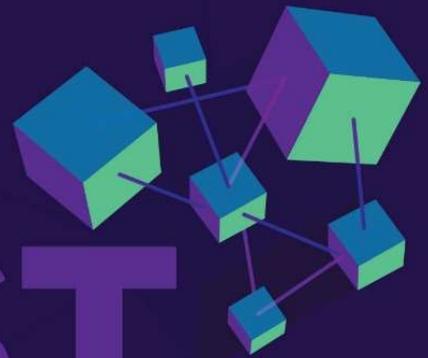




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TRUST FOOD

Trainee Handbook

English



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Introduction

In recent years, blockchain has emerged as a revolutionary technology, promising transparency, security, and efficiency across various industries. One of the most promising applications of blockchain lies in transforming the global food supply chain. The food supply chain is inherently complex, spanning multiple stages from production to consumption. Traditional supply chain systems often suffer from inefficiencies, lack of transparency, and susceptibility to fraud or contamination. With consumers increasingly demanding transparency and accountability in the sourcing and distribution of food products, blockchain presents a sufficient solution to address these concerns because it offers a decentralized, immutable ledger system that can revolutionize the way we track, trace, and verify the journey of food products from farm to fork.

TRUSTFOOD is a Digital Europe initiative that offers short-term training programs aimed at upskilling and reskilling the workforce, particularly targeting owners, managers, and employees of SMEs in the food supply chain sector. The project aims to enhance the advanced digital skills of the workforce, especially within SMEs, and also extends to job seekers by offering access to specialized training courses. These courses incorporate the latest advancements in blockchain technologies as applied comprehensively to the food supply chain. The courses are highly practical, providing in-depth knowledge of blockchain and its specific applications in the food supply chain. More specifically, the TRUSTFOOD platform offers twenty (20) courses with a total number of one hundred twenty-seven (127) lessons that comprise ninety-two hours (92) and forty-five (45) minutes of training.

This handbook offers to trainees information regarding the content and duration of each course, its objective and learning outcomes, the course level, education level required, and prerequisites, the target audience, information regarding the assessment, the certification of attendance and badges, guidelines - activities tips for each one of the lessons offered as well as relevant readings. With the guidelines - activities tips sections, trainees have an additional tool in their hands to be guided through each one of the lessons to increase understanding of the lessons content.

Therefore, it is expected that the combination of the courses and the trainee handbook will provide workforce with a toolbox to develop their skills regarding the application of blockchain in food supply chain and consequently change the way we produce, distribute, and consume food.

Course #1: Introduction to Blockchain Technology and Digital Assets

Content and Duration

The lessons provided with the course “Introduction to Blockchain Technology and Digital Assets” are as follows:



Lesson 1: Short history of money and how bitcoin was created

Lesson 2: Fundamentals of blockchain technology

Lesson 3: Blockchain technology and transactions.

Lesson 4: Blockchain Management System. Composition and types

Lesson 5: Bitcoin and Ethereum Basics

Lesson 6: DeFi

Lesson 7: Blockchain in Food Supply Chain: An Outlook



Approx. 4 hours to complete.

Objective

This course equips you with a comprehensive understanding of blockchain technology, its architecture, and its potential to revolutionize industries. You'll explore core concepts, delve into blockchains' structure, and learn how they ensure security. Discover the differences between public, private, and consortium blockchains, and explore the world of digital assets like cryptocurrencies and NFTs. Finally, we'll dive into how blockchain can transform food supply chain transparency and security.

Learning Outcomes

What you will learn:



Evolution of money from barter systems to digital currencies. Historical development of blockchain technology (Lesson 1).

Differentiation between blockchain technology and traditional databases. Role of cryptography in securing blockchain transactions. Core components and functionalities of a blockchain system (Lesson 2).

How transactions are processed and secured on a blockchain network. (Lesson 3).

Identify and differentiate between different types of Blockchain Management Systems (BMS). Concept of Distributed Ledger Technology (DLT) and its relation to blockchain. Compare and contrast public and private blockchain systems. (Lesson 4).

Basic functionalities of Bitcoin as the first and most popular cryptocurrency. The concept of smart contracts and their role on the Ethereum blockchain. Purpose and potential of Decentralized Applications (DApps) (Lesson 5).

Differentiation between tokens and coins used in blockchain ecosystems. Identify different token standards and their applications. The concept of Non-Fungible Tokens (NFTs) and their use cases (Lesson 6).

Analyze the potential applications of blockchain technology within the food supply chain. (Lesson 7).

Course Level, Education Level Required, and Prerequisites



Beginners, Professional Development or Continuing Education



High School Diploma or Equivalent



-

Target Audience



University students, university graduates, business managers, business owners, agrifood company employees and food supply chain personnel

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with 7 corresponding quizzes (1 for each lesson) that consists of 3-4 multiple choice and true-false questions.



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

Begin the course by reviewing the objective, the learning outcomes and structure (i.e., lessons).

Lesson 1: Short history of money and how bitcoin was created



Journey Through Money

Explore the evolution of money from barter systems using seashells and stones to the development of metal coins.

Check the introduction of paper money in China and the concept of fiat money.

Analyze the advantages and disadvantages of fiat money compared to commodity-backed currencies.



Cryptography and the Rise of Cypherpunks

Explain the concept of cryptography and its historical role in protecting information.

Introduce the cypherpunk movement and their dedication to privacy and freedom through cryptography.

Check the contribution of cypherpunks in creating the foundation for secure digital currencies.



Demystifying Bitcoin

Define Bitcoin and its revolutionary role as a decentralized digital currency.

Explain the concept of blockchain technology as the backbone of Bitcoin's security and transparency.

Check the benefits of Bitcoin such as decentralization, security, and faster transactions compared to traditional systems.

Explore the challenges and future prospects of Bitcoin, including its volatility and potential to transform financial systems.

Take advantage of quizzes and polls: Don't see them as tests, but as opportunities to gauge your understanding and identify areas where you might need to revisit the material.

Expand your learning: The real-world case studies can spark your curiosity. Research these applications further to gain a deeper understanding of blockchain's potential.

Lesson 2: Fundamentals of blockchain technology

Demystifying Blockchain - Building Blocks

Come prepared with a basic understanding of the internet and digital communication. This will help you grasp how blockchain technology disrupts traditional methods of information sharing.



Focus on understanding the core concepts: Blockchain technology, immutability, transparency, security. These are the cornerstones of this technology.

Think outside the box: When participating in the cryptographic concept skits or role-play activities, use your creativity to connect these concepts to real-world scenarios.

The Backbone of Security - Hashing

Pay close attention to the properties of good hash functions. These properties (determinism, one-way computation, collision resistance) are crucial for understanding how hashing secures data in blockchain.



Take advantage of diagrams and animations to solidify your understanding of how hash functions work.

Connect the dots: Look for opportunities to relate the course content to your everyday experiences. How are password verification systems similar to how hashing works in blockchain?

A Historical Perspective - The Foundation Laid

This section will connect the dots! See how historical cryptographic research and advancements paved the way for the development of blockchain technology.

Make connections between the foundational works and the concepts you learned earlier. How does RSA encryption relate to public-key cryptography?



Be curious! The discussion on potential applications of blockchain technology beyond cryptocurrency is your chance to explore the vast possibilities of this technology. Think about how it could impact your field of study or future career.

Take advantage of quizzes and polls: Don't see them as tests, but as opportunities to gauge your understanding and identify areas where you might need to revisit the material.

Expand your learning: The real-world case studies can spark your curiosity. Research these applications further to gain a deeper understanding of blockchain's potential.

Lesson 3: Blockchain technology and transactions

Demystifying Blockchain - The Core Concepts

Grasp the foundational concept: Blockchain is a distributed ledger technology that facilitates secure, transparent, and tamper-proof transactions. It's like a shared record-keeping system where everyone has a copy.



Focus on the key features: Security (encryption), transparency (publicly viewable transactions), immutability (unchangeable records), and efficiency (faster transactions).

Break down the jargon: Don't be afraid to ask for clarification on terms like transactions, blocks, public/private keys, and addresses. These are the building blocks of blockchain.

Think in analogies: Imagine a shared Google Doc where everyone can see the edits but no one can erase them. This can help visualize the transparency and immutability of blockchain.

Behind the Scenes - The Power of DLT

Dive deeper into Distributed Ledger Technology (DLT): Understand how DLT decentralizes data storage and management, creating a more secure and reliable system compared to centralized databases.



Explore the key properties of DLT: Decentralization, immutability, transparency, security, traceability, resilience, and auditability. These properties are what make blockchain so powerful.

Visualize the process: Look for diagrams or animations that illustrate how transactions are added to blocks, verified by the network, and chained together chronologically.

Applications and Beyond - Blockchain in Action

Move from theory to practice: Learn about various applications of blockchain technology beyond cryptocurrency (e.g., supply chain management, voting systems, identity management).

Think critically: Consider the benefits and limitations of blockchain for different industries. Is it a perfect solution, or are there potential drawbacks?



Stay curious! The world of blockchain is constantly evolving. Explore real-world case studies to see how companies are implementing this technology.

Take advantage of quizzes and polls: Don't see them as tests, but as opportunities to gauge your understanding and identify areas where you might need to revisit the material.

Expand your learning: The real-world case studies can spark your curiosity. Research these applications further to gain a deeper understanding of blockchain's potential.

Lesson 4: Blockchain Management System. Composition and types.

Demystifying Blockchain Systems - Building Blocks

Grasp the core concepts: Understand the difference between a traditional database and a Distributed Ledger Technology (DLT). DLT allows for secure, transparent, and tamper-proof record-keeping across a network of computers.



Blockchain Management Systems (BMS): Recognize that a BMS is a software platform specifically designed to manage and operate blockchain networks. It acts as a control center for this new technology.

The Power of Properties: Focus on the key properties of a BMS, like immutability, authorship confirmation, orderliness, time stamping, audit openness, peer-to-peer interaction, and limited data modification. These properties are the foundation of trust and security in blockchain systems.

Public vs. Private: Understanding the Blockchain Landscape

Public vs. Private Blockchains: This is a crucial distinction! Public blockchains are open to everyone, while private blockchains are permissioned networks with restricted access.



Public Blockchains: Transparency & Security: Explore the advantages of public blockchains, such as transparency (everyone can see transactions), security (powered by consensus mechanisms like Proof of Work), and decentralization (no single entity controls the network). Examples include Bitcoin and Ethereum.

Private Blockchains: Speed & Control: Recognize the benefits of private blockchains, including faster transaction processing, scalability (suitable for high-volume applications), and enhanced privacy (transactions are visible only to authorized participants). Examples include supply chain management and healthcare data management.

Beyond the Basics - Exploring Different Blockchain Systems

Consortium Blockchains - A Collaborative Approach: Learn about consortium blockchains, which combine features of public and private blockchains. They are managed by a group of trusted organizations and offer a balance between control and collaboration.

Hybrid Blockchains - Tailored Solutions: Understand the concept of hybrid blockchains, which can combine elements of different blockchain types to create a customized solution for specific needs. They offer flexibility in terms of access control, scalability, and privacy.



Choosing the Right Blockchain: Recognize that the type of blockchain system (public, private, consortium, or hybrid) depends on the specific needs of the application. Consider factors like transparency, privacy, scalability, and control requirements.

Take advantage of quizzes and polls: Don't see them as tests, but as opportunities to gauge your understanding and identify areas where you might need to revisit the material.

Expand your learning: The real-world case studies can spark your curiosity. Research these applications further to gain a deeper understanding of blockchain's potential.

Lesson 5: Bitcoin and Ethereum Basics.

Demystifying Cryptocurrencies - Bitcoin & Beyond

Grasp the Core Concepts: Start by understanding the concept of digital currencies and how they differ from traditional currencies. Explore the role of blockchain technology in creating a decentralized and secure system for online transactions.



Bitcoin: The Pioneer: Focus on Bitcoin as the first widely adopted cryptocurrency. Learn about its origin, underlying technology (Proof-of-Work), and key features like its decentralized nature, limited supply, and role as a store of value.

Understanding Transactions: Break down the process of Bitcoin transactions. Explore concepts like mining, digital wallets, and transaction fees. Consider the trade-off between security and scalability with Proof-of-Work.

Unveiling the Power of Ethereum - Beyond Payments

Introducing Ethereum: Move on to Ethereum, a more versatile platform compared to Bitcoin. Understand its core functions beyond just being a cryptocurrency.



Smart Contracts - The Game Changer: Deep dive into the concept of smart contracts. These self-executing contracts automate agreements and transactions, eliminating the need for intermediaries. Explore their potential to revolutionize various industries.

Decentralized Applications (DApps): Learn how Ethereum empowers the creation of DApps - applications that operate on a decentralized network, free from central control. Discover the possibilities DApps offer for innovation and disruption.

Contrasting the Giants - Bitcoin vs. Ethereum

Understanding the Differences: Now that you understand both Bitcoin and Ethereum, compare and contrast their key features. This includes aspects like consensus mechanisms (Proof-of-Work vs. Proof-of-Stake), transaction speed, scalability, and primary focus (payments vs. DApps).



The Future of Cryptocurrencies: Consider the potential future of Bitcoin and Ethereum. How might these technologies evolve and what impact could they have on the financial world and beyond?

Exploring Other Blockchains: While this course focuses on Bitcoin and Ethereum, recognize that other blockchain platforms exist. Stay curious and explore these alternatives to broaden your understanding of the cryptocurrency landscape.

Take advantage of quizzes and polls: Don't see them as tests, but as opportunities to gauge your understanding and identify areas where you might need to revisit the material.

Expand your learning: The real-world case studies can spark your curiosity. Research these applications further to gain a deeper understanding of blockchain's potential.

Lesson 6: DeFi.

Unveiling the Promise of DeFi - A New Financial Era

DeFi 101: Start by understanding the core concepts of DeFi. Explore how it leverages blockchain technology and smart contracts to create a decentralized financial system, free from intermediaries.



Key Features and Benefits: Focus on the key features of DeFi, including decentralization, transparency, and accessibility. Recognize the benefits it offers, such as lower fees, innovative financial products, and greater financial inclusion for everyone.

Demystifying Core DeFi Applications: Get acquainted with the foundational DeFi applications that are transforming finance. This includes decentralized exchanges (DEXes), lending platforms, yield farming, and stablecoins.

Deep Dive into DeFi Applications - Understanding How They Work

Decentralized Exchanges (DEXes): delve into DEXes and how they facilitate peer-to-peer cryptocurrency trading without relying on centralized authorities. Explore the benefits of DEXes, including security, transparency, and user control.



Lending and Borrowing Cryptocurrencies: Uncover how DeFi lending platforms empower users to borrow and lend cryptocurrencies, unlocking new financial opportunities. Understand the mechanics of collateralized loans, variable/fixed interest rates, and yield farming strategies.

The Rise of Stablecoins: Grasp the concept of stablecoins - cryptocurrencies pegged to real-world assets like fiat currencies or commodities. Explore the different types of stablecoins (fiat-backed, commodity-backed, crypto-backed) and their role in DeFi.

DeFi - The Road Ahead

The Future of DeFi: Consider the potential future of DeFi. How can it evolve to address challenges like scalability, security, and regulation? Explore how DeFi might reshape traditional financial institutions and empower individuals to manage their finances autonomously.



Exploring Other Blockchains: While this course focuses on DeFi within the Ethereum ecosystem, recognize that other blockchain platforms support DeFi applications. Stay

curious and explore these alternatives to broaden your understanding of the DeFi landscape.

Staying Informed in DeFi: The DeFi space is constantly evolving. Follow reliable news sources, communities, and influencers to stay updated on the latest trends, innovations, and potential risks associated with DeFi.

Take advantage of quizzes and polls: Don't see them as tests, but as opportunities to gauge your understanding and identify areas where you might need to revisit the material.

Expand your learning: The real-world case studies can spark your curiosity. Research these applications further to gain a deeper understanding of blockchain's potential.

Lesson 7: Blockchain in the food supply chain.

Unveiling the Potential of Blockchain - A Revolution on the Plate

Blockchain 101 for Food: Start by understanding the core concepts of blockchain technology. Explore how it can be applied to the food supply chain, creating a decentralized and transparent system for tracking food from farm to fork.



Transparency on Your Plate: Focus on the transformative power of blockchain for transparency. Discover how it creates an immutable record, allowing everyone to trace the journey of food products and identify potential issues like fraud or contamination.

Benefits Beyond Transparency: Go beyond just transparency. Recognize the additional benefits blockchain offers, such as streamlining operations, reducing costs, and enhancing food safety throughout the supply chain.

Deep Dive into Blockchain Applications - Transforming Food Systems

Tracking Every Step - The Power of Traceability: Delve into the concept of traceability in the food supply chain. Explore how blockchain enables real-time tracking of food products, from origin to consumption, empowering informed decisions and ensuring accountability.



Ensuring Food Safety - From Farm to Fork Protection: Understand how blockchain revolutionizes food safety. Learn how it facilitates real-time monitoring of environmental conditions and rapid identification of contaminated products, minimizing risks and safeguarding public health.

Financial Innovation for Food - Blockchain and Beyond Crypto: Discover how blockchain goes beyond just a financial technology. Explore how it can be used to create innovative financial solutions for the food industry, such as secure payments, improved access to financing for farmers, and promoting sustainable practices.

The Future of Food - A Blockchain Revolution



Challenges and Opportunities - Navigating the Blockchain Landscape: While blockchain offers immense potential, acknowledge the existing challenges. Explore aspects like

scalability, evolving regulations, and cost considerations. Discuss how these challenges can be addressed to facilitate wider adoption.

Case Studies - Learning from Real-World Applications: Get inspired by real-world examples of blockchain in action. Explore case studies like Walmart, IBM and Maersk, Provenance, and BanQu. See how these companies are leveraging blockchain to improve transparency, efficiency, and food safety.

The Road Ahead - A Vision for a More Secure Food System: Consider the future potential of blockchain in the food industry. Explore how it can further enhance traceability, streamline operations, and promote sustainable agricultural practices. Imagine a future where consumers have complete trust in the food they eat, thanks to blockchain technology.

Take advantage of quizzes and polls: Don't see them as tests, but as opportunities to gauge your understanding and identify areas where you might need to revisit the material.

Expand your learning: The real-world case studies can spark your curiosity. Research these applications further to gain a deeper understanding of blockchain's potential.

Relevant Readings

“Bitcoin: A Peer-to-Peer Electronic Cash System” by Satoshi Nakamoto
<https://bitcoin.org/bitcoin.pdf>

“Mastering Bitcoin: Unlocking Digital Cryptocurrencies” by Andreas M. Antonopoulos

“The Basics of Bitcoins and Blockchains” by Antony Lewis

“Blockchain Basics: A Non-Technical Introduction in 25 Steps” by Daniel Drescher

“Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World” by Don Tapscott and Alex Tapscott

“Blockchain: The Complete Guide to Understanding Blockchain Technology, Bitcoin, Cryptocurrency and the Future of Money” by Mark Gates

“Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” by Arvind Narayanan

“Blockchain Technology Explained: The Ultimate Beginner's Guide About Blockchain Wallet, Mining, Bitcoin, Ethereum, Litecoin, Zcash, Monero, Ripple, Dash, IOTA and Smart Contracts” by Alan T. Norman

“Blockchain: A Practical Guide to Developing Business, Law, and Technology Solutions” by R. Todd Stephens, et al.

“Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” by Arvind Narayanan.



“Blockchain: A Technical and Business Perspective” by R. Todd Stephens

“ANALYSIS AND SOLUTION OF THE CONCEPTUAL AND TERMINOLOGICAL PROBLEM OF THE BLOCKCHAIN CONCEPT DEFINITION” by Sergiy Obushnyi, Roman Kravchenko, Leonid Khatskevych, Sergii Nekrasov, Artem Frantsiiian
https://journal.eae.com.ua/index.php/journal/article/view/92/83?fbclid=IwAR1GvC3W-8_Ymvm1d97w_LOE8Lb3y5NaLIWwXI_IpK946i54bo5zbnOCycE

Course Provider / Contact Details



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Course #2: Exploring Digital Asset Management and Tokenization

Content and Duration

The lessons provided with the course “Exploring Digital Asset Management and Tokenization” are as follows:

Lesson 1: Contextualizing Blockchain in the Agrifood Supply Chain

Lesson 2: Introduction to digital assets in the food supply chain

Lesson 3: Types of digital assets

Lesson 4: The Interplay Between Digital Assets and the Agrifood Supply Chain

Lesson 5: The Fundamentals of Digital Asset Management

Lesson 6: Potential benefits and challenges of digital asset management and tokenization in the agrifood industry

Lesson 7: Exploring Real-world Implementations

Lesson 8: Future trends and advancements in digital asset management and tokenization



Approx. 5 hours to complete (including study time).

Objective

The objective of this course is to understand the fundamentals of digital assets and tokenization within the context of the food supply chain. The course begins with a foundational objective, which is to ensure that participants gain a solid understanding of the fundamentals of digital assets and tokenization. This knowledge is contextualized within the food supply chain, highlighting the relevance and application of these concepts in this specific area. A significant part of the course is dedicated to exploring how blockchain technology can be utilized to manage digital assets efficiently and facilitate the process of tokenization in the food industry. This exploration will not only cover theoretical aspects but also delve into practical applications, demonstrating how blockchain can transform the way digital assets are handled in the food sector. Finally, the course aims to bridge the gap between theory and practice. It focuses on the application of the acquired knowledge about digital assets and tokenization to real-world scenarios in the food supply chain. This objective is crucial as it allows learners to translate their understanding into practical skills that can be applied in real-life situations, enhancing the relevance and impact of their learning experience.

Learning Outcomes

As a participant in this course, you will be engaged in a comprehensive and effective learning journey structured around the following outcomes:

Fundamentals of Blockchain Technology: You will develop a solid foundational understanding of blockchain technology, encompassing its key characteristics and origins, to grasp how it functions and its implications.

Classification of Blockchains: You will learn to categorize different types of blockchains and understand their unique features and applications.

Understanding of Smart Contracts: You will delve into the mechanics of smart contracts, learning how they operate, are triggered, and executed, enhancing your comprehension of their role in digital transactions.

Blockchain's Impact on Agrifood Supply Chains: You will explore the transformative potential of blockchain and smart contracts within agrifood supply chains, recognizing their capacity to revolutionize this sector.

Defining Digital Assets: You will define and comprehend the evolution of digital assets within the agrifood context, appreciating their growing significance.

Digital Assets in Food Supply Chain: You will examine the critical role of digital assets in managing the food supply chain, with a focus on traceability, quality assurance, and operational efficiency.

Knowledge of NFTs and Tokens: You will acquire knowledge about Non-Fungible Tokens (NFTs), Utility Tokens, and Security Tokens, understanding their distinct characteristics and the value they bring.



Choosing the Right Digital Asset: You will learn the importance of selecting the most appropriate digital assets for specific applications within the agrifood sector, enhancing strategic decision-making.

Transparency and Traceability in Agrifood Sector: You will gain insights into how digital assets contribute to unprecedented levels of transparency and traceability in the agrifood sector.

- **Digital Asset Management (DAM) Essentials:** You will grasp the essentials of Digital Asset Management (DAM), understanding its strategic importance and how blockchain technology can be integrated to enhance DAM systems in the agrifood sector.
- **Case Study Analysis and Future Trends:** Through the analysis of various case studies, you will understand practical applications and solutions. This knowledge will empower you to anticipate and adapt to technological, regulatory, and market changes affecting DAM and tokenization in the agrifood sector.

Course Level, Education Level Required, and Prerequisites



Intermediate Level



Minimum education level required: High School Diploma or Equivalent



This course as an advanced level of TrustFood Course 1: Introduction to Blockchain Technology and Digital Assets

Target Audience



Generic, Agrifood Industry Professionals, Technology Professionals and Developers, Business Strategists and Entrepreneurs, Supply Chain and Logistics Managers, Educators and Academics, Students in Related Fields, Technology Consultants and Advisors.

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quizzes. There is one quiz for each lesson. Each quiz has 3-5 questions (i.e. multiple choice, true/false etc).



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

As a trainee, embrace a proactive, self-guided learning style to learn about blockchain in the food supply chain. Focus on understanding lesson objectives, exploring blockchain platforms, and self-motivation through interactive participation and reflection.

Lesson 1: Contextualizing Blockchain in the Agrifood Supply Chain

As you embark on the journey through this lesson on "Contextualizing Blockchain in the Agrifood Supply Chain," begin by immersing yourself in a narrative that showcases the real-world impact of blockchain technology in the agrifood sector. Consider how this technology offers a solution to longstanding issues such as food fraud, supply chain inefficiencies, and lack of transparency. Visual aids or infographics will serve as your guides, illustrating the revolutionary changes blockchain is bringing to the agrifood sector.

Your objective in this lesson is clear: to understand the foundational aspects of blockchain technology and its significance in the agrifood supply chain. Here's how you can navigate through the content effectively:



Blockchain may seem daunting at first but think of it as a ledger that's not just unalterable but also accessible to all parties involved. This transparency ensures that every transaction, every movement of goods, can be traced back to its source. Analogies, such as comparing the blockchain to a digital "bread crumb trail," can make these concepts more relatable.

As you encounter technical terms like "nodes," "blocks," "chains," and "consensus mechanisms," take a moment to relate them to their functions within the blockchain. For instance, nodes can be thought of as the keepers of the ledger, ensuring that every transaction is recorded and validated according to the rules of the network.

After each key concept is introduced, pause to reflect on how this technology could transform the agrifood supply chain. Interactive elements, such as short quizzes, will help reinforce your understanding and gauge your initial knowledge.

Towards the end of the lesson, focus on the practical applications of blockchain and smart contracts in the agrifood sector. How do they contribute to enhancing traceability,

ensuring food safety, and building consumer trust? Reflect on these questions and consider how you might apply this knowledge in real-world scenarios.

If you're learning alongside peers from diverse backgrounds, take this opportunity to analyze different aspects of the lesson together. This collaborative approach can provide a richer learning experience, allowing you to gain multiple perspectives on the subject matter.

By the end of this lesson, you'll have a comprehensive understanding of how blockchain technology is poised to revolutionize the agrifood supply chain, making it more transparent, efficient, and trustworthy. Remember, the knowledge you gain here is not just theoretical; it's a powerful tool that can be applied to address real-world challenges in the agrifood sector.

Lesson 2: Introduction to Digital Assets in the Food Supply Chain

This lesson will help you uncover the transformative power of digital assets, from cryptocurrencies to blockchain-based tokens, in revolutionizing supply chain transparency, efficiency, and food quality assurance.

Begin with context by familiarizing yourself with the concept of digital assets. Understand their evolution within the agrifood sector and their role in addressing traditional supply chain challenges such as traceability and quality assurance.

Dive into the specifics of different digital assets, including cryptocurrencies and tokens. Recognize their characteristics, applications, and how they differ from non-blockchain based digital assets. This will help you appreciate their unique value in the agrifood supply chain.



See digital assets in action through real-world examples. Grasp how digital assets are being implemented in the agrifood sector to ensure food safety, enhance supply chain operations, and build consumer trust.

Engage and reflect by utilizing the interactive quiz to test your understanding of digital assets and their implications for the agrifood sector. Reflect on how these technologies can be applied to solve real-world challenges in food supply chain management.

Apply your knowledge by considering the impact of digital assets on the agrifood supply chain. How can they improve transparency, reduce waste, and ensure quality? Use the knowledge gained to think critically about potential applications in real-world scenarios.

This lesson serves as your guide to the world of digital assets in the agrifood sector, providing you with the foundational knowledge to envision their role in creating a more transparent, efficient, and trustworthy food supply chain.

Lesson 3: Types of digital assets

Lesson 3 explores Non-Fungible Tokens (NFTs), Utility Tokens, and Security Tokens within the context of the agrifood sector. This lesson is your gateway to understanding the unique characteristics and practical applications of these digital assets, emphasizing the strategic selection of the right type for specific needs.

NFTs: Begin by understanding Non-Fungible Tokens which are digital assets renowned for their uniqueness and the ability to verify ownership via blockchain. Delve into how NFTs can offer unparalleled traceability and transparency in the agrifood supply chain, transforming the way we think about digital ownership and authenticity.

Utility Tokens: Transition to exploring Utility Tokens, which are more than mere transactional tools; they embody participation and engagement within a blockchain ecosystem. Reflect on the potential of Utility Tokens to drive engagement and transparency in the agrifood supply chain, enhancing the connection from farm to table.

Security Tokens: Investigate Security Tokens, digital representations of ownership or stakes in real-world assets, regulated and offering fractional ownership. Through examples, understand how Security Tokens can open new investment avenues in the agrifood sector, ensuring transparency and compliance.

Reflect on the potential of digital assets to address challenges within the agrifood sector, leveraging their unique benefits for supply chain efficiency, food quality, and safety.

By the end of this lesson, you will have a nuanced understanding of the digital assets landscape. Making informed choices between NFTs, Utility Tokens, and Security Tokens goes beyond technical considerations; it's about strategic planning with implications for regulatory compliance and the success of agrifood initiatives.



Lesson 4: The Interplay Between Digital Assets and the Agrifood Supply Chain

Dive into the transformative role of digital assets in the agrifood supply chain, exploring how NFTs, Utility Tokens, and Security Tokens redefine efficiencies, transparency, and stakeholder engagement. This lesson guides you through the dynamic interplay of these digital innovations with traditional agrifood processes, illuminating their potential to revolutionize the sector.

Start by understanding the foundational role of digital assets. Grasp how they address challenges within the agrifood supply chain, from enhancing product traceability to ensuring quality assurance and operational efficiencies.

Reflect on their implementation in ensuring food safety, optimizing supply chain operations, and strengthening consumer trust.



Finally, consider the broader impact of digital assets on the agrifood supply chain. How do they contribute to more transparent, efficient, and trustworthy food systems? Your exploration will provide insights into the potential of digital assets to transform agrifood practices, benefiting producers, intermediaries, and consumers alike.

This lesson serves as a comprehensive guide, equipping you with the knowledge to navigate the evolving landscape of digital assets in the agrifood sector. It's an invitation to envision their role in fostering a more sustainable, efficient, and consumer-centric food supply chain.

Lesson 5: The Fundamentals of Digital Asset Management

As you navigate through this lesson on the Fundamentals of Digital Asset Management (DAM) within the agrifood sector, start by understanding the central role of DAM as a tool for efficiently managing digital assets. This exploration will guide you through how DAM not only enhances organizational efficiency but also supports the strategic management of digital content across various platforms and channels.

Begin by reviewing the core objectives of this lesson, aiming to provide you with a thorough comprehension of DAM's functionality, benefits, and its integration within the agrifood sector. Familiarize yourself with the expected learning outcomes, ensuring you grasp how DAM contributes to resource efficiency, improved productivity, and customer engagement.

Examine the key features of DAM systems, emphasizing the importance of seamless integration with existing organizational systems such as CRM, ERP, and SCM tools. This understanding is crucial for leveraging DAM to its full potential, enhancing asset accessibility, and streamlining workflows.



Dive into the transformative role of blockchain technology in DAM, exploring how it can significantly enhance asset management through increased security, transparency, and automation of processes. Engage with content that elaborates on smart contracts, microtransactions, and the overall impact of blockchain on traditional DAM practices.

Reflect on the challenges and considerations associated with implementing blockchain-driven DAM, particularly focusing on GDPR concerns, the energy impact of blockchain, and the initial investment required. These insights will prepare you for potential hurdles and enable informed decision-making regarding DAM integration.

By the end of this lesson, aim to consolidate your learning, reflecting on how DAM, powered by blockchain technology and advancements like NFTs and tokenization, can revolutionize digital asset management. This knowledge will empower you to envision and implement effective DAM strategies within the agrifood supply chain, driving innovation and efficiency.

Lesson 6: Potential benefits and challenges of digital asset management and tokenization in the agri-food industry

Lesson 6 is your roadmap to comprehending the potential benefits and addressing the challenges of integrating DAM and tokenization in the agrifood sector. It will help you understand how these technologies are not just trends but essential tools for revolutionizing food supply chains.

Begin by exploring the concept of Digital Asset Management (DAM). It's a centralized system that enables organizations to store, retrieve, and distribute digital assets securely and efficiently. Reflect on how DAM can streamline operations in the agrifood sector, from reducing redundancy to enhancing brand consistency and boosting productivity through quick asset access.

Consider the transformative role of tokenization in the agrifood supply chain. Tokenization can enhance security, increase liquidity, and ensure transparency and traceability. These benefits are crucial for modern agrifood systems, where trust and efficiency are paramount.



Acknowledge the challenges that come with implementing these technologies. From scalability and privacy concerns to high implementation costs and the need for global regulation, it's important to weigh the potential obstacles alongside the benefits.

Reflect on how DAM and tokenization could be applied in real-world agrifood scenarios to solve existing challenges, enhance supply chain management, and improve consumer engagement.

As you conclude, ponder the advanced techniques introduced in this lesson. How do DAM and tokenization build upon the foundational knowledge of digital assets you've gained? Consider the strategic implications for the agrifood industry and envision how you might apply these insights to foster innovation and sustainability in food supply chains.

This lesson aims not only to inform but also to inspire you to think critically about the application of DAM and tokenization in the agrifood sector. By understanding the benefits and navigating the challenges, you're equipped to contribute to the evolution of more efficient, transparent, and trustworthy food systems.

Lesson 7: Exploring Real-world Implementations



This lesson sheds light on how digital innovations are transforming the supply chain, offering unprecedented transparency throughout the entire product journey. You will explore several case studies that highlight the effectiveness of these technologies in real-world scenarios.

Begin your exploration with "Trace My Egg," where blockchain provides a transparent journey of eggs throughout the entire product journey. Reflect on how this level of transparency not only builds trust with consumers but also encourages accountability within the supply chain.

