Harnessing the Power of Responsible Innovation: The Shift towards Human-centered Skills and Competences in AI Engineering

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Abstract

Particularly against the backdrop of several notable incidents of abuse and malicious use of technology, in recent years, ethical issues across all technological fields, including artificial intelligence, have become a prominent topic for public discussion. The European Union, with its industry and academia at the forefront, is now viewed as a pioneer on the world stage for the implementation of an ethical approach toward an ethically-driven, data-empowered society, with efforts such as the High-Level Expert Group of the EC on AI and the European Act on Artificial Intelligence (AIA), to name a few.

The rising set of ethical standards for empowering trustworthy and technically sound Artificial Intelligence has unavoidably resulted in an industrial movement toward human-centered skills and competences. The industry demands at any phase of the AI lifecycle are rapidly changing, posing considerable difficulties to academia and its ability to quickly design and implement an industry-relevant curriculum, encompassing both the technical and the ethical requirements for AI professionals.

This paper will investigate this shift of demands in the context of the rising body of legal, regulatory, and compliance frameworks, using current research and a needs and market study done as part of HCAIM – a project aimed at establishing a Human-Centered Master's Program on Artificial Intelligence.

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1. Introduction

Technology is a competitive advantage and a critical component of business success nowadays. This phenomenon is especially valid in advanced information societies [1] and IT-intensive sectors of the economy. Artificial Intelligence (AI) has made quick advances in various application areas, including administrative assistance, healthcare, and finance, to mention a few [2]. Simultaneously, negative aspects of AI, including multiple privacy issues, bias in decision-making and fatal mistakes in conclusions made by ungoverned, opaque algorithms, have sparked public and academic interest in AI ethics [4, 5]. Thus, the current AI boom has been accompanied by frequent demands for applied ethics, hoping to limit the disruptive potential of AI technologies.

To address public concerns about AI's risks and unintended consequences, governments and international organizations such as the EU, professional associations such as the IEEE, and numerous enterprises have shared their vision for trustworthy AI, including principles, standards, and guidelines [3]. In the same vein, an EU High-Level Expert Group was established in 2019 [6] to develop ethical standards for AI to assure technically robust, reliable, and resilient AI development. The Asilomar Principles of Beneficial Artificial Intelligence [7] and the IEEE Global Initiative on Ethics [8] are among many other notable initiatives to better understand the risks of artificial intelligence and develop legal frameworks and codes of conduct and values-based design methods for autonomous and intelligent systems. Similarly, the European Commission also issued a proposal for a European Act on Artificial Intelligence (AIA) in April 2021 [9]. The AIA risk-based approach and the proposed legal framework for the implementation of trustworthy AI-based systems and services in EU extend the human-centered AI concept with technical and legal requirements depending on the application area and associated risk levels (for humans). Furthermore, the AIA outlines the respective schemes and levels of conformity assessments and certifications to transform all those requirements in practice.

Doubling the number of data science professionals in Europe to more than 10 million, a critical component of the European Data Strategy of 2020 [10], combined with the growing demand for ethical compliance, poses a significant challenge to data science and artificial intelligence. Thus, responsible data collection, processing, and storage requirements and the relevant skills, competences and knowledge become vital to meet these market needs.

To that aim, professionals with a specific combination of skills, knowledge, and competencies, combining technical competency with societal awareness and strong ethical understanding, are required for artificial intelligence development, implementation, and integration [11].

The purpose of this paper is to report on the main findings of a market needs analysis conducted as part of the "Human-Centred AI Master's Programme Project" – a project dedicated to developing and piloting a Master's Program in Ethical AI at four European universities: Ireland, the Netherlands, Budapest, and Italy. The analysis's key findings provide information on business and academics' requirements, expectations, and demands regarding AI education and AI professionals in light of this transition toward responsible AI.

Most significantly, this paper will give an aggregated report on the skills, knowledge, and competencies recognized by industry and academic experts across Europe that graduates and young AI professionals need to remain relevant against the rising demands of the AI field.

