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The impact of the AI revolution on the ICT labour market

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Artificial intelligence evolves in cyclical patterns, with phases of dynamic technical progress, referred to as "AI springs", interspersed with periods of stagnation, called "AI winters". The current phase, known not only as another "AI spring" but rather as an "AI revolution", has accelerated particularly over the past year, starting with the launch of the ChatGPT service on November 30, 2022. The widespread adoption of generative AI systems has significantly impacted numerous aspects of socio-economic life, with a particular focus on the ICT sector. This paper presents a detailed and comprehensive analysis of the labour market, utilising quantitative and qualitative data, to assess the impact of artificial intelligence tools, including their effects on the IT industry, potential AI applications across various sectors of the global economy, and a detailed study of the transformation of the Polish labour market in terms of AI-related occupations. In addition, the challenges facing the higher education system due to the growing demand for specialised personnel in artificial intelligence are identified. The paper also attempts to evaluate future trends

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in the labour market relating to the further development of artificial intelligence, with a particular focus on potential changes in the demand for competencies and possible challenges faced by various sectors of the economy.

Keywords: AI revolution, generative AI, ICT labour market, digital skills, data analysis

Wpływ rewolucji AI na rynek pracy TIK

Sztuczna inteligencja rozwija się w sposób cykliczny – fazy dynamicznego postępu technicznego określane mianem „wiosen AI" przeplatają się z okresami stagnacji nazywanymi „zimami AI". Obecna faza, znana nie tylko jako kolejna „wiosna AI", lecz wręcz jako „rewolucja AI", przyspieszyła szczególnie na przestrzeni ostatniego roku, począwszy od 30 listopada 2022 roku, gdy wprowadzono na rynek usługi programu ChatGPT. Szeroka adopcja generatywnych systemów AI wywarła głęboki wpływ na liczne aspekty życia społeczno-gospodarczego, ze szczególnym uwzględnieniem sektora TIK. W niniejszej pracy dokonano kompleksowej analizy rynku pracy w kontekście wpływu narzędzi sztucznej inteligencji, z uwzględnieniem ich oddziaływania na branżę IT, potencjalnych zastosowań AI w różnych sektorach gospodarki światowej oraz szczegółowego badania transformacji polskiego rynku pracy w zakresie zawodów związanych z AI. Ponadto zidentyfikowano wyzwania stojące przed systemem edukacji wyższej, wynikające z rosnącego zapotrzebowania na specjalistyczną kadrę w dziedzinie sztucznej inteligencji. W pracy podjęto również próbę oceny przyszłych trendów na rynku pracy związanych z dalszym rozwojem sztucznej inteligencji, ze szczególnym uwzględnieniem potencjalnych zmian w zapotrzebowaniu na kompetencje oraz możliwych wyzwań, przed którymi staną różnorodne sektory gospodarki.

Słowa kluczowe: rewolucja sztucznej inteligencji, generatywna sztuczna inteligencja, rynek pracy TIK, kompetencje cyfrowe, analiza zbiorów danych

1. Introduction

The term "artificial intelligence" (AI) refers to the ability of machines to mimic human skills, such as reasoning, learning, planning and creativity. It has long been one of the critical areas of technological research and development, going through cycles of intense progress and periods of stagnation, known as "AI springs" and "AI winters", respectively. John McCarthy probably defined it in 1956 at the Dartmouth Conference (Andresen, 2002). Today, many different definitions are familiar, of which the following two are worth mentioning in the context of this paper:

1. "AI is the ability of a machine to display human-like capabilities such as reasoning, learning, planning and creativity" (European Parliament, 2020).

2. "Artificial intelligence is a field of knowledge encompassing, among other things, neural networks, robotics and the creation of models of intelligent behaviour and computer programs to simulate this behaviour, including machine learning, deep learning and reinforcement learning" (Ministry of Digital Affairs of the Government of the Republic of Poland, n.d.).

AI optimises business processes, creates advanced security systems, and adapts faster to market changes. AI is making many industries more flexible and responsive to customer needs. Companies invest in AI to increase efficiency and innovation and meet growing market demands. Thanks to the spread of so-called generative artificial intelligence, we are experiencing another "AI spring" and even a revolution in this field. Its widespread adoption influences changes in employment patterns, the need for new competencies and the emergence of new professions. Understanding these dynamic changes is crucial for businesses, educational institutions and policymakers.

