BLOCK CHAIN FOR AGRI FOOD EDU

Blockchain teaching in higher education in the agri-food sector

Status quo of blockchain related to higher education and agrifood sector

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Introduction

The Project *Blockchain teaching in higher education in the agri-food sector* is a project by FH Münster and explores opportunities and limitations of current blockchain teaching in agri-food disciplines in our countries' HE systems. Part of the project is providing an overview over the status quo of blockchain related to higher education and agrifood sector in the following EU countries: Germany, Denmark, Ireland, Slovenia, Slovakia and Czech Republic.

Therefore, the following document aims in serving as an overview over the status quo of blockchain related to higher education and agrifood sector. To this end, an insight into the two areas is provided at the beginning, organized by country.

The different status quo blockchain related to higher education and agrifood sector of the countries are presented through an overview as well as a ranking matrix designed based on digital indices and a comparable ranking matrix.

We present status quo of blockchain related to higher education and agri-food sector of different European countries through a literature research overview as well as two comparable ranking matrices based on digital indices.

The goal of the guide is to provide the reader with prior knowledge of the status of blockchain in the EU and to uncover deficits and potentials.

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1 Status quo

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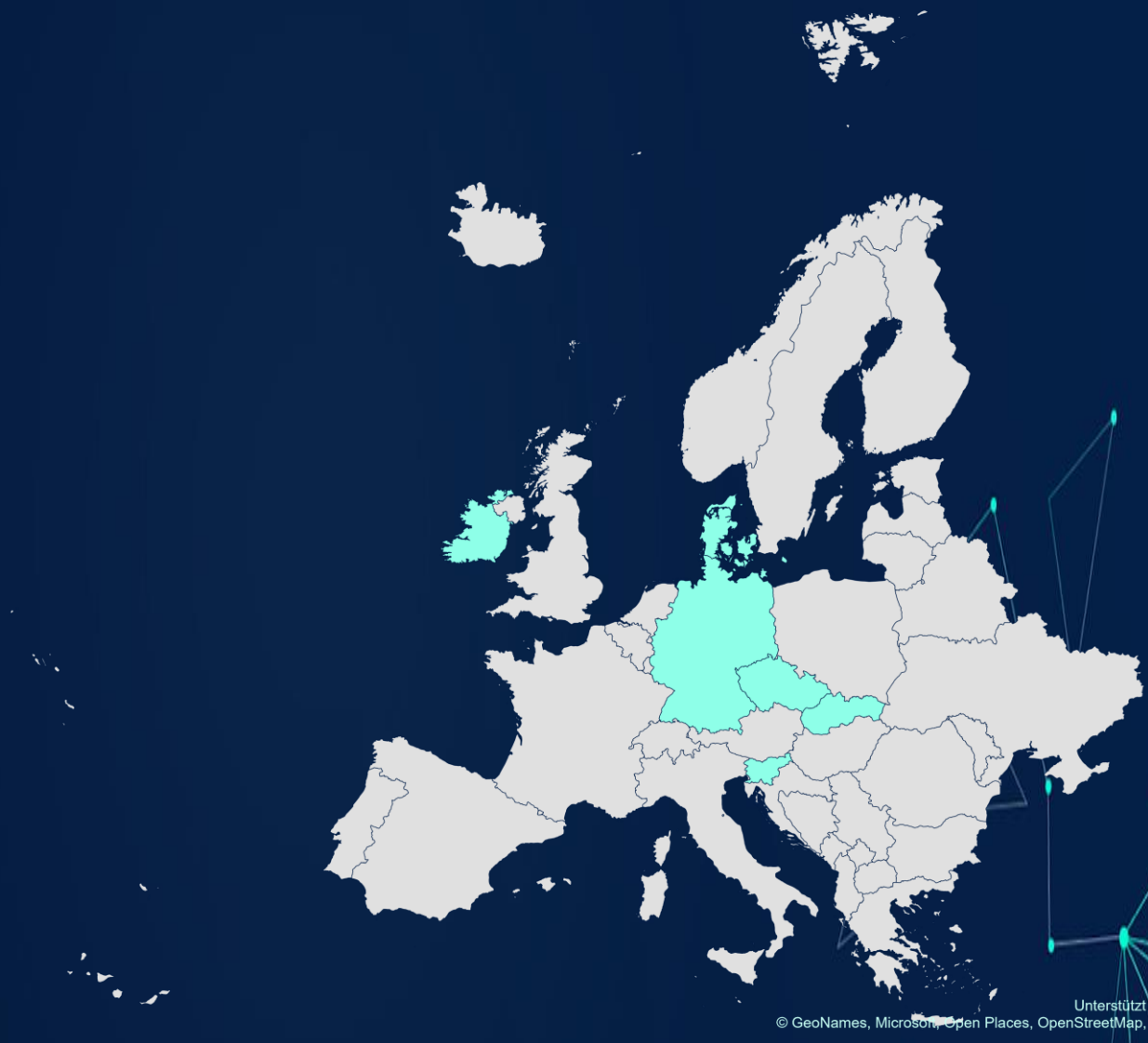
1.1 Introduction