Delve into how TE-FOOD utilizes blockchain to offer comprehensive farm-to-table traceability. This case study exemplifies how blockchain can be applied across various stages of the food supply chain, benefiting everyone from farmers to consumers by enhancing operational efficiency and ensuring food safety.

Investigate GreenToken's approach to providing full transparency in supply chains. This example emphasizes the importance of tracking and verifying the "suppliers of suppliers," showcasing blockchain's potential to monitor Environmental, Social, and Governance (ESG) factors effectively.

Learn about AgroToken's pioneering effort in grain tokenization. This case illustrates the innovative use of blockchain to create new avenues for investment and liquidity in the agrifood sector, transforming how agricultural commodities are traded and financed.

Engage with AgriLedger's mission to bridge gaps within the global agriculture market. This case study offers insights into how blockchain-based solutions can streamline carbon credit systems, promote sustainability, and drive economic growth by providing end-to-end food tracking and dynamic analytics.

Each case study in this lesson serves as a testament to the innovative applications of blockchain in the agrifood sector, demonstrating the technology's potential to solve longstanding issues related to traceability, transparency, and efficiency. By the end of this lesson, you will have a deeper understanding of how blockchain technology is being practically applied to revolutionize the agrifood supply chain, offering lessons that could inspire similar implementations in other sectors.

This lesson aims to bridge the gap between theoretical knowledge and practical application, equipping you with a deeper understanding of the transformative potential of blockchain and digital assets in the agrifood sector. It's an invitation to envision innovative solutions that harness the power of these technologies for a more sustainable and transparent food supply chain.

Lesson 8: Future trends and advancements in digital asset management and tokenization



This final lesson equips you to anticipate and navigate the evolving landscape of digital assets and their management, setting the stage for innovation in the digital era.

Begin by exploring the expected advancements in DAM. Reflect on how these developments could streamline operations across various sectors, especially agri-food,

enhancing efficiency and regulatory compliance. Consider the role of DAM in managing digital assets more effectively, from storage and retrieval to distribution.

Dive into how tokenization is set to reshape the digital world. Tokenization's ability to secure and liquify assets presents new opportunities for investment and ownership. Ponder on its potential to democratize access to investments and transform asset management with enhanced security and transparency.

Reflect on the synergy between DAM systems and blockchain technology. How can integrating blockchain with DAM systems revolutionize asset management by ensuring security, transparency, and trust? Think about the practical applications of this integration in the agri-food sector, from farm management to supply chain transparency.

Examine the predicted growth of the tokenization market and its impact across industries. How will the expansion of tokenized assets influence investment strategies, consumer engagement, and asset liquidity? Delve into case studies and market data to grasp the scale of this growth and its potential benefits.

Consider the technological, regulatory, and market changes that are on the horizon. How can you stay ahead of these trends to leverage DAM and tokenization effectively? Engage with the content to understand the implications of these advancements and how they can be harnessed to drive innovation and efficiency in your field.

Navigate the evolving regulatory landscape surrounding tokenization. Understand the importance of international collaboration and the challenges of maintaining trust and security in tokenized transactions. Reflect on how regulatory developments could influence the adoption and integration of tokenization in the agri-food sector and beyond.

This lesson is a journey through the forthcoming changes in DAM and tokenization, offering a glimpse into their profound impact on industries worldwide. By understanding these trends and their implications, you are better prepared to adapt and innovate, ensuring you're at the forefront of the digital transformation wave.

Relevant Readings



- Tarhini, Mahmoud. "Application of asset tokenization, smart contracts and decentralized finance in agriculture." *Revista de Studii Financiare* 6.10 (2021): 152-163.
- Wang, Gang, and Mark Nixon. "SoK: Tokenization on blockchain." *Proceedings of the 14th IEEE/ACM International Conference on Utility and Cloud Computing Companion*. 2021.
- "Token Economy: How Blockchain and Smart Contracts Revolutionize the Economy" by Shermin Vasumitr: This book explores the concept of tokenization and its impact on various industries, including the food supply chain. It covers

topics such as token standards, decentralized finance, and the potential of blockchain-based token economies.

- "Blockchain: Blueprint for a New Economy" by Melanie Swan: This comprehensive book covers various aspects of blockchain technology, including tokenization and its applications across different industries. It provides insights into the potential benefits and challenges of implementing tokenization in real-world scenarios.

Additional readings can be found within each Lesson.

Course Provider / Contact Details



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Course #3: MiCA Regulation and CBDC

Content and Duration

The lessons provided with the course “MiCA Regulation and CBDC” are as follows:

Lesson 1: Introduction to MiCA: Its origins, principles, and objectives

Lesson 2: Detailed analysis of MiCA regulation: What does it mean for businesses and individuals dealing with crypto-assets.



Lesson 3: Introduction to Central Bank Digital Currencies (CBDCs): The case for CBDCs, how they function, and their role in the global economy.

Lesson 4: The impact of MiCA regulations and CBDCs on cryptoassets within the food supply chain

Lesson 5: Case Studies of CBDCs



Approx. 4 hours to complete (including study time).

Objective

The course on MiCA Regulation and CBDCs is designed to provide a comprehensive understanding of the intricate landscape of crypto-asset regulation and the pioneering role of Central Bank Digital Currencies in the financial ecosystem. Participants will explore the Markets in Crypto-Assets (MiCA) regulation, uncovering its origins, objectives, and the regulatory framework established to safeguard and stimulate innovation in the digital asset markets in Europe.

A significant portion of the course is dedicated to unraveling the complexities of CBDCs, from their conceptualization to their potential to redefine monetary transactions, enhance financial inclusivity, and streamline global economic operations. The curriculum delves into the operational mechanisms of CBDCs, highlighting their advantages, and providing a critical analysis of their impact on global financial systems.

Special attention is given to the interconnection between MiCA, CBDCs, and the food supply chain. The course examines how these regulatory and technological advancements can transform transactions, improve transparency, and foster sustainability within the agrifood sector. Through case studies and real-world examples, participants will gain insights into the challenges and opportunities presented by the integration of blockchain technology, digital payments, and crypto regulations in the food supply chain.

Concluding with a forward-looking perspective, the course aims to equip learners with the knowledge and skills to navigate the future landscape of digital finance, anticipate emerging trends, and apply innovative solutions within their own sectors. By bridging regulatory insights with practical applications, this course empowers participants to leverage the potential of MiCA and CBDCs in fostering a more efficient, transparent, and resilient financial system.

Learning Outcomes

As a participant in this course you will be engaged in a comprehensive and effective learning journey structured around the following outcomes:

- **Grasp the Fundamentals of MiCA Regulation:** Participants will gain a comprehensive understanding of the Markets in Crypto-Assets (MiCA) regulation, including its origins, objectives, and the regulatory framework it establishes within the European Union. This includes a deep dive into how MiCA seeks to balance innovation with consumer protection, market integrity, and financial stability.
- **Understand the Role and Impact of CBDCs:** You will explore the concept of Central Bank Digital Currencies (CBDCs), understanding their design, operational mechanisms, and potential to transform the financial system. This includes how CBDCs differ from traditional and other digital currencies, and their implications for monetary policy, financial inclusion, and cross-border transactions.
- **Comprehend MiCA and CBDCs in the Food Supply Chain:** This course will enable you to understand the intersection of MiCA regulation, CBDCs, and the agrifood sector. Learn how these regulatory and technological advancements can influence



transparency, efficiency, and innovation within the food supply chain, particularly through the tokenization of food products and digital payments.

- **Analyze the Impact of MiCA on Crypto Assets and Services:** Gain insights into the specific provisions of MiCA concerning various crypto assets, including stablecoins and digital tokens. Understand the classification of crypto assets under MiCA, the requirements for issuers and service providers, and the legislation's impact on the broader crypto asset market in the EU.
- **Evaluate the Global Landscape of CBDCs:** Delve into the global initiatives and real-world case studies of CBDC implementations. Assess the motivations behind different countries' exploration and adoption of CBDCs, their approaches to design and deployment, and the challenges and successes encountered.
- **Predict Future Developments and Trends:** By the end of the course, participants will be equipped to anticipate future trends in the regulation of crypto assets and the evolution of CBDCs. Understand how ongoing developments in these areas might further influence the financial sector, including the agrifood supply chain, and prepare to innovate and adapt to these changes.

Course Level, Education Level Required, and Prerequisites



Advanced Level, Professional Development



Bachelor's Degree



Consider this course as an advanced level of "Course 1 - Introduction to Blockchain Technology and Digital Assets" & "Course 2 - Exploring Digital Asset Management and Tokenization".

Target Audience



Financial Professionals, Regulatory and Compliance Officers, Blockchain and FinTech Entrepreneurs, Legal Professionals, Academics and Researchers, Students in Finance and Technology, Supply Chain Professionals, Tech Enthusiasts.

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quizzes. There is one quiz for each lesson. Each quiz has 3-5 questions (i.e. multiple choice, true/false etc).



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

Adopt a proactive, self-guided learning style to learn about MiCA regulations in the blockchain and food supply chain. Focus on understanding course objectives, relating personal experiences to regulatory content, exploring blockchain platforms, and actively participating in exercises.

Lesson 1: Introduction to MiCA: Its origins, principles, and objectives.

Lesson 1 explores the Markets in Crypto-Assets Regulation (MiCA), providing an understanding of its origins, core principles, and overarching goals. This foundational session is designed to equip you with a solid knowledge base about MiCA, emphasizing its critical role in shaping the regulatory landscape for crypto-assets within the European Union.

You will begin with a historical overview, tracing MiCA's development from the early recognition of the need for regulation in the crypto-space to its formal approval. This part of the lesson aims to provide you with a clear picture of the regulatory challenges and opportunities that prompted the European Union to introduce MiCA. By understanding the backdrop against which MiCA was proposed, you can appreciate the regulation's significance and the objectives it seeks to achieve.



Diving deeper, you will explore the key principles underlying MiCA. This section aims to illuminate how the regulation balances the promotion of innovation with the imperative of ensuring user and investor safety. You will learn about MiCA's harmonizing effect, intended to unify the regulatory framework across EU member states by replacing a patchwork of national regulations with a comprehensive, EU-wide approach.

As you progress, you will closely examine the specific provisions of MiCA, understanding its implications for various stakeholders in the crypto-asset ecosystem, including service providers, token issuers, and investors. This part of the lesson is crucial for grasping how MiCA addresses issues such as market integrity, consumer protection, and financial stability, setting out clear rules for crypto-assets that were previously outside the scope of existing financial legislation.

Finally, you will delve into the future implications of MiCA for the crypto-asset market within the EU and possibly on a global scale. This segment encourages you to consider how

MiCA positions the EU as a frontrunner in crypto regulation and to reflect on the potential ripple effects this may have on international regulatory practices.

Throughout this lesson, you are encouraged to analyze and take notes on how MiCA might influence the broader landscape of digital finance and what this means for the future of innovation and regulation in the crypto space. For further exploration, you can check online sources and regulatory updates to stay informed about the latest developments related to MiCA and its implementation across the EU.

Lesson 2: Detailed analysis of MiCA regulation: What does it mean for businesses and individuals dealing with crypto-assets

Begin Lesson 2 by delving into the intricacies of the Markets in Crypto-Assets (MiCA) regulation, focusing on its comprehensive approach to enhancing transparency, investor protection, and innovation within the crypto space. This session aims to equip you with a thorough understanding of MiCA's foundational principles, exploring how this landmark legislation influences businesses and individuals involved in crypto-assets across the European Union.

Start with a deep dive into the origins and objectives of MiCA, understanding its role in establishing a harmonized regulatory framework for crypto-assets. Reflect on the conditions that necessitated the creation of MiCA, from the rapid evolution of digital assets to the emerging challenges in ensuring market integrity and consumer protection.

Explore MiCA's broad scope, covering key aspects such as stablecoin issuance, crypto asset service providers, and the classification of crypto-assets. This will help you grasp the regulation's comprehensive coverage and its implications for the crypto market.



Shift your focus to the detailed provisions of MiCA, examining its requirements for crypto-asset issuers, including the necessity of a white paper and the operational standards for crypto-asset service providers. Analyze the classification criteria that MiCA establishes for different types of crypto-assets and the rationale behind the inclusion or exclusion of specific assets like NFTs and DeFi projects.

Consider the practical implications of MiCA for various stakeholders in the crypto ecosystem. Reflect on how MiCA aims to balance innovation with consumer protection, ensuring a safer and more transparent crypto market. Discuss the potential challenges and opportunities that MiCA presents for businesses, investors, and regulators.

You will also gain insights into how MiCA is set to transform the regulatory landscape for crypto-assets in the EU. Evaluate the strategic considerations for businesses navigating the new regulatory environment and the broader impact of MiCA on the global crypto market.

Conclude Lesson 2 by synthesizing your understanding of MiCA's role in shaping the future of crypto regulation. Reflect on how this comprehensive framework could serve as a model

for other jurisdictions, fostering a safer, more innovative, and transparent digital asset ecosystem globally.

Lesson 3: Introduction to Central Bank Digital Currencies (CBDCs): The case for CBDCs, how they function, and their role in the global economy

Lesson 3 explores the innovative world of Central Bank Digital Currencies (CBDCs), a pioneering step towards the digitization of national currencies. This session aims to unfold the essence of CBDCs, their operational frameworks, and the significant impact they are poised to have on the global financial ecosystem.

Start your exploration by understanding the fundamental concept of CBDCs. Discover how these digital currencies, issued by central banks, differentiate from traditional money and decentralized cryptocurrencies through their unique attributes of security, efficiency, and central oversight.

Dive deeper into the operational mechanics of CBDCs, where you'll learn about the different types of CBDCs—wholesale and retail—and their respective roles within the financial system. This section will help you understand the technology behind CBDCs, such as blockchain, and how it fosters transparency and security in transactions.



Shift your focus to the potential benefits and challenges of CBDCs. Evaluate the dual aspects of enhancing transaction efficiency and promoting financial inclusion, alongside considering the cybersecurity risks and privacy concerns associated with their adoption.

Engage with the global perspective by analyzing the varying approaches to CBDC implementation across countries. Through case studies, you'll examine the strategic motivations behind CBDC initiatives, from bolstering monetary policy to combating financial crimes.

Reflect on the implications of CBDCs for consumers and businesses alike. Understand how CBDCs could transform the payment landscape, offering faster, cheaper, and more accessible financial services, and what this means for the future of banking and commerce.

By navigating lesson 3, you will be equipped with a well-rounded understanding of Central Bank Digital Currencies, their significance in today's digital age, and how they could shape the future of economic transactions globally.

Lesson 4: The impact of MiCA regulations and CBDCs on cryptoassets within the food supply chain



Lesson 4 explores the transformative impact of the Markets in Crypto-Assets (MiCA) regulations and Central Bank Digital Currencies (CBDCs) on the food supply chain. This session is tailored to guide you through the intricate ways in which blockchain technology,

particularly through tokenization and cryptocurrency payments, is reshaping the agrifood sector.

Begin by understanding the foundation of MiCA regulations and CBDCs, focusing on their objectives and how they aim to provide a regulatory framework for crypto-assets and digital currencies. This foundational knowledge will set the stage for a deeper dive into the specifics of these regulations and their implications for the agrifood sector.

Afterwards, explore how converting rights to food products into digital tokens can revolutionize the traceability and authenticity of food items. This segment will illuminate the role of blockchain in ensuring the genuineness and origin of food products, bolstered by the trust and security offered by MiCA regulations.

Examine cryptocurrency payments within the agrifood supply chain, contrasting traditional payment methods with the efficiency and cost benefits of crypto transactions. This comparison will reveal the potential of cryptocurrencies to streamline operations, reduce transaction fees, and foster faster, more direct international trade.

Engage with the potential challenges and opportunities presented by the integration of MiCA regulations, CBDCs, and blockchain technology in the food supply chain. You will critically assess both the benefits, such as increased operational efficiency and innovation, and the hurdles, including regulatory compliance and adoption barriers.

Envision future trends by forecasting how the continued evolution of blockchain technology, alongside the development and implementation of MiCA regulations and CBDCs, might shape the future of the food supply chain. This forward-looking perspective will encourage you to think about the potential for these technologies to drive further innovation and sustainability in the agrifood sector.

By completing Lesson 4, you will gain a comprehensive understanding of the implications MiCA regulations and CBDCs on the tokenization of food products and the adoption of cryptocurrencies for transactions within this chain. This knowledge will equip you with the insights needed to navigate the evolving landscape of agrifood technology, preparing you to leverage these innovations in your own work or studies within the sector.

Lesson 5: Case Studies of CBDCs



Lesson 5 delves into the transformative world of Central Bank Digital Currencies (CBDCs), showcasing their pioneering influence on the global financial landscape. This session is designed to navigate you through various real-world case studies, highlighting the role CBDCs play in modernizing economies and reshaping monetary policies.

Start by bringing to mind the essence of digital currencies issued by central banks and their potential to streamline monetary transactions, enhance financial inclusion, and secure financial systems against emerging digital threats.

Explore the case studies from around the globe, including the European Digital Euro, China's Digital Yuan, and potential initiatives like the Digital Dollar in the United States and the Digital Pound in the United Kingdom. These real-world applications provide a comprehensive view of how different countries are approaching the development and implementation of CBDCs.

Reflect on the economic implications and the technological, regulatory, and societal challenges these digital currencies face. Consider the strategic importance of CBDCs in maintaining a country's financial sovereignty and their impact on the international financial system.

Each case study presents innovation and challenges. Learn about the operational mechanics of CBDCs, their role in enhancing cross-border transactions, and the potential they hold for reshaping global trade and finance.

Engage with the broader questions of privacy, cybersecurity, and the future of money. Understand how CBDCs can foster a more inclusive financial ecosystem while pondering the balance between innovation and regulation.

Conclude the lesson by considering the future trajectory of CBDCs. Reflect on how these digital currencies could redefine the relationship between citizens, financial institutions, and governments. Anticipate how ongoing developments and pilot projects could inform the next steps in the adoption and impact of CBDCs worldwide.

Lesson 5 equips you with a profound understanding of CBDCs' role in the future of global finance, preparing you to navigate and contribute to the ongoing dialogue surrounding digital currencies and their place in our digital economy.

Relevant Readings



- Central Banks and Digital Currencies by Professor George Giaglis: <https://www.youtube.com/watch?v=mitdNXqza98> {Accessed on 19/10/2023}
- Schickler, J. (2022), Europe's CBDC Designers Wrestle with Privacy Issues', CoinDesk. Available at: <https://www.coindesk.com/policy/2022/04/04/europes-cbdc-designers-wrestle-with-privacy-issues/> {Accessed on 19/10/2023}
- Mandeng, O.J., (2023). 'CBDCs are set to transform how payments are made: Development of the digital currencies is gathering pace around the world'. Financial Times. Available at: <https://www.ft.com/content/c5042679-d4d5-4fcc-9e01-7781c339a7f7> (Accessed: 24/10/2023)
- MICA: EU's Comprehensive New Crypto Regulation Explained. CoinDesk. Available at: <https://www.coindesk.com/learn/mica-eus-comprehensive-new-crypto-regulation-explained/> [Accessed 17 October 2023].

- Garbade, M., 2021. One currency to rule them all: Facebook's Diem has global ambitions. Cointelegraph. Available at: <https://cointelegraph.com/news/one-currency-to-rule-them-all-facebook-s-diem-has-global-ambitions> [Accessed 17 October 2023].
- Jenkinson, G. (2023), 'CBDC frameworks must guard user privacy, monetary freedom of choice: BIS Chief', CoinTelegraph. Available at: <https://cointelegraph.com/news/cbdc-frameworks-must-guard-user-privacy-monetary-freedom-of-choice-bis-chief> {Accessed on 19/10/2023}
- US Federal Reserve (2023), FAQ on CBDCs. Available at: <https://www.federalreserve.gov/cbdc-faqs.htm> {Accessed on 24/10/2023}

Additional readings can be found within each Lesson.

Course Provider/Contact Details



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Course #4: Financial Technology (FinTech) with Example Applications in Food Supply Chain

Content and Duration

The lessons provided with the course “Financial Technology (FinTech) with Example Applications in Food Supply Chain” are as follows:

Lesson 1: Introduction to FinTech: Understanding its components and key technologies.

Lesson 2: The impact of FinTech on various industries, with a focus on the agrifood sector.

Lesson 3: The Interplay Between FinTech and the Food Supply Chain

Lesson 4: Key FinTech applications in the food supply chain

Lesson 5: Exploring Real-world Implementations

Lesson 6: Future Trends



Approx. 4 hours to complete (including study time).

Objective

The objective of Course #4: Financial Technology (FinTech) with Example Applications in the Food Supply Chain is to provide a thorough understanding of FinTech, its core components, and its transformative applications in various sectors, particularly focusing on the agrifood sector. The course aims to explore the influence of FinTech innovations on the food supply chain, highlighting how technologies such as blockchain, AI, data analytics, digital payments, and smart contracts enhance efficiency, traceability, and transaction management. Participants will engage in assessing real-world case studies to understand the practical implementation of these technologies in the agrifood sector. Furthermore, the course will investigate the future trends in FinTech, providing insights into upcoming developments that could significantly impact the agrifood industry.

Learning Outcomes

As a participant in this course on blockchain technology, smart contracts, and digital assets in the agrifood sector, you will be engaged in a comprehensive and effective learning journey structured around the following outcomes:

- Understand the Foundational Concepts and Terminology of FinTech: Gain an understanding of basic FinTech concepts, terminology, and integration of technology in financial services.
- Understand Transparency and Traceability in Agrifood: Comprehend how FinTech enhances transparency and traceability in the agrifood supply chain, focusing on the role of digital assets.
- Recognize the Importance of Cost Efficiency: Learn about cost efficiency's significance in the agrifood supply chain and how digital assets contribute to expense reduction.
- Identify Challenges and Opportunities in FinTech: Discuss general and sector-specific challenges in FinTech, alongside opportunities and solutions it presents.
- Role of FinTech in Agrifood Sector: Comprehend how FinTech enhances financial transactions, data management, and traceability within the supply chain.
- Identify Key FinTech Applications in Agrifood: Explain different FinTech applications crucial in the agrifood sector for financial inclusion and business innovation.
- Understand the Benefits of Digital Payments and AI: Recognize how digital payments and AI improve efficiency, forecasting, safety, and sustainability in agrifood.



- Understand FinTech Evolution: Discuss the evolution of FinTech, focusing on emerging trends in the agrifood sector and understand how innovative FinTech tools could reshape the financial landscape of the agrifood sector.

Course Level, Education Level Required, and Prerequisites



Intermediate Level, Professional Development



Minimum education level required: Bachelor's Degree



Consider this course as an advanced level of "Course 1 - Introduction to Blockchain Technology and Digital Assets".

Information provided in this course could be considered as an introduction to some concepts that are presented in Courses #6, #10, #12, #19

Target Audience



Professionals in the Agrifood Industry, FinTech Entrepreneurs and Innovators, Supply Chain Managers, Financial and Banking Professionals, Academics and Researchers, Students in Related Fields

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quizzes. There is one quiz for each lesson. Each quiz has 3-5 questions (i.e. multiple choice, true/false etc.).



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

Adopt a proactive, self-guided approach to effectively follow the FinTech course focused on blockchain applications in the food supply chain. Key areas include understanding learning objectives, linking personal experiences to blockchain and FinTech, exploring blockchain platforms and actively participating in course activities.

Lesson 1: Introduction to FinTech: Understanding its components and key technologies.

In Lesson 1, we delve into the fundamental principles of Financial Technology (FinTech), examining its core components and the innovative technologies that are shaping the financial sector. This session is designed to provide a comprehensive introduction to FinTech, highlighting its transformative impact on financial services, the advantages and challenges it presents, and the key technologies driving its evolution.

Start with an in-depth exploration of FinTech's basic concepts and terminology. Gain insights into how FinTech integrates cutting-edge technologies into financial services, improving their delivery and use across the financial landscape.

Investigate the underlying technologies that power FinTech, including Blockchain, Artificial Intelligence (AI), Machine Learning (ML), among others. Understand how these technologies enable the development of new financial solutions and services, pushing the boundaries of innovation in the sector.



Examine the numerous benefits FinTech brings to the table, such as enhanced accessibility to financial services, increased cost efficiency, and improved security measures. Reflect on how FinTech fosters innovation, offering a diverse range of financial products tailored to meet the needs of a broad audience.

Furthermore consider the various challenges and risks associated with FinTech, including operational risks, digital dependency, privacy issues, and the potential for increasing financial inequalities. Understanding these challenges is crucial for comprehending the complexities of FinTech and its practical applications.

This lesson aims to equip you with a solid foundation in FinTech, preparing you for a deeper exploration of its applications within the agrifood sector in subsequent lessons. Upon completion, you will have a thorough understanding of the principles underlying FinTech, its impact on the financial services industry, and the critical considerations for its implementation.

Lesson 2: The impact of FinTech on various industries, with a focus on the agrifood sector.

Begin Lesson 2 by focusing on understanding the significant impact of Financial Technology (FinTech) across various industries, with a special emphasis on the agrifood sector. This lesson aims to reveal how innovations like blockchain, AI, and machine learning are reshaping financial transactions, enhancing supply chain transparency, and improving operational efficiencies.



Start by exploring the foundational concepts of FinTech. Delve into its core components, understanding how it merges technology with financial services to innovate and streamline transactions.

Examine the key technologies underpinning FinTech. Gain insights into how Distributed Ledger Technology (DLT), Artificial Intelligence (AI), Machine Learning (ML), and other digital advancements are driving the FinTech revolution.

Shift your focus to how FinTech applications are uniquely positioned to transform the agrifood supply chain. Understand the role of digital assets in enhancing the transparency and traceability of food products from farm to table.

Reflect on the importance of cost efficiency and how FinTech facilitates the reduction of operational expenses, contributing to more sustainable agricultural practices.

Through the examination of specific FinTech solutions, comprehend how these technologies address challenges within the agrifood sector, offering innovative solutions for better financial management and supply chain operations.

Identify the potential challenges and opportunities presented by FinTech in the agrifood sector. Assess how these solutions can lead to overcoming hurdles, promoting efficiency, and fostering innovation.

Conclude the lesson by synthesizing your understanding of FinTech's transformative effects across industries, with a focus on its applications within the agrifood sector. Reflect on the broader implications of these innovations for enhancing transparency, efficiency, and stakeholder engagement in the agrifood supply chain.

Prepare to apply the knowledge gained from exploring FinTech's role in the agrifood sector to real-world scenarios, envisioning how these technologies can be leveraged to address specific challenges and capitalize on new opportunities within the industry.

Lesson 3: The Interplay Between FinTech and the Food Supply Chain

Lesson 3 delves into the transformative interplay between Financial Technology (FinTech) and the agrifood supply chain. This session is designed to guide you through how FinTech innovations streamline financial transactions, enhance data management, and ensure the traceability of products within the agrifood sector.

Begin with a comprehensive look at FinTech's crucial role in the agrifood supply chain. Understand how technologies like blockchain, and smart contracts are revolutionizing financial operations and data handling from farm to table.



Explore core concepts by diving into the specifics of Supply Chain Finance (SCF) and AgriFinTech. Learn how these FinTech solutions are designed to improve cash flow management and operational efficiency, contributing to the sustainability of agricultural practices.

Focus on technological applications by shifting your attention to examining how FinTech facilitates smoother transactions within the agrifood sector. Analyze the impact of digital

payment systems, blockchain for traceability, and the automation brought by smart contracts.

Consider financial inclusion by reflecting on the role of FinTech in extending financial services to underserved groups within the agrifood industry. Acknowledge how these innovations are empowering small-scale farmers and enhancing market access.

Engage with real-world examples by applying your knowledge through case studies that showcase FinTech's application in real agrifood scenarios. Understand the practical benefits and challenges of implementing these technologies in enhancing food safety, quality, and compliance.

Actionable insights are prepared to transfer the insights gained into actionable strategies. Envision applying FinTech solutions to address challenges within the agrifood sector, leveraging technology to drive innovation and sustainability.

Through this guided exploration, Lesson 3 equips you with a deep understanding of FinTech's role in transforming the agrifood supply chain, preparing you to navigate and contribute to the evolving landscape of agricultural technology.

Lesson 4: Key FinTech applications in the food supply chain

This lesson is dedicated to uncovering the potential of technologies such as blockchain, artificial intelligence (AI), and digital payment systems in revolutionizing the way we track, manage, and finance the journey of food from farm to consumer.

Begin by grasping the essence of FinTech in the agrifood context. Understand the convergence of finance and technology, and how this synergy is crafting more efficient, transparent, and resilient food supply chains.

Explore the underpinning technologies driving the FinTech revolution: Dive into Distributed Ledger Technology (DLT), AI, Machine Learning (ML), and their pivotal roles in enhancing data management, transaction security, and predictive analytics in the agrifood sector.

Focus on the application of FinTech within the agrifood supply chain. Discover how digital assets, through blockchain, enhance traceability from the producer to the end consumer, ensuring food safety and sustainability.

Reflect on the significance of cost efficiency, facilitated by FinTech solutions. Learn how leveraging digital technologies can streamline operations, reduce waste, and thus contribute to more economically sustainable agricultural practices.

Examine specific FinTech solutions in action within the agrifood sector. Gain insights into real-world applications that address critical challenges, from financial inclusion for smallholder farmers to creating more responsive supply chains.



Assess the challenges and opportunities presented by FinTech in the agrifood ecosystem. Critically analyze how these innovative solutions can help overcome existing barriers and unlock new avenues for growth and efficiency.

Embarking on Lesson 4, you are stepping into a critical examination of how financial technology reshapes the very fabric of agrifood systems, promising a future where technology and sustainability converge for the betterment of the industry and its consumers.

Lesson 5: Exploring Real-world Implementations

Lesson 5 focuses on unveiling real-world implementations of FinTech solutions within the agrifood sector. This lesson will help guide you through innovative platforms like IBM Food Trust, Beefledger, and ProducePay, showcasing their transformative impact on the agriculture industry.

Begin with a comprehensive introduction to FinTech's role in revolutionizing agricultural processes. Understand how these technologies are not just reshaping financial transactions but are also enhancing transparency, efficiency, and trust across the supply chain.

Dive into case studies to explore the practical applications of these FinTech solutions. Examine how IBM Food Trust utilizes blockchain technology to create a transparent and accountable food supply chain, connecting all stakeholders from producers to consumers.

Consider the challenges and added value brought by these platforms. Reflect on the hurdles such as digital infrastructure needs, security concerns, and the importance of sustainable practices, and how these platforms address them.



Explore broader challenges within the FinTech and crowdfunding contexts. Delve into issues related to digital infrastructure, security, and the need for alignment with Sustainable Development Goals. Understand how overcoming these challenges is critical for the success of FinTech applications in agriculture.

Through more detailed case studies, gain insights into how FinTech solutions are addressing specific challenges in agriculture. Learn about Beefledger's approach to enhancing supply chain transparency and ProducePay's role in connecting farmers with buyers, providing financial solutions, and ensuring trade protection.

Conclude the lesson by reflecting on the broader implications of FinTech innovations for the agrifood sector, including how they contribute to addressing critical issues such as food safety, fraud, and market access.

Prepare to apply the insights gained from exploring real-world FinTech implementations in agriculture. Envision how these technologies can be leveraged to tackle specific

challenges within the sector, fostering innovation, efficiency, and sustainability in agricultural practices.

Overall, Lesson 5 equips you with a deep understanding of FinTech's role in transforming the agricultural sector, preparing you to engage with and contribute to the evolving landscape of agricultural technology.

Lesson 6: Future Trends

Lesson 6 explores the horizon of FinTech innovations that are set to redefine the agrifood sector. This lesson navigates through emerging FinTech trends, focusing on how blockchain, artificial intelligence (AI), and other disruptive technologies are poised to transform agrifood finance, offering a glimpse into the future of agricultural practices.

Kick off with a dive into the latest FinTech trends, understanding their potential to revolutionize the financial landscape of the agrifood sector. Discover how these innovations are not just reshaping the way financial transactions are conducted but also how they are integral to enhancing supply chain management, improving transparency, and fostering efficiency within the agricultural industry.

Shift your focus to the role of disruptive technologies such as blockchain in agrifood. Unpack how these advancements promise to bring about significant changes, streamlining operations, and creating new business models that could potentially lead to more sustainable and resilient agricultural ecosystems.



The lesson emphasizes the importance of developing strategic foresight to effectively navigate the evolving FinTech landscape. Engage with the concept of digital transformation in the agrifood sector, recognizing the challenges and opportunities that lie ahead. This will help you to anticipate future developments and prepare strategies that align with these technological advancements, ensuring that the agrifood sector remains competitive and innovative.

Explore the impact of technologies like Banking as a Service (BaaS), digital currencies, and decentralized finance (DeFi) on agrifood. Understand how these tools can offer customized financial solutions, enhance liquidity, and provide more inclusive financial services to the unbanked or underserved populations in the agricultural community.

Prepare to leverage the insights gained from this exploration of future FinTech trends in agrifood. Envision practical applications of these technologies in addressing specific challenges within the sector, and anticipate how you can contribute to the digital transformation of agriculture, making it more efficient, transparent, and sustainable.