This publication analyses the impact of the aforementioned AI revolution on the labour market, focusing on the ICT sector. As part of this objective, the following research activities were undertaken:

- Investigate the impact of generative artificial intelligence on the IT industry.
- Conduct an analysis of the Polish labour market in the field of AI.
- Analyse the challenges relating to AI in the higher education system.
- Attempt to formulate forecasts of future trends.

The paper uses a multidisciplinary approach, combining qualitative and quantitative analysis.

2. Generative artificial intelligence as a driving force of the revolution

2.1. Definition and characteristics of generative AI

Generative AI is a sub-discipline of AI that focuses on creating new content – text, images, sounds or even source code – based on patterns derived from provided training data (IBM Research, 2023). Unlike traditional AI models, which mainly classify or predict data, generative models can create original and realistic content.

A distinctive feature of generative AI is deep neural networks, mainly transform models, which enable the processing of vast amounts of data and understanding the complex relationships between them (IBM Research, 2023). Examples of such models include large language models, such as GPT-3 or GPT-4, which can generate texts of near-human quality.

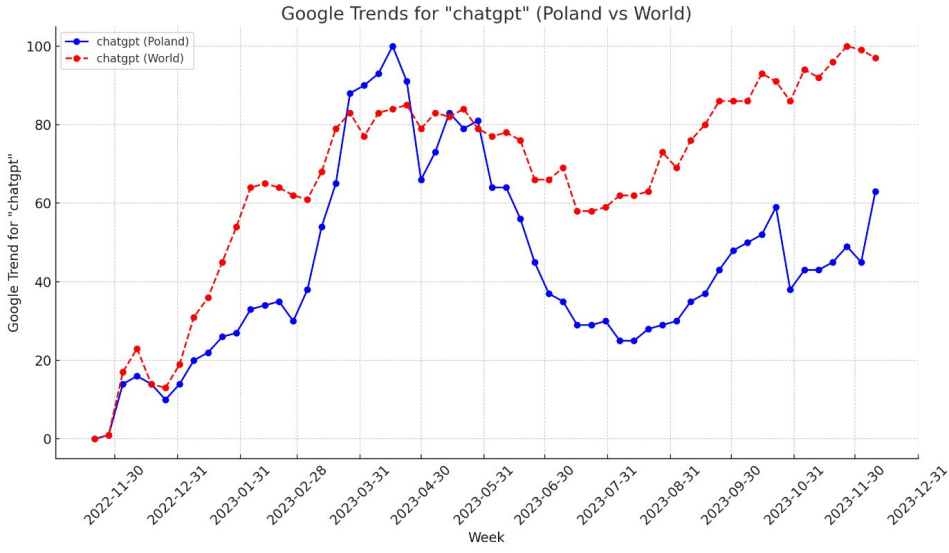
2.2. Breakthroughs: Introduction of ChatGPT

One of the critical moments in the development of generative AI was when OpenAI made the ChatGPT service public in November 2022

(Baidoo-Anu & Owusu Ansah, 2023). ChatGPT is an interactive language model based on a GPT (generative pre-trained transformer) architecture that enables natural conversations with the user, answering questions, giving advice, or even generating creative content.

The introduction of ChatGPT has been met with tremendous interest worldwide. According to Google Trends data (Google Trends, n.d.), the phrase "chatgpt" experienced a surge in popularity in the first months of 2023. In Poland, interest peaked in April 2023, as shown in Figure 1. Although Poland ranks further back in search intensity (only 69th out of 82), the global trend indicates a growing awareness and interest in generative AI. Asian countries are leading the way, with the top five places going to China, the Philippines, Nepal, Pakistan and Sri Lanka.