2. Steering trustworthy artificial intelligence in Europe

Without trust, the artificial intelligence system may hurt people unintentionally, with the prospect of a range of undesirable outcomes; obstructing the fulfilment of the enormous social and economic advantages, that artificial intelligence might bring to the European digital market. Confidence in the creation, deployment and usage of artificial intelligence systems relates to the intrinsic features of the technology and the quality of the socio-technical systems involved in AI applications [6].

With AI progressively being incorporated into areas such as aviation, nuclear energy, and defense, the trustworthiness of artificial intelligence systems is no longer a feature but a must for market entry. As a result, striving for reliable artificial intelligence requires the reliability of the artificial intelligence system itself and a holistic and systematic approach that includes the reliability of all participants and processes that are part of the system's social-technical background.

The AI-HLEG [6] specifies three critical components of trustworthy AI that must be satisfied throughout the system's life cycle:

- **lawful**, complying with all applicable laws and regulations;
- **ethical**, ensuring adherence to ethical principles and values;
- **robust and secure**, both from a technical and social perspective since, even with good intentions, AI systems can cause unintentional harm;

Each of the components above is required but insufficient to ensure AI's trustworthiness. In an ideal world, these three functions would be synchronized and overlapping.

Our collective and individual obligation as a society is to work hard to guarantee that all three components contribute to the security of dependable artificial

intelligence. A reliable strategy is essential for establishing "responsible competitiveness". It creates a foundation for all persons affected by artificial intelligence systems to guarantee that their design, development, and usage are legal and ethical.

Following a series of other initiatives in the field of Artificial Intelligence governance and standardization on a global, European, and national level, the European Commission published the proposal for the new EU Artificial Intelligence Act (AIA) [9], which is one of the first initiatives worldwide aimed at providing a legal framework for AI. It adheres to the risk-based approach to AI development, implementation, and usage that the Commission outlined earlier in 2020 with the White paper on AI [12], while also extensively using the AI-findings HLEG and recommendations on trustworthy AI. As part of AIA, appointing national bodies in charge of standards and oversight of AI development has emerged to put the EU in a position of "leading by example" in the global arena as one of the worlds pioneers in dependable artificial intelligence.

As a result, strengthening governance and certification for trusted artificial intelligence systems is critical for promoting and sustaining fundamental human rights across Europe. Only through assuring credibility can European residents, and by extension, citizens globally, fully appreciate the benefits of artificial intelligence systems and be confident that efforts have been made to mitigate any threats [3].

Considering national initiatives, among those of other European countries, the Bulgarian government has also been part of this approach towards a human-centered shift of AI. Bulgaria embraced Bulgarian scientists' research as an idea for a national AI capacity development strategy. The concept is based on two documents, "Framework for a National Strategy for the Development of Artificial Intelligence in Bulgaria" (2019) and "Strategy for the Development of Artificial Intelligence in Bulgaria until 2030" [3,13] developed by a team of the Bulgarian Academy of Sciences and a group of external experts and endorsed by the Bulgarian Government in 2020.

The Concept for the Development of Artificial Intelligence (AI) in Bulgaria by 2030 is consistent with current European Commission documents, strategic initiatives, and policies, which regard AI as one of the primary drivers of digital transformation in Europe and a critical factor in ensuring the European economy's competitiveness and high quality of life.

Furthermore, the concept defines particular features of the European vision of "trustworthy AI", including methods to gather accessible, high-quality data, communicate knowledge broadly, and enable fair access to the advantages of AI technology.

3. Examining the need for AI competences shift

The fast pace of AI research has resulted in international initiatives to expand investment in technology in vital industries such as healthcare, drug testing and discovery, transportation, cybersecurity, BFSI, education, and energy.

According to one of Grand View Research's [14] most recent research, the worldwide artificial intelligence market accounted for 62.35 billion USD in 2020 and is predicted to rise at a compound annual growth rate (CAGR) of 40.2 per cent from 2021 to 2028. According to the same report, "access to historical datasets is the essential facet accelerating the rate of innovation in the field of AI". The last, along with advancements in other technologies, open data policies, and data sets provided by IoT devices and sensors, has served as a prerequisite for the development and integration of AI solutions in a variety of sectors and disciplines.

