DOI: 10.2478/ijasitels-2024-0019

The Emerging Technologies: The Drivers for Digital Transformation in Business and Education

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Abstract

Emerging technologies, including Blockchain, Quantum Computing, Artificial Intelligence (AI), and Internet of Things (IoT), whether utilized individually or in combinations such as AIoT and IIoT, possess a disruptive nature that is poised to fundamentally reshape the functioning of specific industries, education, and society at large. These technologies act as catalysts for digital transformation, fostering the emergence of novel business models and opportunities for development. Launched as an initiative of the Cluj IT cluster and supported by the Hasso Plattner Institute in Potsdam, Germany, Sibiu Innovation Days (SID) represented a necessity for Sibiu, for the university, for companies in the area, in the idea of bringing together of all decision makers that acts around the concepts of digitalization, innovation and knowledge transfer to a smarter society and a better life for its members. Emerging technologies can exploit Romania's connectivity and broadband capabilities, where Romania is above the European average, bringing it into line with and keeping pace with developed countries in terms of the digitalization of industry, agriculture and society as a whole. In this regard, we believe that no effort is useless to increase Romania's innovation performance, and through the activities carried out at Sibiu Innovation Days 2024, solutions to some of these challenges were addressed and proposed.

Keywords: Emerging technologies, Innovation, Research, Digital Transformation

1 Introduction

1.1 Emerging technologies – catalysts for digital transformation

The disruptive nature of emerging technologies, such as blockchain, quantum computing, artificial intelligence (AI), and the internet of things (IoT), whether applied singly or in combination (AIoT – Artificial Intelligence of Things and IIoT – Industrial Internet of Things), has the potential to drastically alter how particular industries, education, and society as a whole operate. These technologies serve as drivers of digital transformation, encouraging the creation of innovative corporate strategies and growth prospects. Among a multitude of research initiatives, Blockchain technologies have undergone swift evolution, transitioning from applications like cryptocurrencies and decentralized ledgers to a decentralized, programmable, and secure infrastructure.

The rapid evolution of Blockchain technologies has led to the development of decentralized infrastructures, with diverse applications in compliance verification,

data integrity, digital identity management and other areas. At the European Union (EU) level, the construction of a Blockchain services infrastructure is underway, known as the European Blockchain Partnership[1], with each country hosting a node. The applications stemming from Blockchain technologies encompass various domains, including the automation of compliance checks in time-sensitive processes, verification of data integrity, electronic medical records, European digital identity management, authentication of educational diplomas and credentials, dependable data sharing among different EU authorities, as well as applications in finance, insurance, and energy supply. At the national level, since 2023, the application for the digital assessment of the written papers of the Baccalaureate exam, administered by the Ministry of Education, integrates the Blockchain technology developed by the experts of the Special Telecommunications Service (STS), which is an active participant in the European Blockchain Services Infrastructure (EBSI).

Concerning generative artificial intelligence and tools embedded in technologies like ChatGPT, Bard, Bing Chat, etc., the year 2023 witnessed a surge in information and challenges. These developments culminated in the approval, on February 2nd, 2024, of the inaugural EU law[2] designed to regulate Artificial Intelligence (AI). This legislation establishes a classification framework based on the potential risks posed by applications utilizing artificial intelligence and the requirements for integrity in all areas of research in the context of current use of AI. Its primary objectives are to enhance the security of AI systems, ensure their compliance with human rights, and establish clear parameters for the use of AI in military, crime, security and other sensitive contexts. Thus, one challenge will be to develop best practice in ethical decisions using AI considering the current academic and research integrity concerns including transparency, informed consent, data privacy, authentic data collection and accuracy of source use.

Quantum represents the 21st century technology that will revolutionize complex computations, information security and medical diagnostics, and the EU is committed to becoming a global leader in quantum technology[3] by developing an ecosystem of excellence and innovation in this field. In the next few years, quantum technologies will make it possible to do things quickly that simply cannot be done today, from complex computational tasks such as modelling biomolecular and chemical reactions that the most powerful supercomputers cannot handle today to sending sensitive information securely anywhere or diagnosing diseases faster and more accurately just by looking inside cells. Intense research based on quantum mechanics has led to major technical advances in many different fields, including quantum computing, sensors, simulations, cryptography, and telecommunications. On 5 December 2023, the EU Council released a declaration[4] that EU Member States are signing to indicate that they recognize the strategic importance of quantum technologies for the EU's scientific and industrial competitiveness and are committed to working together to develop a world-class quantum technology ecosystem across Europe, with the ultimate goal of making Europe the 'quantum valley' of the world, a leading global

