

## OFEDS.INDUSTRY 4.0 AND THE CEE COUNTRIES IT SERVICES OUTSOURCING SECTOR

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### **Abstract**

*Industry 4.0 has significantly transformed business structures, not only in the technological domain but across all aspects of operations, by reshaping workflows and driving innovation aimed at increasing productivity. This article primarily explores the evolution of outsourcing and nearshoring in the software development sector within Central and Eastern European (CEE) countries under the influence of Industry 4.0. Over the past decade, this sector has experienced substantial growth and has emerged as a pivotal driver of economic development in the CEE region. Industry 4.0 serves as both a transformative force in redefining the technological landscape and business structures as well as a catalyst for innovation.*

*This article aims to synthesize the primary transformation directions of outsourcing/nearshoring tech-organizations and to objectively list the predictions posited by recent literature. The sector is rapidly evolving, growing into a mature one under the pressure of adapting to macro-economic policies and the adoption of Industry 4.0' emergent technologies. While many aspects have been predicted in literature, reality has shifted these predictions. The article will examine the main directions outlined by literature that have proven to align with reality or still hold potential.*

*The article is structured in 4 main sections. Introduction: providing and overview of the context of nearshoring/outsourcing in CEE countries as discussed in literature. Second, we have an overview of the Industry 4.0 impact in outsourcing/nearshoring technology sector and how did this sector evolve throughout the latest decade. Third, our research is focused on the strategies and their transformative effects on business processes and specifics of nearshoring/outsourcing organizations. Finally, the conclusions and future challenges to be explored: facing reality, reviewing future strategic business approaches recommended by literature based on sector current realities.*

**Keywords:** *Industry 4.0; outsourcing and nearshoring; business models; sustainability in Industry 4.0; Deeptech.*

**JEL Classification:** O32; O12; O33; M15.

### **1. INTRODUCTION: OUTSOURCING AND INDUSTRY 4.0**

Outsourcing has been a concept that become known mostly in the '90, when productivity targets and global markets mutations have leveraged increase of

productivity through re-location of labour. This strategy has changed shapes through eras of industry development and facilitated alignment of macro-economic indicators between high-risen economies and those emerging, between Western and Eastern European countries.

“The global software development outsourcing market is expected to exhibit a compound annual growth rate (CAGR) of 11.5% from 2023 to 2028” was predicted by a renowned market reports site (Global Market Estimates, 2023). Software development, IT consulting, and IT services are the most common types of nearshoring services in Europe. The countries that typically engage in this practice include the Czech Republic, Hungary, Ukraine, Romania, and Poland.

On the other hand, countries that nearshore software development to these regions are ones that have a considerably higher cost of living. These include the Western European countries such as Germany, United Kingdom, France, and Italy, as well as the Nordic states – Denmark, Sweden, Finland, and Norway. (Klucs, 2024a)

The evolution of the outsourcing sector in CEE countries (and not only) is a process developing in the context of important technology changes brought in by Industry 4.0.

Industry 4.0 (I4.0) represents a concept that encapsulates the ongoing digital revolution. It integrates technologies such as the Internet of Things (IoT), smart automation, big data analytics, and connectivity to foster highly efficient, flexible, and interconnected production and manufacturing ecosystems. (Alarcón and Alarcón, 2025) As an evolution of traditional control and automation systems, Industry 4.0 enhances process monitoring and automation capabilities within companies. Its key features include device interconnectivity, real-time data collection and analysis, and data-driven decision-making, setting it apart as a transformative force in modern industry (Tredicine *et al.*, 2024).

The footprint that I4.0 is leaving upon tech business-flows and organization structures is reflected early on by Schuh, Potente, Wesch-Potente, Weber and Prote, in 2014 (Schuh *et al.*, 2014), through major characteristics estimated in their study:

- **Technical and Intelligent Engineering Perspective:** Industry 4.0 denotes the integration of smart products and services within technologically relevant environments, such as the Industrial Internet of Things, smart homes, or intelligent production systems.
- **Organizational and Transformational Perspective:** Industry 4.0 encompasses the dynamic generation and rapid utilization of organizational interfaces, facilitating the formation of expertise networks and enhancing operational capacity.
- **Economic and Value-Oriented Perspective:** Industry 4.0 acknowledges the significance of collaboration-driven productivity, emphasizing the role of interconnected systems in optimizing economic performance.

