ESIEM
EUROPEAN SCHOOL OF
INDUSTRIAL ENGINEERING
& MANAGEMENT

The European Observatory



Industrial Engineering and Management Higher Education

Knowledge Needs and GAP Analysis

ESIEM – European Observatory
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Foreword

The European School of Industrial Engineering and Management (ESIEM) is a participatory foundation funded by the Italian Government with the aim of developing the culture of Industrial Engineering and Management (IE&M) across Europe. A main activity of the School is promoting the renewal of Higher Education in IE&M for the competitiveness of European Companies (https://www.esiem.eu).

To this purpose, the Scientific Committee of the Foundation established the European Observatory[1] of the School to monitor Companies' knowledge needs and analyse the main skill gaps against the competences offered by Universities' IE&M master level programs across Europe. Knowledge needs and gap analysis have been performed by a questionnaire-based survey.

This report provides the results of the Survey based on the opinions of the relevant stakeholders being Academic, Students, and Industry networks.

A special thanks are due to all respondents. The list of organizations is in Annex 1.

The Report is structured as follows.

After introducing the methodological approach, the survey on Companies, University Professors, and University Master level Students is provided in Chapters I, II, and III, respectively. Chapter IV reports cross-analyses between companies' knowledge requirements and current or planned academic offer outlining current and expected knowledge gap, useful information for addressing the renewal of academic programs. Chapter V analyses the evolution of Knowledge needs and Gaps by comparing the knowledge needs and Gaps of the present survey with the 2020 survey carried out by the 'Industrial Engineering and Management Higher Education – IE3' Erasmus+ project (https://ie3.eu). Most of the members of the WG also contributed to the IE3 project.

A special thanks to the members of the working group, authors of the report, and to the Scientific Committee that promoted and made the survey possible.

Giovanni Mummolo

President of ESIEM

[1] The Observatory operates through the voluntary action of a working group (WG) of University professors and students belonging to the European Academy for Industrial Management (AIM, https://europe-aim.eu/) and European Students of Industrial Engineering and Management (ESTIEM, https://estiem.org/), respectively. Both European Associations are Supporting Members of the Foundation.

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Executive Summary

Methodological approach

The Report shows the results of a web-based European survey on higher education in Industrial Engineering and Management promoted by the *'European Observatory'* of the Foundation *'European School of Industrial Engineering and Management'*. The WG of the *'European Observatory'* identified 28 main competence areas. European Companies, University Professors, and Master Level Students were asked to provide opinions on the importance of each competence area by a 0-3 scoring system. The samples of respondents consist of 36 companies, 62 university professors, and 58 master level students.

Terminology used in the report

Professors offer: topics currently taught.

Professors planned: topics that should be taught or are planned.

Students offer: topics currently received by students.

Students expected: topics that students would like to know.

Companies' requirements: expertise required from IE&M graduates.

Companies' requirements

The key requirement that companies expect from IE&M graduates is their ability to contribute effectively to the solution of complex problems from the outset. These results suggest that companies do not view IE&M graduates solely as technical analysts; rather, they expect them to coordinate people, structure ambiguous problems, and deliver improvements through projects.

Brain / Soft skills, like *'Decision making'*, *'Team working'*, and *'Communication skills'*, as well as classical management skills like *'Project Management'*, *'Quality Management'*, *'Operations Management'*, and *'ESG strategic management'* are at the top of the companies' preferred competences.

AI & digital skills like *'Big Data Analysis'*, *'Applied Prompt Engineering & AI Interfacing'*, *'AI ethics and critical verification'* are increasing in importance for companies, even higher than some classical IE&M topics like *'Investment & Finance*', *'Industrial Marketing'*, *'Ergonomics'*, *'Sensor-based monitoring'*, which can be considered niche, although important, competence areas.

Expected AI competence

The expected fields of Artificial Intelligence (AI) applications are in *'Project Management'* and *'Operations Management'*, followed by *'Maintenance Management'*, *'Supply chain'* and *'Cybersecurity'*. This reflects the ability attributed by companies to AI in supporting decision making and reporting in production as well as the ability of AI technologies in *'Data Analysis'* for predictive maintenance which is a fundamental pillar in lean production systems.

Expectations by companies in increasing productivity by AI are particularly strong: two-thirds of companies' respondents expect *'High'* or *'Very high'* use of Generative AI tools by newly graduated IE&M engineers. This suggests that AI fluency is becoming part of the expected baseline for daily operational work, not only a specialist data-science capability.

The curriculum implication is not to replace traditional IE&M foundations, but to make them more data-rich, AI-aware, cybersecurity-conscious, and practice-based. The strongest opportunities lie in embedding AI governance, verification, prompt-based work, cyber risks, data privacy, and safety into core IE&M projects and courses rather than treating them as isolated subjects.

Green skills

Green skills show high variance in the scores provided by companies. This may be due to different involvement of carbon accounting and circular economy principles across the operations and organizational roles. This suggests integrating sustainability issues into different IE&M decision-making contexts rather than treating them as isolated subjects.

Academic Offer

University Professors

University professors represent the majority of respondents, with a smaller share of programme coordinators and other academic roles. The institutional base is heterogeneous, with substantial representation from medium-large and large universities.

Traditional IE&M topics are already well covered and remain important in future planning. *'Project Management'* and *'Operations Management'*, *'Logistics'*, *'Quality Management'*, *'Problem Solving'* and *'Team Working*' form the stable core of the curriculum. By contrast, several AI-related and digital competences show lower current scores even though they are subject to planned expansion.

The largest planned expansion concerns *'Applied Prompt Engineering & AI Interfacing'*, followed by *'Cyber security'*, '*AI Ethics and Critical Verification', 'Big Data Analysis', 'Corporate Data Governance and AI Privacy'*. The need to integrate emerging digital and AI capabilities more strongly into IE&M curricula is recognised. Conversely, *'Operations Management'*, *'Industrial Organization'*, *'Quality Management'* and *'Logistics'* areas are considered as already mature and are not expected to expand substantially.

University Students

According to the students' evaluations, management and brain/soft skills, particularly *'Problem Solving and Decision-Making*', *'Operations Management'*, *'Project Management'*, *'Team Working'* and *'Logistics'*, achieve high scores for both current provision and expected coverage, confirming their central role in the curriculum. Students identify the most substantial gaps in emerging digital and AI competences, including *'Applied Prompt Engineering & AI Interfacing'*, *'Machine Learning and AI'*, *'Big Data'*, *'Data Governance and AI Privacy'*, and *'AI Ethics and Critical Verification'*.

Overall, students expect IE&M programmes to preserve their established disciplinary core while providing stronger coverage of

digital, AI and managerial competences which represent the most visible area in which students expect the curriculum to evolve.

GAP Analysis

By comparing *'Companies Requirements'* with current *'Programs Offer'* by university professors, the current knowledge gaps are identified: Digital / AI competence areas like *'Prompt Engineering'*, *'Cyber Security'*, *'Corporate Data Governance and AI Privacy'* show the largest gap.

University professors were also asked to provide a prospective evaluation on how they expect academic coverage of master level programs to evolve. This comparison highlights residual gaps between the academic plan and company requirements. Residual gaps are identified for *'Cyber Security'* and *'Applied Prompt Engineering & AI Interfacing'*, *'AI Ethics and Critical verification'*, *'Corporate Data Governance and AI Privacy'*. A novel high GAP is observed in Safety of Work. Further efforts are required also for *'Team-working'*. Such results suggest that future curriculum plans acknowledge the direction of change, but the planned level may still be insufficient for some fast-moving or high-risk competences.

The comparison of *'Companies Requirements'* with *'Academic offerings', as* perceived by university students, leads to some differences in the GAP analysis. Students perceive substantially higher exposure to *'Safety of Work'* and *'Ergonomics'*, and moderately higher exposure to *'Applied Prompt Engineering & AI Interfacing'*, *'ESG Strategy'*, *'AI Ethics and Critical verification'* and *'Corporate Data Governance and AI Privacy'*. Students perceive less coverage than professors in *'Operations Management'*, *'Management Software Tools'*, *'Logistics',* and *'Investment & Finance'*. These are important diagnostic signals: content may exist in curricula but not be sufficiently visible, explicit or recognisable to students under these competence labels.

The GAP analysis was also performed at macro-area level grouping the 28 competence areas in four macro areas:

- *'Digital, Data & AI';*
- *'Human & Management Skills';*
- *'Operations, Engineering & Supply Chain';*
- *'Strategy, Business & Sustainability'.*

At macro-area level, the largest gap of '*Company requirements vs. Professor offer*' is in '*Digital, Data & AI*'. *Human & Managerial Skills* also show a strong gap between company requirements and what universities offer. Such a GAP is confirmed by Companies requirements vs. Students' evaluations of offered coverage.

The planning of academia tends, on the average, to reduce the major gaps. However, significant gaps still remain in Digital, Data & AI topics in the academic planning stage. Such a tendency is also confirmed by students' expectations. In the planning stage, students expect more coverage in *'Operations, Engineering & Supply Chain'* and *'Strategy, Business & Sustainability'*.

Trend Analysis

The 2026 Survey carried out by the European Observatory has been subjected to a trend analysis with same results provided by the 2020 survey of IE3 Erasmus Plus Project[2]. It keeps the analytical boundary unchanged. The trend analysis discusses how companies, professors and students changed their opinions over time, without estimating cross-stakeholder gaps.

The trend analysis compares 23 comparable IE&M topics across five stakeholder dimensions: companies required, professors offered, professors planned, students offered and students expected. The further 5 topics included in the 2026 survey relate to AI and digital competence; such topics were not considered in the 2020 Survey as AI technologies were almost absent both in work environment and in higher education.

The main critical message from the trend analysis is that the six-year period appears to be one of curriculum consolidation rather than universal expansion. Current exposure increased for professors and students, while forward-looking dimensions - professors planned and students expected - became more selective. This pattern can be interpreted as a maturation effect: by 2026, some competences may have moved from aspirational intentions into actual offering, reducing the need to rate them as future priorities. However, maturation is not automatically positive. It becomes positive only if it reflects actual curricular implementation and learning outcomes. If it reflects lower ambition, institutional fatigue or inability to update curricula, rigid accreditation cycles taking 1–2+ years to update syllabi, the pattern would be problematic. The survey results therefore call for follow-up curriculum mapping rather than a purely descriptive conclusion.

Pedagogical issues

University Professors

The professor survey also captures how IE&M curricula are delivered. *'Face-to-face'* lectures remain the dominant teaching format and are not expected to grow further. The planned increases are concentrated in field trips, e-learning modules, video tutorials, streamed lectures, augmented reality, and flipped classroom. This suggests a diversification of the teaching mix rather than a replacement of traditional teaching.

Teaching tools remain strongly anchored in lecture notes, PowerPoint/Blackboard and books. Planned changes are limited overall, with the clearest positive movement in virtual tours and classroom ICT facilities. This suggests that digital transformation is more visible in competence content than in the everyday toolkit used for teaching delivery.

[2] Industrial Engineering and Management of European Higher Education, https://ie3.eu, Erasmus+ Program - Knowledge Alliance EAC/A03/2018

The survey reveals considerable differences in the extent to which IE&M programmes provide the students with direct exposure to industrial environments and professional practice. A substantial share of programmes report that obligatory internships are not applicable, while others offer internships of short or moderate duration. At the same time, professors plan modest increases in field trips, company labs, university–company labs and learning factories.

This highlights a potential strategic direction: IE&M programmes can strengthen students' employability by integrating more real-world industrial data, company-based case studies and collaborative learning spaces.

Companies

Micro-credentials are viewed positively by companies, but with greater caution. This suggests that they can complement a traditional master's degree, particularly in rapidly evolving fields such as AI, cloud computing, cybersecurity, and green technologies. However, they are not perceived as a substitute for the broader integrative value provided by a full degree.

University Students

Students' preferences for teaching formats point towards a gradual shift from conventional delivery to more varied and experiential approaches. The largest gap concerns field trips, followed by augmented reality environments, and workshops. Students also expect more frequent use of video tutorials, streamed lectures, and e-learning modules. Face-to-face lectures are the only format showing a negative evaluation, suggesting that students are not rejecting classroom teaching, but would prefer it to play a less dominant role within a more diversified learning environment. University–company labs, university labs, company labs, learning factories, and case-based learning are expected to be used more frequently. These findings reinforce the idea that students want more opportunities to apply knowledge in practical settings rather than a simple increase in conventional academic activities.

AI in Teaching

Artificial Intelligence is already influencing teaching and assessment, although its integration remains uneven and institutional responses are still fragmented. Professors most frequently report a shift toward *'in-class'* problem-solving activities and, to a lesser extent, the explicit assessment of AI prompts or usage. Nevertheless, many indicate that no changes have yet occurred, reflecting the coexistence of experimentation and inertia typical of an early adoption phase. Accordingly, AI is used in teaching mainly sometimes or rarely, with only a small minority of professors reporting very frequent use. This limited integration is even more evident at the institutional level: most respondents indicate that 24/7 AI tutors are unavailable, still under discussion or unknown, while only a few institutions have implemented or planned them. Overall, AI adoption appears to be advancing more rapidly through individual teaching practices than through institution-wide educational services.

Curriculum agility is a critical constraint. The most frequent response indicates that formal integration of disruptive technologies into the core Master syllabus takes 1-2 years or more. This is a significant challenge for fast-moving technologies such as generative AI. Flexible mechanisms such as micro-credentials, lifelong learning modules, and personalized paths can partially compensate for slower formal curriculum approval cycles.

A more substantial change is expected by students. Most students report that they use AI *'at least sometimes'*. However, confidence in verifying AI outputs is less developed, as most students report only a medium level of confidence. Students' individual adoption of AI is progressing faster than its formal integration into teaching and laboratory activities. Research is the most frequently mentioned activity, while references to faster work, understanding, thinking, summarising information and saving time also emerge. Responses indicate that students mainly use AI to support information retrieval, comprehension, and efficiency.

Overall, everyday teaching tools remain relatively stable, while AI is already changing how students work independently, creating a need for stronger institutional support, practical applications, and critical verification skills. Teaching methods are expected to evolve gradually toward more experiential, industry-connected, and digitally supported approaches. Knowledge assessment still remains a challenge to be faced with.

The use of AI and digital technologies in teaching suggests adopting an inductive rather than a deductive approach. The former appears to be better suited to IE&M contexts involving creative problem-solving, engineering, and skills development. By this approach, concepts emerge from the abstraction and reflection on lessons learned, rather than being introduced in advance through theoretical frameworks. This may be particularly appropriate for new generations of digital learners, who may respond less favourably to theory-first approaches. However, the deductive approach should be considered still an option for delivering classical, more structured models of IE&M.

Methodological Note of the Survey

The WG of the Survey preliminarily designed and tested online questionnaires, one for each stakeholder.

In answering the questionnaires, the stakeholders expressed their choices using the following score system:

- Expertise scoring: Not offered/not required = 0, Low = 1, Medium = 2, High = 3.
- Frequency scoring: Never = 0, Occasionally = 1, Sometimes = 2, Often = 3, Very often = 4.
- Missing and "Don't know/not aware" values were excluded from mean calculations.
- High+Medium shares were calculated over valid, non-missing, and non-"Don't know" responses.
- Macro-area groupings are analytical and were defined to support interpretation across the 28 competences.

Competences were grouped into four macro-areas for interpretation as reported in the following table: *'Digital, Data & AI'*; *'Human and Managerial skills'*; *'Operations, Engineering & Supply Chain'*; *'Strategy, Business and Sustainability'*.

Table 1. Clustering of the competence areas in macro-areas.

Competence Area	MacroArea
AI Ethics and Critical Verification (Fact-checking AI)	Digital, Data & AI
Applied Prompt Engineering & AI Interfacing	Digital, Data & AI
Big Data Analysis	Digital, Data & AI
Computer-based Statistics competencies	Digital, Data & AI
Corporate Data Governance and AI Privacy	Digital, Data & AI
Cyber Security competencies	Digital, Data & AI
IoT monitoring competencies	Digital, Data & AI
Machine Learning/AI competencies	Digital, Data & AI
Management software tools (e.g., ERP, CRP, MES, etc.)	Digital, Data & AI
Sensor-based competencies	Digital, Data & AI
Communication skills	Human & Managerial Skills
Entrepreneurial Mindset and Skills	Human & Managerial Skills
Leadership Issues	Human & Managerial Skills
Problem solving and decision making	Human & Managerial Skills
Team working	Human & Managerial Skills
Ergonomics	Operations, Engineering & Supply Chain
Industrial Organization	Operations, Engineering & Supply Chain
Logistics	Operations, Engineering & Supply Chain
Operations Management	Operations, Engineering & Supply Chain
Project Management	Operations, Engineering & Supply Chain
Quality Management	Operations, Engineering & Supply Chain
Safety of work	Operations, Engineering & Supply Chain
Supply Chain Risk and Resilience Management	Operations, Engineering & Supply Chain
Environmental Social and Governance Strategy	Strategy, Business & Sustainability
Industrial Marketing	Strategy, Business & Sustainability
Innovation and Change Management	Strategy, Business & Sustainability
Investment and Finance	Strategy, Business & Sustainability
Strategic Management	Strategy, Business & Sustainability

Data from the questionnaires were analysed to identify current knowledge needs expressed by companies, as well as the current and planned offerings of master level university programs, as reported by university professors and students.

The sample of each class of stakeholders proved to be statistically meaningful, as confirmed by the sample size analysis.

The Survey took three months to collect answers, starting in April 2026. A special thanks to all respondents for the time and valuable contribution provided to the Survey.

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I. Survey on European Companies

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I.1 Executive Summary

The survey points to a clear company-side expectation for IE&M Master's graduates: they should combine robust managerial execution capabilities with strong transversal skills and an increasingly explicit digital, AI and cybersecurity profile.

- The company requirements are highly concentrated in cybersecurity, AI ethics and verification, prompt engineering, data governance/privacy, safety of work, communication and teamwork.
- The highest company requirements are not purely technical: problem solving and decision making, teamwork, project management are among the top three requirements in the ranking followed by quality management, operations management and innovation/change management.
- Generative AI has become a concrete productivity expectation: 66.7% of companies expect High or Very high use of AI tools by newly graduated IE&M engineers.
- Companies still value direct and experiential transfer: face-to-face training is the most selected upskilling channel, while teaching factories, learning factories and online labs are also relevant.

Key Message

The curriculum implication is not to replace traditional IE&M foundations, but to make them more data-rich, AI-aware, cybersecurity-conscious and practice-based. The strongest opportunities lie in embedding AI governance, verification, prompt-based work, cyber risk, data privacy and safety into core IE&M projects rather than treating them as isolated electives.

I.2 Company Sample Analysis and Statistics

The dataset contains 36 valid response records. Company ratings are analysed at the level of 28 expertise areas covering managerial, operational, soft, digital, AI, sustainability and resilience domains. The profile of respondents is summarized in figure 1.

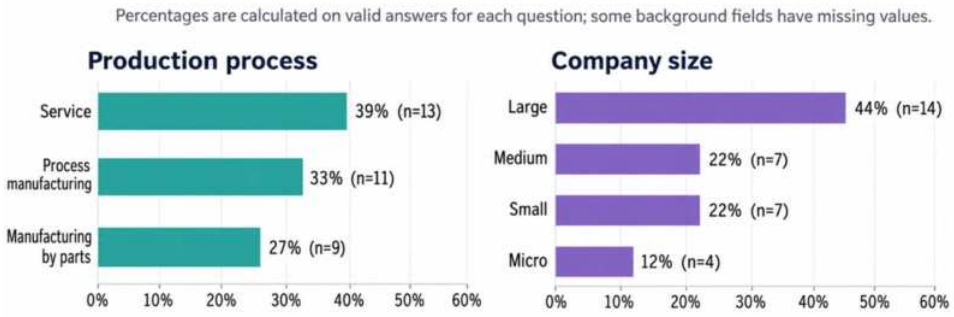


Figure 1. Respondent-company profile

The company sample combines services, process manufacturing and manufacturing by parts. Large companies represent the largest single size class; small, medium and micro enterprises are also present.

I.3 Training context

Training practices (figure 2) suggest that companies do not rely exclusively on universities for up-skilling. More than half of respondents reports a combination of internal and external training channels, and the most frequent training frequency category is High. This creates an opportunity for master's programmes to position themselves as partners in continuous education, applied projects and micro-credential pathways.

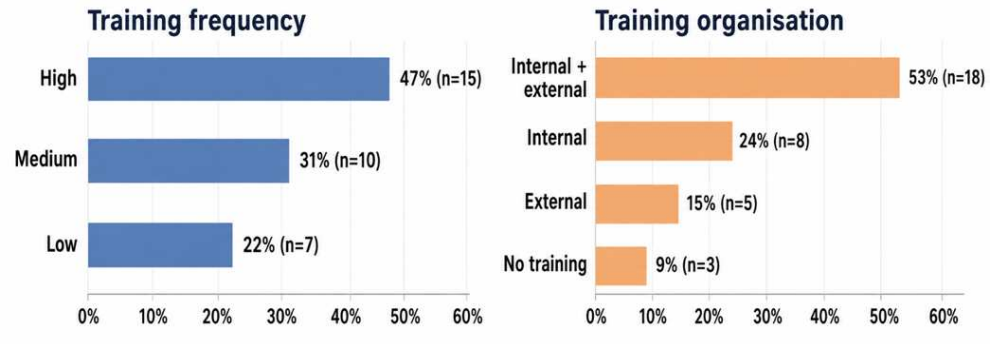


Figure 2. Respondent training context

I.4 Required expertise

Ranking of expertise areas

Figure 3 and Table 2 show the ranking of the requirements. The *'High + Medium'* percentage of evaluations provided by respondents is calculated over all company responses, including "Don't know" and *'Missing values'* in the denominator.

The leading requirements are that companies expect IE&M graduates to be immediately useful in complex problems. These results suggest that companies do not view IE&M graduates only as technical analysts; they expect them to coordinate people, structure ambiguous problems, and deliver improvements through projects. The competences in Table I.1 are grouped into three main categories: Soft-Brain Skills (green coloured), Management Skills (grey coloured), AI Digital Skills (cyan coloured). Soft-Brain skills like *'Problem solving and Decision making'*, *'Team working'*, *'Communication skills'*, *'Leadership issues'* as well as IE&M competence in *'Project Management'*, *'Quality Management'*, *'Computer-based statistics'*, *'Management software tools'*, *'Innovation and Change management'* are among the top of the ranking.

AI digital skills are increasing in importance which is becoming even higher than some classical IE&M topics like *'Investment & Finance'*, *'Industrial Marketing'*, as well as *'Ergonomics'*; this last competence is probably considered a niche of competence, although important, more easily covered by specialists.

