BLOCK CHAIN FOR AGRI FOOD EDU

Blockchain teaching in higher education in the agri-food sector

Baseline Research Report

https://blockchainforagrifood.eu/

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INTRODUCTION

1.1 ERASMUS+ INITIAL PROJECT

Blockchain for Agri-Food Educators is an innovative project that seeks to transform the provision of education in the agribusiness, food science, and nutrition sectors through the strategic utilization of blockchain technology. By developing innovative pedagogical approaches that encompass a wide range of theories, methods, processes, and teaching concepts, this project aims to enable higher education educators to take the lead in digitizing the food sector while simultaneously addressing critical societal challenges within the food supply chain.

The Blockchain for Agri-Food Educators project aims to address the challenges faced by the agri-food sector in the European Union, which is the largest industrial manufacturing sector with an annual turnover exceeding €1.109 trillion and 4.57 million employees. The COVID-19 pandemic has put unprecedented pressure on food supply chains, exacerbating inefficiencies and food fraud.

"Blockchain technology has the potential to transform any sector of the economy, and the food sector is no exception. It has the potential to enable more transparency and traceability, greater efficiency, and more secure and resilient supply chains."

Frank Yiannas,
Deputy Commissioner for
Food Policy and Response at the US FDA

https://blockchainforagrifood.eu/

1.2 OVERVIEW OF OUTPUTS

1. Blockchain Education in the Agri-food Sector Baseline Research Report:

Achieves a better understanding of the opportunities and limitations of current blockchain teaching in agri-food

2. Guide to Blockchain Education in the Agri-food Sector:

Identifies, catalogue and present recommended approaches to blockchain teaching in agri-food disciplines; learning from education in industry 4.0 from other sectors.

How do you benefit from this guide?

Improve your understanding of the relationship between blockchain and the most pressing agri-food challenges/opportunities

Raise your awareness of higher educators of the very latest societal challenges in the agri-food sector

Through examples, empower educators to unlock the power of Blockchain for their agri-food student population, while also providing leadership for industry players.

1.3 INSIGHTS FROM PRACTICE

The B-chain Compendium, with 20 qualitative interviews on the current teaching of blockchain, is a unique training resource that brings together the diverse knowledge to provide educators with a complete guide of the Status Quo of Blockchain in Agri-food Education Research in Europe. As the demand for Blockchain technology knowledge continues to grow across Europe, this will make an important contribution to your own professional development, improving your outcomes and opening doors for your students to career opportunities in the Agri-food industry.

We encourage you to use content from the interviews and pedagogical practice examples as part of your teaching/training practice.

Why?

Qualitative insights from practice are:

- used as a teaching tool to show the application of a theory or concept to real situations
- fact- and context-driven. They create empathy with the main characters, are relevant to the reader, in relating to a challenge that needs to be solved
- a way of discovering the concept in a new manner

1.3 INSIGHTS FROM PRACTICE

B-Chain will substantially improve training for agri-food educators by:

• supporting their own professional development with input from teaching experiences, improve their results and open doors for future careers.

A major advantage of teaching with qualitative insights is that the learners are actively engaged in figuring out the principles by abstracting from the examples. This develops their skills in the key competencies of:

- problem-solving
- analytical tools, quantitative, and/or qualitative, depending on the case
- decision making in complex situations
- coping with ambiguities

1.4 BLOCKCHAIN AND SUPPLY CHAIN MANAGEMENT

Problems in existing supply chains:

* Large number of globally distributed stakeholders

* Lack of shared information

* Low levels of trust - need for third-party intermediaries, resulting in additional costs and delays

* Low levels of digitalisation - most compliance data and information stored on paper or in a centralised database

* Human error

* Data manipulation

* Inefficient, costly

Blockchain as a potential solution:

* Blockchain as a distributed, decentralised ledger

- * Everyone on the Blockchain (nodes) receives an identical, synchronised copy of the information

- * Data entered into the Blockchain must be verified and validated by all participants (consensus)

- * Data entered into the Blockchain is immutable

02
STATUS QUO

2.1 CURRENT TEACHING ON BLOCKCHAIN IN EUROPE

Many universities in Europe and elsewhere are becoming increasingly interested in blockchain technology (Grech & Camilleri, 2017, p.12)

The use of blockchain in education is still very new as of 2017; there isn't much published research in the field that has undergone peer review (Grech & Camilleri, 2017, p.11)

Most universities have failed to make use of blockchain technology's business, technical, legal, or other aspects (Themistocleous et al., 2020, p.5338)

There haven't been many German universities that explicitly teach Blockchain knowledge.
(Lenz, Barkel, Tsangaratos, Klõga & Llorente, 2021, p.31).