Relevant Readings

- Kagan, J. (2023) Financial Technology (Fintech): Its uses and impact on our lives, Investopedia. Available at: <https://www.investopedia.com/terms/f/fintech.asp>
- Neil C, (2021). How Fintech is driving the new age of retail agility, FinTech Futures. Available at: <https://www.fintechfutures.com/2021/12/how-fintech-is-driving-the-new-age-of-retail-agility/>
- Phukan, Dr.P.K. (2023) Financial Technology (FinTech) and Sustainability, LinkedIn. Available at: <https://www.linkedin.com/pulse/financial-technology-fintech-sustainability-dr-pranjal-kumar-phukan/>
- Phukan, Dr.P.K. (2023) Financial Technology (FinTech) and Sustainability, LinkedIn. Available at: <https://www.linkedin.com/pulse/financial-technology-fintech-sustainability-dr-pranjal-kumar-phukan/>
- Pothula, S.R., 2023. Review and analysis of FinTech approaches for smart agriculture in one place. Journal of Agriculture, Science and Technology, 22(1), pp.60-69.
- Anshari, M., Almunawar, M.N., Masri, M. and Hamdan, M., 2019. Digital marketplace and FinTech to support agriculture sustainability. Energy Procedia, 156, pp.234-238.



Additional readings can be found within each Lesson's presentation.

Course Provider/Contact Details



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Course #5: Tokenization with Example Applications in Food Supply Chain

Content and Duration

The lessons provided with the course “Tokenization with Example Applications in Food Supply Chain” are as follows:

Lesson 1: Introduction to Tokenization

Lesson 2: The role of blockchain in tokenization



Lesson 3: Different types of tokens

Lesson 4: Tokenization in Food Supply Chain

Lesson 5: Exploring Real-world Implementations

Lesson 6: Future Trends



Approx. 4 hours to complete (including study time).

Objective

The objective of Course 5: “Tokenization with Example Applications in Food Supply Chain” is to provide a understanding of tokenization, its applications and its role in various industries, with a special focus on the food supply chain. The course is designed to guide learners through the fundamental concepts of tokenization, explaining how it works, and the benefits and challenges associated with it. It describes the integral role of blockchain technology in enabling secure and transparent tokenization and explores different types of tokens, including governance, utility, security, platform, and non-fungible tokens (NFTs). Additionally, the course highlights how tokenization can be applied specifically in the food supply chain, enhancing traceability, verifying food safety, and improving transparency and accountability in sourcing and delivery. Learners will also have the opportunity to examine real-world implementations of tokenization and look ahead to future trends, gaining insights into how this technology could continue to evolve and impact the food supply chain.

Learning Outcomes

As a participant in this course, you will be engaged in a comprehensive and effective learning journey structured around the following outcomes:

- **Understanding Tokenization:** Define and explain the concept of tokenization, along with describing its basic process.
- **Benefits and Challenges of Tokenization:** List and understand the benefits and challenges associated with tokenization.
- **Blockchain’s Fundamentals:** Describe the foundational principles of blockchain technology.
- **Blockchain in Tokenization:** Explain how blockchain facilitates secure and transparent tokenization and understand its benefits from smart contracts and consensus algorithms.
- **Differentiating Token Types:** Differentiate between various types of tokens, including their distinct features and applications, especially in the agrifood sector.
- **Tokenization in Food Safety:** Recognize the transformative potential of tokenization in ensuring food safety, authenticity, and traceability.
- **Addressing Food Supply Chain Challenges:** Identify key challenges in the food supply chain that tokenization can address and understand the practical implementation of tokenization in overcoming these challenges.
- **Case Studies and Future Trends in Tokenization:** Examine real-world case studies to understand the advantages and outcomes of tokenized systems. Additionally, investigate future trends in tokenization applied in the food supply chain.



Course Level, Education Level Required, and Prerequisites



Intermediate Level



Bachelor’s Degree



Consider this course as an advanced level of “Course 1 - Introduction to Blockchain Technology and Digital Assets” & “Course 2 - Exploring Digital Asset Management and Tokenization”.

Target Audience



Professionals in the Agrifood Industry, FinTech and Blockchain Enthusiasts, Technology Developers and Entrepreneurs, Academic Researchers and Students

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quizzes. There is one quiz for each lesson. Each quiz has 3-5 questions (i.e. multiple choice, true/false etc).



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

Adopt a proactive, self-directed learning approach to learn about Tokenization, focusing on its applications in the food supply chain. Understanding learning objectives, relating your experiences to blockchain and tokenization, and engaging actively in discussions and activities will enhance your understanding and skills in implementing tokenization strategies within the food industry.

Lesson 1: Introduction to FinTech: Understanding its components and key technologies

Lesson 1 focuses on foundational aspects of tokenization, its mechanisms, and its pivotal role in revolutionizing the agrifood sector. This lesson serves as your guide to understanding the transformative power of tokenization, from enhancing data security to fostering transparency in the food supply chain.

Begin by unraveling the concept of tokenization, a process that secures sensitive data by converting it into non-sensitive tokens. Reflect on how this method not only safeguards information but also paves the way for improved traceability and transparency from farm to consumer, crucial for modern agrifood systems where trust and efficiency are paramount.



Explore the operational process of tokenization, observing how it functions within the agrifood sector to replace sensitive data with unique tokens. This conversion facilitates secure data handling, ensuring the integrity of information as it moves through the supply chain.

Contemplate the benefits tokenization brings to the agrifood industry—enhanced traceability, increased transparency, and bolstered food safety. These advantages underscore tokenization's role in building consumer trust, streamlining operations, and combating fraud.

Yet, the path to implementing tokenization comes with its challenges. From technological barriers and initial costs to ensuring data accuracy and navigating regulatory landscapes, consider the hurdles that must be overcome. Reflect on the strategies to address these challenges, ensuring successful integration of tokenization into agrifood processes.

As you delve into the distinctions between tokenization, encryption, and hashing, appreciate the unique advantages tokenization offers. Its ability to maintain the confidentiality of the original data while enabling secure transactions illuminates its suitability for the agrifood sector.

Finally, envision the potential of tokenization in real-world agrifood scenarios. How can this technology solve existing challenges, enhance supply chain management, and improve consumer confidence?

This lesson aims to equip you with a thorough understanding of tokenization, inspiring you to consider its application in addressing the agrifood sector's current and future challenges. By grasping the concept, benefits, and practical considerations of tokenization, you're prepared to contribute to the evolution of more secure, transparent, and trustworthy agrifood supply chains.

Lesson 2: The role of blockchain in tokenization

Lesson 2 dissects how blockchain technology underpins the mechanism of tokenization, particularly emphasizing its implications for the agrifood sector. This lesson aims to illuminate the symbiotic relationship between blockchain and tokenization, revealing how they collectively drive innovation in securing and streamlining agrifood supply chains.

Initiate your exploration by delving into the core principles of blockchain technology. Understand its decentralized nature, immutability, and transparency, which form the bedrock for creating and validating digital tokens. Reflect on how these characteristics of blockchain not only bolster security but also foster trust and efficiency across the agrifood supply chain.



Dive deeper into the mechanics of token creation and validation on the blockchain. Discover the pivotal role of smart contracts in automating token transactions, ensuring adherence to predefined rules and regulations without the need for intermediaries. Contemplate the transformative impact this automation can have in the agrifood sector, from simplifying payments to enhancing product traceability.

Acknowledge the consensus mechanisms, such as Proof of Work and Proof of Stake, that ensure the integrity and security of transactions on the blockchain. These mechanisms validate token transactions, maintaining the network's trust and reliability. Explore the challenges these technologies face, including scalability, energy consumption, and regulatory uncertainties, and envision potential solutions to overcome these obstacles.

Envision the future of tokenization and blockchain within the agrifood industry. Consider the evolving standards, the integration with the Internet of Things (IoT), and the rise of eco-friendly consensus mechanisms. Reflect on how these advancements could further refine and expand the applications of tokenization in ensuring food safety, authenticity, and sustainability.

As you conclude this lesson, ponder the strategic implications of blockchain-enabled tokenization for the agrifood sector. Consider how overcoming the present challenges could unlock new possibilities for innovation, efficiency, and transparency in food supply chains.

Lesson 3: Different types of tokens

Lesson 3 unveils the diversity and functionality of different token types. This lesson acts as a beacon, illuminating the intricate world of tokens, from governance and utility tokens to the unique non-fungible tokens (NFTs), each playing a pivotal role in the fabric of the agrifood sector.

Initiate your exploration by understanding the core of tokenization—the process that transforms rights or assets into digital tokens on a blockchain. This journey uncovers the essence of governance tokens, which empower holders with decision-making capabilities, driving decentralized governance and potentially sharing in a platform's success.

Venture into the realm of utility tokens, designed to grant access to services or products within a specific ecosystem. These tokens, devoid of ownership stakes, reflect their value in the utility they provide, shaping new ways to engage with and benefit from platform offerings.



Security tokens come into focus as digital representations of ownership in real-world assets, subject to securities regulations. This segment explores how these tokens bridge the traditional financial world with the digital, offering equity, dividends, or voting rights, and opening new avenues for investment in the agrifood sector.

Platform tokens, vital for the operation of blockchain networks, and non-fungible tokens (NFTs), each with its unique identity, unfold their roles. Understand how platform tokens facilitate transactions and network operations, while NFTs assure the authenticity and uniqueness of assets, revolutionizing the traceability and verification of agrifood products.

Acknowledge the challenges that accompany the adoption of these tokens in the agrifood sector, from ensuring technological compatibility to navigating regulatory landscapes. Reflect on the strategies to leverage these tokens effectively, overcoming hurdles to harness their full potential.

This lesson is designed not just to educate but also to inspire you to think innovatively about the application of diverse tokens in the agrifood sector. By the end, you'll have a

comprehensive understanding of the types of tokens, their functionalities, and the promising opportunities they present for revolutionizing the agrifood supply chain.

Lesson 4: Tokenization in Food Supply Chain

Lesson 4 ventures into the realm of blockchain's transformative potential in the agrifood sector, focusing on the application of smart contracts and consensus mechanisms. This lesson demystifies the technical intricacies of blockchain that enable seamless, secure tokenization processes, highlighting their critical role in enhancing the integrity and efficiency of agrifood supply chains.

Begin by exploring the essence of smart contracts within the blockchain ecosystem. Grasp how these self-executing contracts, with terms directly written into code, automate and secure transactions, making them indispensable for tokenization. Reflect on their capability to enforce agreements without intermediaries, thereby streamlining operations from production to distribution in the agrifood chain.



Contemplate the challenges posed by blockchain adoption, such as scalability issues, energy consumption, and the integration with existing systems. Engage with the ongoing efforts to address these challenges. Reflect on how overcoming these hurdles can pave the way for more sustainable and efficient agrifood supply chains.

Envision the future landscape where blockchain and tokenization technologies are fully integrated into the agrifood sector. Anticipate the evolution of token standards, the potential of IoT integration, and the advent of eco-friendly consensus mechanisms. Reflect on how these advancements could further revolutionize agrifood supply chains, making them more transparent, traceable, and resilient.

This lesson aims to inspire a deep appreciation for the capabilities and potential of blockchain technology in transforming the agrifood sector. By comprehending the critical role of smart contracts and consensus mechanisms, you are better positioned to leverage blockchain technology for creating more secure, transparent, and efficient food supply chains.

Lesson 5: Exploring Real-world Implementations



Lesson 5 dives into the practical applications of tokenization within the food supply chain, showcasing real-world implementations that highlight the transformative power of this technology in enhancing transparency, authenticity, and equity across the global food system. This lesson provides a vital bridge between theoretical knowledge and tangible outcomes, focusing on how tokenization addresses critical challenges in the food industry.

Begin your exploration by understanding the complex challenges that the food industry faces, such as ensuring transparency and verifying the authenticity of food products. Reflect on how these challenges undermine consumer trust and the integrity of the food supply chain.

Progress to analyzing specific case studies that illuminate the application of tokenization across various sectors of the food industry. These case studies will offer insights into the operational aspects of tokenization, showcasing its effectiveness in tackling real-world problems. Through examples like tokenizing organic certifications and ensuring traceability in seafood sourcing, grasp the practical benefits of tokenization for ensuring product authenticity and consumer trust.

Contemplate the tangible benefits tokenization brings to all stakeholders involved, from farmers to consumers. Understand how tokenization not only enhances the traceability and transparency of food products but also supports sustainable and ethical food production practices. Reflect on the role of blockchain technology in facilitating these benefits, providing a secure and immutable record of product histories.

As you delve into the intricacies of these case studies, consider the broader implications of tokenization in revolutionizing the food supply chain. Envision how this technology can be further leveraged to address emerging challenges in the agrifood sector, promoting a more sustainable, transparent, and equitable food system.

Concluding Lesson 5, you will emerge with a comprehensive understanding of the real-world impact of tokenization in the agrifood sector. This lesson not only highlights the potential of tokenization to solve pressing industry challenges but also inspires you to consider how you can apply these insights to foster innovation and transparency in your own agrifood initiatives.

Lesson 6: Future Trends

Lesson 6 charts the future of tokenization within the agrifood sector. This lesson aims to unveil the anticipated trends, potential applications, and forthcoming challenges as the agrifood industry increasingly integrates tokenization. Gain insights into the evolving landscape, where innovation meets tradition, and discover how tokenization is set to redefine the agrifood supply chain.



Start by investigating the projected growth of the tokenization market, understanding its trajectory and the factors driving its expansion. Reflect on the potential of tokenization to revolutionize various aspects of the agrifood sector, from enhancing transparency to facilitating sustainable practices.

Dive into the emerging applications of tokenization within the agrifood sector. Explore how new technologies and innovative approaches are creating opportunities for

tokenization to address complex challenges in food safety, supply chain efficiency, and consumer engagement. Contemplate the integration of tokenization with IoT devices for real-time tracking and the role of personalized loyalty programs in enhancing consumer experiences.

Acknowledge the challenges that lie ahead, including regulatory hurdles, technological constraints, and the need for standardization. Consider how these obstacles can be navigated to unlock the full potential of tokenization in the agrifood sector. Reflect on the importance of developing robust legal frameworks and technological infrastructures to support the widespread adoption of tokenization.

As you conclude this lesson, envision the transformative impact of tokenization on the agrifood industry. Consider how the convergence of blockchain technology, digital innovation, and tokenization could usher in a new era of efficiency, transparency, and sustainability in food supply chains. By understanding the trends, applications, and challenges presented in this lesson, you are better equipped to contribute to the evolution of the agrifood sector, making it more resilient, sustainable, and aligned with the needs of the digital age.

Relevant Readings



- Swan, Melanie. Blockchain: Blueprint for a new economy. " O'Reilly Media, Inc.", 2015.
- Lee, Jei Young. "A decentralized token economy: How blockchain and cryptocurrency can revolutionize business." Business Horizons 62.6 (2019): 773-784.
- "Token Economy: How Blockchain and Smart Contracts Revolutionize the Economy" by Shermin Vasumitr: This book explores the concept of tokenization and its impact on various industries, including the food supply chain. It covers topics such as token standards, decentralized finance, and the potential of blockchain-based token economies.
- "Blockchain: Blueprint for a New Economy" by Melanie Swan: This comprehensive book covers various aspects of blockchain technology, including tokenization and its applications across different industries. It provides insights into the potential benefits and challenges of implementing tokenization in real-world scenarios.

Additional readings can be found within each Lesson.

Course Provider / Contact Details



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Course #6: Introduction to Blockchain in the Food Supply Chain: Building Trust and Ensuring Safety

Content and Duration

The lessons provided with the course “Introduction to Blockchain in the Food Supply Chain: Building Trust and Ensuring Safety” are as follows:

Lesson 1: Supply Chain Essentials and Challenges in the Food Industry

Lesson 2: Blockchain Technology Essentials – Part I

Lesson 3: Blockchain Technology Essentials – Part II



Lesson 4: Role of Blockchain in Optimizing the Food Supply Chain

Lesson 5: Blockchain for trust-building in the food supply chain

Lesson 6: Ensuring Food Safety through Blockchain

Lesson 7: Exploring Real-world Implementations

Lesson 8: Future Trends



Approx. 6 hours to complete (including study time).

Objective

The objective of Course #6, “Introduction to Blockchain in the Food Supply Chain: Building Trust and Ensuring Safety” is to provide participants with an understanding of blockchain technology and its applications in the food supply chain. This course aims to describe how blockchain can enhance transparency, improve food safety and foster trust among various stakeholders within the food supply chain. Participants will be guided through a journey that starts with understanding the essentials of the food supply chain and the challenges faced by its stakeholders. The course will also discuss the core principles of blockchain technology, its key features such as immutability and decentralization, and the different types of blockchain, including their advantages, disadvantages, and real-world applications. The course will also explore how blockchain’s inherent characteristics can be leveraged to build trust among food supply chain stakeholders and ensure food safety, underlined by real-world examples. Finally, the course will conclude by examining real-world implementations of blockchain in the food supply chain through case studies and future trends in the field.

Learning Outcomes

As a participant in this course on blockchain technology, smart contracts, and digital assets in the agrifood sector, you will be engaged in a comprehensive and effective learning journey structured around the following outcomes:

- Comprehend Food Supply Chain: Understand the design, key stages, and stakeholders of the food supply chain from agricultural sources to end-users.
- Identify the Stakeholders: Identify primary and secondary stakeholders in the food supply chain, understanding their roles and impacts.
- Recognize Supply Chain Challenges: Acknowledge the obstacles faced in the food supply chain, including logistical issues and quality control.
- Understand Blockchain Basics: Recognize the key elements of blockchain technology, its data storage method, and the significance of its tamper-evident nature.
- Blockchain in Food Supply Chain: Identify blockchain attributes that address challenges in the food supply chain.
- Blockchain for Trust-Building: Understand blockchain's role in enhancing trust, transparency, and authenticity in the food supply chain.
- Blockchain for Food Safety: Identify how blockchain enhances food traceability and safety, including real-world case studies.
- Blockchain Solutions to Industry Challenges: Recognize how blockchain addresses key challenges in the food supply industry.
- Future Trends in Blockchain: Understand future trends and the evolving significance of blockchain in the food supply chain.



Course Level, Education Level Required, and Prerequisites



Beginners Level



Bachelor's Degree



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Target Audience



Food Industry Professionals, Supply Chain Managers and Logistics Experts, Food Safety Regulators and Policy Makers, Technology Professionals with an Interest in Agri-tech, Agricultural Entrepreneurs and Innovators, Food Industry Consultants and Advisors, Academics and Researchers in Food Technology and Blockchain, Students in Food Science, Supply Chain Management and Technology.

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quizzes. There is one quiz for each lesson. Each quiz has 3-5 questions (i.e. multiple choice, true/false etc).



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

This course integrates diverse educational theories, such as constructivism and humanism, to support various learning styles with dynamic, interactive content including slide decks, videos, and quizzes. Focus on understanding the course objectives and engage with the course activities.

Lesson 1: Supply Chain Essentials and Challenges in the Food Industry

In lesson 1 of the course, aim to understand the complexities and challenges within the food supply chain. Your learning will cover the essentials of the food supply chain, spotlighting its key components and the hurdles that stakeholders navigate daily. This foundational knowledge sets the stage for deeper insights into how blockchain technology can offer solutions, fostering trust and safety from farm to fork.

As you start, remember that the perspectives shared here aim to enrich your understanding and do not necessarily reflect the European Union's official stance. The course content, while informative, should serve as a basis for your exploration and not be construed as professional advice.

Your objectives in this lesson are to grasp the intricate design of the food supply chain, recognizing how food products move from agricultural sources to end consumers. You will learn to identify both primary and secondary stakeholders, understanding their roles and the impact they have on the supply chain's efficiency and integrity. Additionally, you'll examine the various obstacles that the food supply chain encounters, including logistical issues and quality assurance challenges.

Through this lesson, you will understand the sequence of processes in the supply chain, from raw material procurement to the delivery of the final product to consumers. This knowledge is crucial for appreciating the supply chain's breadth and the importance of each stage in ensuring food safety and quality.



By exploring quality assurance checks, inventory management, transportation logistics, and warehousing, you'll gain insights into the operational aspects that underpin the food supply chain's functionality. You'll see how each process is designed to maintain product quality, manage stock levels, and ensure efficient product distribution.

Delving into the food supply chain specifically, you'll see how it differs from other supply chains, with a focus on the journey of food products from farms to tables. This section will highlight the roles of producers, distributors, retailers, and consumers, emphasizing the supply chain's goal: to deliver safe, quality food products to consumers efficiently.

As you progress, consider the challenges detailed in this lesson, reflecting on how they affect food supply chain efficiency and what solutions might address them. Think about the role of blockchain technology in overcoming these challenges, particularly in enhancing traceability, transparency, and food safety.

By the end of this lesson, you should be able to comprehend the food supply chain's complexity, differentiate between the roles of its stakeholders, and recognize the challenges it faces. This understanding is your first step toward appreciating how blockchain can revolutionize the food industry, paving the way for a more transparent, efficient, and safe food supply chain.

Lesson 2: Blockchain Technology Essentials – Part I

In Lesson 2, you delve into the foundational concepts of blockchain technology, unraveling the mechanisms that make it a revolutionary force in various sectors, especially in the food supply chain. Your journey will begin by understanding what blockchain is: a digital ledger that offers a tamper-evident, secure, and transparent method for recording transactions and tracking assets across a network.

You will explore the significance of decentralization in blockchain, learning how this approach distributes control across all participants, enhancing the system's security and transparency. The concept of immutability will be a key focus, illustrating how once data is entered into the blockchain, altering it becomes nearly impossible, thus ensuring the integrity and reliability of the information stored.

Through this lesson, you will become familiar with the term "hash" and how it's used to secure transactions within the blockchain. The SHA-256 algorithm, for example, will be discussed to demonstrate how data is encrypted to maintain confidentiality and security.

The learning outcomes are designed to equip you with the ability to recognize blockchain's key elements and understand its operation. You'll examine how blockchain's decentralization promotes security and transparency, and why immutability is crucial for maintaining data reliability.



As you progress, consider how the principles of blockchain can address some of the traditional challenges faced by transaction ledgers, such as inefficiency, high costs, lack of transparency, and susceptibility to fraud. Reflect on how blockchain's structure—comprising chains, blocks, nodes, and consensus mechanisms—facilitates a more efficient, secure, and transparent way of conducting transactions without the need for intermediaries.

This lesson also introduces smart contracts, automated agreements that execute when predetermined conditions are met. You'll see how these contracts can streamline processes, reduce errors, and enhance trust across transactions.

By the end of this lesson, you will have a solid understanding of how blockchain technology works and its key characteristics, including decentralization, transparency, immutability, efficiency, and security. This knowledge lays the groundwork for further exploration of how blockchain can be applied within the food supply chain to solve existing challenges, improve traceability, ensure food safety, and build consumer trust.

Remember, the information provided here is a steppingstone to understanding the broader implications and potential applications of blockchain technology. Keep an open mind as you progress through the course and consider how the foundational knowledge gained in this lesson can be applied to real-world scenarios in the food supply chain and beyond.

Lesson 3: Blockchain Technology Essentials – Part II



- Start by exploring the various types of blockchain, such as public, private, consortium, and hybrid blockchains. Learn about their unique characteristics and how they differ from each other.
- Understand the strengths and weaknesses of each blockchain type. Reflect on their suitability for different scenarios, particularly in the context of the food supply chain.
- Study case studies or examples that illustrate the application of different blockchain types in real-world scenarios. Think about how these examples can apply to your understanding of blockchain in the food industry.
- Conclude by summarizing the diverse types of blockchains and their implications for the food supply chain. Reflect on what you have learned and how it applies to your professional or educational context.
- Utilize interactive elements like polls or questions provided in the course to assess your initial knowledge and set your learning expectations.
- Engage with course-provided questions and discussions to assess your understanding. This will also keep your learning experience interactive and dynamic.

Lesson 4: Role of Blockchain in Optimizing the Food Supply Chain

Lesson 4 focuses on blockchain technology's transformative role in optimizing the food supply chain, highlighting how it can address food safety, traceability, sustainability, and transparency challenges. This lesson explores blockchain's potential to revolutionize the way we manage food from farm to table, ensuring a more transparent, efficient, and trustworthy system.



You'll learn about blockchain's capacity for improving transparency and traceability, ensuring every transaction is recorded, which is vital for food safety and consumer trust. The lesson also covers how blockchain enhances efficiency and reduces costs by streamlining processes and cutting down on administrative paperwork.

A key part of the lesson is understanding how blockchain technology aids in fraud prevention, especially in markets vulnerable to misrepresentation, and facilitates better stakeholder engagement across the food supply chain. By promoting seamless collaboration among all parties, blockchain paves the way for a more unified and efficient approach to managing food supply chains.

The lesson illustrates blockchain's impact through examples of enhanced traceability, security, and cost savings, showing how it can provide complete oversight, authenticity

checks, and simplified regulatory compliance. It concludes by envisioning a future where blockchain drives global food supply chains towards greater sustainability, safety, and consumer-centric practices.

By the end of this lesson, you'll appreciate blockchain's potential in creating more sustainable, safe, and transparent food supply chains, equipped with insights to imagine and contribute to blockchain-based solutions in the agrifood sector.

Lesson 5: Blockchain for Trust-building in the Food Supply Chain

Lesson 5 delves into how blockchain technology enhances trust in the food supply chain. This session uncovers the power of blockchain to overcome the limitations of traditional traceability methods, which often fall short in today's complex supply chains and the growing consumer demand for transparency.

You will explore the concept of trust through immutability, learning how blockchain ensures the authenticity of information by making data alterations nearly impossible. The lesson emphasizes the importance of transparency, showing how blockchain provides a clear ledger that is accessible to every stakeholder in the food supply chain. This not only fosters trust among businesses but also empowers you, as a consumer, with the ability to verify the product details at each step.

Through this lesson, you'll understand the significance of collaborative trust-building. Blockchain's decentralized nature encourages every participant to contribute to and validate the supply chain, creating a collective trust that benefits everyone involved.

A significant part of your learning will focus on how blockchain can transform the current state of the food supply chain. You'll examine specific properties of blockchain, such as immutability, transparency, and decentralization, and how they serve as robust tools to bridge the trust deficit, ensuring integrity throughout the product journey.

You will also gain insights into the practical application of blockchain technology in the food supply chain. This includes understanding how it can establish a safer, more transparent, and efficient global system, significantly impacting how food safety, traceability, and consumer trust are managed.

By the end of this lesson, you'll be able to pinpoint where traditional systems fall short and how blockchain's inherent properties fortify it as a superior mechanism for instilling trust at every step of the food's journey. This knowledge equips you to visualize the transformative potential of integrating blockchain into the food supply chain, emphasizing its role in building a more trustful and transparent food ecosystem.



Lesson 6: Ensuring Food Safety through Blockchain

Lesson 6 dives into how blockchain technology is reshaping the way we approach food safety within the global supply chain. This lesson is designed to give you a thorough understanding of how blockchain can track, verify, and ensure the quality and safety of food from the farm to your table. Through case studies and insights into current regulatory frameworks, you'll gain a comprehensive view of the potential and challenges of leveraging blockchain for food safety.



You'll learn about the core aspects of food safety and blockchain, exploring how blockchain's capabilities can help prevent contamination and ensure the integrity of the food supply. This includes a deep dive into traceability and recall efficiency, illustrating how blockchain streamlines the process of tracing products back through the supply chain quickly and accurately in the event of a safety recall.

By the end of this lesson, you'll be able to identify the ways blockchain can enhance traceability and safety of food products, understand its role as a tool for regulatory bodies to monitor and enforce food safety standards, and appreciate its potential to transform food safety in global supply chains and crisis management.

Examples like "Trace My Egg" and "OriginChain" will show you practical applications of blockchain in ensuring food safety, providing a clear picture of how blockchain technology can be integrated into the food supply chain to safeguard against risks and build consumer trust.

Lesson 7: Exploring Real-world Implementations

Lesson 7 delves into the practical applications of blockchain technology across the food supply chain. This lesson showcases a variety of case studies, each illustrating the transformative impact blockchain has had on enhancing transparency, efficiency, and trust from farm to fork. You'll explore examples from egg traceability to comprehensive supply chain solutions, highlighting how different sectors are leveraging blockchain to address specific challenges.



Through these case studies, you'll gain insights into the real-world integration of blockchain technology, understanding its role in solving issues related to food safety, traceability, and sustainability. Learn about the challenges encountered during implementation and how they were overcome, offering a balanced view of blockchain's potential alongside its limitations.

By the end of this lesson, you'll have a solid grasp of how blockchain technology is being applied in the food industry. You'll be equipped to evaluate blockchain applications critically, recognizing the challenges within the food supply industry and understanding

the integration process and benefits of blockchain for increased transparency and trust in food systems.

Lesson 8: Future Trends

Lesson 8 explores the horizon of blockchain technology in the food supply chain, focusing on emerging trends and the future of food distribution and safety. This lesson highlights the potential of blockchain to further revolutionize the way we track, verify, and ensure the integrity of our food from farm to table.



You will explore the cutting-edge developments and speculate on the future roles blockchain might play in enhancing sustainability, operational efficiency, and global food systems. Through discussions on increased end-to-end visibility, integration with IoT for real-time tracking, innovations in food safety, and the rise in consumer engagement platforms, you'll gain insight into how blockchain could address the evolving needs and challenges of the food supply chain.

By understanding the implications of widespread blockchain adoption, including regulatory compliance and consumer engagement, you will be better equipped to envision how blockchain technology can drive innovation and transform the global food supply chain towards a more transparent, efficient, and sustainable future.

Relevant Readings



- Zhao, Guoqing, et al. "Blockchain technology in agri-food value chain management: A synthesis of applications, challenges and future research directions", *Computers in industry* 109 (2019): 83-99.
- Ehsan, Ibtisam, et al. "A conceptual model for blockchain-based agriculture food supply chain system", *Scientific Programming* 2022 (2022): 1-15.
- Li, Kungpeng, Jun-Yeon Lee, and Amir Gharehgozli. "Blockchain in food supply chains: A literature review and synthesis analysis of platforms, benefits and challenges", *International Journal of Production Research* 61.11 (2023): 3527-3546.

Additional readings can be found within each Lesson's presentation.

Course Provider / Contact Details



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Course #7: Basic Blockchain Skills

Content and Duration

The lessons provided with the course “Basic Blockchain Skills” are as follows:

Lesson 1: Hash Functions

Lesson 2: Understanding Cryptocurrency Transactions

Lesson 3: Block Structure and Blockchain Connection



Lesson 4: Nonce #

Lesson 5 : Block Explorers

Lesson 6: UTXO Transaction Model

Lesson 7 : Seed Phrase, Private Key, and Address



Approx. 4.25 hours to complete.

Objective

This course unlocks the mysteries of blockchain! We'll explore hashing functions (like SHA-256 & Keccak) that link blocks for security and unveil the role of nonces. Dive deeper with hands-on skills: learn to navigate block explorers and understand transaction models like UTXO. Finally, we'll solidify your grasp of blockchain fundamentals by connecting seed phrases, private keys, and addresses. This comprehensive journey equips you to confidently navigate the world of blockchain.

Learning Outcomes

What you will learn:

How hash functions work and their critical role in securing blockchain data. Implement practical applications of common hash functions like SHA-256 and Keccak. Analyze and manipulate data using online hash function tools (Lesson 1).



Describe the basic structure and components of a cryptocurrency transaction. Compare and contrast transaction processes for popular blockchains like Bitcoin and Ethereum. Explain the purpose and impact of transaction fees and confirmation times. (Lesson 2).

Deconstruct the structure of a block within a blockchain network. Demonstrate the connection between blocks using hashing algorithms. Utilize online tools to explore and analyze blockchain structures (Lesson 3).

Define and explain the significance of the Nonce concept in blockchain. Apply Nonce functionalities in block validation and mining processes (Lesson 4).

Identify and leverage the functionalities of block explorers for blockchain analysis. Navigate and interpret data presented on popular block explorers (Lesson 5).

Explain the Unspent Transaction Output (UTXO) model used in some blockchains. Analyze transaction inputs and outputs within the UTXO model. Utilize block explorers to effectively analyze and understand UTXOs (Lesson 6).

Establish the connection between seed phrases, private keys, and blockchain addresses. Generate private keys and addresses from seed phrases using appropriate tools. Implement best practices for managing seed phrases and private keys with a focus on security (Lesson 7).

Course Level, Education Level Required, and Prerequisites



Beginners, Professional Development or Continuing Education



High School Diploma or Equivalent



Supply chain basics, Trust Food Course #1, basic understanding of certification processes, background in agriculture and/or food science.

Target Audience



University students, university graduates, business managers, business owners, agrifood company employees and food supply chain personnel

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with 7 corresponding quizzes (1 for each lesson) that consists of 3-4 multiple choice and true-false questions.



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

Begin the course by reviewing the objective, the learning outcomes and structure (i.e., lessons).

Lesson 1: Introduction to hash functions and their role in blockchain

Demystifying Hash Functions - The Secret Sauce of Data

Hash Function Fundamentals: Start by understanding the core concept of hash functions. Explore how they transform data of any size into a fixed-size "fingerprint" called a hash. Recognize that this hash is unique for a specific input and changes entirely if the data is altered.



Key Properties of Hash Functions: Focus on the crucial properties of hash functions that make them valuable in cryptography and blockchain. These include determinism (consistent output for the same input), one-way nature (impossible to recreate original data from the hash), and collision resistance (extremely difficult to find two different inputs with the same hash).

Visualizing the Hashing Process: Gain a deeper understanding through visualizations of how hash functions work. Imagine the input data being broken down into smaller pieces, with mathematical operations performed on each piece. The output of these operations becomes the input for the next step, ultimately leading to the fixed-size hash value.

The Power of Hash Functions in Blockchain

Securing the Blockchain Network: Explore how hash functions are the cornerstone of blockchain security. They verify the authenticity of transactions and prevent tampering with data. Since each block contains the hash of the previous block, modifying any data would corrupt the entire chain.



Transparency Through Hashing: Recognize the role of hash functions in ensuring transparency on the blockchain. Hashing transactions allows anyone to verify their legitimacy and trace ownership. This fosters trust and accountability within the network.