[1] https://digital-strategy.ec.europa.eu/en/policies/blockchain-partnership
[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1689#document1
[3] https://defence-industry-space.ec.europa.eu/eu-space/research-development-and-innovation/quantum-technologies_en
[4] https://digital-strategy.ec.europa.eu/en/library/european-declaration-quantum-technologies

region for quantum excellence and innovation. Through the RONAQCI (Romanian National Quantum Communication Infrastructure) project[5] and SID2024[6], Romania is aligning itself with these efforts.

In addition to the aforementioned themes, Education, Cybersecurity, and Digital Green Transition and Transformation in both industry and society were focal points at Sibiu Innovation Days 2024 conference. The emphasis, however, lied on approaching these subjects in a sustainable, resilient manner that is centered on human needs. The conference served as a valuable opportunity for all Lucian Blaga University of Sibiu (ULBS) partners to share the latest research and innovation outcomes from their ongoing projects.

1.2 About Sibiu Innovation Days (SID)

Celebrating its fifth edition, the Sibiu Innovation Days 2024 conference has become a significant milestone on Romania's innovation map, playing a crucial role in fostering collaborative networks among experts from industry, public administration, and the academic research community. Building upon the success of its four previous editions since 2020, the Sibiu Innovation Days 2024 conference continues to promote the growth of an innovation ecosystem in the Transylvania region, Romania. This ecosystem is centered around the Cluj IT and Sibiu IT Clusters, with a profound impact on shaping the economic and social vitality of the entire region.

The organizing team comprises the Lucian Blaga University of Sibiu (ULBS) through the Hasso-Plattner Knowledge Transfer Institute [1, 2] and the Cluj IT and Sibiu IT Clusters. The Sibiu Innovation Days 2024 conference was scheduled to take place on October 24th and 25th, 2024. As a novelty this year, within the framework of the European CoDEMO (Co-Creative Decision-Makers for 5.0 Organizations) project[7], ULBS was receiving support from Marquardt Schaltsysteme SCS to facilitate one of the workshops entitled “5.0 Value Co-Creation Mechanisms and Experimentations: Case Studies.”

The format of the event included four sections:

- Conference in the form of panels (S1)
- Hackathon for students (S2)
- Session of innovative projects developed by students (S3)
- Industrial Workshops – hands on experience for participants (WS)

1.2.1 European context of SID 2024

Technology is evolving faster than humans can adapt (AI, Blockchain, etc.) [3]. In the same time, the geopolitical and environmental pressures (e.g. global warming, climate changes) are intensifying. To all these challenges the European ecosystem of computing systems should react quickly and efficiently to improve its place within the

[5] https://www.ronaqci.upb.ro/
[6] https://events.ulbsibiu.ro/innovationdays/
[7] https://www.codemo-project.eu/

competition and propose solutions that conform to “European” ethics. The society faces now ‘next computing paradigm’ which combines aspects of the web, cyber-physical systems, digital twins, the cloud, the internet of things, the metaverse and artificial intelligence (AI) into a coherent continuum of computing, intertwining the real world with the cyberworld. Europe assumes leadership roles in promoting the “next computing paradigm” and developing the technologies that will make it happen. Among the objectives we mention: to make the European Union a strong player in AI and Blockchain, to develop innovative and efficient new hardware solutions, from architecture to technology for running new AI models. Making cybersecurity a major upfront concern in every computing system and making sustainability lifecycle assessment a requirement for all new computing systems are also of large interest. In order to fulfil these, there is a need to foster global thinking, to develop methods and tools relating to complex heterogeneous integrations and promote cross-domains and cross-topic collaborations between academic, industrial partners and legal authorities from multiple levels of governance (European, national and regional [1]).

1.2.2 Regional context of SID 2024

Originating as an initiative of the Cluj IT cluster and supported by the Hasso Plattner Knowledge Transfer Institute from ULBS (KTI HPI-ULBS) Sibiu Innovation Days aims creating a mindset for innovation and boost regional innovation by successful knowledge transfer and development of collaborative networks that replicate the best models of innovation from strong innovator countries to Sibiu, and Transylvania region, Romania. SID 2024 included actors from Quadruple Helix of Open Innovation and brought together at Sibiu partners from academia, businesses, municipalities and decision makers. This year participated 22 Academic Partners (new partners from countries like Spain, Germany, France or Romania), 27 Industrial Partners & Open Innovation Community and 1 representative of Municipalities and Decision Makers, bodies generating policies and rules at local or European level (European Commission).