BKCT research on agriculture discusses food production records, monitoring of production steps, a circular economy, data protection, product certification, reputation systems (Sendros et al., 2022, p. 1).

Integrative teaching content, speculative teaching methods, diversified team of educators, discussion-based assessment to shape students' ability, mindset with Internet and BKCT (Wang & Huang, 2020, p.556).

Most studies propose practical teaching as a teaching method.

Studies targeting food supply chain to address key issues from food safety to traceability, transparency, elimination of intermediaries (Srivastava& Dashora, 2022, p.1).

2.1 CURRENT TEACHING ON BLOCKCHAIN IN EUROPE

A stream of teaching method research are studies, which apply a game-based approach to teaching BKCT (Choi et al., 2022; Sunny et al., 2022; Tsang et al., 2022).

Choi et al. (2022) designed a game-based teaching based on the six steps of ASSURE model's educational design process to introduce principles of consensus mechanisms, private blockchain, and public domain (p.1).

A secure system can support farmers to achieve higher levels of decentralization, traceability, non-repudiation, payment, automation of commodity exchange, sharing information and improving operational efficiency (Krithika, 2022, p.3; Lim et al., 2021, p.2).

All data about the condition of farms, stocks, contracts and administration are collected and stored in the BKCT in a secure and transparent manner (Krithika, 2022, p.3).

2.2 USE OF BLOCKCHAIN & DEGREES OF BLOCKCHAIN

USE OF BLOCKCHAIN

Focus: Educational institutions offering Blockchain praograms + applicability in agrifood

A limited number of universities around the world offer Blockchain programs

(Themistocleus, M., Christodoulou, K., Iosif, E., Louca, S., Tseas, D. 2020)

Current research doesn't focus on implementation, only conceptual designs

(Demestichas, K., Peppes, N., Alexakis, T., Adamopoulou, E. 2020)

DEGREES AND BLOCKCHAIN

Universities websites and classes

(Bergische Universität Wuppertal. (nd.)

A need for proficiency in informatics to join those degrees

Term "blockchain" absent from the classes offered by the agri-food universities

2.2 USE OF BLOCKCHAIN & DEGREES OF BLOCKCHAIN

Examples of possible cases

(FAO, 2019)

Overseeing Farm Inventory
Enhancing Agricultural Supply Chains
AgTech IoT Optimization
Fair Pricing
Agricultural Subsidies Oversight
Modernizing Farm Management Software
Community-Supported Agriculture
Incentivizing Sustainable Practices
Greater Accountability for Multinationals
Mobile Remittance for Small Farmers

2.3 Blockchain in the field of agricultural sciences

Slovenia: OriginTrail – Revolution in agriculture

EIP-Ekopakt: A Slovenian project that uses the OriginTrail decentralised knowledge graph and other digital technologies to link data between a wide range of actors in the organic beef supply chain and create transparency from producer to consumer.

Decentralised OriginTrail technology, the project builds trust and integrity in supply chain data and increases consumer confidence in organic beef production in Slovenia.

OriginTrail protocol supports several trusted agri-food supply chain solutions in pan-European research and innovation consortia such as SmartAgriHubs, DEMETER and The Food Safety Market (TheFSM). (https://origintrail.io/solutions/sustainable-agriculture)

2.3 Blockchain in the field of agricultural sciences

Denmark: DanishAgro

Invest in blockchain technology

All activities are related to be best possible business partner for farmers, and for all products for which they follow the entire value chain - from the field to the dining table.