Efficiency Boost with Merkle Trees: Learn how Merkle trees, built using hash functions, enhance efficiency in blockchain networks. They allow for faster verification of specific data within a block without needing to check the entire block.



Exploring the Landscape - Challenges and Applications

Balancing Performance and Security: Consider the challenges associated with hash functions in blockchain. While hashing is crucial for security, it can be computationally expensive, impacting network performance. Finding the right balance between these factors is essential.

The Importance of Collision Resistance: Recognize the critical role of collision resistance in hash functions. Without it, attackers could potentially exploit vulnerabilities to manipulate data within the blockchain. Choosing a secure hash function with strong collision resistance is paramount.

Real-World Applications - Case Studies: See hash functions in action! Explore how popular blockchains like Bitcoin (SHA-256) and Ethereum (SHA-3) utilize hash functions for security and transparency.

Take advantage of quizzes and polls: Don't see them as tests, but as opportunities to gauge your understanding and identify areas where you might need to revisit the material. **Expand your learning:** The real-world case studies can spark your curiosity. Research these applications further to gain a deeper understanding of blockchain's potential.

Lesson 2: Understanding Cryptocurrency Transactions

Unveiling the World of Crypto Transactions - A New Era of Value Transfer

Demystifying Crypto Transactions: Start by understanding the core concept of cryptocurrency transactions. Explore how they differ from traditional transfers and how they leverage blockchain technology for a secure and transparent exchange of value.



Benefits and Drawbacks: Weigh the advantages and disadvantages of cryptocurrency transactions. Recognize the benefits like transparency, security, and global reach. Be aware of the challenges like scalability limitations, market volatility, and evolving regulations.

A Glimpse into History: Take a quick tour of cryptocurrency transaction history. Learn about the first Bitcoin transaction and how the landscape has evolved with increasing adoption.

The Mechanics Behind the Magic - How Crypto Transactions Work

Step-by-Step Breakdown: Gain a clear understanding of the process behind cryptocurrency transactions. Explore how transaction requests are initiated, verified by miners, and added to the blockchain for permanent recording.



Understanding Transaction Fees: Recognize the role of transaction fees in incentivizing miners and maintaining network security. Learn how fees can fluctuate based on network traffic.

Privacy Considerations: Explore the concept of privacy in cryptocurrency transactions. Distinguish between public blockchains like Bitcoin and privacy-focused options like Monero.

Putting it into Practice - Sending, Receiving, and Staying Safe

Your Gateway to Crypto - Cryptocurrency Wallets: Learn about cryptocurrency wallets, the essential tools for storing, sending, and receiving cryptocurrencies. Explore popular software and hardware wallet options.

Sending and Receiving Crypto: Gain practical knowledge on how to initiate and receive cryptocurrency transactions. Understand the role of recipient addresses, transaction fees, and digital signatures.



Cryptocurrency Exchanges - Your Trading Platform: Explore cryptocurrency exchanges, platforms that allow you to buy, sell, and trade various cryptocurrencies. Learn about popular exchanges and their functionalities.

Beware of Scams - Protecting Yourself in the Crypto World: Be aware of prevalent cryptocurrency scams like ICO frauds, pump-and-dump schemes, and phishing attacks. Learn how to protect yourself with best practices like thorough research and robust security measures.

Lesson 3: Block Structure and Blockchain Connection

Demystifying Blockchain - The Foundation of Secure Transactions

Blockchain Fundamentals: Begin by understanding the core concept of blockchain technology. Explore how it utilizes distributed ledgers and cryptography to create a secure and transparent system for recording data.



Understanding Blocks: Delve into the structure of blocks, the building blocks of a blockchain. Grasp the functionalities of block headers (version, hash, timestamp, etc.) and the block body that stores transaction data.

The Power of Immutability: Recognize the significance of block chaining. Explore how the linking of blocks with previous block hashes ensures data immutability, making it nearly impossible to tamper with past records.

Achieving Consensus - The Key to Trust in a Decentralized Network

The Need for Consensus: Understand the critical role of consensus mechanisms in blockchain. They ensure agreement among all network participants regarding the current state of the ledger, preventing manipulation and double-spending.



Proof of Work (PoW) - The Forerunner: Learn about Proof of Work (PoW), the consensus mechanism powering Bitcoin. Explore how miners compete to solve complex puzzles to validate transactions and secure the network, though with high energy consumption.

Alternative Approaches - Exploring Other Mechanisms: Discover alternative consensus mechanisms like Proof of Stake (PoS), Delegated Proof of Stake (DPoS), Proof of Authority (PoA), and Byzantine Fault Tolerance (BFT). Evaluate their advantages (energy efficiency, scalability) and disadvantages (centralization, security trade-offs).

Beyond Crypto - Unveiling the Potential of Blockchain

The Rise of Cryptocurrencies: Explore how cryptocurrencies like Bitcoin and Ethereum leverage blockchain technology for secure and transparent peer-to-peer transactions, bypassing centralized institutions.



Decentralized Finance (DeFi): A New Financial Frontier: Learn about DeFi, a growing ecosystem built on blockchain that offers financial services like lending, borrowing, and trading without intermediaries.

Revolutionizing Industries - Blockchain Applications Beyond Finance: Explore the potential of blockchain technology across various sectors like supply chain management (enhanced transparency and traceability), healthcare (secure medical record keeping), and voting systems (increased security and reduced fraud).

Lesson 4: Nonce

Unveiling the Unsung Hero - Nonce in Blockchain

Demystifying Nonce: Begin by understanding the concept of a nonce and its general role in cryptography. Learn how it functions as a unique, one-time-use number employed to enhance security.



Nonce in Blockchain - The Guardian of Integrity: Explore the significance of nonce specifically within blockchain technology. Recognize its critical role in maintaining the security and immutability of transactions.

The Power of Hashing: Gain a solid understanding of hash functions. Grasp how they transform data into unique fingerprints and how the nonce serves as an input that influences the resulting hash value.

Nonce - The Backbone of Security in Proof-of-Work

Understanding Proof-of-Work (PoW): Learn about the PoW consensus mechanism, the foundation for securing blockchains like Bitcoin. Explore how miners compete to solve complex puzzles to validate transactions.



The Magic of Nonce in PoW: Dive deeper into how the nonce is utilized in PoW. Recognize how miners continually adjust the nonce value until a hash meeting a specific difficulty threshold is generated. This ensures only validated transactions are added to the blockchain.

Preventing Double Spending - A Crucial Function: Understand the concept of double spending and how it can threaten the integrity of digital currencies. Learn how the unique nonce value assigned to each transaction helps prevent this by creating unique transaction hashes.

Nonce - Evolving with the Blockchain Landscape

Nonce and Scalability Challenges: Explore the potential limitations of PoW, particularly regarding scalability issues as transaction volume increases. Learn how the complexity of PoW puzzles may lead to longer block creation times.



Alternative Consensus Mechanisms: Discuss alternative approaches to securing blockchains that move beyond the nonce-centric PoW system. Explore how these mechanisms aim to improve scalability without jeopardizing security.

The Future of Nonce: Consider the potential future of nonce in blockchain technology. While its role might evolve alongside emerging consensus mechanisms and advancements in cryptography, its significance as a unique identifier and input for cryptographic processes is likely to remain.

Lesson 5: Blockchain Explorers.

Unveiling the Power of Blockchain Explorers

Blockchain Explorers - Demystifying the Invisible: Begin by understanding the concept of blockchain explorers and their role in the blockchain ecosystem. Recognize how they function as search engines specifically designed for navigating the intricacies of blockchains.



Essential Features of Blockchain Explorers: Explore the key functionalities offered by blockchain explorers. Learn how to conduct transaction searches, explore blocks, look up addresses, and analyze network statistics to gain valuable insights into network health.

Real-World Applications: Discover the practical applications of blockchain explorers across a variety of domains. See how they are used in finance, law enforcement, education, and more.

Diving Deeper - The Technical Backbone

Behind the Scenes - Technical Implementation: Explore the technical infrastructure that powers blockchain explorers. Understand the critical factors that influence their efficacy, such as data indexing, storage, processing, querying, networking, and data synchronization.



Data Indexing and Storage: Learn how data on the blockchain is meticulously indexed and stored to enable efficient retrieval. Explore common indexing techniques like hash-based

and tree-based indexing, as well as storage solutions like databases and blockchain-specific storage options.

Processing Power and Efficient Queries: Discover how blockchain explorers utilize high-performance computing resources and optimized database structures to process and query blockchain data efficiently, enabling real-time updates and complex search functionalities.

The Future of Blockchain Explorers

Evolving Landscape - Anticipated Advancements: Discuss the anticipated future developments in blockchain explorer technology. Explore how features like real-time monitoring, predictive analytics, and enhanced user interfaces will further improve the user experience.



Case Studies - Blockchain Explorers in Action: Analyze real-world case studies to understand how blockchain explorers have been used in investigations like the Mt. Gox hack or the Silk Road seizure. See how they are used for "whale watching" and market analysis.

Lesson 6: UTXO Transaction Model.

Unveiling the UTXO Model - The Backbone of Crypto Transactions

Demystifying UTXOs: Begin by understanding the concept of the UTXO model and its critical role in cryptocurrencies like Bitcoin. Recognize how it differs from traditional account-based models and how it forms the foundation for transaction processing within blockchain networks.



UTXOs in Action: Explore the core functionalities of the UTXO model. Learn how UTXOs are created, spent, and used to track the flow of value across the blockchain. See how transactions link UTXOs together, preventing double-spending.

Security & Transparency: Gain a solid understanding of how the UTXO model safeguards against double-spending, a critical challenge in digital currencies. Recognize how the immutability of UTXOs and the chain of transactions ensure transparency and auditability.

Deep Dive into UTXOs - Practical Applications and Technicalities

UTXO Management: Explore how Bitcoin wallets and block explorers interact with UTXOs. Learn how wallets track a user's UTXOs (representing their balance), facilitate transaction creation, and broadcast them to the network. See how block explorers enable users to search, visualize, and analyze UTXO data.



Performance Considerations: Discuss the importance of performance optimization in UTXO-based systems. With a growing number of transactions, wallets and block explorers need to efficiently manage the complexity of UTXOs to maintain a smooth user experience.

UTXO Advantages and Trade-offs: Evaluate the advantages and limitations of the UTXO model. While it excels in security and transparency, understand how it might impact scalability compared to account-based models. Explore how some cryptocurrencies implement variations of the UTXO model.

The Future of UTXO - Evolution and Potential

UTXOs and Scalability Solutions: Discuss how the UTXO model can be adapted or integrated with future scalability solutions for blockchain technology. Explore concepts like Lightning Network and their potential impact on UTXO management.



UTXO Innovation: Consider the potential for innovation within the UTXO model itself. Are there ways to optimize its structure or functionality to address current limitations or enhance its capabilities?

Staying Informed: The world of cryptocurrency is constantly evolving. Follow reliable news sources and industry leaders to stay updated on advancements in UTXO-based systems and their role in the future of blockchain technology.

Lesson 7: Blockchain in the food supply chain.

Understanding the Crypto Wallet Ecosystem - The Big Three

The Power Trio: Begin by establishing a solid understanding of seed phrases, private keys, and addresses, and how they work together to secure and manage your cryptocurrency wallet. Recognize the critical role each element plays in the overall functionality.



Seed Phrase - The Mastermind: Deep dive into seed phrases. Learn how they generate private keys for your wallet and act as a backup for recovery in case you lose your private key. Understand the importance of keeping your seed phrase confidential and secure, as it holds the key to your entire crypto fortune.

Private Key - The Authorizer: Explore the role of private keys. Recognize how they act like a digital signature, authorizing cryptocurrency transactions on your behalf. Check the importance of safeguarding your private key, as anyone who gains access to it can steal your cryptocurrency.

Security and Best Practices - Protecting Your Crypto

The Importance of Secure Storage: Highlight the critical importance of storing your seed phrase and private key securely. Discuss various methods like paper wallets, hardware wallets, and password managers, emphasizing the pros and cons of each approach. Recommend never storing them electronically on your computer or phone.



Understanding Public vs. Private: Distinguish between public addresses and private keys. Explain how addresses are like your public bank account number, used to receive cryptocurrency, while private keys are like your ATM card and PIN, used for spending.

Real-World Examples: Illustrate the concepts with real-world scenarios. Explain how seed phrases and private keys are used to recover a lost wallet or how private keys are used to sign a transaction to send cryptocurrency.

Advanced Considerations and the Future

Security Best Practices: Discuss best practices for maintaining overall cryptocurrency security beyond seed phrases and private keys. Emphasize the importance of using strong passwords, keeping your wallet software updated, and being cautious of online scams.



Future of Crypto Wallets: Explore potential advancements in cryptocurrency wallet technology. Discuss how concepts like multi-signature wallets or biometric authentication might play a role in future security measures.

Staying Informed: The world of cryptocurrency is constantly evolving. Recommend following reliable news sources and industry leaders to stay updated on best practices and potential security risks related to seed phrases, private keys, and wallet management.

Relevant Readings

Antonopoulos, A. M. (2017). *Mastering Bitcoin: Unlocking Digital Cryptocurrencies*. O'Reilly Media, Inc.



Drescher, D. (2017). *Blockchain Basics: A Non-Technical Introduction in 25 Steps*.

Tapscott, D., & Tapscott, A. (2016). *Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies is Changing the World*.

Bashir, I. (2018). *Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications*.

Course Provider / Contact Details



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Course #8: Advanced Blockchain Skills

Content and Duration

The lessons provided with the course “Advanced Blockchain Skills” are as follows:

Lesson 1: Crypto Wallets

Lesson 2: Blockchain Test Nets



Lesson 3: Test Net Faucets

Lesson 4: Smart Contracts

Lesson 5: Multi-Signature Transactions

Lesson 6: Security Considerations



Approx. 3.75 hours to complete.

Objective

This course empowers you to unlock the potential of blockchain technology! By the end, you'll possess a solid understanding of:

Blockchain Security: Demystify hashing functions and nonces, the cornerstones of blockchain security.

Blockchain Exploration: Master the use of block explorers to navigate real-world blockchains.

Understanding Transactions: Grasp the UTXO model, the foundation for tracking cryptocurrency ownership.

Secure Blockchain Interaction: Unravel the connection between seed phrases, private keys, and addresses for confident blockchain participation.

Learning Outcomes

What you will learn:

Crypto Management and Development:



Explain the purpose and functionality of crypto wallets in interacting with blockchains. Identify and differentiate between various types of crypto wallets based on custody, storage, and access (custodial vs. non-custodial, hot vs. cold, hardware wallets). Implement best practices for secure management of crypto wallets, considering security vulnerabilities (Lesson 1).

Understand the concept of blockchain test nets and their role in development and testing.

Identify and explore popular test net environments used for blockchain development (Lesson 2).

Utilize test net faucets to acquire tokens for development and testing purposes (Lesson 3). Gain a basic understanding of smart contracts and their potential in blockchain applications. Leverage the Solidity programming language for creating basic smart contracts. Deploy smart contracts on a test net environment using tools like Remix IDE (Lesson 4).

Explain the concept of multi-signature transactions and their benefits for security. Utilize a popular multi-signature wallet solution like Gnosis Safe to create and execute secure transactions (Lesson 5).

Security and Advanced Concepts:

Identify and analyze common security vulnerabilities within blockchain applications. Implement best practices for securing crypto wallets, smart contracts, and blockchain transactions. Explore auditing tools and techniques for enhancing blockchain security (Lesson 6).

Explain the functionalities of various consensus mechanisms beyond Proof of Work (e.g., Proof of Stake, Delegated Proof of Stake, Byzantine Fault Tolerance). Analyze the "Blockchain Trilemma" and its impact on blockchain design. Understand the concept of Layer 2 blockchain solutions and their purpose. Explain the challenges and potential of blockchain interoperability through cross-chain transactions and bridges (Lesson 7).

Course Level, Education Level Required, and Prerequisites



Beginners, Professional Development or Continuing Education



High School Diploma or Equivalent



Supply chain basics, Trust Food course #1 and #7 and, basic understanding of certification processes, background in agriculture and/or food science.

Target Audience



University students, university graduates, business managers, business owners, agrifood company employees and food supply chain personnel

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with 6 corresponding quizzes (1 for each lesson) that consists of 3-4 multiple choice and true-false questions.



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

Begin the course by reviewing the objective, the learning outcomes and structure (i.e., lessons).

Lesson 1: Crypto wallets

Demystifying Crypto Wallets - Understanding the Fundamentals

The Need for Crypto Wallets: Check how they function as the backbone for interacting with cryptocurrencies, enabling storage, transfers, and management of your digital assets.



Hot vs. Cold Wallets: Distinguish their key characteristics and how hot wallets offer convenience with constant internet connection, while cold wallets prioritize security by remaining offline.

Explore the different formats that crypto wallets can take. Check software wallets for computers and mobile devices, hardware wallets as physical storage solutions, and paper wallets for offline security.

Understanding Your Needs: Emphasize the importance of identifying your individual needs before selecting a crypto wallet. Consider factors like the amount of cryptocurrency you plan to store, transaction frequency, and desired level of security. Check the various features offered by different wallets. Explore functionalities like multi-currency support, built-in exchanges, and integration with DeFi platforms.



Security Best Practices: Check the critical role of security when using crypto wallets. Recommend strong passwords, multi-factor authentication (MFA), and secure storage methods for seed phrases and private keys.

Overview popular hot and cold wallet options, along with their pros and cons. This can include wallets like MetaMask, Coinbase Wallet, Ledger Nano S Plus, and Trezor Model One. Check how features like MFA and secure seed phrase storage work to safeguard your crypto assets.



Lesson 2: Blockchain Test Nets



Check the critical role of blockchain test nets in safeguarding the development process and how they allow developers to experiment with new features and applications without jeopardizing real cryptocurrency or disrupting the main network. Study how they provide a secure environment for developers to test smart contracts, identify and fix bugs, optimize performance, and gather valuable user feedback before deploying applications on the main net.

Examine the Ethereum 2.0 upgrade and how the Medalla test net played a crucial role in testing the Proof of Stake consensus mechanism before its implementation on the main net.

Explore the different types of blockchain test nets available. Distinguish public test nets open to all users, private test nets designed for specific projects, and permissioned test nets with restricted access.



Matching Needs with Features: Consider factors like the blockchain platform they are developing for, the test net's stability and security features, and the availability of test net tokens. **Popular Test Net Examples:** Provide an overview of popular test nets for prominent blockchain platforms like Ethereum (Goerli, Sepolia), Polygon (Mumbai), and Avalanche (Fuji). Examine their unique functionalities and how developers can leverage them for testing purposes.



Study how to acquire test net tokens, a vital resource for interacting with the test net environment. Review methods like using test net faucets, participating in airdrops or grants, and engaging in community initiatives offering test net tokens as rewards.

Step-by-Step Guide: Look at a step-by-step guide on acquiring test net tokens using a faucet service (e.g., Goerli Faucet for Ethereum test net).

Lesson 3: Test Net Faucets



Study the importance of test net faucets in blockchain development and how they provide developers with free test tokens, acting as the "fuel" for experimenting with blockchain applications in a safe, simulated environment.

Check the additional benefits of test net faucets. These include enabling developers to test transactions, smart contracts, and other functionalities without risking real cryptocurrency. Examine the concept of community engagement and its role with test net faucets and how some faucets might require participation in community events or membership in groups to receive test tokens. This fosters collaboration and a sense of shared responsibility within the blockchain ecosystem.



Explore the diverse landscape of test net faucets available for different blockchain networks. Check popular options like QuickNode, Alchemy, and Avalanche Faucet as well as the importance of choosing a faucet compatible with the specific test net you're using. Check the importance of using test net faucets responsibly and their potential limitations imposed, such as request frequency restrictions or minimum main net token requirements.



Developers can leverage acquired test net tokens to experiment with various functionalities within the test net environment. This can involve testing transactions, smart contracts, and exploring the capabilities of the blockchain platform. Study the importance of thorough testing using test net tokens before deploying applications to the main net. Explain how test nets help identify bugs, optimize performance, and ensure a smooth and successful main net launch.

Lesson 4: Smart Contracts.



Check the fundamental concept of smart contracts and how they are essentially self-executing agreements written in code and stored on a blockchain. Examine the elimination of intermediaries and the potential cost savings associated with smart contracts compared to traditional contracts.



Study the core principles of smart contracts, including trust minimization, automation capabilities, transparency, and auditability and how smart contracts remove the need for trusted third parties and ensure all participants have access to the same immutable record of transactions. Examine the diverse applications of smart contracts across various industries. Focus on the agri-food supply chain as a prominent example. Explore how smart contracts can enhance transparency, automate payments and logistics, and improve food safety.

Check the programming languages commonly used for developing smart contracts. Focus on languages like Solidity (Ethereum), Vyper (Ethereum-inspired with security focus), and Michelson (Tezos). Study the importance of security when developing and deploying smart contracts as well as common vulnerabilities like bugs and exploits, and how they can lead to financial losses.



Learn the potential impact of smart contracts on various aspects of our digital landscape and how they can revolutionize industries, reshape business models, and empower individuals through secure and transparent transactions. Challenges associated with smart contracts include development complexity, security vulnerabilities, and the evolving legal and regulatory landscape.

Lesson 5: Multisignature Transactions.

Study the concept of multisignature transactions and how they differ from traditional transactions, which require only one private key for authorization. Check the enhanced security offered by multisig, as it necessitates multiple approvals for any transaction to occur.



Check real-world applications of multisignature transactions across various industries where shared control and enhanced security are crucial. Examples can include securing company treasuries, managing family accounts, and safeguarding crypto exchange cold storage.

Benefits of Multisignature include:

- **Enhanced Security:** Reduced risk of unauthorized access and fraudulent activity due to the requirement for multiple signatures.
- **Shared Control and Transparency:** Enables joint ownership and control over funds, fostering accountability and preventing unilateral actions.
- **Dispute Resolution:** Predefined approval thresholds ensure only authorized transactions are executed, minimizing conflicts.



Potential risks associated with multisignature transactions include:

- **Complexity and Inconvenience:** Setting up and managing a multisig wallet can be more complex than using a single-key wallet.
- **Transaction Delays:** Obtaining signatures from multiple parties can delay transactions, especially if geographically dispersed.

Check the different tools and resources available for implementing multisignature transactions. Explore hardware wallets like Trezor or Ledger, multisig-enabled software wallets like Electrum, and services offered by custodian providers.



Examine the potential future developments and expanding applications of multisignature transactions. Explore how this technology can contribute to a more secure and decentralized financial landscape.

Lesson 6: Security Considerations.

Begin with the concept of blockchain security and its importance in protecting digital assets. Check the inherent security features of blockchain (decentralization, immutability) but have in mind that vulnerabilities still exist.



There are different ways malicious actors can exploit vulnerabilities in blockchain systems:

- **Key Management Issues:** improper private key storage can lead to unauthorized access and loss of funds.
- **Smart Contract Exploits:** vulnerabilities in smart contract code can be exploited to steal funds or manipulate transactions.

- Phishing Attacks: deceptive tactics can be used to trick users into revealing sensitive information like private keys.
- Exchange Hacks: security breaches on cryptocurrency exchanges can result in the theft of user funds.

The Wormhole bridge hack or the Ronin hack can illustrate the impact of security vulnerabilities.

Study best practices for securely storing private keys and the importance of hardware wallets and avoiding online storage options. Moreover, you could check the importance of thorough smart contract audits before deployment.



Get knowledge on how to identify and avoid phishing attempts. These tactics include checking website legitimacy, verifying sender identities, and being cautious of unsolicited messages. Security Best Practices for Users: These can include using strong passwords, keeping software updated, and diversifying holdings across platforms.

Developer Responsibilities: includes secure coding practices, continuous monitoring for vulnerabilities, and prompt deployment of security updates.



Importance of Education: ongoing education and awareness about emerging threats and security best practices is crucial for both developers and users.

Relevant Readings

Advanced Blockchain Concepts and Architectures:

Books:

Tapscott, D. & Tapscott, A. (2016). Blockchain Revolution: Hyperledger Fabric, Ethereum, and the Future of Distributed Ledgers. [Book 1: Blockchain Revolution]

Antonopoulos, A. M. (2017). Mastering Blockchain: Programming, Decentralized Applications and Future Technologies. [Book 2: Mastering Blockchain]

Articles:

Understanding Blockchain Consensus Algorithms. (2023, July 11). Medium: <https://medium.com/@genesishack/understanding-blockchain-consensus-algorithms-433f0e1dc8bd>

The State of Scaling Ethereum. (2023, April 14). ConsenSys: <https://consensys.io/blog/the-state-of-scaling-ethereum>



II. Crypto Wallets:

Books:

Lewis, A. (2018). Blockchain Basics: A Layman's Guide to Understanding the Technology That Underpins Cryptocurrencies, Decentralized Applications, and the Future of Finance. [Book 3: Blockchain Basics]

Articles:

Wallets vs Exchanges: Understanding the Difference. (n.d.). BitPay: <https://bitpay.com/blog/wallets-vs-exchanges/>

Cryptocurrency Wallets Explained. (2023, October 26). Investopedia: <https://www.investopedia.com/cryptocurrency-wallets-5272123>

Hardware Wallet. (n.d.). CoinDesk: <https://www.coindesk.com/tag/hardware-wallet/>

III. Testnets and Testnet Faucets:

Online Resources:

Rinkeby Faucet. Rinkeby Faucet: <https://rinkebyfaucet.io/> (Example Ethereum Rinkeby Testnet faucet)

Binance Smart Chain Testnet Faucet. (2022, March 25). Binance: <https://www.binance.com/en/feed/post/159397>

Articles:

What Is a Testnet? A Beginner's Guide to Testnets in Crypto. (2023, January 12). Bitdegree: <https://www.bitdegree.org/crypto/learn/crypto-terms/what-is-testnet>

Best Crypto Faucets in 2023: Top Free Crypto to Claim. (2023, February 14). Crypto News: <https://cryptonews.com/cryptocurrency/best-crypto-faucets/>

IV. Smart Contracts (Basic Understanding):

Books:

Antonopoulos, A. M. (2017). Mastering Blockchain: Programming, Decentralized Applications and Future Technologies (Chapter on Smart Contracts). [Book 2: Mastering Blockchain]

Online Courses:

Smart Contracts with Solidity: Create an Ethereum Contract. Coursera: <https://www.coursera.org/projects/smart-contracts-with-solidity-create-an-ethereum-contract>

Introduction to Blockchain Technologies. EdX: <https://www.edx.org/>

V. Multisignature Transactions (Gnosis Safe):

Resources:

Gnosis Safe. Gnosis Safe: <https://safe.global/> (Gnosis Safe Documentation)

Articles:

Multi-Signature vs Single Signature Wallets: What's the Difference? (n.d.). CoinMarketCap: <https://coinmarketcap.com/alexandria/glossary/multi-signature-multi-sig>

How to Create a Multisig Wallet Using Gnosis Safe: A Tutorial. (2022, August 10). Nextrope: <https://nextrope.com/how-to-create-a-multisig-wallet-using-gnosis-safe-tutorial/>

Course Provider / Contact Details



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Course #9: Applications of Blockchain in the Agri-Food Industry

Content and Duration

The lessons provided with the course “Applications of Blockchain in the Agri-Food Industry” are as follows:

Lesson 1: Blockchain in Farming and Agriculture

Lesson 2: Blockchain in Food Supply Chain

Lesson 3: Blockchain in Seafood and Fisheries

Lesson 4: Blockchain in Food Safety and Quality Assurance

Lesson 5: Blockchain in Fair Trade and Organic Certification

Lesson 6: Blockchain and Sustainable Agriculture



Approx. 5 hours to complete (including study time).

Objective

The course “Applications of Blockchain in the Agri-Food Industry” is designed to provide an understanding of how blockchain technology can be applied across different segments of the agricultural and food sectors. The course focuses on exploring the diverse applications of blockchain in enhancing traceability, transparency, and efficiency in farming, agriculture, food supply chains, seafood and fisheries, and food safety and quality assurance. Additionally, it investigates blockchain’s role in verifying the authenticity of fair trade and organic certifications and its potential contribution to sustainable agriculture practices, including carbon trading. By analysing the benefits and challenges of implementing blockchain technology in these areas, the course equips participants with the knowledge to critically assess its impact and the practicalities of its adoption in the agri-food industry.

Learning Outcomes

As a participant in this course, you will be engaged in a comprehensive and effective learning journey structured around the following outcomes:

- Blockchain in Agriculture & Food Supply Chain: Understand the revolutionizing effect of blockchain technology in agriculture and food supply chain in particular, particularly in enhancing traceability.
- Smart Contracts in Agri-Food: Learn about the implementation and advantages of smart contracts in farming, focusing on financial transparency and fairness.
- Blockchain in Food Supply Chain: Comprehend how blockchain can improve transparency in the food supply chain and the efficiency gains achievable through its application in supply chain management.
- Blockchain for Food Safety: Conceptualize the implementation of blockchain for food safety, recognizing its role in regulatory compliance and standard enforcement.
- Crisis Management in Supply Chains: Assess blockchain's potential in crisis management in supply chains.
- Blockchain in Certifying Fair Trade and Organic Products: Understand blockchain's role in authenticating fair trade and organic certifications and maintaining the credibility and integrity of these labels.
- Blockchain in Sustainable Agriculture: Gain insights into the application of blockchain in sustainable agriculture and its potential in promoting environmental sustainability.



Course Level, Education Level Required, and Prerequisites



Beginner Level



Bachelor's Degree



Consider this course as an advanced level of Course #6: "Introduction to Blockchain in the Food Supply Chain".

Target Audience



Food Industry Professionals, Supply Chain Managers and Logistics Experts, Food Safety Regulators and Policy Makers, Technology Professionals with an Interest in Agri-tech, Agricultural Entrepreneurs and Innovators, Food Industry Consultants and Advisors, Academics and Researchers in Food Technology and Blockchain, Students in Food Science, Supply Chain Management and Technology.

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quizzes. There is one quiz for each lesson. Each quiz has 3-5 questions (i.e. multiple choice, true/false etc.).



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

This course incorporates diverse learning theories to accommodate various learning styles. Key focus areas include understanding course objectives, connecting your blockchain and food supply chain experiences to the content, engaging with interactive materials on blockchain platforms, and participating actively in discussions and exercises.

Lesson 1: Blockchain in Farming and Agriculture

As you dive into Lesson 1 on Blockchain in Farming and Agriculture, you're about to uncover how blockchain technology can revolutionize the agricultural sector. This lesson focuses on enhancing traceability and transparency from farm to table, ensuring that every product's journey is recorded. This is key to building trust in the food we consume and in supporting the hard work of farmers through fair compensation.

Reflect on the concept of smart contracts and their role in automating transactions, making the compensation process more transparent and fairer. This aspect of blockchain could significantly impact the livelihoods of farmers, especially those in smaller or more vulnerable communities.



Through case studies and examples, you'll see firsthand the challenges and triumphs of implementing blockchain in agriculture. These real-world insights will help you appreciate the practical applications and potential hurdles of this technology.

This lesson it's about envisioning a more sustainable and equitable future for farming. As you learn, think about how blockchain can contribute to solving global food security challenges while promoting environmental sustainability.

By the end of this lesson, you'll understand the transformative potential of blockchain in agriculture, equipped with knowledge to engage in meaningful discussions about its future impact.

Lesson 2: Blockchain in Food Supply Chain

Lesson 2 focuses on the role blockchain technology plays in revolutionizing the way we track, manage, and ensure the integrity of food from its origin to the consumer. This lesson is an exploration of blockchain's capacity to enhance traceability, improve transparency, and boost overall efficiency within the food supply ecosystem.

Starting with an understanding of the food supply chain's key stages and stakeholders—from producers and distributors to retailers and consumers—you'll see how blockchain acts as a bridge connecting these diverse entities more transparently and efficiently. Reflect on the challenges currently facing the food supply chain, such as poor inventory control, temperature-controlled shipping hurdles, and the lack of traceability. Consider how blockchain offers solutions to these issues, enabling better inventory management, more reliable temperature monitoring, and enhanced traceability.



Through the course, you'll learn about blockchain's transformative impact on the food supply chain. You'll see how it provides complete oversight, facilitates authenticity checks, ensures information symmetry, and greatly reduces the risk of counterfeiting. The concept of immutability, a cornerstone of blockchain technology, will be highlighted, showing how

it fosters trust among all stakeholders by providing a secure, unchangeable record of transactions.

As you engage with case studies observe how blockchain technology is already being applied to improve transparency and efficiency in real-world food supply chains. These examples will help you visualize the potential of blockchain to mitigate risks, optimize operations, and build consumer trust.

By the end of this lesson, you'll appreciate the significant advantages blockchain brings to the food supply chain, including improved transparency, enhanced traceability, increased efficiency, and robust security measures. You'll be equipped with the knowledge to envision how blockchain can be further implemented to address the challenges of the modern food supply chain, making it more sustainable, reliable, and consumer-friendly.

Lesson 3: Blockchain in Seafood and Fisheries

Lesson 3 on Blockchain in Seafood and Fisheries explores how blockchain technology is making waves in promoting sustainability and combating illegal fishing within the industry. This lesson will unfold the significant role blockchain plays in tracing and verifying the legitimacy of seafood products, ensuring that what ends up on your plate is not only fresh but ethically sourced.

As you navigate through this lesson, keep in mind the critical challenges the seafood industry faces, such as illegal fishing, mislabeling of species, and the complex international supply chains that make transparency difficult. Reflect on how blockchain technology offers solutions to these issues by enabling an immutable record of a product's journey from the ocean to the consumer, enhancing the traceability and sustainability of seafood products.