Table 2. Ranking of the competences that companies require of IE&M graduates: Soft-Brain Skills (green coloured), Management Skills (grey coloured), AI Digital Skills (cyan coloured)

Rank	Expertise area	Mean score (max 3)	High +Medium
1	Problem solving and decision making	2.72	94 %
2	Team working	2.60	92 %
3	Project Management	2.42	91 %
4	Quality Management	2.36	89 %
5	Operations Management	2.35	89 %
6	Innovation and Change Management	2.31	89 %
7	Computer-based Statistics competencies	2.30	85 %
8	Communication skills	2.28	81 %
9	Leadership Issues	2.27	79 %
10	Management software tools (e.g., ERP, CRP, MES, etc.)	2.17	72 %
11	Industrial Organization	2.14	78 %
12	Machine learning and AI	2.12	69 %
13	Big Data Analysis	2.09	78 %
14	Safety of Work	2.08	75 %
15	Cyber Security	2.06	75 %
16	Strategic Management	2.00	78 %
17	Environmental, Social and Governance Strategy	1.97	69 %
18	Applied Prompt Engineering	1.97	76 %
19	Corporate Data Governance and AI Privacy	1.91	60 %
20	AI Ethics and Critical Verification (Fact-checking AI)	1.88	65 %
21	Entrepreneurial Mindset and Skills	1.84	58 %
22	Supply Chain Risk and Resilience Management	1.83	64 %
23	Logistics	1.75	67 %
24	Investment and Finance	1.69	69 %
25	IoT Monitoring	1.58	58 %
27	Ergonomics	1.56	56 %
26	Industrial Marketing	1.44	53 %
28	Sensor-based competence	1.23	58 %

The top-ranked expertise areas are not driven by a small minority of highly demanding respondents. They show broad consensus, with *'High + Medium'* shares around or above 80–90% for *'Problem solving'*, *'Teamwork'*, *'Project management'*, *'Quality'*, *'Operations'*, '*Innovation/change management'* (green bars in figure I.3) and several digital/data-related competences.

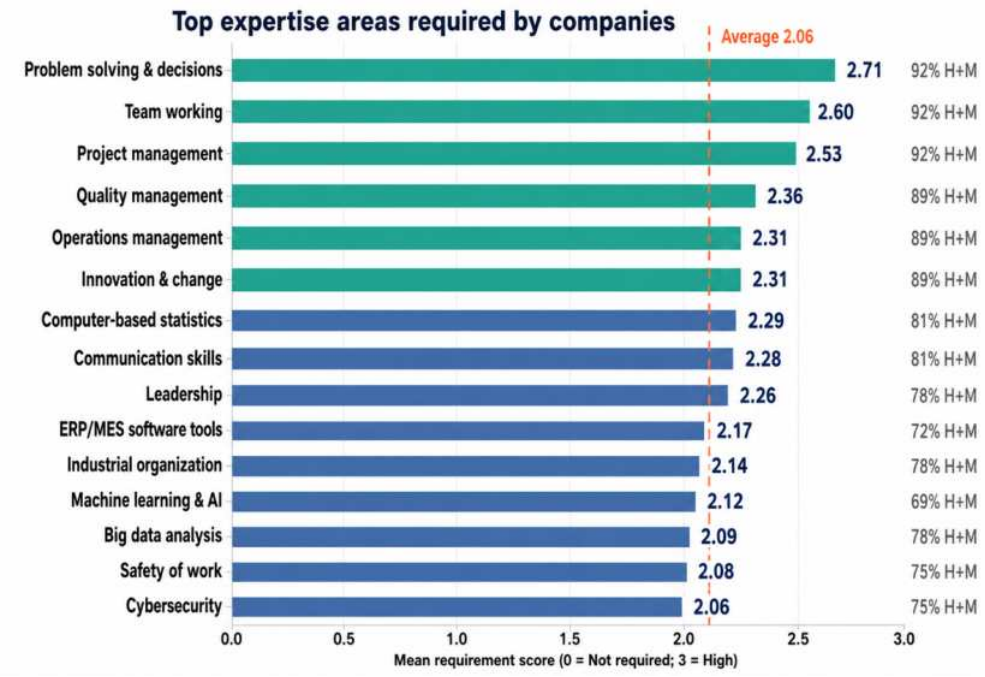


Figure 3. Top required expertise areas according to companies
(H+M = share of total responses rated High or Medium).

Despite the different production processes and company size, low variability in companies' responses was observed for all the 28 questions (figure 4), estimated by the coefficient of variation (Standard deviation / Mean) which has been estimated lower than 0.4 for all questions. This witnesses a good accordance among the companies' evaluations.

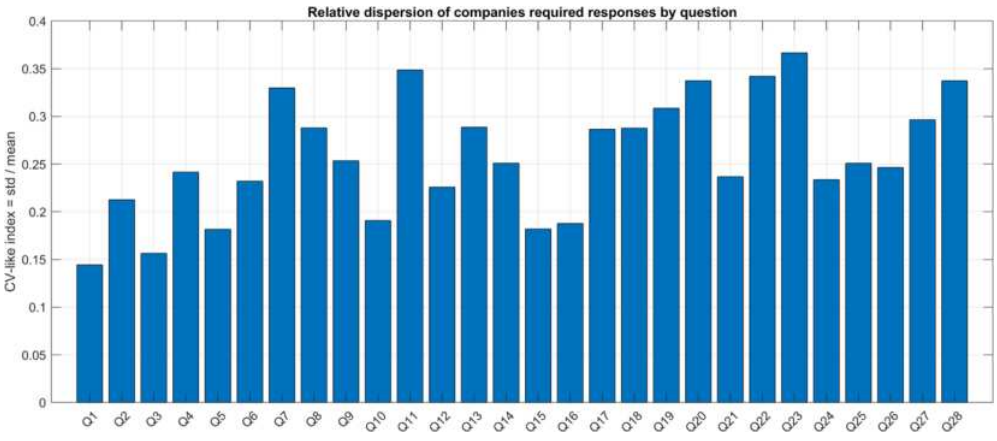


Figure 4. Coefficient of Variation (Standard deviation / Mean) of
answers by Companies vs. 28 questionnaires' questions

Future-facing expectations: AI, micro-credentials and green skills

Companies' expectations on AI, micro credentials and green skills are in figure 5.

AI productivity expectations are particularly strong: two-thirds of respondents expect *'High'* or *'Very high'* use of Generative AI tools by newly graduated IE&M engineers. This suggests that AI fluency is becoming part of the expected baseline for daily operational work, not only a specialist data-science capability.

Micro-credentials are viewed positively but more cautiously. The largest category is *'Medium'*, with *'High'* and *'Very high'* responses forming a smaller but still meaningful group. This suggests that micro-credentials can complement a traditional master's degree, especially in fast-changing fields such as AI, cloud, cyber or green technologies, but they do not replace the degree's broader integrative value.

Green skills show high variance in the scores provided by companies. This may be due to different involvement of carbon accounting and circular economy principles across the operations and organizational roles. This suggests integrating sustainability issues into different IE&M decision-making contexts rather than treating them as a peripheral educational topic.

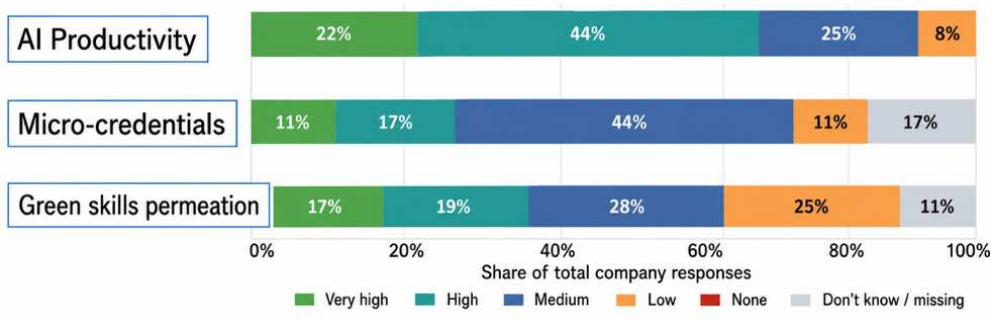


Figure 5. Distribution of expectations around AI productivity, micro-credentials and green skills

AI adoption areas

AI applications are expected (figure 6) especially in project management and operations management, followed by maintenance, supply chain and cybersecurity.

The expected first three fields of AI applications are in Project Management, Operations Management, and Maintenance Management. This reflects the ability attributed by companies to AI in supporting decision making and reporting both in Project and in Process/by part productions systems as well as the ability of AI technologies in Data Analysis for Predictive Maintenance which is a fundamental pillar in lean production systems.

This strongly supports the idea of embedding AI tasks in core IE&M modules: project planning, operational dashboards, and maintenance analytics.

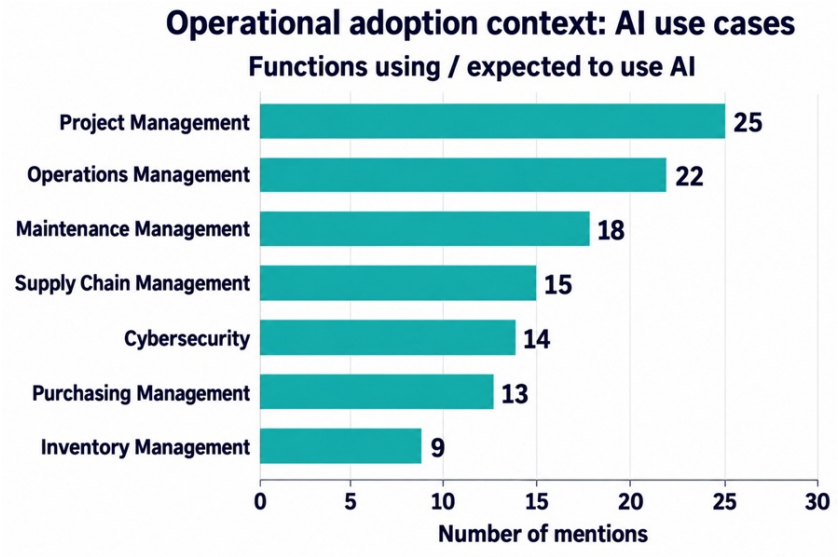


Figure 6. Organisational AI adoption areas (multi-choice questions: counts can exceed respondent totals).

Preferred Upskilling Methods

The preferred upskilling methods also have a clear message. *'Face-to-face'* training remains the most selected method; teaching / learning factories, online labs, and web-based methods also received significant consensus. Companies therefore seem to value blended, experiential and problem-based learning environments that connect classroom knowledge with industrial practice.

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II. Survey on European University Professors

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II.1 Executive Summary

The survey, based on 62 professors' responses, presents the academic perspective on the evolution of IE&M curricula. Traditional areas remain central, while a moderate expansion is planned, particularly in Digital, Data and AI competencies. Teaching methods are also expected to gradually evolve in the planning stage toward more experiential, industry-connected and digitally supported approaches.

- Largest individual planned increase: Applied Prompt Engineering & AI Interfacing.
- Traditional IE&M competences are already mature and show limited change, especially for Operations Management and Industrial Organization.
- AI affects assessment practices, but institutional readiness is uneven: most programmes need 1-2 years or more than 2 years to integrate disruptive technologies formally into the core syllabus.

Key Message

IE&M programmes are evolving rather than being radically restructured: they retain a strong foundation in traditional operations and management competences while progressively expanding Digital, Data and AI skills and adopting more experiential, industry-connected teaching approaches.

II.2 Respondent and institutional profile

The respondent profile is predominantly academic: teachers represent the majority of respondents, with a smaller share of programme coordinators and other academic roles. The institutional base is heterogeneous, with substantial representation from medium-large and large universities. The largest group is composed of professors followed by programme coordinators.-Most respondents are affiliated with universities enrolling at least 20,000 students, and many report IE&M-related cohorts exceeding 200 students per academic year (fig. 7).

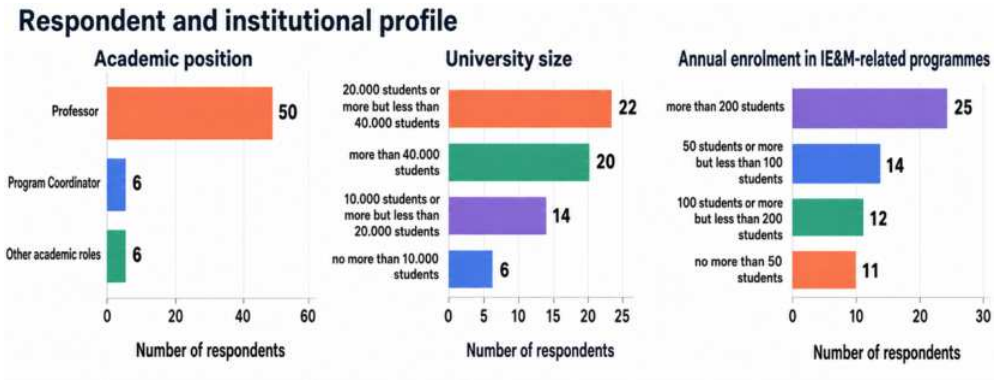


Figure 7. Profile of respondents, university size and IE&M programme enrolment size.

'Industrial Engineering and Management' is the most frequently reported programme label, followed by *'Mechanical Engineering'* and *'Engineering Management'*. The programme portfolio also includes *'Production Management'*, *'Industrial Management'*, *'Manufacturing Management'* and several specialized or emerging tracks. This diversity is important because professors may interpret IE&M competences through different institutional and disciplinary lenses.

II.3 Current offered expertise vs planned curriculum emphasis

The core analytical question is how professors perceive the current expertise coverage of IE&M programmes and how they expect that coverage to evolve. Each competence is positioned according to its current offered mean score and its planned mean score (Figure 8), with points above the diagonal indicating areas for which reinforcement is planned. As can be seen, traditional IE&M topics cluster in the upper-right part of the chart, meaning that they are already well covered and remain important in future planning. *'Operations Management'*, *'Project Management'*, *'Logistics'*, *'Quality Management'*, '*Problem Solving and Decision Making'* and *'Team Working'* form the stable core of the curriculum. By contrast, several AI-related and digital competences show lower current scores but are positioned above the diagonal, indicating their planned expansion.

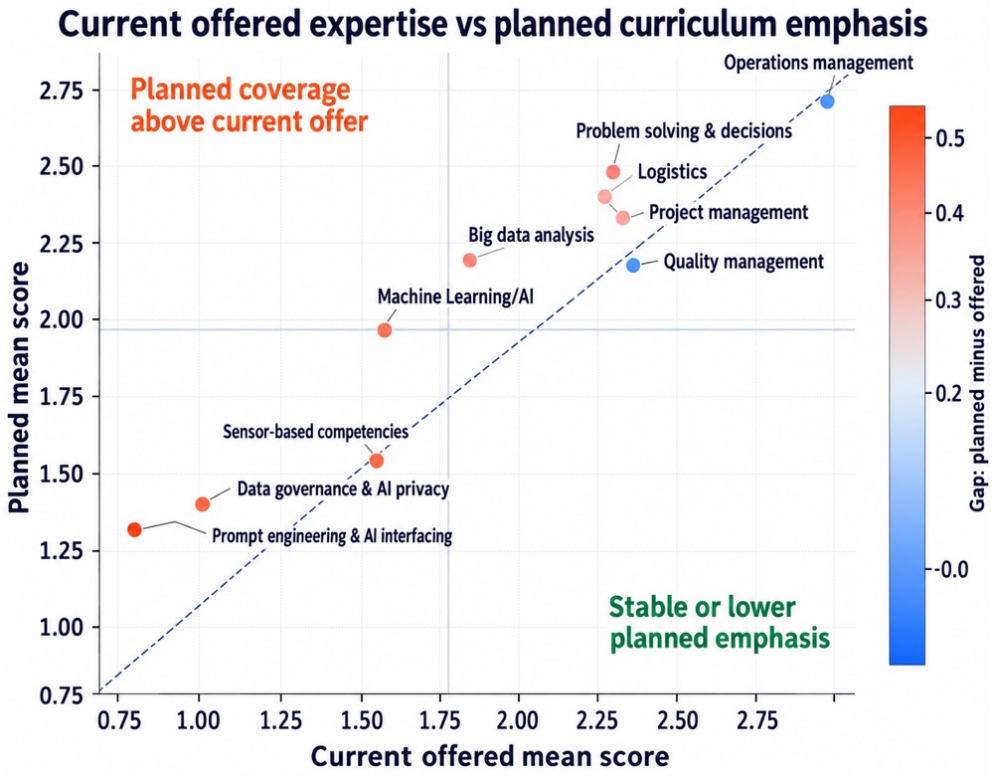


Figure 8. Offered vs planned mean expertise scores across 28 IE&M competences.

The lower-left area of the chart includes competences whose current provision is considered relatively limited compared with their anticipated future relevance. The largest planned expansion concerns *'Applied Prompt Engineering & AI Interfacing'*, followed by *'Cyber Security'*, '*AI Ethics and Critical Verification'*, *'Big Data Analysis'*, *'Corporate Data Governance and AI Privacy'*, *'Machine Learning/AI'* and sensor-based competences. These results show that professors recognize the need to integrate emerging digital and AI capabilities more strongly into IE&M curricula. Conversely, *'Operations Management'*, *'Industrial Organization'*, *'Quality Management'* and *'Logistics'* show low or slightly negative expected increase, suggesting that these areas are considered by professors already mature and are not expected to expand substantially.

II.4 Digital, Data & AI competence transformation

Within the *'Digital, Data & AI'* macro-area, the most dynamic areas are those linked to generative AI use, trustworthiness, security and data responsibility. *'Prompt engineering and AI inbterfacing'* is the strongest planned increase, while *'Cybersecurity'*, *'AI ethics'*, '*Data governance and AI privacy*' also show substantial growth. 'Big Data Analysis' and 'Machine Learning/AI' move toward stronger curriculum coverage, suggesting that analytical and AI literacy are becoming expected parts of the IE&M academic profile.

The distributional chart shown in Figure 9 highlights that planned improvement is not only a small change in averages: for the selected digital competences, the share of Medium and High ratings increases visibly from *'offered'* to *'planned'*. At the same time, the persistence of Low and Not offered/not required responses indicates uneven maturity across institutions. The transition is therefore both strategic and heterogeneous.

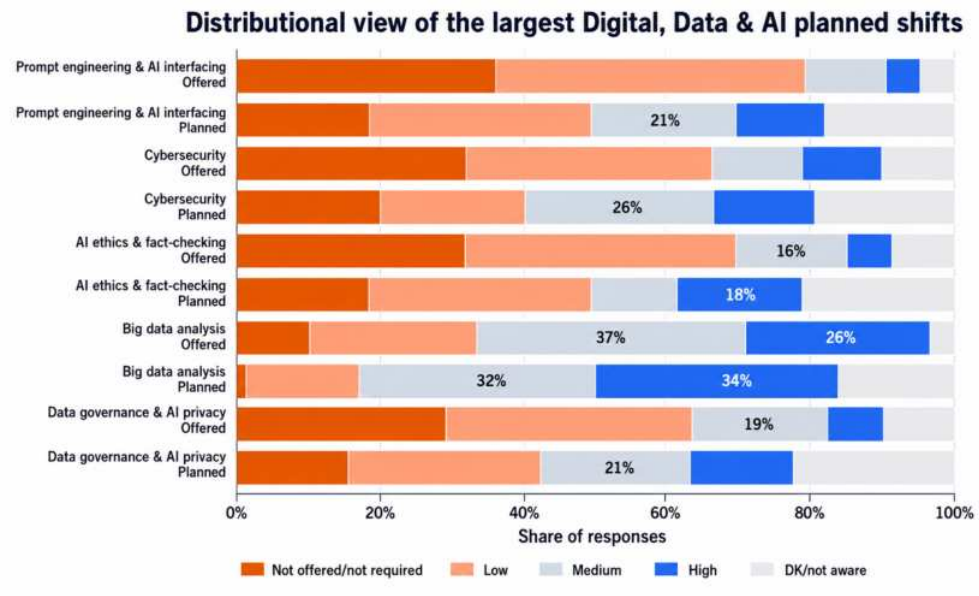


Figure 9. Distribution of responses for selected Digital, Data & AI competences.

II.5 Teaching formats, learning activities and industry exposure

The professors' survey captures how IE&M curricula are delivered. The results, summarized in Figure 10, show that *'face-to-face'* lectures, seminars, and workshops remain the dominant teaching format and are not expected to grow further. The planned increases are concentrated in: *'face-to-face field trips', 'e-learning modules', 'video tutorials', 'streamed lectures'. This* suggests a diversification of the teaching mix rather than a replacement of traditional teaching.

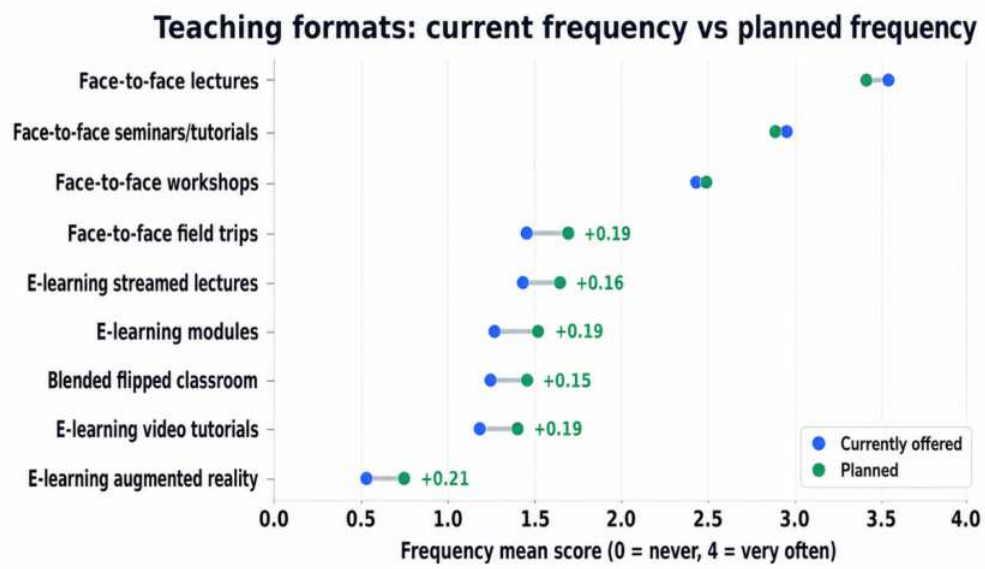


Figure 10. Teaching formats: current offered frequency and planned frequency.

Similarly to teaching formats, teaching tools do not appear to show major changes. As illustrated in Figure 11, they remain strongly anchored in lecture notes, PowerPoint/Blackboard and books. Planned changes are limited overall, with the clearest positive movement in virtual tours. This suggests that digital transformation is more visible in competence content than in the everyday toolkit used for teaching delivery.