(https://danishagro.com/products-and-services
https://www.appsruntheworld.com/customers-database/customers/view/danish-agro-denmark)

2.3 Blockchain in the field of agricultural sciences

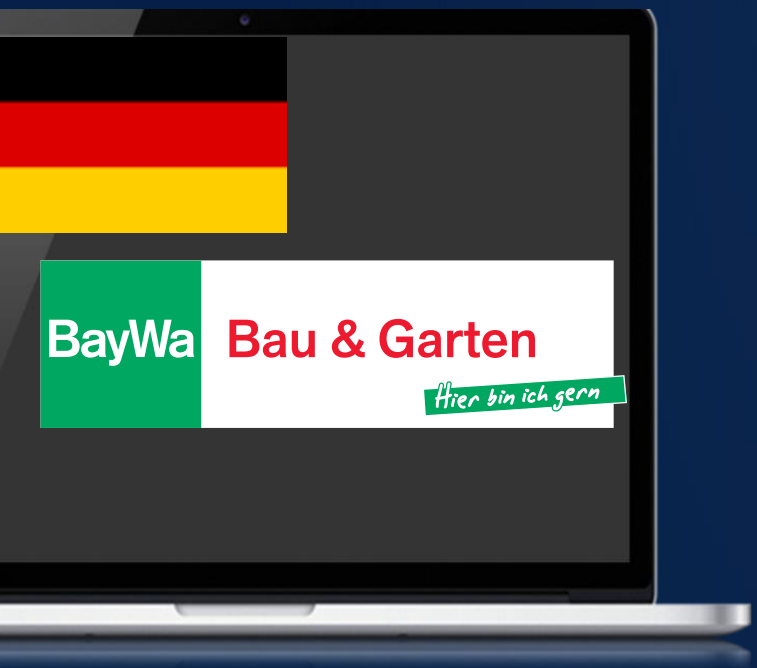
Germany: BayWa

-BayWa's sister company, Youki, increases transparency within the value chain and secures the data of participating stakeholders and increases their efficiency.

They offer a blockchain solution.

This way, customers can later directly track the steps a product has gone through until it is consumed.

(https://www.youki.ai/combayn)



2.3 Blockchain in the field of agricultural sciences

Ireland: Farmeye

Farmeye tests and measures soil health and carbon sequestration on farms.

They are using a blockchain-backed chain.

Their technologies enable food producers, governments and farmers to measure, monitor and prove their farms' sustainability metrics.

(https://worldagritechusa.com/ida-ireland-blockchain/)

2.3 Blockchain in the field of agricultural sciences

International: Australia and USA

AgriChain (Australia)

Is a software platform that brings together all stakeholders in the agricultural supply chain. This is also intended to reduce inefficiencies in supply chains.

IBM Food Trust (USA)

Food Trust is a modular solution based on blockchain that provides a safer, smarter and more sustainable food ecosystem for all network participants. This increases transparency of food origins.

(https://agrichain.com/about-the-platform/)

(https://www.ibm.com/de-de/products/supply-chain-intelligence-suite/food-trust)

03
METHODOLOGY

3.1 Research questions

To gain insights from the current teaching of blockchain in the agricultural sector and technical courses, we have posed the following research questions.

RQ1
What stops educators from adapting blockchain?

RQ1.1 Why do educators not adapt blockchain technology to the educational process?

RQ1.2 Which skepticism toward the implementation of blockchain do educators face?

RQ2
How can educators effectively implement blockchain into education?

RQ2.1 How can educators teach blockchain to students?

RQ2.2 What are the best practices of embedding blockchain into education program?

3.2 The qualitative Approach

WHY & WHAT

Qualitative research involves collecting and analyzing non-numerical data (e.g., text, video, or audio) to understand concepts, opinions, or experiences. It can be used to gather in-depth insights into a problem or generate new ideas for research.

Bhandari, P. (2020, June 19).

3.3 Distinction between two target groups

In order to obtain content from practice and teaching, we divided the target groups. For this purpose, experts from the technical sector of the respective countries were consulted and experts from the agricultural sector.

The aim was to share experiences on the extent to which teachers in the agricultural sector are currently still experiencing obstacles in the implementation of blockchain technology in teaching. In addition, best practices should be identified from teachers in the technical fields who have already studied this technology and are familiar with its teaching.

Agri-food experts

Blockchain experts

3.4 Criteria of finding the interview partners

Agri-food experts

- Agri-food, Agriculture economics
- Academics at higher institutions
- Have written works related to their field
- Have knowledge on agri-food industry

Blockchain experts

- IT, Computer Science, Digital logistics, Digitalization
- Academics at higher institutions
- Have researched and/or lectures about blockchain
- Have an educated opinion on Blockchain's current use

To identify identical interviewees across the respective European countries, the following points helped to identify the interviewees.