According to Gartner [15], the commercial value of AI will reach USD 5 billion by 2025, with 23 per cent of CEOs questioned in their survey claiming to have already adopted AI in their organizations, either as a separate product or as an integrated solution to assist their routine business processes. Half of the respondents emphasize assessing financial and commercial risks before implementing AI initiatives. Consequently, we may deduce that the potential of AI for company growth and innovation is immense, but a thorough risk assessment must be undertaken before the project begins.

Similarly, North America will lead the market in 2020, accounting for around 40.4 per cent of global revenue. This high proportion may be ascribed to government initiatives that encourage artificial intelligence (AI) in a wide range of enterprises and sectors. **The American AI Initiative** [16], the country's plan to increase artificial intelligence leadership, is one example. Federal authorities have developed criteria for the development and real-world application of AI-based systems across numerous industrial sectors as part of this effort, increasing public confidence in these systems. There is a strong inclination among the international community to examine as much as possible the dangers and consequences of AI technology adoption, which centers mainly on the technology's research components, as opposed to certain favorable features of its rapid delivery to the worldwide market.

To solve challenges like as **power consumption, sluggish processing, and inefficiency**, hardware-based AI solutions are being developed. As the industry evolves, however, new business models based on predictive, efficient automation and scalable parallel processing capabilities will become more vital.

In recent years, few companies have invested in developing these hardware components; however, to gain a competitive advantage, companies such as IBM and Intel have begun producing artificial intelligence chipsets to achieve high performance in scaling dynamic operations in parallel.

Several key industry participants, including Apple Inc., Google, Samsung Electronics Co., Ltd., Baidu Inc., and Qualcomm Technologies, Inc., have developed artificial intelligence processors to handle inference workloads at the edge, according to Grand View [14]. Amazon.com, Inc., for example, is working on an artificial intelligence processor based on ASICs to power its Alexa personal assistant.

The hardware sector is projected to gain another boost from technologies such as ML, as seen by the rising demand for artificial intelligence applications. One such example is public surveillance technologies, which have also been the topic of several debates and discussions in recent years. According to Stanford HAI, the technology necessary for large-scale surveillance is fast evolving, with image classification technologies, face identification, video analysis, and speech recognition all making substantial development in 2020.

In the midst of the COVID-19 epidemic, various governments have begun using big data technologies to gather and monitor people's COVID status and quarantine compliance, raising many ethical problems.

Aside from ethical concerns, the massive demand for image recognition systems has many key obstacles that impede the industry's development. The necessity for vast volumes of data to train artificial intelligence systems for biometrics and image recognition is one such issue. Furthermore, stacking such an enormous volume of data improves data traceability. Artificial intelligence is used by companies such as Google and Facebook in picture identification systems that need access to massive volumes of data. However, these datasets are abundant compared to data availability for AI developments in the healthcare industry, where enormous datasets for AI solutions are still uncommon.

In healthcare, one such example is the data required to identify cancer in scans and X-rays. The fundamental issue that emerges in artificial intelligence due to a lack of data availability is using existing data to make appropriate judgments. One cause for this lack of data is the capacity to acquire, handle, and ethically dispose of such artifacts.

According to Stanford HAI, the number of papers containing ethics-related keywords in AI conference titles has grown since 2015. However, the average number of article titles matching ethics-related keywords in major AI conferences has remained low. Fortunately, various organizations have developed to address the absence of ethical criteria in AI.

Against this backdrop, Europe is a part of the worldwide effort to address the ICT skills shortage [17, 18, 19]. By 2021, the global talent shortfall will have reached 40 million skilled employees. The worldwide talent shortfall will reach 85.2 million employees by 2030 [20]. Companies globally risk losing $8.4 trillion in sales due to a shortage of competent people [20]. Computer and information technology employees are expected to rise 11 percent from 2019 to 2029,

substantially faster than the overall average [20]. These vocations are expected to generate 531,200 additional employments. The increased focus on cloud computing, extensive data collecting and storage, and information security will increase the demand for these personnel [21].

The demand for ICT specialists in businesses grows in tandem with the development of the digital economy. Still, factors such as the aging population, accelerated migration processes, the difficulties of academia in keeping up with the technological development pace, and differences in educational quality (even across national borders) impede solutions.

The scarcity of AI-related workers in Europe may be due to a mismatch between supply and demand for skills. The academic sector develops and produces graduates with primarily scientific knowledge in AI rather than competent professionals capable of working on high-end projects that mix technology with medical, mechanical engineering, biology, social sciences, and other disciplines.