This section looks at the **status quo** of blockchain in the areas of higher education and agriculture in the following countries.

Germany, Denmark, Ireland, Slovenia, Slovakia, the Czech Republic and other *EU* countries.



Status quo
1.2 Higher education

1

Germany
1.2.1 Higher education

There are currently only a few colleges and universities in Germany that offer special blockchain degree programmes. Nevertheless, some educational institutions offer courses that deal with blockchain and offer the opportunity to train as a certified blockchain manager, for example. Overall, the range of dedicated blockchain degree programmes is still limited. At the same time, however, many universities offer separate seminars. Examples include the Hochschule Mittweida, the Frankfurt School of Finance & Management, the Technische Universität Chemnitz and the Technische Universität München. (Henk, 2023)

Hochschule Mittweida, for example, offers the Master's programme Blockchain in Distributed Ledger Technologies (DLT), which is also the first Master's programme in Europe to focus on blockchain. It is not only open to computer science graduates, but also to graduates from various other disciplines such as mathematics, forensics, economics and the humanities. Programming skills are useful, but not essential, as the degree programme combines technical, economic and social topics. In each of the first two semesters, students choose four compulsory elective modules, including both technical and non-technical subjects. The elective modules complement four mandatory courses. (Hochschule Mittweida, n. D.)

In addition to the study programmes and seminars, there are also research projects such as the research project at the Fachhochschule Südwestfalen, which aims to set up a blockchain network. (Bc4SC, n. D.)

Furthermore, there is the Aachen Blockchain Club, which uses interactive workshops, discussions and practical experience to make blockchain technology easier to understand and educate individuals about blockchain as a group. (Aachen Blockchain Club e.V., n. D.)

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Denmark
1.2.2 Higher education

The current hindrance to the adoption of blockchain solutions in Denmark is attributed to the absence of standardized solutions and a shortage of experts. Addressing this challenge necessitates engaging in standardization initiatives and implementing additional training and education programs to cultivate a pool of skilled blockchain professionals. (Beck et al., 2019, p. 12)

Dedicated to advancing blockchain education and knowledge, the International Blockchain School, now in its seventh year, stands as an initiative of the European Blockchain Center. The program is jointly administered by faculty members from the IT University of Copenhagen, Copenhagen Business School, and Copenhagen University. (Blockchain School, n. D. a) The event features presentations by lecturers and industry partners, followed by hackathons/makathons centered on showcasing use cases, culminating in a day where students present their work, concluding with the Nordic Blockchain Summit. (Blockchain School, n. D. b) The 7th International Blockchain School in Copenhagen fosters collaboration among academia, industry, and the public sector, inviting students from diverse disciplines and regions to co-create ideas and solutions. (Blockchain School, n. D. a)

Furthermore, in Denmark, there exists the Blockchain Academy Network. The Danish Industry Foundation has invested DKK 6.7 million in the network, aiming to qualify Danish business leaders for a future with entirely new business technologies. (Blockchain Academy Network, n. D.)