Industry 4.0 represents a significant milestone in the global economic development through the integration of advanced technologies, having been announced and outlined as a strategic direction by the European Union as early as 2015-2016. Currently, in theory, we are transitioning towards the next phase – Industry 5.0 – which focuses on human-centric approaches and resource recirculation. As stated, “*It complements the existing 'Industry 4.0' approach by specifically putting research and innovation at the service of the transition to a sustainable, human-centric and resilient European industry.*” (Gálvez *et al.*, 2025).

Based on the above perspectives, the current study is analysing the impact of the I 4.0 upon IT sector of CEE countries. It aims to analyse specifically the structural transformations within the outsourcing industry in Central and Eastern European (CEE) countries in the context of Industry 4.0 implementation. It also examines the challenges faced by both service providers and companies outsourcing activities, particularly in the software services sector, as well as the necessary adaptations required to maintain competitiveness in a rapidly evolving economic landscape.

The primary objective is to synthesize how Industry 4.0 has structurally transformed business models, with a particular focus on outsourcing and nearshoring in the CEE regions, and to identify key insights from the lessons learned thus far. This course of action considers also the aspects mentioned as main directions of the I4.0 impact: economic and value orientation.

Over the past decade, strategic directions have been continuously outlined and re-adapted (European Parliament, 2016), both in terms of global policies and through the natural dynamics of business, driven by concrete actions, evolution, and voluntary or adaptive transformations within the sector. This study will specifically examine software service providers and technology hubs in CEE countries, where both anticipated changes and adjustments aimed at ensuring continuity amid market volatility can be observed.

Research questions: The study in this article is aiming to answer a few specific questions based on which also resources have been filtered and summarized:

- Q1: Which are current trends of transformative changes of outsourcing in CEE countries?
- Q2: Which are additional factors and challenges involved in the transformation?
- Q3: Which are the trend adaptation strategies stipulated by literature as observed or recommended for organizations of outsourcing in CEE countries under all circumstances of volatility and Industry 4.0?

The methodology employed in this study involved a systematic approach of selecting and analysing relevant literature, as well as own inference based on confronting different sources and market realities. Academic articles from

databases such as ScienceDirect, Sci-Hub, Sage, and ResearchGate were included based on specific search terms: Information Technology Outsourcing/Business Processes Outsourcing/Knowledge Processes Outsourcing (ITO/BPO/KPO); nearshore, DeepTech, outsourcing, Industry 4.0, reshoring, impact of DeepTech on the software market; business environment in the DeepTech era, adaptive strategies in Industry 4.0. Additionally, there were considered market research reports, including IDC, NATEK and World Economic Forum on digital transformation expenditures and cloud services, data security and governance or articles and market studies conducted by different consulting companies such as BCG, McKinsey (McKinsey, 2022), and Deloitte. The inclusion criteria focused on studies published between 2020 and 2025, with an emphasis on research from past two years to reflect recent developments in the field. However, some sources since before pandemic (2020) have been considered as trend-setters and predictions have been at the time set by literature and studies, whereas COVID has accelerated adoption of certain measures that enriched impact of I4.0 in IT sector. Selected articles:

- Addressed the relationship between I 4.0 and transformation of outsourcing/nearshoring models in CEE countries;
- I 4.0 technologies adoption in the business sector based on different organizational models and business structures;
- Addressed also the transformations that innovation could bring into tech business of CEE countries (entrepreneurship also covered).

There have been used sources older than the date range specified, when definitions of different concepts had to be cited (e.g., ITO, BPO, KPO) or cited European Parliament and other EU political authorities for tracking directives of Industry 4.0.

Exclusion criteria included:

- Studies focused exclusively on the technical aspects of I 4.0 without addressing other business models, unless tech aspects were involved;
- Studies that solely debate specific sectors of nearshoring/reshoring such as manufacturing industries without focusing on the tech perspective of these business-flows;
- Statistics that only referenced job dynamics and employee skills in software without discussing how these are integrated into the business environment dynamics;
- Governmental measures that aim only state sector without a clear reference to outsourcing/nearshoring private sector. For instance, a lot of state organizations that present needs of digitalization, being part of the over-all IT sector development policy but not touching directly privately held organizations.