Figure 1.
Trend graph of the keyword "chatgpt" in Poland and worldwide



Source: generated by Google Trends: https://trends.google.com/trends/

2.3. Differences between the current revolution and previous "AI springs"

The current stage of AI development, often referred to as the "AI revolution", differs significantly from previous "AI springs" in several respects (Bughin et al., 2017; Chui, Hazan, Roberts, Singla & Smaje, 2023; Chui, Yee, Hall, Singla & Sukharevsky, 2023; Schuchmann, 2019):

- Scale and availability of technology: Earlier waves of interest in AI were limited by a lack of computing power and access to data. Thanks to cloud computing and extensive data development, AI models can be trained unprecedentedly.
- Practical applications: Previous "AI springs" often ended in disappointment due to a lack of real-world applications. In contrast, generative AI is widely used in business, medicine, education, and entertainment.
- User interaction: Modern generative models, such as ChatGPT, offer interactive and intuitive user interaction, which increases their usability and social acceptance.
- Labour market impact: The current AI revolution significantly impacts the labour market by introducing the automation of tasks requiring physical and cognitive skills. This forces the need to adapt and acquire new competencies.
- Speed of adoption: The rate at which generative AI is being introduced into various sectors of the economy is significantly higher than in previous decades, driven by globalisation and the digitalisation of business processes.

These factors mean that the current AI revolution has a much more profound and lasting impact on society and the economy than previous phases of technology.

3. The impact of generative AI on the ICT industry and the labour market

3.1 Transforming the IT industry through artificial intelligence

Artificial intelligence (AI) is pivotal in transforming the IT industry, bringing revolutionary change through process automation, advanced data analytics and the creation of adaptive algorithms. IT companies are increasingly investing in AI technologies, allowing them to increase operational efficiency and innovate to meet the growing demands of a rapidly evolving market. Implementing AI optimises business processes and enables developing advanced security systems and faster adaptation to market changes. The IT industry has become more flexible thanks to AI, allowing it to better adapt to customer needs and improve the quality of services and products (Bielińska-Dusza, 2022; Chui, Hazan, Roberts, Singla & Smaje, 2023).

Large language models such as GPTs enable natural language processing tasks. They can generate content on a given topic, provide complex answers, translate texts, analyse data and perform many other tasks. Compared to previous artificial intelligence solutions, their main advantage is their ability to create new content and provide answers and analyses that require additional knowledge. This opens up a wide range of possibilities to support processes within IT service management through automation, personalisation, in-depth analysis, or even handling critical and unusual events.

ChatGPT in the IT industry can support developers by generating code, finding bugs, creating technical documentation, or helping with project management and customer service. Contrary to common fears, these tools do not replace people but support their work by supporting their thought processes, generating ideas or suggesting solutions. This allows employees to focus on strategic tasks.

3.2. Artificial intelligence in service management

IT service management (ITSM) is an approach that focuses on delivering IT services according to business needs. In this area, generative AI is also gaining prominence, automating critical tasks, leading to increased efficiency and reduced response times to requests. One of AI's main applications in ITSM is incident management automation. AI can classify tickets and assign them to the appropriate teams, significantly streamlining the process. Additionally, generative AI enables the creation of chatbots that operate 24/7, providing quick and accurate responses and analysing large amounts of data in real-time. This allows IT teams to focus on more complex and critical problems, increasing efficiency (Li et al., 2023).

AI also plays an essential role in prioritising requests, learning from previous cases and assigning the right people to tasks. Such automation allows better management of resources, speeding up the resolution of critical issues and increasing the productivity of IT teams.

Despite the many benefits, implementing AI in ITSM comes with some challenges. Training employees to use the new tools effectively is crucial. It is also essential to seamlessly integrate AI with existing systems and ensure data security. Additionally, managing the complexity of AI decision-making processes requires careful planning and continuous monitoring to avoid errors and ensure that AI activities are aligned with business objectives. Despite these challenges, generative AI in ITSM has great potential to transform IT service management, increasing flexibility, efficiency and user satisfaction. As AI technology evolves, its role in ITSM will intensify, revolutionising how organisations manage their IT systems (Li, Reinhard, Peters, Oeste-Reiss & Leimeister, 2023).

3.3. Artificial intelligence in the software development process

Generative AI brings revolutionary changes to software development, automating essential tasks such as code generation, debugging, testing and documentation. With AI, developers can count on support at every stage of the software development lifecycle, significantly increasing efficiency. At the same time, this synergy makes it possible to create so-called "collective intelligence".