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Ireland
1.2.3 Higher education

In Ireland, there are abundant opportunities for higher education in the field of Blockchain. A notable option is the MSc program in Blockchain (Distributed Ledger Technologies) offered by Technology Ireland ICT Skillnet. This two-year program comprises eight modules, providing in-depth insights into various aspects of Blockchain technology:

1. Semester: Research Methods and Professional Skills, Blockchain Basics and Applications
2. Semester: Cryptography and Number Theory, Cloud Systems
3. Semester: Blockchain Scalability, Public Key Cryptography and Security Protocols
4. Semester: Developing Blockchain Systems, Computer Security

(Technology Ireland ICT Skillnet, n. D. b)

The Trinity College Dublin offers the Unpacking Crypto and Blockchain programme, which lasts 4 days. This is a practical introduction to blockchain technology, cryptocurrencies and digital assets. The programme provides an understanding of their role in different industries, addresses governance and regulatory challenges of cryptocurrencies and shows how organisations are working on them. It includes personal experiences such as opening a cryptocurrency account, setting up a digital wallet, creating an NFT, staking assets and participating in DeFi protocols. Finally, it provides the knowledge needed to maximise the potential of blockchain technology, cryptocurrencies and digital assets. (Trinity College Dublin, 2024)

Technology Ireland ICT Skillnet supports the workforce development needs of businesses within the technology sector. The Level 9 Postgraduate Certificate in Blockchain for Leaders* (30 ECTS credits) is a modular program with three individual modules: Fundamentals of Blockchain Technology, Blockchain Digital Transformation, and Blockchain for Decentralised Finance. These modules can be taken together for the full certificate or separately for 10 ECTS credits each. Upon completion, participants will possess the ability to offer insights into the intricate aspects of blockchain technologies and recognize applicable solutions and services for organizational adoption. (Technology Ireland ICT Skillnet, n. D. a)

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Slovenia
1.2.4 Higher education

IRCAI and its partners, including Data-Pop Alliance, have successfully set up research networks since 2004, such as NeuroColt, PASCAL, and AI4D. These networks played a pivotal role in advancing AI globally, receiving over 50 million EUR in funding and empowering countless researchers. Building on this success, Slovenia introduces NAIXUS, an initiative aimed at bridging AI and Sustainable Development Goals (SDGs). NAIXUS seeks to facilitate collaboration beyond individual research interests, transferring machine learning expertise into the realm of sustainable development. Aligned with UN resolutions like A/RES/76/213, NAIXUS emphasizes technology assessment, inclusive approaches, and global partnerships to support SDGs research.(International Research Centre on Artificial Intelligence under the auspices of UNESCO)

Slovenia has undergone significant changes in the last 25 years, but the enrollment process for higher education remains largely unchanged. However, with the establishment of a national records and analytical information system for higher education, there's now comprehensive data available since 2006. Plans are underway to integrate data on graduate employability. Authors propose using AI and BDA to modernize higher education management, focusing on optimizing individual preferences and abilities in curriculum design and candidate selection.
(Marjetič, Lesjak, 2018, p. 103)

1

Slovakia
1.2.5 Higher education

The study program Data Analysis and Artificial Intelligence is an interdisciplinary study program that combines in a balanced way the knowledge of mathematics and computer science. Interdisciplinarity gives graduates greater opportunities in the selection of follow-up study programs or in practice. (Institute of Computer Science, n. D.)

Examining the integration of digital learning tools within a Slovakian higher education institution amid the Industry 4.0 landscape, this study evaluates challenges and critical issues. It highlights collaborative efforts in utilizing tools like Building Information Modeling (BIM) technology and augmented reality, addressing obstacles such as bridging the gap between education and industry and forecasting future trends. Emphasizing the necessity for strategic support, the study underscores the importance of implementing digital learning tools in Slovakia's educational framework.
(Porubcinova, Novotná, Fidlerova, 2020, p. 161)

The integration of artificial intelligence (AI) into university systems aims to enhance efficiency and staff motivation. Methods employed include surveys, content analysis, statistical analysis, and focus groups. Discrepancies between academic staff motivation and university stimulation methods highlight the need for a new system combining natural and artificial intelligence. Introducing AI improves university competitiveness and academic reputation. Pioneering AI integration in university staff motivation systems, the study offers practical technologies for efficiency improvement. Optimal technologies involve balancing staff motivation, integrating AI in educational activities and staff motivation systems, and enhancing publication and grant activities through AI-assisted team building.
(Vinichenko, Melnichuk, Karácsony, 2020, p. 2696)