You'll encounter case studies, such as FishCoin and Bumblebee, that showcase the real-world application of blockchain in the seafood sector. These examples will illuminate how blockchain can empower stakeholders across the supply chain, from fishermen to consumers, with the tools to ensure the ethical sourcing and sustainability of seafood.

Consider the broader implications of blockchain technology in fostering sustainable fishing practices and how it aligns with global efforts to protect our oceans for future generations. This lesson isn't just about the technology itself but about envisioning a future where the seafood industry operates more transparently and sustainably, thanks to blockchain.

By the end of this lesson, you should be able to articulate how blockchain technology can tackle some of the most pressing issues in the seafood and fisheries sector, from improving traceability to ensuring sustainability and ethical sourcing. This knowledge will equip you to engage in meaningful discussions about the potential of blockchain to revolutionize the industry and contribute to a more sustainable future.

Lesson 4: Blockchain in Food Safety and Quality Assurance

Lesson 4 on Blockchain in Food Safety and Quality Assurance ventures into how blockchain technology is reshaping the landscape of food safety, enhancing traceability, and building consumer trust in the agri-food supply chain.

Begin by considering the fundamental challenges that the food industry faces in maintaining safety and quality. Issues such as foodborne illnesses, contamination, and fraud underscore the need for robust systems capable of ensuring the safety and authenticity of food products. Reflect on how blockchain's immutable ledger offers a solution by providing a transparent, tamper-proof record of every transaction within the supply chain.



Engage with the concept of smart contracts as a means of automating quality assurance processes and ensuring compliance with safety standards. These automated agreements facilitate real-time verification and streamline operations, significantly enhancing the efficiency and reliability of food safety audits.

Throughout this lesson, consider the broader implications of blockchain technology in promoting sustainable and ethical food production practices. The integration of blockchain into the food supply chain not only enhances safety and quality assurance but also supports the movement towards more responsible and sustainable food systems.

By the end of this lesson, you'll have a comprehensive understanding of blockchain's transformative potential in food safety and quality assurance. You'll be equipped with insights into how blockchain technology can be leveraged to foster a more transparent, safe, and trustworthy food supply chain, benefiting consumers, producers, and regulators alike.

Lesson 5: Blockchain in Fair Trade and Organic Certification

Lesson 5 on Blockchain in Fair Trade and Organic Certification tackles how blockchain technology is reshaping the certification landscape for fair trade and organic products. This lesson focuses on blockchain's capability to authenticate and maintain the integrity of these vital certifications, offering a new layer of trust and transparency in the agri-food industry.



The complexity of supply chains and the multitude of intermediaries can often dilute the very essence of fair trade and organic principles. Reflect on how blockchain technology, with its immutable ledger, offers a solution by providing a transparent, tamper-proof verification process for certifications.

As you delve into the core concepts, consider how blockchain not only verifies the authenticity of certifications but also ensures the ongoing credibility of fair trade and

organic labels. This technology empowers consumers with the confidence that the products they choose align with their ethical and environmental values.

Throughout this lesson, engage with the idea that blockchain can streamline the certification process, making it more efficient and less costly. This is particularly beneficial for small-scale producers, who often bear the brunt of extensive paperwork and high certification costs. Blockchain's ability to offer full supply chain visibility ensures that every stakeholder, from the farmer to the consumer, has access to reliable information regarding the product's journey and its compliance with fair trade and organic standards.

By the end of this lesson, you will be able to recognize the transformative role of blockchain in enhancing the certification processes for fair trade and organic products. You'll understand how this technology not only supports the ethical dimensions of agriculture but also contributes to a more sustainable and equitable food system.

Lesson 6: Blockchain and Sustainable Agriculture

Lesson 6 prepares you to delve into the crucial role of blockchain technology in revolutionizing sustainable practices within the agricultural sector. This lesson aims to unfold the myriad ways blockchain facilitates not just the traceability and efficiency of sustainable farming but also its significant impact on carbon credit trading and environmental sustainability.

As you navigate through the concepts of sustainable agriculture, reflect on the potential of blockchain to transform carbon trading. With climate change posing a significant threat to global agriculture, carbon credit trading emerges as a vital tool in the fight against global warming. Blockchain's transparency and efficiency could revolutionize this market, making it more accessible and reliable for farmers and investors alike.



Through the course, you will encounter examples showcasing blockchain's application in sustainable agriculture and carbon trading. These case studies, such as ReSea and Dimitra, highlight the practical benefits and challenges of integrating blockchain into the agri-food sector. They serve as a testament to the technology's potential to support environmental sustainability while promoting economic inclusion for farmers worldwide.

By the end of this lesson, you will have gained a comprehensive understanding of how blockchain technology underpins sustainable agricultural practices, contributes to environmental sustainability, and enhances the integrity of carbon credit trading. This knowledge equips you to critically assess the role of blockchain in addressing some of the most pressing challenges faced by the agricultural sector today.

Relevant Readings



- Motta, Giorgio Alessandro, Bedir Tekinerdogan, and Ioannis N. Athanasiadis. "Blockchain applications in the agri-food domain: the first wave." *Frontiers in Blockchain* 3 (2020): 6.
- Menon, Sheetal, and Karuna Jain. "Blockchain technology for transparency in agri-food supply chain: Use cases, limitations, and future directions." *IEEE Transactions on Engineering Management* (2021).
- Menon, Sheetal, and Karuna Jain. "Blockchain technology for transparency in agri-food supply chain: Use cases, limitations, and future directions." *IEEE Transactions on Engineering Management* (2021).
- Pakseresht, Ashkan, et al. "The intersection of blockchain technology and circular economy in the agri-food sector." *Sustainable Production and Consumption* 35 (2023): 260-274.

Additional readings can be found within each Lesson.

Course Provider/Contact Details



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Course #10: Smart Contracts with Example Applications in Food Supply Chain

Content and Duration

The lessons provided with the course "Smart Contracts with Example Applications in Food Supply Chain" are as follows:



Lesson 1: Introduction to Blockchain and Smart Contracts

Lesson 2: Types of Smart Contracts

Lesson 3: Introduction to applications with smart contracts in food supply chain

Lesson 4: Use Cases of Smart Contracts in Food Supply Chain

Lesson 5: Benefits & Potential challenges of smart contracts

Lesson 6: Intro to Smart Contract Development

Lesson 7: The structure of a Solidity file

Lesson 8: Designing and Writing Smart Contracts

Lesson 9: Deploying and Testing Smart Contracts



Approx. 7 hours and 40 minutes to complete.

Objective

The objective of this course is to provide interested participants, with a particular focus on SMEs owners, managers, and employees in the Food Supply Chain (FSC), the knowledge and practical skills necessary to understand, implement, and leverage blockchain technology as regards its relevance and application to smart contracts. The course consists of 9 lessons that will gradually equip the participants with the adequate knowledge and critical thinking skills necessary to understand, evaluate, and potentially contribute to the implementation of smart contracts in the Food Supply Chain.

Smart contracts that employ blockchain technology provide efficiency, transparency, and reliable transactions. Various types of contracts are investigated aimed at addressing problems encountered in the sector. By presenting the challenges currently faced in the FSC, participants can appreciate the potential benefits that smart contracts provide. Finally, by examining real-world applications trainees can grasp the practical implications of this technology, enabling them to make informed decisions and contribute effectively to the advancement of the food supply chain industry.

Fostering an innovative and collaborative mindset will be essential as participants move through the course in order to grab emerging opportunities and overcome any barriers to the adoption of blockchain technology. Furthermore, it emphasizes how crucial it is to keep learning and adapting as the area of blockchain technology quickly expands to keep participants at the forefront of business advancements.

Learning Outcomes

What you will learn:

Define the fundamental concepts of blockchain and smart contracts.

Identify key features of blockchain technology and understand their significance in transforming common procedures within the supply chain.

Gain familiarity with popular smart contracts platforms and their unique features.

Assess the advantages and risks of using smart contracts in the food supply chain.

Learn how smart contracts create opportunities for future innovation.

Evaluate the influence of smart contracts on matters such as the assurance of food safety, the deterrence of fraud, and the enhancement of supply chain efficiency and specify



possible implementation scenarios for the following strategy or concept: specific instances wherein smart contracts contribute to the improvement of the food supply chain.

Exhibit the utilization of smart contracts across diverse sectors of the food industry.

Acknowledge the significance of traceability in ensuring the authenticity and excellence of products and evaluate the influence of smart contracts on matters such as food safety and food supply chain efficiency.

Discuss intellectual property considerations and liability challenges associated with smart contracts.

Evaluate the legal challenges and regulatory considerations associated with the use of smart contracts.

Analyze potential barriers and solutions related to smart contract implementation.

Learn the basics of Ethereum and Solidity and then explore Smart Contract Layout.

Understand Decentralized Apps (DApps).

Gain a comprehensive understanding of the entire smart contract development, testing, and deployment lifecycle.

Course Level, Education Level Required, and Prerequisites



Advanced Level, Professional Development or Continuing Education



Bachelor's Degree



Supply chain basics, Trust Food course #9 "Areas of application for Blockchain Technology", background in information technology and/or basic programming skills in order to understand the realm of smart contract development.

Target Audience



University students, university graduates, business managers, business owners, agrifood company employees and food supply chain personnel with basic programming skills.

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quiz that is comprised of 49 multiple choice and true-false questions.



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

Begin the course by reviewing the objective, the learning outcomes and structure (i.e., lessons).

Lesson 1: Introduction to Blockchain and Smart Contracts

The lesson begins with an introduction to blockchain and its fundamental characteristics that enhance transaction security and integrity. Do you know what blockchain is? The term blockchain refers to a distributed decentralized digital ledger that securely and openly records transactions in chronological order across numerous computers, creating a “chain” of blocks (an arrangement of these transactions). Key features such as decentralization, immutability, and transparency are emphasized. Decentralization ensures that no single entity controls the network, while immutability guarantees that once data is recorded on the blockchain, it cannot be altered or tampered with. Transparency ensures that all participants have access to the same information, fostering trust and accountability.



The consensus mechanism, a vital protocol that is met in the world of blockchain are being further explained. The two most consensus mechanisms, Proof of Work (PoW) and Proof of Stake (PoS) are defined and put in comparison.

Since you probably haven't met the term smart contract before, the next slide presents the definition of smart contracts while it mentions how the term was created. Smart contracts are self-executing contracts with the terms of the agreement directly written into code. This innovative concept revolutionizes traditional contract enforcement by automating and executing agreements in a transparent and trustless manner.

The rest of the lesson focuses on a deeper understanding of the term. The characteristics and also the most used smart contract platforms, such as Ethereum or Hyperledger Fabric, are presented.

Lesson 2: Types of Smart Contracts

Smart contracts come in various forms, such as Payment Contracts automating financial transactions and Voting Contracts decentralizing governance. Each type contributes uniquely to improving efficiency, transparency, and trust.



Lesson 2 investigates the different types of smart contracts that address specific problems that appear in the food sector, by streamlining processes. Payment contracts and legal smart contracts are the first ones introduced. If you don't understand how a type of smart contracts works, you can also check the examples which are provided.

What might be more appealing to you are the supply chain contracts, which revolutionize the management and traceability of goods throughout the supply chain. By the end of this lesson what you will have acquired is the ability to assess the advantages and the risks of using smart contracts in the food supply chain and the link to the blockchain technology.

Lesson 3: Introduction to applications with smart contracts in food supply chain

Lesson 3 signifies the first step into the domain of smart contracts within the context of the food supply chain. Before exploring the advantages and obstacles, it is crucial to develop an in-depth understanding of the foundational technology underlying this revolutionary system, namely blockchain.

The lesson begins with an exploration of the term "Food Supply Chain". Do you know how blockchain technology benefits and enhances the food supply sector? As you progress through this lesson, you will discover that blockchain emerges as an answer, providing traceability, sustainability, and transparency.



From the general concept of blockchain technology the smart contracts application is then presenting, and you will understand how smart contracts increase productivity while reducing human involvement. The whole food supply chain is being revolutionized by the inclusion of smart contracts, which further automate procedures from quality control to payment and settlement. This will become clear to you by the specific applications of smart contracts in the agricultural supply chain which are described in detail.

In order for you to get a deeper understanding of the significance of blockchain in the food supply chain, do not bypass the video:

<https://www.youtube.com/watch?v=r0pv7e1oLPo>

Lesson 4: Use Cases of Smart Contracts in Food Supply Chain

Blockchain technology has resulted in an era of traceability, transparency, and security, which offers the food industry opportunities to enhance its operations. In Lesson 4, specific use cases from a variety of industries are being examined as we explored the numerous food supply chain applications of smart contracts.



Aspects of critical food industries, including livestock, aquaculture, dairy, beverages, and frozen foods, are analyzed in terms of specific smart contract use cases. Through detailed analysis, you will gain insight into how blockchain technology and smart contracts are employed to optimize operations and address challenges within these sectors.

In this lesson, we present the way these sectors employ these technologies to increase effectiveness, establish trust, validate authenticity, and monitor the integrity of food provision.

If you want to realize the real-world impact of smart contracts deployed across various sectors within the food supply chain, make sure not to skip this lesson!

Lesson 5: Benefits & potential challenges of smart contracts

Smart contracts offer numerous benefits but also present potential challenges. Lesson 5 recaps the ways in which smart contracts are a useful and innovative technology that may be used in a variety of fields, including supply chain management, financial services, and contracts for other purposes.



But what about the legal issues associated with this innovation that need to be addressed in order to facilitate a secure and efficient transition to this revolutionary technology?

Did you know that in order for a company to use a smart contract to offer digital securities, it must ensure that it conforms with SEC regulations and other financial laws?

Like every other innovative method that offers benefits with its application, several challenges and obstacles are met on the way. In order to be effective, you need to be aware of these challenges prior to their application so as to act effectively. The lesson navigates through the barriers of smart contract governance, international trade implications, and the evolving landscape of insurance policies.

Lesson 6: Intro to Smart Contract Development

Lesson 6 presents a practical application of smart contracts, focusing on Ethereum as a prominent platform for their implementation.

Do you know Ethereum? Ethereum is a global decentralized platform for peer-to-peer transactions through blockchain technology enabling the secure execution of smart contracts.

What about Solidity? If you are familiar with smart contracts development, maybe you have met Solidity before. Solidity, a high-level programming language, plays a pivotal role in smart contract development on the Ethereum platform.



If you want to learn more about Solidity, visit this page: <https://docs.soliditylang.org/en/v0.8.21/>

Writing and implementing smart contracts on Ethereum-based blockchains is part of the Solidity development process. The platform and tools required for programmers to create these smart contracts and decentralized apps (DApps) are provided by Solidity.

The lesson ends with details of the actual structure of a contract, providing you with insights into its components and functionalities!

Do not forget to check this video tutorial showcasing the creation of an Ethereum smart contract: <https://www.youtube.com/watch?v=bNXJNeaYl8Q>

Lesson 7: The structure of a Solidity file

Lesson 6 presented Solidity, the driving force behind decentralized application development that provides expertise at well-structured and effective smart contracts creation. Lesson 7 delves deeper into the core elements of Solidity file structure.



This lesson adopts a holistic approach, emphasizing the significance of optimization techniques, licensing compliance, best practices, and clear documentation through comments. The focus on these key aspects will empower you as a potential developer to create secure, efficient and maintainable decentralized applications.

In general, this lesson will make you familiar with the best practices in code!

Lesson 8: Designing and Writing Smart Contracts

Are you ready to become well-equipped to handle the constantly changing field of blockchain technology? By completing lesson 8, you will be able to create precise contract terms and evolve to an expert in coding and deploying.

This lesson serves as a reminder of key concepts essential to smart contract development, including decentralization, transparency, traceability, and immutable ledgers.



Do you know the fundamentals of smart contract development? What key principles are to be followed especially for applications in complex systems like the food supply chain?

If you want answers to these questions, check out the necessary practical skills for the development of smart contracts.

Finally, lesson 8 presents a few methods that prioritize accessibility, simplicity and user experience fostering the development of user-friendly smart contracts.

Lesson 9: Deploying and Testing Smart Contracts

Do you want to implement smart contracts confidently and in accordance with best practices?

Course #10 is concluded with lesson 9 that provides a thorough exploration of the complexities involved in developing Ethereum smart contracts.

Completing lesson 9 will equip you with the skills that are required in order to guarantee the dependability and functioning of individual components. The lesson covers techniques for unit testing, utilizing well-known frameworks such as Truffle and Hardhat.



Do you know any sophisticated deployment strategies already? What about the value of security audits?

Lesson 9 explores the essential elements of setting up a testing environment, presents best practices for deployment and efficient testing of state transitions.

Make sure to check out the videos for additional help:

<https://www.youtube.com/watch?v=bZKVfXmzRDw>

<https://www.youtube.com/watch?v=ooN6kZ9vqNQ>

Relevant Readings

Academy, S. (2023). Enhancing Smart Contract Communication: Breaking Down the Barriers  . Medium. Available at: <https://medium.com/@solidity101/enhancing-smart-contract-communication-breaking-down-the-barriers-5e67e6b6b351>

Anon, (2022). Layout of a Solidity Source File – Be on the Right Side of Change. Available at: <https://blog.finxter.com/layout-of-a-solidity-source-file/>

BitPay Blog. (2023). Understanding Smart Contracts: How They Work & Their Role in Crypto Payments | BitPay. Available at: <https://bitpay.com/blog/understanding-smart-contracts/>

Chaijs.com. (2018). Chai. Available at: <https://www.chaijs.com/>

Cointelegraph. A deep dive into the 5 popular smart contract development platforms and their comparison. Available at: <https://cointelegraph.com/learn/smart-contract-development-platforms>

DevTeam.Space. (2022). What are the 5 Best Smart Contract Platforms for 2022? | DevTeam.Space. Available at: <https://www.devteam.space/blog/what-are-the-5-best-smart-contract-platforms-for-2022/>

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Course Provider / Contact Details



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Course #11: Blockchain platforms

Content and Duration

The lessons provided with the course “Blockchain platforms” are as follows:

Lesson 1: Introduction to Blockchain Platforms

Lesson 2: Exploration of Key Blockchain Platforms – Part I

Lesson 3: Exploration of Key Blockchain Platforms – Part II

Lesson 4: Exploration of Key Blockchain Platforms – Part III



Lesson 5: Exploration of Key Blockchain Platforms – Part IV

Lesson 6: Exploration of Key Blockchain Platforms – Part V

Lesson 7: Exploration of Key Blockchain Platforms – Part VI

Lesson 8: Exploration of Key Blockchain Platforms – Part VII

Lesson 9: Exploration of Key Blockchain Platforms – Part VII

Lesson 10: Comparison of Blockchain Platforms



Approx. 11 hours to complete (including study time).

Objective

The course “Blockchain Platforms” aims to provide an understanding on different blockchain platforms and their specific applications, particularly in the context of the food supply chain. Participants will gain insights into various types of blockchain platforms, each with its unique strengths, limitations, and use-cases. The course begins with an introduction to the fundamental types and purposes of these platforms. This course covers major platforms like Ethereum, Hyperledger Fabric, IBM Food Trust, VeChain, Tezos, NEAR, Polkadot, and Solana. Each lesson will focus on the unique aspects of these platforms, including smart contracts, decentralized applications, private and permissioned blockchains, scalability, and developer-friendly interfaces. Participants will examine real-world case studies to understand how these platforms are applied in the food supply chain, evaluating factors such as security, scalability, consensus mechanisms, and smart contract functionality. This course is designed to equip learners with the knowledge to critically assess and choose the most appropriate blockchain platform for various applications in the food supply chain.

Learning Outcomes

As a trainee, you will:

- Overview of Blockchain Types: Learn about the differences between public, private, and consortium blockchains, and how they are applied in the food supply chain.
- Blockchain's Role in Food Supply Chain Management: Understand how blockchain platforms enhance traceability, transparency, and efficiency from farm to table.
- Ethereum's Applications: Gain insights into Ethereum's smart contracts and decentralized applications, and their contributions to food safety and supply chain transparency.
- Hyperledger Fabric's Business Applications: Explore the architecture and unique features of Hyperledger Fabric, recognizing its advantages in supply chain efficiency and security in the food industry.
- IBM Food Trust Platform Analysis: Analyze the IBM Food Trust platform's role in enhancing food safety and its impact on supply chain processes.
- VeChain in Supply Chain Management: Learn about VeChain's role in supply chain management with real-world examples from the food industry.
- Tezos' Application in Agriculture: Discover Tezos' application in decentralized solutions for agricultural insurance and its role in enhancing food safety and quality in the supply chain.
- NEAR Protocol's Unique Features: Identify the unique features of NEAR Protocol and assess its potential in driving innovation and enhancing supply chain solutions in the food industry.
- Interoperability in Polkadot: Understand the concept of interoperability in Polkadot, its function, benefits of sidechains, and its importance for the food supply chain.
- Solana's Technological Advantages: Evaluate Solana's technological features and its suitability for large-scale, real-time operations in the food industry.
- Comparative Analysis of Blockchain Platforms: Conduct an analysis and comparison of various blockchain platforms, identifying the technologies best suited for specific applications in the food supply chain.



Course Level, Education Level Required, and Prerequisites



Intermediate Level, Professional Development



Bachelor's Degree



Consider this course as an advanced level of “Course 1: Introduction to Blockchain Technology and Digital Assets”, “Course 7: Basic Blockchain Skills”, “Course 8: Advanced Blockchain Skills”.

Target Audience



Professionals in the Agri-Food Industry, Blockchain Developers and Technologists, Supply Chain Managers, Academics and Researchers, Students in Related Fields

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quizzes. There is one quiz for each lesson. Each quiz has 3-5 questions (i.e. multiple choice, true/false etc).



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

To effectively engage with the “Blockchain Platforms” course, adopt an active, self-directed learning strategy. This course offers a blend of dynamic and interactive experiences, meticulously designed to meet your unique needs and varied learning styles.

Lesson 1: Introduction to Blockchain Platforms



Start the Lesson: Begin by exploring various types of blockchain platforms and their significance in the food supply chain. Understand the course's goal of familiarizing yourself with these platforms and comprehending their applications.

Key Concepts of Blockchain Types: Study the key concepts related to different blockchain types, including public, private, and consortium blockchains, and their roles in food supply chain management.

In-Depth Exploration: Study each blockchain type, learning about their unique features, advantages, disadvantages, and examples. Self-assess your understanding of the primary types of blockchain platforms and their potential uses in the food supply chain.



Lesson Conclusion: Conclude the lesson by summarizing for yourself the different blockchain types and their applications in enhancing traceability and efficiency from producer to consumer.

Interactive Elements for Self-Assessment: Utilize interactive elements like questions provided in the course to gauge your initial knowledge and expectations.



Formative Assessment: Engage with the provided questions and discussions to assess your understanding. This also keeps your learning experience interactive and engaging.

Lesson 2: Exploration of Key Blockchain Platforms – Part I

Introduction to Ethereum: Begin by exploring Ethereum's role in the blockchain landscape, particularly its use in smart contracts and decentralized applications (dApps) within the food supply chain.



Understanding Ethereum's Smart Contracts: Learn about how Ethereum's smart contracts contribute to food traceability and safety. Discuss the impact of dApps in enhancing supply chain transparency.

Architecture of Ethereum: Study Ethereum's architecture, including its virtual machine (EVM) and the functionality of Ether, its native currency.

Case Study Analysis: Examine a case study like TE-FOOD to understand Ethereum's practical application in the food supply chain.



Lesson Summary: Summarize the lesson's key points, focusing on Ethereum's smart contract functionality and its application in the food supply chain.

Interactive Elements for Self-Assessment: Utilize interactive elements like questions provided in the course to gauge your initial knowledge and expectations.



Formative Assessment: Engage with the provided questions and discussions to assess your understanding. This also keeps your learning experience interactive and engaging.

Lesson 3: Exploration of Key Blockchain Platforms – Part II

Introduction to Hyperledger Fabric: Start by learning about Hyperledger Fabric, a private, permissioned blockchain platform ideal for business applications, with a focus on its use in the food supply chain.



Exploring Hyperledger Fabric's Architecture: Understand how Hyperledger Fabric's architecture supports secure and efficient supply chain management. Analyze the IBM Food Trust case study as an application of Hyperledger Fabric in the food supply chain.

Architecture of Ethereum: Study Ethereum's architecture, including its virtual machine (EVM) and the functionality of Ether, its native currency.



Lesson Summary: Review the lesson, emphasizing Hyperledger Fabric's modular and configurable design and its role in supply chain efficiency and security.



Interactive Elements for Self-Assessment: Utilize interactive elements like questions provided in the course to gauge your initial knowledge and expectations.

Formative Assessment: Engage with the provided questions and discussions to assess your understanding. This also keeps your learning experience interactive and engaging.

Lesson 4: Exploration of Key Blockchain Platforms – Part III

Introduction to IBM Food Trust: Start by learning about the IBM Food Trust platform, its design tailored for the food supply chain, and how it enhances food safety and supply chain efficiency.



Understanding IBM Food Trust's Role: Explore how IBM Food Trust ensures food safety and traceability and streamlines supply chain processes.

Addressing Supply Chain Challenges: Understand the challenges in the food supply chain, like limited transparency, and how IBM Food Trust addresses these issues.



Overview of IBM Food Trust: Investigate the IBM Food Trust platform, including its use of blockchain technology, key features, and benefits.

Lesson Summary: Summarize the key points, focusing on the tailored design of IBM Food Trust for food safety and supply chain efficiency.



Interactive Elements for Self-Assessment: Utilize interactive elements like questions provided in the course to gauge your initial knowledge and expectations.

Formative Assessment: Engage with the provided questions and discussions to assess your understanding. This also keeps your learning experience interactive and engaging.

Lesson 5: Exploration of Key Blockchain Platforms – Part IV



Introduction to VeChain: Begin by learning about VeChain, its specialization in supply chain and logistics, especially in the food industry, and its unique features addressing logistics challenges.

Technical Aspects of VeChain: Cover VeChain's technical details, including its consensus model (Proof of Authority), governance, efficiency, and smart contract functionality.



Lesson Summary: Review the key points covered in the lesson, focusing on VeChain's specialization in supply chain logistics and its real-world applications in the food industry.



Interactive Elements for Self-Assessment: Utilize interactive elements like questions provided in the course to gauge your initial knowledge and expectations.

Formative Assessment: Engage with the provided questions and discussions to assess your understanding. This also keeps your learning experience interactive and engaging.

Lesson 6: Exploration of Key Blockchain Platforms – Part V



Introduction to Tezos: Start by exploring Tezos, especially its role in agricultural insurance and the food supply chain. Learn about Tezos' unique features that contribute to food safety and quality assurance.

Understanding Tezos' Key Features: Study Tezos' features like self-amendment, formal verification, and liquid proof-of-stake mechanism. Understand how these features make Tezos suitable for applications in agriculture and food supply chains.



Tezos in Food Supply Chain: Learn how Tezos enhances traceability with immutable records for product tracking and smart contracts for process automation in the food supply chain.

Lesson Summary: Review Tezos' potential to revolutionize safety and quality assurance in agriculture, focusing on its innovative features and applications.



Interactive Elements for Self-Assessment: Utilize interactive elements like questions provided in the course to gauge your initial knowledge and expectations.

Formative Assessment: Engage with the provided questions and discussions to assess your understanding. This also keeps your learning experience interactive and engaging.

Lesson 7: Exploration of Key Blockchain Platforms – Part VI



Introduction to NEAR Protocol: Begin by learning about NEAR Protocol, its scalable and developer-friendly features, and its application in the food supply chain.

NEAR's Technical Features: Understand NEAR's design, including its sharding mechanism, proof-of-stake consensus model, and cross-chain interoperability.



NEAR in the Food Industry: Explore the application of NEAR in the agriculture field.



Interactive Elements for Self-Assessment: Utilize interactive elements like questions provided in the course to gauge your initial knowledge and expectations.

Formative Assessment: Engage with the provided questions and discussions to assess your understanding. This also keeps your learning experience interactive and engaging.

Lesson 8: Exploration of Key Blockchain Platforms – Part VII



Introduction to Polkadot: Start by exploring Polkadot, focusing on its interoperability and use of sidechains, and how these features can enhance solutions in the food supply chain.

Polkadot's Core Features: Learn about Polkadot's scalability, consensus mechanism, security model, upgradeability, and cross-chain composability.

Polkadot's Architecture: Understand Polkadot's structure, including the relay chain, parachains, and bridges.



Interactive Elements for Self-Assessment: Utilize interactive elements like questions provided in the course to gauge your initial knowledge and expectations.

Formative Assessment: Engage with the provided questions and discussions to assess your understanding. This also keeps your learning experience interactive and engaging.

Lesson 9: Exploration of Key Blockchain Platforms – Part VIII



Introduction to Solana: Begin by exploring Solana's high-speed and high-capacity features and their potential to revolutionize operations in the food industry.

Understanding Solana's Technical Features: Study Solana's unique technical features, including transaction speed, low latency, and innovative architecture.

Solana's Ecosystem: Learn about Solana's growing ecosystem and diverse applications, including DeFi and NFTs.



Applying Solana in Agriculture: Discover how Solana's features can be applied to large-scale agricultural operations, focusing on scalability, cost-effectiveness, and IoT integration for precision agriculture.

Lesson Summary: Summarize Solana's impact on supply chain management, emphasizing its performance and potential in large-scale operations.



Interactive Elements for Self-Assessment: Utilize interactive elements like questions provided in the course to gauge your initial knowledge and expectations.

Formative Assessment: Engage with the provided questions and discussions to assess your understanding. This also keeps your learning experience interactive and engaging.

Lesson 10: Comparison of Blockchain Platforms

Introduction to Blockchain Platform Comparison: Start by learning about the unique features of various blockchain platforms and their relevance to the food supply chain.

Criteria for Comparison: Understand the criteria for comparing blockchain platforms, such as security features, scalability, and smart contract support.



Overview of Blockchain Platforms: Get a detailed overview of each blockchain platform, covering their characteristics and impact on food supply chain applications.

Comparative Analysis: Leverage the provided excel file to conduct a comparative analysis of the platforms based on the predefined criteria, evaluating each platform's strengths and limitations.

Interactive Elements for Self-Assessment: Utilize interactive elements like questions provided in the course to gauge your initial knowledge and expectations.



Formative Assessment: Engage with the provided questions and discussions to assess your understanding. This also keeps your learning experience interactive and engaging.

Relevant Readings



- Hedera. Available at: <https://hedera.com>
- Ripple. Available at: <https://ripple.com>
- Stellar. Available at: <https://stellar.org>
- Antonopoulos, A. M. and Wood, G. (2018) Mastering Ethereum: building smart contracts and dapps. O'Reilly Media.
- Hyperledger. Hyperledger Fabric. Available at: <https://www.hyperledger.org/projects/fabric>

- R3. Corda. Available at: <https://r3.com/products/corda/>
- ConsenSys. Quorum. Available at: <https://consensys.net/quorum/>
- Litecoin. Available at: <https://litecoin.org>
- Solana, Web3 Infrastructure for Everyone. Available at: <https://solana.com/>
- VeChain, Available at: <https://www.vechain.org/>

Additional readings can be found within each Lesson's presentation.

Course Provider / Contact Details



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Course #12: Blockchain and Traceability in Relation to Food Supply Chain Integrity

Content and Duration

The lessons provided with the course “Blockchain and Traceability in Relation to Food Supply Chain Integrity” are as follows:

Lesson 1: A holistic approach to food supply chain integrity

Lesson 2: Principles of a traditional traceability system in the food supply chain

Lesson 3: Examples of traceability systems in different food sectors

Lesson 4: Blockchain principles

Lesson 5: Using blockchain principles in designing traceability systems

Lesson 6: Blockchain examples from the food sector: implementation benefits and challenges



4 hours and 30 minutes

Objective

The objective of this course module is to provide interested participants, with a particular focus on SME owners, managers, and employees in the food supply chain, the knowledge and practical skills necessary to understand and implement blockchain technology in traceability systems to support food supply chain integrity. You will familiarise yourself with the topic of food supply chain integrity, comprehend the traceability systems principles and their application in food supply chains, and get an understanding of the basic operating principles of blockchain technology and how they can support traceability systems. You will gain insight into how to design and practically use blockchain-based traceability systems through concrete examples from the food sector. By the end of this course, you will be able to recognise how blockchain-based food traceability could be designed and what the benefits and challenges of such systems are.

Learning Outcomes

What you will learn:



- Recognise the holistic approach to food integrity
- Explain the steps in designing a food traceability system and describe its benefits and challenges
- Describe how RFID and QR codes could be used in traceability systems in the food sector
- Recognise the operating principles of blockchain and explain its functionalities
- Identify how blockchain functionalities can support food supply chain traceability
- Recognise benefits and challenges in the implementation of blockchain-based traceability systems in the food sector through concrete examples

Course Level, Education Level Required, and Prerequisites



Intermediate level, Professional Development or Continuing Education



To follow this course, minimally a bachelor's degree or equivalent is required



To follow this course, experience in the food sector in quality control and/or assurance, food quality logistics, and/or quality management is expected. It is advised to first follow TRUST-FOOD courses “6 – Introduction to Blockchain in the Food Supply Chain” and “7 - Basic Blockchain Skills”.

Target Audience



Food professionals working in small and medium enterprises in the food sector, such as employees working in procurement, supply control, quality control, and assurance (QC and QA) and senior managers (QC and QA). The module is also useful for just graduated students (University, Applied Science) who start searching for a job.

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quizzes.



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

Begin the course by reviewing the objective, the learning outcomes and the structure. In lesson 1, you can find the overall aim of the module (in slide #2) and the main learning outcomes for each lesson (in slide #4).

Lesson 1: A holistic approach to food supply chain integrity



Before beginning this lesson, realize that there is no univocal concept for food integrity and that food integrity is a multi-dimensional and multi-disciplinary concept which requires a holistic approach and involves safety, quality, authenticity and defence aspects.