## 2. CURRENT CONTEXT OF OUTSOURCING IN EUROPEAN SPACE

The transformative organizational effects represent one of the three foundational perspectives (Schuh *et al.*, 2014) that underpins this article and serves as the lens through which the trends of the structural changes of nearshoring/offshoring business have unfolded in CEE countries. We will further summarize how the main types of the outsourcing have set the trends within European space. Western European and East European countries have a specific dynamic into outsourcing complexities.

There have been different types that outsourcing can be identified in manifesting along the evolution of the business practice in various industries. With regards to information technologies, this has 3 main specific practice shapes: ITO, BPO, KPO.

- *ITO* is a practice where companies outsource IT functions to external providers, often to leverage specialized skills and reduce costs (Meyer, 2006).
- *BPO* is a business practice where an organization contracts with an external service provider to perform essential business functions or tasks. These can include back-office processes like accounting and front-office processes such as customer service (Bharadwaj and Saxena, 2010).
- *KPO* involves outsourcing core business activities and highly specialized knowledge-related work to third-party professionals. This allows businesses to access specialized expertise and improve efficiency (Currie and Willcocks, 1997)

The outsourcing has undergone a transformation in its objectives, taking initially the shape of the externalization of specific segments of the production processes, referred to as ITO. As technology began to assume a larger role in these processes, outsourcing evolved into the relocation of software-related services, which are more easily outsourced, controlled, and audited – this form being known as BPO. The way in which ITO has transformed in response to the growing complexity of business operations leads to a shift in outsourcing/nearshoring towards KPO. In this context, outsourcing has evolved not only to encompass the externalization of processes but also the externalization of expertise, synchronized with the increasing level of specializing training (Sen and Shiel, 2006).

A first answer to research question Q1 goes into area of diversifying outsourced processes by adding complexity to it. Starting with outsourcing the simple IT functions (ITO), early on in beginning of years 2000s, this took a while to ramp-up into new, growing complexity outsourcing models. Expertise and business view has matured since then, within the sector, allowing it to organically develop business trusted relationships as well as technological management strategies with direct impact in the context of BPO and KPO.

According to reports from McKinsey and the Boston Consulting Group (Klucs, 2024b) developed European markets provide a favourable environment

for the expansion of the nearshoring sector. Given that the primary countries outsourcing services to Central and Eastern European (CEE) nations in a nearshoring model are the United Kingdom, Germany, and the Nordic countries, several key factors indicate that nearshoring is expected to continue its growth trajectory in the coming years:

- *United Kingdom*: The ITO market is projected to reach €47.70 billion by 2028, driven by a post-Brexit talent shortage and rising labour costs, which are accelerating outsourcing to external service providers.
- *Germany*: The German ITO market is anticipated to grow from €22.95 billion in 2023 to €38.07 billion by 2028, as German companies increasingly adopt nearshoring strategies to address skill shortages.
- *Nordic Countries*: Approximately 40% of organizations plan to integrate nearshoring into their outsourcing strategies, creating opportunities for ITO providers in emerging economies. These countries are at the forefront of adopting AI and ML technologies, presenting valuable prospects for specialized service providers.

Based on the number predictions of the literature, nearshoring is increasingly directed towards CEE countries, which have the potential to manage strategic processes in geographically proximate locations. These regions offer access to a well-educated, young workforce proficient in multiple foreign languages, along with strong technical and financial expertise. This expertise has been cultivated through the historical expansion of the outsourcing sector and the ongoing shift from ITO to KPO.

While looking through the lens of literature's mentioning, it is observed that outsourcing is presented as an economy growth factor in EU countries. This translates through CEE countries developing a new sector of services provided mainly towards the established economies (UK, Germany, the Nordic Countries). Overall, the development of outsourcing/nearshoring in EU is a balancing and unifying factor for EU countries economies, facilitating collaboration in a unified geo-political space supported by European laws and directives. To add to the Q1 and Q3 answers, this marks another trend of the I4.0 impact on CEE countries consolidating collaboration within the space leveraging on the productivity factor of both parties involved, which, in the end benefits the European economy and tech-advancement, shaping outsourcing more into nearshoring.