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Czech Republic
1.2.6 Higher education

Upon graduation, students will possess the capability to develop and deploy intelligent systems across various domains, including automatic scheduling, data analysis, and automated reasoning. Proficiency in assessing algorithmic computational complexity ensures the efficacy of implemented systems. Furthermore, graduates will excel in managing diverse computational datasets, with a strong emphasis on employing machine learning techniques. These versatile skills prepare graduates for both practical applications and research pursuits, including potential doctoral studies in computer science. (Faculty of Electrical Engineering CTU in Prague, n. D.)

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Other Countries

Norway – Higher education

It is widely acknowledged that fostering collaboration across faculties and institutes poses difficulties in many universities, not only in Norway but globally. Overcoming this challenge is crucial for developing high-quality courses in this domain, as a comprehensive understanding of the phenomenon from both economic and technological perspectives is essential. (Ølnes & Knutsen, 2020, p. 382)

Status quo
1.3 Agri-food sector

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Germany
1.3.1 Agri-food sector

There is a heterogeneous distribution of blockchain platforms in the agricultural and food industry in Germany. Despite the suitability of the existing technological infrastructure for blockchain, there are only isolated initiatives in the areas of food traceability, supply chains, harvest insurance and transaction optimisation. (Ferdinand & Reckleben, 2020, p. 77)

So far, the use of blockchains in the agricultural and food sector has mainly been in the area of trade and transport, for example for the seamless tracking of supply chains. However, as Agriculture 4.0 progresses, it is expected that these technologies will spread to all stages of the value chain. (Kliem et al., 2023)

Looking to the future of agriculture, blockchain technology will play a key role and potentially revolutionise the market. Until now, agriculture has been heavily characterised by entrenched, often inefficient structures. Blockchain technology has the potential to break through and improve these structures. (Krypto Magazin, n. D.)

One example of the use of blockchain in agriculture in Germany is the TraceHarvest network, which was developed by BlockApps in collaboration with Bayer AG. This network can make agricultural supply chains more efficient and transparent, thus improving quality, safety and sustainability. Members of the agricultural value chain such as farmers, manufacturers, traders, processors and technology providers can register with TraceHarvest. (Nestler, 2021)

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Denmark
1.3.2 Agri-food sector

Danish agriculture has hurdles to overcome in its drive towards digitalisation. However, the basic prerequisites are very good: the Kingdom and its citizens are among the global leaders in terms of both IT infrastructure and digital skills. However, the exchange of data between all players in the value chain is in need of improvement. According to an SCB survey, over half of potential users struggle with the cost-benefit analysis of smart farming solutions. One in four farmers feels that they lack the necessary skills and knowledge. Compensating for this lack is not easy because there is a shortage of skilled labour - even Danish digital natives are more likely to be drawn to biotech than organic farming. (Woźniak, 2020)

According to the industry association LF, precision farming is already used on 70 percent of agricultural land. More than a third of all Danish farmers use smart farming technologies. In the under-40 age group, the figure is as high as 60 percent. (Woźniak, 2020)

The Technical University of Denmark is actively working on developing blockchain solutions tailored for small and medium-sized food manufacturers, aiming to combat food fraud in high-value products. Researchers from the Food Institute, along with the Compute and Skylab departments at the university, are collaborating on the “Bottom-up Blockchain” project. This initiative seeks to provide local companies with a secure and trustworthy platform for tracking and tracing their supply chains. The one-year pilot project has secured DKK 3.6 million (€4.8 million) in funding from the Danish philanthropic foundation, Industriens Fond. Despite larger players like Carrefour and Nestlé implementing blockchain in certain supply chains, small and medium-sized enterprises have been slower to adopt such technologies. (Southey, 2019)