A holistic approach to food supply chain integrity is necessary to ensure safe, palatable, and authentic food, and to provide consumers with trust and the ability to trace the origin of their food. Having solely a food safety management system in place is not enough to provide food supply chain integrity, as it does not prevent deliberate contamination. However, traceability and new technologies, such as blockchain, could support food safety, high quality, and authenticity by enhancing trust and transparency.

Based on this approach, think for a few minutes about what the term “food integrity” means to you.

While on slide #7, make sure that you understand the differences between food integrity and food fraud concepts. Can you already give an example of both concepts?



In slide #9, consumer trust is given as one of the reasons of why assuring food integrity is important. Could you think about the possible reasons for the decline in trust in the food supply chain? Do you trust the food you consume? Why?

Slide #10 highlights the four elements of the food integrity concept that should be considered across the food supply chain. Try to connect this information with the examples in slides #11-12 as they are defined by the researchers of corresponding articles.

Given the information you learnt, what do you believe to be the most vulnerable integrity element (i.e. product, process, people or data)?

Slide #13 shows how the holistic approach to food integrity. Remember that the food integrity concept needs a multi-dimensional and disciplinary approach, as it is explained in the slide notes.

On slide #15, examples of food fraud incidents are mentioned. Can you remember any other food fraud incidents that you have faced or heard about? Try to distinguish which food integrity element might have been manipulated in these incidents.

Based on slide #19, try to elaborate on your understanding of how traceability can support the elimination of food fraud.



After the lesson, you could check the monthly basis reports on food fraud incidents published by the EU (visit the website given on the last slide). Do you recognize which integrity element has been manipulated in these fraud incidents?

Lesson 2: Principles of a traditional traceability system in the food supply chain

This lesson introduces the principles of traditional food traceability systems. Before starting this lesson, first have a look at the EU's General Food Law Regulation on food traceability via the official website to get some context about regulations associated with food traceability.



In slide #3, food traceability is defined as the ability to follow the movement of a food product and its ingredients through all steps in the supply chain, both backwards (tracing) and forward (tracking). As a consumer, would you like to know the origin and history of the food products you purchase? Why?

On slide #6, realize that there are no strict requirements about what a traceability system should contain. The elements described in this slide are some of the most common ones. Similarly, there is no univocal way to design a traceability system either and the steps introduced in slide #7 are recommended steps to consider in the design. Have you ever been involved in designing a traceability system in one way or another? Do you recognize these steps?



In slide #8, the trade-off between costs and benefits is mentioned as a consideration when designing a traceability system. As a consumer, what would you be willing to pay extra for improved traceability? Does that differ for you per product (category)?

On slide # 9, think about the possible implications of the various strategies on the design of the track and trace system. If you work in a food business, consider what the drivers are of the traceability strategy in your company.

On slide #13, common technologies in food traceability systems are mentioned. Have you experienced or faced one of those technologies in food traceability? If so, how were they used?

On slides #14-16, think about the benefits of having a traceability system in the food supply chain and the challenges in the application of traceability to food systems.



Before moving on to the next lesson, it is advised to read the articles that are used for the cases in lesson 3. Besides, you can already try to find and examine some food packages with RFID tags or QR codes while doing your groceries.

Lesson 3: Examples of traceability systems in different food sectors

This lesson dives into two examples to enhance the understanding of common traceability applications in the food supply chain. These examples are based on the articles of Regattieri et al. (2007) and Chen et al. (2020). The design steps of the traceability systems are following the structure as given in the corresponding articles. Each design might have extra or different steps as compared to the three steps defined in the key concept slide (slide #3). When going through the examples, try to build a general understanding for yourself of the traceability system design aspects.



Before going to slide #5, take a few minutes to remember the traceability applications from lesson #2. Have you seen an RFID Tag or QR code on any food package before? If so, for what purpose were they being used?



When going through the two case examples, try to recognize the design steps that are common for a traceability system (i.e., the steps as shown in slide #3). If you would like to know more details about the design of the traceability systems as discussed in the examples, make sure to read through the corresponding articles.



At the end of this lesson, think about the benefits the designed traceability systems provide to food companies. You can also check the articles of the case studies to see whether any benefit is mentioned.

Lesson 4: Blockchain principles



This lesson discusses the basic operating principles of blockchain technology. Be aware that this lesson does not aim to provide an advanced level of knowledge on blockchain technology, but only provides the relevant information to be able to understand the application of blockchain technology in food traceability.

In slide #3, some key terms are introduced that will be used in the next slides. Please refer to this slide when you need to remember the definition of these terms during the lesson.

In slides #8-10, try to understand how blockchain provides a secure storage environment for data/information entered through transactions.

The main functionalities of blockchain are introduced in slides #11-13. Understanding the basics of these functionalities is crucial to be able to understand the possible benefits of blockchain in food traceability.



There are several and ever-developing consensus algorithms that play a role in the controlling of transactions. In slide #14, three of them are simply introduced. If you are interested to learn about the other and latest consensus algorithms, please check the relevant literature.

Slide #15 summarizes how blockchain works. You can imagine that in a blockchain-applied food traceability system, each stakeholder's data entry will follow a similar flow.

So far, you have learned about how blockchain secures data/information and how it operates according to consensus algorithms. Based on the decided securing of the data and consensus rules, blockchain architectures can be classified as shown in slide #16.



At the end of this lesson, try to think about how blockchain can be leveraged in food traceability, based on the information you have learned so far.

Lesson 5: Using blockchain principles in designing traceability systems



Before this lesson, try to remember the general aspects of designing a food traceability system that you have learnt in lesson 2.

In this lesson, you will learn the basics of a blockchain-based food traceability system design. Realize that these design steps are recommended aspects to consider and therefore the context of steps or the number of steps might change according to design aims and requirements.

In slide #3, you find terminology that will be helpful in the next slides. Here, the smart contract term is explained with other words than the previous lesson, but with the same meaning to make you familiar with different definitions.

In slide #5, some general needs and challenges in food traceability systems are highlighted. How do you think that blockchain implementation to food traceability can address the mentioned challenges and needs?



Slides #10-18 involve the recommended design steps for a blockchain-based food traceability system, which you can think of as a guideline for a systematic and transparent design.

After the lesson, you can practice *Tailoring the blockchain-based traceability system* by selecting a food product supply chain and collecting some basic data on it. Then, try to answer the simple questions given in the ‘tailoring the blockchain-based traceability system’ design step (slide #17).



Lesson 6: Blockchain examples from the food sector: implementation benefits and challenges

Similar to lesson 3, in this lesson some examples of blockchain-based food traceability system designs are discussed. The design steps of the traceability systems are following the structure as given in the corresponding articles. Each design might have extra or different steps as compared to the steps defined in slide #5. When going through the examples, try to build a general understanding for yourself of the blockchain-based traceability system design aspects.



Before this lesson, please read the articles of the case studies that are examined to recognise the blockchain-based food traceability design steps.

In case study 1 (slides #6-16), a private company in China that aims to implement blockchain technology in the apple fruit traceability system for the storage and query of product information through the supply chain is examined (Yang et al., 2021). Try to familiarize yourself with the aspects suggested in the blockchain-based traceability design through this case study.

In lesson 5, you learnt that several layer types can be used in the building architectural design step. In the case studies in this lesson, you will see some of those layers that are specifically defined for the examples by the researchers of the articles. Realize that different layers can be involved and defined to design a process based on the requirements and the aim of the design. For instance, in case study 1 (slide #13), four layers are involved in building the architectural design process and are specifically defined based on the goals of the design.



In slide #14, try to remember the simple questions for the assessment of system design that were introduced in lesson 5. These kinds of questions can be helpful when evaluating the suitability (and reasoning behind it) of blockchain for the selected system, and the determination of the most suitable blockchain technology.

To observe the user application module provided by the researchers of the article you can scan the QR code in slide #16.

In case study 2 (slides # 17-26), a private meat company in Portugal that wants to control and enhance the product (i.e., ham) quality and make the product's origin transparent to the final consumer through a blockchain-based traceability system (Arvana et al., 2023) is examined.

Through this last case study, you can check whether you are able to recognise the motivation (strategy) behind the blockchain-based traceability design, selected traceable resource unit, the approaches in the data handling step and classification of identified system requirements (slides # 19-22).

In slide #23, similar to the previous case study, researchers specifically defined 4 layers for the building the architectural design. Can you identify different layers compared to the previous case study?

In this case study, different from the previous one, researchers also shared information regarding the defined accessibility requirements for potential users of the designed system (slide #24). You might recognize that there might be additional and/or different considerations/steps in the design process based on the aim of the design.

At the end of the lesson (slides #27-28), the mentioned benefits and challenges in the corresponding articles are examined. Do you think the gained benefits outweigh the challenges in the blockchain implementation in those case studies? Why?



In slide #32 you will find an overview of what you have learnt through this course module. Do you think you reached the overall aims of lessons and the expected learning outcomes of this module? Which parts are still unclear for you?

Relevant Readings

- It is recommended to look through the following book;

Luning, P. A., & Marcelis, W. J. (2020). Food quality management: technological and managerial principles and practices. In Food Quality Management. Wageningen Academic.



- It is also recommended to check the further reading list provided for each lesson. These lists may contain useful resources with which you can elaborate your understanding of the topic.
- In lesson 3, the following articles were used in the case studies;
 - 1) Regattieri, A., Gamberi, M., & Manzini, R. (2007). Traceability of food products: General framework and experimental evidence. *Journal of Food Engineering*, 81(2), 347-356.

- 2) Chen, T., Ding, K., ShuaiKang, H., GenDao, L., & JingYe, Q. (2020). Batch-based traceability for pork: a mobile solution with 2D barcode technology. Food Control, 107.
- In lesson 6, the following articles were used in the case studies;
 - 1) Yang, X., Li, M., Yu, H., Wang, M., Xu, D., & Sun, C. (2021). A trusted blockchain-based traceability system for fruit and vegetable agricultural products. IEEE Access, 9, 36282-36293.
 - 2) Arvana, M., Rocha, A. D., & Barata, J. (2023). Agri-Food Value Chain Traceability Using Blockchain Technology: Portuguese Hams' Production Scenario. Foods, 12(23), 4246.

Course Provider / Contact Details



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Course #13: Blockchain Applications for Food Quality Assurance and Certification

Content and Duration

The lessons provided with the course “Blockchain Applications for Food Quality Assurance and Certification” are as follows:

Lesson 1: Introduction to Food Quality Assurance and Certification

Lesson 2: Supply Chain and Blockchain Application for Food Quality Assurance and Certification



Lesson 3: Blockchain Application for Milk Quality Assurance and Certification

Lesson 4: Blockchain Application for Honey Quality Assurance and Certification

Lesson 5: Blockchain Application for Wine Quality Assurance and Certification

Lesson 6: Blockchain Application for Olive Oil Quality Assurance and Certification



Approx. 4 hours and 45 minutes to complete.

Objective

The objective of this course is to provide to interested participants, with a particular focus on SMEs owners, managers, and employees in the FSC, the knowledge and practical skills necessary to understand, implement, and leverage blockchain technology for enhancing food quality assurance and respond to certification processes. The FSC is a complex network of interconnected activities, processes, and entities involved in the production, processing, distribution, and consumption of food products. It includes all the stages and intermediaries through which food travels from the initial point of production to the final point of consumption. More specifically, the FSC involves numerous stakeholders, including producers, processors, distributors, retailers, regulatory authorities, and consumers. Therefore, the FSC is a critical component of the food industry and plays a significant role in ensuring that food products reach consumers safely and efficiently. Blockchain technology is increasingly being used to enhance transparency, traceability, and trust in the FSC. Therefore, the main goal of this course focuses on gaining a good understanding of how blockchain technology is applied in the FSC for food quality assurance and certification. More specifically, the first lesson provides familiarization with the notions of food quality assurance and food quality certification under the light of the FSC. With the second lesson attendees will gain familiarity with the utilization of blockchain technology in ensuring food quality and certification, particularly within the framework of the FSC by a step-by-step process to identify stakeholders in FSC. The following four lessons provide how the step-by-step process is applied for four different case studies, namely the milk, honey, wine, and olive oil supply chains.

Learning Outcomes

What you will learn:

- Understand the underlying processes and potential issues in food quality assurance and certification.
- Understand the benefits of blockchain adoption for food quality assurance and certification.
- Learn how blockchain technology can be used for food quality assurance and certification.
- Learn how to design and adapt their own blockchain application for food quality assurance and certification.
- Get familiar with and dive into specific case studies of blockchain application in food quality assurance (covering different food categories).



Course Level - Education Level Required - Prerequisites



Beginners, Professional Development or Continuing Education



High School Diploma or Equivalent



Supply chain basics, basic understanding of certification processes, background in agriculture and/or food science

Target Audience



Agrifood company employees and food supply chain personnel, logistics companies, university students, university graduates, business managers, business owners

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quiz that is comprised of 24 multiple choice and true-false questions.



A certificate of attendance will be provided upon completion of all lessons and quizzes

Guidelines - Activities Tips for Trainee

Begin the course by reviewing the objective, the learning outcomes and structure (i.e., lessons).

Lesson 1: Introduction to Food Quality Assurance and Certification

At the beginning of this lesson, have in mind that the food quality is a rather heterogeneous term because it is directly related to the individual perception of the consumer. Based on that statement you could wonder on what means for you the term “food quality”.



You could check the following link https://knowledge4policy.ec.europa.eu/food-fraud-quality/topic/food-fraud_en. Did you know that in 2019, Europol seized a whopping 150 tons of sunflower oil falsely labeled as Olive Oil?

And that genuine Olive Oil from Apulia and Greece was sold as Protected Geographical Indication (PGI) Toscano?

Did you know about the information in this picture?

Is this close to what you were thinking?

While at slide #7 think about how safe you feel with the food you consume on a frequent basis. Choose one or two of these products and try to make notes by recording potential vulnerabilities and contamination causes that make the product unsafe. Think about specific products such as cow milk, olive oil, rice etc. For example, potential vulnerabilities and contamination causes for cow milk could be antibiotics and/or other chemicals, poor hygiene, contaminated feed, or water, inadequate temperature while stored and transported. You could think about vulnerabilities and contamination causes other products (e.g., honey, wine, fruits).



Lesson 2: Supply Chain and Blockchain Application for Food Quality Assurance and Certification

The blockchain technology has been increasingly used in to ensure transparency and traceability, which is becoming an important issue for ensuring food safety. You will gain familiarity with the utilization of blockchain technology in ensuring food quality and certification, particularly within the several stages of the FSC.



Before you proceed, make sure that you have a clear understanding of key concepts, i.e. FSC and Blockchain.

When completed with slide #5 try to imagine the ideal food products and a FSC that makes you feel safe and that you trust. Slides #9 to #12, focus on food quality assurance. It is important here to combine with the knowledge provided in previous lesson regarding food quality assurance with ISO standards. Moreover, have in mind that this is not a solution that fits all and different products may require different approaches and solutions.

Try to understand the advantage of having everything recorded in the supply chain. Design the supply chain of one product that you made notes while at slide #5. Combine each stage of the supply chain with the identified vulnerabilities and contamination causes that make the product unsafe.



For example, the supply chain of cow milk could involve, dairy farm (causes: antibiotics, contaminated feed, or water, poor hygiene etc), transportation to processing facility (causes: inadequate temperature, poor hygiene etc.), milk processing facility (inadequate pasteurization temperature, poor hygiene, mixing with other milks etc), transportation to retail store (causes: inadequate temperature, poor hygiene etc.), retail store (causes: inadequate temperature, poor hygiene etc.).



While at slide #7 think about how safe you feel with the food you consume on a frequent basis. Choose one or two of these products and try to make notes by recording potential vulnerabilities and contamination causes that make the product unsafe. Think about specific products such as cow milk, olive oil, rice etc. For example, potential vulnerabilities

and contamination causes for cow milk could be antibiotics and/or other chemicals, poor hygiene, contaminated feed, or water, inadequate temperature while stored and transported. You could think about vulnerabilities and contamination causes other products (e.g., honey, wine, fruits).

Slides #13 to #15, focus on food certification. Likewise, it is important here to combine with the knowledge provided in previous lesson regarding food certification (organic, PGO, PGI, TSG, Fairtrade).

Slides #16 to #21 provide a step-by-step process that is applied for selected case studies. Make sure that each of these stages are clear and that you can utilize for a given supply chain for both food quality assurance and certification.

Lesson 3: Blockchain Application for Milk Quality Assurance and Certification



Start this lesson by having a look at key point of the the following article “Recent food safety and fraud issues within the dairy supply chain (2015–2019)” (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7561604/>). Try to identify the importance of milk in several aspects (e.g. consumption, production, employment sector).



Try to analyse the cow milk supply chain based on the previous lessons and try to identify the quality problems that may occur at each stage.

When at slide #13 make a review of the whole milk supply chain for certification. Likewise, this supply chain could cover ISO standards. Moreover, it is important to understand that other types of milk may have differences in their supply chain (e.g., sheep and goat milk). Additionally, other milk products such as yogurt and cheese may also have differences in their supply chains.



Associate with each one of the cow milk supply chain stakeholders with causes of quality issues. For example, in the dairy farm this could be antibiotics, contaminated feed, or water, poor hygiene etc, during transportation to processing facility it could be inadequate temperature, poor hygiene etc., in the milk processing facility it could be inadequate pasteurization temperature, poor hygiene, mixing with other milks etc), during transportation to retail store it could be inadequate temperature, poor hygiene etc., in the retail store it could be inadequate temperature, poor hygiene etc.

Lesson 4: Blockchain Application for Honey Quality Assurance and Certification



You could start the honey case study by briefly reading the following article “Food fraud: How genuine is your honey?” (https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/food-fraud-how-genuine-your-honey-2023-03-23_en). Emphasise on the

“Improved, harmonised and generally accepted analytical methods are needed to increase the capability of official control laboratories to detect honey adulterated with sugar syrups.”, from the section “Better detection capability”. Try to understand the importance of beekeeping in several aspects (e.g. consumption, production, employment sector).



Try to analyse the honey supply chain based on the previous lessons and identify the honey quality problems that may occur at each stage.

When at slide #13 try to map the whole honey supply chain for certification. Likewise, this supply chain could cover ISO standards. Moreover, it is important to make understand that depending on the flowering and the pollen source (e.g. trees, flowers) as well as other beekeeping products like propolis and royal jelly, the supply chain may be different or modified.



Associate with each one of the honey supply chain stakeholders with causes of quality issues. Focus on slides #21 - #29 for the advantages of using the Blockchain technology for traceability and transparency in the honey supply chain. The “Honeygate: How Europe is being flooded with fake honey” (<https://www.euractiv.com/section/agriculture-food/news/honey-gate-how-europe-is-being-flooded-with-fake-honey/>) is an important reading for justifying the importance for traceability and transparency.

Lesson 5: Blockchain Application for Wine Quality Assurance and Certification

The wine industry is important for the economy of several countries. Wine is a popular product in terms of consumption but on the other hand it may cause health problems because of low quality. This lesson will help you to become familiar with how blockchain technology contributes to ensuring the quality and certification of wine.



The “Europe’s valuable wine and beer industries are working to retain their competitive edge with an expanded range of aromas and blockchain-based fraud prevention.” (<https://projects.research-and-innovation.ec.europa.eu/en/horizon-magazine/extra-flavour-and-fraud-prevention-menu-europes-beer-and-wine-industries>) could help you to understand the importance of the wine quality issues.



Try to analyse the wine supply chain based on the previous lessons, their experiences and vineyard location and you may also identify the quality problems that may occur at each stage (e.g., think about impacts on quality with longer transportation times when vineyards are in mountainous areas).



When at slide #13 try to make a map of the whole wine supply chain for certification. Likewise, this supply chain could cover ISO standards. Moreover, it is important to understand that other grapes-based wines and spirits may have differences in their supply chain. However, blockchain technology is not a solution that fits for all FSC.

Try to associate each one of the wine supply chain stakeholders with the possible impacts on wine quality issues. Focus on the data that need to be stored in the blockchain to succeed transparency and traceability in the wine supply chain (slides #22 – 27).

The article “A Smart-Contract Enabled Blockchain Traceability System Against Wine Supply Chain Counterfeiting” (https://link.springer.com/chapter/10.1007/978-3-031-16407-1_56) could expand your knowledge by focusing on the technological part (i.e., smart contracts).

Lesson 6: Blockchain Application for Olive Oil Quality Assurance and Certification



Do you know that olive oil was valued so highly at one point that was used as currency and that it is also known as “liquid gold”? This was a term made popular by the great Ancient Greek writer Homer.



Try to analyse the olive oil supply chain based on the previous lessons. You could also identify the quality problems that may occur at each stage. The article “Enhancing the competitive advantage via Blockchain: an olive oil case study” (<https://www.sciencedirect.com/science/article/pii/S2405896322002397>) could help focusing on the “competitive advantage” that the blockchain technology offers.



When at slide #13 try to map the whole olive oil supply chain for certification. Likewise, this supply chain could cover ISO standards. Moreover, it is important to understand that other types of oil (e.g., sunflower, maize, soya) or other types of products such as olives may have differences in their supply chain.

Try to associate each one of the olive oil supply chain stakeholders with causes of quality issues. Make an effort to compare the traditional supply chain with one that is using blockchain technology to guarantee that the final product is organic, PGO, PGI, has been produced following sustainable practices, quality standards (e.g., ISO).

Relevant Readings

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Course Provider / Contact Details



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Course #14: ESG and SDGs in Food Supply Chain using Blockchain Technology

Content and Duration

The lessons provided with the course “ESG and SDGs in Food Supply Chain using Blockchain Technology” are as follows:



Lesson 1: Introduction to ESG and SDGs

Lesson 2: The Role of Blockchain in ESG and SDGs

Lesson 3: Institutional mechanisms surrounding ESG and SDGs in Food Supply Chain

Lesson 4: Practical case studies of Blockchain application for ESG and SDG

Lesson 5: Implications and Future Trends



Approx. 3 hours to complete.

Objective

By the End of This Course, You Will Be Able To:

1. Grasp the Fundamentals: Define and explain Environmental, Social, and Governance (ESG) principles and their importance in the food supply chain. Explain Sustainable Development Goals (SDGs) and their relevance to the food industry.
2. Comprehend the Role of Blockchain: Analyze how blockchain technology enhances transparency, traceability, and compliance with ESG and SDG goals in the food supply chain. Explain how blockchain can be used to monitor, report, and verify ESG and SDG performance within the food industry.
3. Apply Practical Knowledge: Evaluate real-world case studies to understand how blockchain is currently being used to achieve ESG and SDG goals in the food supply chain.
4. Navigate the Regulatory Landscape: Explain the existing regulatory environment surrounding ESG and SDGs in the food supply chain. Analyze how blockchain technology can facilitate compliance with these regulations.
5. Analyze Stakeholder Impact: Assess the potential implications of implementing blockchain for ESG and SDGs on various stakeholders within the food supply chain (e.g., farmers, consumers, policymakers).
6. Anticipate Future Trends: Identify emerging trends and future applications of blockchain technology for advancing ESG and SDGs in the food supply chain.

Learning Outcomes

What you will learn:

By the End of This Course, You Will Be Able To:

1. Define Key Terminology:

Explain the concept of Environmental, Social, and Governance (ESG) principles and their application in the food supply chain.

Define Sustainable Development Goals (SDGs) and their relevance to the food industry.

Describe the meaning and importance of traceability and transparency within the food supply chain.

Explain blockchain technology and its core functionalities.

2. Analyze the Importance of ESG and SDGs:

Describe the significance of ESG and SDG principles for a sustainable food supply chain.

3. Understand Blockchain's Impact on Transparency:



Explain how blockchain technology enhances transparency and traceability of food products throughout the supply chain.

4. Evaluate Blockchain's Role in Sustainable Agriculture:

Identify how blockchain can be used to promote sustainable agricultural practices.

5. Navigate the Regulatory Landscape:

Analyze the existing regulations surrounding ESG and SDGs in the food supply chain.

6. Assess Challenges and Benefits of Blockchain Implementation:

Discuss the potential benefits and challenges associated with implementing blockchain for monitoring ESG and SDG performance in the food industry.

7. Explore Future Applications:

Recognize emerging trends and future applications of blockchain technology for advancing ESG and SDGs in the food supply chain.

Course Level, Education Level Required, and Prerequisites



Beginners, Professional Development or Continuing Education



High School Diploma or Equivalent



Supply chain basics, Trust Food course #1, basic understanding of certification processes, background in agriculture and/or food science.

Target Audience



University students, university graduates, business managers, business owners, agrifood company employees and food supply chain personnel

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with 5 corresponding quizzes (1 for each lesson) that consists of 3-4 multiple choice and true-false questions.



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

Begin the course by reviewing the objective, the learning outcomes and structure (i.e., lessons).

Lesson 1: Introduction to ESG and SDGs

Before the Course Begins:



Familiarize yourself with the key terms: Environmental, Social, and Governance (ESG), Sustainable Development Goals (SDGs), Sustainability. Look up definitions and get a general understanding of their importance in the business world. The course glossary provides a good starting point.

Explore the United Nations SDGs: Briefly review the 17 UN SDGs to understand the global challenges they address. The course material provides a brief overview but you can find more information on the UN website (<https://sdgs.un.org/goals>).

During the Course:



Pay attention to the real-world examples: The course material includes case studies of companies like Unilever and Nestle. Focus on how these companies are applying ESG principles and SDGs in their food supply chains.

While studying lectures and materials, take clear and concise notes. Mind maps, flowcharts, or any visual aids that work for you can be helpful in organizing the information. This will make reviewing and retaining the knowledge much easier later.

Assignments and Exams:



Read the assigned materials carefully: Don't skim the readings. Take the time to fully understand the concepts before attempting assignments.

Focus on applying the concepts: Don't just memorize facts. Be able to explain how ESG and SDGs are interrelated and how they impact the food supply chain.

Practice with sample questions: Use Formative Assessment questions and quizzes to test your understanding and identify areas where you need more review.

Additional Resources:

GRI Standards: The Global Reporting Initiative (GRI) provides a framework for companies to report on their ESG performance (<https://www.globalreporting.org/>).

SASB Standards: The Sustainability Accounting Standards Board (SASB) offers industry-specific ESG standards (<https://sasb.ifrs.org/>).

Corporate Sustainability Reports: Many companies publish annual sustainability reports that outline their ESG strategies and performance. Look for reports from companies in the food industry.

Lesson 2: The Role of Blockchain in ESG and SDGs

Before the Course Begins:



Review Key Concepts: Briefly skim the bolded key concepts like "Supply Chain Efficiency" and "Stakeholder Facilitation." This will give you a roadmap for the information to come.

Blockchain Basics: If you're unfamiliar with blockchain technology, do a quick web search to understand the core concepts of immutability, traceability, and decentralization.

During the Course:

Focus on How Blockchain Addresses Challenges: The lesson dives into how blockchain's features can address challenges in incorporating ESG and SDGs within the food supply chain. Pay close attention to these connections.



Real-World Examples: The lesson highlights real-world applications. Make sure you understand how blockchain is being used in these cases to improve ESG and SDGs in the food industry.

Learning Outcomes: Keep the five learning outcomes (listed under "Learning Outcomes") in mind as you read. These will help you identify the key takeaways from the lesson.

Assignments and Exams:

Review the Taxonomy: The "Blockchain taxonomy of the problem statements in SDGs and ESG" categorizes challenges and their corresponding blockchain solutions. This is a valuable resource for understanding how blockchain can be applied in different scenarios.



Formative Assessment: Test your understanding by trying to answer the two provided assessment questions. This will help solidify your knowledge and identify areas that might need revisiting.

Additional Resources:

The lesson provides a glossary of relevant terms like "ESG" and "SDGs." Refer back to this if you encounter unfamiliar terms.

The lesson mentions resources like the Microsoft Sustainability Cloud and AWS for Sustainability. You can explore these platforms to get a better understanding of how technology is being used to achieve sustainability goals.

Lesson 3: Institutional mechanisms surrounding ESG and SDGs in Food Supply Chain

Before the Course Begins:

Familiarize yourself with key terms: ESG (Environmental, Social, and Governance), SDGs (Sustainable Development Goals), Blockchain technology, Transaction costs, Value Chain, Industrial Clusters, Decentralized Autonomous Organizations (DAOs). Look up definitions and get a general understanding of their importance in the food supply chain.



Review the Foundations of Economics: Basic understanding of supply and demand, market structures, and externalities will be helpful. Review introductory economic concepts you might have learned in previous courses.

Explore the UN SDGs: Briefly review the 17 UN SDGs to understand the global challenges they address, particularly those related to food production and consumption. The course material provides a brief overview but you can find more information on the UN website (<https://sdgs.un.org/goals>).

During the Course:

Focus on how the institutional mechanisms, blockchain technology, and collaborative structures contribute to achieving ESG and SDG goals in the food supply chain.

Focus on Real-World Examples: The course material includes case studies of companies and industrial clusters applying these concepts. Pay close attention to how these examples address challenges and implement sustainable practices.



Take Good Notes: Capture key points, not everything verbatim. Focus on understanding rather than memorizing. Use headings, bullet points, or outlines to structure your notes. This will help you see connections later. Create a central topic (e.g., "Achieving SDG 12: Responsible Consumption") and branch out with subtopics. Use arrows or colors to show how institutional mechanisms, blockchain technology, and collaborative structures connect to achieve the goal. Underline important points, use icons or colors for different categories (e.g., environmental, social, governance), and include relevant diagrams from the course material. Take time to revisit your notes, connect them to other course materials, and solidify your understanding.

Assignments and Exams:



Read the Assigned Materials Carefully: Don't skim the readings. Take the time to fully understand the concepts related to institutional mechanisms (like Coase Theorem and New Institutional Economics), blockchain technology, and collaborative structures (like

industrial clusters and DAOs). Their role in achieving ESG and SDG goals in the food supply chain is central to the course.

Apply the Concepts to Case Studies: Analyze real-world scenarios using the frameworks learned in the course. Consider how institutional mechanisms, blockchain technology, and collaborative structures can be leveraged to address sustainability challenges in the food supply chain.

Practice with Sample Questions: Use quiz questions to test your understanding and identify areas where you need more review. Focus on applying your knowledge to analyze how institutional mechanisms, blockchain technology, and collaborative structures contribute to ESG and SDG goals.

Additional Resources:

GRI Standards: The Global Reporting Initiative (GRI) provides a framework for companies to report on their ESG performance (<https://www.globalreporting.org/>).

SASB Standards: The Sustainability Accounting Standards Board (SASB) offers industry-specific ESG standards (<https://sasb.ifrs.org/>).

Corporate Sustainability Reports: Many companies publish annual sustainability reports that outline their ESG strategies and performance in the food industry. Look for reports from companies you recognize as leaders in sustainability.

The World Business Council for Sustainable Development (WBCSD): This organization is a global leader in promoting sustainable business practices. They have extensive resources related to ESG and supply chain management (<https://www.wbcsd.org/>).

Lesson 4: Practical case studies of Blockchain application for ESG and SDG

Before the Course Begins:

Grasp the Core Concepts: Familiarize yourself with terms like Blockchain, ESG (Environmental, Social, and Governance), SDGs (Sustainable Development Goals), traceability, and transparency. You can find definitions online or in introductory business or technology courses.



Explore Case Studies: Look for online examples of how companies are using blockchain for ESG and SDG goals. This will give you a head start on the real-world applications you'll explore in the course.

Review the UN SDGs: Briefly explore the 17 UN SDGs to understand the global sustainability challenges they address, particularly those related to your area of interest (e.g., food supply chain). Information is available on the UN website (<https://sdgs.un.org/goals>).

During the Course:

Ask yourself thoughtful questions about the readings and case studies. Consider how the presented blockchain applications address ESG challenges and contribute to achieving SDGs. Write down these questions for future reference.



Focus on Practical Applications: Pay close attention to the real-world examples presented in the course materials. Analyze how these blockchain solutions improve transparency, traceability, and accountability in different industries.

Take Comprehensive Notes: Don't just copy everything. Focus on capturing the main points of the course material, paying close attention to the relationships between concepts like blockchain and ESG factors. Include specific examples that illustrate the course content. These examples will be crucial for understanding how the concepts work in real-world applications.

Assignments and Exams:

Read Deeply: Don't skim the assigned readings. Take the time to understand the mechanisms by which blockchain contributes to ESG goals and SDGs. Focus on the case studies and analyze how they address specific sustainability challenges.

Apply Your Knowledge: Analyze real-world scenarios and demonstrate how you would leverage blockchain technology to address ESG challenges and contribute to achieving SDGs.



Practice with Sample Questions: Use quiz questions to test your understanding and identify areas where you need more review. Practice applying your knowledge to analyze how blockchain contributes to ESG goals and SDGs.

Additional Resources:

GRI Standards: The Global Reporting Initiative (GRI) provides a framework for companies to report on their ESG performance (<https://www.globalreporting.org/>).

SASB Standards: The Sustainability Accounting Standards Board (SASB) offers industry-specific ESG standards (<https://sasb.ifrs.org/>).

Lesson 5: Implications and Future Trends.

Before the Course Begins:



Grasp the Core Concepts: Familiarize yourself with ESG (Environmental, Social, and Governance) factors, SDGs (Sustainable Development Goals), and blockchain technology. Understand how blockchain can improve transparency and traceability. Resources like online articles or introductory business/technology courses can be helpful.

Explore the Food Supply Chain: Gain a basic understanding of the different stages involved in getting food from farm to fork. This will help you understand how blockchain can impact different stakeholders in the supply chain.

Review the UN SDGs: Briefly explore the 17 UN SDGs, particularly those related to food production and consumption (e.g., SDG 2: Zero Hunger). The UN website provides information (<https://sdgs.un.org/goals>).