### **3. OUTSOURCING STRATEGIES ADOPTED FOR I4.0**

The literature indicates that digital service providers in the field of I4.0 technologies from CEE countries (Jipa-Muşat *et al.*, 2024) must adopt certain strategies to ensure continuity in this context. There are highlighted several classifications of these strategies mainly focusing on those increasing the productivity for clients. This aspect of productivity increasing outlines a predilection of adoption of new technologies (AI) for basic services, thus allowing

companies to focus on re-directing budgets towards innovation or other development departments, reshuffling storage costs by mixes of on-prem/cloud solutions or targeting low-digitalized sectors as new clients. All of these employ different additional advantages like generating new services, focusing on consultancy services and requiring cross-domain knowledge for leading change processes in new sectors (Sftecu,N 2025). These strategies reflect differently on various types of organizations: corporations, SMEs, start-ups.

### **3.1. Business strategies of main size-categories of outsourcing services providers**

The trends have been evolving in alignment with the strategic directions established prior to Industry 4.0. According to the World Economic Forum (2023), “70% of the new value to be created in the global economy over the next decade will be based on productivity gains from digital technology adoption” The cited study highlights not only the growth opportunities for large corporations but also for small and medium-sized enterprises (SMEs), whether as clients or providers of IT services that generate added value in the economy.

Several sources refer to *corporations* and their strategies of ensuring adaptability throughout I 4.0:

- Companies are transforming their service portfolios by shifting towards AI consultancy and advanced technological solutions, or even outsourced research and development departments (Klucs, 2025). They are relocating development processes and storage resources while maintaining expertise – a major factor influencing added value, thus focusing on niche talent to be acquired through local efforts (Madsen, 2025).
- Through consultancy, they are targeting new sectors for digitalization (administrative, healthcare, construction), generating partnerships primarily to increase flexibility, thereby reducing multiple contracting (Klucs, 2025).

*Small and medium-sized enterprises (SMEs)* in outsourcing play a particularly crucial role in the global economy, accounting for over 98% of all companies in the European Union and generating more than 100 million jobs (Silva *et al.*, 2025).

- They provide DevOps, Data Science, and IT security services for SMEs, assisting with cloud migration and cost optimization driven by economic volatility and the widespread use of cloud solutions (Madsen, 2025).
- The transition to subscription-based business models ("as a service") reduces dependence on Time & Materials (T&M) contracts, shifting to monthly subscription services instead of one-time license sales, making them much more accessible to SMEs as potential clients. 83% of small businesses will maintain or increase their spending on outsourced business services in 2023 (Clutch Team, 2023).

The contribution of SMEs to economic growth, their potential for self-development, and their impact on the global economy are analysed in a study proposing a methodology for the efficient adoption of new technologies in SMEs' digitalization processes by differentiating between digital readiness levels and digital maturity levels (Silva *et al.*, 2025). Given the scarcity of resources, the level of knowledge, and the necessity of investing in new technologies – often sophisticated, yet costly to integrate into business workflows – the *DORAM* model has been introduced. This model is particularly relevant as it provides a structured approach to optimizing technology adoption, ensuring that organizations integrate innovations where they genuinely offer a competitive advantage in the market and in their specific business activities.

*Start-ups – An Essential Element in the Business Environment of Industry 4.0:* In the organizational conglomerate of the economies of Central and East European countries, deep-tech start-ups contribute to achieving the United Nations' Sustainable Development Goals (SDGs). The majority of these companies are founded by entrepreneurs with advanced academic qualifications – a sustainable trend characteristic of Industry 4.0. However, they face significant challenges, such as high costs, lengthy research processes, and substantial risks of failure (Nguyen *et al.*, 2024). This paper explores how European deep-tech start-ups can enhance their success by integrating strategic foresight and context, not merely technological innovations. The study employs Partial Least Squares Structural Equation Modelling (PLS-SEM) to analyse the impact of market, technology, and environmental characteristics on strategic foresight capabilities. The findings indicate that deep-tech start-ups must combine technological expertise with market analysis skills to ensure more efficient adoption of innovations at lower costs (Romme *et al.*, 2023).