Ireland
1.3.3 Agri-food sector

Ireland's agriculture sector holds significant importance, contributing over €8 billion in output from its 137,000 farms, as reported by the Department of Agriculture, Food, and the Marine. Presently, Irish enterprises are enhancing the sector's efficiency by adopting Internet of Things technologies, ushering in an era referred to as 'Agriculture 4.0.' (Walsha, 2022) Other technologies such as "smart meters" and "blockchain" in connection with microgrids are not yet widespread in Ireland. (Deutsch-Irische Industrie- und Handelskammer, 2020, p. 17)

Downstream Beer (Ireland Craft Beers 2017) is pioneering the use of blockchain technology in the beer industry, providing comprehensive information about its beer, including ingredients and brewing methods. Every detail of this craft beer is meticulously recorded and stored on the blockchain, ensuring transparency and authenticity. Consumers can conveniently use their smartphones to scan the QR code on the bottle, directing them to a website with relevant information ranging from raw ingredients to the bottling process. (Kamilaris et al., 2019, p. 9)

A pioneering Irish agri-food company, Origin Chain Networks, has been honored with the European 'Standards+Innovation' Award for its significant contributions to Blockchain Standards. This startup utilizes blockchain technology to develop solutions for the agri-food supply chain. (NSAI, n. D.)

Dr. John Breslin, a senior lecturer and innovation programs leader at the National University of Ireland, Galway, highlights the growing use of blockchain in agrifood and technology companies for enhanced traceability. Notable projects include tracking animal drug usage and protecting farm infrastructure. Several American companies like ConsenSys, IBM, and Fidelity are engaged in blockchain initiatives in Ireland, with Deloitte establishing a regional innovation lab. IBM Ireland Research is specifically working on a blockchain project for food traceability. Given Ireland's reliance on cattle, numerous blockchain projects aim to modernize supply chain assurance for beef and dairy farmers, covering aspects like livestock selection, breeding, and monitoring genetic traits for animal health and welfare. (Cowley, 2019)

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Slovenia
1.3.4 Agri-food sector

Slovenia stands out among the new Eastern European member states of the European Union for its significant economic growth and per-capita income. Compared to other EU extension states, Slovenia has undergone the most successful transformation in terms of economic policy and structures. This success can be attributed to several key factors. Historical influences have played a crucial role, including the relatively liberal economic socialism and minimal conflict during the war for independence. The country's stringent political reform and development policies post-independence have contributed to a rapid and effective transformation process. Favorable regional economic conditions, such as diverse local potentials for development, have further enhanced Slovenia's transformation success. Together, these factors have propelled Slovenia towards remarkable economic growth and development within the European Union. (Hilpert, Kräusslich, 2007, p. 38)

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Slovakia
1.3.5 Agri-food sector

Industry 4.0 revolutionizes production processes through automation and advanced technologies, with broad societal implications. While agriculture confronts similar challenges, Slovakia's delayed adoption of Industry 4.0 hampers its competitiveness, allowing foreign enterprises to dominate. Despite growing support for agriculture, funding predominantly favors crop production. Ensuring alignment between industrial policy and scientific and educational efforts is essential for achieving digitization objectives and fostering the transition to Agriculture 4.0. (Paculík, Gažová, n. D., p. 354)

This investigation explores the application of machine learning (ML) models for pan evaporation (PE) modeling on a macro-regional scale in Slovakia. It examines significant PE changes across various agroclimatic zones using data from 35 meteorological stations. The stations are categorized into six macro-regions, and 11 variables are utilized for modeling during the vegetation period from 2010 to 2020. Eight ML models are tested, demonstrating varied prediction accuracies across geographical locations. Comparisons are made among the predicted values from these models. (Novotná, Jurík, Cimo, Palkovic, Chvíla, Kišš, 2022, p. 1)

This study explores the application of artificial intelligence, specifically artificial neural networks, in analyzing agricultural businesses. It focuses on using Kohonen networks to assess the current state and predict the future development of the agricultural sector. By identifying significant clusters of businesses, the study aims to estimate future success, stagnation, and failure rates. Despite the complexity of Kohonen networks, their potential for providing valuable insights into agricultural business dynamics is substantial. (Horak, 2019, p. 1)

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Czech Republic
1.3.6 Agri-food sector