1

Location

- Denmark
- Slovenia
- Slovakia
- Czech Republic
- Ireland
- Germany

3.5 Process of the interview

1 - Defining the interview guidelines RQ and writing down the consent form

2 - Finding interviewees in blockchain and agrifood sector and writing them down in the table

3 - Writing an introduction email and translating it, deciding how to address the interviewees

4 - Splitting the work and sending out the emails

5 – Scheduling and conducting the interviews, coding the answers

3.6 Interview partner

Inteviewee A

Bavaria

Chair of computer Science

Inteviewee B

Saxony

Research Assistant computer science

Inteviewee C

NRW

Prof in Digital Logistics

Inteviewee D

Lower Saxony

Prof. in Agricultural Science

Inteviewee E

Lower Saxony

Prof. in Agricultural Science

Inteviewee F

NRW

Prof. in Technical Economics

Inteviewee A

Initiative with blockchain-related companies

Inteviewee B

Dean and lecturer Electrical Engineering & Computer Science

Inteviewee C

Professor for informatics & statistical methods

Inteviewee D

Professor of Sustainable Development

Inteviewee A

Prague

Lecturer in algorithmic principles

Inteviewee B

Prague

IT Department

Inteviewee C

Prague

Ass. Prof at IT Department

Inteviewee D

Prague

Ass. Prof. at IT Department

Inteviewee E

Prague

Ass. Prof. at IT Department

Inteviewee F

Prague

Lecturer for Computer networks

3.6 Interview partner

Inteviewee A

Lecturer of Food and Nutrition

Inteviewee B

Lecturer on food regulation and sustainability

Inteviewee C

Head of Health and Nutritional Science:

Inteviewee D

Assistant Professo in Management Information System

Inteviewee A

Professor in Management Information System

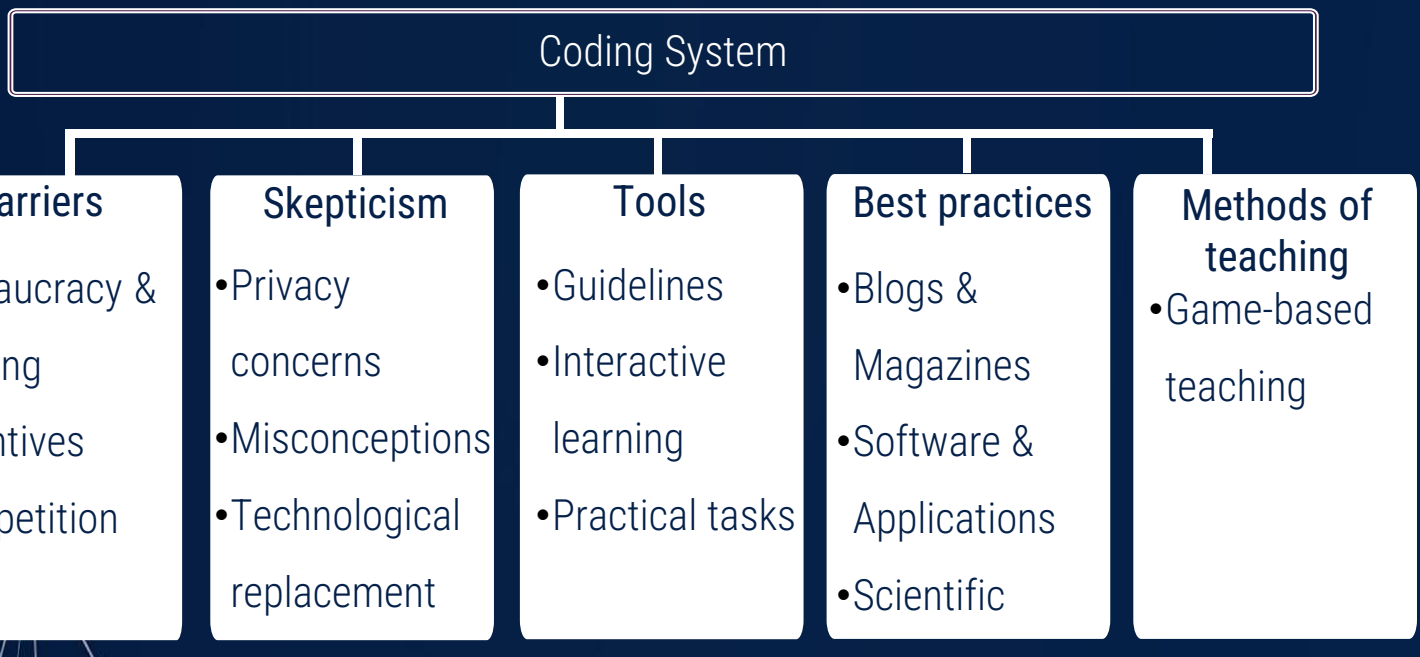
3.7 Coding the interviews

The various interviews with the two target groups were analysed using the following codes and grouped in the following.