Figure 1. Panels and number of lectures at Sibiu Innovation Days 2024

For the fifth time, Sibiu Innovation Days reconfirmed its position on the regional and even national scene, positioning itself as a promoter of innovation and also a connector between private actors, representatives of public authorities, the local ecosystem and academia, research, bringing into attention current issues at a

supranational and implicitly national level. SID conference series are already a reputable reference of the academic environment in Romania and played from its first edition in 2020 a fundamental role in the development of collaborative networks between specialists from industry, administration and research community from universities.

During the two days of the SID2024 conference it was explored, with the guidance and expertise of invited speakers, the process of digital transformation and how this can help our community of students, researchers, business and decision makers to add value to their projects, initiatives and day to day activities. The event was looking to strengthen the collaboration among all these stakeholders, while also improving the way in which we understand and use the innovative services available in Transylvania and the Sibiu region. The conference activities emphasized current research and development concerns of companies active in the area, as well as created new opportunities for collaboration among participants active in a wide array of industries and fields. While highlighting contributions from Hasso-Plattner Knowledge Transfer Institute, active in "Lucian Blaga" University of Sibiu, to the development of the local innovation ecosystem, the conference represented an important component in consolidating Sibiu City's position as an emerging innovation center.

With this 5th edition, SID offered a very rich and exciting program, focused on the emerging technologies seen as the drivers for digital transformation both in business and education. SID2024 topics and presentations aimed adapting industrial and administrative processes in the context of digitalization, as well as towards value creation through structural transformation and generating of new businesses, startups or spinoffs by innovative partnerships. At SID2024 the topics were very timely, focusing on the challenges of the ongoing 5^{th} industrial revolution and the growing role of Artificial Intelligence, Blockchain, Quantum Computing and Communication, and Cybersecurity in systems development. Very interesting lecture presented the AI as a driver of innovative collaboration within and across 5.0 organizations.

The "*Artificial Intelligence*" panel included interesting lectures and debates regarding fairness, equity, ethics, and human-AI collaboration. The conditions of human-AI companionship were defined for ethically tempting jobs, especially in the case of top executive management. The speakers revealed that AI is transforming various fields by enabling personalized learning paths in education and facilitating multilingual journalism with automated news summaries. It enhances creativity in sustainable design hubs through co-creative tools like "Nature's Voice" and drives innovation by optimizing machine learning models for diverse use cases. Efforts to solve AI's black box problem aim to make its decision-making processes more transparent and meaningful, fostering trust. Additionally, artificial intelligence is revolutionizing business practices and workflows, reshaping how we work and innovate across industries.

Even if society in the digital age is dynamically developing, the changes must be sustainable and take into account the limited natural resources. In the "*Green Digitalization Transition*" panel, the speakers revealed limitations and synergies of twin-transition (green and digital), highlighting digital innovations as foundations for driving sustainability and empowering green enterprises and communities for the transition towards cleaner energy futures. As industries move towards a 5.0 transition, smart optimization approaches and digitalization play crucial roles in solving real-

world challenges and enabling sustainable practices, ensuring the seamless transition of enterprises from the 4.0 paradigm, based on digitalization and technologies, to the 5.0 paradigm, focused on resilience, a "green" mindset, and a human-centric approach. These advancements create pathways for more resilient and efficient systems, aligning technology with environmental and societal goals.

In the panel entitled "*Blockchain & Cybersecurity*" many speakers from business environment mentioned these emerging technologies as drivers for innovation across diverse fields like automotive, energy sector, or finance. Blockchain is pioneering applications in sectors like energy, insurance, digital identity management, educational credits recognition and decentralized finance, offering secure, transparent solutions. Concurrently, advancements in cybersecurity, including IoT authentication, encryption, and automotive cybersecurity, are vital to protecting modern applications. Strategic planning and design of cybersecurity programs are essential to address emerging digital threats and ensure resilience in evolving technological landscapes.