The Czech Republic, a major hops producer and leader in beer consumption, faced challenges in agriculture due to climate change and pathogen outbreaks. To address these issues, Agritecture partnered with Microsoft and Asahi to utilize artificial intelligence (AI) and IoT technologies in hop farming. The project aims to optimize water usage and monitor plant health in real-time through data collection and AI modeling. Annotated data, collected through computer vision and manual labeling, enables machine learning insights to predict crop yields and detect plant stress. Despite challenges, these advancements offer promising solutions for precision agriculture and smart farming, empowering farmers to enhance yields and mitigate risks. (cloudfactory, 2022)

The adoption of precision agriculture technologies in Czech agricultural enterprises is examined through a survey of 131 farms. Findings reveal a greater usage of these technologies in crop production, with intelligent weather stations, unmanned vehicles, and navigation/optimization systems being commonly employed. These trends reflect agricultural enterprises' readiness to embrace new advancements, offering insights for policymakers to direct funding towards initiatives supporting precision farming. (Vrchota, Pech, Švepešová, 2022, p. 2)

The evaluation of Czech milk production productivity is compared with the EU using stochastic frontier analysis on panel data from 27 member states spanning 2004–2016. Czech milk production exhibits higher technical efficiency than the EU-13 average. The analysis reveals increasing returns to scale in Czech milk production, with scale effects and technical efficiency changes influencing total factor productivity dynamics, reflecting nuanced productivity trends within the European dairy landscape.
(Kroupová, Hálová, Rumánková, 2020, p. 115)

1.3.7 Other Countries

Finland – Agri-food sector

The Arla Milkchain is a pioneering pilot project in Finland. Using blockchain technology, it ensures maximum transparency by digitally recording and securely linking data on milk production, personnel involved, transportation, and processing time. Consumers can access various details such as the number of cows milked, milk production quantity, calf births, and the time taken from milking to filling the final drinking milk using the production date on the milk packaging via an app or the internet. (Lech, 2019)

United Nations – Agri-food sector

The adoption of blockchain applications in agriculture and food has been swiftly increasing. Numerous companies offer services related to tracking the blockchain ecosystem, with a significant portion being ongoing pilot projects or having a limited operational duration. Often, it remains unclear or is kept confidential which aspects of blockchain technology are employed, the manner of their implementation, and their subsequent impacts. (van Wassenaer et al., 2021, p. 15)

Italy – Agri-food sector

Italian pasta and pesto sauce producer, Barilla, has partnered with IBM to address transparency and traceability within its pesto production cycle. Every detail, from cultivation and treatment in the field to transportation, storage, quality control, production, and delivery to the customer, is meticulously tracked and accessible through a blockchain system. Customers can verify this information by scanning the QR code on the pesto packaging. (Sylvester, 2019, p. 8)

1.3.7 Other countries

Europe – Agri-food sector

Carrefour, the European grocery retailer, employs blockchain technology to authenticate standards and trace the origins of food across diverse categories, including meat, fish, fruits, vegetables, and dairy products. (Kamilaris et al., 2019, p. 9)

UK – Agri-food sector

The UK-based social enterprise Provenance has been a pioneer in advocating for the application of blockchain technology to agricultural supply chains, particularly in recording certifications. (Ge et al., 2017, p. 10) Startups like Provenance and Derivation utilize blockchain to offer concrete proof of their food supplies' origins and to secure and publicize their food supply chains, ensuring inclusivity among all partners. Provenance extensively documents ingredients, supply chain materials, and products on the blockchain ledger, enhancing customer transparency about product authenticity and origin. The startup provides buyers with a fully transparent record through a real-time data platform, allowing them to track each step in the product's journey, including its current location, owner, and the duration it spent with a particular person. (Aldag, 2019, p. 10)