### **3.2. Collaboration models in I 4.0 outsourcing**

Another aspect addressed by research literature and economic reports concerning the impact of Industry 4.0 is the transformation of organizational structures and how companies adapt to market demands, not only through technology but also through integrated operational mechanisms with adaptive and scalable capabilities. Following we will list some of the models adopted according to existing research:

- **Transactional Model vs. Strategic Partnership:** Both studies and research papers emphasize value-added services and analyse contracting strategies for outsourcing software development within the context of Industry 4.0. A study proposes two contractual models: *pay-per-time and revenue-sharing* (Wang and Zheng, 2024), which can help companies manage market uncertainty and asymmetric information between providers and clients. The paper highlights the importance of adapting contracts to ensure software interoperability and scalability in digital manufacturing.

- **Traditional Outsourcing vs. Innovation-Based Outsourcing:** In traditional outsourcing, the focus was primarily on workflow outsourcing (BPO). However, innovation-based outsourcing is oriented toward specialized skill sets with deeper domain knowledge. The study *From Business Process Outsourcing (BPO) to Knowledge Process Outsourcing (KPO)* (Sen and Shiel, 2006) explores this transition in different contexts and at the technological level (in the US, during the 2000s). The growth of this phenomenon is driven by the shortage of skilled labour in industrialized countries and the availability of specialized human resources in emerging economies, making it relevant in the analysis of outsourcing transitions within Industry 4.0. The study highlights challenges associated with KPO, including higher infrastructure requirements and specialized competencies, as well as the additional risks involved in this type of outsourcing.
  - **Higher Complexity:** KPO involves high-end processes that often lack standardized methods for achieving solutions, introducing risks and uncertainties that are less pronounced in the more routine activities of BPO.
  - **Integration with Client Operations:** KPO requires a deeper understanding of the client firm's operations and strategic goals to effectively add value. Building this integration demands strong communication and trust between the outsourcing provider and the client.
- **Co-Innovation and Technological Partnerships:** This new approach involves companies reinventing themselves by outsourcing processes requiring optimization to strategic partners who possess niche knowledge, expertise, and the capacity to support innovation through AI. For example, the use of digital twin concepts for optimizing production flows in large companies (Monferdini *et al.*, 2025).

On a deeper cross-overview of the collaboration models, organization types and process typologies in outsourcing area of the CEE countries, we can summarize the linkage of them and some specifics reasoning of each, making sense of the multiple possibilities exposed in a structured way (see Table 1).

**Table 1. Possible structure of the mix business models – organization size – outsourcing type**

Business collaboration model		Outsourcing type	Organization type (client/provider)	Specifics of the model - organization - practice process	Examples of service offerings adapted to I4.0
Traditional outsourcing	Transactional model	ITO, BPO	Corporations (provider/client) & SMEs (provider/client)	Services with a low-potential of innovation Subscription-based services Addresses mostly maintenance services	Re-configuring cloud migrations/maintenance services specific affordable services for automation of simple processes “as a service” (standardized)
	Strategic Partnership	BPO, KPO	Corporations (provider/client) & SMEs (provider/client)	Newly digitalized SMEs/corporations standardized services	Employing digitalization consultancy for low-readiness levels organizations/sectors (KPO mode)  Cyber security services (subscription-based)
Innovation based outsourcing	Outsourcing innovation	BPO, KPO	Corporations (client), SMEs (provider)	Niche expertise. (e.g. AI flows customization to be incorporated through AI expertise SMEs covering only the integration and customization process)	Governance services AI automated routines (chatbot)  Corporations of heavily non-digitalized sectors (medicine, constructions, finance) partnerships between corporations of similar technology chain
	Co-innovation	KPO	Corporations linked in the chain of market products (for instance automotive software linked with smart highway infrastructure companies)	Besides production chain of value is linking the entities, there might be also involved academic & research organizations involved.	(automotive – telecom; governmental – AI; medicine – AI; medicine – robotics)

Source: based on author’s interpretation

Considering the structural changes of the outsourcing from ITO to KPO, we have synched these with the literature mentioned strategies from transactional model to strategic partnerships or partnership based strictly on innovation/co-innovation. The observation of the market supports several horizontal connections

between these 3 aspects that consolidate towards main trends of how organizations are approaching sustainability under the influence of I4.0 wave.