Modern AI-based tools, such as GitHub Copilot, support developers by suggesting code fragments, auto-completion and identifying potential errors. This not only accelerates the programming process but also assists developers, especially those who are beginners, in avoiding or identifying errors and understanding compiler messages, which enhances their learning experience and positively impacts the final product's quality. Studies have shown that using AI in programming can increase developer productivity by up to 55% (Peng et al., 2023).

In software testing, generative AI enables the automatic generation of test cases and the prediction of potential points of failure. These methods can analyse source code and identify patterns that can lead to errors, speeding up the fault detection and repair process. They also allow the automatic creation of technical documentation (Ebert & Louridas, 2023).

AI also supports the management of IT projects by analysing project data and providing forecasts on lead times or resource utilisation. AI-based tools can monitor work progress, identify potential risks and suggest optimal solutions (Oxari, 2023).

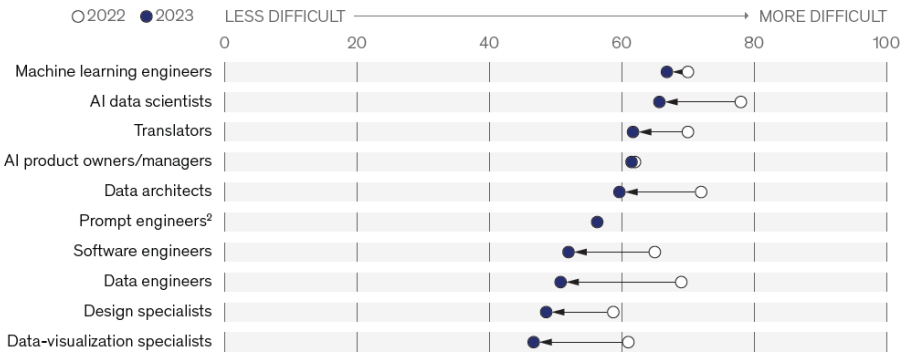
3.4. Generative artificial intelligence in business and the labour market

A report by McKinsey & Company, *The Economic Potential of Generative AI in 2023* (Chui, Hazan, Roberts, Singla & Smaje, 2023), indicates an increase

in investment in AI as it improves efficiency in areas such as marketing, sales, software engineering and R&D. Organisations are seeing gains and planning further investments. The authors of the report estimate that AI will increase global productivity by trillions of dollars. Advanced analytics, ubiquitous machine learning, and deep learning tools alone will grow the global economy by between $11 trillion and $17.7 trillion. At the same time, the full implementation of generative AI capabilities in total employee productivity allows total AI economic potential to increase to a range of $17.1 trillion to $25.6 trillion.

In a report by McKinsey & Company, *The State of AI in 2023: Generative AI's Breakout Year* (Chui, Yee, Hall, Singla & Sukharevsky, 2023), we can see that during the period of the emergence of the ChatGPT tool, the difficulty of finding specialists in particular fields decreased by a few to several percent, as can be seen in Figure 2. The most significant decreases were recorded for occupations such as AI data scientists, translators, data architects, software engineers, data engineers, design specialists and data-visualisation specialists.

Figure 2.
Results of an analysis of the difficulty of sourcing specialists for selected ICT positions – comparison 2022 vs 2023



Source: Chui, Yee, Hall, Singla & Sukharevsky, 2023.

4. Analysis of the Polish labour market in the context of AI

This section analyses the dataset "Polish job offers in AI" (Kaggle, 2023), which provides information on the interest of the IT market in jobs relating to artificial intelligence. The dataset was developed based on data downloaded from the No Fluff Jobs portal, which has been operating in the Polish market since 2014. The portal is distinguished by the fact that each employer has to specify a number of details in their advertisements, such as salary range, technologies, software, etc. This makes it an excellent place to look for IT jobs in Poland, especially for people with a lot of experience and skills.