5 main coding themes

More than 15 sub-categories

35 valuable coded answers



04
RESULTS

GENERAL OVERVIEW OF THE OBSTACLES

1. LACK OF RESOURCES

Bureaucracy, insufficient fundings and incentives

Lack of resources

TECHNOLOGY ADOPTION

Bureaucracy

Insufficient fundings

Lack of incentives

INTERVIEWEE E: “The bureaucracy of adapting new technology into conservative teaching modules is such an immense process [...] bringing it into teaching, it's not easy to do.”

INTERVIEWEE B: "It would help if they would provide enough supply of funds for hiring people to teach blockchain. "

INTERVIEWEE E: “having a sort of incentive system for the professors to change their way of thinking, not necessarily more money, but perhaps a relief in teaching duties or a different approach of doing my work with students, more home office allowance, more modern tooling."

Time

INTERVIEWEE A: “Approachable understanding of blockchain technology from a food and nutrition perspective. Developing these materials from scratch requires significant time and effort.

GENERAL OVERVIEW OF THE OBSTACLES

1. LACK OF RESOURCES

Bureaucracy, insufficient fundings and incentives

Wrong expectations, misunderstanding the concept of the blockchain, questionable usability

2. FLAWED KNOWLEDGE & SKEPTISIM

Flawed knowledge & skepticism

TECHNOLOGY ADOPTION

Wrong expectations from students

Misunderstood concepts and ideas

Questioned usability

INTERVIEWEE A: "The understanding sometimes is not as accurate as we wish it to be. So even though all of the concepts seem to be pretty easy, there's just no heavy cryptography involved… But on a very basic level, there's not much going on…"

INTERVIEWEE A: "Even though these things are easy, […] the combination and understanding how all these things work together is hard.

INTERVIEWEE D: "Could be an issue that there's not much knowledge and awareness."

Privacy concerns

Misconceptions

Technological replacement

INTERVIEWEE B: "But the question is it [blockchain] just the most efficient and optimal way or is there any others, like data storage or storage service available that does the same thing better"

INTERVIEWEE D: "I can imagine that people will have doubts about the privacy. So even though you could maybe make the case that and explain that this just wouldn't be an issue, people would still not trust it."

No competition yet

No worldwide standard

No pressure from private sector

INTERVIEWEE E: "some of our students left [University A] and went to [University B] because it's more modern, it's more state of the art. […] just letting people go because [University A] is not competing with [University B]. So, the sort of competition in this government owned scientific community really causes some changes."

INTERVIEWEE C: "Normally companies or even authorities are always connected to different material and information flows. […] There are always a lot of customers, and every customer is implementing another system. […] There is no worldwide standard."

INTERVIEWEE D: "I think it can only be successful when we have a clear use case and a clear market, and companies want to implement that and then we get the pressure bottom up."

Flawed knowledge & skepticism

TECHNOLOGY ADOPTION

Prejudice | **Media presentation** | **Less time**

INTERVIEWEE A: “Main obstacle for integrating blockchain in the HEI curriculum is prejudice. Driven by media coverage of crypto-related topics and misunderstanding of the blockchain.”

INTERVIEWEE B: "There are not a lot of examples of use of blockchain technology outside of cryptocurrencies and this is what makes teaching about blockchain really difficult (…)."

INTERVIEWEE C: “Majority of the people still mix blockchain with cryptocurrencies because of the media attention given to them." "There are a lot of students who did not attend gymnasiums and consequently have different background knowledge."

INTERVIEWEE D: "I should not start teaching something until I have the time to properly study it."

Module characteristics | **Abuse** | **Technical requirements**

INTERVIEWEE A: “BTC could be taught as a module since it relates heavily to information systems principles pertaining to database design.”