- Traditional outsourcing (based in ITO and BPO and low level KPO)
  - *Transactional models and strategic partnership* reflect mostly into realities of long-term organizational relationship, whereas services (like “testing” or “DevOps”) have been for a long time confirmed as efficient and thus *big corporations* were used to outsource to more than just one provider. Now, they have started to incline to keep only preferred, rapidly translated into margins focused collaboration. For many tech corporations wanting to focus on innovation, budgets are being free to go more into that strategic direction by adopting a short list of confirmed, long-term outsourcing collaboration for the low innovation potential areas of their products life-cycle. When processes have already been standardized, the transactional model of outsourcing/nearshoring takes over costs of labour and its risks (ITO). Most known example of such strategy is keeping outsourcing transactional model in place for testing services of big tech corporations or processes where the infrastructure maintenance of a cloud framework is being outsourced based on a previous long-term collaboration, so that DevOps Team are strategically pulled into further contracts. These services can be even transformed into a subscription-based maintenance service, where process itself is a secure one, being standardized and easy to be scalable included into the cost projections of the client corporations. In the same time, standardization of these services, allows providers of it (SMEs or corporations with knowledge of process) to further provide the same service to another segment of the market: *SMEs with a low level digitalization readiness factor*. These are low-complexity services offered in a standardized manner. Under these approaches, we can notice a prevalence of ITO/BPO type of business in the big corporations-outsourcing providers relationship and a low-level complexity KPO profiled in the area of services for low-level digitalized SMEs. Here, providers contribute with an advisory component towards the clients but referring only to a most common/standardized recommended practice, that introducing the KPO nuance.
- *Innovation based partnership* – also a preeminent trend of the I4.0 takes precedence in nearshoring sector through concrete BPO/KPO structures that either go into outsourcing expertise niche to deep-knowledge experts (SMEs or even research organizations) or into innovative collaborations unifying forces of expertise to emerge new products.

- For the first aspect of the innovation-based outsourcing, we can notice in the market a strong need of expertise cross-domains in order to raise the pace of digitalization of low-digitalized sectors (constructions, medicine). Nevertheless, the digitalization of these sectors, as imminent as it may appear, has a good reason for not being yet on a low level: lack of expertise of the specific domain merged with tech-savvy understanding. Until the education sector itself will provide such educated specialist that can serve a cross-domain expertise sector, market is catching-up through open-minded specialists, seasoned technology experts that have been exposed to other specific domains and had a high learning aperture. Until now, these were known as seasoned business analysts, which have sound skills of understanding of cross-domains concepts and making it easier for tech experts to understand the needs of the construction domain or medicine domain (or others). Education (self and by experience) is bridging separate domains and allows a new segment of expertise to rise and express through innovation-based collaborations. These processes are profoundly marked by the expertise of the specific domain, thus we can firmly state that in these cases outsourcing is re-shaping towards consistent KPO more than BPO.
- Co-innovation – is when processes of 2 organizations are unified in a totally new manner towards innovating cross-products. Samples of these have already entered our lives through IoT whereas any industry has been raised to the rang of “smart” once their management and personalization has been combined with telecom functionalities. Other emerging collaborations can be observed as trending already in the market: automotive – telecom; governmental – AI; medicine – AI; medicine – robotics. This kind of cross-domain collaborations will emerge even more innovative products and will allow industry to merge into new market domains. A major contribution to this part of the innovation-based outsourcing/partnership is also the involvement of academic organizations through their more practical implications from research areas.