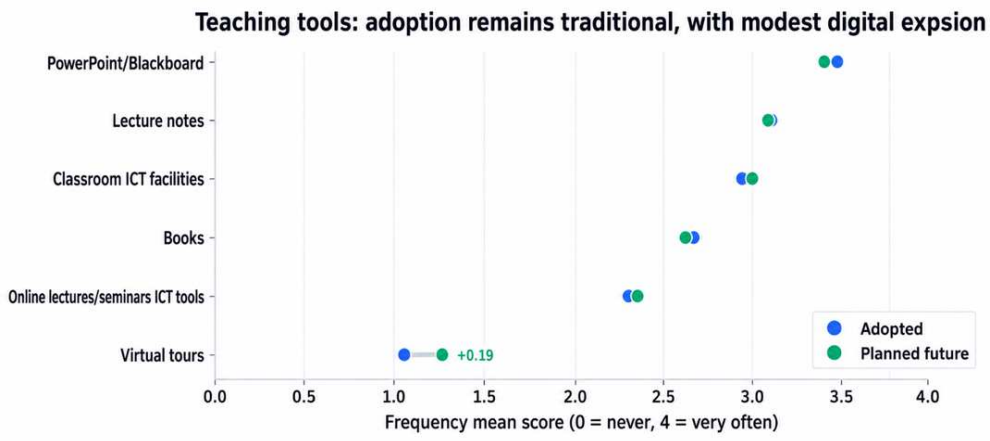


Figure 11. Teaching tools: adopted and planned future frequency.

The survey results reveal considerable differences in the extent to which IE&M programmes provide students with direct exposure to industrial environments and professional practice. As shown in Figure 12, a substantial share of programmes report that obligatory internships are not applicable, while others offer internships of short or moderate duration. At the same time, professors plan modest increases in field trips, company labs, university–company labs and learning factories. This highlights a potential strategic direction: IE&M programmes can strengthen students' employability by integrating more real-world industrial data, company-based case studies and collaborative learning spaces.

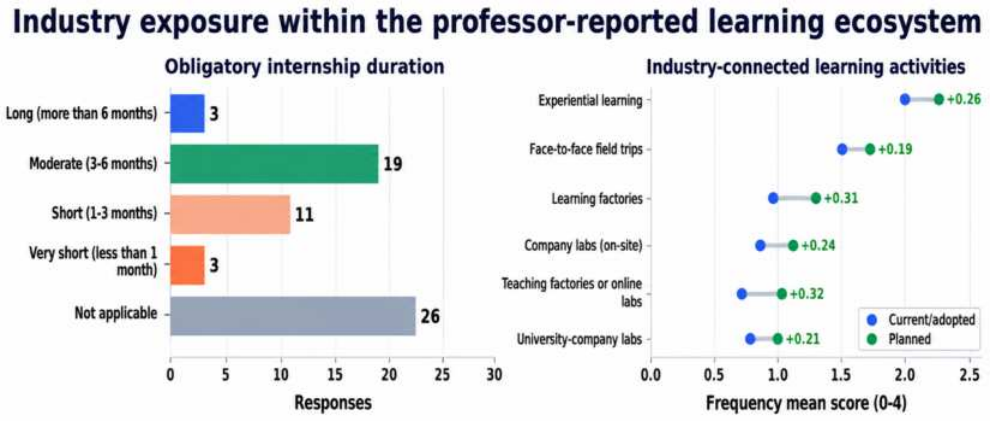


Figure 12. Internship duration and industry-connected learning activities.

II.6 AI in assessment, teaching and curriculum agility

Artificial Intelligence is already influencing teaching and assessment, although its integration remains uneven and institutional responses are still fragmented (Figure 13). Professors most frequently report a shift toward in-class problem-solving activities and, to a lesser extent, the explicit assessment of AI prompts or usage. Nevertheless, many indicate that no changes have yet occurred, reflecting the coexistence of experimentation and inertia typical of an early adoption phase. Accordingly, AI is used in teaching mainly *'sometimes'* or *'rarely'*, with only a small minority of professors reporting *'very frequent'* use. This limited integration is even more evident at the institutional level: most respondents indicate that 24/7 AI tutors are unavailable, still under discussion or unknown, while only a few institutions have implemented or planned them.

Overall, AI adoption appears to be advancing more rapidly through individual teaching practices than through institution-wide educational services.

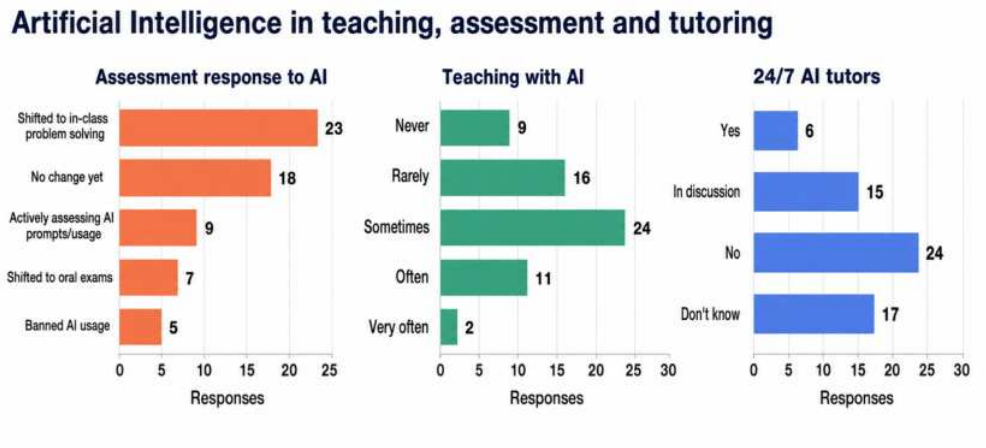


Figure 13. AI-related assessment changes, teaching use and AI tutor readiness.

Curriculum agility is a critical constraint. As shown in Figure 14, the most frequent response indicates that formal integration of disruptive technologies into the core Master syllabus takes 1-2 years, followed by more than 2 years. This is a significant challenge for fast-moving technologies such as generative AI. Flexible mechanisms such as micro-credentials, lifelong learning modules and personalized paths can partially compensate for slower formal curriculum approval cycles.

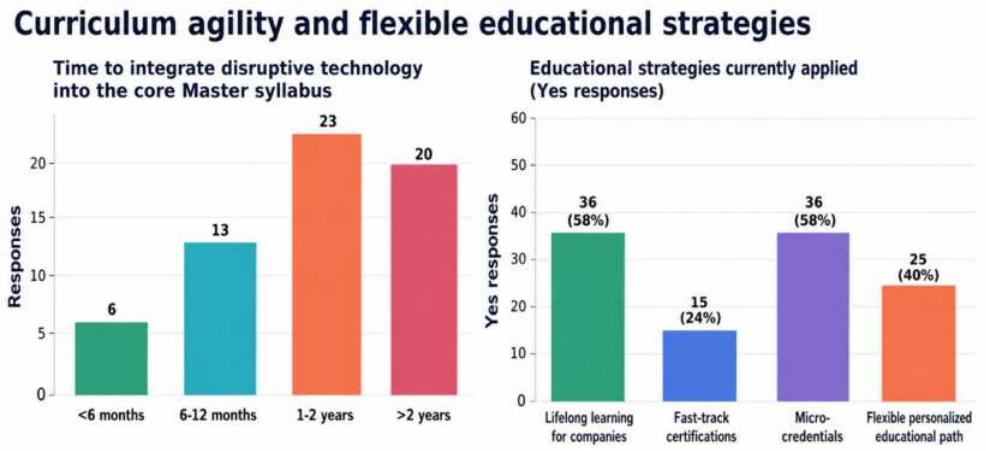


Figure 14. Curriculum agility and flexible educational strategies

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III. Survey on European University Students

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III.1 Executive Summary

The survey, based exclusively on Master students' responses, examines the expertise they expect from IE&M programmes compared with the teaching offer they currently perceive. Students do not demand a radically different curriculum, but consistently expect stronger, more practice-oriented coverage, particularly in emerging digital technologies, entrepreneurship and leadership.

- The survey, based on 58 Master students' responses, presents the student perspective on IE&M curricula. Traditional managerial and operational competences remain central, while students expect stronger coverage of Digital, Data & AI, leadership, entrepreneurship and management software tools. Teaching approaches are also expected to become more experiential, laboratory-based and connected with real industrial contexts.
- Largest macro-area gap: Digital, Data & AI, confirming this area as the main priority for curriculum modernisation.
- Largest individual expectation gap: *'Applied Prompt Engineering & AI Interfacing'*, followed by *'Management Software Tools'* and *'Machine Learning/AI'*.
- Traditional IE&M competences remain the most highly expected: *'Problem Solving and Decision Making'* ranks first, followed by *'Project Management'* and *'Operations Management'*.
- Students expect more experiential and industry-connected learning through field trips, workshops, laboratories, company data and university–company labs. Generative AI is already widely used: 42 out of 58 students use it at least sometimes but confidence in verification and opportunities for applying 'AI/Machine Learning' to industrial datasets remain limited.

Key Message

Students value solid IE&M foundations but expect curricula to become more digital, experiential and industry connected. The main priorities are applied AI and data competences, management software, leadership and entrepreneurship, alongside laboratories and real-world projects. As AI use is already widespread, programmes should strengthen critical verification and industrial application skills.

III.2 Respondent and institutional profile

The student respondent profile indicates that the sample mainly comprises students in the advanced stages of their Master's programme. As shown in Figure 15, 53 of the 58 respondents (91%) are enrolled in the second, third or fourth semester, with fourth-semester students representing the largest group (20 respondents). In terms of academic background, most participants are enrolled in Mechanical Engineering (20) or Industrial Engineering and Management (17), while the remainder are distributed across Engineering Management, Production Management and other related programmes. Perceived transfer effectiveness is generally positive: 34 students (59%) rate it as high or very high, while 18 (31%) consider it medium. Only six respondents report very low effectiveness, and none regard it as entirely ineffective.

Overall, the sample primarily reflects the views of students who have already gained substantial experience of their programmes and who generally perceive the transfer of knowledge and competences as effective.

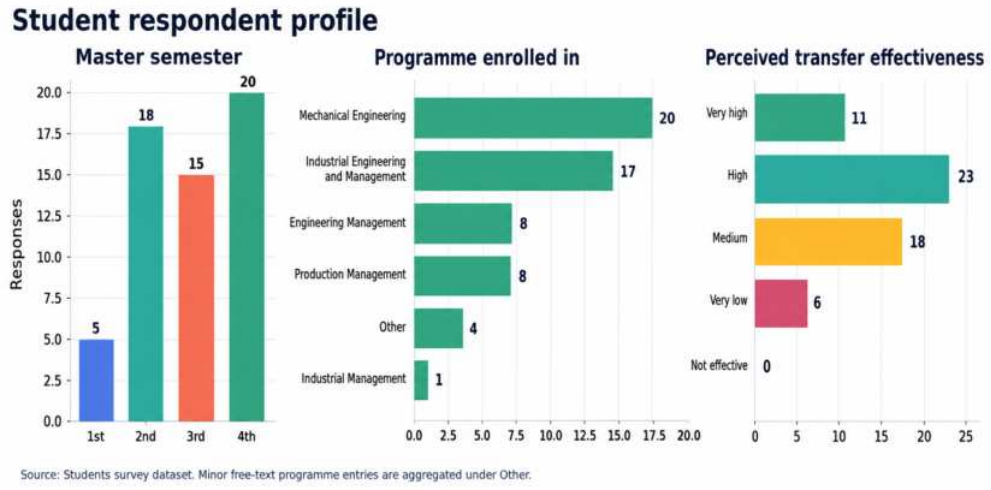


Figure 15. Respondent profile: semester, programme and perceived transfer effectiveness.

III.3 Expertise expected by students vs perceived curriculum offer

The comparison of the 28 expertise areas provides a comprehensive overview of the differences between the curriculum currently perceived by students and the coverage they expect. As shown in Figure 16, expected scores are higher than offered scores across the entire competence portfolio, although the size of the gap varies considerably. Traditional IE&M topics, particularly *'Problem Solving and Decision-Making'*, *'Operations Management'*, *'Project Management'*, *'Team Working'* and *'Logistics'*, achieve high scores for both current provision and expected coverage, confirming their central role in the curriculum. The most substantial gaps concern emerging digital and AI competences, including *'Prompt Engineering and AI Interfacing'*,

'Machine Learning and AI', *'Big Data'*, *'Data Governance and AI Privacy'*, and *'AI Ethics and Critical Verification'*. Relevant differences also emerge for *'Management Software Tools'*, *'Entrepreneurial Mindset'* and *'Leadership'*.

Overall, students expect IE&M programmes to preserve their established disciplinary core while providing stronger coverage of digital, AI and managerial competences.

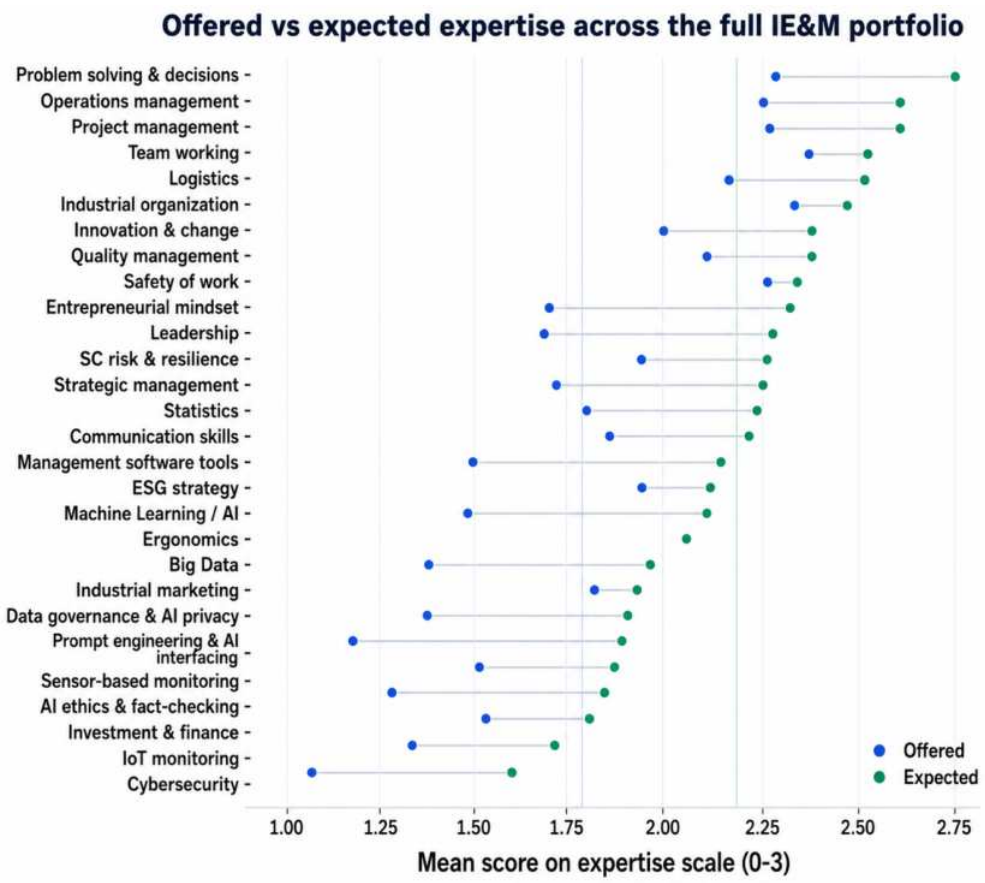


Figure 16. Dumbbell chart of offered vs expected expertise.

III.4 Digital, Data & AI focus

Students' expectations for the Digital, Data and AI cluster point to a clear demand for curriculum modernization. As shown in Figure 17, a substantial share of respondents expects medium or high coverage across most of these competences, particularly *'Management Software Tools'*, *'Machine Learning and AI'*, *'Big Data'*, *'Statistics'* and *'Prompt Engineering and AI Interfacing'*. Expectations also extend beyond purely technical content. *'Data Governance and AI Privacy'*, *'AI Ethics and Critical Verification'*, and *'Cybersecurity'* are considered relevant parts of the expected competence portfolio, showing that students also value the responsible, critical and secure use of digital technologies. At the same time, the relatively mixed responses for areas such as *'Cybersecurity'*, *'IoT Monitoring'* and *'Sensor-based Monitoring'* suggest that their role within IE&M programmes is not yet perceived uniformly.

Overall, Digital, Data and AI represent the most visible area in which students expect the curriculum to evolve.

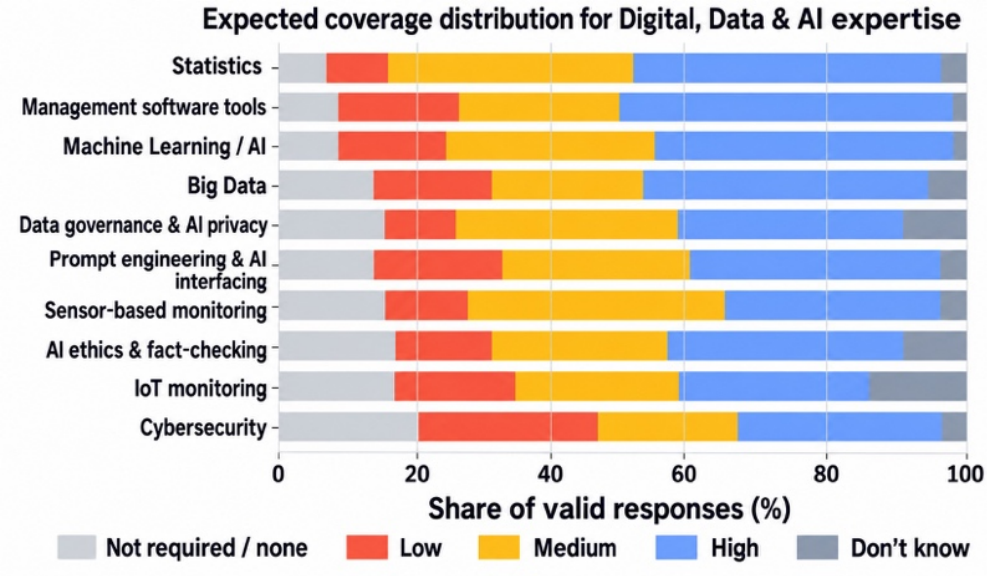


Figure 17. Distribution of expected coverage for Digital, Data & AI expertise.

III.5 Teaching formats, learning activities and industry exposure

Students' preferences for teaching formats point towards a gradual shift from conventional delivery to more varied and experiential approaches. As shown in Figure 18, the largest positive gap concerns field trips, followed by augmented reality environments and workshops. Students also expect more frequent use of video tutorials, streamed lectures and e-learning modules. Face-to-face lectures are the only format showing a negative gap, suggesting that students are not rejecting classroom teaching, but would prefer it to play a less dominant role within a more diversified learning experience.

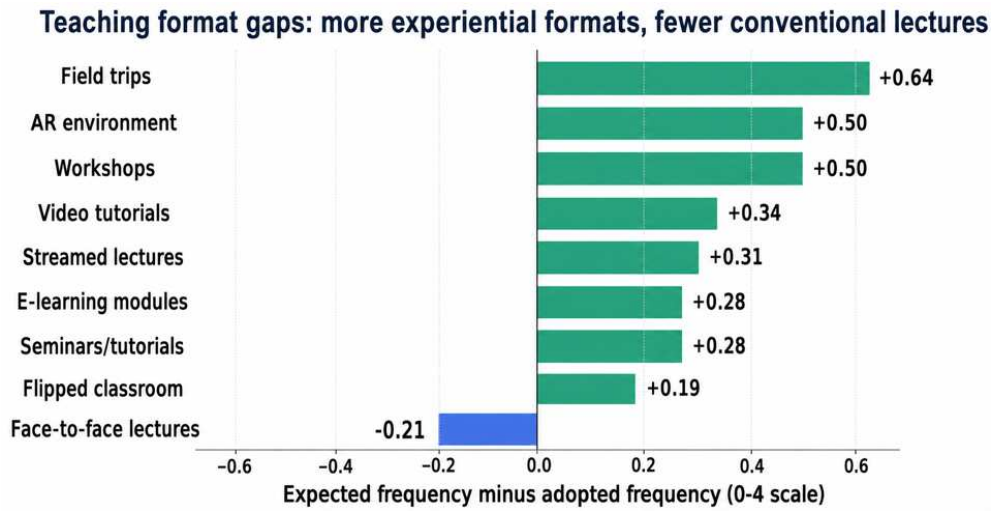


Figure 18. Teaching format gaps.

This preference becomes even clearer when specific learning activities are considered. Figure 19 shows that experiential learning has the largest expectation gap, followed by university–company labs, university labs and company labs. Learning factories, online laboratories and case-based learning are also expected to be used more frequently. By contrast, exercises and group projects are broadly aligned with current practice, while theoretical studies show a slightly negative gap. These findings reinforce the idea that students want more opportunities to apply knowledge in practical settings rather than a simple increase in conventional academic activities.

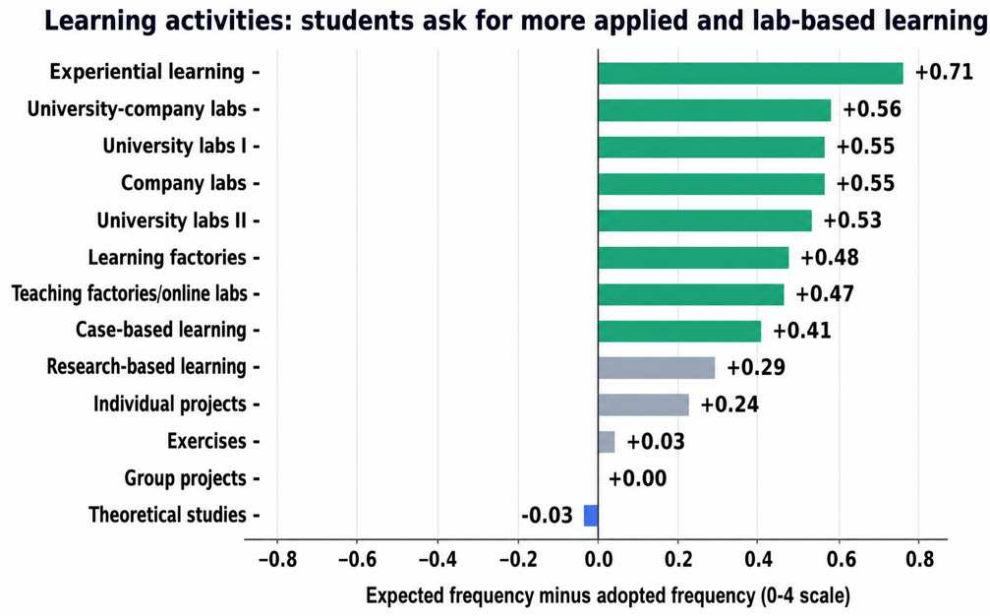


Figure 19. Learning activity gaps.