During the Course:

Focus on Challenges and Opportunities: The course explores both the challenges and exciting opportunities blockchain presents for achieving ESG and SDG goals in the agri-food sector. Pay close attention to how these challenges can be overcome and how potential applications can be implemented.



Analyze Real-World Examples: The course includes case studies of companies using blockchain in the food supply chain (e.g., Walmart, IBM and Maersk, Provenance, BanQu). Actively analyze these cases to understand the benefits and remaining challenges associated with each application.

Consider the Bigger Picture: Think beyond the agri-food sector. How can the lessons learned from blockchain applications in food contribute to achieving ESG and SDG goals in other industries?

Assignments and Exams:

Read Deeply: Don't skim the readings. Focus on understanding how blockchain technology addresses specific ESG challenges and contributes to achieving SDGs in the agri-food sector.

Apply Your Knowledge: Don't just memorize facts. During exams or assignments, demonstrate your understanding by analyzing real-world scenarios and proposing solutions using blockchain technology to address ESG challenges and contribute to achieving SDGs.



Think Critically: Blockchain is not a silver bullet. Consider potential limitations of blockchain technology and broader challenges that need to be addressed to achieve a more sustainable food system.

Additional Resources:

The World Business Council for Sustainable Development (WBCSD): This organization is a global leader in promoting sustainable business practices. They have extensive resources related to ESG and supply chain management (<https://www.wbcsd.org/>).

Food and Agriculture Organization of the United Nations (FAO): The FAO works to achieve food security for all and ensure that people have regular access to enough high-quality food to lead active, healthy lives. Their website includes information on sustainable food systems

Relevant Readings

Lesson 1: Introduction to ESG and SDGs

Food and Agriculture Organization of the United Nations (FAO). (2023). The State of Agricultural Commodity Markets. <https://www.fao.org/publications/home/fao-flagship-publications/the-state-of-agricultural-commodity-markets/en>

World Business Council for Sustainable Development (WBCSD). <https://www.wbcsd.org/>

Lesson 2: The Role of Blockchain in ESG and SDGs

World Economic Forum. (2020, September 3). How Blockchain Can Help Us Achieve the SDGs. <https://www.weforum.org/agenda/2020/09/3-ways-blockchain-can-contribute-to-sustainable-development/>

IBM Food Trust. (n.d.). A secure and transparent global food ecosystem. <https://www.ibm.com/products/supply-chain-intelligence-suite/food-trust>

Lesson 3: Institutional mechanisms surrounding ESG and SDGs in Food Supply Chain

The Global Alliance for Improved Nutrition (GAIN). (n.d.). Blockchain for a More Sustainable Food System. <https://www.gainhealth.org/>

The Food and Land Use Coalition. <https://www.foodandlandusecoalition.org/>

Lesson 4: Practical case studies of Blockchain application for ESG and SDG

Provenance. (n.d.). About. <https://www.provenance.org/>

BanQu. <https://www.banqu.co/>

Lesson 5: Implications and Future Trends

The Brookings Institution. (2023). Blockchain for Climate Action. https://www3.weforum.org/docs/WEF_Blockchain_for_Scaling_Climate_Action_2023.pdf

McKinsey & Company. (2023, March 29). The Future of Food: How New Technologies Are Transforming the Way We Shop and Eat. <https://www.mckinsey.com/~media/mckinsey/email/rethink/2023/03/2023-03-29d.html>

Course Provider / Contact Details



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Course #15: Climate Action, Energy transition and Blockchain in Food Supply chain

Content and Duration

The lessons provided with the course “Climate Action, Energy transition and Blockchain in Food Supply chain.” are as follows:



Lesson 1: Blockchain for Environmental Impact and Sustainability in the Food Supply Chain

Lesson 2: Blockchain for Green Energy transition

Lesson 3: Blockchain for Life Cycle Assessment (LCA)

Lesson 4: Blockchain for Measurement, Reporting, and Verification (MRV)

Lesson 5: Sustainable Agriculture and Smart Farming Practices

Lesson 6: Environmental impact of Blockchain technology



Approx. 3 hours to complete

Objective

1. Foundational Knowledge: Understand the interconnected nature of climate change, energy use, and food production systems (Climate-Energy-Food Nexus). Gain knowledge about the importance of sustainable agriculture practices in mitigating climate change.
2. Blockchain Applications: Master how blockchain technology can be leveraged to support climate action and the transition to renewable energy sources within the food supply chain. Acquire the ability to design and implement blockchain solutions that contribute to achieving net-zero emissions in the food supply chain.
3. Technical Skills: Understand how blockchain technology can be used for Life Cycle Assessment (LCA) in the food supply chain. Gain knowledge of how blockchain can be applied for Measurement, Reporting, and Verification (MRV) within the food supply chain.
4. Environmental Considerations: Be aware of the potential environmental impacts associated with blockchain technology.

Learning Outcomes

What you will learn:

By the end of this course, you will be able to:

1. Grasp the Big Picture:

Explain the connection between climate change, energy use, and food production systems (Climate-Energy-Food Nexus).

Understand the importance of sustainable agriculture practices in tackling climate change.

2. Leverage Blockchain for Change:

Identify how blockchain technology can be a tool for climate action and the transition to renewable energy in the food supply chain.



Design basic blockchain solutions to support achieving net-zero emissions within the food supply chain. (This outcome avoids specifics about the presentation material).

Evaluate the strengths and weaknesses of using blockchain for climate action in the food sector.

3. Master Blockchain Applications:

Explore how blockchain technology can be applied to Life Cycle Assessment (LCA) in the food supply chain (Building on what Lesson 3 title suggests).

Gain an understanding of how blockchain can be used for Measurement, Reporting, and Verification (MRV) within the food supply chain (Building on what Lesson 4 title suggests).

4. Be Mindful of the Environment:

Discuss the potential environmental impacts of blockchain technology and propose solutions to minimize them.

Course Level, Education Level Required, and Prerequisites



Beginners, Professional Development or Continuing Education



High School Diploma or Equivalent



Supply chain basics, Trust Food course #1, basic understanding of certification processes, background in agriculture and/or food science.

Target Audience



University students, university graduates, business managers, business owners, agrifood company employees and food supply chain personnel

Assessment - Certification of Attendance – Badges



The assessment for this course is realized with 6 corresponding quizzes (1 for each lesson) that consists of 3-4 multiple choice and true-false questions.



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

Begin the course by reviewing the objective, the learning outcomes and structure (i.e., lessons).

Lesson 1: Blockchain for Environmental Impact and Sustainability in the Food Supply Chain

Before the Course Begins:

Grasp the Core Concepts: Familiarize yourself with blockchain technology, its core features (transparency, security, traceability, decentralization), and terminology like distributed ledger technology (DLT). Resources like online articles, educational videos, or introductory business/technology courses can be helpful.



Understand the Food Supply Chain: Gain a basic understanding of the different stages involved in getting food from farm to fork. This will help you appreciate how blockchain can impact different stakeholders within the supply chain.

Explore Food Waste Issues: Research the significance of food waste and its environmental impact. This background knowledge will enrich your understanding of how blockchain can contribute to solutions.

During the Course:



Focus on Solutions and Trade-offs: The course explores how blockchain can address challenges related to food safety, sustainability, and food waste. Pay close attention to specific applications and case studies (e.g., BRUSCHETTA platform). Analyze both the benefits and potential challenges associated with implementing blockchain solutions.

Consider the Bigger Picture: Think beyond the technical aspects of blockchain. How can blockchain empower consumers to make informed choices and encourage sustainable practices throughout the supply chain?

Assignments and Exams:

Read Deeply: Don't just skim the readings. Focus on understanding the specific ways blockchain addresses sustainability challenges in the food supply chain.

Apply Your Knowledge: During exams or assignments, don't just list benefits. Demonstrate your understanding by analyzing real-world scenarios and proposing solutions using blockchain to improve food safety, reduce waste, or promote sustainable practices.

Think Critically: Consider potential limitations of blockchain technology, broader challenges in the food system, and trade-offs between affordability and environmental impact.



Additional Resources:

Food and Agriculture Organization of the United Nations (FAO): The FAO works to achieve food security for all and ensure that people have regular access to enough high-quality food to lead active, healthy lives. Their website includes information on sustainable food systems.

World Wildlife Fund (WWF): The WWF works to conserve nature and reduce humanity's most pressing environmental threats. They have resources related to sustainable food production (<https://www.worldwildlife.org/>).

Lesson 2: Blockchain for Green Energy transition

Before the Course Begins:

Review basic blockchain concepts: Familiarize yourself with core blockchain functionalities like decentralization, immutability, and transparency. This foundation will be crucial for understanding the applications in green energy.



Explore the EU's Green Deal: Gain a basic understanding of the EU's goals for achieving climate neutrality. This context will be essential for comprehending how blockchain supports these initiatives.

During the Course:

Focus on core concepts: Pay close attention to the key pillars of the EU's green and energy transition strategy, especially renewable energy, electrification, and the Guarantees of Origin mechanism. Understand how these strategies aim to reduce carbon emissions.



Become a Connector: Look for connections between different course elements. For example, research how the Internet of Things (IoT) and blockchain can work together to improve energy management in agriculture.

Mind Mapping Magic: Create a mind map where the central theme is "Green Energy Solutions." Branch out with subtopics for different renewable energy sources like solar or wind. Then, create sub-branches for how blockchain and IoT can be applied to each source to improve efficiency or transparency.

Useful Learning Strategies:



Summarize key points: After each lesson, condense the main takeaways into concise summaries for better recall.

Research real-world applications: Look for case studies or news articles about existing blockchain projects in the green energy sector. This will help solidify your understanding and make the course content more relatable.

Lesson 3: Blockchain for Life Cycle Assessment (LCA)

Before the Course Begins



Brush up on Blockchain Basics: Get familiar with core blockchain concepts such as decentralization, immutability, and transparency. This foundation will be crucial for understanding how blockchain can be used with LCA.

Explore the EU's Green Deal: Gain a basic understanding of the EU's goals for achieving climate neutrality. Understanding these goals will help you see how blockchain can support these initiatives in the context of LCA.

During the Course



Focus on Core LCA Concepts: Pay close attention to the different stages of LCA (cradle-to-gate, cradle-to-grave, etc.) and how they are used to assess environmental impact. Understand how these impact assessments are used to inform decision-making.

Connecting the Dots: See how different course elements fit together. Consider how blockchain can improve data integrity, a major challenge in LCA. Analyze how blockchain's secure and tamper-proof nature can lead to more accurate environmental footprint calculations for products.

Example Power: Create a specific example to illustrate your understanding. Imagine a product like a cotton T-shirt. Analyze how blockchain could track its entire lifecycle, from cotton farming to garment production, ensuring data transparency and improving the accuracy of its LCA assessment..

Learning Strategies



Create Mind Maps: Visually organize information to see the connections between LCA stages, environmental impacts, and how blockchain can be applied to each.

Summarize Key Points: After each lesson, condense the main takeaways into concise summaries for better recall.

Seek Real-World Examples: Look for case studies or news articles on existing projects that combine LCA and blockchain in the agri-food sector (Nestlé, Unilever, Danone are good examples provided in the material). This will help solidify your understanding and make the course content more relatable.

The World Business Council for Sustainable Development (WBCSD): This organization is a global leader in promoting sustainable business practices. They have extensive resources related to ESG and supply chain management (<https://www.wbcsd.org/>).

Lesson 4: Blockchain for Measurement, Reporting, and Verification (MRV)

Before the Course Begins

Familiarize yourself with the MRV Framework: Gain a basic understanding of MRV (Measurement, Reporting, and Verification) and its role in climate change mitigation strategies. This foundational knowledge will be crucial for understanding how blockchain can be applied to MRV processes.



Explore the Lesson Glossary: Review the provided glossary to solidify your understanding of key terms like GHG Protocol, Carbon Credits, and CBAM (Carbon Border Adjustment Mechanism). Having a strong grasp of this terminology will make the lectures much easier to follow.

During the Course

Case Study Detective: Analyze case studies in detail, considering how blockchain can address challenges in GHG emissions tracking within the food supply chain. Write down your insights and analyses as if you were participating in a class discussion.

Big Picture Thinking: See how the different topics in the lesson fit together. For example, explore how blockchain can address challenges in GHG emissions tracking within the food supply chain. Analyze how this contributes to a more sustainable food system overall.



Mind Mapping Magic: Create a mind map with "Sustainable Agri-Food Systems" as the central theme. Branch out with subtopics for areas like "GHG Emissions Tracking" and "Blockchain Applications." Then, further explore how blockchain can improve tracking and contribute to a more sustainable system.

Take Good Notes: Pay close attention to the learning objectives outlined for each lesson. Summarize the main points in your own words to solidify your understanding and for easy review later.

Learning Strategies



Create Mind Maps: Visually organize information to see the relationships between MRV components (measurement, reporting, verification), blockchain applications, and benefits for the food supply chain.

Research Case Studies: Look for online resources or articles that discuss existing projects that combine MRV and blockchain in the food industry. These real-world examples can make the course content more relatable and engaging.

Lesson 5: Sustainable Agriculture and Smart Farming Practices

Before the Course Begins



Brush Up on Sustainability Concepts: Get a basic understanding of core sustainability principles like resource conservation, environmental protection, and social responsibility in agriculture. This foundation will be crucial for understanding how smart farming and blockchain can contribute to a more sustainable food system.

Explore Blockchain Basics: Familiarize yourself with the foundational concepts of blockchain technology, such as decentralization, immutability, and transparency. This will help you understand how blockchain can be applied in agriculture to enhance traceability and trust.

During the Course



Focus on Connections: See how the different topics in the course interconnect. For example, think about how data collected from smart farming sensors can be securely stored and verified using blockchain, ultimately promoting consumer trust in sustainable agricultural practices.

Take Effective Notes: Pay close attention to the learning objectives outlined for the lesson. Summarize the main points in your own words for better understanding and easier review later.

Learning Strategies



Create Mind Maps: Visually organize information to see the relationships between smart farming technologies (agrovoltatics, vertical farming, etc.), blockchain applications, and the benefits for sustainable agriculture.

Find Real-World Examples: Search online for case studies or news articles that discuss existing projects that combine smart farming and blockchain in agriculture. Analyzing these real-world applications can make the course content more relatable and engaging.

Think Like a Farmer: Consider the challenges faced by farmers in your area or region. Can you brainstorm innovative solutions that integrate smart farming technologies and blockchain to address these challenges and promote sustainable practices?

Lesson 6: Environmental impact of Blockchain technology

Before the Course Begins



Brush Up on Sustainability Concepts: Gain a basic understanding of core sustainability principles such as resource conservation, environmental protection, and social responsibility. This foundation will be crucial for understanding how blockchain technology can be applied to create a more sustainable future.

Explore Cryptocurrency Basics: Familiarize yourself with the fundamentals of cryptocurrency, including mining and blockchain technology. This will provide you with a context for understanding the environmental impact of Bitcoin and the potential for alternative consensus mechanisms.

During the Course



Formulate questions about environmental challenges faced by specific industries (e.g., excessive water use, pesticide runoff) and how blockchain technology could be a solution (e.g., water rights tracking, sustainable sourcing).

Think Critically: Analyze the environmental benefits and drawbacks of various blockchain applications in agriculture. Consider factors like energy consumption of blockchain compared to traditional methods, potential for increased transparency leading to better resource management, etc.

Take Effective Notes: Pay close attention to the learning objectives outlined for each lesson. Summarize the main points in your own words for better understanding and easier review later.

Learning Strategies



Create a Mind Map: Visually organize information to see the relationships between Proof of Work (PoW), Proof of Stake (PoS), and their environmental impact on blockchain technology. Include examples of successful blockchain applications that are environmentally friendly.

Research Case Studies: Find online resources or articles that discuss existing projects that use blockchain technology to address environmental challenges. Analyzing these real-world applications can make the course content more relatable and engaging.

Debate the Future: Imagine a future scenario where blockchain technology is widely adopted. What environmental benefits or challenges could arise? How can we ensure that blockchain is used as a force for good?

Relevant Readings

1. Blockchain for Environmental Impact and Sustainability in the Food Supply Chain

World Wildlife Fund (WWF). (n.d.). Blockchain for Conservation. <https://techhub.wwf.ca/>

This webpage explores how WWF is using blockchain technology to track tuna fishing and other initiatives to promote sustainable practices.

IBM Food Trust. (n.d.). Food Supply Chain Transparency.

<https://www.ibm.com/products/supply-chain-intelligence-suite/food-trust>

This website details how IBM Food Trust is leveraging blockchain to create a transparent and accountable food supply chain.

World Business Council for Sustainable Development (WBCSD). (2020). Blockchain for a Sustainable Food System. <https://www.wbcsd.org/>

This report explores the potential of blockchain to transform the food system towards greater sustainability.

2. Blockchain for Green Energy Transition

Rocky Mountain Institute. (2021, September 21). How Blockchain Can Accelerate the Clean Energy Transition. <https://rmi.org/blockchain-reimagining-rules-game-energy-sector/>



This article explores various applications of blockchain in the energy sector, including renewable energy integration and peer-to-peer energy trading.

International Renewable Energy Agency (IRENA). (2019, September). Blockchain for the Energy Sector: A Potential Game Changer.

<https://www.irena.org/publications/2019/Sep/Blockchain>

This report by IRENA examines the potential of blockchain to transform the energy sector and unlock new business models for renewables.

The Conversation. (2020, October 28). How blockchain can help us reach net-zero emissions. <https://www.linkedin.com/pulse/how-blockchain-can-revolutionize-fight-against-global-dar-rto5f>

This article explores how blockchain can be used to track carbon emissions and support carbon offset markets.

3. Blockchain for Life Cycle Assessment (LCA)

Minderhout, S., Circular Economy, Geissdoerfer, M., & Snow, E. (2017, January).

Blockchain Technology and the Circular Economy: A Systematic Literature Review.

ResearchGate,

https://www.researchgate.net/publication/363218788_Blockchain_Technology_and_the_Circular_Economy_A_Systematic_Literature_Review

This report explores how blockchain can be used to track materials and products throughout their lifecycle, which is essential for LCA.

The Stockholm Environment Institute (SEI). (n.d.). Blockchain for Transparency in Life Cycle Assessment. <https://www.sei.org/>

This article discusses the potential of blockchain to improve transparency and data integrity in LCA studies.

4. Blockchain for Measurement, Reporting, and Verification (MRV)

Gold Standard. (2022, February 10). Gold Standard Announces Proposals to Allow Creation of Digital Tokens for Carbon Credits. <https://www.goldstandard.org/>

This webpage explores how Gold Standard is using blockchain to improve the monitoring, reporting, and verification (MRV) of climate action projects.

Institute of Chartered Accountants in England and Wales (ICAEW). (2020, September 29). Blockchain and Sustainability Reporting.

<https://assets.kpmg.com/content/dam/kpmg/pt/pdf/pt-websummit-blockchain-and-climate-reporting.pdf>

This article explores how blockchain can be used to enhance the accuracy, transparency, and auditability of sustainability reporting, which relies on MRV data.

5. Sustainable Agriculture and Smart Farming Practices

Food and Agriculture Organization of the United Nations (FAO). (n.d.). Climate-Smart Agriculture. <https://www.fao.org/climate-smart-agriculture/en/>

This FAO webpage provides a wealth of information on climate-smart agriculture practices that can help mitigate and adapt to climate change.

The Rodale Institute. (n.d.). Regenerative Organic Agriculture.

<https://rodaleinstitute.org/why-organic/organic-basics/regenerative-organic-agriculture/>

The Rodale Institute is a leading organization promoting regenerative organic agriculture practices that improve soil health, biodiversity, and climate resilience.

Course Provider / Contact Details



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Course #16: Blockchain Adoption Strategies for Small and Medium-sized Enterprises in the Food Sector

Content and Duration

The lessons provided with the course “Blockchain Adoption Strategies for Small and Medium-sized Enterprises in the Food Sector” are as follows:



Lesson 1: Understanding the potential of blockchain technology for SMEs in the food sector.

Lesson 2: The challenges of blockchain adoption for SMEs in the food sector.

Lesson 3: Key steps in Blockchain Adoption for SMEs in the food sector.

Lesson 4: Case Studies.



Approx. 3 hours to complete (including study time).

Objective

This course aims to equip participants with an understanding of the potential benefits and challenges associated with integrating blockchain technology in small and medium-sized enterprises within the food industry. The course investigates the transformative impact of blockchain in enhancing traceability, reducing fraud, and building consumer trust, while also addressing the technical and financial complexities inherent in its adoption. Participants will learn not only about the strategic importance of blockchain for compliance with food safety regulations but also about the pragmatic aspects of its implementation. This includes conducting a needs assessment, engaging stakeholders effectively, selecting the appropriate blockchain platform, and developing a comprehensive implementation strategy. Furthermore, the course provides real-world insights through case studies, highlighting successful blockchain implementations in the sector.

Learning Outcomes

As a participant in this course you will be engaged in a comprehensive and effective learning journey structured around the following outcomes:



- Understand the basic principles and benefits of blockchain technology for SMEs operating in the food industry.
- Identify methods used by blockchain to reduce fraud and ensure product authenticity.

- Analyse the role of blockchain in efficient SME inventory management.
- Evaluate the impact of blockchain on building consumer trust through transparency.
- Investigate the specific hurdles SMEs face in adopting blockchain, including financial and human resource limitations, technical expertise gaps, and integration challenges with current IT infrastructures.
- Examine the initial and ongoing costs associated with blockchain adoption, including hardware, software, network fees, and system maintenance costs.
- Explore the technical complexities of blockchain, such as scalability, performance issues, standardization, interoperability, and compatibility with legacy systems.
- Investigate various solutions to adoption challenges, including industry-wide and technical standards, partnerships, collaborations, and leveraging grants and funding opportunities.
- Learn how to assess whether blockchain technology aligns with business goals and technical capabilities, including technology understanding, business goal alignment, cost-benefit analysis, supply chain efficiency, regulatory compliance, partner and supplier readiness, technical feasibility, data privacy, and market dynamics.
- Learn the steps to develop a comprehensive strategy for blockchain implementation, including identifying use cases, developing a proof of concept, selecting the right platform, and deploying the technology effectively.
- Understand the importance of staff training and change management in the adoption of blockchain technology, focusing on addressing knowledge gaps and managing the organizational impact of this new technology.

Course Level, Education Level Required, and Prerequisites



Beginners Level, Professional Development



High School Diploma or Equivalent



Consider this course as an advanced level of “Course 7: Basic Blockchain Skills”

Target Audience



Entrepreneurs and Business Owners in the Food Sector, Operations and Supply Chain Managers, IT and Technology Professionals in the Food Industry, Food Safety and Compliance Officers, Academics and Researchers

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quizzes. There is one quiz for each lesson. Each quiz has 3-5 questions (i.e. multiple choice, true/false etc).



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activity Tips for Trainee

The course “Blockchain Adoption Strategies for Small and Medium-sized Enterprises in the Food Sector” uses a blended learning approach, combining traditional and digital methods. It emphasizes objective clarity, personal connection, exploration of blockchain in SMEs, active learning, and continuous self-motivation for practical application.

Lesson 1: Understanding the potential of blockchain technology for SMEs in the food sector

Lesson 1 breaks down complex ideas using simple, non-technical language to ensure you understand blockchain's potential to transform the food industry.

The lesson will also highlight real-life examples; you'll see first-hand how blockchain introduces transparency into supply chains, making it easier to track the journey of food products from farm to table. We'll also explore common types of fraud in the food sector and explore how blockchain technology can combat these issues.

Another key area we'll cover is the challenges faced with traditional inventory management systems and how blockchain offers more efficient solutions. Moreover, you'll learn about blockchain's role in streamlining regulatory reporting, thereby enhancing compliance efficiency in the food sector.



To wrap up, we'll summarize the major benefits that blockchain technology brings to small and medium-sized enterprises (SMEs) in the food industry, emphasizing its transformative potential.

To make this learning experience more interactive, we'll incorporate elements like polls or questions to test what you have learned. We encourage you to analyze different aspects of the lesson collaboratively with other students or individually.

Finally, our formative assessment will assess your understanding of the lesson and will give you the time needed to think what you have learned!

Lesson 2: The challenges of blockchain adoption for SMEs in the food sector

Lesson 2 starts with an overview of the challenges that small and medium-sized enterprises (SMEs) commonly encounter when considering the adoption of blockchain technology, anchoring the discussion in real-life scenarios.

You will explore the specifics of these challenges, which include limited resources available to SMEs, the technical complexities inherent in blockchain technology, and regulatory hurdles, such as those presented by the General Data Protection Regulation (GDPR). It's crucial to highlight the significance of understanding and adhering to data protection laws, with GDPR serving as a prime example of such regulations.

After exploring the challenges, you're encouraged to examine potential solutions and strategies that can aid in overcoming these obstacles. This includes fostering industry collaboration, exploring funding opportunities, and emphasizing the importance of education in this field. Through real-world examples and case studies, you'll learn about how various businesses have successfully tackled these challenges.



The session will wrap up with a summary of the main challenges and solutions discussed, ensuring you have a clear understanding of the key points.

To make this learning experience more interactive, we'll incorporate elements like polls or questions to test what you have learned. We encourage you to analyze different aspects of the lesson collaboratively with other students or individually.

Finally, our formative assessment will assess your understanding of the lesson and will give you the time needed to think what you have learned!

Lesson 3: Key Steps in Blockchain Adoption for SMEs in the food sector

Lesson 3 dives into the key steps of blockchain adoption process for SMEs in the food sector. We will explore a step-by-step approach to ensure you have a clear roadmap for implementation.

To begin with, we'll discuss the importance of assessing the feasibility of blockchain for your business, which includes evaluating technical suitability, economic viability, and alignment with your business objectives.



Next, you'll learn about the criteria for selecting the right blockchain platform. This selection is based on factors such as scalability, throughput, energy efficiency, and regulatory compliance, which are crucial for the success of your blockchain project.

We'll then outline the steps for developing a comprehensive strategy for blockchain implementation, ensuring you have a solid plan in place. A significant part of this process involves the importance of staff training and effective change management strategies as you transition to a blockchain-based system. Preparing a team for this change is essential for a smooth integration.

The lesson will also cover regulatory requirements and data privacy concerns that come with blockchain implementation.

To help you understand the landscape of blockchain platforms, we'll use a comparative approach, highlighting the pros and cons of each.

The lesson will wrap up with a summary, reiterating the importance of strategic assessment and careful planning in the successful adoption of blockchain technology.

To make this learning experience more interactive, we'll incorporate elements like polls or questions to test what you have learned. We encourage you to analyze different aspects of the lesson collaboratively with other students or individually.

Finally, our formative assessment will assess your understanding of the lesson and keep the session interactive. You will be asked to conduct a role-play or scenario-based activity to bring to life the challenges and strategies involved in managing organizational change during blockchain adoption. This practical exercise will help solidify your understanding and prepare you for real-world applications.

Lesson 4: Case Studies

Lesson 4, will explore a series of enlightening case studies that highlight the Blockchain Adoption Strategies for Small and Medium-sized Enterprises (SMEs) in the Food Sector. By examining real-world applications, we will uncover how these businesses have navigated the complexities of integrating blockchain technology to enhance traceability, efficiency, and transparency within their operations.

For each case study, such as Kezzler, Ripe.io, and TagOne, we will dive into a comprehensive analysis of how these companies have implemented blockchain technology in their operations.

Following the presentation of each case study, you are encouraged to think about the strategies employed and the results achieved by these companies.



Through comparing and contrasting these different case studies, you will be able to understand the diverse applications of blockchain in the food sector, highlighting its versatility and potential.

Engage with the material critically by pondering questions such as, "Which implementation impressed you the most, and why?" This will encourage you to think deep about the case studies presented.

The lesson will wrap up with the key insights derived from the case studies, emphasizing how these learnings can be practically applied in your potential endeavors within the food sector.

To make this learning experience more interactive, we'll incorporate elements like polls or questions to test what you have learned. We encourage you to analyze different aspects of the lesson collaboratively with other students or individually.

Finally, our formative assessment will assess your understanding of the lesson and maintain an interactive learning environment.

Relevant Readings



- Vu, Nam, Abhijeet Ghadge, and Michael Bourlakis. "Blockchain adoption in food supply chains: A review and implementation framework." *Production Planning & Control* 34.6 (2023): 506-523.
- Ilbiz, Ethem, and Susanne Durst. "The appropriation of blockchain for small and medium-sized enterprises." *Journal of Innovation Management* 7.1 (2019): 26-45.
- Mohammed, Abubakar, et al. "Blockchain Adoption in Food Supply Chains: A Systematic Literature Review on Enablers, Benefits, and Barriers." *IEEE Access* (2023).
- Kumar Bhardwaj, Amit, Arunesh Garg, and Yuvraj Gajpal. "Determinants of blockchain technology adoption in supply chains by small and medium enterprises (SMEs) in India." *Mathematical Problems in Engineering* 2021 (2021): 1-14.
- Vu, Nam, Abhijeet Ghadge, and Michael Bourlakis. "Blockchain adoption in food supply chains: A review and implementation framework." *Production Planning & Control* 34.6 (2023): 506-523.

Additional readings can be found within each Lesson's presentation.

Course Provider/Contact Details



Comments and inquiries may be addressed to Stamatis Papangelou (papangelou.m@unic.ac.cy), University of Nicosia

Course #17: Ethical Considerations and Governance in Blockchain-enabled Food Supply Chains

Content and Duration

The lessons provided with the course “Ethical Considerations and Governance in Blockchain-enabled Food Supply Chains” are as follows:



Lesson 1: Introduction to Blockchain Technology in Food Supply Chains

Lesson 2: Ethical Considerations and Transparency in Blockchain-enabled Supply Chains

Lesson 3: Governance and Decision-making in Blockchain-enabled Food Supply Chains

Lesson 4: Social and Environmental Impacts of Blockchain Implementation

Lesson 5: Regulatory Landscape for Blockchain in the Food Supply Chain and Future Directions



Approx. 3 hours to complete (including study time).

Objective

This course aims to equip participants with an understanding of the potential benefits and challenges associated with integrating blockchain technology in small and medium-sized enterprises within the food industry. The course investigates the transformative impact of blockchain in enhancing traceability, reducing fraud, and building consumer trust, while also addressing the technical and financial complexities inherent in its adoption. Participants will learn not only about the strategic importance of blockchain for compliance with food safety regulations but also about the pragmatic aspects of its implementation. This includes conducting a needs assessment, engaging stakeholders effectively, selecting the appropriate blockchain platform, and developing a comprehensive implementation strategy. Furthermore, the course provides real-world insights through case studies, highlighting successful blockchain implementations in the sector. Through a comprehensive curriculum, learners will gain the skills to analyze and recommend solutions to the ethical challenges posed by blockchain technology, evaluate governance mechanisms for its deployment, and assess its social and environmental footprint. This educational journey will empower participants with the knowledge to contribute thoughtfully to the discourse on blockchain technology in food supply chains, advocating for ethical practices, robust governance, and sustainable outcomes.

Learning Outcomes

As a participant in this course you will be engaged in a comprehensive and effective learning journey structured around the following outcomes:

- Understand the basic principles and benefits of blockchain technology for SMEs operating in the food industry.
- Identify methods used by blockchain to reduce fraud and ensure product authenticity.
- Analyse the role of blockchain in efficient SME inventory management.
- Evaluate the impact of blockchain on building consumer trust through transparency.
- Investigate the specific hurdles SMEs face in adopting blockchain, including financial and human resource limitations, technical expertise gaps, and integration challenges with current IT infrastructures.
- Examine the initial and ongoing costs associated with blockchain adoption, including hardware, software, network fees, and system maintenance costs.
- Explore the technical complexities of blockchain, such as scalability, performance issues, standardization, interoperability, and compatibility with legacy systems.
- Investigate various solutions to adoption challenges, including industry-wide and technical standards, partnerships, collaborations, and leveraging grants and funding opportunities.
- Learn how to assess whether blockchain technology aligns with business goals and technical capabilities, including technology understanding, business goal alignment, cost-benefit analysis, supply chain efficiency, regulatory compliance, partner and supplier readiness, technical feasibility, data privacy, and market dynamics.
- Learn the steps to develop a comprehensive strategy for blockchain implementation, including identifying use cases, developing a proof of concept, selecting the right platform, and deploying the technology effectively.
- Understand the importance of staff training and change management in the adoption of blockchain technology, focusing on addressing knowledge gaps and managing the organizational impact of this new technology.



Course Level, Education Level Required, and Prerequisites



Beginners Level, Professional Development



High School Diploma or Equivalent



Consider this course as an advanced level of "Course 1 - Introduction to Blockchain Technology and Digital Assets" and "Course 7: Basic Blockchain Skills"

Target Audience



Entrepreneurs and Business Owners in the Food Sector, Operations and Supply Chain Managers, IT and Technology Professionals in the Food Industry, Food Safety and Compliance Officers, Academics and Researchers

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quizzes. There is one quiz for each lesson. Each quiz has 3-5 questions (i.e. multiple choice, true/false etc).



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activity Tips for Trainee

Trainees should adopt a self-guided, proactive learning approach to effectively apply blockchain technology in the food supply chain. This approach integrates constructivism, behaviourism, social cognitive theory, humanism, and connectivism, ensuring a comprehensive understanding and practical application of blockchain technology.

Lesson 1: Introduction to Blockchain Technology in Food Supply Chains



Lesson 1 explores how blockchain technology reshapes the food supply chain. This initial lesson is designed to not only introduce you to the concept but also to guide you through understanding its significant impact on enhancing transparency, traceability, and trust

throughout the supply network. You'll delve into both the transformative effects and the challenges this technology presents to the sector.