The above analysis of models and strategies adopted comes to answer our research questions. With regards to the trends of outsourcing under I 4.0 impact (research question Q1), we are witnessing the shaping of business processes with a focus on delivering added value to benefit technological and economic growth. We are moving toward personalization through the creation of scalable and adaptable generic models, which imbue the business environment with sustainability and resilience. Trends revolve around a form of adaptability, trying

to focus on partnerships, scalability of solutions and innovation in services structures or workflows to ensure continuity. Most probably outsourcing becomes more a form of partnership in service deliveries. This providing answers also to our Q3 research question with regards to strategies of I4.0 adaptation for the outsourcing companies.

These business processes and collaboration models of outsourcing are still to be explored through market reality and further observation. It is important to notice how these might or might not contribute to increasing complexity and push towards higher value driven approaches. The mix of strategies and models observed by literature as adopted or to be adopted have still a lot of changing potential that is to be researched and developed.

### **3.3. Contextual factors modelling I 4.0 adaptation of outsourcing – inducing volatility**

In addition to the new adaptive models, outsourcing in Industry 4.0 is significantly influenced by factors that contribute to the increased volatility of the outsourcing/nearshoring environment, as highlighted in the literature: *Legislative Changes and Geopolitical Impact, Taxation, Security & Governance, Talent Shortage*. All of these increase the complexity of the outsourcing environment adding pressure to the need of creative solutions towards sustainability of business.

The political instability in CEE countries over the past 2-3 years (such as the war in Ukraine, the turmoil caused by extremist movements in major European powers, as well as in economically polarized countries like the USA and Russia) imposes a high degree of economic volatility. This geopolitical volatility adds unpredictability to outsourcing and nearshoring strategies. A consequence of the aforementioned instability, as well as an independent factor, taxation policies within CEE countries introduces long-term instability for investors. These policies recalibrate the cost advantages for processes relocated to the CEE countries, increasing price competition with countries in Asia. Furthermore, the growing average salaries in CEE countries and advancements in online collaborative technologies have allowed low-cost Far Eastern countries to offer competitive service solutions to Western BPO customers (Peköz, 2025).

Data security and regulations, such as GDPR and other policies, are major factors influencing outsourcing decisions. On the other hand, IT security concerns act both as a barrier as well as a catalyst for the adoption of Industry 4.0. SMEs with a higher degree of digitalization are more exposed to cybersecurity risks but are also better equipped to implement advanced protection solutions. Key challenges include financial constraints, inadequate IT infrastructure, and a shortage of digital skills, as discussed in *The Effect of IT Security Issues on the Implementation of Industry 4.0 in SMEs* (Arroyabe *et al.*, 2024). Additionally, in

an IDC report, it was noted that skills, AI, and enterprise solutions will play a crucial role in addressing these concerns (Loomis, 2024).

The growing demand for IT specialists and its effects on the labour market are also major challenges. As highlighted in the study *Future Workforce for Industry 5.0* (Saheal and Mohammad, 2025), employees should possess self-management abilities and the capacity to learn new skills or enhance existing ones to assess, compare, and comprehend information effectively. To overcome obstacles during the transition to Industry 5.0, workers need resilience, stress tolerance, and adaptability. One of the biggest challenges for companies in CEE countries remains the digital skills gap. In Romania, for example, only 27.7% of the population has basic digital skills, and only 2.6% of employees are specialized in IT. To maintain the competitive advantage of outsourcing, it is essential to accelerate upskilling and reskilling programs to address this gap (Saheal and Mohammad, 2025).

Coming back to our research questions, which would be the factors that challenge the I4.0 adaptation strategies of outsourcing in CEE countries (Q2), it is noticed from literature that CEE countries have confronted and still are under the sign of political-economic volatility and instability. This makes it even harder for the education domain to thrive by raising adequate labour force in sync with the wave of technological change pace. We will still face gaps in the training of specialists in the area of new technologies in Industry 4.0, but these will quickly recover profitability only through the flexibilization of contracts and the way emerging technologies and services supporting their wide-scale adoption are accessed. Companies will need to focus not only on developing cognitive skills but also on emotional intelligence for their employees, as these are fundamental elements for their comprehensive development. Moreover, specialists must adapt and acquire the digital competencies necessary in the digital society, including digital identity, responsible use of digital technologies, digital security, cybersecurity, *digital emotional intelligence*, digital communication, digital literacy, and digital rights. Legislation changes, new EU regulations, cybersecurity standards and most of all geopolitical factors still predict an increased volatility of the sector which brings an added level of pressure on the sustainability aspect of any business but mostly on business sectors where technology is a main feature.