Similarly, educating limited experts such as system engineers, software developers, network/system administrators, and electrical engineers complicates the effective fulfillment of IT workers. The interdisciplinary character of current jobs, such as data scientists, IoT engineers, cybersecurity specialists, and robotics engineers, necessitates a more holistic and complicated approach to program design in educational institutions [21]. Knowing the demands of the industry is a keen start on developing new requirements for higher education, vocational training, and professional development.

4. Primary outcomes of the HCAIM AI market analysis

Our research began by establishing the goal of creating a Master's Program curriculum in human-centered AI to train ethical AI architects who perform in keeping with the European Union's vision of the future of AI. We used the European e-Competence Framework for the technical interpretation of the profile (e-CF) [22]. CEN (European Committee for Standardization) has created 30 ICT profiles based on the e-CF [22]. The Human-Centered AI expert primarily focuses on the Data Scientist, Data Specialist, and Systems Architect positions.

Although the new e-CF definition includes a data scientist profile, **this description lacks the competences that match specific data scientist positions in enterprises**. The e-CF3.0 integrates with the organization's workflow, yet data science requires connecting multiple organizational roles and departments. As a result, the e-CF3.0 provided an overly broad framework for defining IT competencies and allocating them to data science competencies.

However, the EDISON framework [23] provides a solution. It may be viewed as an extension of the e-CF framework, especially for the professional profile of the data scientist [24]. This framework has been used to form the data science

competences of the Human-Centered AI Master's Program. However, we had to make a more complex decision regarding the ethical competences.

The awareness of ethical and societal factors in the professional competences as specified in e-CF is a distinguishing feature of the human-centered AI professional profile. Only a pre-release version of the EU ICT Ethics initiative [25] was available when this analysis was conducted. The EU ICT Ethics has compiled a list of ethically linked essential human aspects and components, which, coupled with e-CF knowledge, skills, and behavior, can serve as a pattern for a proactive approach to ethics. Thus, for the study of the needs of the AI market, we took competences related to societal, organizational and technical aspects of AI from the e-CF and let industry and academia representatives rate their importance according to their company's context and experience.

The project's assessment strategy includes categorization and mapping methodologies executed through an online survey and focus group interviews. The methods used allow us to assess subsequently each implementation of the Master's Program in sufficient depth to discover the best practices that can be applied to improve the HCAI Master's programs. The online survey and focus group interviews conducted with program recipients from the sector served to verify and validate the research implications of the previous 2-3 years.

Following best practices in educational research, it was required to design data collecting procedures that could be deployed consistently by both experienced and young researchers across numerous focus groups, nations, and organizational contexts.

As a result, several data gathering technologies have been established. **Quantitative data is mainly collected using questionnaires, while qualitative information is gathered through various methods, including facilitator-led focus group observations and literature studies.**

To shorten the time spent responding to the surveys, we used Likert questions as much as feasible. However, the survey's broad questions enabled us to grasp market requirements thoroughly. As a result, whereas questionnaires allow us to obtain many surface data from many participants, we require observation and interviews to collect more in-depth data from fewer individuals.

We must comprehend specific corporate representatives' experiences to appreciate better, why a particular topic or ability is vital to the industry. Data is gathered from numerous sources to improve efficacy in achieving that goal.

Data mainly from the Industry Survey Questionnaire will be used for this paper.

The Industry Survey was divided into four major categories to get a detailed grasp of the respondents' perspectives and profiles, as follows:

1. **Definitions and Understanding**. The primary purpose of this section of the survey was to obtain a broad profile of the respondents and their grasp of

the many concepts in human-centered artificial intelligence.

2. **Societal Aspects**. This section aims to gather insight into the themes, skills, knowledge, and competencies that respondents deem essential for practical work on human-centered artificial intelligence initiatives.

3. **Organizational Considerations**. This section aims to provide a clear picture of the relevance of numerous business and management-related subjects, skills, knowledge, and competencies perceived by respondents.

4. **Technological Aspects**. This section of the survey intends to structure essential technical ideas, skills, and talents in the field of human-centered artificial intelligence based on the responses.