1.4 Overview Status Quo of blockchain in higher education and the agri-food sector

Germany	Higher education: Limited range but offer of study programmes, modules and projects at various universities is given. Agri-food sector: Heterogeneous distribution of blockchain approaches in agriculture.
Denmark	Higher education: The current hindrance to the implementation of blockchain solutions in Denmark is linked to the absence of standardized solutions and a scarcity of experts. Agri-food sector: Good basic prerequisites for implementation but currently hardly any realisation of projects or use of blockchain in the agricultural sector.
Ireland	Higher education: There are isolated modules and programmes on blockchain. Agri-food sector: Agriculture is a very important industry in Ireland, but the teaching and use of blockchain is not yet widespread but growing.
Slovenia	Higher education: Slovenia launches systems for AI and sustainable development goals and plans for AI-driven higher education management are in progress. Agri-food sector: Slovenia's remarkable economic growth within the EU is is available mainly there because of the reformations.
Slovakia	Higher education: Integration of digital tools in Slovakian higher education and AI adoption for university efficiency and staff motivation. Agri-food sector: Slovakia's Industry 4.0 uptake impacts agricultural competitiveness.
Czech Republic	Higher education: Programs are offered that teach the use of machine learning and computer science. Agri-food sector: Czech agriculture embraces AI and IoT in farming with growing adoption of precision technologies.

Table 1: Overview status quo of blockchain in higher education and the agri-food sector

2 Ranking matrix

2

Overview Status Quo
2.1 Rating matrix

The countries under consideration can be categorised according to their (digital) development and their given prerequisites for the use of digital technology. To this end, the individual criteria for the respective countries were researched at the beginning. In the next step, the scale values were adjusted so that all criteria used the same scale range. Then the individual criteria were weighted according to their importance in order to finally obtain a final value. These final results allow a ranking between the countries based on the criteria.

Criteria

DESI:
The Digital Economy and Society Index (DESI) is a composite index that summarises relevant indicators of Europe's digital performance and tracks the development of EU member states in five main dimensions. The overall DESI index is calculated as a weighted average of the four main dimensions: 1. connectivity, 2. human capital, 3. integration of digital technology and 4. digital public services.
Maximum achievable value: 100
(Europäische Kommission, 2022)

GII:
Global Innovation Index
The criteria of the Global Innovation Index are the following: investment in science and innovation, technological progress, technology adoption, socio-economic impact.
Maximum achievable value: 100
(Dutta et al., 2023, p. 19 & 22)

Research and development expenditure as % of GDP
Maximum achievable value: 100
(Statistisches Bundesamt, 2024)

Overview Status Quo
Rating matrix

2. 2 Criteria:

GEI

The GEDI Institute has compiled entrepreneurship and business statistics, assessing a country's entrepreneurial ecosystem via the Global Entrepreneurship Index (GEI). The GEDI methodology gathers data on the entrepreneurial attitudes, skills, and aspirations of the local population, weighting them against the existing social and economic infrastructure, which encompasses factors like broadband connectivity and transportation links to external markets. This methodology results in 14 'pillars' utilized by GEDI to evaluate the overall health of the regional ecosystem.

Maximum achievable value: 100

(GEDI, 2019)

Overview Status Quo
Rating matrix

2. 3 Weighting:

Weighting between 1 and 3.
1 less important
2 important
3 very important

DESI: Weighting = 3
The aspects of connectivity, human capital, integration of digital technology and digital public services are all crucial to the success of blockchain technology. The combination of these four key factors will enable the comprehensive development and integration of blockchain in society.

GII: Weighting = 3
Factors such as science and innovation investment, technology progress, technology adoption and socioeconomic impact are essential for the development and success of blockchain. Innovation and advances in technology are particularly important for driving the adaptation and social impact of blockchain.

Research and development expenditure as % of GDP: Weighting = 3
Research and development are of crucial importance for the further development of blockchain technologies. The high weighting reflects the importance of countries investing in research and development in the area of blockchain.

GEI: Weighting = 1
The weighting of the Global Entrepreneurship Index (GEI) with 1 is based on the assessment that the factors measured in this index are less directly related to the specific requirements and dynamics of blockchain, but represent a good starting point. The GEI focuses on collecting data on entrepreneurial attitudes, skills and ambitions of the local population and weights these against the existing social and economic infrastructure.

