Industrial Engineering and Management of European Higher Education

# Training Needs Analysis

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*Note:*

*For anyone interested in having more information about the project, please contact us at: info@ie3.eu*

# Summary

# Introduction

In this document, results of a European survey on higher education in Industrial Engineering and Management (IE&M) are presented. The survey has been designed and carried out in the framework of the Industrial Engineering and Management of European Higher Education (IE3) project (Erasmus+ Program - Knowledge Alliance EAC/A03/2018) that strives to recognize the gap between contemporary industry needs and the offer of Higher Education Institutions (HEIs) in order to design, test, and validate a new model of Higher Education in IE&M to meet Industry 4.0 knowledge needs[1].

The survey design starts from the results of a research on scientific literature on Industry 4.0 topics and knowledge offered by HEIs on these topics. Results obtained from an extended literature review and the analysis of syllabi of 352 courses offered in the IE&M 2nd level (master) programs of 14 EU Countries (Belgium, Finland, France, Germany, Hungary, Italy, Latvia, Netherlands, Poland, Portugal, Slovenia , Spain, Sweden, and United Kingdom) and 2 extra-EU Countries (Serbia and Republic of North Macedonia) allow to identify key knowledge areas and potential gaps in the IE&M field.

The survey consisted of two sequential steps. In the first step, based on the results above mentioned, a semi-structured interview with companies was designed and carried out by project partners. The answers of the interview allowed to qualitative evaluate the training needs of a significant sample of companies mainly located in the project partners' Countries (Italy, Poland, Spain, Sweden).

A critical analysis of answers received from companies and of topics covered by the sample of 352 courses offered by HEIs in IE&M knowledge areas led to the design of a quantitative survey based on questionnaires addressed to all the stakeholders of the IE&M knowledge areas: Academics, Students, Alumni, and Companies. The aim of the second step of the survey was to evaluate (on a quantitative base) the training needs and the gap between the industry needs in implementing I4.0 paradigm and the Master Level Academic Programs in the field of IE&M offered by European Universities.

This document is structured as follows: in the first section, results of the qualitative semi-structured interviews are presented; in the second section, the structure of the quantitative questionnaires designed for the different stakeholders is illustrated; results obtained from the questionnaires are in the third section; finally, conclusion are in the final section.

[1] More information about the project's consortium and the results achieved by the project can be found at www.ie3.eu

# Executive summary

Main findings obtained by surveys will be summarized in the following. They relate to training demand and offer of companies as well as to Industrial Engineering and Management (IE&M) 2nd level (Master) Programs offered by Higher Educational Institutions (HEIs).

1) Large companies are looking for new and multidisciplinary competencies in order to gain the required resilience to rapid changes and to remain successfully in a very dynamic and competitive market.

2) Companies consider soft skills as important as or more than "hard" skills. Soft skills refer to the ability of interacting with people, including communication ability e team working attitudes. "*We can train people on technical areas in which they do not have previous knowledge, but it is very difficult for us to teach them how to effectively work in or lead a team*". Companies are looking for people able to face with changes in their work environment: "continuous learning", "innovation thinking", and "continuous improvement" are considered key personal attitudes.

3) There is a net positive knowledge demand from Companies. For both "hard" skill (Problem Solving and Decision Making, Project Management) and "soft" skills (Team Working, Communication Skills) the knowledge demand expressed by companies is not balanced by their training offer.

4) Among operational tools, the highest demand expressed by companies is related to analytical competencies (Computer-based Statistic Competencies, Management Software Tools, Big Data Analysis)

5) Face-to-Face is still the most required knowledge transfer methodology. Web-based asynchronous sessions are preferred to synchronous ones.

6) By comparing companies' knowledge demand and HEIs' offer, it is possible to identify some priority areas in which the demand of companies is higher than the training offer of both companies and HEIs.

7) The 'internal' demand expressed by HEIs (derived from the knowledge of HEIs of job market needs and perspective) is in accordance with companies' knowledge demand.

8) Academics involved in IE&M 2nd level Master Programs consider of high value both long internship periods and the presence of industry professors in Program courses.

9) Alumni and students of Master Programs in IE&M identified in soft skills the main shortcoming in the Programs attended.

10) Although the offer in IE&M 2nd level Master Programs perceived by students and alumni is lower than the offer expressed by academics, the majority of students and alumni considers contents of the Program attended compliant with the job market requirements.

# The semi-structured interviews

In the period 28/03/2020 -26/04/2020, semi-structured interviews were carried out with 30 companies located in the project partners' Countries (Italy, Poland, Spain, Sweden). Companies were selected on the base of the personal contacts of the project team. The aim of the interviews was to collect companies' opinion on knowledge and skills required by young workers with an academic IE&M cv. In order to carry out the interviews avoiding the risk to not receive answers or to receive incomplete answers, contact person(s) in managerial role (or in a role with a strategic and/or an overall view of the company/production plant) were selected (E.g.: Plan director, CEO, HR Manager, R&D Managers, Lean Manufacturing Managers.). Interviews lasted for 45 to 60 min and were conducted both in presence or on-line.

A format was developed in order to drive the interviews and collect the answers received. The format consists of three main parts.

Before starting, the interviewed was well informed about the IE3 project and the aim of the interview itself. No name and surname of the interviewed was recorded. He/her could leave his/her email address on a voluntary basis in order to receive results of the semi-structured interviews.

In the first part, the interviewed was asked to provide data about his position in the company and the company itself: production site location, sector, EU NACE code, size of the company and capital structure. For the last four data, predefined answers were provided:

Production process:

- ◊ manufacturing by parts
- ◊ process manufacturing
- ◊ service

Size of the company:

- ◊ micro (no more than 10 staff)
- ◊ small (staff 10 or more but less than 50)
- ◊ medium (staff 50 or more but less than 250)
- ◊ large (staff 250 or more)

Capital structure:

- ◊ domestic capital only
- ◊ mixed capital
- ◊ foreign capital only

As far as concern the EU NACE code, the interviewed was provided with a first-level list of EU NACE code (Statistical Classification of Economic Activities in the European Community, Rev. 2 (2008)) and

with a link to the official EU webpage:
https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=NACE_REV2&StrLanguageCode=EN

In the second (core) part of the interview, the interviewed was asked to answer and discuss three open questions:

Q1. **Which are the main engineering professional roles (Industrial Engineering and & Management skills) the company organization needs (e.g. program manager, purchase manager, security technician, etc)?**

Q2. **For each of the engineering professional roles identified in the previous question, which is the educational level required (e.g. technical secondary school, undergraduate, graduate, post-graduate, etc.)?**

Q3. **Which personal attitudes (soft skills - e.g. communication capacity, team working attitude, etc) are you looking for when you interview an engineering candidate? Please specify the contemplated position.**

The final part of the interview was based on a list of knowledge areas (contents and operational tools) in the IE&M area (see the list below). The interviewed was asked to identify the most relevant for his/her company, and to suggest further items not included in the list. This last part of the interview was aimed at acquiring useful information for the tuning of the quantitative questionnaires adopted in the second step of the survey.

A. Contents macro-area:

Management Issues (Operations management - Logistics - Problem solving, decision making, leadership - Entrepreneurial Mindset and Skills - Human Resources Management - Strategic Management - Entrepreneurial Mindset and Skills - Other);

Quality Issues (Statistical Process Control - Standards - Other);

Safety and Healthy Issues (Ergonomics - Safety - Legal - Other);

Social Issues (Communication skills - Team working - Other).

B. Operational tools macro-area:

Digital Technology Issues (3D Printing - Augmented/Virtual Reality - Cyber Security - Sensor-based monitoring competencies - IoT monitoring - Other);

Analytical skill Issues (Computer-based Statistics - Management software tools (e.g. ERP, CRP, MES, etc.) - Data Analytics - Machine Learning/AI).

## Analysis of the collected answers

Companies' profile

Companies involved in the semi-structured interviews are quite equally distributed among project partners Countries, with a prevalence of Swedish company (see Figure 1).

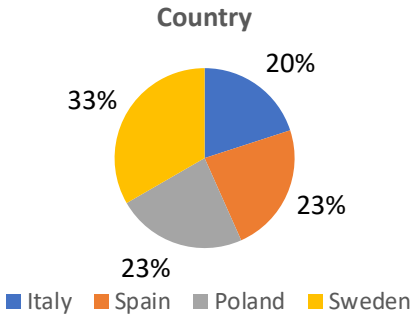



Fig. 1 – Companies' Country

More than 50% of the Companies involved were large companies with domestic capital (see Figure 2). Nevertheless, all dimensions (from micro to large) were in the company sample. This gave the opportunity to collect different point of view on the topic.

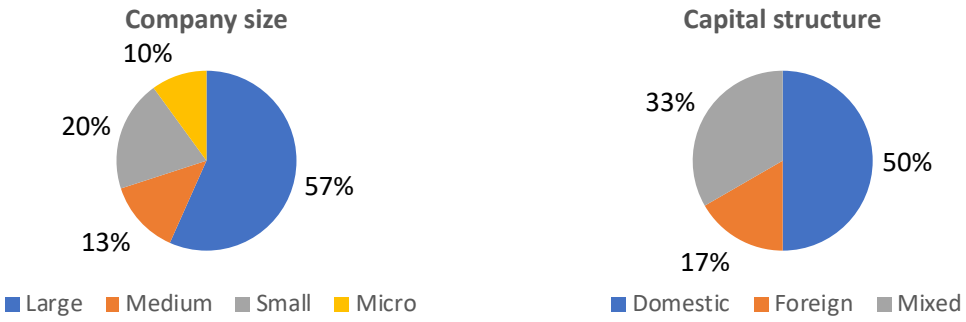



Fig. 2 – Size and structure of companies involved in the semi-structured interviews

As far as concern the sector of the companies (i.e. the type of production process implemented), the majority of companies were in the sector "manufacturing by parts". Finally, referring to the EU Classification of Economic Activities, a prevalence of activity of type "C" (Manufacturing) were observed.

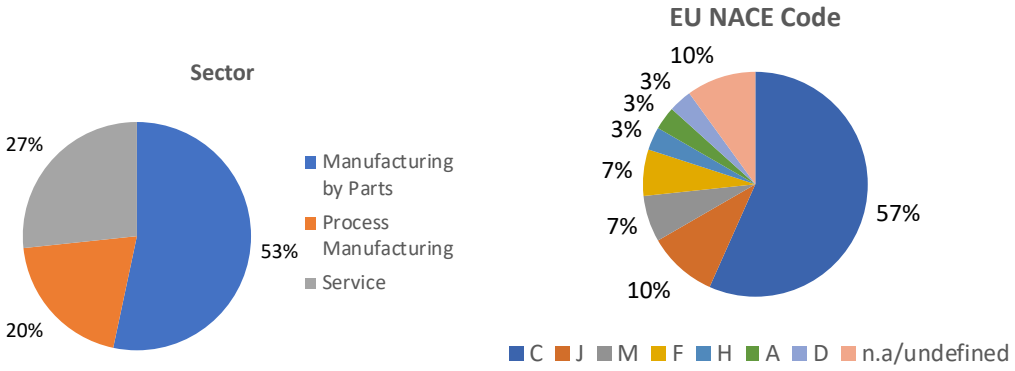



Fig. 3 – sector and EU NACE code of companies involved in the semi-structured interview (C = manufacturing; J = information and communication; M = professional, scientific and technical activities; F = construction; H = transportation and storage; A = agriculture, forestry and fishing; D = electricity, gas, steam and air conditioning supply)

Answers to open questions

In the following, main findings of the analysis of answers received to the three open questions (Q1, Q2, Q3) are discussed. Preliminary analysis of the answers received were carried out in order to identify significant difference between companies of different Countries and activity sector, but no meaningful differences were found.

### Question 1

The analysis of answers received to Q1 shows how medium and small companies are more oriented towards classical roles of IE&M (e.g. project manager, production manager, logistics manager, quality manager, purchase manager, sales manager). In case of large company, new and mixed competencies are required. New competencies are in the area of "digitalization", as it is the case of IT developer and digital specialist. Competencies on enabling technologies of I4.0 are also required: artificial Intelligence, additive manufacturing, and big data are some examples of these new competencies looked for in professionals with an IE&M background. Large companies are looking for IE&M professionals with multiple competencies (e.g. economic and logistics; production management and purchase management; planning, scheduling, and production with technical and documental support) since this polyfunctional role are considered of high value-added for the companies. A Swedish service company stated that they need "Business management skills where you see customer needs and could formulate that into a business plan. Help the customers to fill the gap between business and engineering", and a polish manufacturing company that they need professionals "able to consume lots of numbers, to make appropriate decisions, able to present findings in an appealing manner both in writing and orally, resolving non-standard inquiries, …". From these answers it is evident the need for the company to acquire professionals able to manage not only the whole (or almost whole) production process, but also able to effectively translate customer specifications or production data into concrete solutions.

A further trend comes out from the analysis of answers received to Q1. Large companies always more often require competencies in the field of continuous improvement and innovation (mainly product innovation). This points out the need of the companies (even if they are large companies) to remain competitive in a very dynamic and competitive market, and hence to have internal competencies able to provide the required resilience to rapid changes.

### Question 2

MSc is the most frequent educational level required. In very few cases, and for specific technical roles, undergraduate education level is required. MSc is still the educational level guaranteeing the best carrier's opportunity as well clarified by a large Swedish manufacturing company: "The graduate students are the ones taking major steps in the hierarchy of the company". PhD educational level is not so common even in case of large companies, and few of them consider it as a title required for strategic roles, as stated by a large Spanish service company: "A team responsible MUST have (a) PhD".

### Question 3

Despite of differences observed in the answers received to Q1 and Q2, a general alignment has been observed in case of Q3. Companies consider personal attitudes a key success factor for their employees. Soft skills are considered prevalent on "hardware" ones. As stated by a large Italian manufacturing

company: "We can train people on technical areas in which they do not have previous knowledge, but it is very difficult for us to teach them how to effectively work in or lead a team".

One of the most frequent personal attitudes found in answers received is "team working", often together with "communication capacity". The attitude of working with a group of people and to coordinate them is not the only personal attitude frequently looked for by companies. Many companies consider of great value competencies and skills like "conflict resolution", "stress management", and "coaching skill", all attitudes contributing to improve the work environment. Companies are also looking for people able to face with changes in their work environment. As a consequence, they consider attitudes as "continuous learning", "lifelong learning", and "learning agility" very important. "Innovation thinking", "continuous improvement", "target oriented", "leading by content", "proactive attitude" are also considered important personal attitude. Moreover, many companies focused on "challenge motivation", "creative thinking", and "linguistic skill".

Knowledge areas

In Figure 4, results of the last part of the semi-structured interview are shown.

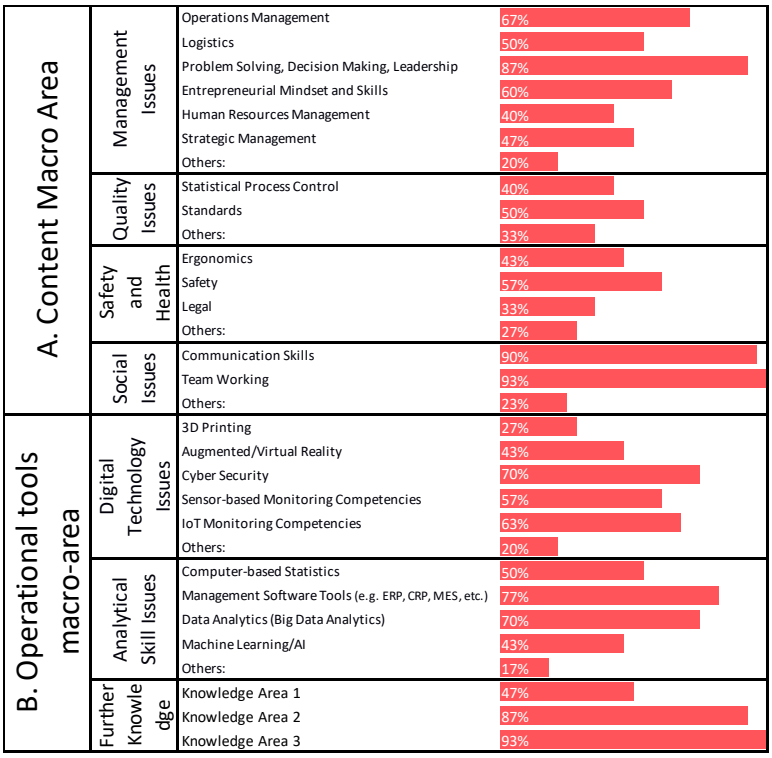



Fig. 4 – Results of the last part of the semi-structured interviews (knowledge areas of interest)

Again, no meaningful differences have been observed when clustering results by companies' country or by companies' size. As it can be observed in Figure 4, in the "Content macro-area", the most frequent interest has been recorded in the "Management issue" (Problem solving, decision making, leadership) and "Social issues" (communication skills and team working) content sub-macro areas. This is consistent with answers received in the first two section of the semi-structured interviews. In the "Quality" and "Safety and Health" areas, more than 50% of companies identified as important knowledge on "Standars" and "Safety". In the "Operational tools macro area", both sub-areas ("Digital technology issues" and "Analytical skill issues") proved to be of companies interests. The most important knowledge

area identified by companies is "Management software tools" (77%), followed by "Cyber security" and "Big data analytics" (70%). This leads to conclude that although the main interest of companies relies on a "traditional" competence field ("Management software tools"), there is a strong interest in digital transformation. This is also supported by the great number of preferences recorded by "Sensor based monitoring competencies" and "IoT monitoring". Finally, not all the companies involved in the semi-structured interviews consider specific enabling technology of I4.0 of great importance ("3D printing", "Augmented/Virtual Reality", "Machine Learning/Artificial Intelligence"). This could be explained considering that in not all working environments these technologies are evaluated as "essentials" or mature enough to replace traditional ones. As an example, in one of the semi-structured interview, a large manufacturing Italian company stated they were using 3D printing for auto-producing spare parts, but they consider that production useful only for very less critical components, or as an "emergency" action to be undertaken to face with suppliers lead time uncertainty, rather than an alternative solution for spare parts procurement. At the same time, they do not look for this kind of competence in new employees, since they considered enough the availability of very few units (2-3 workers) in the 3D printing department.

As it is shown in Figure 4, many companies involved in the semi-structured interviews suggested other knowledge sub-area of interests (under the areas already proposed), and almost the whole sample proposed further knowledge areas.

In the "Management issues", companies explicited their interest in leadership (leading by content), continuous improvement, cost control, finance (for non finance people), innovation, and commercial issues. Reporting (KPI and dashboards), continuous improvement methodologies and tools (WCM, Six sigma, TQM), quality tools (Measurement System Analysis, Production Part Approval Process, Statistical Process Control, failure Mode and Effects Analysis), and standards are the main suggestions received for the "Quality issues" area. In the "Safety Issues" area, companies identified in Behavior Based Safety, Industrial hygiene, IT Security, and ergonomics relevant knowledge. Answers received in the "Social Issues" area are the same received by companies in Q3.

In the "Digital Technology Issues", companies identified in cloud computing, cloud management, Hybrid App development and cobot further knowledge areas of interest. Finally, very few suggestions were received with reference to the "Analytical skill issues" area (e.g. prescriptive analytics, data-driven development).

During the semi-structured interviews, Companies identified other knowledge areas and sub-areas besides the ones proposed during the interviews. They can be grouped into two main knowledge areas: product innovation and Information Technology (IT).

Knowledge areas and sub-areas suggested by companies revealed useful in the setting-up of the second (quantitative) part of the survey.

# The quantitative survey

The second part of the survey was based on four quantitative questionnaires. They were addressed to all stakeholders (i.e. Academics, Students, Alumni, and Companies) with the aim of evaluating, on a quantitative base, the training needs and the gap between the industry needs in implementing I4.0 paradigm and the Master Level Academic Programs in the field of IE&M offered by European Universities.

The questionnaires were initially designed starting from the results of the first part of the IE3 research project (RIF R1.3). The preliminary version of the questionnaires was tuned thanks to the answers obtained from the semi-qualitative interviews. The final version of the questionnaires was defined after discussions with all partners of the project and feedbacks received from partners during the test phase. During the test phase, the preliminary version of the questionnaires has been tested with at least four stakeholders in each category with the aim to collect suggestions on the understandability and completeness of questions proposed.

## Content and structure of the questionnaires

The common structure of the four questionnaires is in Table 1 and is discussed in the following.

| |
|---|
| Introduction to IE3 Erasmus+ Project |
| Disclaimer |
| General information |
| A. Learning skills and competencies<br>A.1 Knowledge, skills and competencies<br>A.2 Operational tools<br>Digital Technology Competencies<br>Analytical skill Competencies |
| B. Learning environment<br>B.1 Knowledge Transfer Methodology<br>B.2 Learning activities (*) |

Tab. 1 – Structure of the questionnaires; (*) = not in the questionnaire for Companies

In the first part of the questionnaire ("Introduction to IE3 Erasmus+ Project"), basic information on the project as well as all links to official web resources (project website, Facebook and LinkedIn project accounts) are provided.

In the section "Disclaimer", mandatory information as per GDPR 2016/279 are provided. Moreover, in this section the responder is invited to insert his/her email address in order to receive results of the survey and to register to the project newsletter in order to stay updated on project development.