The same pattern is confirmed when attention shifts specifically to industry-facing learning. As illustrated in Figure 20, students expect greater exposure to experiential learning, field trips, company data and materials used in class, collaborative university–company laboratories and learning factories. Internship duration also records a positive gap, despite already having one of the highest current and expected scores. Taken together, the three figures suggest that students are asking for a more applied and industry-connected educational experience, in which traditional teaching is complemented by direct engagement with companies, real data and practical learning environments.

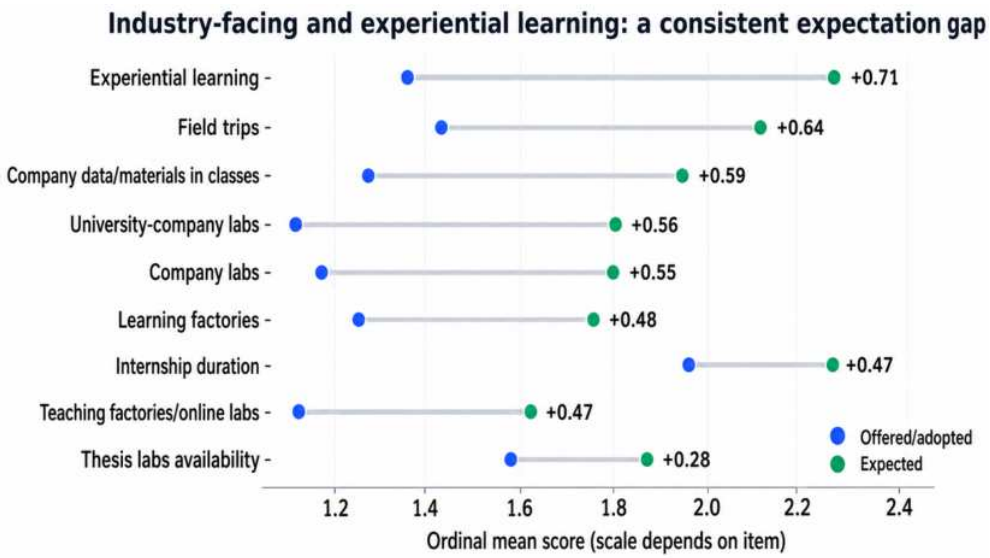


Figure 20. Industry-facing and experiential learning opportunities.

III.6 Teaching tools, AI study habits and student perceptions

Students' expectations regarding teaching tools point to substantial continuity with current practices. As shown in Figure 21, lecture notes are almost perfectly aligned with expectations, while modest increases emerge for books, online teaching tools and classroom ICT. PowerPoint and Blackboard remain the most frequently used tools, although students expect them to be used slightly less.

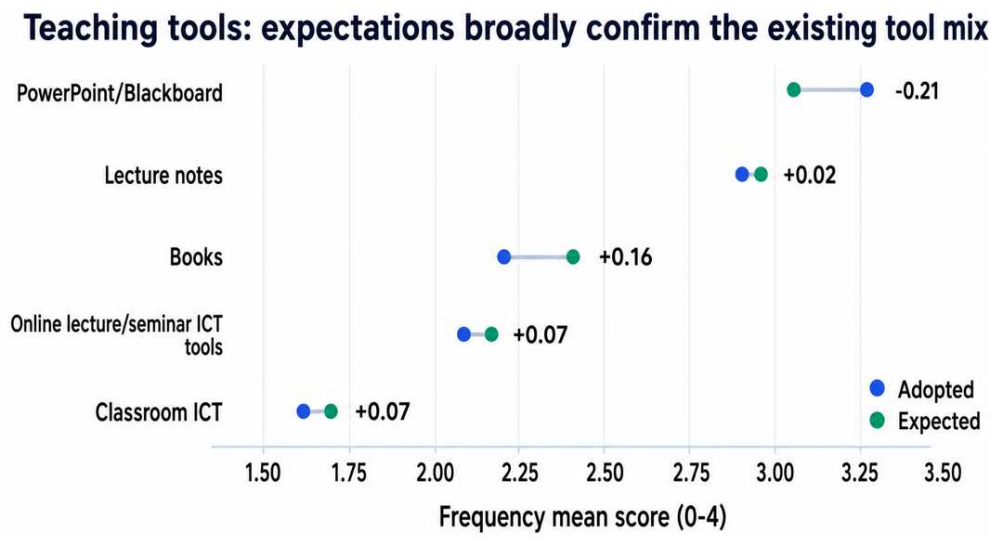


Figure 21. Teaching tools: adopted vs expected frequency.

A more substantial change emerges when the focus shifts to Generative AI. Figure 22 shows that its use for study activities is already widespread, with 42 of the 58 respondents reporting that they use it at least sometimes. However, confidence in verifying AI outputs is less developed, as most students report only a medium level of confidence. An even clearer gap concerns its practical integration into university laboratories: 33 respondents describe the current application of AI and Machine Learning as *'low'* or *'very low'*, while only seven rate it as high. This suggests that students' individual adoption of AI is progressing faster than its formal integration into teaching and laboratory activities.

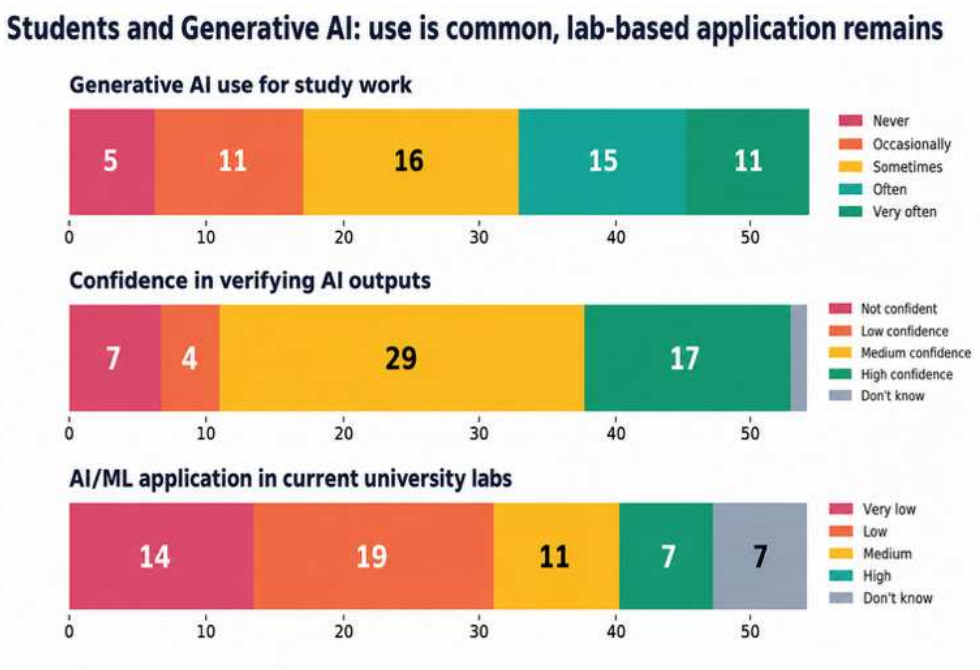


Figure 22. Generative AI use, verification of confidence and AI in labs.

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IV. Cross-stakeholder Survey Analysis

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IV.1 Executive Summary

The cross analysis involved 36 companies, 62 professors, and 58 master level students.

The analysis covers the 28 competence domains relevant to Master-level Industrial Engineering & Management education as already mentioned in the *'Methodological Note of the Survey'*.

Scores are mapped to a 0–3 scale: 0 = not required/not offered, 1 = low, 2 = medium, 3 = high. "Don't know" and missing answers are excluded from mean-score calculations.

The analysis shows that company requirements exceed the current academic offering gap aligned on the average with the perception of students. When compared with professors' planned coverage, the residual gap tends to reduce. This suggests that academic planning is directionally aligned with the market, although it does not completely absorb the demand premium observed in the company questionnaire.

More in detail, the most visible gaps 'Company-demand vs. against current Academic offering' are concentrated in Digital, Data & AI competences: *'Applied Prompt Engineering & AI Interfacing'*, '*Cyber Security', 'AI Ethics and Critical Verification', and 'Corporate Data Governance and AI Privacy'. 'Leadership'*and '*Communication Skills'*also emerge as strong cross-stakeholder gaps.

Against professors' planned coverage, the largest residual gaps remain in '*Cyber Security', 'Applied Prompt Engineering & AI Interfacing', 'AI Ethics and Critical Verification', 'Safety of Work', 'Corporate Data Governance and AI Privacy',* and '*Team Working'*. Planning narrows the average gap, but it does not fully close it in the fastest-moving or risk-sensitive competence areas.

Students and professors are almost aligned in their overall view of current offering. However, competence-level differences are substantial. Students perceive more current coverage in '*Safety of Work', 'Ergonomics', 'Prompt Engineering', 'ESG Strategy', 'AI Ethics and Critical Verification',* and '*Data Governance'*, while they perceive less coverage in '*Operations Management', 'Big Data Analysis', 'Management Software Tools', 'Logistics',* and '*Investment & Finance'*.

IV.2 Methodology and interpretation rules

The analysis combines three questionnaires: companies, professors and students. Each competence is evaluated through stakeholder-specific dimensions: companies report the required level, professors report current offered and planned academic coverage, and students report current offered and expected coverage.

The meaning of stakeholder-specific dimensions is in the following table.

Indicator	Meaning
Companies required	External labour-market requirement
Professors offered	Current academic offering
Professors planned	Planned academic coverage
Students offered	Students' perception of current offering
Students expected	Students' expected level of coverage
Company - Prof offered	Average current curriculum-demand gap
Company - Prof planned	Average residual gap after planning
Company - Student offered	Average employability-readiness gap perceived by students

All comparisons in the report are cross-stakeholder comparisons. The following pairs are analysed: Company requirements vs Professors offered; Company requirements vs Professors planned; Students offered vs Professors offered; Company requirements vs Students offered; Students expected vs Professors planned; and Students expected vs Company requirements. No analytical section compares two dimensions from the same stakeholder group.

Because the respondents are independent samples rather than matched dyads, gaps should be interpreted as differences between stakeholder-group averages, not as respondent-level differences. Mean score of each group used for cross-stakeholder comparisons is in figure 23 along with the percentage of (High + Medium) evaluations over the overall evaluations, expressed by each stakeholder.

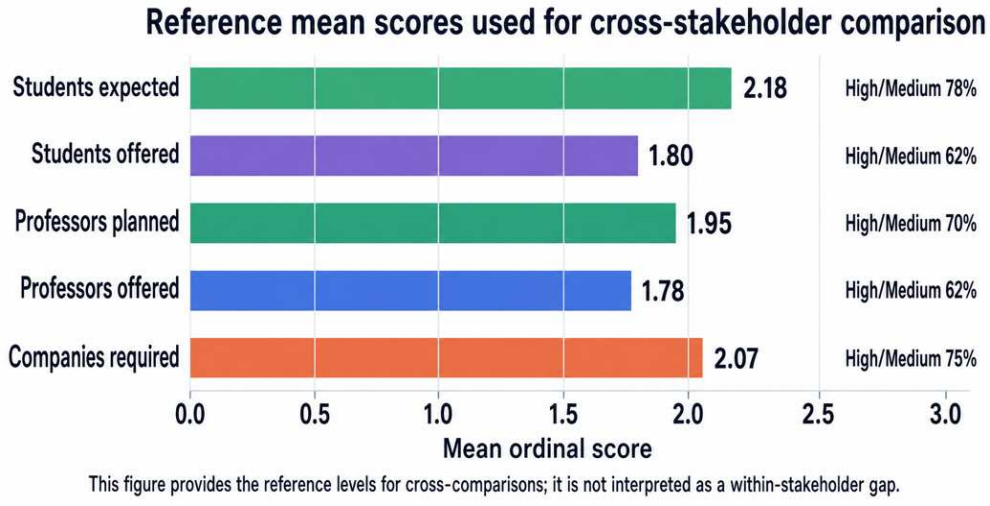


Figure 23. Reference mean scores used as the basis for the cross-stakeholder comparisons

IV.3 Professors offered vs Company requirements

This comparison evaluates whether the current academic offering, as perceived by professors, is aligned with the competences required by companies for recently graduated IE&M engineers. Results are in figures 24, 25, and 26. Positive values indicate that company requirements exceed the current offering; negative values indicate that the current offering is above the company mean.

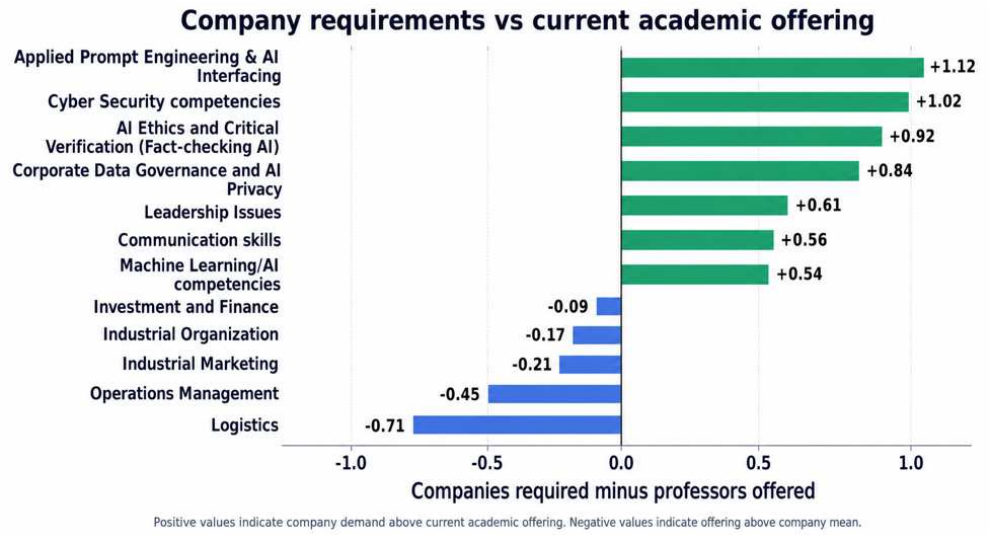


Figure 24. Largest positive and negative gaps: company requirements minus professors offered.

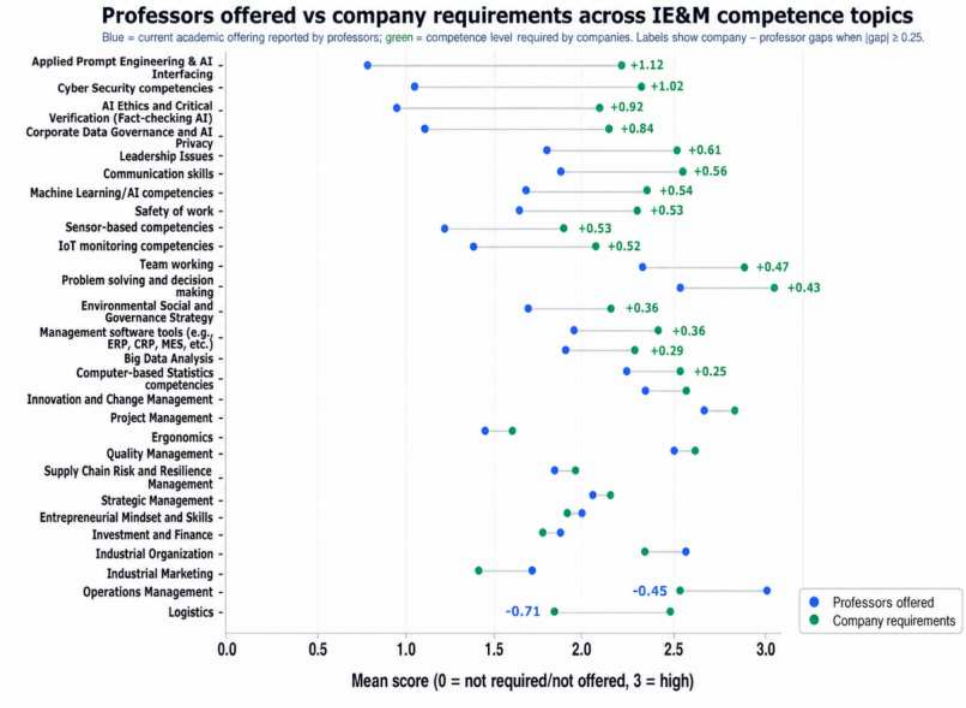


Figure 25. Largest positive and negative gaps: company requirements minus professors offered

The largest gaps concern digital and AI-intensive competences. Prompt Engineering, Cyber Security, AI Ethics, and Data Governance are all above +0.80 against the maximum theoretical Gap = 3. This is a strong signal that companies expect graduates to be operationally conversant with AI-enabled work, data governance and security risks, whereas these topics are still less mature in current curricula.

The negative side of the chart is concentrated in traditional IE&M areas: Logistics (-0.71), Operations Management (-0.45), Industrial Marketing (-0.21) and Industrial Organization (-0.17). These are not necessarily "over-taught" areas; rather, the mean academic coverage is higher than the mean requirement reported by companies in this sample. In other words, negative gaps may be associated with full satisfactory offer by academia.

The same mean scores are visualized in the scatter alignment map in figure IV.5 and successive table.

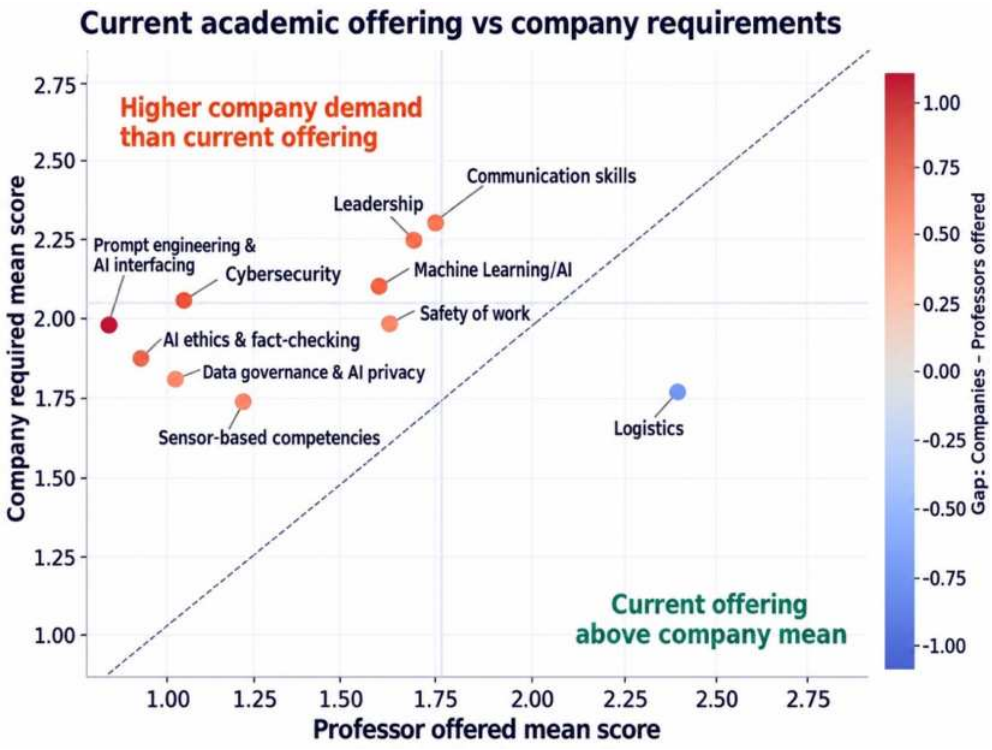


Figure 26. Scatter alignment map: Professors offered vs Company requirements

Numerical values shown in table 3 can better clarify what is expected by companies against the academia offering. Operations management is at the top of the offer (2.77 on a 3 max value) and companies recognize such competence (2.31). As observed in AI use, the academic offering could rationalize the programs of Operations Management by introducing AI applications. The percentages of (Medium + High) evaluations are greater than 90 % witnessing low uncertainty by both Companies and Professors. A different conclusion should be drawn for Industrial Marketing (1.44), and Logistics (1.75) whose companies' score is below the value 'medium' against an offering exceeding such a value.

Table 3. Professors offered vs Company requirements

Competence	Companies required	Professors offered	Gap	Companies High+ Medium	Professors High + Medium
Prompt Engineering & AI Interfacing	1.97	0.85	+1.12	76%	17%
Cyber Security competencies	2.06	1.04	+1.02	77%	27%
AI Ethics and Critical Verification (Fact-checking AI)	1.88	0.96	+0.92	65%	25%
Corporate Data Governance and AI Privacy	1.91	1.07	+0.84	60%	30%
Leadership Issues	2.26	1.65	+0.61	80%	58%
Communication skills	2.28	1.72	+0.56	81%	62%
Industrial Organization	2.14	2.31	-0.17	78%	85%
Industrial Marketing	1.44	1.66	-0.21	53%	62%
Operations Management	2.31	2.77	-0.45	91%	97%
Logistics	1.75	2.46	-0.71	67%	87%

IV.4 Professors planned vs Company requirements

The planned dimension represents how professors expect academic coverage to evolve. This comparison reported in figures 27 and 28, therefore highlights residual gaps between the future academic plan and company requirements. Positive values should be read as curriculum-updating priorities.

Planning clearly reduces (generally halved) the overall company-academia gap, yet several gaps remain substantial. Cyber Security and Prompt Engineering both remain at +0.64. AI Ethics (+0.54), and Data Governance (+0.48) also remain substantial.

A novel high GAP is observed in Safety of Work (+0.50): competence by companies should be covered by academia in the planning stage.

Differently, planning increases the gap in Industrial Marketing (from -0.21 at current to -0.43 planned) and Investment and Finance (from -0.09 to -0.21) witnessing unjustified efforts by academia if compared with companies' requirements.

Almost unchanged in the prospective planned stage are the negative Gaps in IE&M skills, Operations Management and Logistics. Further efforts are required for *'team-working'*.

These results suggest that future curriculum plans acknowledge the direction of change, but the planned level may still be insufficient for some fast-moving or high-risk competences.