The lecturers have presented in the "*Innovative Partnership*" panel research and innovation European initiatives, such as those under Horizon Europe that foster partnerships to drive innovation and support 5.0 organizations by enhancing skills and capabilities, and demonstrating how cutting-edge technologies can be used to address societal needs. Collaborations on different topics and research partnerships between academia and industry play a crucial role in advancing technology and using up-to-date tools and equipment in student education. The speakers also reflected on the challenges and successful recipes for building tech startups in Romania. Additionally, funding opportunities from the European level and national and regional ecosystem support are enabling deep-tech startups to scale and thrive, emphasizing the importance of technological transfer and boundaryless ideation for sustainable growth.

For the first time at Sibiu Innovation Days participated lecturers from academia and industry within the "*Quantum Computing and Quantum Information*" panel. Quantum computing and communications based on it represent 21st-century technologies, with advancements both in speeding up computing and with efforts for reducing data storage, with the development of its software stack and toolchains and metrology applications, driving innovation in many domains. Post-quantum cryptography is emerging as a critical area to secure systems against future threats. The density matrix formalism plays a vital role in understanding quantum systems, highlighting the growing importance of quantum mechanics in both theoretical and practical domains. The speakers emphasized the importance of developing education and research in the quantum technology industry, in quantum communications, because this is the first technology closest to the market and, in practice, has the greatest technological maturity.

The last panel of the Sibiu Innovation Days 2024 was dedicated to "*Education transformation: upskilling, reskilling, Lifelong Learning*". Panelists analyzed digital education, showing how it contributes to transforming learning and skills development, mostly for adults who finished some (or many) years ago their academic study. They emphasized that Massive Open Online Courses (MOOCs) are becoming central to digital universities, and lifelong learning is empowering future-ready individuals. Integrating theories like self-determination in cybersecurity education highlights the importance of motivation in digital training. In the Industry 5.0 era,

corporate amnesia underscores the need for continuous reskilling, while training programs play a vital role in supporting industry and organizational transformation. Innovative approaches, such as those at industrial companies from the Sibiu region, showcased how learning can drive adaptation and growth in a rapidly evolving digital world.

In collaboration with ULBS partners – the industrial companies MultiversX Sibiu and Marquardt Schaltsysteme Sibiu, there were organized two industrial demonstrative workshops as part of Sibiu Innovation Days 2024 conference program.

On 24.10.2024 took place the first industrial workshop entitled "*WS1: Introduction to Interacting with the MultiversX Network*" focused on blockchain education of students. The students learnt about challenges in blockchain scalability through parallel execution of transactions and how to detect and predict transactions conflicts (shared objects). In the end of the workshop the conclusions were drawn and open discussions took place and the participants were required to provide feedback. Judging by feedbacks and also that the time allocated for workshop of the 90 minutes was overtook with more than half of hour, important conclusions were that the young students and participants appreciated the technical quality of the presenter and of the workshop in general and are eager for such demonstrative events in future.

On 25.10.2024 took place the second industrial workshop entitled "*WS2: 5.0 Value Co-Creation mechanisms and experimentations, Case studies*" organized within the context of CoDEMO project. The goal of the workshop was to present how could be used a Digital Innovation Environment (established at Sibiu with the help of OMiLAB[8] - ULBS partner in CoDEMO project) to optimize a system test process within Marquardt Company. During product system test phase, it is necessary to determine the passed/failed status of tests via network signals analysis. A second layer of verification is introduced by using a camera taking pictures triggered by those signals. Using Design Thinking concept, Scene2Model and BeeUp tools the students learnt to develop a conceptual model for optimizing the system test process.

2 The Vision of SID2024 Organizers

"*Digitalization is the irreversible path to progress, and the dynamics of technology-driven change are constantly increasing. Blockchain technologies have evolved rapidly, moving from applications such as cryptocurrencies and decentralized ledgers to a decentralized, programmable and secure infrastructure. At the European Union (EU) level, the construction of a blockchain service infrastructure is underway, known as the European Blockchain Partnership, with each country hosting a node. Applications stemming from Blockchain technologies span diverse areas, including the automation of compliance checks in time-sensitive processes, data integrity verification, electronic health records, European digital identity management, diploma and accreditation authentication, secure data exchange between different EU authorities, as well as applications in finance, insurance and energy supply. At the national level, since 2023, the digital evaluation application for written works for the Baccalaureate exam, administered by the Ministry of Education, integrates Blockchain technology developed by experts from the Special Telecommunications*

[8] https://www.omilab.org/omilab_nodes/ulbs/

Service (STS), which is an active participant in the European Blockchain Services Infrastructure (EBSI).