(Lee et al., 2023, S. 4)

Overview Status Quo
2. 4 Matrix

Criteria	Weighting	Germany	Denmark	Ireland	Slovenia	Slovakia	Czech Republic
DESI	3	52,88	69,34	62,73	53,36	43,45	49,14
GII	3	58,8	58,7	50,4	42,2	36,2	44,8
Research and Development expenditure as % of GDP	3	3,1	2,9	1	2,1	1	2
GEI	1	65,9	74,3	73,7	53,8	44,9	43,4

Final result		102,56	116,78	104,02	86,70	71,71	82,81

Ranking		3	1	2	4	6	5

Table 2: Rating matrix for blockchain requirements

Overview Status Quo
2. 5 Comparable ranking matrix

The Euler Hermes Digital EDI Ranking 2018 (Enabling Digitalisation Index) is used as a comparison. This uses five criteria for a successful culture of digitalisation and thus corresponds to the same objective as the ranking matrix already presented.

This ranking is less tailored to the topic of blockchain in higher education and in the agri-food sector, which is why a new matrix was created.

1. Regulation: Based on the "Distance To Frontier" indicator (Worldbank Doing Business study). The indicator examines regulatory aspects that are important for digitalisation, for example creditworthiness or protection for minority investors.

2. Basic knowledge: Based on the Higher Education and Training Index (secondary and tertiary enrolment rates, quality of education system and use of employee training) and the Innovation Index ("R&D" by companies, cooperation between universities and the private sector, intellectual property laws) developed by the World Economic Forum.

3. Connectivity: Based on four indicators: the proportion of internet users in the total population, the number of mobile phone contracts, the number of landlines per person and the number of secure servers per person.

4. Infrastructure: Based on the Logistic Performance Index (Worldbank Doing Business study).

5. Size: Based on the number of internet users and their income (compared to nominal GDP).
(Islam et al., 2018)

Overview Status Quo
2. 5 Comparable ranking matrix

Criteria	Germany	Denmark	Ireland	Slovenia	Slovakia	Czech Republic
Regulation	86,4	95,5	87,4	80	79,1	81,5
Knowledge	92,6	88,3	80,6	64,5	45,3	61,5
Connectivity	79,4	75	61,2	56,9	48,9	58,1
Infrastructure	100	82,6	81,7	55,9	62,3	76,6
Size	17,9	1,5	1,3	0,2	0,6	1,3
Final result	75,3 1	68,6 2	62,4 3	51,5 5	47,2 6	55,8 4

Table 3: Comparable ranking matrix

2. 5 Conclusion

Overall, teaching blockchain can be improved in all the countries analyzed, both in higher education and in agriculture. Individual pilot projects, research efforts, teaching modules, and programs are already in place, but there is still room for improvement in expanding blockchain education in the future.

Both ranking matrices come to the same conclusion: among the countries analyzed, the conditions for blockchain adoption are most in need of improvement. Therefore, there is significant potential for enhancing the conditions for blockchain adoption.

The following output, "Pedagogical teaching methods," should therefore contribute to the improvement of deficiencies in teaching blockchain and, consequently, advance the digitalization of countries, especially in agriculture, in the long term, taking into account both current students and the workforce of tomorrow.

List of Tables

List of Abbreviations

AI	Artificial Intelligence
Bc4SC	Blockchain for supply chain
BDA	Big Data Analytics
BIM	Building Information Modeling
CTU	Central processing unit
DESI	Digital Economy and Society Index
DKK	Danish krone
DLT	Distributed Ledger Technology
ECTS	European Credit Transfer and Accumulation System
Et al.	et alii
EU	European Union
e.V.	registered association
GDP	Gross domestic product
GEDI	Global Ecosystem Dynamics Investigation
GEI	Global Entrepreneurship Index
GII	Global Innovation Index
ICT	Information and Communication Technology
IoT	Internet of Things
IRCAI UNESCO	International Research Centre on Artificial Intelligence under the auspices of
IT	Information Technology
LF	Landbrug & Fødevarer
ML	Machine Learning
MSc	Master of Science
NAIXUS	Network for Artificial Intelligence, Knowledge and SUStainable development
n.D.	no Date
p.	page
PE	Pan Evaporation
SDGs	Sustainable Development Goals

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