All competency descriptions were derived from the European e-Competence Framework and classed as social, organizational, or technological.

The participants were provided with the competences descriptors when answering the questions related to them and during the focus group interviews when those were discussed.

The goal is to present a comprehensive picture of respondents' thoughts on the worth of each ability in each of the three specified elements: technological, organizational, and societal. The subsequent prioritization of the skills suggested by the replies helped to a deeper understanding of the comprehensive and multidisciplinary nature of the AI knowledge area. **The survey findings were then crosschecked with focus group data and augmented with feedback from participants in the focus groups.**

The HCAIM Project Industry Survey was completed by an overall 49 people, representing companies from eight countries, namely:

- Ireland (17 people);
- Italy (10 people);
- Hungary (6 people);
- Bulgaria (4 people);
- Netherlands (3 people);
- USA (3 people);
- Belgium (1 person);
- Russia (1 person).

It is worth noting that one person responded that they had not yet registered their corporation. Another survey respondent did not submit a response to this question. Finally yet importantly, two participants claimed that their firms operate globally and are not located in a single nation.

Participants in the poll primarily represent four types of organizations: industry, research, education, and public (government) agencies.

The poll respondents were primarily senior experts (18) who represented mainly large enterprises (23), as shown in Figure 1.

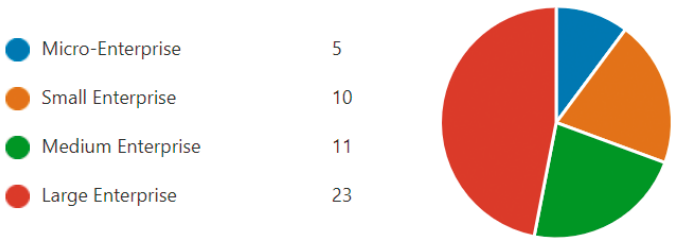

Figure 1: [HCAIM Survey] Participants by organization size

Furthermore, the participants engaged have been preselected so that they were sufficiently aware, and their organizations worked on AI-related initiatives. The majority of survey responses came from organizations that are actively developing or implementing (or both) AI solutions. Most participants stated that their job primarily focuses on the infrastructure and smart cities sector (13 persons) or the healthcare sector (12 people), as shown in Figure 2.

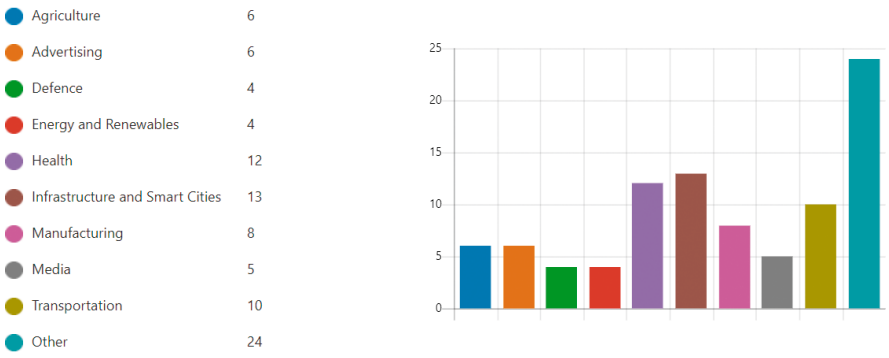

Figure 2: [HCAIM Survey] Domains in which participants' organizations have developed or integrated AI-related solutions

From the participants, who answered with "Other", we received the following clarifications:

- Finance (3);
- Education (2);
- Identity Verification;
- Telecommunication;
- Cybersecurity;
- IT;
- Physical Security;
- Enterprise Software;
- Biotech.

The majority of the participants (41 out of 49) state that they plan to design, to develop or use AI-related solutions within the following year.

The participants in the HCAIM Industry Survey took part in the relevant focus groups as well. To obtain a deeper understanding of the needs and expectations of the internal and external stakeholders, especially of the program's labor market, the HCAIM project consortium set out to conduct focus group interviews.

The grouping criteria, core topics for discussion, and the basic parameters for forming and implementing the focus group interviews have been identified and discussed, leveraging the industry survey's preliminary results **in April 2021**.