#### **4. CONCLUSIONS**

Although some of the conclusions in the literature are derived from case studies, there is still no comprehensive manifestation of suggested approaches to addressing the adaptability and sustainability of outsourcing companies in Central and Eastern Europe (CEE), making it difficult to establish a coherent conclusion regarding the validity of the described adaptive models. Furthermore, there is an increasing encouragement to develop domestic products as a solution for

sustainability in the technological evolution of Industry 4.0. This presents an area for exploration – how nearshoring is transforming into onshoring, facilitating local and international partnerships in the development of domestic software products.

In Romania, ANIS stated in their 2030 manifesto (ANIS, 2024), "While the Report contains, as one of its main recommendations, the expansion of measures to support an innovation-based IT sector, the European Innovation Scoreboard 2024 places Romania at the bottom in terms of innovation capacity, with a performance of 34% compared to the EU average, in the category of 'Emerging Innovators.' The latest data indicates a decline compared to 2023 (-1.6%) and a much slower pace of innovation capacity development compared to the dynamics at the community level. Innovation underfunding is a major obstacle, given that allocations for R&D from the state budget represent a minuscule proportion – approximately 0.46%, compared to the EU average of 2% – with Romania investing 21 euros per capita, while the EU average reaches 276 euros per capita." High stakes objectives are projected by EU and implicitly by local representatives, however pressure of business continuity is preserved by an unpredictable pace of innovation and support framework from authorities.

#### **4.1. Missing points of the literature**

Most research focuses only on short-term trends which brings a missing perspective of longitudinal studies regarding the outsourcing strategies and transformations topic. Also, the specific impact of Industry 4.0 on different types of outsourcing is under documented. There is insufficient research on the effects of Industry 4.0 on outsourcing in CEE countries on local economies (growth, inequality, occupational changes), with the literature primarily focusing on positive aspects, such as exploiting the potential of technologies in emerging economies, and less on the negative effects (for example, discouraging innovation in fully domestic products). The ESG (Environmental, Social, Governance) factor emphasized in the latest EU directions is also going to have an impact into how sustainability of outsourcing will evolve and adapt. This aspect in particular could be an additional research point for further studies.

#### **4.2. Outsourcing view during I4.0**

The stage known as Industry 4.0 has transformed business models in outsourcing within the CEE region. Initially, this business models were purely an economic solution for labour relocation aimed at reducing labour costs. Over time, under the influence of Industry 4.0 and the natural evolution of expertise and adaptability, it has become an effective strategic optimization solution based on: added value, innovation and strategic partnerships, automation and niche competencies, transitioning from execution to outsourcing processes and expertise.

Nearshoring, by its very nature – proximity to resources and outsourced processes – provides the opportunity for redistribution of economic growth within the EU: while developed countries with mature economies are fully digitalizing SMEs and adopting optimization policies through innovation, there is an opportunity for CEE countries to meet these needs of the I4.0 catalysing their economic maturation as well. As a result, governance and cybersecurity policies are fully adopted across the European space, which also facilitates the creation of new high-standard business zones in terms of ethics and security. Companies in CEE countries have focused on getting the expertise on implementing such cyber security policies

This paper opens the discussion on business versatility, with the intrinsic potentials of the technological wave dominating the times. It is paving the way for exploring and observing new models that may emerge and how they will maintain their presence in the market. Therefore, even if high efforts are to be invested under the impact of I4.0 and volatility inducing factors, outsourcing/nearshoring will take the shape of cross-countries collaboration, processes of business being re-shaped into innovation services, consultancy services and cross-domain expert solution implementing services. We think that it is most likely that what we still call today outsourcing tomorrow will become the collaboration model of business sector relying on different levels of depth of knowledge and technologies that will be combined towards creative solution into delivering services. We are heading towards a world of technological collaboration of services instead of proprietary end-to-end product providers that externalize parts of their processes.

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