In the section "General information" responder is asked for anonymous information allowing to profile themselves and his/her organization (if applicable). Quality and quantity of information required in this section vary in the four questionnaires. In case of Academics they were asked to select, in a predefined list, the study program(s) within IE&M area offered at Master level or 2nd cycle study from their University; Students and Alumni were asked to select, in the same list, the program in which they were enrolled or in which they graduated, respectively. The list included the following programs, all in the IE&M area:

Industrial Engineering and Management,

Engineering Management,

Production Management,
Manufacturing Management,
Industrial Management.

The interviewed had the possibility to answer other programs out of the list.

The core part of the questionnaires is divided into main subsections, named "A. Learning skills and competencies" and "Learning environment". The former section has been designed in order 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 in order 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.

Section "A. Learning skills and competencies" is organized in two subsections. In subsection A.1, the responder is asked to assess both the degree at which a set of knowledge, skill, competencies (items in the following) are offered inside his/her "organization" and their degree of importance to enter the job market. In case of Academics, Alumni, and Students, the "organization" represents the Study Program identified in the "General information" section. In subsection A.2, the responder is asked to rate in the same way a set of operational tools competencies, further grouped into "Digital Technology Competencies" and "Analytical skill Competencies". Section A consists of 25 questions, 16 in subsection A.1 and 9 (5+4) in subsection A.2. Section A is the same in all four questionnaires.

The section B "Learning environment" is not the same for all questionnaires. In the questionnaires for Academics, Alumni, and Students, this section has the same content and structure: it is organized in two subsections. In subsection B.1, responder is asked to indicate the frequency of adoption (offer side) and of the expected adoption (demand side) of a set of knowledge transfer methodology by the selected Study Program. In subsection B.2, the responder is asked to evaluate in the same way a set of Learning activities. In the questionnaires for Academics, Alumni, and Students, section B consists of 16 questions, 7 in subsection B.1 and 9 in subsection B.2; at the end of each subsection, responder has the opportunity to add and rate further items. In the questionnaire for Companies, this section consists of only 3 questions, and the responder has the opportunity to add and rate further items.

In the following, Sections A and B of the questionnaires are detailed.

### A. Learning, Skills and Competencies (LSCs)

Competencies investigated in section A of the questionnaires are listed below:

A.1 Knowledge, skills and competencies (KSCs)

Project Management
Operations Management
Quality Management
Logistics
Problem Solving and Decision Making
Firm Organization

Industrial Marketing
Investment and Finance
Strategic Management
Innovation and Change Management
Entrepreneurial Mindset and Skills
Leadership Issues
Ergonomics
Safety of Work
Communication Skills
Team Working

A.2 Operational tools (OTs) - Digital Technology Competencies (DTCs)

3D Printing Competencies
Augmented/Virtual Reality Competencies
Cyber Security Competencies
Sensor-based Monitoring Competencies
IoT Monitoring Competencies

A.2 Operational Tools (OTs) - Analytical Skill Competencies (ASCs)

Computer-based Statistics Competencies
Management Software Tools (e.g. ERP, CRP, MES, etc.)
Big Data Analysis
Machine Learning/AI competencies

For each of the items listed in this section, in the questionnaires for academics, students, and alumni, the responder was asked to assess the degree at which it was 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 order to support responders in the selection of the appropriate answer, "low", medium", and "high" answers were detailed as following:

OFFER:
Low = poorly addressed
Medium = moderately addressed in some courses
High = highly addressed
DEMAND:
Low = not so important
Medium = moderately important
High = highly important

In the questionnaire for companies, the same competencies 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, detailed as following:

OFFER:

Low = poorly addressed in the training sessions

Medium = moderately addressed in the training sessions

High = highly addressed in the training sessions

DEMAND:

Low = not so important to enter my company

Medium = moderately important to enter my company

High = highly important to enter my company

**B. Learning environment (LE)**

Learning methodologies investigated in section B of the questionnaires for Academics, Students, and Alumni are listed below:

B.1 Knowledge Transfer Methodology (KTMs)

Traditional Face-to-Face Lectures

Seminars/Tutorials

Workshop

Field Trips (factories/companies)

Web-based: Synchronous Learning on the Web

(e.g. lectures on streaming, workshop on streaming)

Web-based: Asynchronous Learning on the Web

(e.g. e-learning modules/MOOCs, video tutorials, augmented reality environment/virtual factory tour)

B.2 Learning activities (LAs)

Theoretical Studies (books, educational materials, …)

Seminars/Exercises

Case-based Learning

Individual Projects

Group Projects

University Physical Labs

University Virtual/Computer Labs

(e.g. simulation labs)

Experiential Learning

(e.g. internship - industry problem tackled with company staff support)

For each of the items listed in this section, the responder was asked to assess the frequency of adoption (OFFER) and the frequency of the expected adoption (DEMAND) in the Study Program(s) selected. For both OFFER and DEMAND, five predefined answers were proposed: "not offered", "low", "medium", "high", and "don't know". In order to support responders in the selection of the appropriate answer, "low", medium", and "high" answers were detailed as following:

OFFER

Low = rarely adopted

Medium = moderately adopted in some courses

High = frequently adopted

DEMAND

Low = not required to be adopted

Medium = required to be adopted

High = highly recommended to be adopted

Two further questions were at end of section B of the questionnaires for Academic, Students, and Alumni. They aim at investigating the availability and the duration (in weeks) internship in the selected Study Program(s) and the presence of industry professors in courses of IE&M programs (in this case the number of courses were asked to the responder).

In the questionnaire for companies, section B consists of only three items:

Traditional Sessions are: Face-to-Face
(e.g. Lectures, Seminars/Tutorials)
Training Sessions are: Web-based - Synchronous
(e.g. lectures on streaming)
Training Sessions are: Web-based - Asynchronous
(e.g. e-learning modules, video tutorials, augmented reality environment/virtual factory tour)

The responder was asked to assess the frequency of adoption (OFFER) and of the expected adoption (DEMAND) of the three knowledge transfer methodologies listed. The same predefined answers, detailed in a similar way, of the other questionnaires were proposed.

In all questionnaires (Academics, Students, Alumni, and Company), responder has the possibility to identify other knowledge transfer methodologies out of the proposed list.

## The collection and the analysis of answers

In order to make as easy as possible the spread of and the filling in the questionnaires, they were coded in MS Forms®. Four forms were coded, one for each questionnaire (Academic, Students, Alumni, and Company). The choice allowed to automatically collect answers and to monitor the amount of answers received on a daily base, so as to implement corrective actions in order to reach a significant number of answers. During the collection period (20/05/2020-29/06/2020), project partners and associated partners (AIM[2], ESTIM[3]) of the IE3 project sent an invitation to fill the questionnaires to all stakeholders,

[2] European Academy for Industrial Management (AIM); https://europe-aim.eu
[3] European Students of Industrial Engineering and Management (ESTIEM); https://estiem.org

providing them with a brief overview of the project's aims and with the link to the corresponding questionnaire.

At the end of the collection period, more than 700 answers were collected.

In order to obtain quantitative results from the answers obtained, for both questionnaire sections 'A. Learning skills and competencies' and 'B. Knowledge Transfer Methodology', a numerical value was linked to each answer, as shown in Table 2. No numerical value was addressed to the answer "don't know", but the amount of this type of answers was evaluated for each question. For each question, the gap was evaluated as the difference obtained from the numerical value assumed by the DEMAND answer and the one assumed by the OFFER answer. For each question, the gap has been evaluated only in case the responder gave an answer to both OFFER and DEMAND side of the question. The final number of gap data for each question was evaluated.

| | |
|---|---|
| "not offered (OFFER) or not required (DEMAND)" | 0 |
| "low" | 1 |
| "medium" | 2 |
| "high" | 3 |
| "don't know" | *null* |

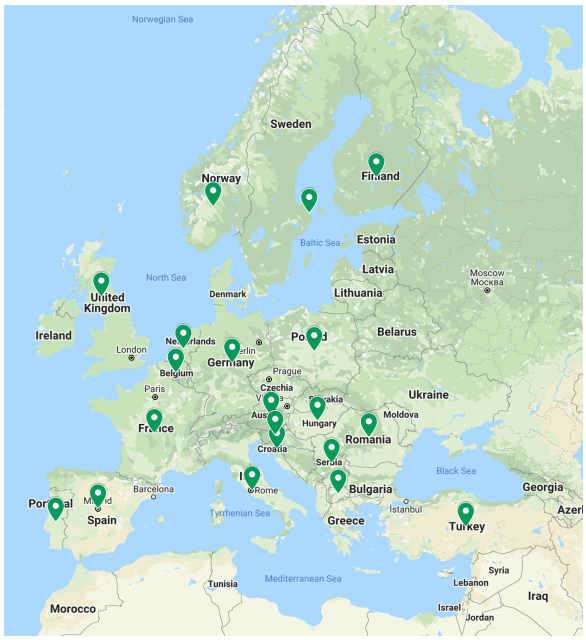
Tab. 2 – Numerical values adopted for each answer in the analysis of questionnaires' results

Results obtained from a first analysis of results were discussed among project's partners. Discussion led to focus on some results obtained in the first stage of the analysis and to add further analysis in order to achieve comprehensive results. Further analysis was carried out by comparing answers obtained from different stakeholders, or clustering answers received by a single stakeholder on the basis of information on responders.

In the following sections, results of the analysis are detailed.

## The companies' perspective

In the collection period, 75 companies located in 20 different countries filled the questionnaire (see Figures 5 and 6). The majority of responders worked in large companies, operating in the "Service" sector and with domestic capital (see Figure 7).



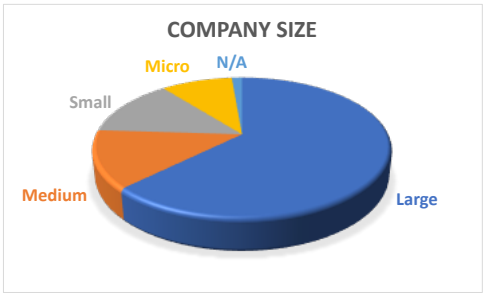

| Country | # |
|---|---|
| Spain | 14 |
| Italy | 11 |
| Poland | 10 |
| Germany | 7 |
| Sweden | 7 |
| The Netherlands | 4 |
| Slovenia | 4 |
| Portugal | 3 |
| Finland | 2 |
| Macedonia | 2 |
| United Kingdom | 2 |
| Austria | 1 |
| Belgium | 1 |
| Croatia | 1 |
| France | 1 |
| Hungary | 1 |
| Norway | 1 |
| Romania | 1 |
| Serbia | 1 |
| Turkey | 1 |

Fig. 5 – Companies' countries

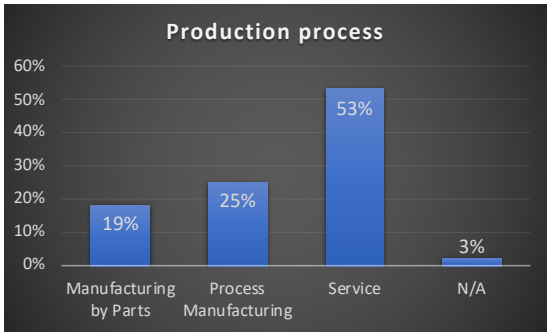
| Country | City |
|---|---|
| Austria | Golling |
| BELGIUM | BRUSSELS |
| Croatia | Solin |
| Finland | Helsinki |
| Finland | Espoo |
| France | Rodez |
| Germany | Berlin |
| | Bremen |
| | Munich |
| | Munich |
| | Munich |
| | Wolfsburg |
| | N/A |
| Hungary | More than one site |
| Italy | Altamura |
| | Bari |
| | Bari |
| | Bitonto |
| | Limena; Modugno |
| | Milano |
| | Milano |
| | Milano |
| | Modugno |
| | Porto Sant'Elpidio |
| Macedonia | Skopje |
| | Skopje |
| Netherlands | Amsterdam |
| | Amsterdam |
| | Rotterdam |
| | More than one site |
| Norway | Oslo |
| Portugal | Alverca |
| | Carregado |
| | Pinhal Novo |
| Romania | Bucharest |
| Serbia | N/A |


| Country | City |
|---|---|
| Poland | Czarnków |
| | Gadki |
| | Kolo |
| | Posen |
| | Poznań |
| | Poznań |
| | Poznań |
| | Radom |
| | Warsaw |
| | Wloclawek |
| Slovenia | Maribor |
| | Maribor |
| | Maribor |
| | N/A |
| Spain | Amorebieta |
| | Avilés |
| | Barcelone |
| | Bilbao |
| | Bonares |
| | Derio |
| | Gatika |
| | Madrid |
| | Madrid |
| | Santurtzi |
| | Several cities in Spain (Avilés, ...) |
| | N/A |
| Sweden | Linkoping |
| | Mjolby |
| | Skarblacka |
| | Skärblacka |
| | Stockholm |
| | Stockholm |
| | N/A |
| Turkey | Izmir |
| United Kingdom | London |
| | N/A |

Fig. 6 – Companies' site locations




| | |
|---|---|
| large (staff 250 or more) | 63% |
| medium (staff 50 or more but less than 250) | 13% |
| small (staff 10 or more but less than 50) | 13% |
| micro (no more than 10 staff) | 9% |
| Not Available | 1% |



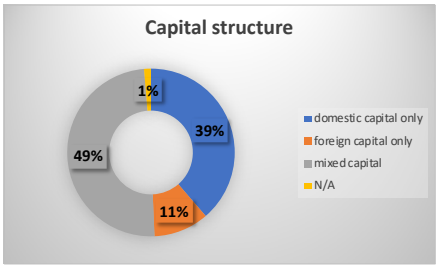




Fig. 7 – Size, production process and capital structure of companies which filled the questionnaire

An overview of the results obtained from the analysis of answers are in Figures 8 and 9. In both figures, OFFER and DEMAND average scores as well as the standard deviation values are shown. For each question, the percentage of "don't know" answers are displayed. Results of the GAP analysis is in figure 10. Here, for each question, the number of data available (#) for the evaluation of the gap is displayed.

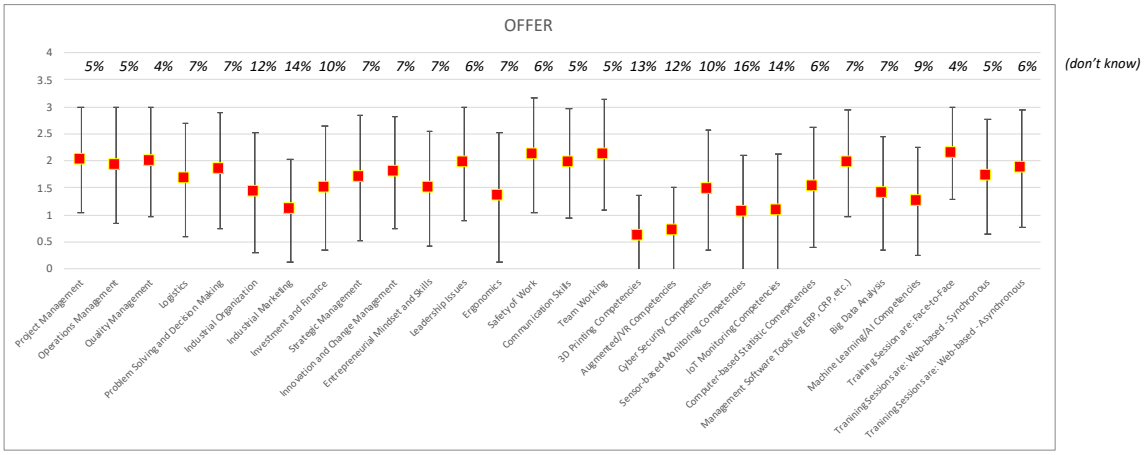



Fig. 8 – Results of the OFFER analysis - companies' questionnaire

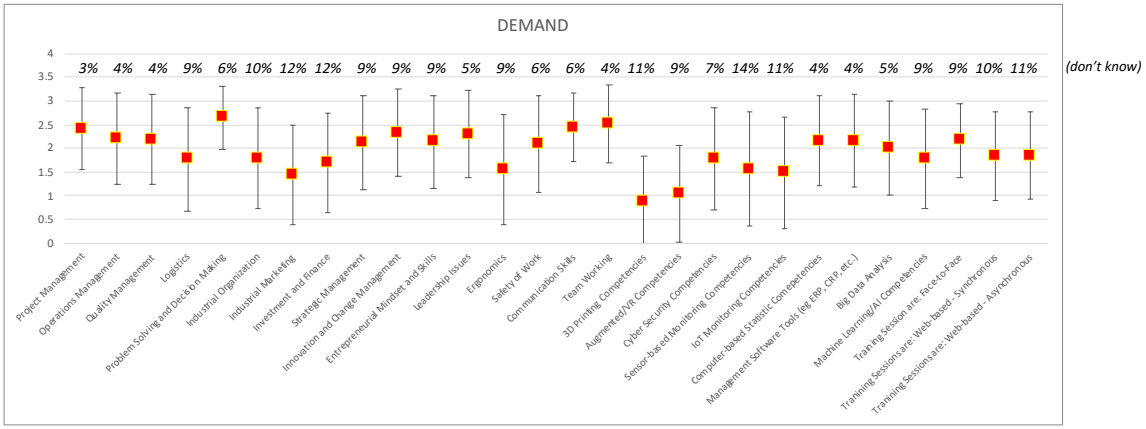



Fig. 9 – Results of the DEMAND analysis - companies' questionnaire


Fig. 10 – Results of the GAP analysis - companies' questionnaire

As shown in Figure 10, some of the topics investigated in the Company questionnaire give back high gap values. Among "Knowledge, Skill and Competencies", both a "hard" competence like "Problem Solving and Decision Making" and a "soft" skill like "Entrepreneurial Mindset and Skill" are characterized by high gap score values. Among "Operational Tools" investigated, demand assumed a significant higher value than offer in case of both "Computer-based Statistic Competencies" and "Big Data Analysis". Finally, only in one case, concerning the "Knowledge Transfer Methodologies", the gap score assumes a negative value: web-based synchronous training sessions. To this last concern, the responders were asked not to consider the contingency of 'Covid' pandemic.

By considering these preliminary results of the analysis, it can be concluded that for all topic investigated, the DEMAND of knowledge of companies is higher than the OFFER, thus highlighting a net positive knowledge demand. Moreover, web-asynchronous is considered the most appropriate knowledge transfer methodology to be adopted.

Despite the gap score values observed allowed to make important conclusions, a deep investigation was required to acquire a better understanding of answers received. In Figures 11 and 13, for each of the topic investigated in section A.1 (KSCs) and A.2 (OTs) of the questionnaire, OFFER, DEMAND, GAP, and DEMAND standard deviation (St. Dev.) values are plotted by decreasing DEMAND values.

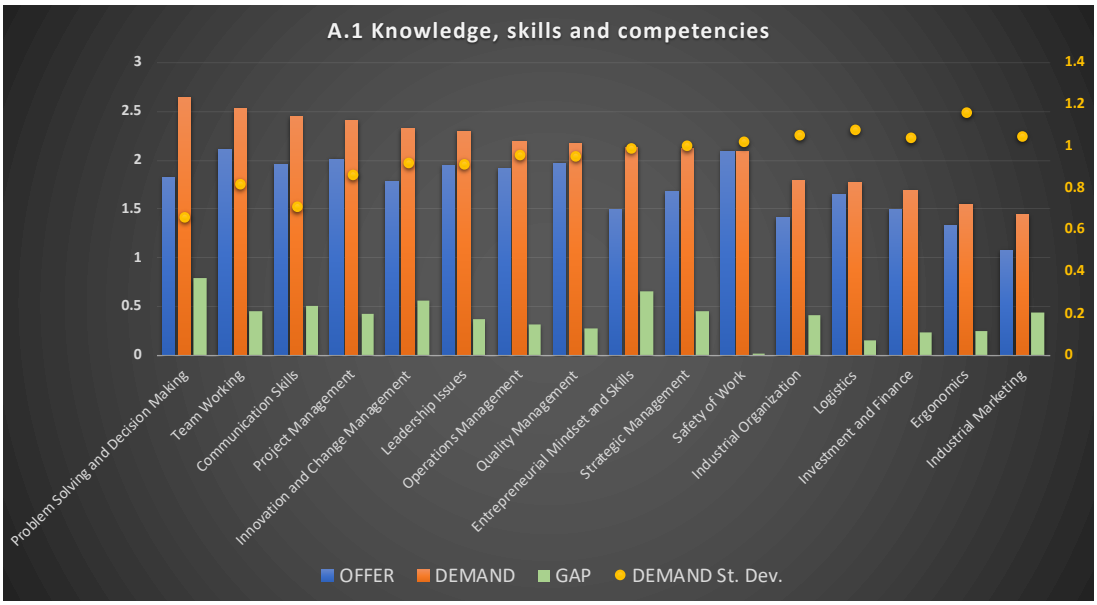



Fig. 11 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by companies in section A.1 (Knowledge, Skills and Competencies - KSCs) of the questionnaire

As shown in Figure 11, it is possible to group KSCs investigated in three classes. A first class characterized by high DEMAND score values and low DEMAND St. Dev. values. In this class there are both hard and soft skills:

Problem Solving and Decision Making
Team Working
Communication Skills
Project Management

This result is coherent with the ones obtained by semi-structured interviews (see Figure 4). The high values of the DEMAND score observed and the corresponding low values of the St. Dev. lead to conclude that these are cross competencies required by almost all the companies in the sample.