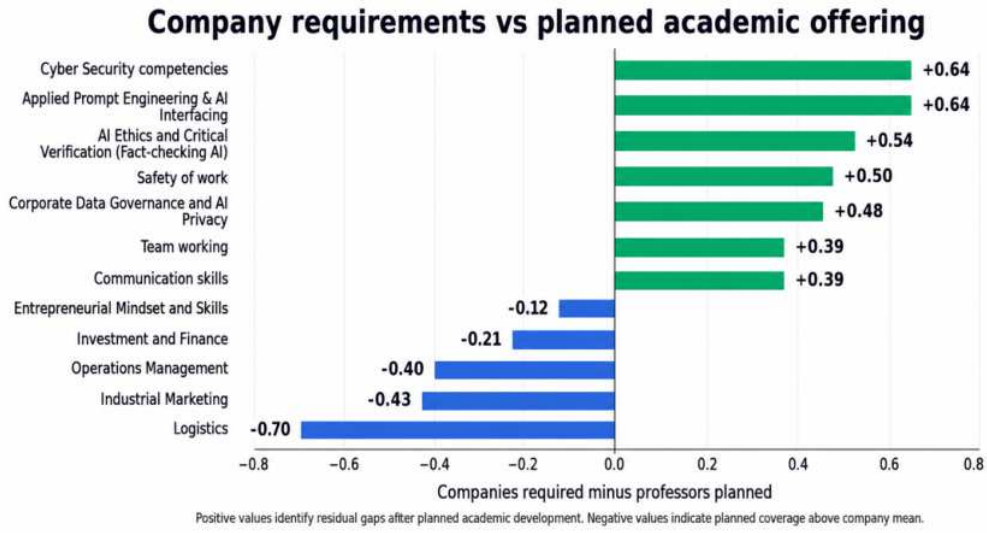


Figure 27. Largest residual gaps: Company requirements minus Professors planned

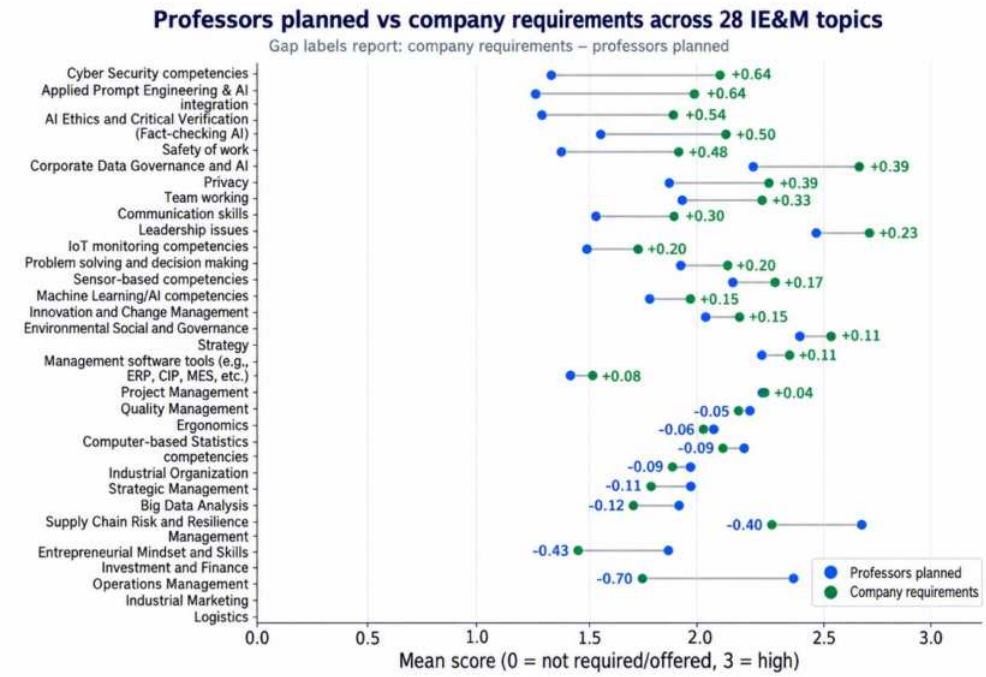


Figure 28. Largest residual gaps: Company requirements minus Professors planned

The scatter map in figure 29 confirms that the strongest residual gaps combine two conditions: company relevance is medium-to-high and academic planning remains below the company level. Conversely, Logistics, Industrial Marketing and Operations Management are in the area where academic planning is above company mean demand. For negative values of gaps, it's worth considering also the company required mean score. This is the case of Operations Management whose score of 2.71 approaches the maximum, witnessing the attention that IE&M community traditionally paid in higher education (and research) on that subject.

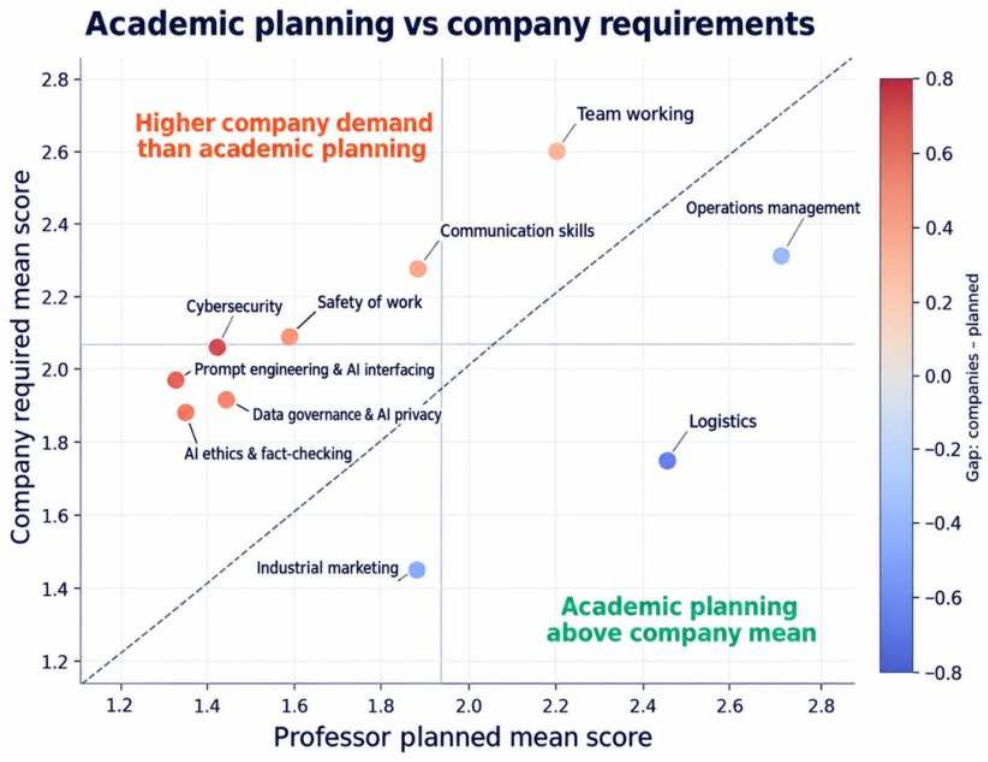


Figure 29. Scatter alignment map: Professors planned vs Company requirements

The table 4 reports numerical values of mean scores for the competence with the largest gaps.

Table 4. Professors planned vs Company requirements

Competence	Companies required	Professors planned	Gap	Companies High + Medium	Professors High + Medium
Cyber Security competencies	2.06	1.42	+0.64	77%	50%
Applied Prompt Engineering & AI Interfacing	1.97	1.33	+0.64	76%	41%
AI Ethics and Critical Verification (Fact-checking AI)	1.88	1.35	+0.54	65%	37%
Safety of work	2.08	1.59	+0.50	75%	57%
Corporate Data Governance and AI Privacy	1.91	1.44	+0.48	60%	46%
Team working	2.60	2.21	+0.39	94%	83%
Investment and Finance	1.69	1.91	-0.21	69%	68%
Operations Management	2.31	2.71	-0.40	91%	94%
Industrial Marketing	1.44	1.87	-0.43	53%	72%
Logistics	1.75	2.45	-0.70	67%	87%

IV. 5 Students offered vs Professors offered

This comparison evaluates whether students and professors perceive the current academic offering in the same way. Positive values indicate that students report more coverage than professors; negative values indicate that students report less coverage than professors. The largest divergences are in figures 30, 31, 32, and table 5.

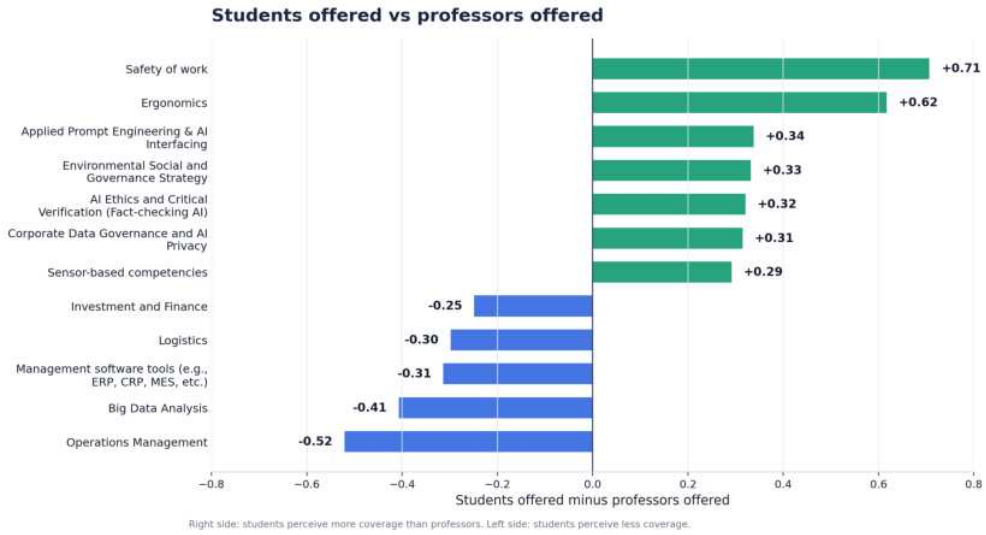


Figure 30. Largest divergences: Students offered minus Professors offered

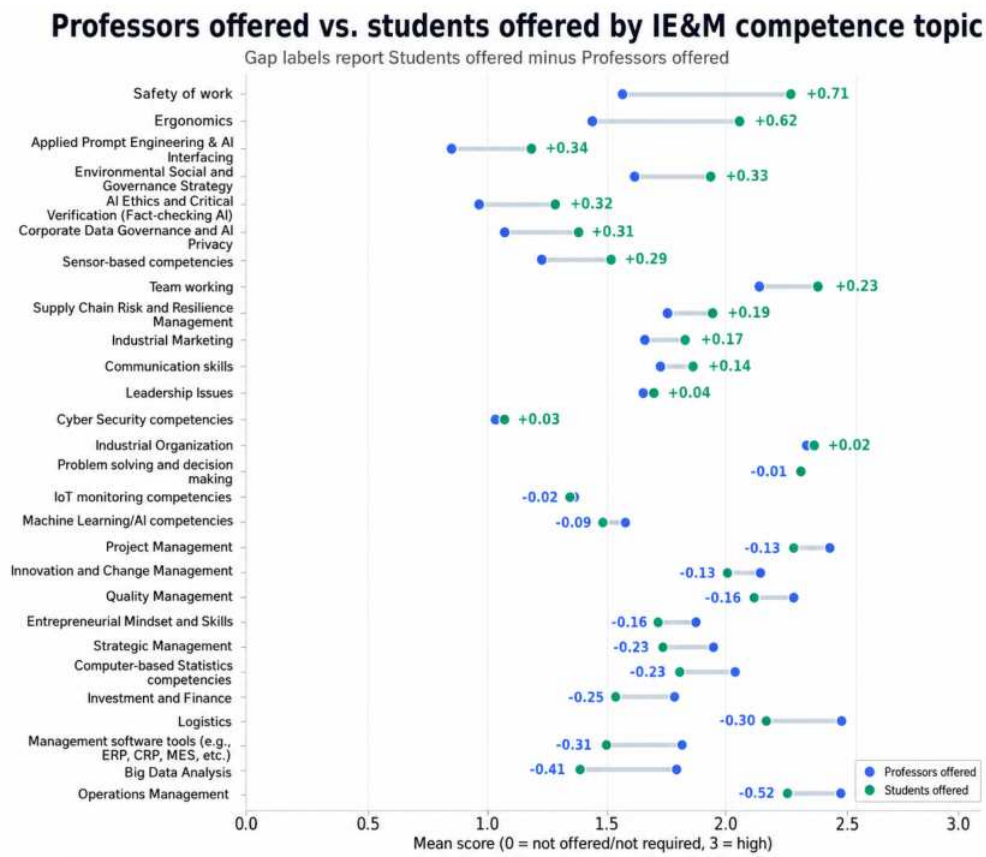


Figure 31. Largest divergences: Students offered minus Professors offered

The aggregate gap is close to zero, but competence-level divergences are meaningful. Students perceive substantially higher exposure to Safety of Work and Ergonomics, and moderately higher exposure to Prompt Engineering, ESG Strategy, AI Ethics and Data Governance. These differences may reflect applied experiences, cross-course exposure or terminology differences.

In contrast, students perceive less coverage than professors in Operations Management, Big Data Analysis, Management Software Tools, Logistics and Investment & Finance. These are important diagnostic signals: content may exist in curricula but not be sufficiently visible, explicit or recognisable to students under these competence labels.

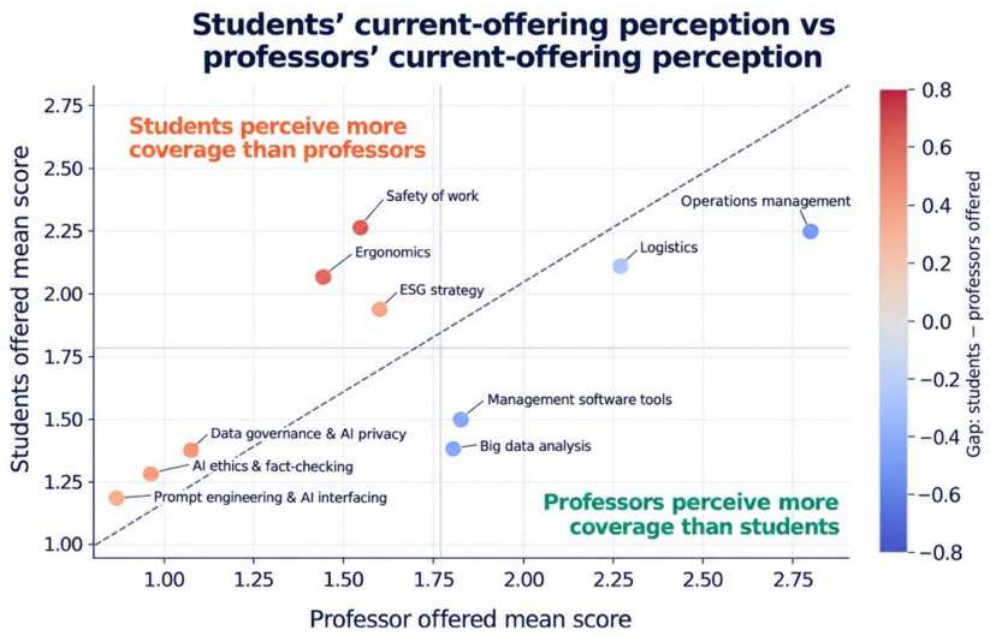


Figure 32. Scatter alignment map: Students offered vs Professors offered

Table 5. Students offered vs Professors offered

Competence	Students offered	Professors offered	Gap	Students High/Medium	Professors High/Medium
Safety of work	2.26	1.55	+0.71	81%	52%
Ergonomics	2.06	1.44	+0.62	72%	42%
Applied Prompt Engineering & AI Interfacing	1.19	0.85	+0.34	37%	17%
Environmental Social and Governance Strategy	1.94	1.61	+0.33	69%	58%
AI Ethics and Critical Verification (Fact-checking AI)	1.29	0.96	+0.32	39%	25%
Corporate Data Governance and AI Privacy	1.39	1.07	+0.31	46%	30%
Investment and Finance	1.53	1.78	-0.25	47%	67%
Logistics	2.16	2.46	-0.30	77%	87%
Management software tools (e.g., ERP, CRP, MES, etc.)	1.50	1.81	-0.31	46%	63%
Big Data Analysis	1.39	1.80	-0.41	43%	65%
Operations Management	2.25	2.77	-0.52	86%	97%

IV.6 Company requirements vs Students' perceived offering

This comparison approximates an employability-readiness gap from the students' perspective. It asks whether the competences students perceive as currently offered match what companies require from graduates.

Results are in figures 33 and 34.

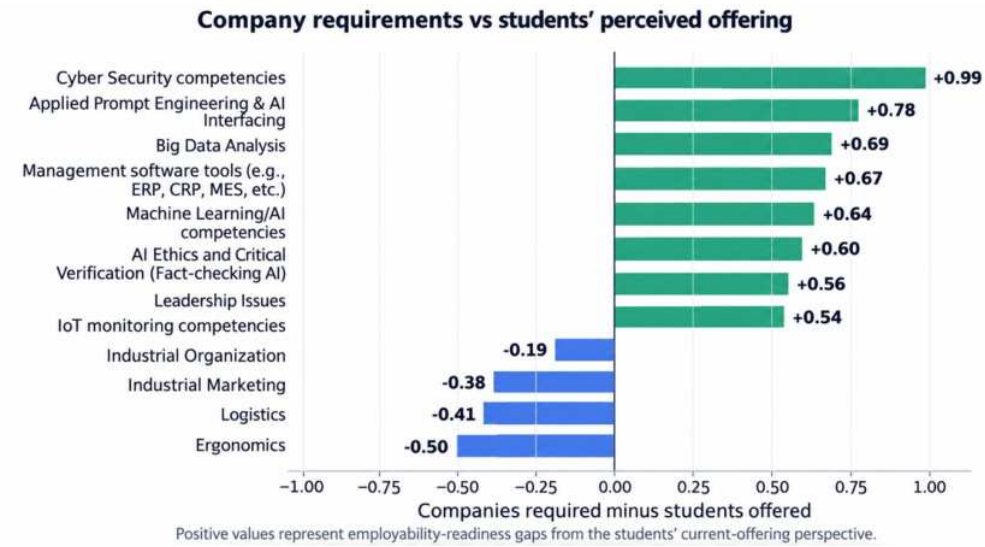


Figure 33. Employability-readiness gap: Company requirements minus Students offered

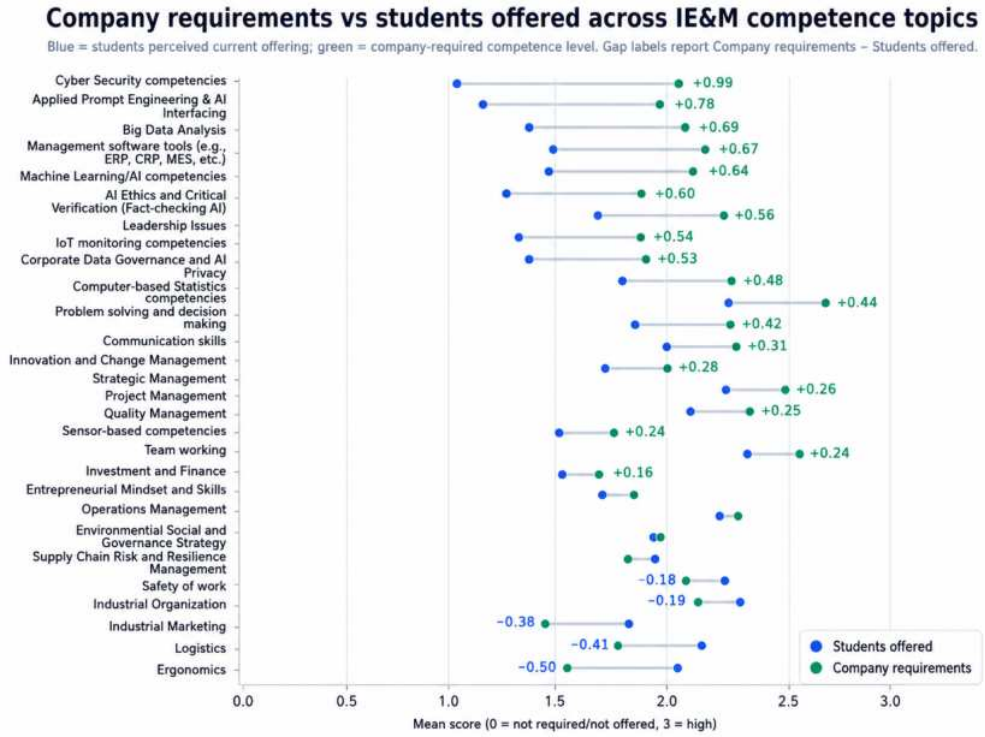


Figure 34. Employability-readiness gap: Company requirements minus Students offered

The strongest readiness gaps are Cyber Security (+0.99), Prompt Engineering (+0.78), Big Data Analysis (+0.69), Management Software Tools (+0.67), Machine Learning/AI (+0.64), and AI Ethics (+0.60). This cluster indicates that, from the student-offering perspective, the most urgent market-alignment challenge is the practical digital/AI capability set.

IV.7 Students expected vs Professors planned

This comparison contrasts student expectations with professors' planned coverage. It is useful for identifying areas where future curriculum planning may not fully match what students expect to receive during their Master-level education.

Results are in figures 35 and 36.

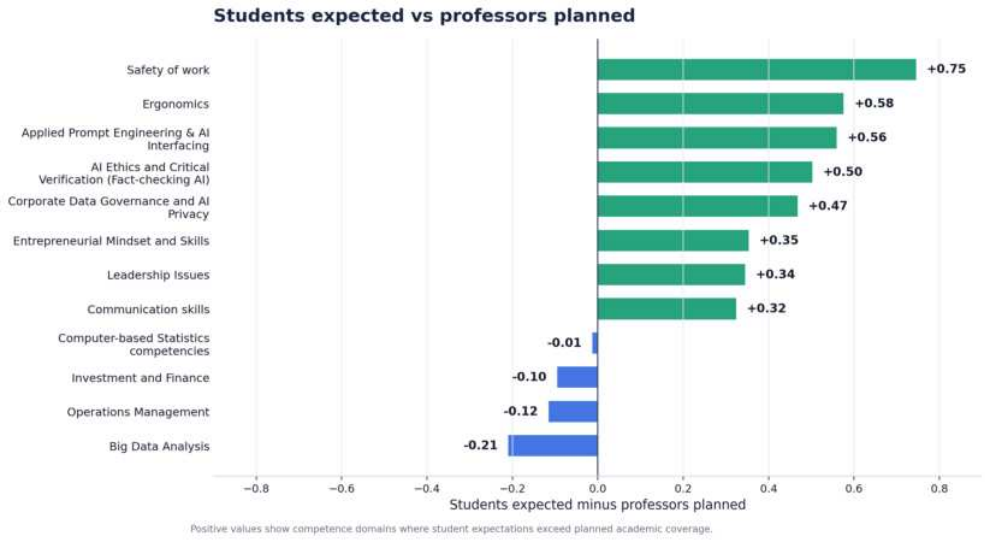


Figure 35. Students expected minus Professors planned

Student expectations exceed professors' planning especially in Safety of Work (+0.75), Ergonomics (+0.58), Prompt Engineering (+0.56), AI Ethics (+0.50), Data Governance (+0.47), and Entrepreneurial Mindset (+0.35). This combination of safety, human factors, AI governance and entrepreneurship suggests that students expect an IE&M curriculum that is both technologically current and practically oriented.