In 2023, there was a surge in knowledge and issues with regard to generative Artificial Intelligence (AI) and the tools integrated into technologies like ChatGPT, Bard, Bing Chat, etc. As a result of these achievements, the EU approved the first law regulating AI on February, 2024. This law creates a classification scheme according to the possible dangers of artificial intelligence applications. Its primary goals are to make AI systems more secure, guarantee that they respect human rights, and establish precise guidelines for the application of AI in security, criminal, military and other sensitive contexts.

In the coming years, quantum technologies will make it possible to rapidly accomplish things that simply cannot be done today, from complex computational tasks such as modelling biomolecular and chemical reactions that the most powerful supercomputers cannot handle today, to sending sensitive information securely anywhere or diagnosing diseases faster and more accurately just by looking inside human cells. Intense research based on quantum mechanics has led to major technical advances in many different fields, including the development of quantum computers, sensors, cryptography, and telecommunications. ULBS as member of RONAQCI project and the Sibiu Innovation Days 2024 conference, makes efforts to align Romania with European context.

The European Union claim that innovation is the only way to maintain a strong, sustainable and competitive economy. However, there are currently significant gaps in the degree of innovation between EU Member States. Statistics from 2024 classify Romania as the least innovative country in the EU, with a performance of 34% of the union average. One solution to mitigate this disadvantage is to develop collaborative networks that reproduce the best innovation models from advanced countries and adapt them to developing countries in Europe. Emerging technologies can exploit Romania's capability in connectivity and broadband internet, where we are above the European average, making Romania align and keep pace with developed countries in terms of the digitalization of industry, agriculture and the entire society. In this sense, we believe that no effort is useless to increase Romania's innovation performance and, through the activities carried out at Sibiu Innovation Days 2024, we try to address and offer solutions to some of these challenges.", mentioned Prof. Dr. Eng. Adrian Florea, director of the Hasso Plattner Knowledge Transfer Institute at the "Lucian Blaga" University of Sibiu and vice-president of Cluj IT Cluster.

"*In the face of the accelerated pace of technological development, the essential thing is not to adopt innovations, but to integrate them in a way that brings real value to the economy and society. At Cluj IT Cluster, we believe that Romania can become an innovation pole in Europe if we focus on developing advanced digital skills and creating collaborative ecosystems between industry, academia and local authorities. Sibiu Innovation Days is the place where these visions can take shape. What I want to emphasize is that, in the process of digital transformation, the key to success lies in how we manage to adapt technologies to our local needs and transform them into long-term competitive advantages. Romania must not only be a consumer of technology, but also an active creator in this digital revolution*," said Prof. Dr. Eng. Stelian Brad, President of Cluj IT Cluster.

"*This year too, Sibiu IT Cluster is actively involved and supports impactful events, such as Sibiu Innovation Days. Digital transformation, sustainable development, community building and the creation of an ecosystem that supports innovation are priorities for us, and Sibiu Innovation Days does an excellent job of highlighting these topics and bringing real value to a diverse audience.*

We believe in the power of collaboration (after all, Sibiu IT Cluster is a collaboration between 35 important local actors) between the private, academic and public sectors, for the benefit of the community. We happily support such initiatives and are actively concerned about what else we can do together for Sibiu, but also at the national level, to strengthen Romania's position on the technological map of Europe," highlighted Mr. Eng. Cătălin Mihacea, President of Sibiu IT Cluster.

3 Conclusions

In the opinion of organizers this fifth edition of the Sibiu Innovation Days event was a real success. More than 400 participants registered for the event, and almost 1000 people were following online stream with 6 technical panels, 3 keynote presentations and 2 workshops involving more than 51 experts from industry and academic environment and delegates from local, national and international authorities and organizations, European Commission experts, and businessmen (from multinationals and established international brands to local startups) from Romania, Germany, France, USA, Italy, Norway, Austria, Poland, Spain. At the same time, they presented points of view, challenges and solutions related to using emerging technologies in business sectors, academia and public services.

At the same time, we are convinced that the collaboration relations between organizers and all participants will not only continue but will flourish in the interest of the ecosystem we represent.

Acknowledgment

Project financed by Lucian Blaga University of Sibiu through the Donation of Hasso Plattner Foundation according with ADDENDUM to the Donation of Funds Agreement dated 18th of July 2018, signed at 22 February 2023.

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