As opposite, in the third class there are KSCs with low value of DEMAND score values and high value of DEMAND St. Dev. Values. This class consists of only hard and traditional competencies:

Industrial Organization
Logistics
Investment and Finance
Ergonomics
Industrial Marketing

The high values of the DEMAND St. Dev. highlight that companies in the sample do not require these competencies with the same strength. This could be partially explained looking at differences, in answers received, between service companies and manufacturing companies characterized by a different production process.

Finally, the second class is characterized by intermediate values of both DEMAND and DEMAND St. Dev.

Conclusions obtained for KSCs are confirmed by a further analysis carried out on answers received. In this analysis, answers received were clustered by companies' sector. Two clusters have been considered, as detailed in Table 3.

| Cluster | Production process | # |
|---|---|---|
| "Manufacturing" | • Manufacturing by Parts<br>• Process Manufacturing | 33 |
| "Service" | • Service | 40 |

Table 3 – Clustering of companies who responded to questionnaire

By observing DEMAND and DEMAND St. Dev. expressed by the two clusters of companies (see Figure 12), previous conclusions are confirmed. Negligible differences are observed for KSCs in the first class. On the contrary, KSCs in the third class are characterized by substantial differences in DEMAND values for the two clusters (with only one exception, "Investment and Finance"). Differences can be observed also for KSCs in the second class (but with higher values of the single DEMAND). This further analysis highlighted that, except for cross competencies previously highlighted, KSCs required by companies are affected by their production process type.

Looking at Manufacturing cluster, further KSCs with high DEMAND values are Operations Management, Quality Management, and Safety of Work. Entrepreneurial Mindset and Skills is the further skill of high value in Service cluster.

Finally, higher values of DEMAND St. Dev. are generally observed in the Service cluster. This could be explained by the high variability of activity (as per NACE code) of companies in Service cluster when compared with ones of Manufacturing cluster, with 75% of companies in activity sector "C - Manufacturing".

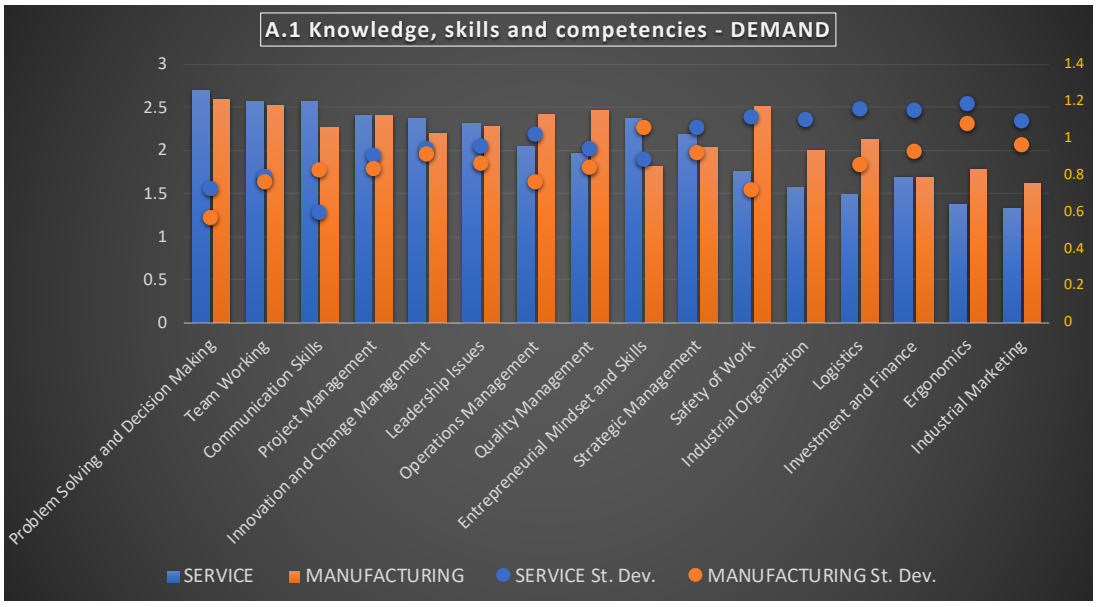



Fig. 12 – Results of the analysis of answers to A.1 (KSCs) clustered in "Service" and "Manufacturing" groups

As far as concern section A.2 (OTs) of the companies' questionnaire, OFFER, DEMAND, GAP, and DEMAND standard deviation (St. Dev.) values are plotted by decreasing DEMAND values in Fig. 13.

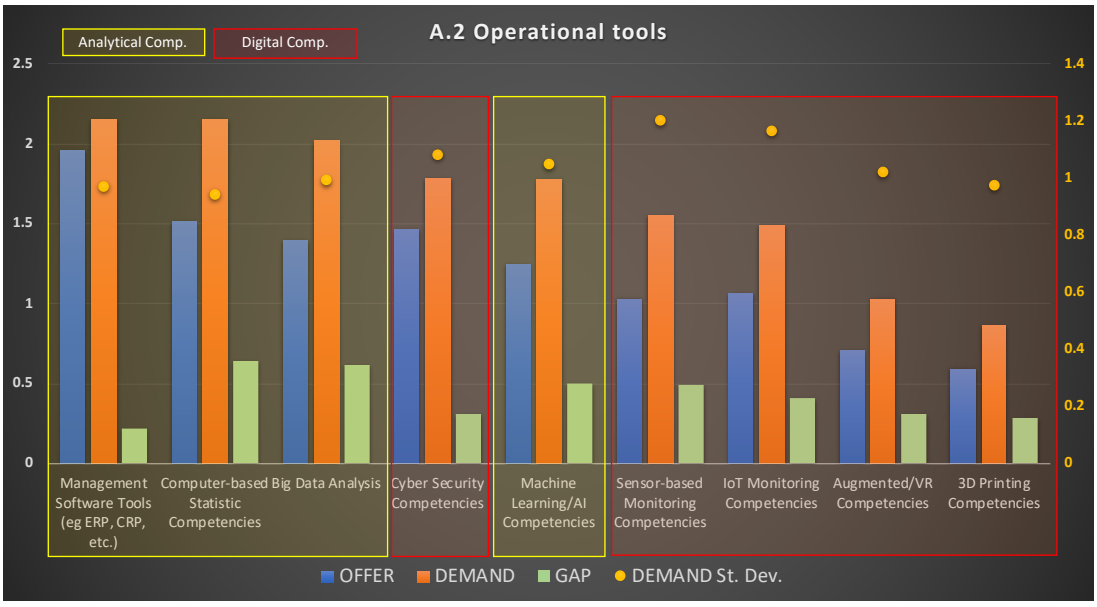



Fig. 13 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by companies in section A.2 (Operational Tools - OTs) of the questionnaire

As in case of KSCs, also for OTs it is possible to identify a group of OTs characterized by higher values of the DEMAND and lower values of the DEMAND St. Dev. (first class OTs):

Computer-based Statistic Competencies
Management Software Tools

Big Data Analysis

In case of OTs, the highest values of the GAP are in this class (Computer-based Statistic Competencies and Big Data Analysis).

OTs with lower values of the DEMAND and higher values of the DEMAND St. Dev. (third class) are:

Sensor-based Monitoring Competencies
IoT Monitoring Competencies
Augmented/VR Competencies
3D Printing Competencies

As it can be observed, OTs in the first class are all Analytical Competencies, while OTs in the third class are all Digital Competencies.

By analyzing the answers on OTs grouped in the two cluster "Service" and "Manufacturing", significant differences were observed in the two cluster (see Figure 14).

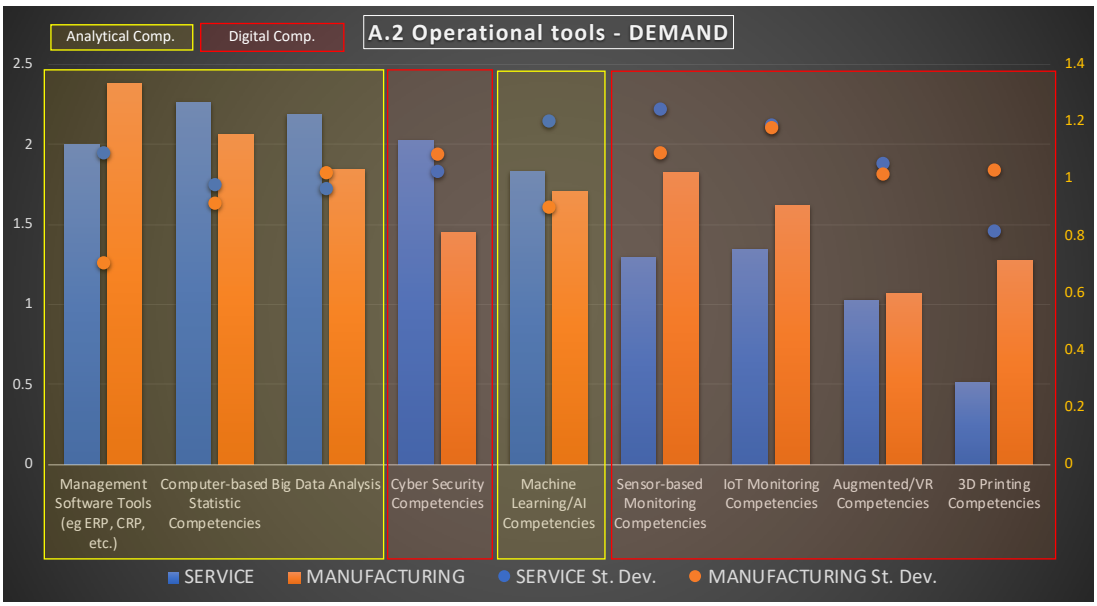



Fig. 14 - Results of the analysis of answers to A.2 (OTs) clustered in "Service" and "Manufacturing" groups

As already observed in case KSCs, OTs belonging to the first class are highly requested by companies, with some differences between the two clusters, but with low values of DEMAND St. Dev. (if compared with other OTs).

Finally, with reference to the section B of the companies' questionnaire (KTM), what is observed is that Face-to-Face is still the most required KTM, and that Web-based asynchronous sessions are preferred to synchronous ones (see Figure 15). In this case, no significant differences were observed between the two clusters "Service" and "Manufacturing".

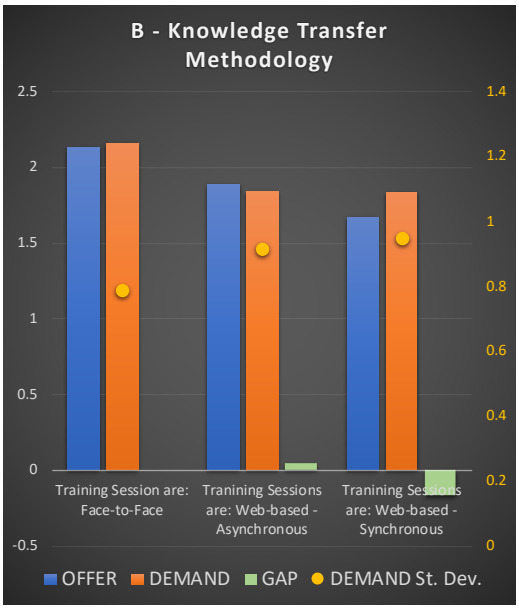



Fig. 15 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by companies in section B (Knowledge Transfer Methodology) of the questionnaire

## The companies' knowledge needs vs the European HEIs' offer

In the previous section the knowledge demand of companies has been analyzed and compared with the companies' training offer. One of the most evident results is a net positive knowledge demand expressed by companies. In this section, the companies' knowledge demand is compared with the knowledge offer provided by European Higher Education Institutions (HEIs) in Industrial Engineering and Management (IE&M) Second (Master) Level Academic Programs in. The HEIs offer considered here is the one expressed by academics (Professors, Program coordinators, Department Deans) who filled the questionnaire for Academics (113 answers received from 64 Universities in 21 Countries). More details on the answers received for this questionnaire are in the next section.

By comparing the knowledge demand expressed by companies and the offer expressed by Professors and Deans in section A.1 (Knowledge, Skills and Competencies - KSCs) of the questionnaires, it is possible to identify three groups of KSCs (see Figure 16). The first group consists of KSCs characterized by a high value of both companies' demand and gap (red boxes in Figure 16). The gap here is evaluated as the difference between companies' demand and HEIs' offer. Both "hard" and "soft" skills belong to this group:

Problem Solving and Decision Making
Team Working
Communication Skills
Project Management
Innovation and Change Management
Leadership Issues

Entrepreneurial Mindset and Skills

Strategic Management
Safety of Work

For all KSCs in this group, companies' demand is higher of both the training offered by companies themselves (except for the case of "Safety of Work") and HEIs (except for the case of "Strategic Management"). Among KSCs in this group, three of them show the highest gap between what is required by companies and what is offered by HEIs: "Leadership Issues", "Communication Skills", and "Problem Solving and Decision Making".

The second group (yellow box in Figure 16) consists of KSCs with a high companies' demand, but with no gap. In this case, the offer score of HEIs is higher than the demand score of companies.

Finally, in the third group (green box in Figure 16) there are KSCs characterized by low companies' demand and high HEIs values. As in the second group, the offer of HEIs is greater than the demand of companies (with only one exception, "Ergonomics").

Results obtained from this analysis identify a priority group of KSCs in which a gap occur between the companies' demand and HEIs' offer:

Leadership Issues
Communication Skills
Problem Solving and Decision Making
Innovation and Change Management
Team Working
Project Management

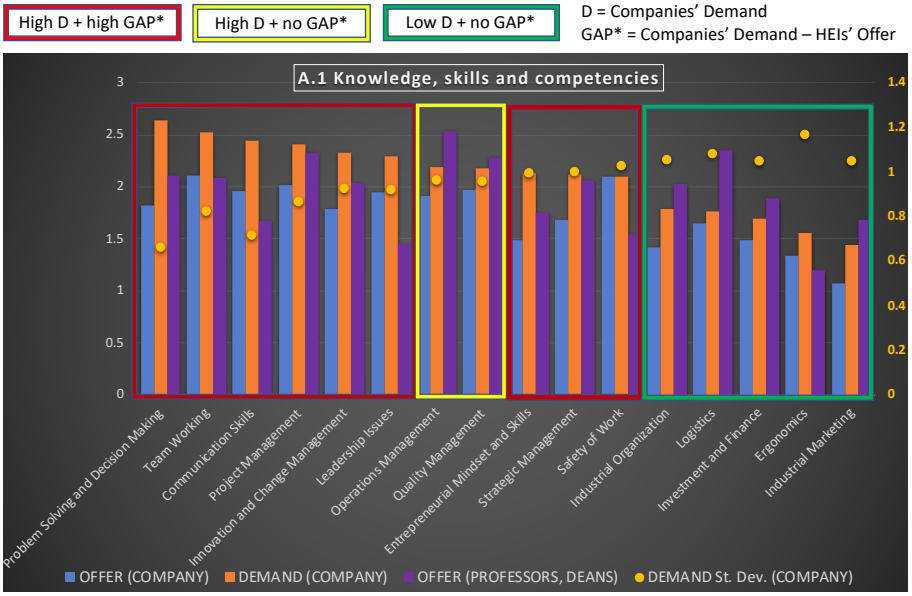



Fig. 16 – OFFER and DEMAND score and DEMAND standard deviation values expressed by companies compared with OFFER score expressed by Academics in section A.1 (Knowledge, Skills and Competencies - KSCs) of the questionnaires

With reference to Operational Tools (OTs) investigated in section A.2 of the questionnaires (see Figure 17), again three groups of OTs can be identified. A first group (Big Data Analysis, Management Software Tools, and Computer-based Statistical Competencies) in which a gap is observed between companies' demand and both companies' training offer and HEIs' offer. A second and a third groups with OTs with low companies' demand and a net positive and negative gap with HEIs' offer, respectively.
In this case, the priority group of OTs to be improved in terms of HEIs' offer correspond to the first group:
Big Data Analysis
Management Software Tools
Computer-based Statistical Competencies.

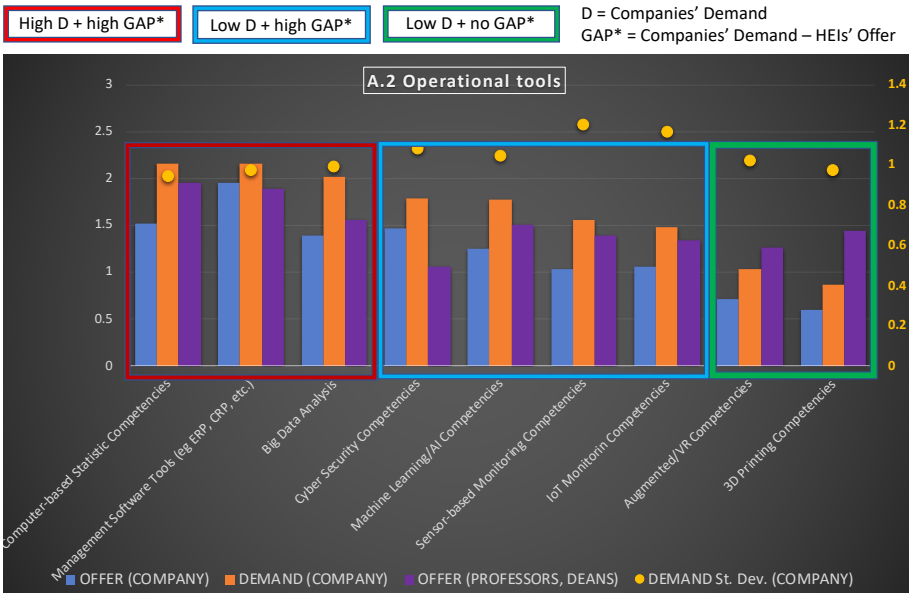



Fig. 17 - OFFER and DEMAND score and DEMAND standard deviation values expressed by companies compared with OFFER score expressed by Academics in section A.2 (Operational Tools - OTs) of the questionnaires

Finally, the knowledge demand expressed by companies has been compared with the "internal" demand expressed by Professors and Deans of HEIs (see Figures 18 and 19). Knowledge demand expressed by HEIs is based on the knowledge of Academics of the job market. It is interesting noting how demand expressed by Academic is higher than the demand expressed by companies (with only two exception: "Industrial Organization" and "Investment and Finance", both very close to companies' demand scores), thus denoting a good knowledge of Academics of Companies' knowledge needs. This is confirmed also by the low values observed (in most of the cases) in the differences between HEI's demand and companies' demand.

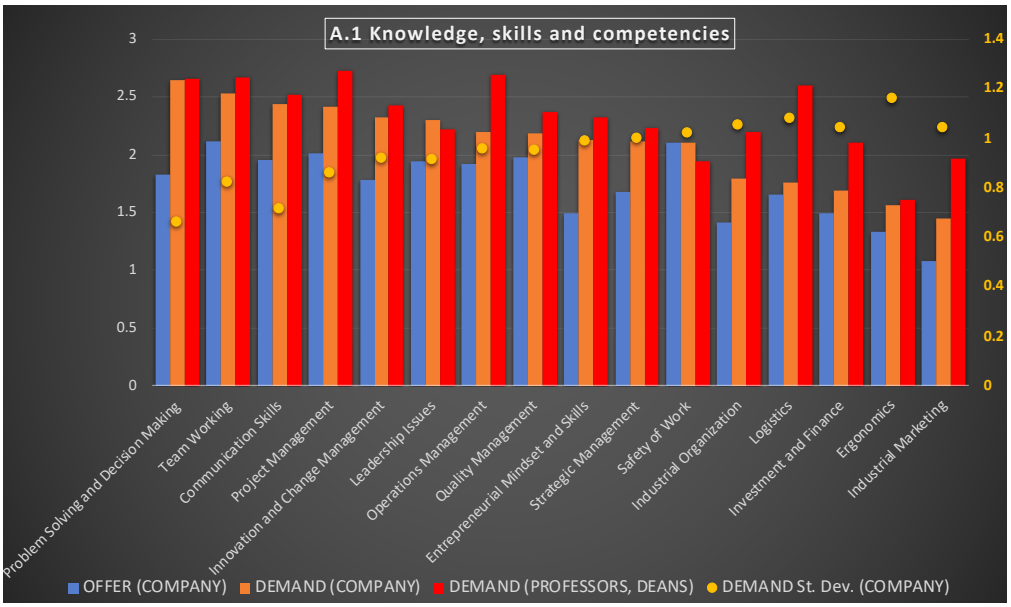



Fig. 18 – OFFER and DEMAND score and DEMAND standard deviation values expressed by companies compared with DEMAND score expressed by Academics in section A.1 (Knowledge, Skills and Competencies - KSCs) of the questionnaires

The same line of reasoning applies to Operational Tools investigated in section A.2 of the questionnaire, as shown in Figure 19.