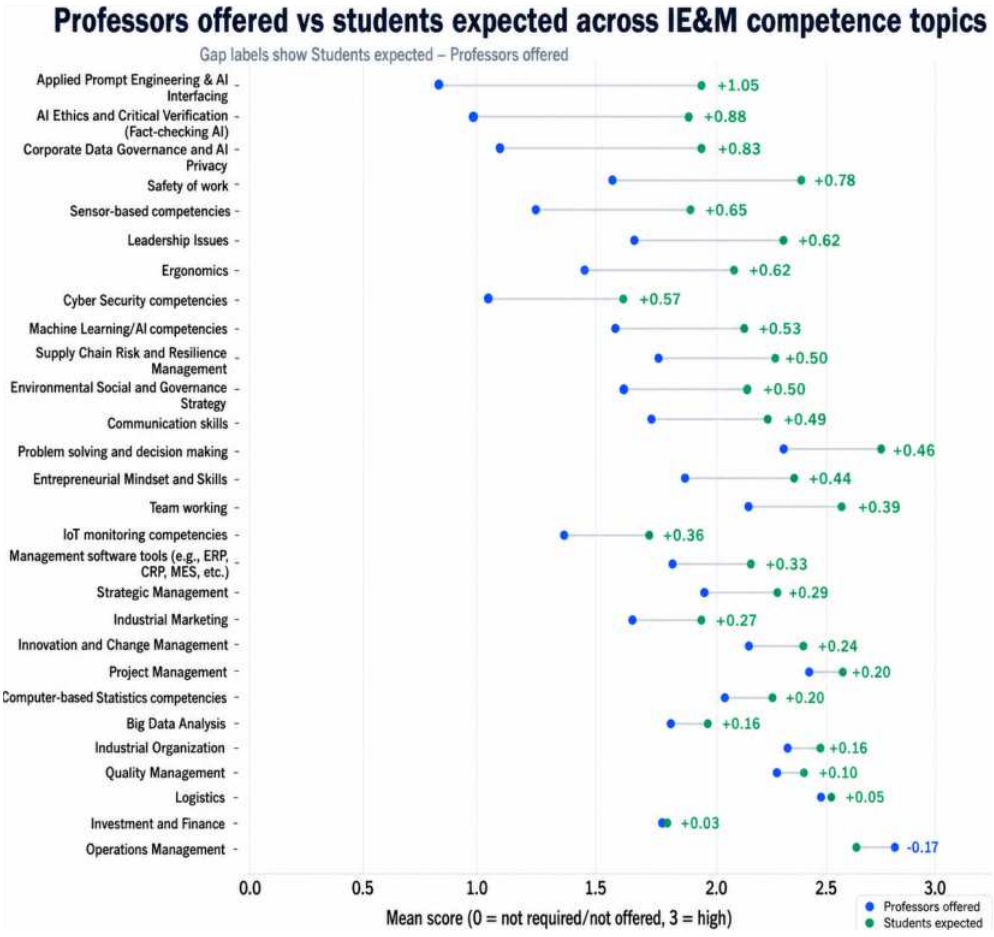


Figure 36. Students expected minus Professors offered

IV.8 Students expected vs Company requirements

Students do not always expect the same competence profile that companies require. Results of the comparison are in figure 37.

Positive values indicate areas where student expectations exceed company requirements; negative values indicate areas where companies require more than students expect.

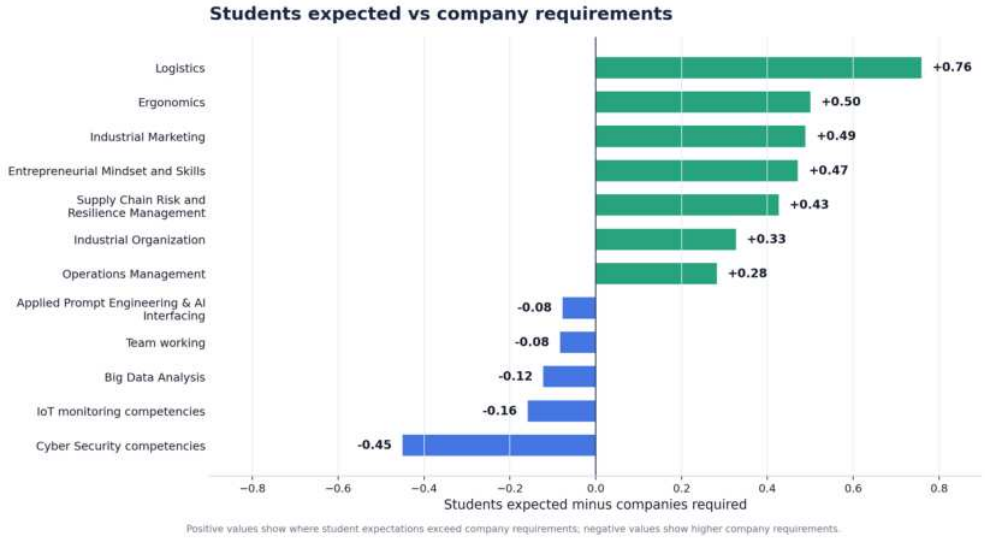


Figure 37. Students expected minus company requirements

The largest positive student-expectation premiums over company requirements, summarized in table 6, are Logistics (+0.76), Ergonomics (+0.50), Industrial Marketing (+0.49), Entrepreneurial Mindset (+0.47), Supply Chain Risk & Resilience Management (+0.43), and Industrial Organization (+0.33). Conversely, company requirements exceed student expectations most clearly for Cyber Security (-0.45), IoT Monitoring (-0.16), Big Data Analysis (-0.12).

Table 6. Students expected versus company requirements

Competence	Students expected	Companies required	Gap
Logistics	2.51	1.75	+0.76
Ergonomics	2.06	1.56	+0.50
Industrial Marketing	1.93	1.44	+0.49
Entrepreneurial Mindset and Skills	2.31	1.84	+0.47
Supply Chain Risk and Resilience Management	2.25	1.83	+0.43
Industrial Organization	2.47	2.14	+0.33
Applied Prompt Engineering & AI Interfacing	1.89	1.97	-0.08
Team working	2.52	2.60	-0.08
Big Data Analysis	1.96	2.09	-0.12
IoT monitoring competencies	1.72	1.88	-0.16
Cyber Security competencies	1.61	2.06	-0.45

IV. 9 Cross-gap synthesis by competence and macro-area

The following matrix in figure 38 summarizes all major cross-stakeholder gaps by competence. It is designed to be read horizontally: each column is a cross-stakeholder comparison, and each cell reports the difference between the first and second dimension named in the column.

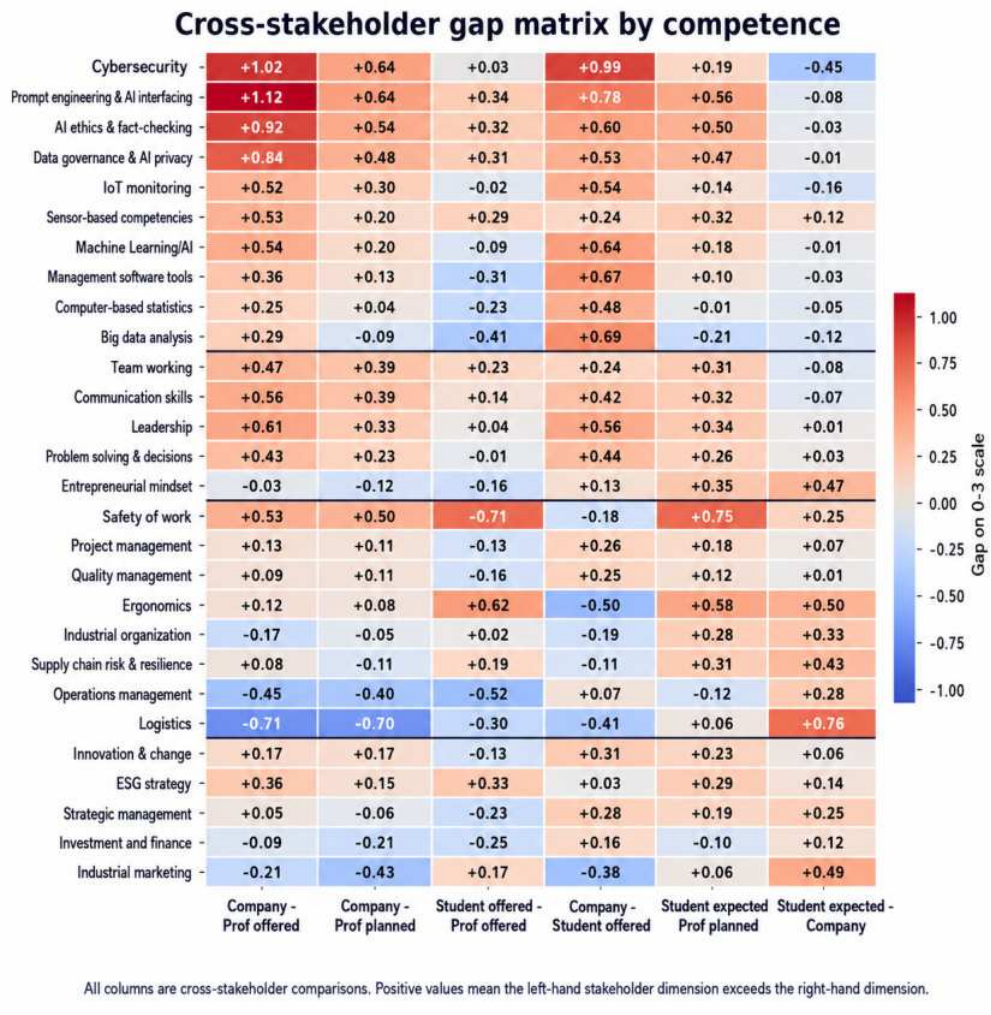


Figure 38. Cross-stakeholder gap matrix by competence

The matrix confirms that Digital, Data & AI is the most consistently exposed macro-area across comparisons. Company demand exceeds both professors' current and planned coverage, and it also exceeds students' perceived offering. At the same time, student expectations exceed planned academic coverage in Safety of work, Ergonomics, AI governance / ethics and Prompt engineering, indicating pressure from both the labour market and the learner side.

At macro-area level (figure 39 and table 7), the largest company-professor offered gap (first column) is in Digital, Data & AI. Human & Managerial Skills also show a strong gap between company requirements and professors' offered coverage. A similar situation is observed in the Company vs. Student offered comparison (fourth column). The planning of academia tends to reduce, on the average, major gaps with company requirements (second column) while students' expectations tend to increase more than professors' planned coverage (third and fifth columns).

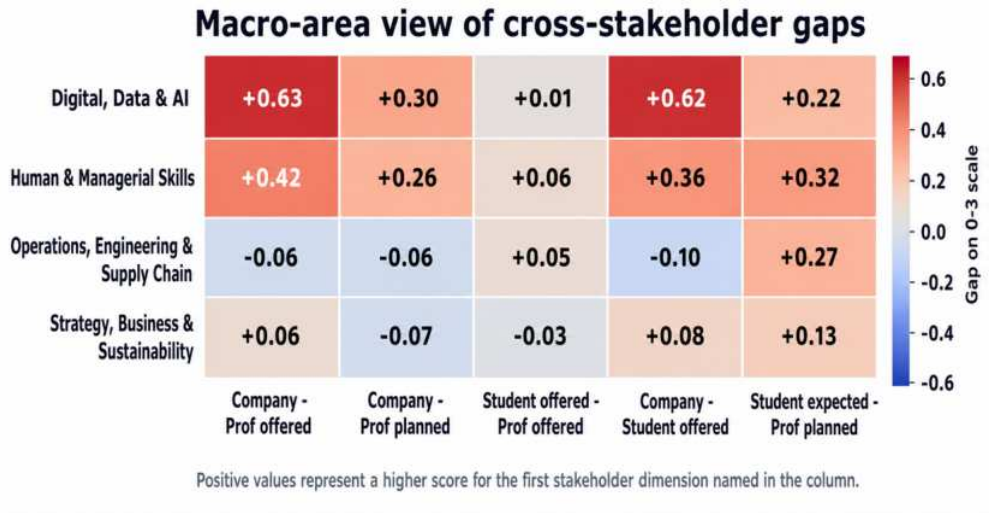


Figure 39. Macro-area cross-gap heatmap

Table 7. Company vs student at Macro-area level

Macro-area	Company - Prof offered	Company - Prof planned	Student offered - Prof offered	Company - Student offered	Student expected - Prof planned
Digital, Data & AI	+0.63	+0.30	+0.01	+0.62	+0.22
Human & Managerial Skills	+0.42	+0.26	+0.06	+0.36	+0.32
Operations, Engineering & Supply Chain	-0.06	-0.06	+0.05	-0.10	+0.27
Strategy, Business & Sustainability	+0.06	-0.07	-0.03	+0.08	+0.13

IV.10 Further Statistics on Cross Analysis

This chapter aims at evaluating the variability of judgements of each stakeholder category on the 28 competences listed in the following table:

QuestionID	Competence
Q1	1. Project Management
Q2	2. Operations Management
Q3	3. Quality Management
Q4	4. Logistics
Q5	5. Problem solving and decision making
Q6	6. Industrial Organization
Q7	7. Industrial Marketing
Q8	8. Investment and Finance
Q9	9. Strategic Management
Q10	10. Innovation and Change Management
Q11	11. Entrepreneurial Mindset and Skills
Q12	12. Leadership Issues
Q13	13. Ergonomics
Q14	14. Safety of work
Q15	15. Communication skills
Q16	16. Team working
Q17	17. Environmental Social and Governance Strategy
Q18	18. Supply Chain Risk and Resilience Management
Q19	19. Corporate Data Governance and AI Privacy
Q20	20. AI Ethics and Critical Verification (Fact-checking AI)
Q21	21. Cyber Security competencies
Q22	22. Sensor-based competencies
Q23	23. IoT monitoring competencies
Q24	24. Computer-based Statistics competencies
Q25	25. Management software tools (e.g., ERP, CRP, MES, etc.)
Q26	26. Big Data Analysis
Q27	27. Machine Learning/AI competencies
Q28	28. Applied Prompt Engineering & AI Interfacing

The chi-square test was used to verify whether the distribution of qualitative responses varies significantly across the five stakeholder categories (Companies required, Professors offer, Professor planned, Students offer, Students expected).

In other words, for each competence area (Q1÷Q28), the test answers the following question: *'do the different stakeholders respond similarly?'*

Figure IV.19 shows, for each competence area, the Holm-corrected p-value for the chi-square test of independence. The Holm correction was applied because many tests are performed, one for each competence area. It therefore serves to reduce the risk of finding significant results solely due to the large number of comparisons.

The null hypothesis of the test is: 'there is no difference between stakeholders for a given competence area at a statistical significance level'. If the p-value is higher than the significance level, the distribution of responses is significantly similar between stakeholders for that competence area, i.e. the null hypothesis is verified.

The graph shows a dashed horizontal line at p = 0.05, which represents the threshold for statistical significance. The points above this line indicate competence areas for which the null hypothesis is verified.

The vertical axis is logarithmic because some p-values are very small and, on a linear scale, would be difficult to distinguish visually. Trend of p-Values in figure 40 shows that the distribution of responses outlines that no statistical evidence of divergence is observed for 7 out of 28 competence areas, listed in the following table:

Q3	Quality Management
Q10	Innovation and Change Management
Q11	Entrepreneurial Mindset and Skills
Q17	Environmental Social and Governance Strategy
Q18	Supply Chain Risk and Resilience Management
Q23	IoT monitoring competencies
Q24	Computer-based Statistics competencies

In other words, there is a significant accordance among the stakeholders about the above-listed competence areas.

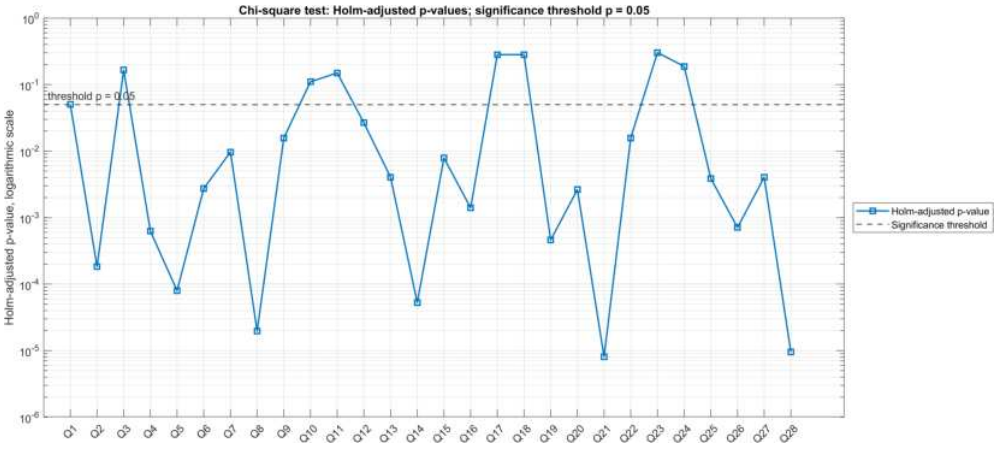


Figure 40. Chi-square test: Holm-corrected p-values

However, a more detailed analysis is required to outline divergences between each couple of stakeholders. To this end the Mann-Whitney test has been adopted. Compared to the chi-square test, this analysis has a different function. The chi-square test examines whether the overall distribution of response categories changes across all stakeholders. The Mann-Whitney test directly compares two stakeholders for each question. Results are in figure 41.

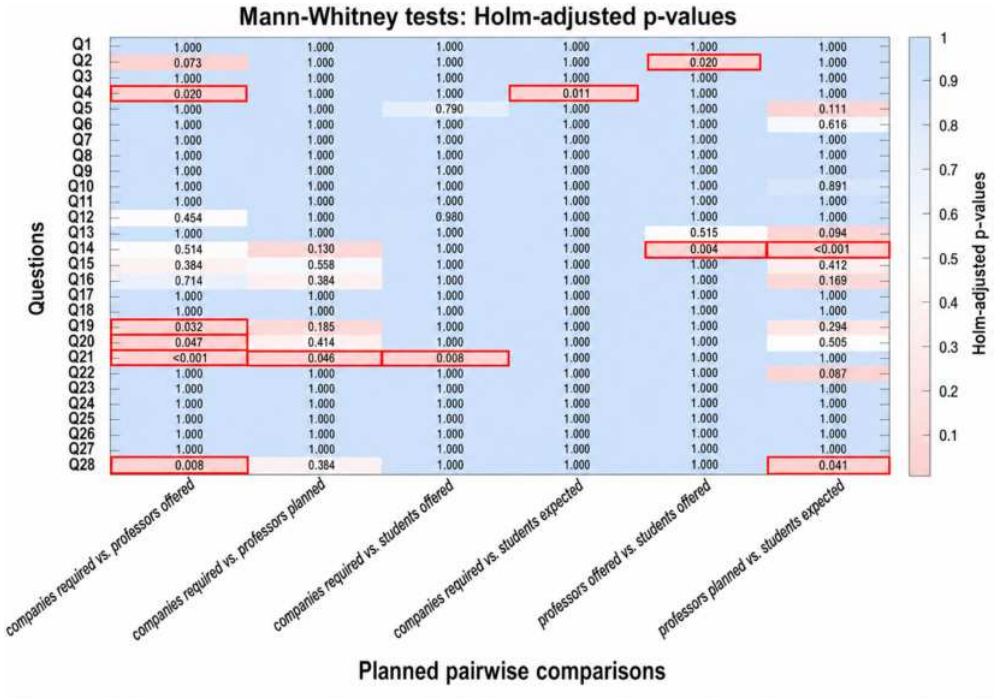


Figure 41. Mann-Whitney: map of Holm-Adjusted p-values

Each row in the table represents a competence area (question from Q1 to Q28) while each column represents a specific couple of stakeholders under comparison. Within each cell, the Holm-adjusted p-value is reported. For a competence area, cells with lower values indicate greater statistical difference between the distributions of values expressed by two stakeholders, for that competence area. Cells with a red border highlight statistically significant comparisons, i.e., those in which the Holm-adjusted p-value is less than 0.05.

This figure therefore helps to understand for which competence areas and for which couple of stakeholders the responses' distributions differ significantly.

Looking at red-rounded boxes one can observe:

1.The number of statistical divergences is limited to 12 comparisons out of 28 x 6 = 168 comparisons, so a good general accordance has been observed among the stakeholders' categories on almost all questions.
2.Divergences are concentrated between 'Companies required' vs. 'Professors offered' on *'Logistics'* (Q4) (more offered than required), while more competence is required by companies for *'Corporate Data Governance and AI Privacy'* (Q19), *'AI Ethics and Critical Verification (Fact-checking AI)'* (Q20), *'Cyber Security'* competencies (Q21), and 'Applied Prompt Engineering & AI Interfacing' (Q28).
3.*'Cyber Security'* competencies (Q21) required by companies seems to be not well aligned also with Professors planned; divergence is observed also with Students offer.
4.*'Operations Management'* (Q2) and *'Safety of work'* (Q14) offered statistically differ from students' perception; in the planning stage of professors, *'Safety of work'* and *'Applied Prompt Engineering & AI Interfacing'* (Q28) are lower than students' expectations.
5.Competence expected by students are statistically aligned with Companies expectations in almost questions with only one exception for Logistics (Q4) where expectations from companies are lower than students' expectations.

IV.11 Implications for Master-level IE&M curriculum development

First; the highest-priority cross-stakeholder gap is not a single course topic but a competence cluster: cybersecurity, prompt engineering, AI ethics, data governance, big data and management software tools. This cluster should be addressed through integrated learning outcomes rather than isolated optional lectures.

Second: company requirements point to a hybrid graduate profile. The labour market values traditional IE&M competences such as project management, operations, quality and problem solving, but the strongest gaps occur where these competences intersect with AI-enabled work, data governance and cyber-resilient operations.

Third: student-professor perception gaps indicate that competence visibility matters. Where students report less coverage than professors, the curriculum may need clearer labelling, explicit learning outcomes, demonstrable artefacts and assessment tasks that make the competence visible to students.

Students report significantly lower coverage than professors in core traditional domains such as Operations Management, Big Data Analysis, and Management Software Tools / ERP (figure 38). This highlights a critical "curriculum visibility gap". Although professors claim these topics are taught, students either do not recognize them under these labels, or the teaching remains overly theoretical rather than applied through practical tools. The relevance of such transversal dimensions should be stressed in the education plans.

Fourth: future planning appears directionally aligned with companies, but residual gaps (e.g. Safety of Work) remain in areas where technology, regulation and organisational risk evolve quickly. Cyber Security, Prompt Engineering, AI Ethics, and Data Governance exhibit the largest gaps between company demand and academic provision. Residual gaps remain even in future academic plans (figure 38).

These topics may require agile curriculum mechanisms, short modules, living case studies, industry datasets, micro-learning units and recurring review with industrial partners.