Start with understanding the global landscape of supply chains. Familiarize yourself with the complex systems that move food from farms to your table and how blockchain technology promises to streamline these processes. This foundational knowledge is crucial for grasping the scope of blockchain's impact.

You'll learn about blockchain technology's capacity to provide real-time visibility into the journey of food products, ensuring that all transactions are visible, verifiable, and tamper-proof.

The lesson will also highlight the importance of traceability in ensuring food safety and compliance with regulatory standards. Blockchain's role in tracking products from origin to end-user not only enhances safety and quality but also builds consumer trust.

As you proceed, you'll analyze how blockchain builds trust among consumers and stakeholders. Trust is paramount in the food supply chain, and you'll see how blockchain's immutable ledger fosters a high level of confidence in the data shared across the network.

Finally, recognize the technology's benefits and challenges. While blockchain offers numerous advantages, including reduced fraud and increased efficiency, its implementation comes with its own set of hurdles. These include technical integration, standardization, and environmental considerations.

By the end of this lesson, you should have a solid understanding of the role and significance of blockchain technology in the food supply chain. This knowledge will serve as a foundation as you continue to explore the ethical considerations and governance mechanisms related to blockchain in the following lessons.

Lesson 2: Ethical Considerations and Transparency in Blockchain-enabled Supply Chains

Lesson 2 uncovers how blockchain can revolutionize ethical practices in supply chains. This lesson is key to understanding blockchain's role in promoting fair trade, organic labeling, and animal welfare, alongside examining some real-world impacts.



You will explore how blockchain brings about transparency and traceability, essential for verifying fair trade and organic claims. This technology ensures that these claims are more than just marketing terms, providing a clear path from farm to consumer.

You're encouraged to think critically about blockchain's potential in addressing ethical challenges within the food supply sector. Through examples like the United Nations World Food Programme's Building Blocks initiative, you'll see how blockchain extends beyond finance, offering solutions for societal benefits.

This lesson will prompt you to consider the broader implications of blockchain technology in creating more ethical supply chains. Reflect on how its application can lead to positive societal changes, enhancing transparency and trust across the board. As you move through this lesson, think about how you can use blockchain to contribute to ethical practices in supply chains.

Lesson 3: Governance and Decision-making in Blockchain-enabled Food Supply Chains

Lesson 3 dives into the intricate world of how decisions are made within blockchain systems. This session is all about understanding the nuts and bolts of governance models, ranging from centralized to decentralized, and the unique differences between on-chain and off-chain governance systems. It's a journey into the heart of blockchain's decision-making processes, where you'll learn about the roles various stakeholders play and how their input influences the blockchain ecosystem.

The lesson explores how governance impacts the functionality and integrity of blockchain operations. This isn't just about the technical side; it's also about the human aspect, understanding how different governance models affect the blockchain community, and recognizing the significance of each stakeholder's role.



Imagine being part of a system where every decision matters, from the minor to the major, and where your voice can contribute to the collective decision-making process. This lesson aims to equip you with the knowledge to differentiate between governance models and critically assess their roles and impacts. Whether decisions are made on-chain, embedded directly within the blockchain's code, or off-chain, through more traditional human-led discussions and implementations, you'll see how each method has its own set of challenges and benefits.

You will discover various real-world examples, like how Bitcoin manages governance without a formal structure and how projects like Tezos incorporate on-chain governance to streamline decision-making. This will help you grasp the practical applications of these governance models and their implications for blockchain projects.

Overall, the lesson will help you deepen your understanding of blockchain governance, a critical aspect that ensures the technology's adaptability, sustainability, and, ultimately, its success in transforming industries, including the food supply chain.

Lesson 4: Social and Environmental Impacts of Blockchain Implementation



Lesson 4, "Social and Environmental Impacts of Blockchain Implementation" focuses on both the bright and the shadowed sides of blockchain technology. This lesson will equip you with the knowledge of how blockchain is reshaping our society and environment.

You're going to learn about the power of blockchain in enhancing transparency, improving efficiency, and fostering trust across various sectors. Simultaneously, we'll explore the challenges it poses, particularly its environmental impact due to energy-intensive processes like mining in cryptocurrency networks.

The lesson discusses the positive impacts of blockchain, such as its potential to support democratic principles and enhance the sustainability of supply chains by ensuring the ethical sourcing of products. You'll see how blockchain's transparency can contribute to a more equitable world. However, it's not all smooth sailing. It also tackles the digital divide that blockchain might widen, where those without access to technology or the internet could be left behind.

On the environmental front, you'll understand the dual nature of blockchain's influence. While it offers innovative solutions for energy distribution and supports renewable energy initiatives, its energy consumption, especially in proof-of-work systems, raises significant concerns. We'll delve into the ongoing debate about the environmental sustainability of blockchain technologies and the steps being taken to mitigate their impact.

By the end of this lesson, you'll have a comprehensive view of how blockchain technology influences our social structures and the environment. You'll be equipped to engage in discussions about how we can harness the benefits of blockchain while addressing its challenges to ensure it contributes positively to our future. Let's embark on this insightful exploration together and uncover the full spectrum of blockchain's impact on our world.

Lesson 5: Regulatory Landscape for Blockchain in the Food Supply Chain and Future Directions

In the final lesson, you will examine the intricate world of regulations governing blockchain technology in the food supply chain and explore the future prospects of this dynamic field. This lesson serves as a comprehensive guide to understanding the diverse regulatory environments for blockchain across different regions, including the European Union, the United States, and Asia.

You will be introduced to the Markets in Crypto-Assets (MiCA) in the EU, learn about the SEC's approach in the U.S., and discover how Asian countries are individually shaping their blockchain regulatory landscape. The lesson delves into current guidelines and standards affecting blockchain's application in the food supply chain and speculates on future regulatory developments.



By the conclusion of this lesson, you will have a deep understanding of the challenges and opportunities presented by blockchain and regulation in the food supply chain. You will be equipped to critically evaluate how these regulatory environments influence blockchain's adoption and the sustainability of food supply chains. Furthermore, the lesson invites a discussion on the potential future directions for blockchain applications in supply chains, considering the evolving regulatory landscape.

Overall, this lesson aims to provide you with a solid foundation in navigating the regulatory frameworks that shape the present and future of blockchain in the food supply chain.

Relevant Readings



- Krzyzanowski Guerra, Kathleen, and Kathryn A. Boys. "A new food chain: Adoption and policy implications to blockchain use in agri-food industries." *Applied Economic Perspectives and Policy* 44.1 (2022): 324-349.
- Menon, Sheetal, and Karuna Jain. "Blockchain technology for transparency in agri-food supply chain: Use cases, limitations, and future directions." *IEEE Transactions on Engineering Management* (2021).
- Chandan, Anulipt, Michele John, and Vidyasagar Potdar. "Achieving UN SDGs in Food Supply Chain Using Blockchain Technology." *Sustainability* 15.3 (2023): 2109.
Additional readings can be found within each Lesson's presentation.

Course Provider/Contact Details



Comments and inquiries may be addressed to Marianna Charalambous (charalmbous.mari@unic.ac.cy), University of Nicosia

Course #18: Combined Powers: Blockchain and Internet of Things in Transforming the Food Supply Chain

Content and Duration

The lessons provided with the course “Combined Powers: Blockchain and Internet of Things in Transforming the Food Supply Chain” are as follows:



Lesson 1: Fundamentals of Blockchain and IoT

Lesson 2: Combining Blockchain and IoT

Lesson 3: Blockchain and IoT: Integration Challenges

Lesson 4: Case Studies & Future Developments



Approx. 2.5 hours to complete (including study time)

Objective

The course on “Combined Powers: Blockchain and Internet of Things in Transforming the Food Supply Chain” is designed to provide a comprehensive understanding of how Blockchain and the Internet of Things (IoT) can revolutionize the food industry. It aims to present and discuss the fundamentals of both technologies, their individual roles, and the synergy they create when integrated within food supply chains. Participants will explore the challenges and solutions involved in this integration, examining how Blockchain and IoT can enhance supply chain efficiency, reduce waste, and improve traceability. The course also includes an evaluation of real-world examples and applications in the food sector, offering insights into smart farming, efficient transportation, and food safety. Lastly, it provides potential future trends and developments in Blockchain and IoT within the food industry.

Learning Outcomes

As a participant in this course, you will be engaged in a comprehensive and effective learning journey structured around the following outcomes:



- Understand the key elements, roles, and functionalities of Blockchain and IoT within the food supply chain.
- Analyse the impact of Blockchain and IoT on the security, transparency, and efficiency of supply chain operations.
- Comprehend the specific roles of IoT in data collection and Blockchain in ensuring data integrity.

- Recognize the benefits and challenges of integrating Blockchain and IoT, including technical and organizational aspects.
- Understand the economic implications, such as cost and ROI considerations, of implementing these technologies.
- Discuss emerging trends and their implications in the integration process of Blockchain and IoT.

Course Level, Education Level Required, and Prerequisites



Advanced Level, Professional Development



Bachelor's Degree



Consider this course as an advanced level of "Course 1 - Introduction to Blockchain Technology and Digital Assets".

Target Audience



Supply Chain Professionals, Technology Developers and Innovators, Business Executives in the Food Industry, Academics and Researchers.

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quizzes. There is one quiz for each lesson. Each quiz has 3-5 questions (i.e. multiple choice, true/false etc).



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activity Tips for Trainee

The course "Blockchain and IoT in Food Supply Chains" uses a blended learning approach, combining traditional and digital techniques and diverse theories. Key learning focus areas include understanding objectives, connecting personal experiences, exploring integration, active engagement, and self-motivation.

Lesson 1: Fundamentals of Blockchain and IoT

Lesson 1 sets the foundation of understanding of what Blockchain and IoT (Internet of Things) are, focusing on their foundational principles and key components. The lesson will break down these emerging technologies into more digestible concepts for you.

The lesson will explore essential concepts such as distributed ledgers, smart contracts, and the various layers of IoT architecture; it will go into the pivotal roles that Blockchain and IoT play within the food supply chain, including waste reduction, real-time monitoring, and the facilitation of more informed decision-making processes.



To summarize the lesson, a recap of the main topics covered will be provided, underscoring the transformative impact that Blockchain and IoT technologies can have on the food supply chain, highlighting their potential to revolutionize this sector.

To make this learning experience more interactive, we'll incorporate elements like polls or questions to test what you have learned. We encourage you to analyze different aspects of the lesson collaboratively with other students.

Finally, our formative assessment will assess your understanding of the lesson and will give you the time needed to think what you have learned!

Lesson 2: Combining Blockchain and IoT

Lesson 2 uncovers the synergistic relationship between Blockchain and IoT. It will help you understand how these technologies complement each other, especially within the context of food supply chains.

Part of this lesson will dive into the different models of Blockchain-IoT integration, including direct integration and middleware integration. Detailed explanations of each model will be provided, and you will be encouraged to discuss their respective benefits.

Lesson 2 continues with exploring real-world applications and case studies where Blockchain and IoT are effectively used together. These case studies will be brought to life, offering you practical insights into how these technologies are applied.



To summarize the lesson, the key points about the integration of Blockchain and IoT in supply chains will be emphasized, ensuring you grasp the significant takeaways.

Finally, our formative assessment will assess your understanding of the lesson and will give you the time needed to think what you have learned! You are encouraged to think about the benefits and challenges of integrating Blockchain and IoT, using interactive elements like polls or debates to make the session more engaging. You'll also be encouraged to participate in group discussions or to reflect individually, exploring the complexities and opportunities presented by the integration of these technologies.

As part of the formative assessment, we'll engage you with questions and discussions to assess your understanding, keeping the session lively and interactive.

Lesson 3: Blockchain and IoT Integration Challenges

Lesson 3 explores the challenges faced when integrating Blockchain and IoT, with a focus on technical, economic, and organizational hurdles.

The lesson analyzes each category of challenges: technical issues such as interoperability and scalability, economic concerns including high initial costs and uncertain return on investment (ROI), and organizational obstacles like change management and the skills gap.

After discussing each challenge, we'll move on to potential solutions. These may involve adopting new blockchain architectures to improve scalability, developing strategies for more accurate ROI calculations, and implementing effective change management approaches.



Lesson 3 will also touch upon emerging challenges like edge computing and decentralized finance (DeFi), examining their potential impact on the integration process. These trends will be highlighted to prompt you to consider their implications for future Blockchain and IoT integrations.

To summarize the lesson, you are encouraged to think about the importance of recognizing and addressing these integration challenges to ensure the successful deployment of Blockchain and IoT technologies in the food supply chain.

To make this learning experience more interactive, we'll incorporate elements like polls or questions to test what you have learned. We encourage you to analyze different aspects of the lesson collaboratively with other students or individually.

Finally, our formative assessment will assess your understanding of the lesson and will give you the time needed to think what you have learned!

Lesson 4: Case Studies & Future Developments

Lesson 4, starts off with an overview that underscores the significance of real-world examples for grasping the practical application of Blockchain and IoT within the food supply chain. It highlights how these technologies are presently revolutionizing the industry.



As the lesson dives into each case study, covering topics like smart farming and efficient transportation, we'll explore the specifics of how these technologies were implemented, the outcomes they produced, and the valuable lessons learned. We'll employ storytelling techniques to make these case studies both engaging and relatable.

You're encouraged to critically examine these cases, paying attention to both the successes and the challenges encountered.

We'll also discuss cutting-edge technologies such as AI-driven blockchain analytics, the use of IoT in autonomous vehicles, and the integration with big data, to give you insight into how these advancements might shape the future of food supply chain management.

It's important to think about how these emerging trends could influence your work or industry.

To summarize the lesson, the key points will be provided, emphasizing the transformative impact of blockchain and IoT on the food supply chain and highlighting the importance of keeping abreast of future technological trends.

To make this learning experience more interactive, we'll incorporate elements like polls or questions to test what you have learned. We encourage you to analyze different aspects of the lesson collaboratively with other students or individually.

Finally, our formative assessment will assess your understanding of the lesson and will give you the time needed to think what you have learned!

Relevant Readings



- Kumar, Shashank, et al. "Integrated blockchain and internet of things in the food supply chain: Adoption barriers." *Technovation* 118 (2022): 102589.
- Duan, Jiang, et al. "A content-analysis based literature review in blockchain adoption within food supply chain." *International journal of environmental research and public health* 17.5 (2020): 1784.
- Kumar, R. Lakshmana, et al. "A survey on blockchain for industrial internet of things." *Alexandria Engineering Journal* 61.8 (2022): 6001-6022.
- Malik, Nida, et al. "A comprehensive review of blockchain applications in industrial Internet of Things and supply chain systems." *Applied Stochastic Models in Business and Industry* 37.3 (2021): 391-412.

Additional readings can be found within each Lesson's presentation.

Course Provider/Contact Details



Comments and inquiries may be addressed to Evgenia Kapassa (kapassa.e@unic.ac.cy), University of Nicosia

Course #19: Combined Powers: Blockchain and AI in Transforming the Food Supply Chain

Content and Duration

The lessons provided with the course “Combined Powers: Blockchain and AI in Transforming the Food Supply Chain” are as follows:

Lesson 1: Introduction to Blockchain and AI

Lesson 2: Food Supply Chain Challenges



Lesson 3: Impact of blockchain and AI applications in Food Supply Chain

Lesson 4: Integrating AI with blockchain for Food Supply Chain Transformation

Lesson 5: Blockchain and AI Use Cases in food supply chain



Approx. 3,5 hours to complete.

Objective

This course introduces us to the concepts of Artificial Intelligence and Blockchain Technology. It aims to approach AI by categorizing it and comparing it to human intelligence followed by an introduction to Blockchain Technology and smart contracts. The limits of the blockchain and the solutions of artificial intelligence are defined to highlight the importance of the blockchain - Artificial Intelligence synergy and the future direction of this synergy is being explored. Additionally, the concept of the Food Supply Chain is introduced. In order to elaborate on the supply chain processes, it is broken down into five stages: production, processing, distribution, retailing, consumption. Each stage of this chain is explained and also the challenges affecting the whole journey of the product from farm to fork are categorized into four different categories and further analyzed. Furthermore, the optimized structure of the Food Supply Chain with the beneficial changes provided by the blockchain technology solutions is approached. The current applications of Artificial Intelligence and blockchain technology in the food supply chain are discussed aiming at highlighting the beneficial impact on the whole process.

With a goal to explore the optimization of the supply chain efficiency, the combination of the future direction of artificial intelligence and blockchain technology is the main topic up next. As blockchain and AI technologies continue to evolve, we can expect to see increased adoption of their applications across the food industry, leading to a more sustainable, resilient, and trustworthy food system. The potential of these two technologies' evolution is presented through various applications in different fields, such as tokenization, decentralized marketplaces, sustainability tracking or food safety compliance. Finally, we investigate the results of integrating artificial intelligence technologies with smart contracts and how AI-

driven smart contracts can enhance traceability and efficiency in the food supply chain. Also, the results of predictive analysis and real-time decision-making with AI and blockchain are examined. Course #19 is completed with the presentation of use cases of these innovative technologies and real-world examples.

Learning Outcomes

What you will learn:

Define the fundamental concepts of artificial intelligence and blockchain.

Recognize the limitations of the blockchain technology and understand how AI can overcome these obstacles.

Explore the future of blockchain – AI synergy.

Have a complete view of the Food Supply Chain/Recognise the main current problems and weak points in the Food Supply Chain.

Get to know the processes and the people involved until a product reaches the consumer.

Identify the key concepts behind blockchain and artificial intelligence technology and how they can be used in the food supply chain.

Recognize the possible advantages of using blockchain innovations for food safety, transparency, and traceability.



Determine the precise methods of AI in the food supply chain that can foster sustainability, innovation, and efficiency.

Explore areas of application combining these innovative technologies for the optimization of the FSC.

Explore the future of the AI – blockchain integration.

Understand possible applications, such as:

- Tokenization,
- Decentralized marketplace
- AI applications for food safety compliance and new product development
- Sustainability tracking

Understand what an AI-driven smart contract is and explore how it benefits the supply chain processes.

Get in touch with examples of companies using these technologies.

Course Level, Education Level Required, and Prerequisites



Intermediate Level, Continuing Education



Bachelor's Degree



Trust Food course #18, Combined Powers: Blockchain and IoT in Transforming the Food Supply Chains.

Target Audience



University students, university graduates, business managers, business owners, agrifood company employees, food supply chain personnel and technology professionals/developers

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quiz that is comprised of 25 multiple choice and true-false questions.



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

Begin the course by reviewing the objective, the learning outcomes and structure (i.e., lessons).

Lesson 1: Introduction to Blockchain and AI

Lesson 1 of course #19 starts with definitions of the term intelligence, moves on to Artificial Intelligence while it examines how we can stimulate artificial intelligence with human intelligence.

If you want to become more familiar with AI's development and solutions, so as to understand it better, make sure to study the next few slides where AI is being split into its basic components and they are explained by category.

The concept of Blockchain technology is then introduced. In order to get a better understanding of the term and how the blockchain technology works check out slide 12. Additionally, slide 13 presents an application of the blockchain technology in a Bitcoin transaction.



Diving deeper in the lesson key elements and types of Blockchain are presented. Elements like immutability, transparency, smart contracts etc. are explained while the 4 main types of Blockchain are categorized as permissioned or not and described.

Coming back to the term intelligence, Blockchain Intelligence is introduced. Did you know that Blockchain can be integrated with AI achieving this way Blockchain Intelligence? AI optimizes blockchain protocols, improving efficiency, scalability, and sustainability.

While Blockchain has many beneficial outcomes it has also limitations. Like all technologies, in order to be efficient and effective during their application, you need to be aware of their limitations. Once you identify the limitations, you need to have prepared corrective actions. AI provides solutions that assist us in overcoming the Blockchain limitations.

Lesson 1 concludes with the future of the Blockchain – AI synergy.

Lesson 2: Food Supply Chain Challenges

Are you familiar with the stages of the Food Supply Chain?

Lesson 2 introduces the interconnected stages that food products go through.



The food supply chain faces several challenges that can impact its efficiency, resilience, and sustainability. Addressing these challenges requires collaboration and innovation across the food supply chain, as well as support from policymakers, regulators, and consumers to promote sustainable and resilient food systems.

Lesson 2 focuses on the challenges that the supply chain is facing, categorizing them in 4 different issues: technical, funding, security and privacy.

Lesson 3: Impact of blockchain and AI applications in Food Supply Chain

Lesson 2 presented the challenges that the supply chain is facing. Lesson 3 is an attempt to approach the optimized structure of the Food Supply Chain with the beneficial changes provided by the blockchain technology solutions.



Slide 6 includes an image that compares the physical to the digital journey of products travelling through the FSC. It is now clear how the whole supply chain can be converted to a blockchain with each block representing a different stage.

The synergistic integration of AI and Blockchain technologies fosters a robust, seamless and efficient food supply chain. Do you know the areas of application of Blockchain – AI in the FSC? These areas are presented and also several applications are examined.

Lesson 4: Integrating AI with blockchain for Food Supply Chain Transformation

The main topic of Lesson 4 is the future direction of artificial intelligence and Blockchain technology combined to optimize the supply chain efficiency.

Starting from the key to the Blockchain future, the decentralized markets in slide 7, Lesson 3 continues with the concept of tokenization and how it can revolutionize the food supply chain. Make sure to take a look in the example presented in slide 21.



Do you need to be reminded on what Artificial Intelligence and Blockchain are or the Impact of Blockchain on AI and vice versa? Don't skip the video in slide 22!

Coming back to the tokenization of Blockchain technology, did you know that AI services can be tokenized? This means that microtransactions and pay as you go models are allowed. Slide 24 visualized how a tokenized transaction works.

Finally, the lesson concludes by exploring the possible ways where the combination of these technologies can revolutionize the food supply chain, enhancing traceability, transparency, efficiency, safety, quality assurance, and consumer engagement.

Lesson 5: Blockchain and AI Use Cases in food supply chain

Lesson 5 starts with the definition of smart contracts and how AI-driven smart contracts benefit the Supply Chain Management.



What are the beneficial outcomes by these applications? How do AI-driven smart contracts can improve the efficiency and traceability of the Food Supply Chain?

The abovementioned questions are answered and additionally applications of IoT smart contracts are presented and justified.

At this point it becomes clear that there are several advantages for transparency, traceability, security, and efficiency in the food supply chain when blockchain technology

is combined with AI-driven smart contracts. Therefore, several notable case studies showcasing these applications are presented next.

Do you know how these applications have the last 10 years? Slide 21 depicts this evolution.

Now that you are aware of what has happened so far, the future of Blockchain and AI synergy is presented.

Relevant Readings

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Course Provider / Contact Details



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Course #20: Roadmap for the Use of Blockchain Technologies in the Food Supply Chain

Course Content and Duration

The lessons provided with the course “Roadmap for the Use of Blockchain Technologies in the Food Supply Chain” are as follows:

Lesson 1: Introduction to the fundamentals of blockchain technology

Lesson 2: Introduction to the food supply chain ecosystem

Lesson 3: Use cases and benefits of blockchain in the food industry

Lesson 4: Private vs. public blockchains

Lesson 5: Real-world examples of successful blockchain implementations

Lesson 6: Assessing the readiness and feasibility of blockchain adoption

Lesson 7: Protecting sensitive data on the blockchain

Lesson 8: Fair trade, sustainability, and responsible sourcing



Approx. 5 hours to complete.

Objective

The overarching aim of the "Roadmap for the Use of Blockchain Technologies in the Food Supply Chain" course is to empower participants with a deep understanding of blockchain's pivotal role and transformative potential within the complex landscape of the food industry. By delving into the intricacies of blockchain technology, participants will dissect the inherent inefficiencies and vulnerabilities present in conventional food supply chains, while concurrently uncovering the myriad benefits that blockchain offers, including heightened transparency, immutable traceability, and fortified trust among stakeholders. Through an immersive journey encompassing real-world case studies, critical analysis of blockchain components, and robust stakeholder engagement, participants will not only grasp the theoretical underpinnings but also gain practical insights into navigating regulatory landscapes, addressing interoperability challenges, and harnessing blockchain's prowess to elevate food safety standards, optimize quality assurance protocols, and catalyze sustainable practices across the entire food supply continuum. Ultimately, armed with this comprehensive knowledge and strategic acumen, participants will emerge poised to architect innovative solutions and chart pragmatic pathways for the seamless integration of blockchain technologies into the multifaceted realm of food supply chain management.

Learning Outcomes

What you will learn:

Demonstrate a comprehensive understanding of how blockchain technology works and its relevance to the food supply chain ecosystem.

Identify key stakeholders, processes, and challenges within the food supply chain and assess how blockchain can address these challenges.

Critically evaluate case studies and real-world examples to assess the effectiveness of blockchain solutions in improving food traceability and safety.

Apply frameworks and methodologies to assess the feasibility and readiness of implementing blockchain technology in food supply chain operations.

Develop a roadmap for the strategic adoption of blockchain in the food industry, considering factors such as scalability, interoperability, and data privacy.

Communicate effectively about the benefits, risks, and considerations associated with blockchain adoption in the food supply chain to stakeholders and decision-makers.



Course Level, Education Level Required, and Prerequisites



Beginners, Professional Development or Continuing Education



High School Diploma or Equivalent



Supply chain basics, Trust Food course #10 and #1, basic understanding of certification processes, background in agriculture and/or food science.

Target Audience



University students, university graduates, agrifood company employees and food supply chain personnel

Assessment - Certification of Attendance - Badges



The assessment for this course is realized with the corresponding quiz that is comprised of 32 multiple choice and true-false questions.



A certificate of attendance will be provided upon completion of all lessons and quizzes.

Guidelines - Activities Tips for Trainee

Begin the course by reviewing the objective, the learning outcomes and structure (i.e., lessons).

Lesson 1: Introduction to the fundamentals of blockchain technology

This lesson will explore the basics of blockchain technology, starting with its basic principles of operation, through an overview of key terms and concepts, all the way to practical applications in the real world.



Participate in blockchain simulation activities as a participant.

Check blockchain's potential impact on various industries, ethical issues or new trends in blockchain technology.



Write down important facts from an interactive presentation that will be made using multimedia tools to explain the basic principles of blockchain technology.

Conduct research and analysis of case studies that demonstrate practical applications of blockchain technology in various industries.

Create infographics that summarize the basics of blockchain technology in a visually appealing and simple way.



At the end of the lesson, try to answer the questions:

What is blockchain technology?

What are the key components of blockchain technology?

What are the some of the applications of blockchain technology?

Lesson 2: Introduction to the food supply chain ecosystem

This lesson will take you on a journey through the intricate network that sustains the global food industry, from production to consumption. We'll explore key concepts, processes, and challenges within the food supply chain, shedding light on its complexities and opportunities.



Create an interactive mind map presentation that will visually depict key concepts, processes and challenges within the food supply chain. Research and analyze different case studies within the food supply chain.



Take a virtual tour through the different stages of the food supply chain, including production, distribution, storage and sales. Use a variety of multimedia resources, such as videos, images and interactive maps, to give students insight into each stage of the food supply chain.



Create an infographic to show the complexity of the food supply chain and the challenges that stakeholders face.

If it is feasible, ask experts about key concepts, challenges and trends within the food supply chain.

Lesson 3: Use cases and benefits of blockchain in the food industry

In this lesson, we'll explore how blockchain addresses challenges such as food fraud, safety concerns, and supply chain inefficiencies. Through real-time traceability, authentication of food products, and promoting sustainability, blockchain ensures food safety, quality, and regulatory compliance.



By the end, you'll understand how blockchain is revolutionizing the food industry and driving positive change for all stakeholders involved.

Explore and analyze various case studies that demonstrate the application of blockchain in the food industry. Focus on cases that show how blockchain solves challenges such as food fraud, security issues and supply chain inefficiencies.



Create an interactive presentation that uses real-world examples to illustrate how blockchain ensures safety, quality, and regulatory compliance in the food industry. You can use multimedia tools such as videos, graphs and diagrams to show students different blockchain applications.



If it is feasible, ask experts about the benefits and challenges of using blockchain in the food industry and expected future trends.

Lesson 4: Private vs. public blockchains

The objective of the lesson "Private vs. public blockchains" is to provide you with a comprehensive understanding of the distinctions between private and public blockchains, including their governance structures, access controls, and applicability in various use cases.



By the end of the lesson, you will be able to discern the advantages and disadvantages of each type and make informed decisions regarding blockchain implementations based on specific project requirements.



Research and analyse of various case studies that demonstrate the application of private and public blockchains in practice. Real-world examples can help you to better understand how these two types of blockchain are used in different industry sectors and situations.



Try to develop a blockchain implementation strategy, where you will develop concrete plans for implementing private or public blockchains in a specific use case.

Lesson 5: Real-world examples of successful blockchain implementations



In this lesson, you will explore how blockchain technology has been applied in various industries to solve real-world problems and achieve significant outcomes. Through examining case studies and success stories, you will gain insights into the diverse applications of blockchain beyond cryptocurrency.



Research and analyze various case studies that showcase successful blockchain implementations in various industries. You can explore examples from finance, healthcare, logistics, energy and other sectors to give students a diverse insight into blockchain applications. Create a presentation that uses blockchain implementation success stories to illustrate various applications of the technology outside of cryptocurrencies.



You could ask people from various industries who have participated in successful blockchain implementations. Moreover, you can ask them questions about the potential benefits, challenges and risks that may arise with the further expansion of blockchain technology.

Lesson 6: Assessing the readiness and feasibility of blockchain adoption



In this lesson, you will learn the crucial step of evaluating how prepared and practical it is to implement blockchain technology within your specific food supply chain. You will be able to define various factors influencing both readiness and feasibility, equipping you with the knowledge to make informed decisions regarding this transformative technology.



Explore the various factors influencing organizations' willingness to adopt blockchain in the food supply chain. These may include technical capacity, regulatory conditions, financial resources, strategic objectives and stakeholder acceptance of the technology.

Analyze the costs and benefits of blockchain adoption in the food supply chain. Explore implementation costs, expected benefits in terms of increased efficiency, reduced waste, improved transparency and other factors that could influence decision making.



Try to write a report on the feasibility of blockchain adoption in the food supply chain. The report should contain a detailed analysis of all relevant readiness and feasibility factors and recommendations for further steps and implementation strategies. Use a variety of sources of information, including research, stakeholder interviews and case study analysis.

Lesson 7: Protecting sensitive data on the blockchain



While blockchain offers remarkable advantages in terms of transparency and traceability, safeguarding sensitive information requires thoughtful consideration. You will explore various strategies and best practices to ensure the security of your data on the blockchain, fostering trust and minimizing potential risks.



Research and analyze different types of threats and risks related to blockchain data security. The intern can investigate potential attacks such as DDoS, phishing, 51% attack and other threats and identify strategies to protect against them.



If it is feasible try to discuss with relevant people data security and blockchain technology as well as the latest trends, technological innovations and best practices for protecting sensitive data on the blockchain.

Analyze compliance requirements related to protecting sensitive data on the blockchain. Research relevant regulations and standards such as GDPR, HIPAA and other legal regulations and identify steps organizations need to take to comply with these requirements.

Lesson 8: Fair trade, sustainability, and responsible sourcing



You will explore how blockchain can be harnessed to support fair trade practices, promote sustainability, and encourage responsible sourcing throughout the food system. By integrating these values into your blockchain strategy, you can contribute to a more just, sustainable, and transparent food supply chain for all stakeholders.



You will gain practical insights and knowledge into how ethical considerations can be embedded into your blockchain implementation, enhancing its potential to create a more responsible and sustainable food system.



Explore the current state of fair trade, sustainability and responsible sourcing practices in the food system. Explore existing initiatives, certifications and regulations and identify current challenges and gaps in implementation.

If it is feasible, discuss with relevant people about the future of fair trade, sustainability and responsible sourcing with the application of blockchain technology as well as about potential benefits, challenges and risks, and discuss possible directions for development and innovation in this area.

Relevant Readings

Reports and White Papers:

"Blockchain: A Game-Changer in the Food Supply Chain" by World Economic Forum

"Blockchain in the Food Industry" by Deloitte

"Blockchain: Opportunities for Fresh Food Supply Chains" by IBM Institute for Business Value

"Digitizing Trust: Blockchain for Supply Chain" by BCG and VeChain

Books:

"Blockchain Basics: A Non-Technical Introduction in 25 Steps" by Daniel Drescher

"Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies Is Changing the World" by Don Tapscott and Alex Tapscott

"Supply Chain Management and Blockchain Technology: The Case of the Food Industry" by Angelika Langer and Christiana Köhler-Schute

Academic Articles:

"Blockchain and the Supply Chain: Concepts, Challenges, and Empirical Evidence" by L.M. Seebacher, S. Schüritz, and P. Maier

"Blockchain for Global Supply Chain: An Empirical Study" by F. Li, et al.

"Blockchain and Supply Chain Management: A Systematic Literature Review" by H. Lu, et al.

"Blockchain Adoption Challenges in Supply Chain Management" by S. Sharma, et al.

Journals and Magazines:

Blockchain in Supply Chain Today (<https://www.blockchaininsupplychain.com/>)

Supply Chain Management Review (<https://www.scmr.com/>)

Harvard Business Review (<https://hbr.org/>)

Empowering women through blockchain: Unlocking opportunities and driving innovation (<https://guardian.ng/slide/empowering-women-through-blockchain-unlocking-opportunities-and-driving-innovation/>)

Online Resources:

Blockchain Technology and the Food Supply Chain (<https://www.foodchainadvisors.org/blockchain-in-the-food-industry/>)

Food Safety and Blockchain (<https://www.foodsafetymagazine.com/magazine-archive1/junejuly-2018/blockchain-technology-for-food-supply-chain-transparency/>)



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