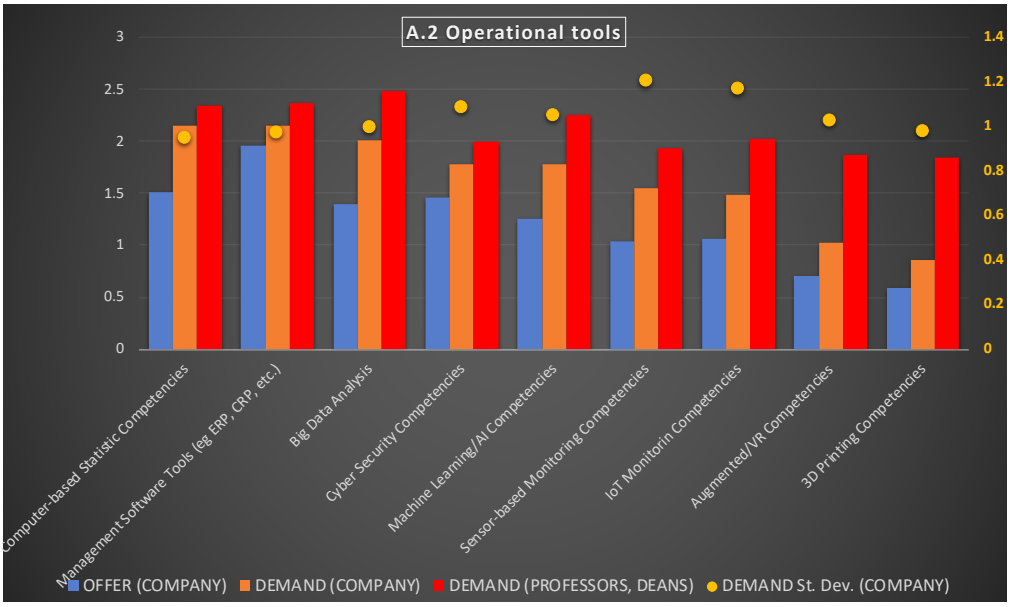
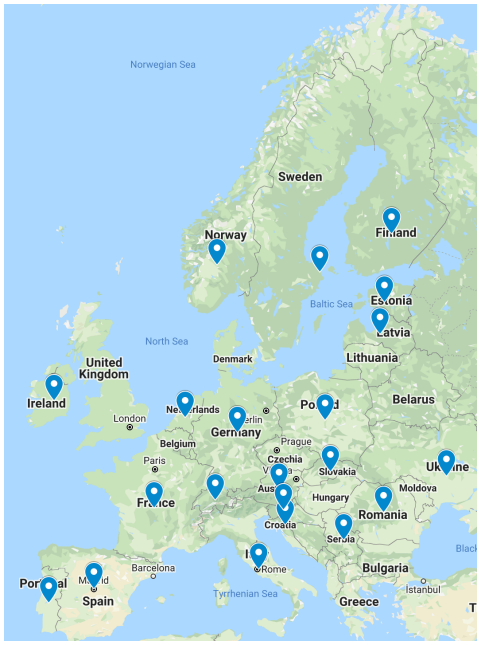



Fig. 19 – OFFER and DEMAND score and DEMAND standard deviation values expressed by companies compared with DEMAND score expressed by Academics in section A.2 (Operational Tools - OTs) of the questionnaires

## The academics' perspective

In this section, results of answers received to the questionnaire for academics (Professors, Program coordinators, Department Deans) are presented. During the collection period, 113 questionnaires were filled from 64 Universities in 21 Countries, 17 of them are EU Countries (see Figures 20 and 21).




| Country | Answers |
|---|---|
| Italy | 28 |
| Spain | 18 |
| Poland | 16 |
| Sweden | 16 |
| Portugal | 8 |
| Croatia | 4 |
| Norway | 3 |
| Ukraine | 3 |
| Austria | 2 |
| Germany | 2 |
| Serbia | 2 |
| Switzerland | 2 |
| Estonia | 1 |
| Finland | 1 |
| France | 1 |
| Ireland | 1 |
| Netherlands | 1 |
| Romania | 1 |
| Slovakia | 1 |
| Slovenia | 1 |
| Latvia | 1 |

Fig. 20 – Professors' countries

| University | # |
|---|---|
| Linkoping University | 14 |
| Politechnic University of Bari | 9 |
| Universidad Politécnica de Madrid | 6 |
| Poznan University of Technology | 5 |
| University of Salento | 4 |
| Norwegian University of Science and Technology (NTNU) | 3 |
| Polytechnic of Turin | 3 |
| University of Zagreb | 3 |
| Cracow University of Technology | 2 |
| Igor Sikorsky Kyiv Polytechnic Institute | 2 |
| University of Minho | 2 |
| Polytechnic University of Marche | 2 |
| Roma Tre University | 2 |
| Technical University of Wien | 2 |
| University of Aveiro | 2 |
| University of La Rioja | 2 |
| University of Novi Sad | 2 |
| Warsaw University of Technology | 2 |
| Universität der Bundeswehr München | 1 |
| University of Cassino and Lazio meridionale | 1 |
| Swiss Federal Institute of Technology Lausanne - EPFL | 1 |
| ETH Zurich | 1 |
| Grenoble Alpes University | 1 |
| Instituto Politécnico de Setúbal | 1 |
| Kazimierz Wielki University | 1 |
| KROK University | 1 |
| Lodz University of Technology | 1 |
| Lublin University of Technology | 1 |
| Lund University | 1 |
| Malardalen University | 1 |
| National University of Ireland Galway | 1 |
| University of Padova | 1 |


| University | # |
|---|---|
| Polytechnic of Milan | 1 |
| Polytechnic University of Catalogna | 1 |
| Riga Technical University | 1 |
| University of Santiago de Compostela | 1 |
| Tallinn University of Technology | 1 |
| Technical University of Cluj-Napoca | 1 |
| Technical University of Kosice | 1 |
| University of León | 1 |
| University of the Basque Country - UPV/EHU | 1 |
| Lusíada University of Vila Nova de Famalicão | 1 |
| Polytechnic University of Valencia | 1 |
| University of Basilicata | 1 |
| University of Bergamo | 1 |
| University of Bielsko-Biala | 1 |
| University of Bologna | 1 |
| University of Coimbra | 1 |
| University of Groningen | 1 |
| University of Huelva | 1 |
| University of Malaga | 1 |
| University of Maribor | 1 |
| University of Napoli Parthenope | 1 |
| University of Oulu | 1 |
| University of Porto | 1 |
| University of Roma Tor Vergata | 1 |
| University of Seville | 1 |
| University of Siegen | 1 |
| University of Split | 1 |
| University of the Basque Country | 1 |
| University of Valladolid | 1 |
| University of Zielona Góra | 1 |
| The Agricultural University of Kraków | 1 |
| West Pomeranian University of Technology | 1 |

Fig. 21 – Professors' Universities

The majority of responders worked for a University offering a 2nd level (Master) Program in Industrial Engineering and Management Program (59%) or a Program in the same cultural area (29%, se Figure 22). Answers were received mainly from big Universities (20.000 students or more but less than 40.000 students) having a variable number of students enrolled in the IE&M area programs (see Figure 23).

Among responders, 83% were Professors, while 12% were program coordinators and 3% Departments or Faculty Deans. This last group was in charge of coordinating (or were Dean of a Department or a Faculty offering) a program in the IE&M area (Industrial Engineering and Management, Engineering Management, and Industrial Management). Program coordinators and Deans were from 7 EU Countries (see Figure 24).

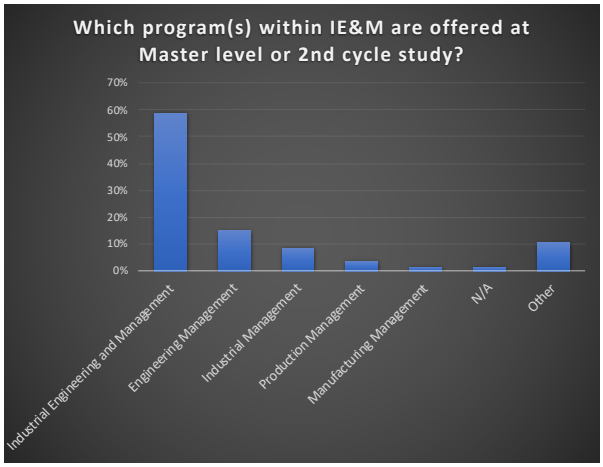



Fig. 22 – Program offered at Universities from which answers were received

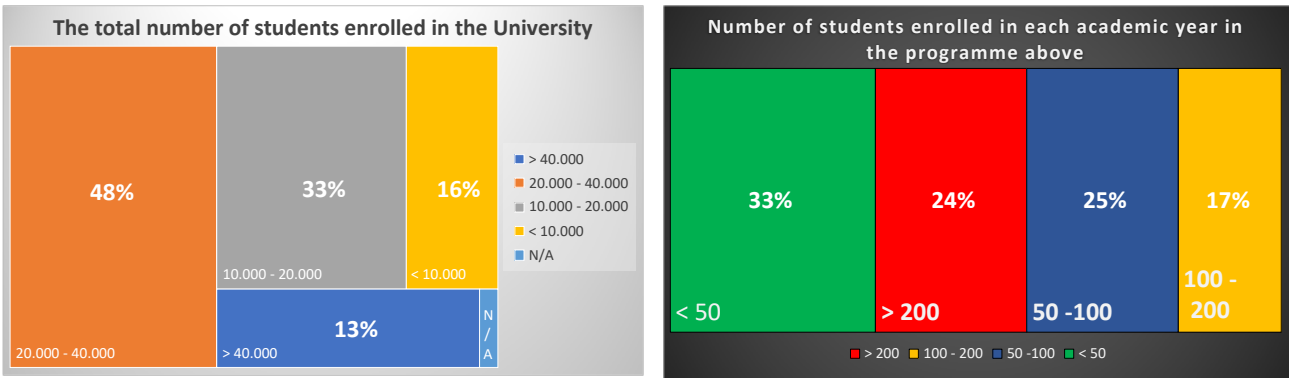
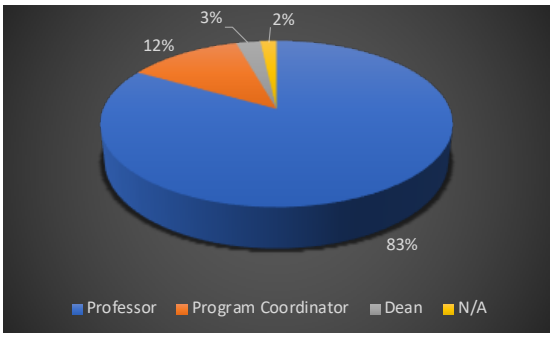



Fig. 23 – Size of Universities and of people attending courses selected by responders




| Position | # |
|---|---|
| • Program Coordinator<br>• Dean | 17 |
| • Professor | 94 |
| • N/A | 2 |

| Program | # |
|---|---|
| Industrial Engineering and Management | 10 |
| Engineering Management | 1 |
| Industrial Management | 1 |
| Other | 5 |

| Country | # |
|---|---|
| Italy | 5 |
| Sweden | 5 |
| Poland | 2 |
| Spain | 2 |
| Portugual | 1 |
| Ukraine | 1 |
| Finland | 1 |

Fig. 24 – Profile of academics who responded to the questionnaire

An overview of the results obtained from the analysis of answers are in Figures 25 and 26. In both figures, OFFER and DEMAND average scores as well as the standard deviation values are shown. For each question, the percentage of "don't know" answers are displayed. Results of the GAP analysis is in figure 27. Here, for each question, the number of data available (#) for the evaluation of the gap is displayed.

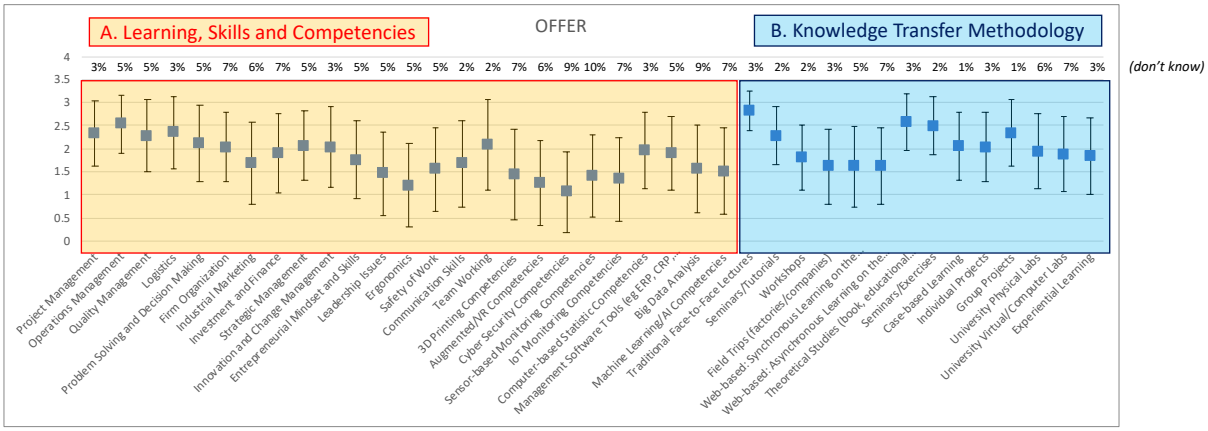



Fig. 25 – Results of the OFFER analysis - Academics' questionnaire

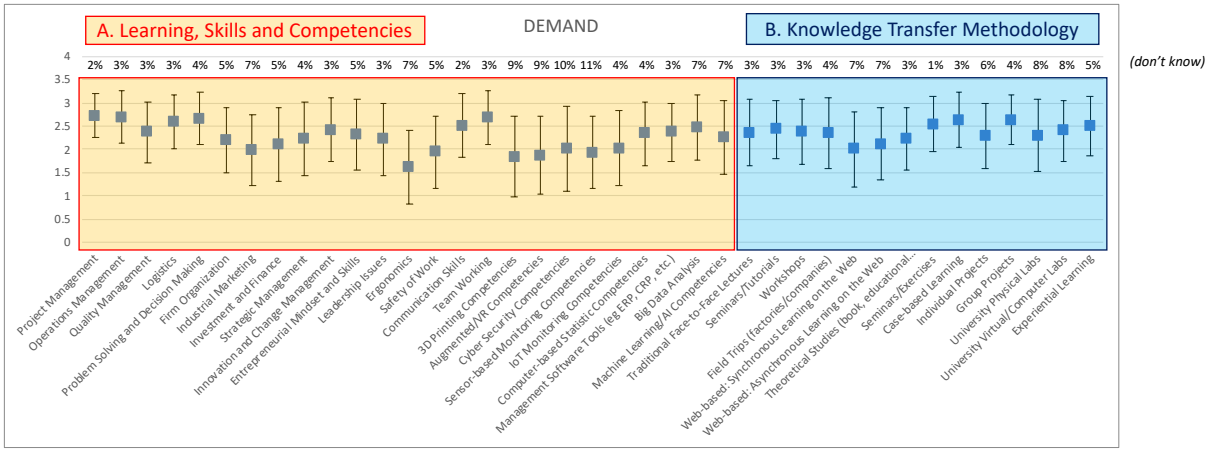



Fig. 26 – Results of the DEMAND analysis - Academics' questionnaire

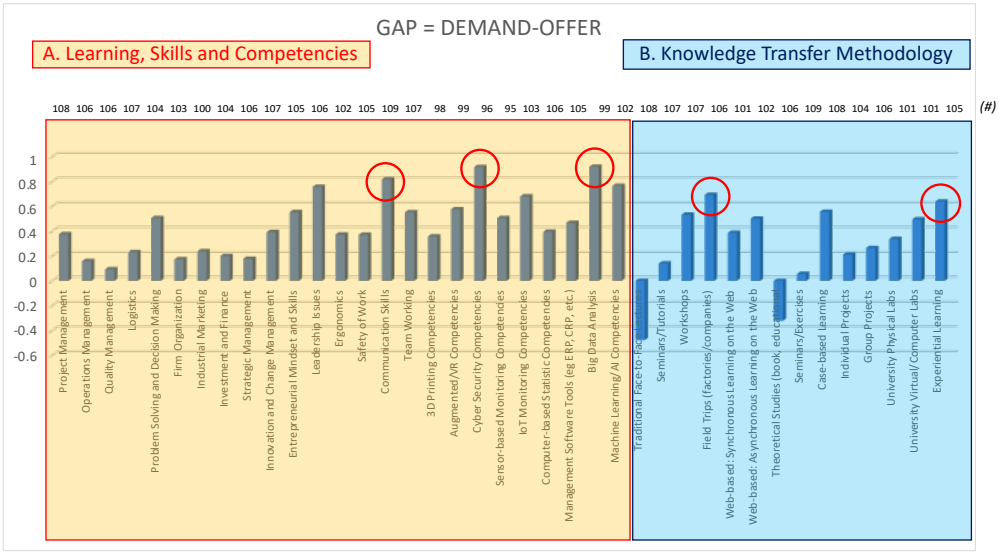



Fig. 27 – Results of the GAP analysis - Academics' questionnaire

As shown in Figure 27, some of the topics investigated in the Academics questionnaire give back high gap values. Among "Knowledge, Skill and Competencies", "Communication skills", "Cyber Security Competencies", and "Big Data Analysis" are characterized by high gap score values. Among "Knowledge Transfer Methodology", the highest gap score values are observed in case of "Field Trips" and "Experiential Learning", while in case of "Traditional Face-to-face Lectures" and "Theoretical Studies", a prevalence of the offer on the demand is observed. To this last concern, the responders were asked not to consider the contingency of 'Covid' pandemic.

Results of a more detailed analysis of answers received to the academics' questionnaire are in the following.

A.1 Knowledge, skills and competencies (KSCs)

DEMAND, OFFER, and GAP scores as well as DEMAND St. Dev. values obtained from the analysis of the answers to section A.1 of the questionnaire are plotted in Figure 28.

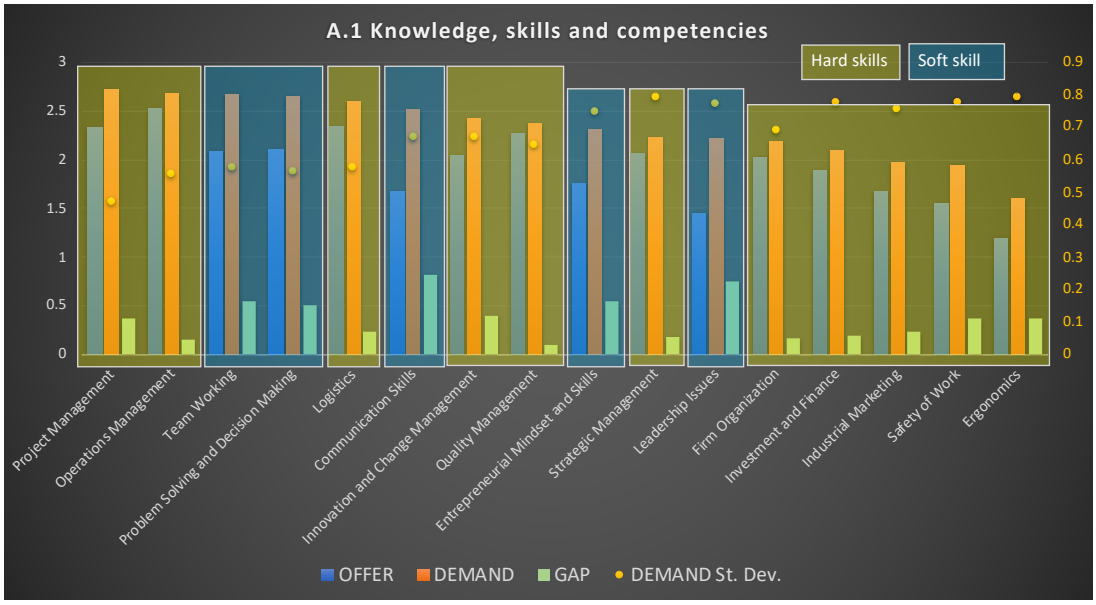



Fig. 28 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by academics in section A.1 (Knowledge, Skills and Competencies - KSCs) of the questionnaire

As one can see from Figure 28, it is possible to identify three different groups of KSCs.

A first group (tallest boxes in the figure) characterized by high values of the DEMAND and low values of DEMAND St. Dev. In this group, both 'hard' (yellow boxes) and 'soft' (blue boxes) skills can be identified. "Project Management", "Operations Management", and "Logistics" are the hard skills characterized by the highest demand values in this group; "Team Working", "Problem Solving and Decision Making", and "Communication Skills" are the soft skills with the highest demand score values. The main differences between these two subgroups of KSCs is in the gap values observed: the distance between DEMAND and OFFER is higher in case of soft skills. A second group (lowest yellow box) consists of only hard skills with lower (compared with other groups) DEMAND values, high DEMAND standard deviation values, and low-medium values of the GAP. Finally, a third group can be identified (medium height boxes), in which intermediate DEMAND values are observed, but with high standard deviation values; in this group, high GAP values characterize soft skills ("Entrepreneurial Mindset and Skill" and "Leadership Issues").

The analysis of section A.1 led to the following main results:

- Results of the answers received from academics' questionnaire revealed that there is an 'internal' demand of knowledge characterized by a net positive gap in all areas (KSCs) investigated;
- The 'internal' demand of knowledge expressed by academics is highest in case of both hard skills (Project Management", "Operations Management", and "Logistics") and soft skills ("Team Working", "Problem Solving and Decision Making");
- Highest gap values are observed in case of soft skills.

Finally, the demand expressed by academics is higher than the one expressed by companies for all areas (KSCs) investigated, with only one exception ("Safety of Work"); in the last case, demand values are comparable (see Figure 29).