IV.12. Recommendations

- Create an integrated Digital, Data & AI spine across the Master curriculum, connecting AI ethics, prompt engineering, data governance, cybersecurity, big data and management software tools to operational decision-making.
- Translate company-demand gaps into assessable learning outcomes, especially for Cyber Security, Prompt Engineering, AI Ethics, Data Governance, Safety of Work and Team Working.
- Use applied cases, industry data and project-based assignments to make digital and managerial competences visible to students and measurable by professors.
- Run a curriculum-visibility audit for competences where students perceive less current coverage than professors, especially Operations Management, Big Data Analysis, Management Software Tools.

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V.1 Scope

The Survey carried out by the European Observatory expands the critical commentary of the previous report carried out by the IE3 Erasmus Plus Project[3]. It keeps the analytical boundary unchanged: the document compares the 2020 and 2026 survey waves within the same stakeholder dimension only. It therefore discusses how companies, professors and students changed their opinions over time, without estimating cross-stakeholder gaps.

The trend analysis compares 23 comparable IE&M topics (e.g. competence areas) across five stakeholder dimensions: companies required, professors offered, professors planned, students offered and students expected. The further 5 topics included in the 2026 survey relate to AI and digital competence; such topics were not considered in the 2020 Survey as AI was almost absent both in work environment and in higher education.

In Appendix A the list of comparable topics.

Terminology used in the report

Professors offered = topics currently taught. Professors planned = topics that should be taught or are planned. Students offered = topics currently received by students. Students expected = topics that students would like to know. Companies required = level of expertise required from IE&M graduates.

Appendix B provides scores by each stakeholder for each topic.

Scores are mapped to a 0-3 scale, where 0 = not required/not offered, 1 = low, 2 = medium and 3 = high. Blank answers and "don't know" responses are excluded from mean-score calculations.

V.2 Executive summary and critical interpretation

The *'2020-2026'* evolution is not a story of uniform growth. Company requirements increased slightly in each competence area. Similarly, professors reported a modest rise in current offering, while professors planned coverage declined sharply. Students perceived a stronger current offering in 2026, but their expected coverage decreased.

Critical reading

The main critical message is that the six-year period appears to be one of curriculum consolidation rather than universal expansion. Current exposure increased for professors and students, while forward-looking dimensions - professors planned and students expected - became more selective. This pattern can be interpreted as a maturation effect: by 2026, some competences may have moved from aspirational intentions into actual offering, reducing the need to rate them as future priorities. Being the comparison concerned 23 out of 28 competence the trend analysis does not consider the AI-digital based competence which represents the main novelty in last six years both in competence required by companies and in the academic offering.

Interpretive implication

Programme committees should not read lower planned or expected scores as automatic evidence of declining ambition. They should ask whether these lower scores reflect real de-prioritisation, improved current coverage or more realistic planning.

Methodological caution

The two survey waves are not a matched panel of the same respondents. The observed movements are group-level differences between 2020 and 2026 samples, not individual longitudinal changes.

The share of valid answers rated medium or high in both 2020 and 2026 surveys is in figure 42.

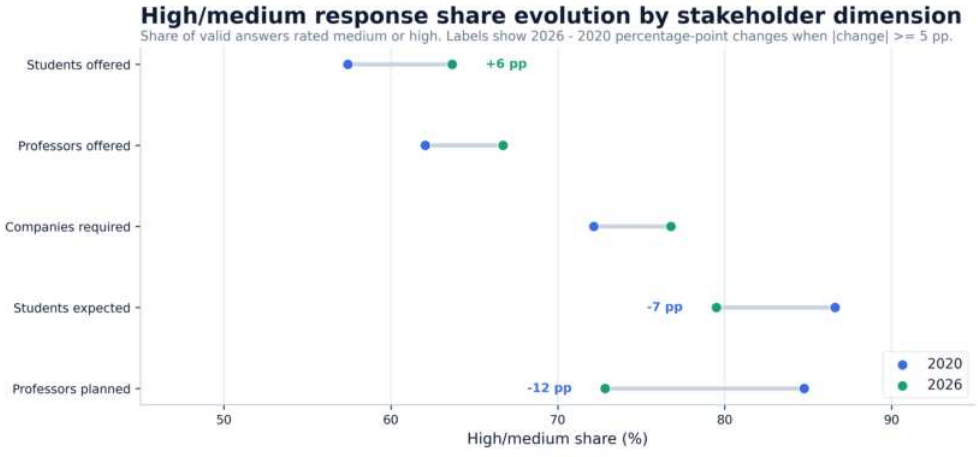


Figure 42. High/medium response share evolution by stakeholder dimension

Companies classified competences as medium or high more often in 2026 (+4.6 percentage points), and students reported a stronger

3

current offering (+6.3 percentage points). In contrast, the share of medium/high ratings fell for professors planned (-11.9 percentage points) and students expected (-7.1 percentage points).

Critical reading

The high/medium results suggest a selective tightening of future-looking evaluations. In 2020, planned and expected coverage may have reflected a broad ambition to include many topics in IE&M curricula. By 2026, respondents may have become more discriminating, possibly distinguishing between core competences, elective specialisations and complementary training.

Interpretive implication

This pattern supports the use of priority-based curriculum design. Rather than simply adding new topics, institutions should define which competences are mandatory at Master level, which belong in elective tracks, and which can be delivered through micro-credentials or industry projects.

Methodological caution

A mean-score decrease in planned or expected dimensions does not reveal the reason for the decrease. Future surveys should ask respondents why an item is rated lower: because it is already covered, because it is less relevant, because there is no capacity to teach it, or because it should be taught outside the core programme.

V.3 Methodological framework and limitations

The trend analysis deliberately avoids cross-stakeholder comparisons. Each figure compares the same variable across time: for instance, *'companies required'* in 2020 versus *'companies required'* in 2026, or *'students expected'* in 2020 versus *'students expected'* in 2026. This design keeps the interpretation focused on temporal change within each stakeholder category.

The scoring logic converts ordered categorical answers into a 0-3 numerical scale. This supports synthetic comparison across topics, but it also compresses ordinal judgements into mean values. For this reason, the commentary treats mean-score changes as directional indicators rather than precise interval-scale measurements.

Why same-category comparison matters

The same-category approach answers a specific question: how did each stakeholder group change between 2020 and 2026? It does not answer whether one group is more aligned than another. That would require a different cross-stakeholder analysis, which is intentionally excluded from this report.

Critical limitation

Because respondent pools may differ between survey waves, a 2026-2020 change may reflect actual evolution in curricula or industry needs, but it may also partly reflect different institutions, countries, programmes, company sectors or student cohorts represented in the sample.

V.4 Overall time-series dynamics

The aggregate results show three simultaneous processes. First, current exposure appears to have strengthened: professors offered and students offered both increased. Second, future-oriented judgements became less expansive: professors planned and students expected both declined. Third, company requirements rose only moderately overall, while changing more sharply in specific topics.

This combination is analytically important. A superficial reading would focus only on whether each dimension rises or falls. A more critical reading is that IE&M higher education may have moved from a phase of broad ambition in 2020 to a phase of more selective institutionalisation in 2026. In other words, some topics may no longer be "future needs" because they have entered the actual teaching portfolio, whereas other topics remain unresolved because they require specialised faculty, updated laboratories, industrial datasets or stronger digital infrastructure. Under this scenario should be considered also the progressive, currently slow, introduction of AI-based competence offering in academic programs (see Chapter II).

V.5 Companies required expertise: 2020 vs 2026

The 2020-2026 trend on competence required by companies can be observed in figure 43 and table 8 Company requirements increased slightly on each competence area. The strongest increases are found in IoT monitoring competencies; Industrial Organization; Machine Learning/AI competencies; Cyber Security competencies; Sensor-based competencies. The strongest decreases are found in Entrepreneurial Mindset and Skills, Communication skills and Strategic Management.



Figure 43. Companies required expertise, 2020 vs 2026

Table 8. Largest positive and negative shifts in company requirements

Topic	Mean 2020	Mean 2026	Change
IoT monitoring competencies	1.48	1.88	+0.39
Industrial Organization	1.79	2.14	+0.35
Machine Learning/AI competencies	1.78	2.12	+0.34
Cyber Security competencies	1.78	2.06	+0.27
Sensor-based competencies	1.56	1.76	+0.20
Quality Management	2.18	2.36	+0.18
Safety of work	2.10	2.08	-0.02
Innovation and Change Management	2.32	2.31	-0.02
Leadership Issues	2.30	2.26	-0.04
Strategic Management	2.12	2.00	-0.12
Communication skills	2.44	2.28	-0.17
Entrepreneurial Mindset and Skills	2.13	1.84	-0.29

Critical reading

The company-side profile indicates that the largest upward movements are concentrated in digital, cyber-physical and automation-related competences. IoT monitoring, Machine Learning/AI and Cyber Security all rose meaningfully. This suggests that companies increasingly expect IE&M graduates to understand digitally mediated operations, data-intensive decision processes and operational technology risks.

Interpretive implication

The result supports a curriculum logic in which digital competences are not treated as isolated IT topics. They should be

integrated into operations, quality, supply chain, maintenance, industrial organisation and managerial decision-making.

Methodological caution

Some decreases, such as Entrepreneurial Mindset and Communication Skills, should not be interpreted as lack of relevance. These competences may be perceived as baseline graduate attributes rather than differentiating expertise, or the sample may include firms with more technical profiles in 2026.

V.6 Professors offered expertise: 2020 vs 2026

The 2020-2026 trend of competence offered by professors in academic master level programs can be observed in figure 44 and table 9.

Professors reported a modest increase in current offering. The largest increases are Industrial Organization; Big Data Analysis; Operations Management; Ergonomics; Leadership Issues. The largest decreases are in Sensor-based competencies; Strategic Management; Investment and Finance.

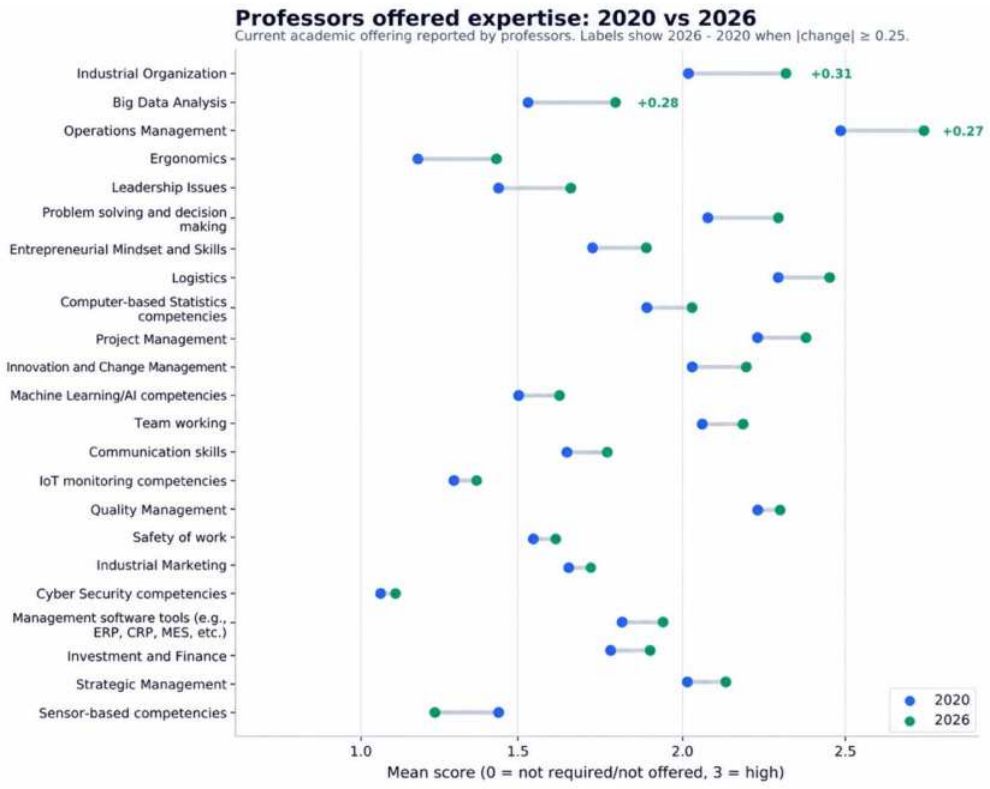


Figure 44. Professors offered expertise, 2020 vs 2026

Table 9. Largest positive and negative shifts in professors offered expertise.

Topic	Mean 2020	Mean 2026	Change
Industrial Organization	2.00	2.31	+0.31
Big Data Analysis	1.52	1.80	+0.28
Operations Management	2.50	2.77	+0.27
Ergonomics	1.20	1.44	+0.23
Leadership Issues	1.44	1.65	+0.21
Problem solving and decision making	2.08	2.28	+0.20
Industrial Marketing	1.66	1.66	-0.00
Cyber Security competencies	1.06	1.04	-0.02
Management software tools (e.g., ERP, CRP, MES, etc.)	1.86	1.81	-0.05
Investment and Finance	1.87	1.78	-0.09
Strategic Management	2.04	1.95	-0.09
Sensor-based competencies	1.38	1.23	-0.15

Critical reading

The offered dimension suggests gradual curriculum updating rather than radical redesign. Increases in Industrial Organization, Big Data Analysis and Operations Management indicate that curricula may have strengthened both traditional IE&M foundations and selected data-intensive topics. However, the increase is not equally distributed across the competence set.

Interpretive implication

The moderate rise in offered coverage should be interpreted as partial institutionalisation. Some new or renewed topics appear to have entered teaching practice, but the pace of change remains uneven. This is typical of curricula that depend on faculty expertise, accreditation constraints and course-cycle approval timelines.

Methodological caution

A rise in mean offered scores does not necessarily imply that students acquire operational proficiency. It indicates reported coverage. Future evaluation should distinguish awareness, conceptual knowledge, applied competence and assessed performance.

The negative movements are also informative. Decreases in Sensor-based competencies, Strategic Management and Investment and Finance may indicate substitution effects: as curricula make room for new operational and data topics, some traditional business or technology areas may lose emphasis. This is a strategic trade-off, not only a statistical shift.

V.7 Professors planned expertise: 2020 vs 2026

The 2020-2026 trend of competence planned by professors in academic master level programs can be observed in figure 45 and table 10.



Figure 45. Professors planned expertise, 2020 vs 2026

Table 10. Largest positive and negative shifts in professors planned expertise.

Topic	Mean 2020	Mean 2026	Change
Operations Management	2.68	2.71	+0.04
Industrial Organization	2.19	2.19	-0.00
Computer-based Statistics competencies	2.34	2.25	-0.09
Industrial Marketing	1.97	1.87	-0.10
Quality Management	2.35	2.25	-0.10
Logistics	2.58	2.45	-0.13
Safety of work	1.95	1.59	-0.37
Sensor-based competencies	1.94	1.56	-0.39
IoT monitoring competencies	2.03	1.58	-0.44
Team working	2.67	2.21	-0.46
Cyber Security competencies	2.02	1.42	-0.60
Communication skills	2.50	1.89	-0.62

Almost all major shifts are negative. The least (and negligible) negative movements are in Operations Management; Industrial Organization; Computer-based Statistics competencies; Industrial Marketing; Quality Management, while the strongest decreases are in Communication skills; Cyber Security competencies; Team working; IoT monitoring competencies; Sensor-based competencies; Safety of work.

Critical reading

This is one of the most critical findings of the time-series analysis. Planned coverage was much higher in 2020 than in 2026. This can be read in two ways. A positive interpretation is that some of the 2020 planned priorities have been absorbed into actual offering by 2026, reducing the remaining planning gap. A more cautious

interpretation is that curriculum ambition may have narrowed because institutions face capacity, staffing, approval or resource constraints, curriculum inertia and rigid accreditation cycles (taking 1–2+ years to update syllabi.

Interpretive implication

The decline in planned coverage should trigger governance questions. Which planned topics were implemented? Which were abandoned? Which were postponed because they require new labs, industrial partners, data access, faculty training or accreditation changes?

Methodological caution

The strongest decreases include Communication Skills, Cyber Security, Team Working and IoT monitoring. These are obviously not obsolete topics. Their lower planned scores may therefore reflect a shift from broad future aspiration to more constrained prioritisation rather than a decline in substantive importance.

From a curriculum-management perspective, the planned dimension is especially sensitive. It captures not only educational relevance but also perceived feasibility. Therefore, a lower 2026 planned score may signal that respondents see less need, or that they see implementation barriers. The current data cannot separate these two mechanisms.

V.7 Students offered expertise: 2020 vs 2026

The 2020-2026 trend of competence perceived by students in academic master level programs are in figure 46 and table 11.

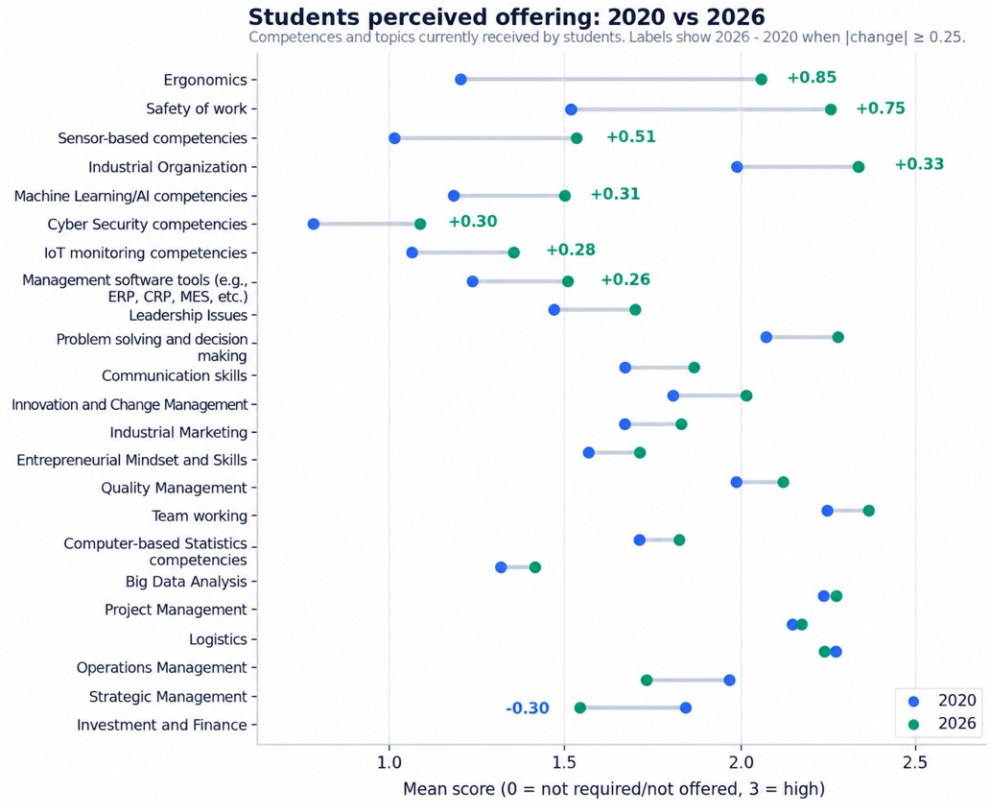


Figure 46. Students perceived offering, 2020 vs 2026

Table 11. Largest positive and negative shifts in students offered expertise

Topic	Mean 2020	Mean 2026	Change
Ergonomics	1.21	2.06	+0.85
Safety of work	1.51	2.26	+0.75
Sensor-based competencies	1.01	1.52	+0.51
Industrial Organization	1.99	2.33	+0.33
Machine Learning/AI competencies	1.17	1.48	+0.31
Cyber Security competencies	0.77	1.07	+0.30
Big Data Analysis	1.32	1.39	+0.08
Project Management	2.24	2.26	+0.02
Logistics	2.15	2.16	+0.01
Operations Management	2.27	2.25	-0.02
Strategic Management	1.96	1.72	-0.24
Investment and Finance	1.84	1.53	-0.30

Students perceived a substantial increase in current offering, the largest overall positive movement among the five dimensions. The largest increases are in Ergonomics; Safety of work; Sensor-based competencies; Industrial Organization; Machine Learning/AI competencies; Cyber Security competencies. The strongest decreases are in Investment and Finance; Strategic Management; Operations Management; Logistics.

Critical reading

The student-offered dimension provides an important perception-based validation of curricular change. Students in 2026 report greater exposure to Safety of Work, Ergonomics, Sensor-based competencies and Machine Learning/AI. This suggests that some practice-oriented and technology-oriented contents became more visible in the student learning experience.

Interpretive implication

The visibility of competence matters. A topic may be present in a syllabus but not recognised by students as a competence unless it is explicitly named, assessed and connected to real tasks. The increase in student-offered scores may indicate better visibility, not only more content.

Methodological caution

Very large increases in Safety of Work and Ergonomics should be interpreted carefully. They may reflect genuine curricular emphasis, but they could also be influenced by programme mix, local safety requirements, terminology, or the presence of more applied/lab-based respondents in the 2026 student sample.

The declines in Investment and Finance and Strategic Management are meaningful because they point to a possible reorientation of the perceived curriculum away from some business-oriented competences. If IE&M programmes aim to produce hybrid technical-managerial graduates, this shift should be monitored to avoid an overly technical curriculum profile.

V.8 Students expected expertise: 2020 vs 2026

The 2020-2026 trend of competence expected by students in academic master level programs are in figure 47 and table 12.

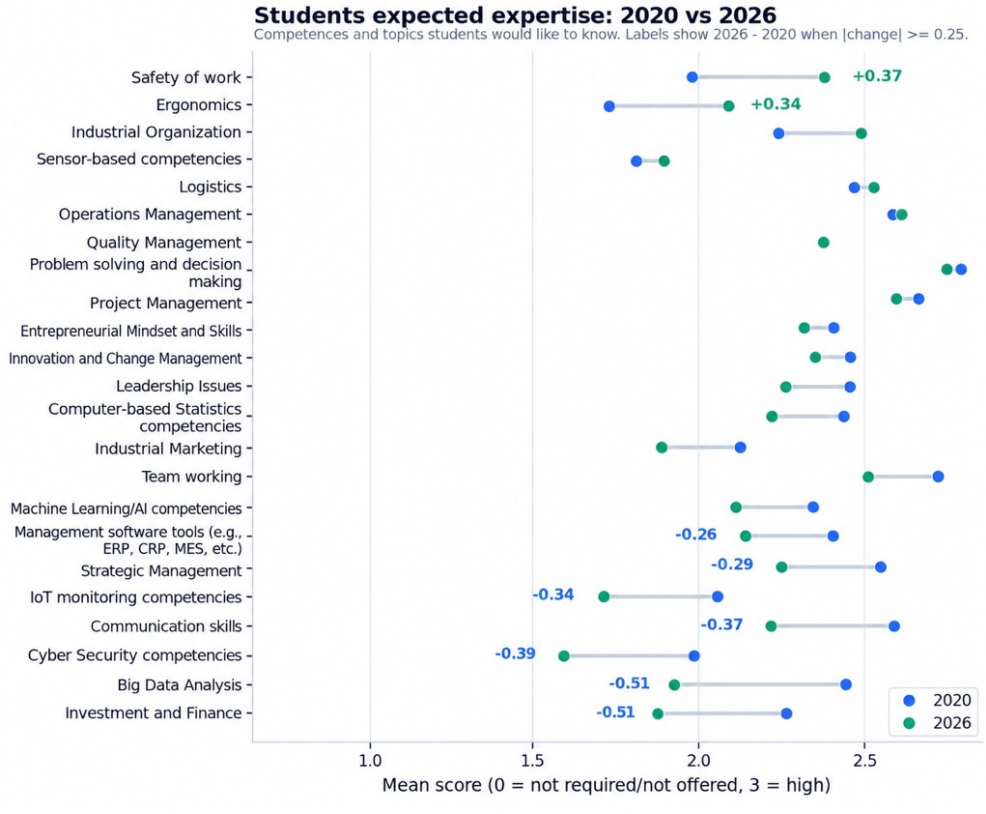


Figure 47. Students expected expertise, 2020 vs 2026

Table 12. Largest positive and negative shifts in students expected expertise.