The HCAIM project defines a focus group interview as a market research method, supporting the consortium to achieve a complete market view of the needs of the industry related to human-centered artificial intelligence masters' programs.

Focus Group Size. 6–12 participants

Format. Online video discussion

Focus Group Moderation. Dual moderation. Two moderators moderate each focus group from the project consortium.

Based on the industry survey results, three focus groups were interviewed, namely 1) small and medium-sized enterprises, 2) large enterprises, and 3) research and academia. The focus group interviews were conducted virtually, in English, July 6–7, 2021.

4.1. Societal aspects of AI

As shown in Figure 3, we can conclude that the knowledge and skills related to technology innovation, needs, requirements analysis, and design are of utmost importance for the business.

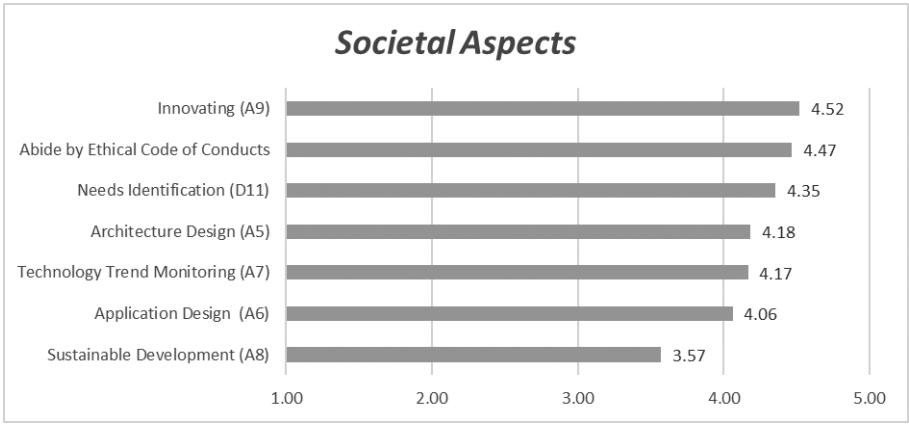

Figure 3: Preferred competences in the field of societal aspects

Those competence domains can be connected and related to the following requirements from the Ethical Guidelines for Trustworthy AI by the AI HLEG:

- Human agency and oversight;
- Transparency;
- Diversity, non-discrimination, and fairness;
- Societal and environmental well-being.

The respondents assessed that during the ideation and design phases (but not only) of an AI solution development cycle, professionals must also be able to evaluate continuously the effects of the solution on society and the environment.

4.2. Organizational aspects of AI

Regarding the organizational aspects, the respondents classified the competences as presented in Figure 4.

Figure 4: The rating of desired competences, related to organizational aspects. The competence labels and encoding refer to the e-CF [22]

The competences with higher importance are:

- Information security (strategy) management/ governance;
- Risk management;
- Problem management;
- Information and knowledge management;
- Process improvement;
- Project and portfolio management.

The two most valued sectors required as credentials and abilities in the industry are information security and risk/problem management and information and knowledge management.

Skills and competencies related to the evaluation of the business implications of research results, cost analysis at each phase for ensuring security and

privacy of personal data and communications, competitive advantages provided by thrust, resilience, and accuracy of advanced solutions, transparency, and explainability of technical issues are among the essential requirements of the EU market for educational institutions.

4.3. Technological aspects of AI

Finally yet importantly, the respondents rated the importance of technological competences. They comprise accountability (testing and validation), software development skills (incommutable when talking about ICT professionals), and system / engineering thinking:

- Testing;
- Application development;
- Solution development;
- System engineering.