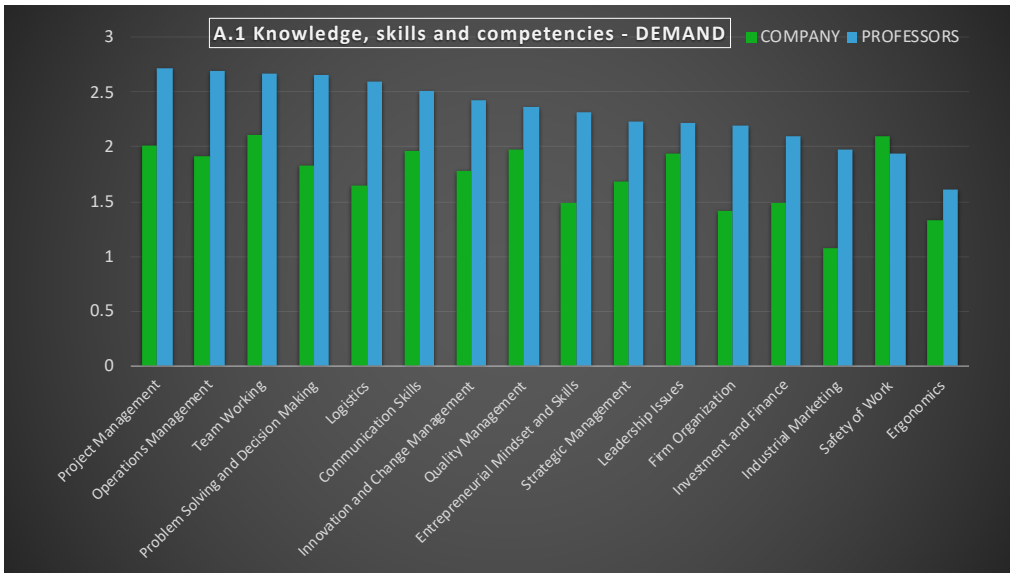



Fig. 29 DEMAND score expressed by academics and companies in section A1 (Knowledge, Skills and Competencies - KSCs) of the questionnaires

A.2 Operational tools - Digital Technology Competencies (DTCs)

DEMAND, OFFER, and GAP scores as well as DEMAND St. Dev. values obtained from the analysis of the answers to section A.2 of the questionnaire are plotted in Figure 30.

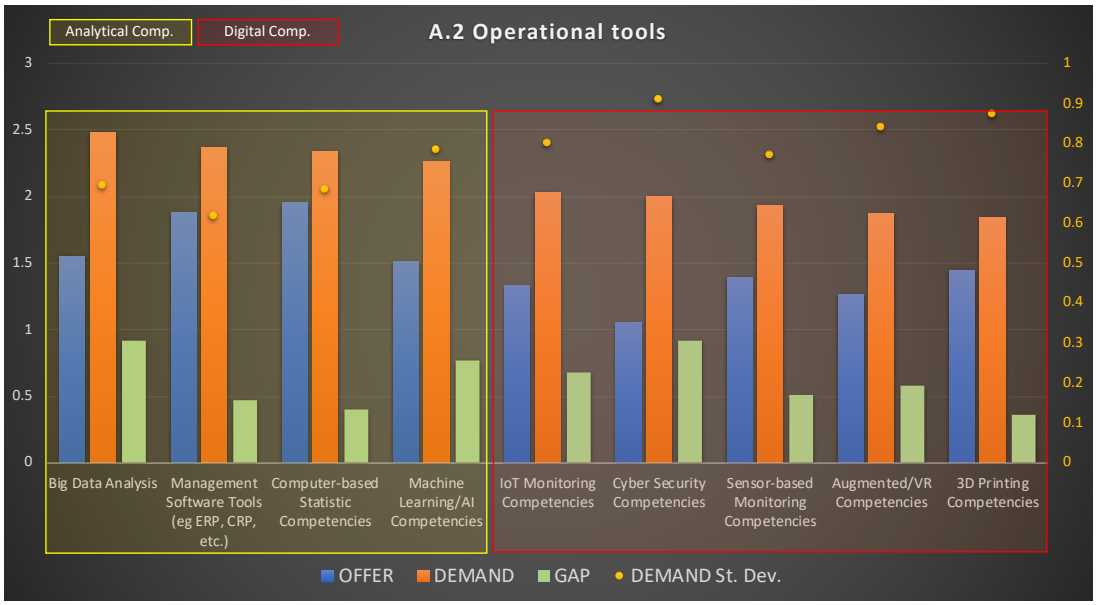



Fig. 30 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by academics in section A.2 (Operational Tools - OTs) of the questionnaire

In case of Operational Tools investigated, academics expressed a higher DEMAND for Analytical Competencies compared with the DEMAND of Digital Competencies. Highest GAP score values are for both tools in the first and in the second competencies group: "Big Data Analysis", "Cyber Security

Competencies", "Machine Learning/AI Competencies", and "IoT Monitoring Competencies". For all the OTs investigated, a net positive gap is obtained.

As in the previous case (KSCs in section A.1), the demand expressed by academics is higher than the demand expressed by companies for all tools investigated (see Fig. 31).

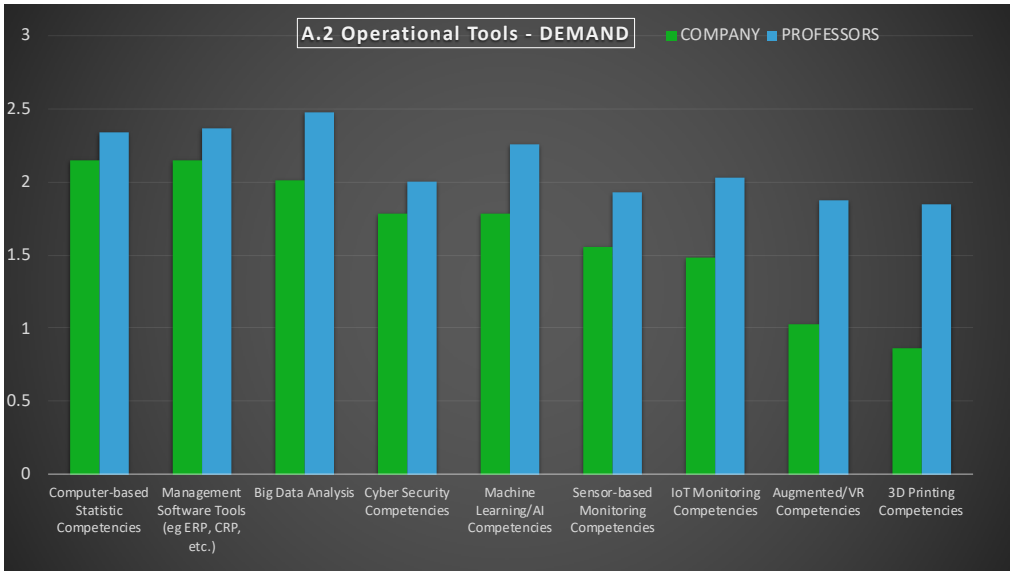



Fig. 31 - DEMAND score expressed by academics and companies in section A2 (Operational Tools - OTs) of the questionnaires

By comparing data in Figures 28 and 30, a further general conclusion is obtained: in academics perspective, the HEIs OFFER of Operational Tools is lower than the OFFER of Knowledge, Skills, and Competences.

B.1 Knowledge Transfer Methodology (KTM)

In section B of the questionnaire, academics were asked to rate different knowledge transfer methodologies (KTMs) and Learning Activities (LAs) in terms of both OFFER and DEMAND.

DEMAND, OFFER, and GAP scores as well as DEMAND St. Dev. values obtained from the analysis of the answers to section B.1 of the questionnaire are plotted in Figure 32.

In case of KTMs, for all methodologies investigated a positive GAP is obtained. Only in 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 industrial environment. Among Web-based KTMs, asynchronous modality is preferred to synchronous one.

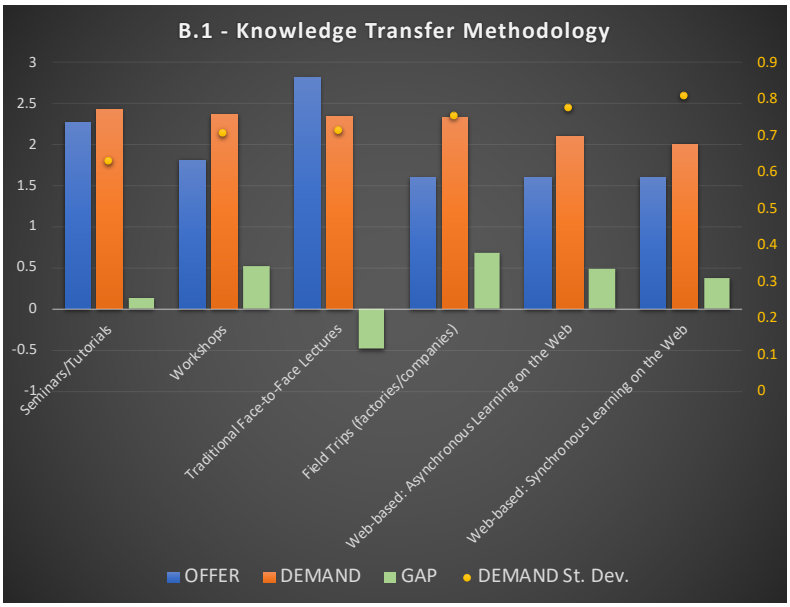



Fig. 32 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by academics in section B.1 (Knowledge Transfer Methodology - KTMs) of the questionnaire

B.2 Learning Activities (LAs)

DEMAND, OFFER, and GAP scores as well as DEMAND St. Dev. values obtained from the analysis of the answers to section B.2 of the questionnaire are plotted in Figure 33.

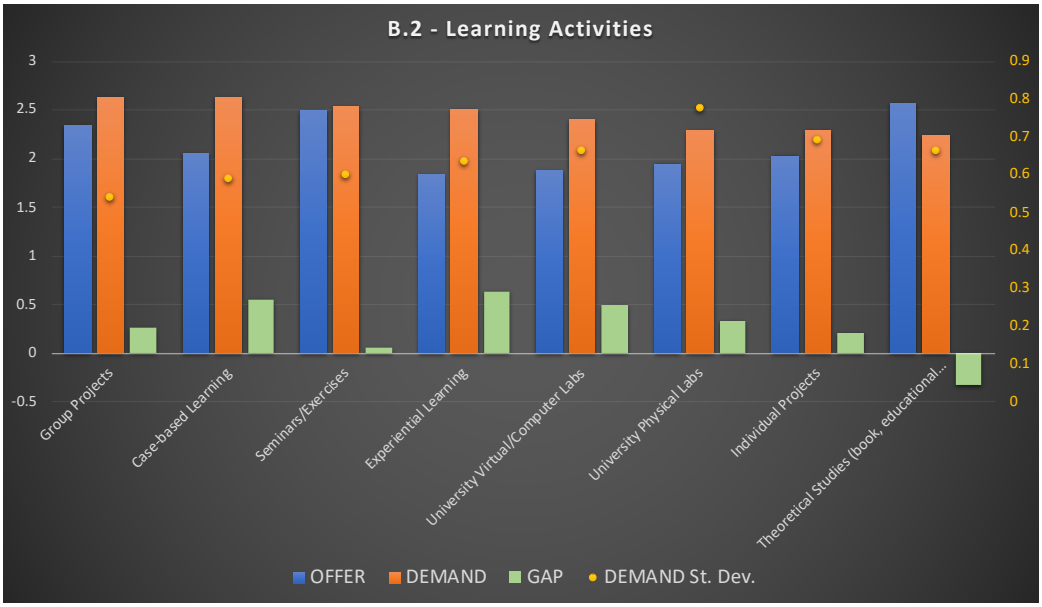



Fig. 33 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by academics in section B.2 (Learning Activities - LAs) of the questionnaire

In case of LAs, academics expressed the highest DEMAND for "Group Projects" and "Case-based Learning"; they are followed by "Seminar/Exercises" and "Experiential Learning". The highest GAP

values are observed in case of "Case-based Learnings" and "Experiential Learning". Only in case of (traditional) "Theoretical Studies", DEMAND score value is lower than the OFFER one.

In Section B.2, two further questions were asked to academics. They were both intended to investigate on the role of industry in the IE&M 2nd level Master Programs. Results of the answers' analysis are in Figure 34 and 35.

As one can see from Figure 34, in the majority of the IE&M 2nd level Master Programs there is an internship. Length of this internship varies, and in more than 40% of cases is higher than 8 weeks. Nevertheless, the internal demand expressed by academics stress out the need to increase the presence of long internship (< 8 weeks) in IE&M 2nd level Master Programs.

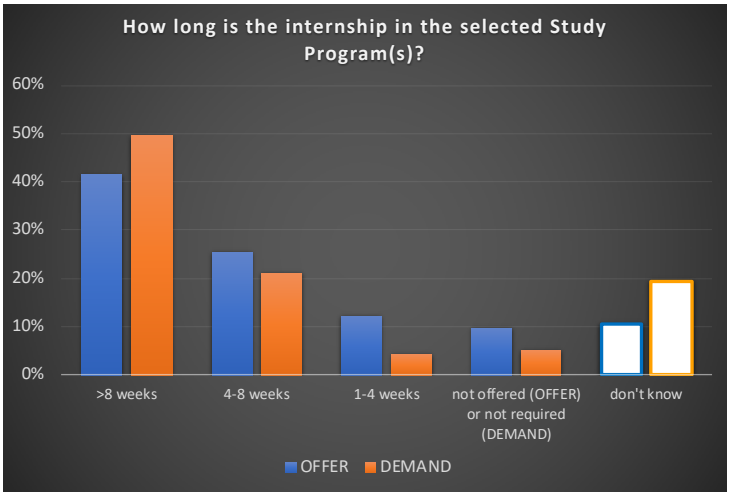



Fig. 34 – Results of the academics' survey on internship length (section B.2 of the questionnaire) in IE&M 2nd level Master Programs

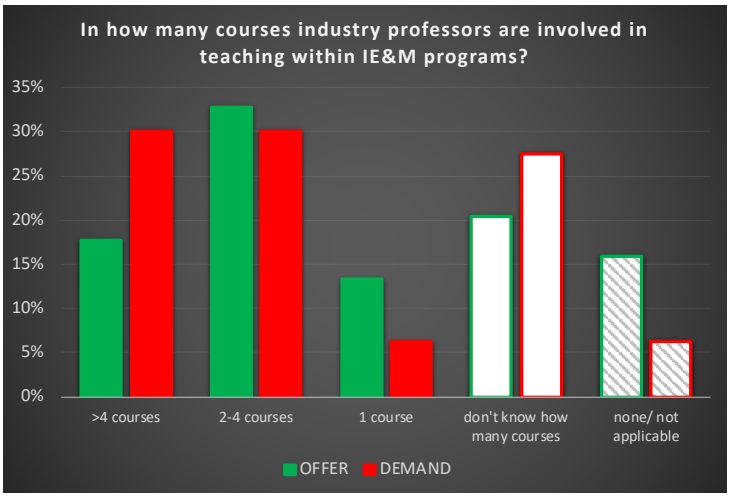


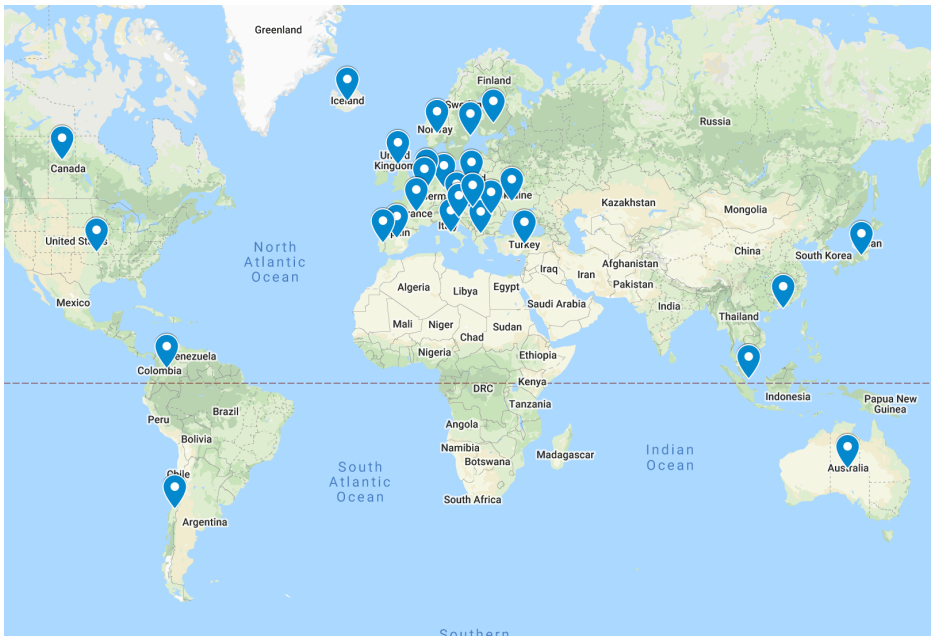

Fig. 35 – Results of the academics' survey on the presence of courses held by industry professors (section B.2 of the questionnaire) in IE&M 2nd level Master Programs

As far as concern the presence of industry professor in IE&M 2nd level Master Program courses, in less than 20% of the cases industry professors hold 4 or more courses. More than 60% of academics

interviewed expressed the need of the presence of industry professors in IE&M 2nd level Master Program in at least 2 courses (see Figure 35).

## The alumni's perspective

In this section, results of answers received to the questionnaire for alumni are presented. During the collection period, 178 questionnaires were filled from alumni of 54 different Universities, the majority of them located in Europe. They were from 29 Countries (see Figures 36 and 37).




| Country | # |
|---|---|
| Spain | 34 |
| Italy | 28 |
| Sweden | 24 |
| Germany | 20 |
| Poland | 10 |
| The Netherlands | 8 |
| Finland | 6 |
| Serbia | 6 |
| Turkey | 5 |
| Austria | 4 |
| North Macedonia | 4 |
| Portugal | 4 |
| Romania | 3 |
| Belgium | 2 |
| Croatia | 2 |
| France | 2 |
| Hungary | 2 |
| United Kingdom | 2 |
| USA | 2 |
| Australia | 1 |
| Canada | 1 |
| Chile | 1 |
| Colombia | 1 |
| Hong Kong | 1 |
| Iceland | 1 |
| Japan | 1 |
| Norway | 1 |
| Singapore | 1 |
| Ukraine | 1 |

Fig. 36 – Alumni's countries

| University | # |
|---|---|
| Universidad Politécnica de Madrid | 30 |
| Polytecnic University of Bari | 19 |
| Linkoping university | 18 |
| Poznań University of Technology | 9 |
| Polytechnic University of Milan | 7 |
| Eindhoven University of Technology | 7 |
| Chalmers University of Technology, Gothenburg | 5 |
| Vienna University of Technology | 4 |
| Karlsruhe Institute of Technology, Germany | 4 |
| University of Novi Sad | 4 |
| Grenoble Institute of Technology | 3 |
| TU Berlin | 3 |
| Lappeenranta University of Technology | 3 |
| FH München | 3 |
| Universty of Paderborn | 3 |
| Technische Universität Hamburg | 3 |
| Sts. Cyril and Methodius University Skopje | 3 |
| University of Porto | 3 |
| University of Belgrade | 3 |
| Istanbul Technical University | 3 |
| Tampere University of Technology | 2 |
| Technische Universität Ilmenau | 2 |
| University of Cambridge | 2 |
| Budapest University of Technology and Economics | 2 |
| University of Lisbon | 2 |
| Politehnica University of Bucharest | 2 |
| University of Sevilla | 2 |


| University | # |
|---|---|
| University of Nottingham, UK | 1 |
| Solvay Brussels School Economics & Management | 1 |
| University of Zagreb | 1 |
| University of Split | 1 |
| Aalto University, Helsinki | 1 |
| Ecole Centrale de Lyon | 1 |
| University of Belgrade | 1 |
| Freiburg University | 1 |
| Grenoble Ecole De Management | 1 |
| RWTH Aachen University | 1 |
| Technical University Darmstadt | 1 |
| TU Graz | 1 |
| University of Salerno | 1 |
| University of Calabria | 1 |
| Keio University | 1 |
| University of Groningen | 1 |
| Universitatea Petru Maior | 1 |
| Barcelona Tech | 1 |
| UPC BarcelonaTech | 1 |
| Karlstad University | 1 |
| KTH Royal Institute of Technology | 1 |
| Lappeenranta University of Technology, Finland | 1 |
| Bilkent University | 1 |
| Ege University | 1 |
| Kyiv Polytechnic Institute, Ukraine | 1 |
| University of the Aegean | 1 |
| Universidad de Oviedo | 1 |

Fig. 37 – Alumni's Universities

The majority of responders took a degree in Industrial Engineering and Management in the last five years (see Figure 38).

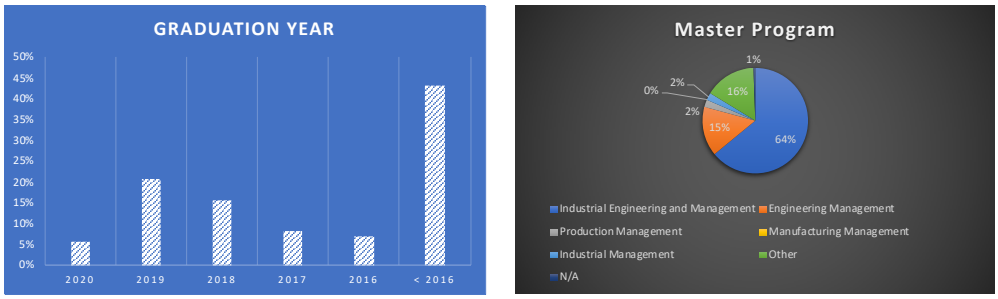



Fig. 38 – Alumni's graduation years and Master Degrees attended

An overview of the results obtained from the analysis of answers are in Figures 39 and 40. In both figures, OFFER and DEMAND average scores as well as the standard deviation values are shown. For each question, the percentage of "don't know" answers are displayed. Results of the GAP analysis is in figure 41. Here, for each question, the number of data available (#) for the evaluation of the gap is displayed.