Topic	Mean 2020	Mean 2026	Change
Safety of work	1.97	2.33	+0.37
Ergonomics	1.72	2.06	+0.34
Industrial Organization	2.22	2.47	+0.25
Sensor-based competencies	1.80	1.88	+0.08
Logistics	2.47	2.51	+0.04
Operations Management	2.58	2.60	+0.02
Strategic Management	2.54	2.25	-0.29
IoT monitoring competencies	2.06	1.72	-0.34
Communication skills	2.58	2.21	-0.37
Cyber Security competencies	1.99	1.61	-0.39
Big Data Analysis	2.48	1.96	-0.51
Investment and Finance	2.33	1.81	-0.51

The main increases are Safety of work; Ergonomics; Industrial Organization. The largest decreases are Investment and Finance; Big Data Analysis; Cyber Security competencies; Communication skills; IoT monitoring competencies; Strategic Management.

The strongest increases in Safety of Work and Ergonomics may indicate a growing student interest in human factors, workplace safety and applied engineering responsibility. This is relevant because contemporary IE&M curricula increasingly need to connect productivity, sustainability, safety and human-centred operations.

Critical reading

Lower student expectations in 2026 should not be reduced to lower demand. Students may now have a clearer perception of what is realistically part of a Master programme, which topics should be specialised, and which competences can be acquired through projects, internships or external certifications. In this sense, lower expected scores may represent a more mature and differentiated expectation profile.

Interpretive implication

However, the decrease in expectations for Big Data Analysis, Cyber Security, IoT monitoring, Machine Learning/AI and management software tools deserves attention. These are areas where industrial practice is evolving quickly. If students expect less in these areas while labour-market relevance is rising, programmes may need to increase students' awareness of emerging professional requirements.

Methodological caution

The expected dimension is affected by student awareness. Students can only ask for what they recognise as important and could believe that the academic programs already provide a satisfactorily knowledge level on digital competence although these competences are being receiving an increasing relevance by labour market.

V.9 Topic-level and macro-area synthesis

The heat map in figure 48 provides the most compact view of the 2020-2026 time-series results. It shows that changes are not evenly distributed.

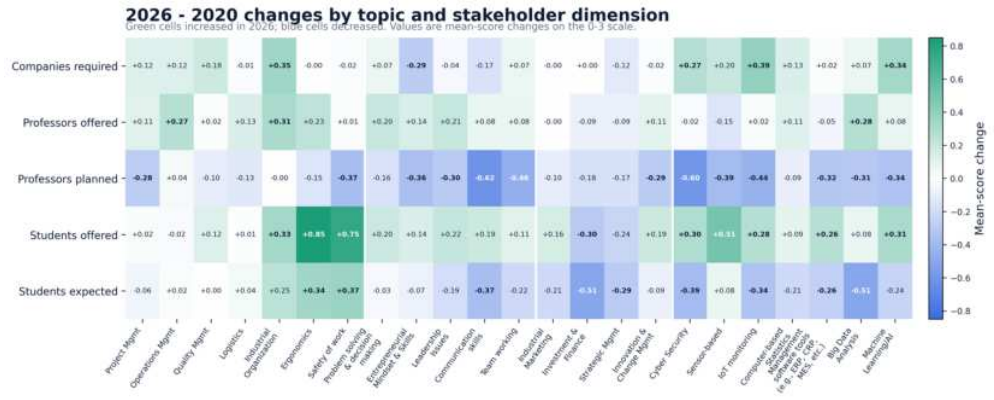


Figure 48. Heatmap of 2026-2020 changes by topic and stakeholder dimension

Some topics move upward in current-exposure dimensions, while many future-oriented ratings move downward. The pattern is especially visible in Digital, Data & Automation and in Human & Managerial Skills.

Critical reading

The heatmap should be read as a diagnostic map rather than a ranking. Green cells indicate where a dimension became stronger in 2026; blue cells indicate where it became weaker. The most important insight is the coexistence of increasing current exposure and declining planned or expected intensity in several topics.

Interpretive implication

This coexistence suggests the need for curriculum lifecycle management. Some topics may be moving from innovation phase to institutionalised phase. Others may be losing priority before being fully embedded. Distinguishing these trajectories is crucial for avoiding both curriculum overload and premature abandonment.

Methodological caution

The heatmap aggregates ordinal ratings into mean changes. It does not measure statistical significance and does not control for respondent composition. It should guide discussion, not replace expert curriculum review.

V.10 Focusing on largest positive and negative shifts

The largest positive shifts (figure 49) include students offered in Ergonomics and Safety of Work, and company requirements in IoT monitoring and Machine Learning/AI. The largest negative shifts are concentrated in professors planned and students expected dimensions, particularly in communication, cyber security, big data, investment/finance and team working.

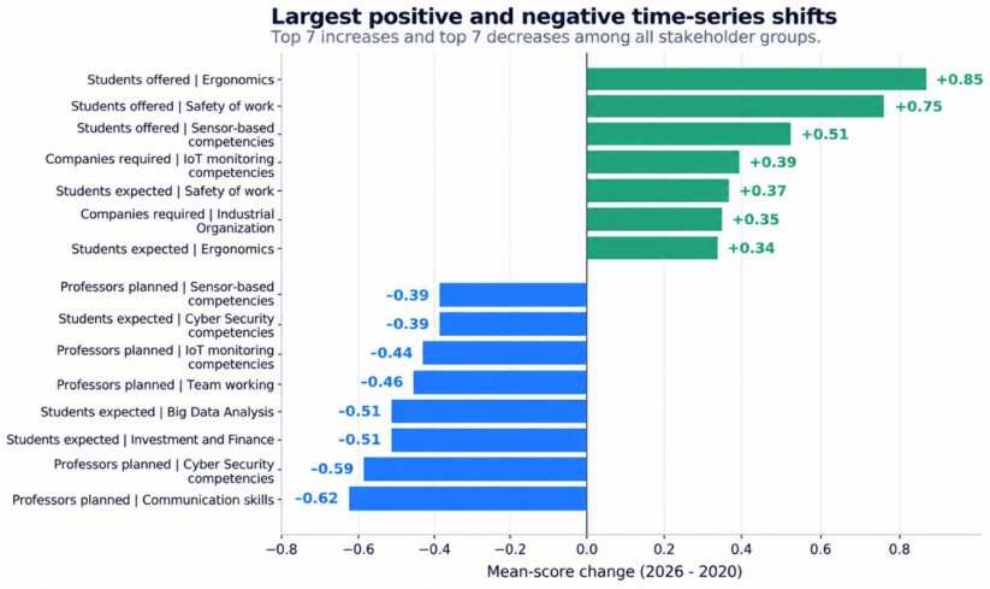


Figure 49. Largest positive and negative shifts across all same-category dimensions

Critical reading

The extremes show that the time-series change is not driven by a single stakeholder dimension. It reflects several simultaneous reallocations of attention. Current experience improved in some applied and safety-oriented areas, companies increased the emphasis on digital/automation topics, and forward-looking educational ambitions became more selective.

Interpretive implication

The report therefore points to a governance challenge rather than a simple content gap. IE&M programmes need mechanisms to decide which emerging competences become core curriculum, which remain electives, which are supported by company projects, and which are better addressed through short-cycle credentials.

Methodological caution

Extreme shifts can be influenced by small valid-response counts for some topics. They should be used to identify discussion priorities, not as standalone evidence for immediate course deletion or creation.

V.11 Focusing on macro-areas

At macro-area level (figure 50 and table 13), company requirements rise most in Digital, Data & Automation, while professors planned coverage and students expected coverage decline in the same broad area. This is not a direct cross-stakeholder comparison, but the parallel movement is strategically relevant: the environment appears to be changing faster than future-oriented educational expectations in some digitally intensive areas.



Figure 50.Macro-area evolution, 2026-2020 mean-score change

Table 13. Macro-area 2026-2020 mean-score changes

Dimension	Operations, Engineering & Supply Chain	Human & Managerial Skills	Strategy, Business & Innovation	Digital, Data & Automation
Companies required	0.10	-0.07	-0.03	0.20
Professors offered	0.16	0.14	-0.02	0.04
Professors planned	-0.14	-0.38	-0.18	-0.36
Students offered	0.30	0.17	-0.05	0.26
Students expected	0.14	-0.18	-0.28	-0.27

Critical reading

The macro-area view reveals a strategic tension. Digital, Data & Automation becomes more prominent in company requirements and student perceived offering, but future-looking planned and expected scores fall. This may mean that digital topics have partly entered the curriculum and therefore are less often rated as future needs. It may also mean that the future agenda is being narrowed too early.

Interpretive implication

For programme design, this argues for a layered model: core digital literacy for all IE&M students, applied analytics and automation in domain courses, and advanced AI/cyber/IoT modules as electives or micro-credentials.

Methodological caution

Macro-area averages can hide topic-specific outliers. For example, cyber security, IoT, machine learning and big data do not necessarily move in the same way. Curriculum decisions should combine macro-area evidence with topic-level detail.

V.12 Integrated critical discussion

V.12.1 From expansion to consolidation

The most coherent interpretation of the results is a transition from expansion to consolidation. In 2020, many future-oriented scores were high, especially professors planned and students expected. In 2026, current offering increased, while future-oriented scores declined. This can be interpreted as evidence that some educational ambitions were implemented, or at least became more visible, over the six-year period.

However, consolidation is not automatically positive. It becomes positive only if it reflects actual curricular implementation and learning outcomes. If it reflects lower ambition, institutional fatigue or inability to update curricula, the same numerical pattern would be problematic. The survey results therefore call for follow-up curriculum mapping rather than a purely descriptive conclusion.

V.12.2 Digital competences in IE&M topics

Digital, Data & Automation is the most strategically sensitive macro-area. Company requirements increased in several digital topics.

A curriculum that merely adds one AI or data course may not be sufficient. IE&M graduates need to connect digital tools to process improvement, operations control, quality systems, supply-chain risk, maintenance, safety, decision-making and organisational change. The time-series evidence supports an embedded approach rather than an isolated module approach.

V.12.3 The risk of interpreting lower expectations as satisfaction

The decrease in student expectations could be read as a positive sign if students perceive that the programme already covers more of what they need. Yet this interpretation is incomplete. Lower expectations can also arise when students do not know which competences will become important in their future work. This is particularly relevant in cybersecurity, IoT, big data and AI-related topics, where professional needs can evolve faster than student awareness.

For this reason, student expectation data should be combined with career-awareness indicators, internship feedback and alumni evidence. A smaller expected-offered gap is encouraging only when it coexists with strong labour-market awareness and demonstrable competence acquisition.

V.12.4 Planning as a feasibility signal

Professors planned scores should not be interpreted only as educational importance. They also capture feasibility. A professor may rate a topic lower in planned coverage not because it is unimportant, but because it is difficult to integrate into existing curricula, requires specialist faculty, depends on human resources, laboratories, or faces accreditation and approval constraints.

This makes the decline in planned coverage particularly important. It may indicate better prioritisation, but it may also reveal implementation barriers. Programme leaders should therefore analyse whether low planned scores correspond to low relevance or low capacity. The policy response would be different in each case.

V.13 Recommendations for curriculum governance

Separate relevance from feasibility

Future surveys should ask respondents to rate both the importance of each competence and the feasibility of integrating it into the curriculum. This would make professors planned scores easier to interpret.

Use curriculum mapping to explain gap narrowing

For each topic, map whether the 2020 ambition was implemented, partially implemented, postponed or dropped. This would clarify whether smaller planned-offered and expected-offered gaps represent progress or lowered expectations.

Strengthen digital integration across domain courses

Digital, Data & Automation should not be confined to standalone modules. It should be embedded in operations, logistics, project management, quality, safety and supply-chain courses through datasets, cases and assessed projects.

Make competences visible to students

Where students report higher current offering, identify what made the competence visible. Where they report lower or declining exposure, review course titles, learning outcomes, assessment tasks and project deliverables.

Keep business and managerial competences in balance

The decline in some business-oriented student-offered and student-expected scores suggests a possible shift toward technical and digital topics. IE&M programmes should preserve the hybrid engineering-management identity.

Improve longitudinal comparability

Future waves should keep the exact same list of topics, include respondent-area metadata. This would support stronger time-series interpretation and more robust regional analysis.

V.14 Conclusions

The 2020-2026 survey comparison shows a nuanced transformation of IE&M higher education. Company requirements rose moderately overall but increased more sharply in digital and automation-related topics. Professors and students reported higher current exposure in 2026, suggesting that some curriculum development occurred over the six-year period. At the same time, professors planned coverage and students expected coverage decreased, indicating a more selective or constrained future agenda.

The critical conclusion is that the dataset does not support a simple narrative of progress or decline. It supports a narrative of rebalancing. Current offering appears stronger in several areas, future expectations are more selective, and digital transformation remains the main moving frontier. The practical challenge for IE&M programmes is to convert this evidence into an adaptive curriculum model that balances foundational engineering management, digital transformation, human and managerial skills, and business-strategy competences.

The next analytical step should be qualitative validation: interviews or workshops with programme coordinators, students, alumni and companies to understand why the 2026 ratings changed. Quantitative time-series patterns identify where to look; qualitative evidence is needed to explain why the changes occurred.

Appendix A. Comparable topics and macro-areas

Table 14.Comparable topics included in the workbook

Topic	Macro-area
Big Data Analysis	Digital, Data & Automation
Computer-based Statistics competencies	Digital, Data & Automation
Cyber Security competencies	Digital, Data & Automation
IoT monitoring competencies	Digital, Data & Automation
Machine Learning/AI competencies	Digital, Data & Automation
Management software tools (e.g., ERP, CRP, MES, etc.)	Digital, Data & Automation
Sensor-based competencies	Digital, Data & Automation
Communication skills	Human & Managerial Skills
Entrepreneurial Mindset and Skills	Human & Managerial Skills
Leadership Issues	Human & Managerial Skills
Problem solving and decision making	Human & Managerial Skills
Team working	Human & Managerial Skills
Ergonomics	Operations, Engineering & Supply Chain
Industrial Organization	Operations, Engineering & Supply Chain
Logistics	Operations, Engineering & Supply Chain
Operations Management	Operations, Engineering & Supply Chain
Project Management	Operations, Engineering & Supply Chain
Quality Management	Operations, Engineering & Supply Chain
Safety of work	Operations, Engineering & Supply Chain
Industrial Marketing	Strategy, Business & Innovation
Innovation and Change Management	Strategy, Business & Innovation
Investment and Finance	Strategy, Business & Innovation
Strategic Management	Strategy, Business & Innovation

Appendix B. Full topic-level changes by dimension

Table 15. Companies required: 2020 vs 2026 changes.

Topic	Mean 2020	Mean 2026	Change
IoT monitoring competencies	1.48	1.88	+0.39
Industrial Organization	1.79	2.14	+0.35
Machine Learning/AI competencies	1.78	2.12	+0.34
Cyber Security competencies	1.78	2.06	+0.27

Topic	Mean 2020	Mean 2026	Change
Sensor-based competencies	1.56	1.76	+0.20
Quality Management	2.18	2.36	+0.18
Computer-based Statistics competencies	2.15	2.29	+0.13
Operations Management	2.19	2.31	+0.12
Project Management	2.41	2.53	+0.12
Team working	2.53	2.60	+0.07
Big Data Analysis	2.01	2.09	+0.07
Problem solving and decision making	2.64	2.71	+0.07
Management software tools (e.g., ERP, CRP, MES, etc.)	2.15	2.17	+0.02
Investment and Finance	1.69	1.69	+0.00
Ergonomics	1.56	1.56	-0.00
Industrial Marketing	1.45	1.44	-0.00
Logistics	1.76	1.75	-0.01
Safety of work	2.10	2.08	-0.02
Innovation and Change Management	2.32	2.31	-0.02
Leadership Issues	2.30	2.26	-0.04
Strategic Management	2.12	2.00	-0.12
Communication skills	2.44	2.28	-0.17
Entrepreneurial Mindset and Skills	2.13	1.84	-0.29

Table 16. Professors offered: 2020 vs 2026 changes.

Topic	Mean 2020	Mean 2026	Change
Industrial Organization	2.00	2.31	+0.31
Big Data Analysis	1.52	1.80	+0.28
Operations Management	2.50	2.77	+0.27
Ergonomics	1.20	1.44	+0.23
Leadership Issues	1.44	1.65	+0.21
Problem solving and decision making	2.08	2.28	+0.20
Entrepreneurial Mindset and Skills	1.73	1.87	+0.14
Logistics	2.32	2.46	+0.13
Computer-based Statistics competencies	1.92	2.03	+0.11
Project Management	2.29	2.39	+0.11
Innovation and Change Management	2.03	2.13	+0.11
Machine Learning/AI competencies	1.49	1.57	+0.08

Topic	Mean 2020	Mean 2026	Change
Team working	2.05	2.13	+0.08
Communication skills	1.65	1.72	+0.08
IoT monitoring competencies	1.33	1.36	+0.02
Quality Management	2.25	2.27	+0.02
Safety of work	1.54	1.55	+0.01
Industrial Marketing	1.66	1.66	-0.00
Cyber Security competencies	1.06	1.04	-0.02
Management software tools (e.g., ERP, CRP, MES, etc.)	1.86	1.81	-0.05
Investment and Finance	1.87	1.78	-0.09
Strategic Management	2.04	1.95	-0.09
Sensor-based competencies	1.38	1.23	-0.15

Table 17. Professors planned: 2020 vs 2026 changes

Topic	Mean 2020	Mean 2026	Change
Operations Management	2.68	2.71	+0.04
Industrial Organization	2.19	2.19	-0.00
Computer-based Statistics competencies	2.34	2.25	-0.09
Industrial Marketing	1.97	1.87	-0.10
Quality Management	2.35	2.25	-0.10
Logistics	2.58	2.45	-0.13
Ergonomics	1.63	1.48	-0.15
Problem solving and decision making	2.65	2.48	-0.16
Strategic Management	2.23	2.06	-0.17
Investment and Finance	2.08	1.91	-0.18
Project Management	2.70	2.42	-0.28
Innovation and Change Management	2.42	2.13	-0.29
Leadership Issues	2.23	1.92	-0.30
Big Data Analysis	2.48	2.17	-0.31
Management software tools (e.g., ERP, CRP, MES, etc.)	2.36	2.04	-0.32
Machine Learning/AI competencies	2.26	1.92	-0.34
Entrepreneurial Mindset and Skills	2.32	1.96	-0.36
Safety of work	1.95	1.59	-0.37
Sensor-based competencies	1.94	1.56	-0.39
IoT monitoring competencies	2.03	1.58	-0.44

Topic	Mean 2020	Mean 2026	Change
Team working	2.67	2.21	-0.46
Cyber Security competencies	2.02	1.42	-0.60
Communication skills	2.50	1.89	-0.62

Table 18. Students offered: 2020 vs 2026 changes.

Topic	Mean 2020	Mean 2026	Change
Ergonomics	1.21	2.06	+0.85
Safety of work	1.51	2.26	+0.75
Sensor-based competencies	1.01	1.52	+0.51
Industrial Organization	1.99	2.33	+0.33
Machine Learning/AI competencies	1.17	1.48	+0.31
Cyber Security competencies	0.77	1.07	+0.30
IoT monitoring competencies	1.06	1.34	+0.28
Management software tools (e.g., ERP, CRP, MES, etc.)	1.24	1.50	+0.26
Leadership Issues	1.47	1.69	+0.22
Problem solving and decision making	2.08	2.28	+0.20
Communication skills	1.67	1.86	+0.19
Innovation and Change Management	1.81	2.00	+0.19
Industrial Marketing	1.67	1.82	+0.16
Entrepreneurial Mindset and Skills	1.57	1.71	+0.14
Quality Management	1.99	2.11	+0.12
Team working	2.25	2.36	+0.11
Computer-based Statistics competencies	1.71	1.80	+0.09
Big Data Analysis	1.32	1.39	+0.08
Project Management	2.24	2.26	+0.02
Logistics	2.15	2.16	+0.01
Operations Management	2.27	2.25	-0.02
Strategic Management	1.96	1.72	-0.24
Investment and Finance	1.84	1.53	-0.30

Table 19. Students expected: 2020 vs 2026 changes.

Topic	Mean 2020	Mean 2026	Change
Safety of work	1.97	2.33	+0.37
Ergonomics	1.72	2.06	+0.34
Industrial Organization	2.22	2.47	+0.25

Topic	Mean 2020	Mean 2026	Change
Sensor-based competencies	1.80	1.88	+0.08
Logistics	2.47	2.51	+0.04
Operations Management	2.58	2.60	+0.02
Quality Management	2.37	2.37	+0.00
Problem solving and decision making	2.78	2.74	-0.03
Project Management	2.66	2.60	-0.06
Entrepreneurial Mindset and Skills	2.39	2.31	-0.07
Innovation and Change Management	2.45	2.37	-0.09
Leadership Issues	2.46	2.27	-0.19
Computer-based Statistics competencies	2.44	2.23	-0.21
Industrial Marketing	2.14	1.93	-0.21
Team working	2.73	2.52	-0.22
Machine Learning/AI competencies	2.35	2.11	-0.24
Management software tools (e.g., ERP, CRP, MES, etc.)	2.40	2.14	-0.26
Strategic Management	2.54	2.25	-0.29
IoT monitoring competencies	2.06	1.72	-0.34
Communication skills	2.58	2.21	-0.37
Cyber Security competencies	1.99	1.61	-0.39
Big Data Analysis	2.48	1.96	-0.51
Investment and Finance	2.33	1.81	-0.51

All analyses are limited to same-category 2020-2026 comparisons.
No cross-stakeholder gaps are estimated in this report.