The collection contains 19 files. Each file contains a snapshot of job vacancies in one of the months between June 2022 and December 2023. The entire database contains 787 records. Each record consists of seven attributes providing information on:

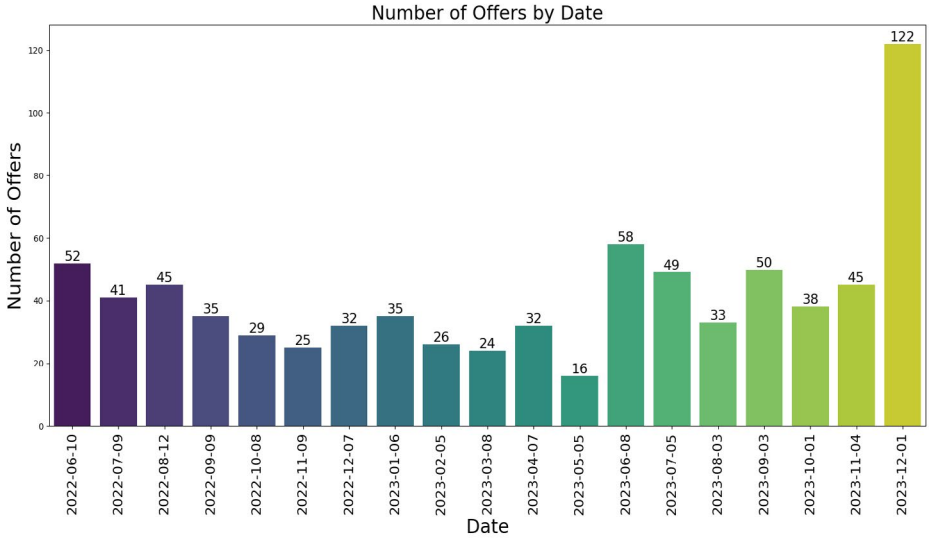
- Identifier: the unique identification number of the offer each month (local value),
- Job title: the name of the job,
- Position level: whether it is a senior level position (yes, if the title contains at least one of the words senior, expert, or lead),
- Company: the company's name,
- Location: place of work,
- Salary: usually given in the form of a range,
- Salary currency: the currency in which the salary is given.

Figure 3 shows the number of AI-related job offers during the period analysed. December 2023 was characterised by a record-high number of job offers, which may indicate an increased demand for AI professionals

towards the end of the year. This sudden increase could be due to the intensification of AI-related projects or the hiring plan for the next financial year.

However, a deeper understanding of these trends is achieved when considering the findings from the 2023 BulldogJob IT Industry Report (BulldogJob, 2023). According to this report, the largest portion of professionals working in AI-related fields in Poland consists of data scientists (61%), with machine learning engineers (27%) and AI engineers (8.5%) making up the remaining workforce. This distribution suggests that while there is a general demand for AI skills, employers may be seeking candidates with a broader data science or machine learning background rather than specific AI roles. Such insights offer additional context to the observed rise in job offers for senior AI positions, as companies may value cross-disciplinary expertise to tackle complex AI challenges.

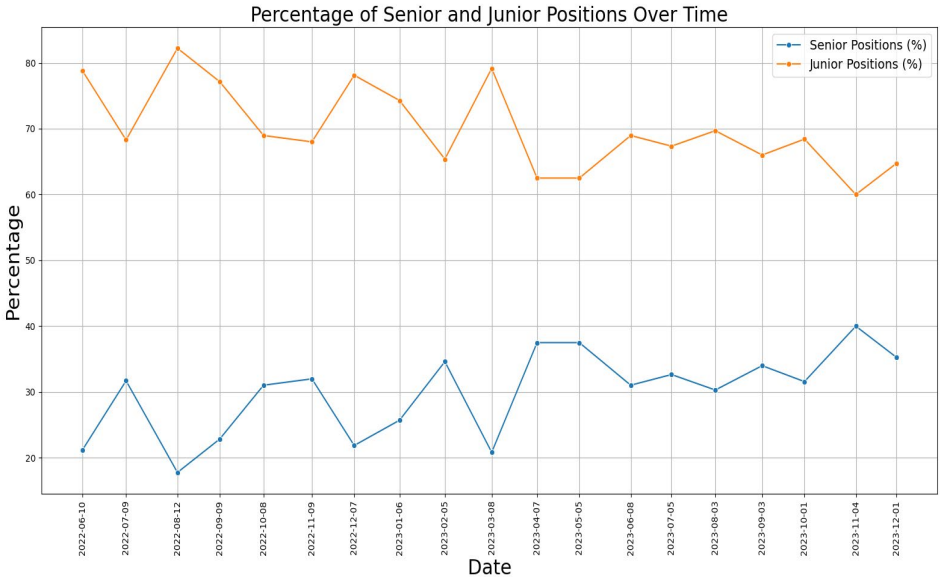
Figure 3.
Graph of the number of job vacancies by month