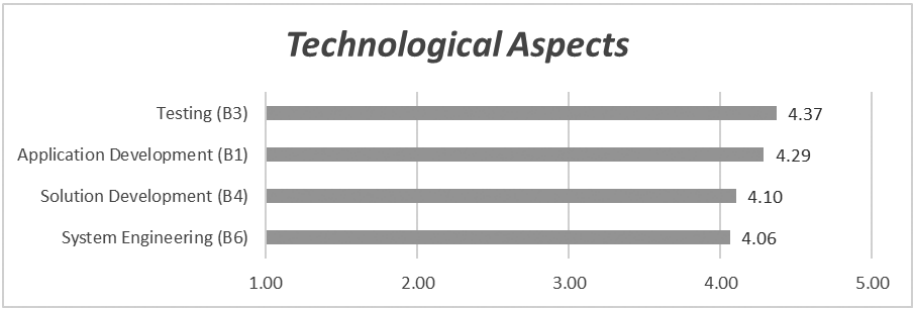

Figure 5: The rating of competences in the technological area

The needs and requirements analysis outcomes should be linked with the technological capabilities and procedures and any restrictions. The AI HLEG suggests doing this using a set of "whitelist" rules (behaviors or states) that the system can follow and "blacklist" limits on behaviors or states that the system should never permit. Furthermore, the AI HLEG proposes how to modify the system architecture to ensure that the Trustworthy AI follows these three phases of the cycle:

- at the "sense"-step, the system should be developed such that it recognizes all environmental elements necessary to ensure adherence to the requirements;
- at the "plan"-step, the system should only consider plans that adhere to the requirements;
- at the "act"-step, the system's actions should be restricted to behaviors that realize the requirements.

Although the proposal is somewhat generic, it provides the basic principles of aligning the technology development part with the requirements analysis and avoiding human and natural well-being risks.

5. Conclusions

We have recognized that artificial intelligence systems hugely positively influence business and the economy. To guarantee the long-term viability of this influence, we must also be concerned with the hazards and other adverse impacts connected with these technologies and ensure that they are effectively implemented.

The growing set of ethical norms for supporting trustworthy and technically sound AI has inevitably led to an industry shift toward human-centered skills and competencies. Industry expectations at any stage of the AI life cycle are continuously changing, offering significant challenges to academia and its ability to swiftly create and implement an industry-relevant curriculum that addresses AI professionals' technical and ethical requirements.

In today's culture, simply understanding how AI works is insufficient. AI developers must also be able to analyze and comprehend the impact of AI solutions on organizations, users, and society. Our research and other work in the field examined in this paper show a need to expand the number of ethically minded AI engineers to enable the widespread implementation of AI. With many current AI initiatives still concentrating only on the technical elements of AI, there is a critical need for engineers who realize that while building and implementing AI, no compromises with the ethical integrity of the solutions can be made and who have the skillset to ensure this. Furthermore, the engineers should also understand and follow the AI-associated threats and risks, the requirements coming from technical and legal frameworks derived from the AIA [9], and relevant implementation and certification schemes to achieve the respective level of technically robust and trustworthy AI-based systems and services.

The purpose of this paper was to report on the findings of a recent analysis of the skills, competencies, and knowledge relevant to the AI industry to contribute to the body of knowledge related to shifting AI market demands and thus inspire educational leaders to reassess their AI curricula. Lastly, as the discussion on AI ethics and reliability grows more widespread and practical, we anticipate that our effort will help provide the groundwork for future research.

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7. References

[1] Floridi, Luciano. “Mature information societies – A matter of expectations”. Philosophy & Technology. (2016). 29(1), 1-4. doi:10.1007/s13347-016-0214-6.

[2] Bartneck, Christoph, Christoph Lütge, Alan Wagner and Sean Welsh. “Application Areas of AI”. (2021). doi: 10.1007/978-3-030-51110-4_9.

[3] Sharkov, George, Christina Todorova, and Pavel Varbanov. “Strategies, Policies, and Standards in the EU Towards a Roadmap for Robust and Trustworthy AI Certification.” Information & Security: An International Journal 50, no. 1 (2021): 11-22. doi:10.11610/isij.5030.

[4] Benbya, Hind, Stella Pachidi and Sirkka Jarvenpaa. “Artificial Intelligence in Organisations: Implications for Information Systems Research,”. Journal of the Association for Information Systems (2021): 22:2. Atlanta: Association for Information Systems, p. 10. doi:10.17705/1jais.00662.

[5] Thilo Hagendorff. “The Ethics of AI Ethics: An Evaluation of Guidelines”. Minds & Machines. (2020): 30, 99–120. doi:10.1007/s11023-020-09517-8.

[6] European Commission. High-Level Expert Group on Artificial Intelligence. “Ethics Guidelines for Trustworthy AI”. April 2019. URL: https://ec.europa.eu/futurium/en/ai-alliance-consultation.1.html.

