importance to enter the job market (DEMAND). For both OFFER and DEMAND, five predefined answers were proposed: “not offered”, “low”, “medium”, “high”, and “don’t know”. In the questionnaire for companies, the same competencies (Section A) were investigated. In this case, the responder was asked to assess the degree at which each item of the list was addressed in the training sessions organized by the company (OFFER) and to estimate the importance of each item of the list for being employed by the company (DEMAND). The same predefined answers were adopted in the questionnaire for companies.

Questionnaires were coded in MS Forms®. Four forms were coded, one for each questionnaire (Academic, Students, Alumni, and Company). The adoption of on-line forms allowed to automatically collect answers. At the end of the collection period, more than 700 answers were collected (75 Companies in 20 Countries; 113 Professors from 64 Universities; 178 Alumni of 54 Universities; 373 Students of 47 Universities).

✦ *Gap analysis*

In order to obtain quantitative results from the answers received, for both questionnaire sections ‘A. Learning skills and competencies’ and ‘B. Knowledge Transfer Methodology’, a numerical score was assumed for each answer, as shown in Table 1. No numerical value was addressed to the answer "don't know”; however, the number of this type of answers was recorded.

Table 1. Score adopted for each answer in the analysis of questionnaires’ results in the IE3 project.

Answer	***"not offered (OFFER) or not required (DEMAND)"***	***"low"***	***"medium"***	***"high"***	***"don’t know"***
Value	0	1	2	3	*null*

For each question, the gap was evaluated as the difference between the numerical value of the DEMAND answer and the one of the corresponding OFFER answer. For each question, the gap has been evaluated only in case the responder gave an answer to both OFFER and DEMAND. The final number of gap data for each question was recorded. Main results of the analysis carried out are in the next Section.

4 EXPERIENCES FROM THE IE3 PROJECT

In this section, a summary of knowledge, skill, competencies, and educational tools obtained by the quantitative survey analysis is carried out.

4.1 Key knowledge, skill and competences

Two main clusters of 'hard' and 'soft' skills are identified. The former relates to engineering skills, including methods, procedures, and techniques (i.e., project management, operations management, strategic management, quality management, logistics, investment and finance, firm organization, industrial marketing, safety of work, and ergonomics). The latter relates to people's personal and social attitudes in the work environment (i.e., problem solving and decision making, team working, communications skills, leadership issues, innovation and change management, entrepreneurial mindset and skills). Analyzing the knowledge demand expressed by companies in the quantitative survey, the following technical knowledge, skill, and competencies (KSCs) classified according to 'hard', and 'soft' skills have been identified. The gap between demand (i.e., business need) and offered (i.e., competence already provided by HEI) was estimated; consequently, the major importance was attributed to KSCs with the higher gap (Tab. 2).

Table 2. List of knowledge, skill, and competencies (KSCs) classified in 'soft' and 'hard' skills in descending order of importance.

Importance	*KSCs*	*Cluster*
1	Problem-solving and Decision Making	Soft skills
2	Entrepreneurial Mindset and Skills	Soft skills
3	Innovation and Change Management	Soft skills
4	Communication skills	Soft skills
5	Strategic management	Hard skills
6	Team working	Soft skills
7	Industrial marketing	Hard skills
8	Project management	Hard skills
9	Industrial organization	Hard skills
10	Leadership issues	Soft skills
>10	Operations management; quality management; ergonomics; investment and finance; logistics; safety of work	Hard skills

Among 'Hard Skills', the 'Operations Management', 'Quality Management', and 'Safety of Work' are characterized by the highest demand value for companies of the "Manufacturing" sector. A high knowledge demand for 'Project Management' is expressed by companies of the "Manufacturing" and "Service" sectors. In most cases, the KSCs included in 'hard skills' offered by HEIs usually satisfy companies' demand (the gap between demand and offer, in these cases, is low). Only in the case of 'Strategic management' a significant gap is observed. The gap is mainly due to a high demand expressed by companies in the manufacturing sector. A similar gap is observed for 'Industrial marketing'; although, in this case, a low need is expressed by companies included in the "Manufacturing" and "Service" sectors. The high HEIs' offer of 'Project Management' should be kept high due to the high demand expressed by companies in both sectors.

For all the "soft skills", a net positive gap was observed when companies' demand was compared with HEIs' offer. Moreover, higher gap values are observed for 'Problem Solving and Decision Making', 'Team Working', and 'Communication Skills'. This means that the current educational offer of HEI on these aspects is not considered sufficient if compared to companies' needs.