Source: own elaboration based on the dataset "Polish job offers in AI": https://www.kaggle.com/datasets/michau96/polish-job-offers-at-ai/

Figure 4 illustrates the gradual decline in the proportion of junior positions and the increase in senior positions over the period analysed. The proportion of offers for juniors is steadily decreasing, while the demand for professionals with more experience is increasing. This trend aligns with the BulldogJob report, which shows that most AI-related professionals in Poland hold mid-level or senior positions (48% and 17%, respectively). Only 25% are at the junior level, which reflects the observed shift in demand from entry-level to more experienced roles. This could be due to the complexity of AI projects requiring advanced skills or the need for experienced professionals to implement sophisticated solutions efficiently.

Figure 4.
Chart of the percentage of senior and junior posts



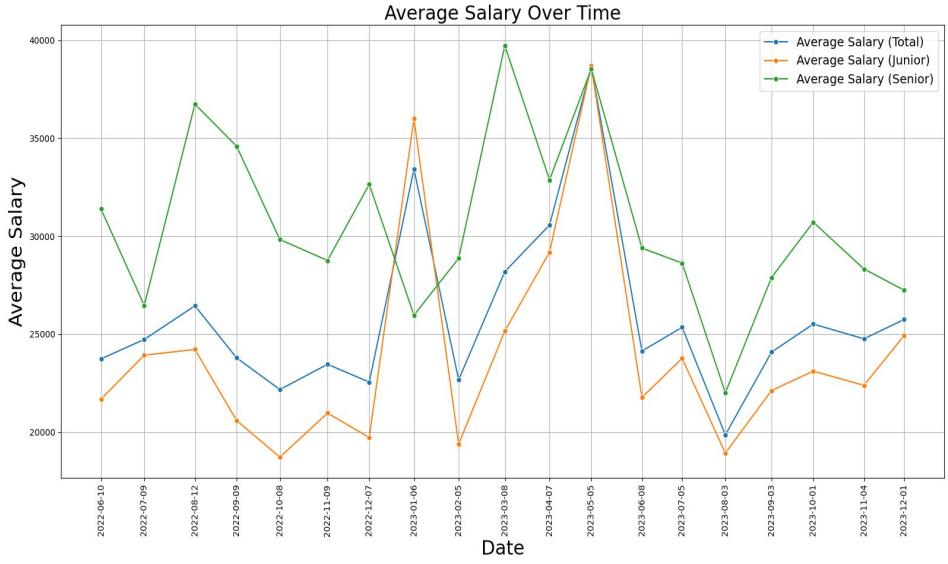
Source: own elaboration based on the dataset "Polish job offers in AI": https://www.kaggle.com/datasets/michau96/polish-job-offers-at-ai/

Similarly, Figure 5 shows the average salaries offered for AI-related positions. It is surprising to observe shaky salaries that do not show an up-

ward trend despite the increasing demand for specialists. Furthermore, a flattening of the gap between senior and junior salaries is apparent. This may be due to several factors:

- An increase in the number of experienced professionals in the market may lead to a stabilisation of salaries.
- Organisations may reduce salary budgets, resulting in a need for salary increases.
- The introduction of generative AI may reduce the need to hire more staff, affecting salary negotiations.

Figure 5.
Graph of average salaries offered



Source: own elaboration based on the dataset "Polish job offers in AI": https://www.kaggle.com/datasets/michau96/polish-job-offers-at-ai/

The BulldogJob report further supports these findings, showing that the skills in high demand for AI roles include machine learning (77%), statistical analysis (69%), and supervised learning (68%). This overlap suggests that candidates with a robust data science background are well-suited to meet the current demands of AI roles. Additionally, the stabilization in

salary growth may be a result of the high availability of skilled professionals, as indicated by the extensive presence of professionals with higher academic qualifications (51% hold a master's degree).