[7] The Future of Life Institute. Asilomar AI Principles, 2017. URL: https://futureoflife.org/ai-principles.

[8] IEEE. The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems, 2018. URL: https://standards.ieee.org/industry-connections/ec/autonomous-systems.html.

[9] European Commission, “Proposal for a regulation of the European Parliament and the Council laying down harmonised rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union legislative acts.” Artificial Intelligence Act. (21 April 2021). EUR-Lex – 52021PC0206. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELLAR:e0649735-a372-11eb-9585-01aa75ed71a1.

[10] European Commission. A European Strategy for Data. February 2020. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020DC0066&from=EN.

[11] Schiff, Daniel, Bogdana Rakova, Aladdin Ayesh, Anat Fanti and Michael Lennon. “Principles to Practices for Responsible AI: Closing the Gap”. (2020). doi: 10.48550/arXiv.2006.04707.

[12] European Commission, “White Paper on AI – A European approach to excellence and trust” (2020). URL: https://ec.europa.eu/info/sites/default/

files/commission-white-paper-artificial-intelligence-feb2020_en.pdf.
[13] Ministry of Transport, Information Technology and Communications. “Strategy for the Development of Artificial Intelligence in Bulgaria until 2030”. (2020). URL:https://www.mtc.government.bg/sites/default/files/koncepciyazarazvitienaiivbulgariyado2030.pdf.
[14] Grand View Research. Artificial Intelligence Market Size, Share & Trends Analysis Report By Solution, By Technology (Deep Learning, Machine Learning, Natural Language Processing, Machine Vision), By End Use, By Region, And Segment Forecasts, 2021 – 2028. June 2021. URL: https://www.grandviewresearch.com/industry-analysis/artificial-intelligence-ai-market/methodology.
[15] Gartner. Information Technologies Insights. Artificial Intelligence. (2021) URL: https://www.gartner.com/en/information-technology/insights/artificial-intelligence.
[16] The White House Office of Science and Technology Policy. “American AI Initiative: Year One Annual Report” (2020). URL: https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/02/American-AI-Initiative-One-Year-Annual-Report.pdf.
[17] ICIMS Report on US Tech Talent. URL: https://www.icims.com/company/newsroom/employers-hired-only-60-of-their-required-tech-talent-in-the-u-s-over-the-last-three-years-based-on-icims-analysis-of-25-million-applicants.
[18] Gartner Inc. Survey (2019) on Global IT Talent Shortage. URL: https://www.gartner.com/en/newsroom/press-releases/2019-01-17-gartner-survey-shows-global-talent-shortage-is-now-the-top-emerging-risk-facing-organizations.
[19] Forbes Report (2021). Analysing The Software Engineer Shortage. URL: https://www.forbes.com/sites/forbestechcouncil/2021/04/13/analyzing-the-software-engineer-shortage/?sh=738c3e32321c.
[20] Daxx Company Report. (2021). The Software Developer Shortage in the US and the Global Tech Talent Shortage in 2021. URL: https://www.daxx.com/blog/development-trends/software-developer-shortage-us.
[21] The US Bureau of Labor Statistics. Occupational Outlook Handbook on Computer and Information Technology. URL: https://www.bls.gov/ooh/computer-and-information-technology/home.htm.
[22] CEN. CWA-16458-1: European ICT professionals role profiles – Part 1: 30 ICT profiles. Brussels. (2018). CEN-CENELEC Management Centre. URL: https://itprofessionalism.org/about-it-professionalism/competences/where-to-buy-the-e-cf-standard.
[23] EDISON Community Initiative. EDISON Data Science Framework EDSF (2017). Release 2. URL: https://edison-project.eu/edison/edison-data-science-framework-edsf.

[24] EDISON Community Initiative. Data Science Competence Framework (CF-DS). (2017). EDISON Data Science Framework: Part 1. doi: 10.5281/zenodo.1044346.
[25] EU ICT Ethics. European Professional Ethics Framework for the ICT Profession. (2020). URL: https://www.ict-ethics.eu.
[26] Project HCAIM. The Human-Centred AI Master's Programme and Community. URL: https://humancentered-ai.eu.