INTERVIEWEE A: “Push for BTC can be misused by geopolitical actors or non-state actors."

INTERVIEWW A: “Alternative sources of energy will be required before BTCs, and other high energy technologies.”

INTERVIEWEE B: BTC continues to struggle out of nascency even though it has been in existence for a decade. Because of this, its difficult envision its use in mainstream industries.

INTERVIEWW B: “It is difficult to find qualified instructors who can teach BTC as it has a narrow bandwidth of applicability with other technologies.”

INTERVIEWEE B: “There would be resistance from private sectors to implement BTC, as the usage of existing technologies has created a culture averse to change.”

INTERVIEWW B: “Food industries are not completely transparent about their practices. For instance (…) implementation of BTC would have to be a top-down approach, (…) because big food companies don't want to be transparent as it comes with significant costs.”

Flawed knowledge & skepticism

TECHNOLOGY ADOPTION

Industry identify need

Automotive

INTERVIEWEE C: “Implementation of a curriculum around BTC, as approval and funding can take years to secure. Hypothetically speaking, by the time industry does identify a need for BTC, the technology and industries will be so far ahead”

INTERVIEWEE B: "BTC won’t likely be adopted until a majority holder of an industry, e.g., for automotive = Volkswagen or Toyota, takes the lead to implement BTC into their supply chain oversight processes, this signals a cultural aversion to change management.”

Challenging topic

Perception

INTERVIEWEE A: “While students in my courses are keen to learn about food traceability and security, they often find the technical details of blockchain challenging.”

INTERVIEWEE A: “The association of blockchain with cryptocurrencies, and the controversies surrounding them, often lead to misunderstandings and even fear among students. It requires effort to shift these perceptions and present blockchain as a tool with much broader applications, including its potential to revolutionise our food systems. "

GENERAL OVERVIEW OF THE OBSTACLES

1. LACK OF RESOURCES

Bureaucracy, insufficient fundings and incentives

Wrong expectations, misunderstanding the concept of the blockchain, questionable usability

2. FLAWED KNOWLEDGE & SKEPTICISM

3. DIGITAL TOOLS

Pedagogical approaches

Digital Tools

TECHNOLOGY ADOPTION

Game-based teaching | **Case-based teaching** | **Blockchain related**

INTERVIEWEE A: “Everyday usage of blockchain technology-related innovations is the most powerful source of education.”

INTERVIEWEE C: “Case-based teaching would prove best to teach about blockchain technology, as showcasing successful use cases enables one to teach about benefits and pitfalls of blockchain technology."

Lab Game | **Physical game** | **Role-playing game**

INTERVIEWEE A: **“**Cryptoeconomics Lab's "Blockchain Game": This is an online simulation game that enables players to experience how a blockchain network operates. Users can mine blocks, conduct transactions, and learn about concepts such as mining difficulty and blockchain forks.”

INTERVIEWEE A: “We undertake a physical game where students create their own 'blockchain' with paper blocks. Each student or team writes down transactions, calculates a simple 'hash' using basic rules, and links blocks together. This helps students understand the basics of transactions, hashing, and how blocks are linked in the chain.”

INTERVIEWEE A: We also play a role-playing game called ‘Blockchain Reaction’, developed by the Institute of the Future. It takes place in a future scenario where a city is planning to use blockchain for public services. Players take on different roles (developers, citizens, government officials) and debate the pros and cons. It's a good way to teach about the broader social implications of blockchain technology.
“

GENERAL OVERVIEW OF THE OBSTACLES

1. LACK OF RESOURCES

Bureaucracy, insufficient fundings and incentives

Wrong expectations, misunderstanding the concept of the blockchain, questionable usability

2. FLAWED KNOWLEDGE & SKEPTICISM

3. DIGITAL TOOLS

Pedagogical approaches

Using Blockchain Technology in companies

4. BEST PRACTICES & TEACHING

Best practices & teaching

BLOCKCHAIN IN COMPANIES

IBM | **Right information** | **Replacement**

INTERVIEWEE A: "There are collaboration between IBM and Carrefour (Europe's largest retailer) with intent (…) to track and trace chicken, eggs and tomatoes (…) travel from farms to stores."

INTERVIEWEE A: "The main barrier is the right information not coming to the right people in the process."

INTERVIEWEE B: "Blockchain technology can solve some of the supply-chain-bottleneck-related problems but not all of them by replacing many powerful aggregating-the-supply major players like big wholesale companies."