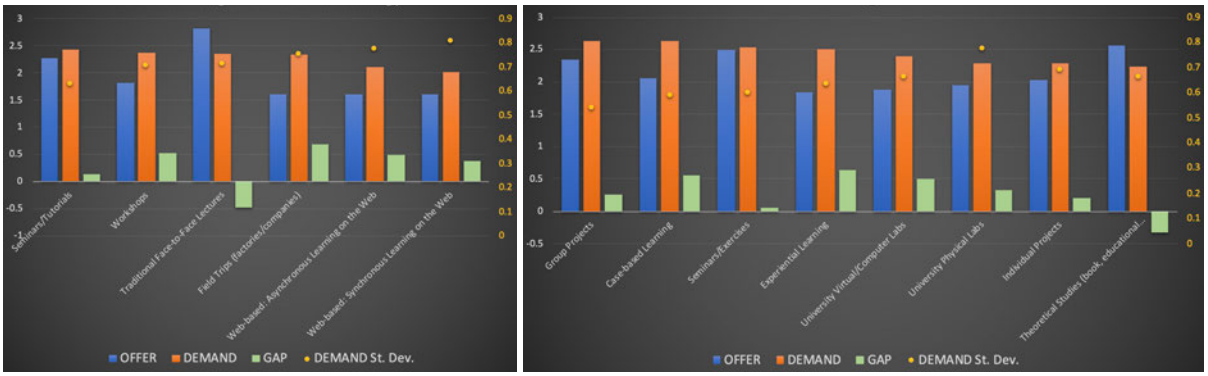
4.2 Learning tools

The advent of mobile education technologies into teaching and learning has given rise to both new opportunities and challenges for educators. According to Cheon et al., mobile technology and learning applications have broadened the scope of learning areas outside of formal education by allowing flexible

and instant access to digital learning sources [10]. Technologies such as electronic learning (e-learning) systems are becoming increasingly relevant in the HEI context. They are economical, flexible, and accessible without time and distance constraints [11]. E-learning has become increasingly popular among learners and instructors today. Online courses are eliminating geographical barriers and spreading knowledge around the globe. A major reason for their popularity is the ability to engage learners. They can simulate classroom-like environments by allowing learners to interact with educators easily. E-learning has been able to redefine teaching strategies, which has led to progress in the education sector.

Besides the basic requirements of a computer and an Internet connection, e-learning uses various technologies. Some of them are specifically designed and developed for e-learning courses, and some are used for providing additional support and features for e-learning. Online course creators can use different software to enhance their courses and engage more and more learners. The main thing to consider is that the technologies used in e-learning should be able to satisfy the requirements of both the instructors and the learners [12].

Two main clusters of learning tools are identified in this research work: 'knowledge transfer methodologies' (KTM) and 'Learning Activities' (LA). The first cluster includes the learning tools based on the communication process between professors and students (i.e., seminars, workshops, face-to-face lectures, field trips, asynchronous web learning, and synchronous web learning.). The second cluster includes activities designed or deployed by the teacher to bring about or create the conditions for learning (i.e., group projects, case-based learning, exercises, experiential learning, computer labs, university physical labs, individual project, and theoretical studies). Results obtained from the quantitative survey submitted to Professors of HEIs are summarized in Figure 4. In the case of KTMs, a positive gap is estimated for all methodologies investigated. Only in the case of "Traditional Face-to-face Lectures", the demand score is lower than the offer. The highest gap score value is obtained for "Field Trips": academics expressed the need to improve the interaction of students with the industrial environment. Among Web-based KTMs, asynchronous modality is preferred to synchronous one (fig. 4a).



a) *b)*

Figure 4. Offer, demand, gap score, and demand standard deviation values expressed by professors on Knowledge Transfer Methodology – KTMs (a) and Learning Activities – Las (b).

In the case of LAs, academics expressed the highest demand for 'Group Projects' and 'Case-based Learning' followed by 'Seminar/Exercises' and 'Experiential Learning'. The highest gap values are observed in the case of 'Case-based Learnings' and 'Experiential Learning'. A negative gap is observed only in the case of (traditional) 'Theoretical Studies' since the demand score value is lower than the offer one (fig.4b).

5 CONCLUSION AND FUTURE RESEARCH

Education plays a crucial role in providing people with the necessary capabilities to advance society, the environment, and economic growth [13]. Consistent with this purpose, the main objective of the research project conducted consists of designing and testing an innovative course in Industrial Engineering and Management IE&M. By introducing cutting-edge learning techniques and tools, support the future generation of knowledge workers. The results of the IE3 project led to developing a specific guideline to plan the course/program renewal process with the aim to fill the gap between academic offers and companies' needs.

The future research will be focused on the preparation of blended courses with the e-learning modules, according to technical criteria and pedagogical strategy defined in the theoretical framework of BoK, and on the development of a pilot action plan containing tools for evaluating the impact of the learning tools adopted.

At the end of the pilot phase for the e-learning course, a process of revision of a whole IE&M Program will start to comply with the information and strategies collected during the training need analysis. In order to identify education and training convergences and divergences between new IE&M courses and the along of training needs required by companies.

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