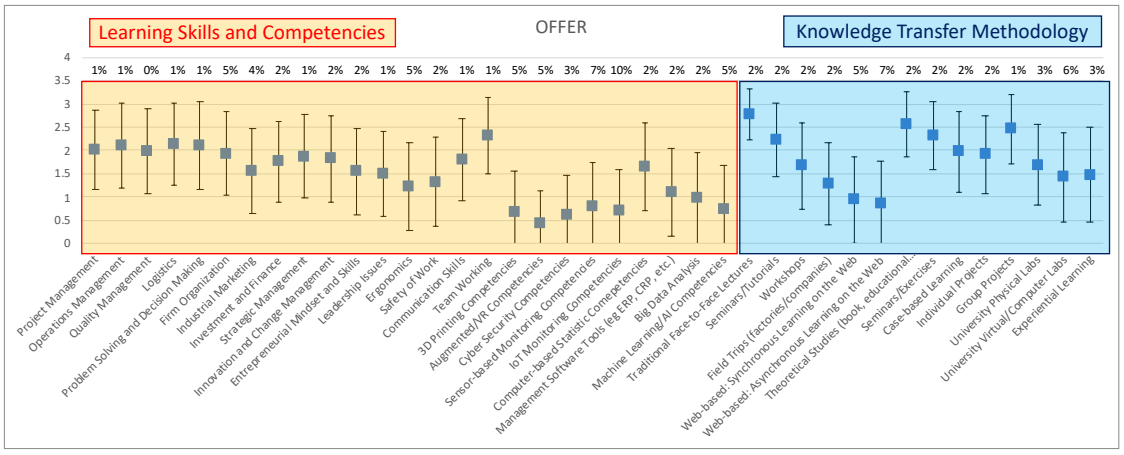



Fig. 39 – Results of the OFFER analysis - Alumni's questionnaire

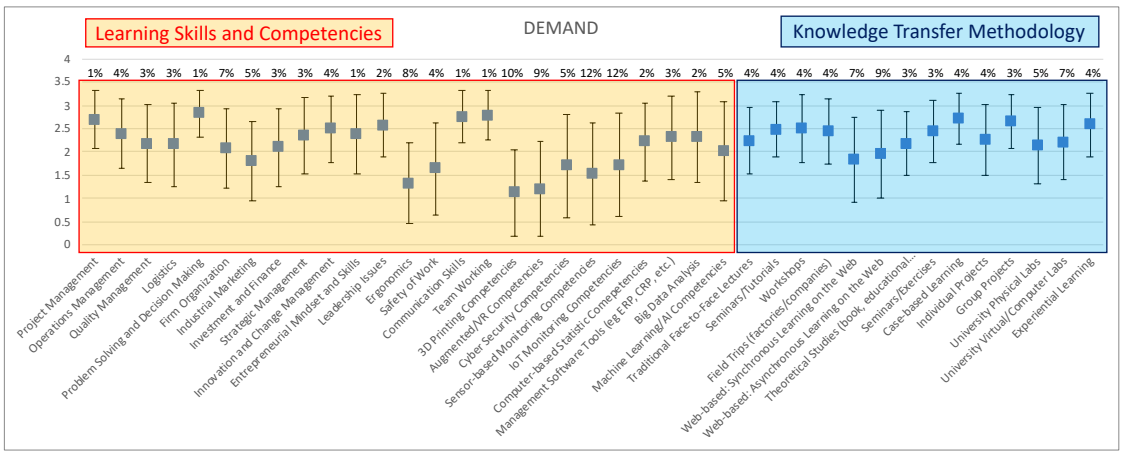



Fig. 40 – Results of the DEMAND analysis - Alumni's questionnaire

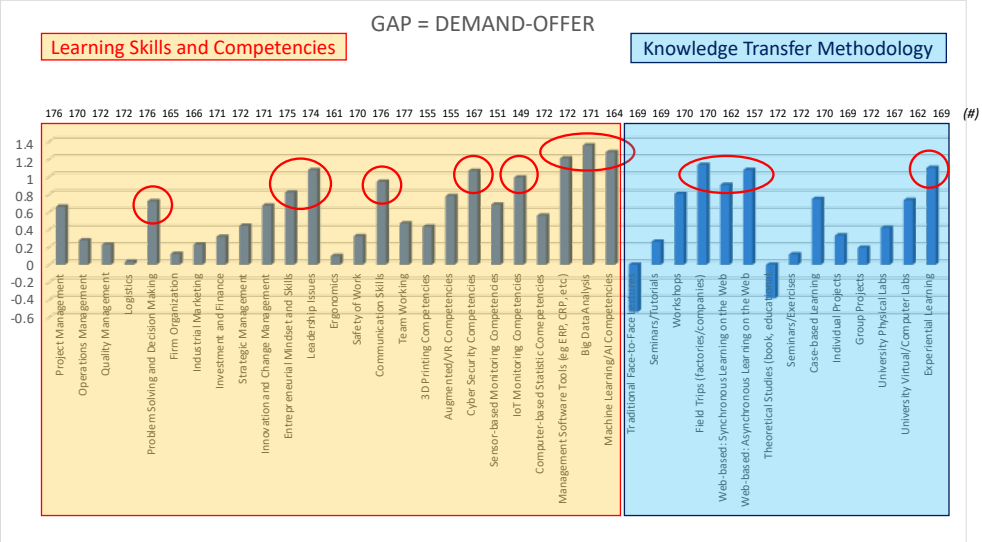



Fig. 41 – Results of the GAP analysis – Alumni's questionnaire

As shown in Figure 41, some of the topics investigated in the Alumni's questionnaire give back high gap values. Among 'Knowledge, Skill and Competencies', highest gap values are obtained for 'soft' skills ("Problem Solving and Decision Making", "Entrepreneurial Mindset and Skills", "Leadership Issues", and "Communication skills") and for both analytical ("Management Software Tools", "Big Data analysis", and "Machine Learning/AI Competencies") and digital competencies ("Cyber Security Competencies" and "IoT Monitoring Competencies"). As far as concern 'Knowledge Transfer Methodology", Alumni expressed the highest gaps in "Field Trips", "Experiential Learning" and in both form of web-based learning (synchronous and asynchronous).

Results of a more detailed analysis of answers received to the alumni's questionnaire are in the following.

A.1 Knowledge, skills and competencies (KSCs)

DEMAND, OFFER, and GAP scores as well as DEMAND St. Dev. values obtained from the analysis of the answers to section A.1 of the questionnaire are plotted in Figure 42.

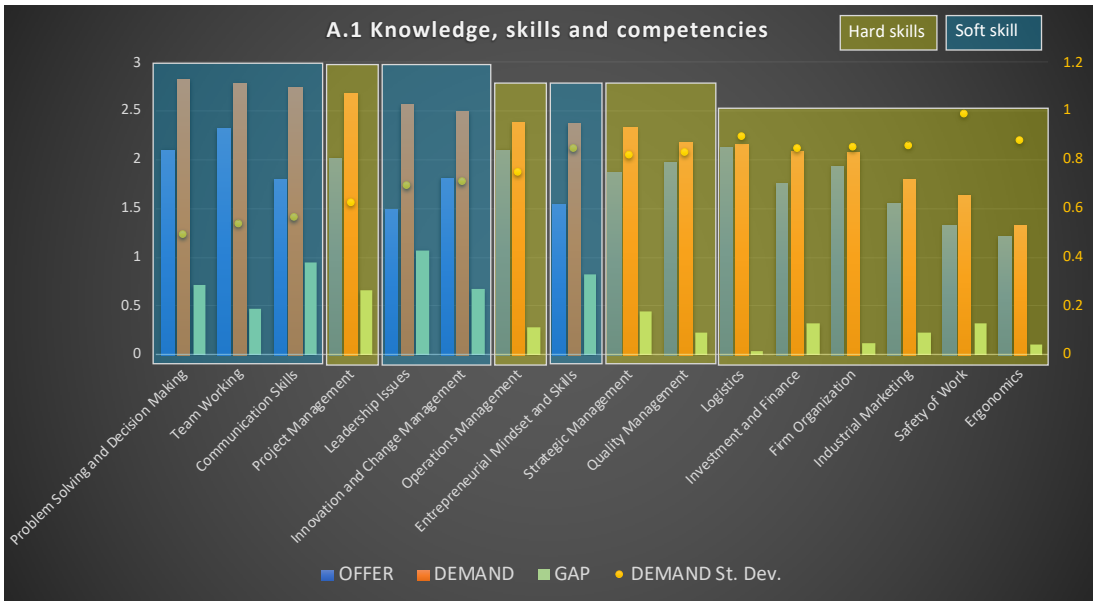



Fig. 42 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by alumni in section A.1 (Knowledge, Skills and Competencies - KSCs) of the questionnaire

As one can see from Figure 42, it is possible to identify three different groups of KSCs.

A first group (tallest boxes in the figure) characterized by high values of the DEMAND and low values of DEMAND St. Dev. In this group, there are mainly 'soft' skills (blue boxes) with high gap score values. "Problem Solving and Decision Making", "Team Working", and "Communication skills" are the soft skills with the highest DEMAND score and the lowest DEMAND standard deviations values, while "Project management" is the only hard skill in this group. A second group (lowest yellow box) consists of only hard skills with lower (compared with other groups) DEMAND values, high DEMAND standard deviation values, and low values of the GAP. Finally, a third group can be identified (medium height boxes), in which intermediate DEMAND values are observed, but with higher standard deviation values (compared with the first group); a high GAP value characterizes the only soft skill in this group ("Entrepreneurial Mindset and Skill").

Results obtained from the analysis of section A.1 of the alumni's questionnaire point out how alumni with a Master in IE&M identify in the soft skills the main shortcoming in the Program attended.

A.2 Operational tools - Digital Technology Competencies (DTCs)

DEMAND, OFFER, and GAP scores as well as DEMAND St. Dev. values obtained from the analysis of the answers to section A.2 of the questionnaire are plotted in Figure 43.

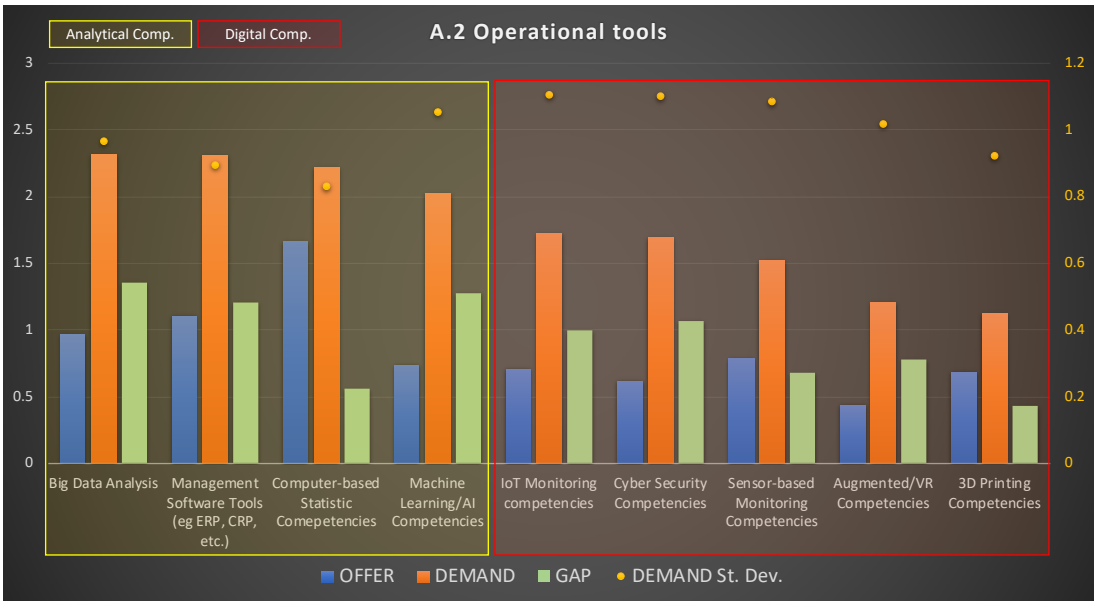



Fig. 43 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by alumni in section A.2 (Operational Tools - OTs) of the questionnaire

As already observed in case of academics, alumni expressed a higher DEMAND for Analytical Competencies compared with the DEMAND of Digital Competencies. Highest GAP score values are for both tools in the first and in the second competencies group: "Big Data Analysis", "Management Software Tools", "Machine Learning/AI Competencies", and "Cyber Security Competencies". For all the OTs investigated, a net positive gap is obtained.

B.1 Knowledge Transfer Methodology (KTM)

In section B of the questionnaire, alumni were asked to rate different knowledge transfer methodologies (KTMs) and Learning Activities (LAs) in terms of both OFFER and DEMAND.

DEMAND, OFFER, and GAP scores as well as DEMAND St. Dev. values obtained from the analysis of the answers to section B.1 of the alumni's questionnaire are plotted in Figure 44.

In case of KTMs, for all methodologies investigated a positive GAP is obtained. Only in 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" and web-based asynchronous knowledge transfer methodology.

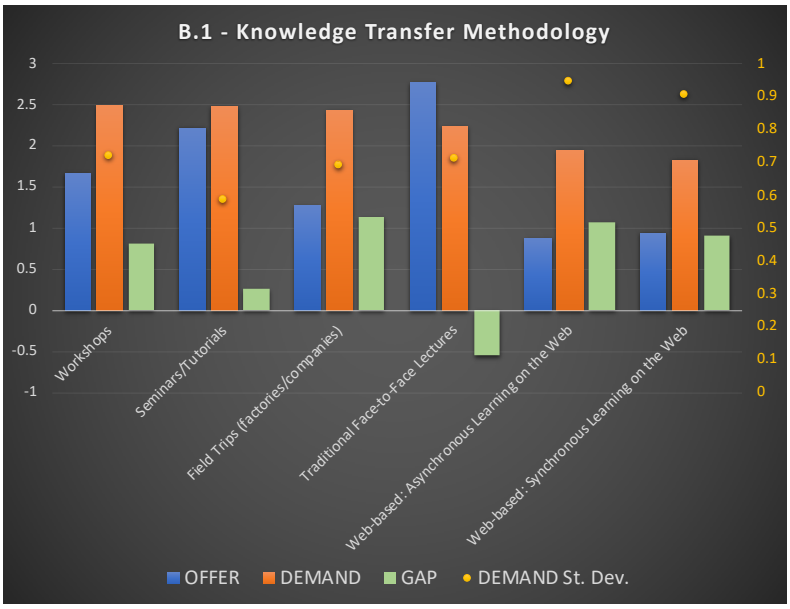



Fig. 44 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by alumni in section B.1 (Knowledge Transfer Methodology - KTMs) of the questionnaire

B.2 Learning Activities (LAs)

DEMAND, OFFER, and GAP scores as well as DEMAND St. Dev. values obtained from the analysis of the answers to section B.2 of the questionnaire are plotted in Figure 45.

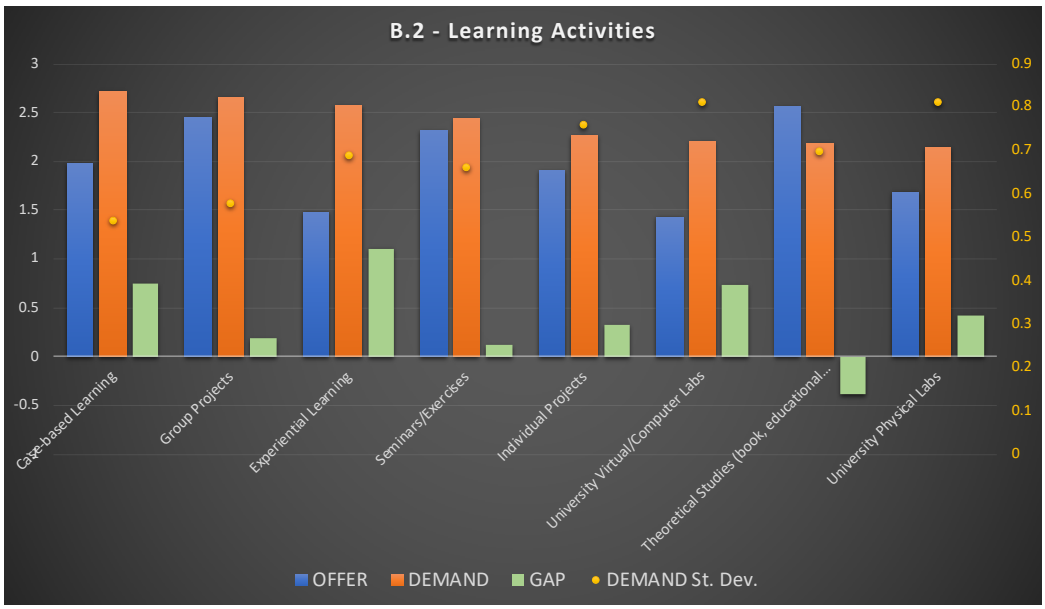



Fig. 45 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by alumni in section B.2 (Learning Activities - LAs) of the questionnaire

In case of LAs, alumni expressed the highest DEMAND for "Case-based Learning" and "Experiential Learning", which are characterized by the highest GAP values, and "Group Projects".

As in the case of academics, in Section B.2, two further questions were asked to alumni in order to investigate on the role of industry in the IE&M 2nd level Master Programs. Results of the answers' analysis are in Figure 46 and 47.

Answers received to both questions give evidence of the need expressed by Alumni for a more intensive contribution of industry in IE&M 2nd level Master Programs, by means of long internships and courses held by industry professors.

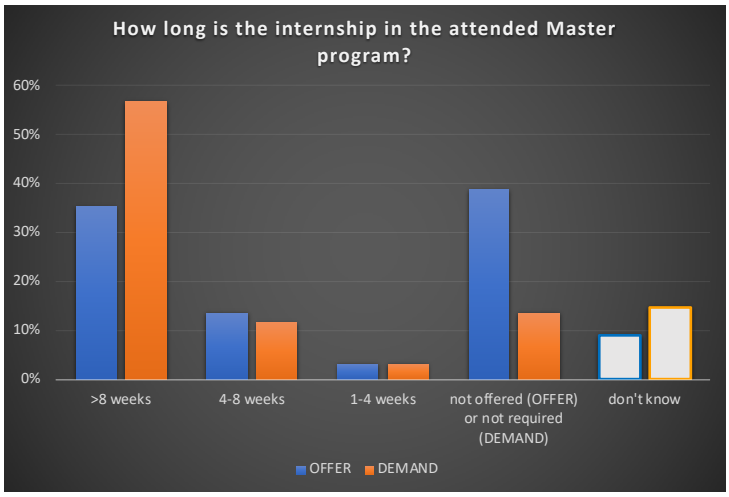



Fig. 46 – Results of the alumni's survey on internship length (section B.2 of the questionnaire) in IE&M 2nd level Master Programs

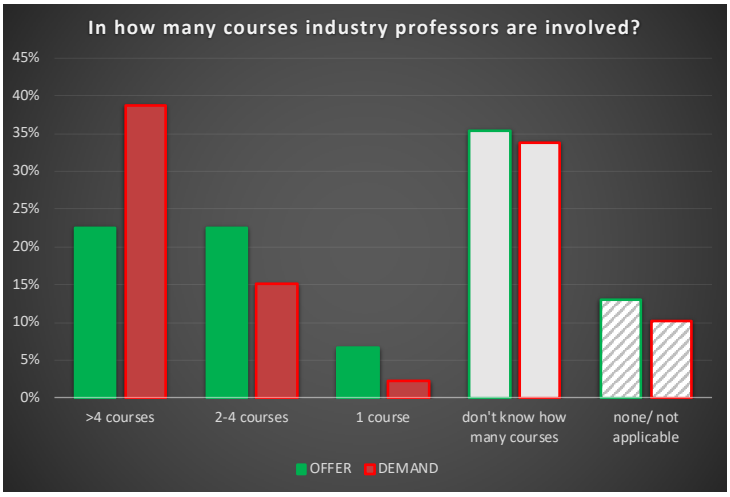



Fig. 47 – Results of the alumni's survey on the presence of courses held by industry professors (section B.2 of the questionnaire) in IE&M 2nd level Master Programs

## The students' perspective

In this section, results of answers received to the questionnaire for students are presented. During the collection period, 373 questionnaires were filled from students of 47 different Universities, the majority of them located in Europe. They were from 20 Countries (see Figures 48 and 49).


| Country | Answers |
|---|---|
| Italy | 126 |
| Spain | 74 |
| Poland | 42 |
| Portugal | 36 |
| Sweden | 34 |
| Germany | 16 |
| Belgium | 8 |
| Romania | 8 |
| Hungary | 7 |
| Greece | 4 |
| Finland | 3 |
| France | 3 |
| Netherlands | 3 |
| Bulgaria | 2 |
| Serbia | 2 |
| Austria | 1 |
| Croatia | 1 |
| Norway | 1 |
| Switzerland | 1 |
| Turkey | 1 |

Fig. 48 – Students' countries

| University | # |
|---|---|
| Polytechnic University of Bari | 78 |
| Technical University of Madrid (UPM) | 70 |
| Poznan University of Technology | 38 |
| Linköping University | 34 |
| University of Porto | 24 |
| University of Calabria, Cosenza, Italy | 13 |
| Polytechnic of Milan | 7 |
| University of Salerno, Italy | 7 |
| Marche Polytechnic University | 7 |
| University of Liège | 7 |
| Polytechnic of Turin | 6 |
| University of Parma | 6 |
| Budapest University of Technology and Econ. | 5 |
| University of Aveiro | 5 |
| Democritus University of Thrace | 4 |
| Technical University of Cluj-napoca | 4 |
| University of Targu Mures | 4 |
| Warsaw University of Technology | 4 |
| Technical University of Darmstadt | 3 |
| Technical University of Kaiserslautern | 3 |
| National Institute of Applied Sciences of Lyon | 2 |
| Karlsruhe Institute of Technology | 2 |
| Tampere University | 2 |


| University | # |
|---|---|
| University of Coimbra | 3 |
| Technical University of Sofia | 2 |
| Technical University of Berlin | 2 |
| Technical Unversity of Dortmund | 2 |
| Technical University of Eindhoven | 2 |
| University of Pisa | 2 |
| University of Lisbon | 2 |
| University of Minho | 2 |
| University of Novi Sad | 2 |
| University of Seville | 2 |
| Dokuz Eylul University | 1 |
| Swiss Federal Institute of Technology Lausanı | 1 |
| Lappeenranta-Lahti University of Technology | 1 |
| Maastricht University | 1 |
| University of Trondheim | 1 |
| RWTH Aachen University | 1 |
| SIGMA Clermont Graduate School of Engineei | 1 |
| Solvay Brussels School Economics & Manager | 1 |
| Technical University of Graz | 1 |
| Technical University of Ilmenau | 1 |
| Universidad de Huelva | 1 |
| University of La Rioja | 1 |
| University of Siegen | 1 |
| University of Zagreb | 1 |
| N/A | 3 |

Fig. 49 – Students' Universities

The majority of responders was attending the 2nd semester of a Program in Industrial Engineering and Management (see Figure 50).