INTERVIEWEE C: "BC can hide a lot of information by breaking it onto smaller pieces and obscuring it via multiple different transactions."

Use in governance | **Transparency in manufacturing** | **Transparent marketing**

INTERVIEWEE A: "BTC may have a use in governance, however the issue of anonymity among users makes it an odd selection for tooling. Nonetheless, it could be used in e-governance, for instance, in elections or polling."

INTERVIEW B: "It can be used to enforce transparency in manufacturing cases where some producers may be motivated to deceive their network of partners."

INTERVIEWW B: "In 2023 German companies will need to prove that their products are free of child labor, and that is a requirement that demands greater transparency and incentive for BTC."

INTERVIEWEE D: "BTC might be useful for transparent marketing and supply-chain management in terms of enforcing regulations and international-trade laws."

Best practices & teaching

BLOCKCHAIN IN COMPANIES

Journey of food items | **Food quality** | **Ethical treatment**

INTERVIEWEE A: “Blockchain technology can provide a secure, transparent, and tamper-proof method of recording the journey of food items from the farm to the consumer's plate. This traceability could potentially reduce food fraud, improve recall processes, and ensure food safety.s.”

INTERVIEWEE A: “BTC his can be of relevance when discussing food quality, food safety regulations, and the complexities of the global food supply chain in your course."

INTERVIEWEE A: “With blockchain, it's possible to verify claims made by food producers about organic farming, ethical treatment of animals, or sustainable fishing practices.”

INTERVIEWEE A: “Blockchain can potentially provide a transparent and tamper-proof method of recording and sharing nutritional information of food items. This transparency could help consumers make more informed decisions about their nutrition and diet.”

INTERVIEWEE A: “TE-FOOD: This is another end-to-end food traceability solution based on blockchain. It has been implemented in several countries, including Vietnam, where it was used to trace and monitor pigs, poultry, and eggs from farm to table, reducing the spread of disease and ensuring food safety.”

Best practices & teaching

METHODS

Theory | **Use cases** | **Experience**

INTERVIEWEE A: “We start with blockchain-related theory after that we study use cases and they should experience themselves. For example: participants download an application that they can study more deeply in the course of the workshop.”

Information system | **Introductory course** | **Start from end**

INTERVIEWEE A: “Students should learn the principles of database management and information systems before learning anything about BTC”

INTERVIEWEE A: “Students need an introductory course into the logic of BTC before suggesting use-cases in which a distributed network can be used for data storage"

INTERVIEWW A: “BTC students would need to learn cryptographic theories.”

INTERVIEWEE C: “Students should be given projects that simulate the need for a decentralized data storage and then have them build an architecture around that need.”

INTERVIEWEE C: “Students should have programming prerequisite courses.”

INTERVIEWEE D: “First coming up with use cases to demonstrate its utility rather than starting with BTC’s theoretical principles.”

INTERVIEWEE C: “Answering the question of implementationn is best started from the end. What are your expectations, what do you want to have as a final product or result? I cannot tell you how you can use it if we don't why we do it”

INTERVIEWEE D: “Project-based teaching students get a project and assign them to do it. They simply elaborate on some case study, for instance, an effective oil company and they analyze the needs of the company and requirements and then they propose a solution based on blockchain “

INTERVIEWEE D: “Project-based teaching students get a project and assign them to do it. They simply elaborate on some case study, for instance, an effective oil company and they analyze the needs of the company and requirements and then they propose a solution based on blockchain “

INTERVIEWEE E: “(…) Concepts such as hash functions, ciphers and digital signatures, and how the public keys work and how the authenticity of public keys are assured with the authorities”

Best practices & teaching

METHODS

Theory | **Use cases** | **Experience**

INTERVIEWEE A: “We start with blockchain-related theory after that we study use cases and they should experience themselves. For example: participants download an application that they can study more deeply in the course of the workshop.”

INTERVIEWEE A: “We need to integrate blockchain technology into our curriculum, using real-world examples to demonstrate its relevance to food and nutrition.“

INTERVIEWEE A: “Collaboration with Computer Science or IT departments can be instrumental, fostering an interdisciplinary learning environment to ensure technical accuracy. Interactive learning strategies, including games and simulations, should be employed to make complex concepts more digestible and engaging.”

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