In conclusion, while this dataset provides insightful trends in the AI job market in Poland, integrating findings from the BulldogJob 2023 report enhances the analysis by offering a comprehensive view of the current workforce profile, educational background, and technological skills prevalent in the Polish AI sector. This broader context underscores the significance of experienced professionals and aligns with the broader industry's shift towards advanced, interdisciplinary roles in AI and data science

5. Challenges for the higher education system

One of the main problems standing in the way of effectively exploiting the benefits of the AI revolution is the inadequacy of educational methods and offers at Polish universities (Bielińska-Dusza, 2022).

In the context of education and economic development, artificial intelligence plays a key role. Technological transformations are leading to a metaverse economy and an attention economy in which digital life is becoming equivalent to physical life. AI is transforming education, healthcare and international relations, introducing new business and industrial models (Kulkov, 2021). Developing an AI-driven economy means emerging new sectors and breakthroughs in technological areas such as FinTech, HealthTech, BioTech, AgriTech or EduTech.

The development of these sectors shows how technology is infiltrating different areas of life and the economy, often creating entirely new business models and opportunities for innovation. Many of these areas benefit from advanced technologies, such as artificial intelligence, big data, the Internet of Things (IoT) or blockchain, further driving their growth and impact on society.

Thus, new digital competencies will be crucial to meet these challenges. This will require a significant transformation in the higher education system to educate the engineers of the future who are equipped with these competencies.

Such challenges include:

- Integrating advanced data analytics into curricula – a skill that has become indispensable over the past few years due to the Big Data era. Organisations increasingly use data analytics and AI to make business decisions (Davenport & Ronanki, 2018). Therefore, universities should introduce courses on data analytics, statistics, and information processing tools.
- Developing digital fluency and computational thinking – these are among the fundamental skills of the 21st century. They include problem-solving, system design and understanding human behaviour using computer concepts (Wing, 2006). Developing such skills will prepare students to work with advanced technologies.
- Education in artificial intelligence in its broadest sense – current algorithms can surpass human capabilities in some aspects. Future engineers must know not only how to use these tools, but also how they work and be aware of the potential risks associated with these technologies.
- Training in soft skills and interdisciplinarity – according to The Future of Jobs Report 2020 (World Economic Forum, 2020), skills such as critical thinking, creativity and emotional intelligence will be increasingly valued in the job market. AI may automate many technical tasks, but soft skills will remain uniquely human and essential for management and innovation.
- Cooperation with the socio-economic environment and investment in modern infrastructure – partnerships between universities

and the private sector enable curricula to be updated in line with current trends and market needs. The participation of practitioners in the teaching of future human resources is essential in the process of filling employment gaps. Equally important are investments in modern laboratories and software – including software based on AI technologies. Corporate social responsibility should oblige companies to invest in the universities from which they draw job candidates.

Education must evolve to develop the skills needed for a future where artificial intelligence plays a central role. The higher education system can only prepare graduates to operate effectively in the future's complex and dynamic professional environment by proactively addressing these challenges.

6. Projections and conclusions

The analysis conducted as part of this paper indicates dynamic changes in the Polish AI labour market. The record increase in the number of jobs offered in December 2023 and the growing share of senior positions indicate that companies are intensifying their efforts to implement AI solutions. At the same time, the volatility of salaries and the flattening of pay gaps between positions may pose a challenge for attracting and retaining talent in this field.

At the same time, the perceived trend towards equalising senior and junior offers may lead to significant difficulties for young, inexperienced ICT graduates in entering the labour market and seeking student placements. Despite the decreasing difficulties in recruiting ICT professionals and recent layoffs in technology companies, predicting a sharp slump in the ICT labour market may be premature and unjustified.

However, it is necessary to highlight the challenges facing higher education in educating future engineers. Many years ago, Ray Kurzweil predicted (Kurzweil, 2005) that AI technology would soon surpass the human brain's capabilities, leading to revolutionary societal changes. To adequately prepare future engineers for these changes, an adaptation of the higher education system that considers the development of competencies in data analytics, digital proficiency and interdisciplinarity is necessary.

The conclusions of this study indicate the need for a proactive approach to the challenges of the labour market and education in the age of the AI revolution. Through close cooperation between the private sector, universities and state institutions, it will be possible to effectively exploit the potential of artificial intelligence and ensure that the Polish economy and society will be ready for future challenges.

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