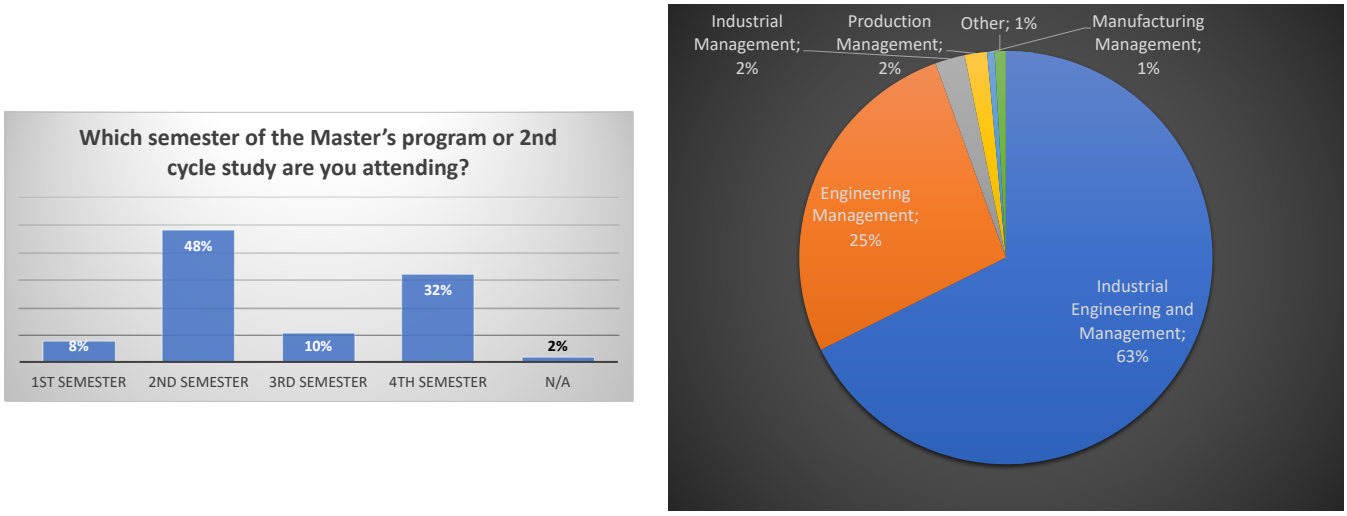



Fig. 50 – Students' semester and attending Program

An overview of the results obtained from the analysis of answers are in Figures 51 and 52. In both figures, OFFER and DEMAND average scores as well as the standard deviation values are shown. For each question, the percentage of "don't know" answers are displayed. Results of the GAP analysis is in figure 53. Here, for each question, the number of data available (#) for the evaluation of the gap is displayed.

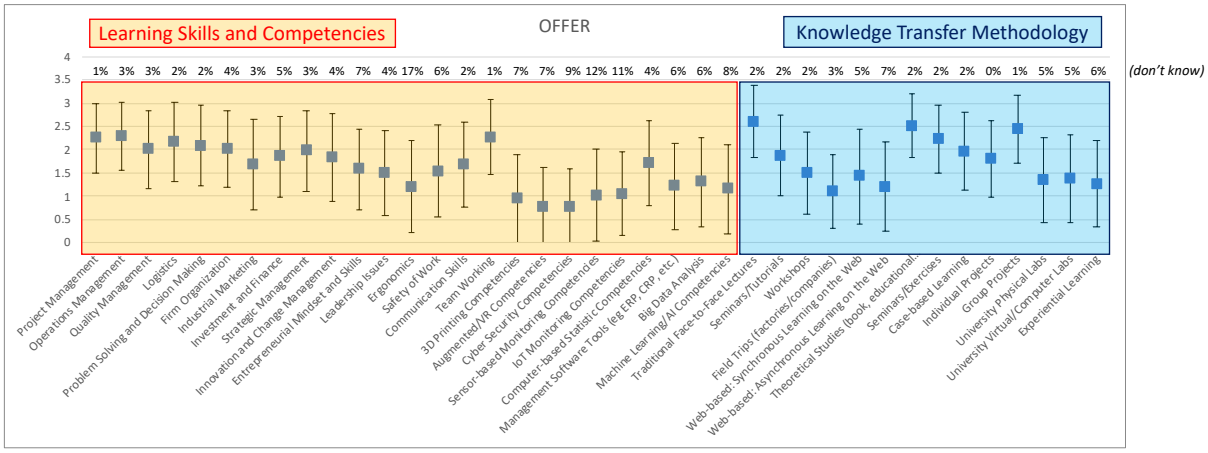



Fig. 51 – Results of the OFFER analysis – Students' questionnaire

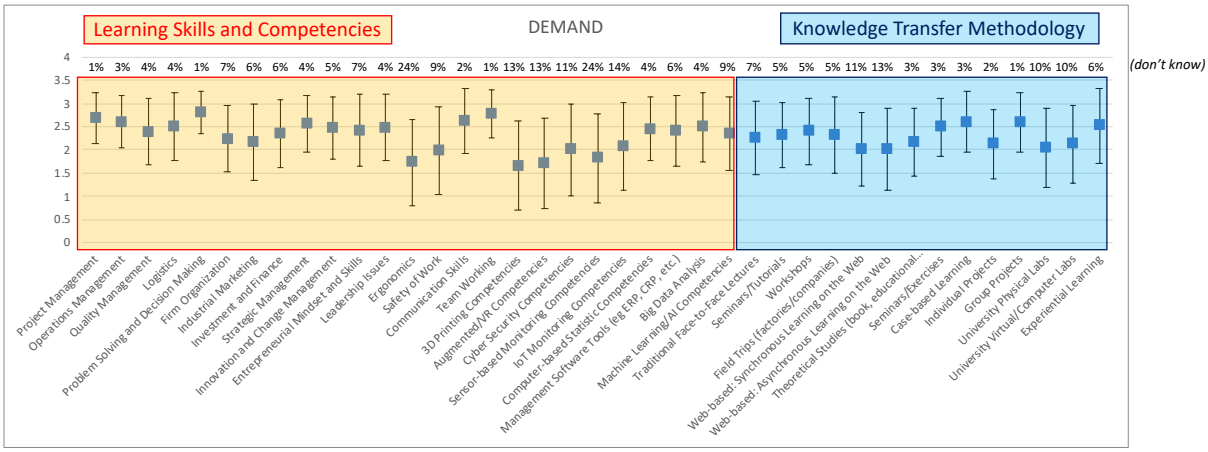


Fig. 52 – Results of the DEMAND analysis – Students' questionnaire

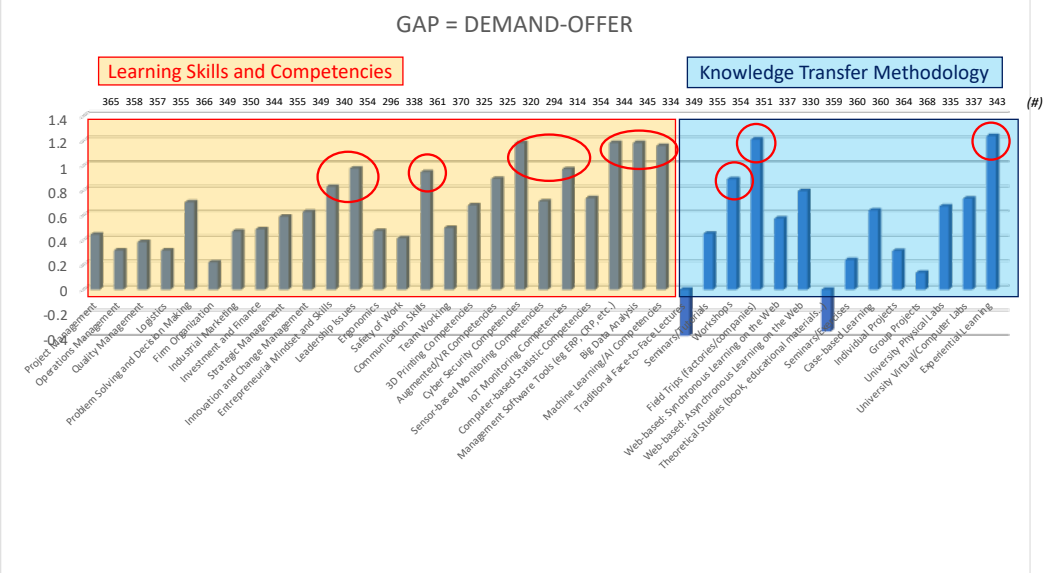



Fig. 53 – Results of the GAP analysis – Students' questionnaire

As shown in Figure 53, students identified the major GAP in 'soft' skills ("Entrepreneurial Mindset and Skills", "Leadership Issues", and "Communication skills") and in some analytical and digital competences (digital: "Cyber Security Competencies", "IoT Monitoring Competencies"; analytical: "Management Software Tools", "Big Data Analysis", and "Machine Learning/AI Competencies"); in terms of Knowledge Transfer Methodology, the highest GAP are identified in "Workshop", "Field Trips", and "Experiential Learning". Finally, "Traditional Face-to-Face Lectures" Theoretical Studies" are characterized by negative GAP score values.

Results of a more detailed analysis of answers received to the students' questionnaire are in the following.

A.1 Knowledge, skills and competencies (KSCs)

DEMAND, OFFER, and GAP scores as well as DEMAND St. Dev. values obtained from the analysis of the answers to section A.1 of the questionnaire are plotted in Figure 54.

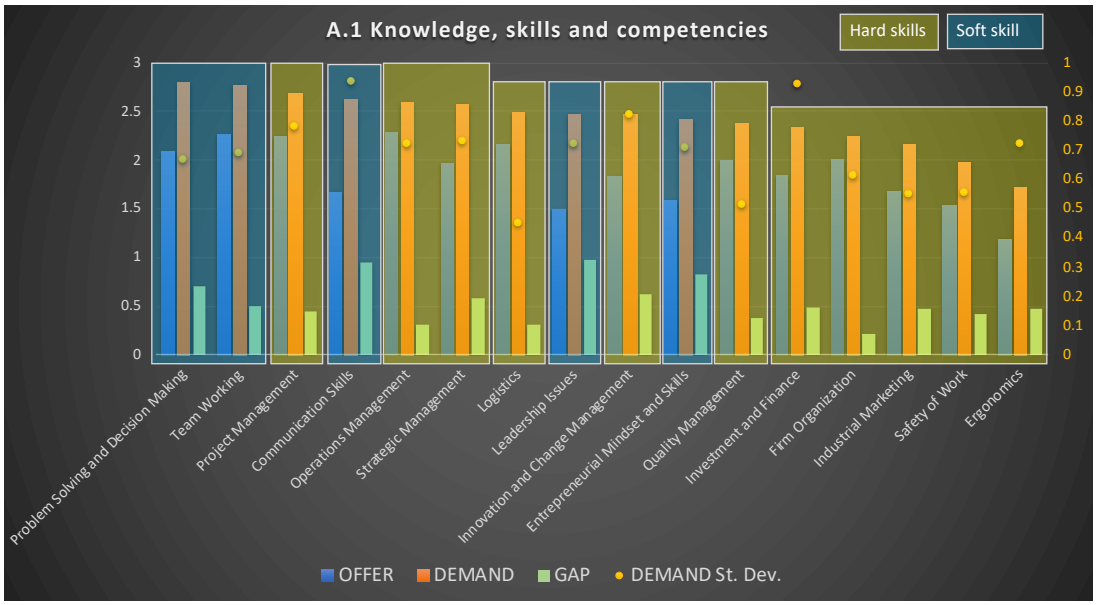



Fig. 54 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by students in section A.1 (Knowledge, Skills and Competencies - KSCs) of the questionnaire

As shown in Figure 54, students expressed the highest DEMAND (with low DEMAND St. Dev.) for both 'soft' skills ("Problem Solving and Decision Making", "Team Working") and 'hard skills' ("Project Management", "Operations Management", "Strategic Management", and "Logistics"). High GAP score values are observed in case of 'soft' skills. For all topics investigated in the section A.1 (KSCs) of the questionnaire, students expressed a net positive GAP.

Results obtained from the analysis of section A.1 of the students' questionnaire point out how students attending 2nd level Master in IE&M identify in the soft skills the main shortcoming in their Program. This result is coherent with the one obtained from alumni's questionnaire. The main difference between students' and alumni's answers is in the rank of KSCs DEMAND: students expressed, on average, a higher demand for 'hard skills' than alumni. This is partially explained from the composition of the students' sample, consisting for more than 50% by students attending the 2nd semester. As shown in figure 55, when answers of students attending the 4th semester and the 2nd are analyzed separately, the rank on KSCs obtained from students attending the 4th semester is more similar to the rank expressed by alumni (see Figure 42 and 55).

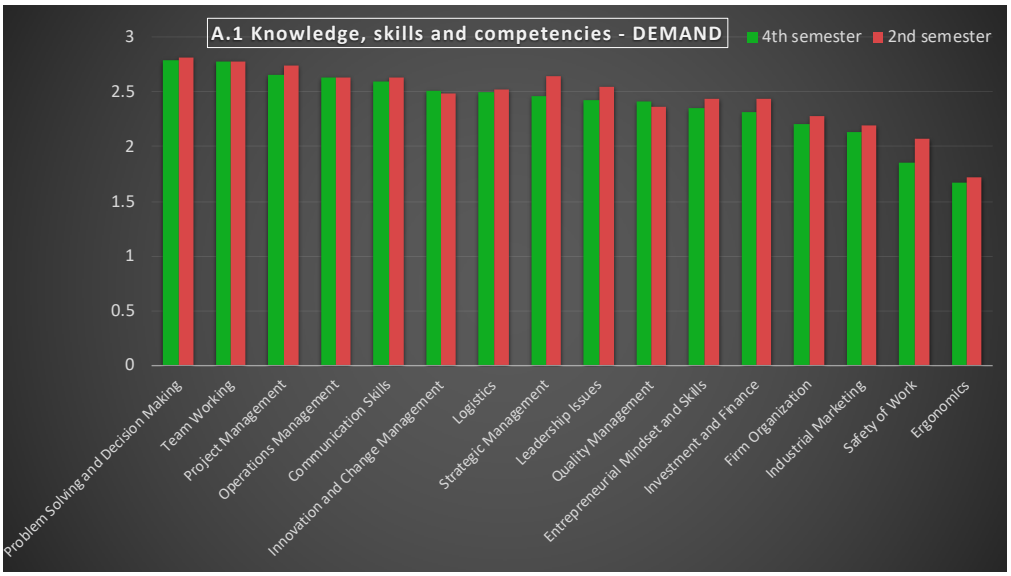



Fig. 55 - DEMAND score expressed by students attending the 2nd and the 4th semester of a Master Program in IE&M in section A.1 (Knowledge, Skills and Competencies - KSCs) of the questionnaire

A.2 Operational tools - Digital Technology Competencies (DTCs)

DEMAND, OFFER, and GAP scores as well as DEMAND St. Dev. values obtained from the analysis of the answers to section A.2 of the questionnaire are plotted in Figure 56.

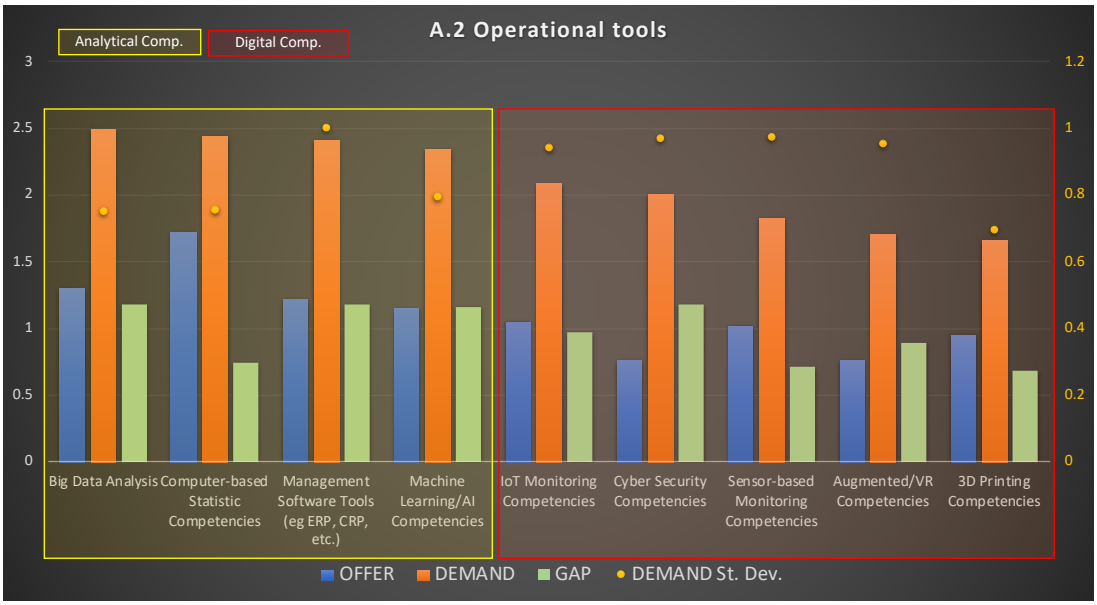



Fig. 56 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by students in section A.2 (Operational Tools - OTs) of the questionnaire

As already observed in case of both academics and alumni, students expressed a higher DEMAND for Analytical Competencies compared with the DEMAND of Digital Competencies. Highest GAP score values are for both tools in the first and in the second competencies group: "Big Data Analysis",

"Management Software Tools", "Machine Learning/AI Competencies", and "Cyber Security Competencies". For all the OTs investigated, a net positive gap is obtained.

In case of Section A.2 (OTs) of the questionnaire, no significant difference are observed when the answers of students attending the 2nd semester are compared with ones of students attending the 4th semester. The same line of reasoning applies in case of section B.1 and B.2, discussed in the following.

B.1 Knowledge Transfer Methodology (KTM)

In section B of the questionnaire, students were asked to rate different knowledge transfer methodologies (KTMs) and Learning Activities (LAs) in terms of both OFFER and DEMAND.

DEMAND, OFFER, and GAP scores as well as DEMAND St. Dev. values obtained from the analysis of the answers to section B.1 of the students' questionnaire are plotted in Figure 57.

In case of KTMs, for all methodologies investigated a positive GAP is obtained. Only in 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" and web-based asynchronous knowledge transfer methodology.

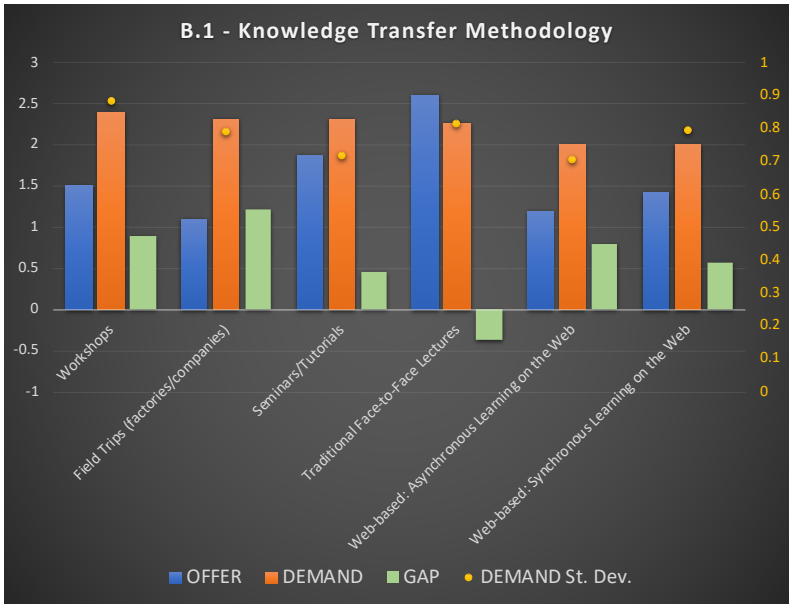



Fig. 57 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by alumni in section B.1 (Knowledge Transfer Methodology - KTMs) of the questionnaire

B.2 Learning Activities (LAs)

DEMAND, OFFER, and GAP scores as well as DEMAND St. Dev. values obtained from the analysis of the answers to section B.2 of the questionnaire are plotted in Figure 58.

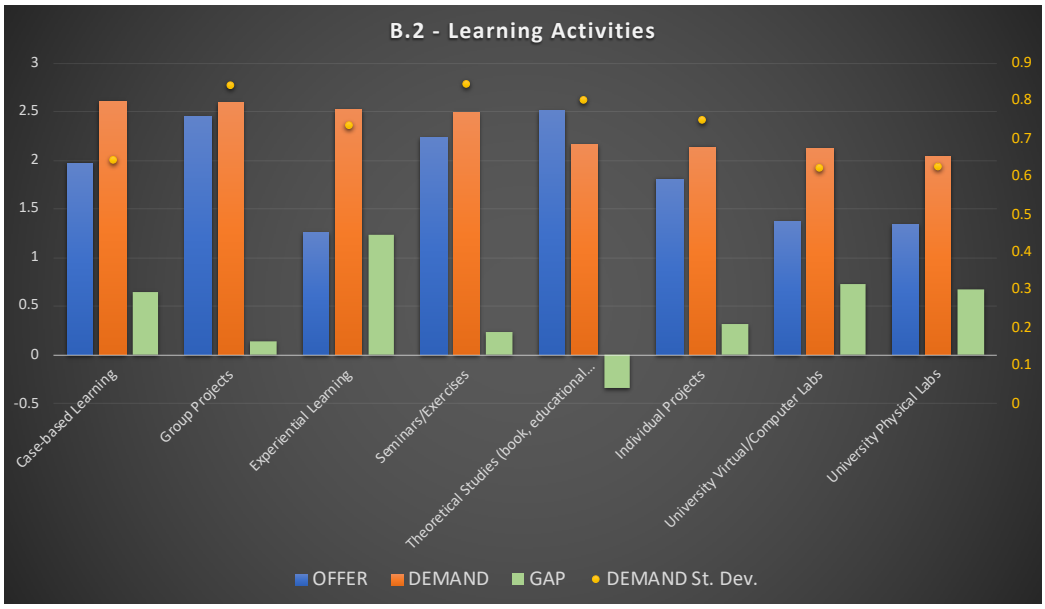



Fig. 58 - OFFER, DEMAND, and GAP score and DEMAND standard deviation values expressed by students in section B.2 (Learning Activities - LAs) of the questionnaire

In case of LAs, students expressed the highest DEMAND (>= 2.5) for "Case-based Learning", "Group Projects", "Experiential Learning", and "Seminar/Exercises". High GAP score value is obtained for "Experiential Learning", but also for Labs (both Computer Labs and Physical Labs).

As in the case of academics and alumni, in Section B.2, two further questions were asked to students in order to investigate on the role of industry in the IE&M 2nd level Master Programs. Results of the answers' analysis are in Figure 59 and 60.

Answers received from students to both questions distributed in a very similar way of answers received from alumni. The main difference is in the higher percentage of "don't know" answers received from students to the first question. Again, this is partially explained by the high percentage of students attending the 2nd semester in the sample. When only answers of students attending the 4th semester are considered, this percentage become very similar to the one observed in case of alumni.

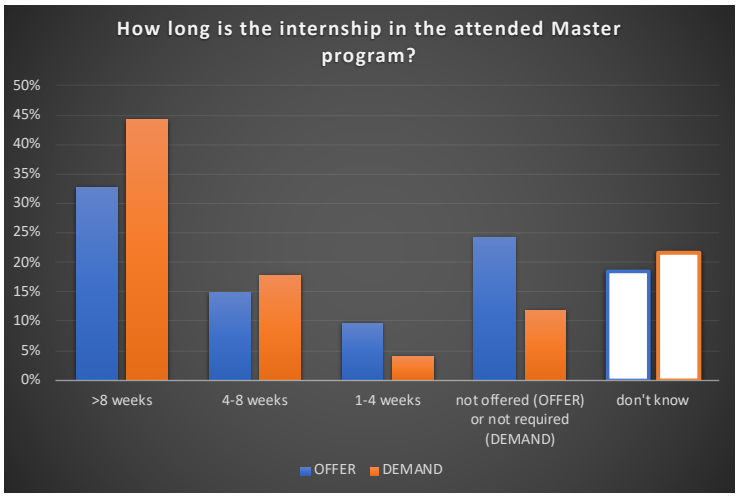


Fig. 59 – Results of the students' survey on internship length (section B.2 of the questionnaire) in IE&M 2nd level Master Programs

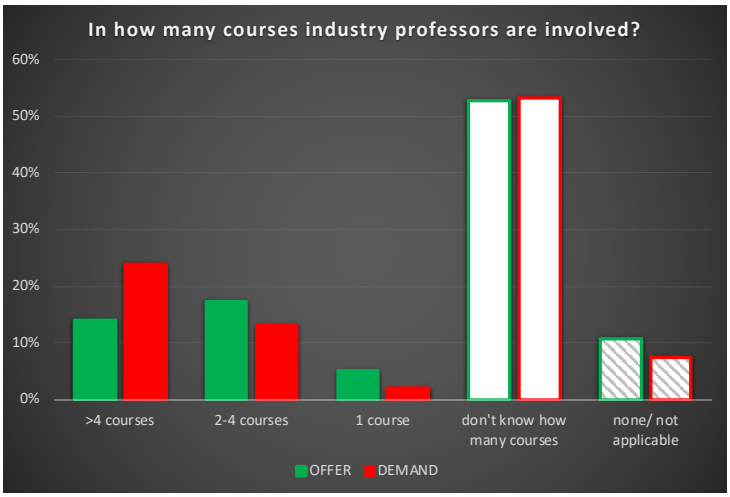



Fig. 60 – Results of the students' survey on the presence of courses held by industry professors (section B.2 of the questionnaire) in IE&M 2nd level Master Programs

## The perception of the HEIs' offer from alumni and students

Although the main goal of the quantitative survey was to identify the main gaps and to evaluate the potential knowledge areas for improvement of 2nd level Master Programs in IE&M, the answers received from alumni, students, and professors allowed to investigate on the perception of the academic offer in the cultural area of IE&M from alumni and students. The investigation is based on the comparison of OFFER score values obtained from answers to questionnaires for academics, alumni, and students (see Figures from 61 to 64) and on the answers received from ad-hoc questions in the questionnaires of students and alumni.

As far as concern topics investigated in section A1 (Knowledge, Skills, and Competencies) of the questionnaires, the comparison shows how the offer perceived from students and alumni in case of some 'hard' skills is lower than the offer expressed by academics. This is the case of "Operations Management", "Logistics", "Project Management", and "Quality Management". However, differences in offer perception is limited in these cases. It is interesting note that in case of 'soft' skills, the offer perception of students and alumni is equivalent or even higher than the offer expressed by academics (see Figure 61).

When Operational Tools are considered, the perception of the offer from students and alumni is lower than the corresponding offer expressed by academics. Nevertheless, for all the three stakeholders the offer of analytical competencies is greater than the offer of digital competencies (see Figure 62).

By comparing Figure 61 and 62, a further conclusion could be withdrawn: in general, the offer of KSCs is higher than the offer of OTs.

When Knowledge Transfer Methodologies are considered, again the offer perceived from students and alumni is lower than the one expressed by academics (see Figure 63). Data plotted in Fig. 63 give

evidence of the fact that traditional face-to-face lectures is still the most common KTMs adopted in IE&M 2nd level Master Programs. Although it is not the KTMs characterized by the highest value of DEMAND, face-to-face lectures is still the KTM preferred to Web-based lectures (see Figure 65).

Finally, considering the Learning Activities, the offer perceived form students and alumni is significantly lower than the offer expressed by academics in case of "Experiential Learning" and University Laboratory (bot computer and physical laboratories).

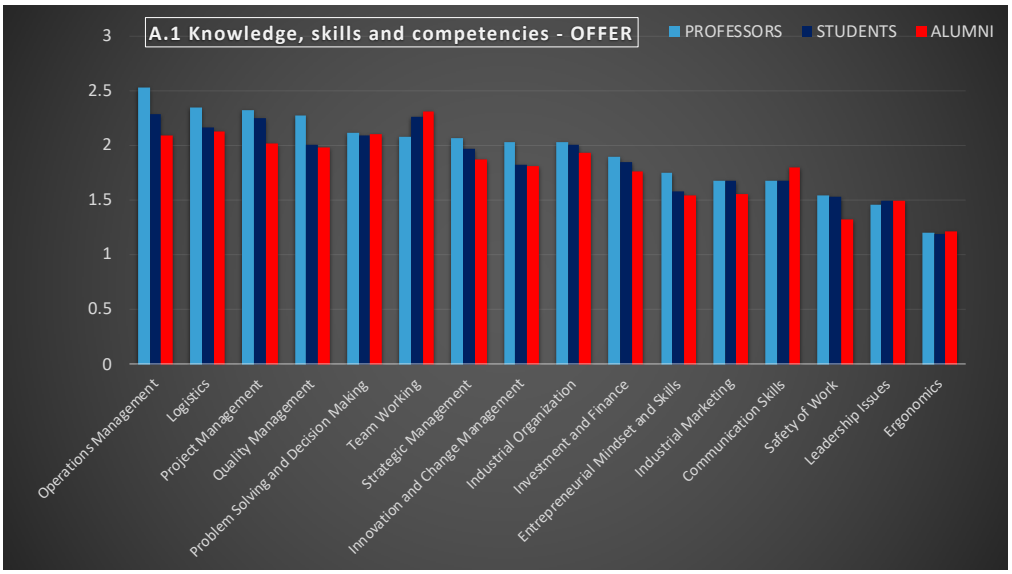



Fig. 61 – OFFER expressed by academics, students and alumni in section A.1 (Knowledge, Skills and Competencies - KSCs) of the questionnaires

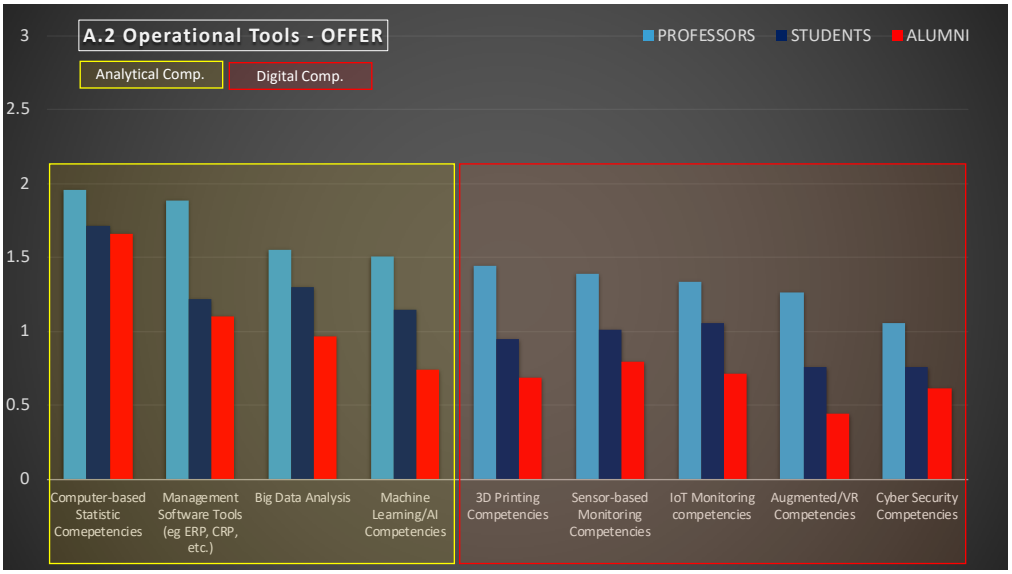



Fig. 62 – OFFER expressed by academics, students and alumni in section A.2 (Operational tools – Ots) of the questionnaires

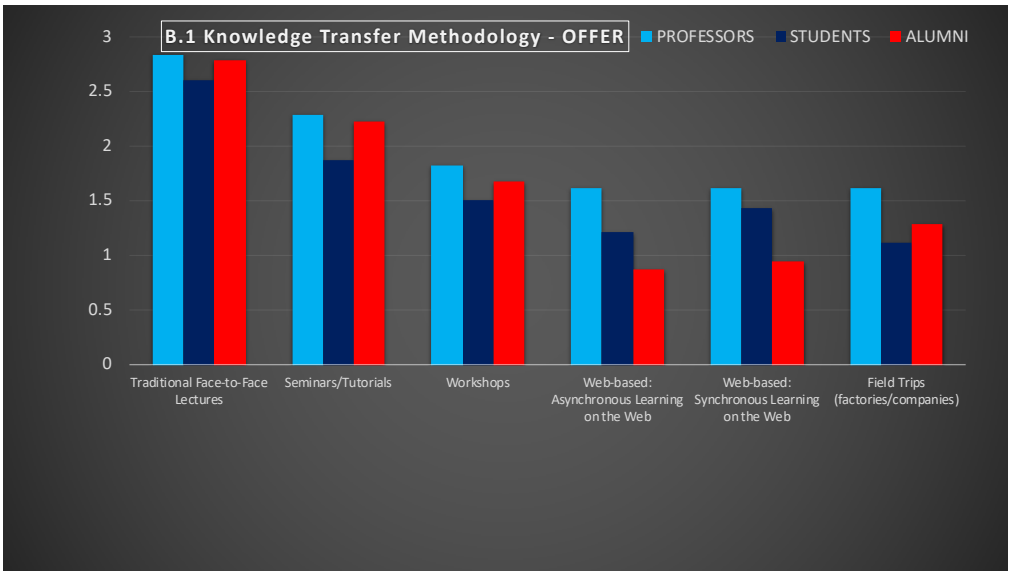



Fig. 63 – OFFER expressed by academics, students and alumni in section B.1 (Knowledge Transfer Methodology - KTM) of the questionnaires

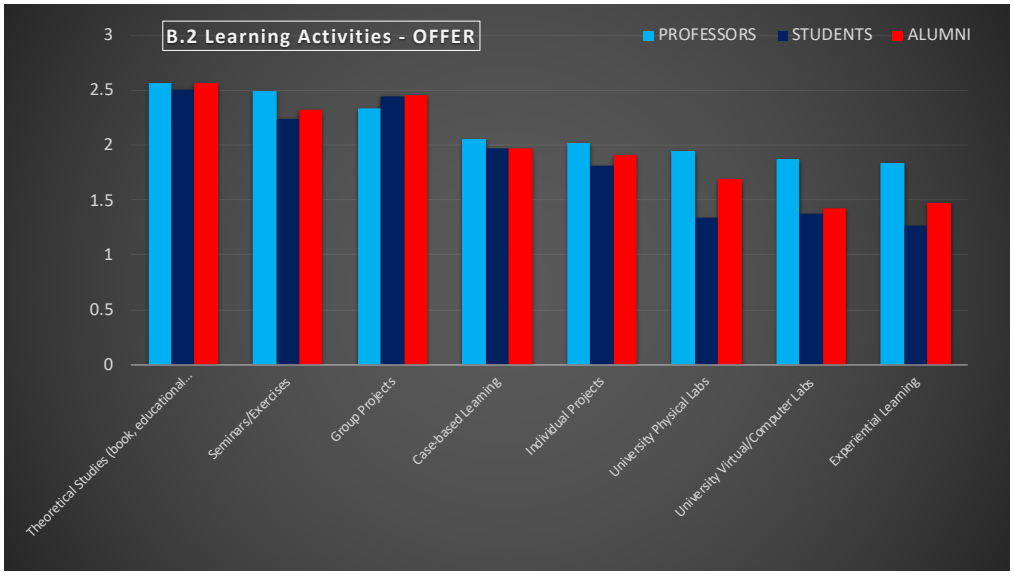



Fig. 64 – OFFER expressed by academics, students and alumni in section B.2 (Learning Activities - LAs) of the questionnaires

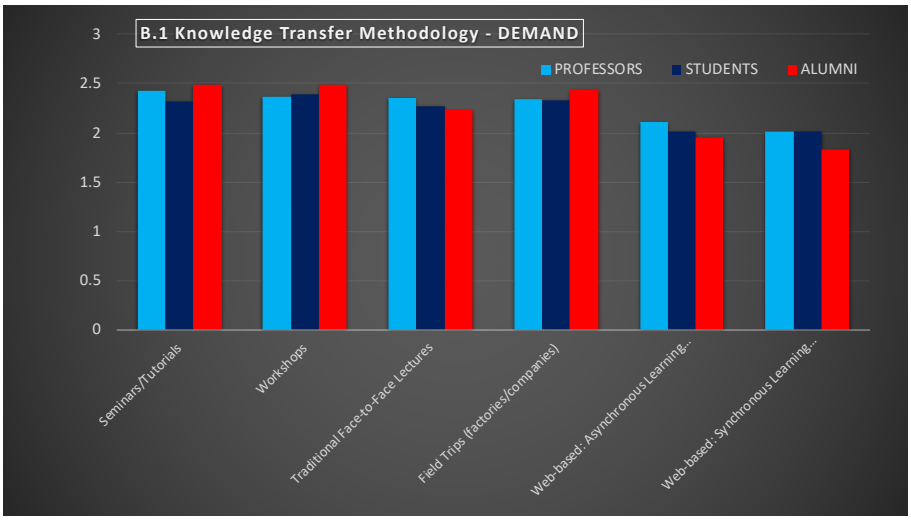



Fig. 65 – DEMAND expressed by academics, students and alumni in section B.1 (Knowledge Transfer Methodology - KTM) of the questionnaires

Although the offer of the HEIs in IE&M 2nd level Master Programs perceived from students and alumni is lower than the offer expressed by academics, both students and alumni positively rated the consistency of the Master Program attending or attended with the industrial context they experienced.

In case of students, the 45% consider the content of the attending Master Program consistent with their internship (see Figure 66). In case of Alumni, more than the 80% expressed a high-medium compliance of the Master Program attended with the job market and with the role held at work (see Figure 67).

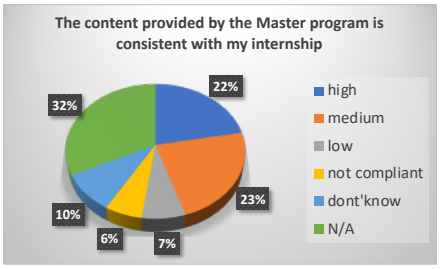



Fig. 66 – Students' opinion on the consistency of the attending Master Program with their internship

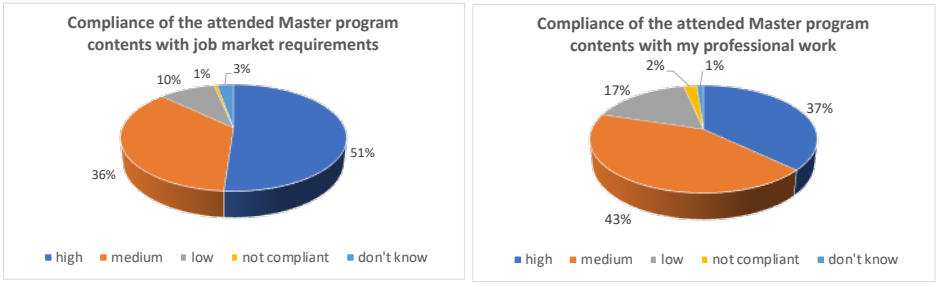



Fig. 67 – Alumni' opinion on the compliance of the attende Master Program with the job market and with their professional roles

Finally, also the effectiveness of the KTMs adopted in IE&M 2nd level Master Program were investigated. As shown in Figure 68 and 69, more than 85% of students and alumni rated as high-medium the effectiveness of KTMs experienced.

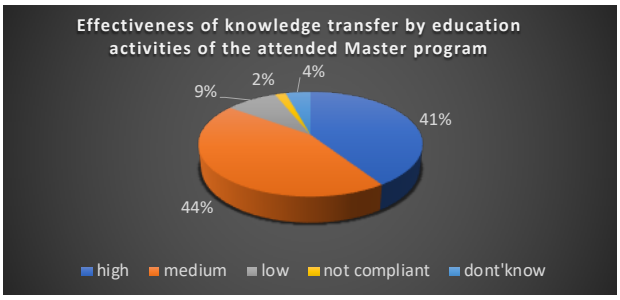



Fig. 68 – Students' opinion on the effectiveness of knowledge transfer experienced in the attending Master Program

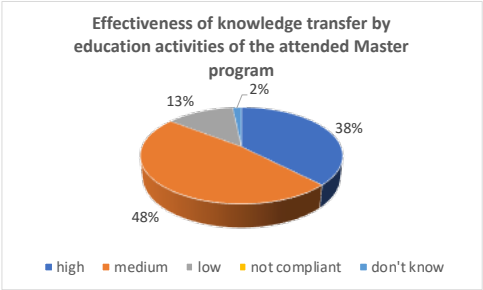



Fig. 69 – Alumni' opinion on the effectiveness of knowledge transfer experienced in the Master Program attended

## Acknowledgement

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