When two chains combine - Blockchain and Supply Chain in Industry

CS 5594 Blockchain Technologies

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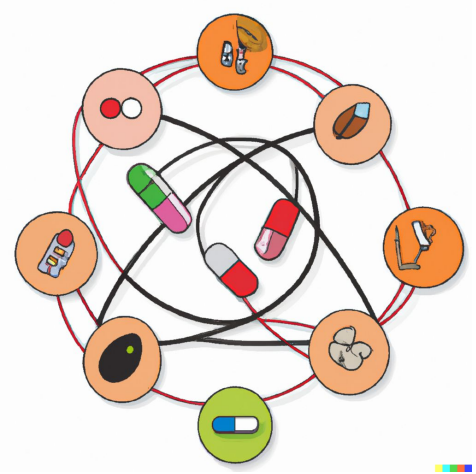
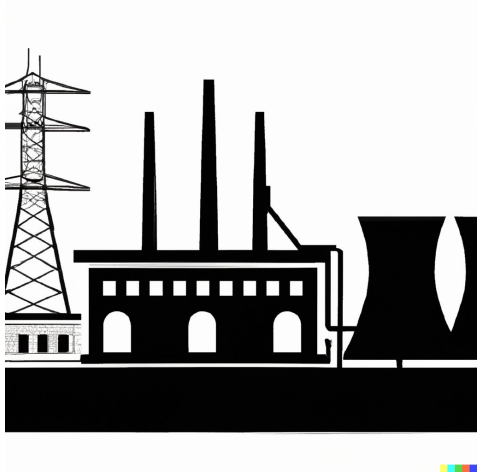
Introduction

- **What is Supply Chain? Why does it matter?**
- What - A supply chain is a network of individuals, organizations, resources, and activities involved in the creation and delivery of a product or service to a customer.
- Why - A supply chain plays a critical role in the success of a business, as it affects the quality, availability, and cost of the products or services provided.
- Our study - Application of Blockchain in 3 key industries - **Retail, Energy and Pharmaceuticals**

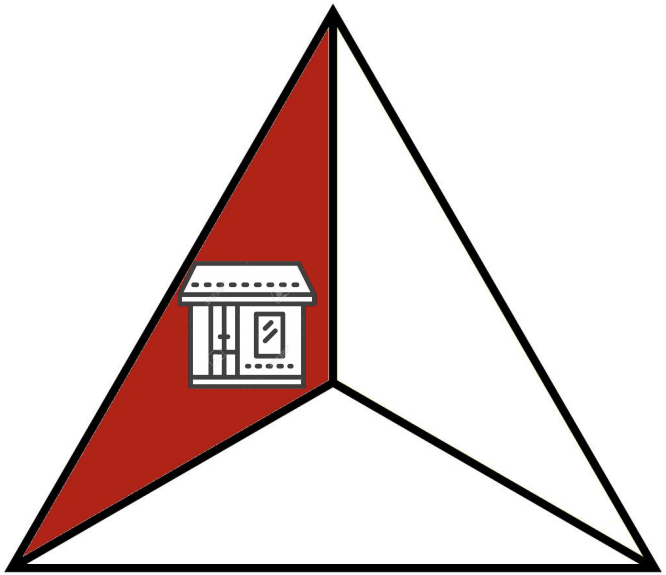
Introduction

Fun fact: Dall-E (AI) generated images for each industry!





Industry 1/3 - Retail



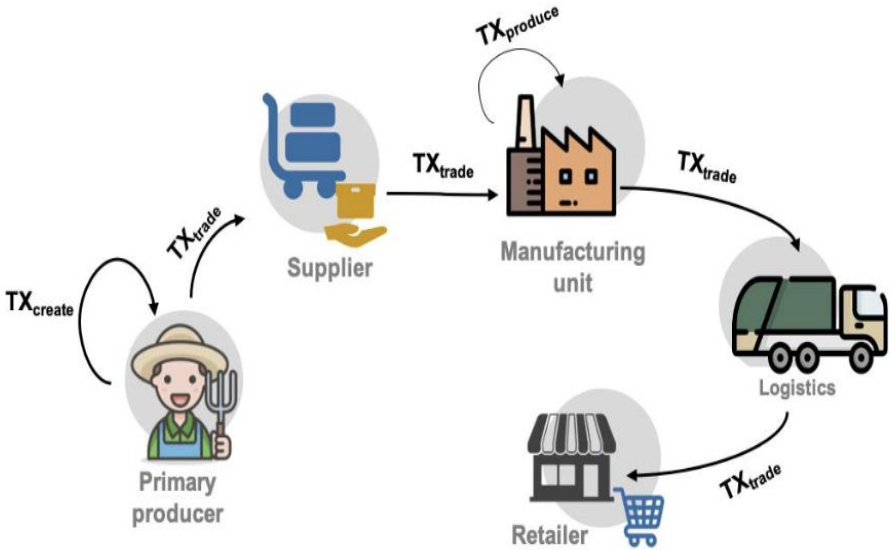
Industry 1/3 - Retail - Introduction

- Retail Industry is one of the top industries which uses blockchain technology

Using blockchain technology in the retail supply chain resolves some of the following pain points;

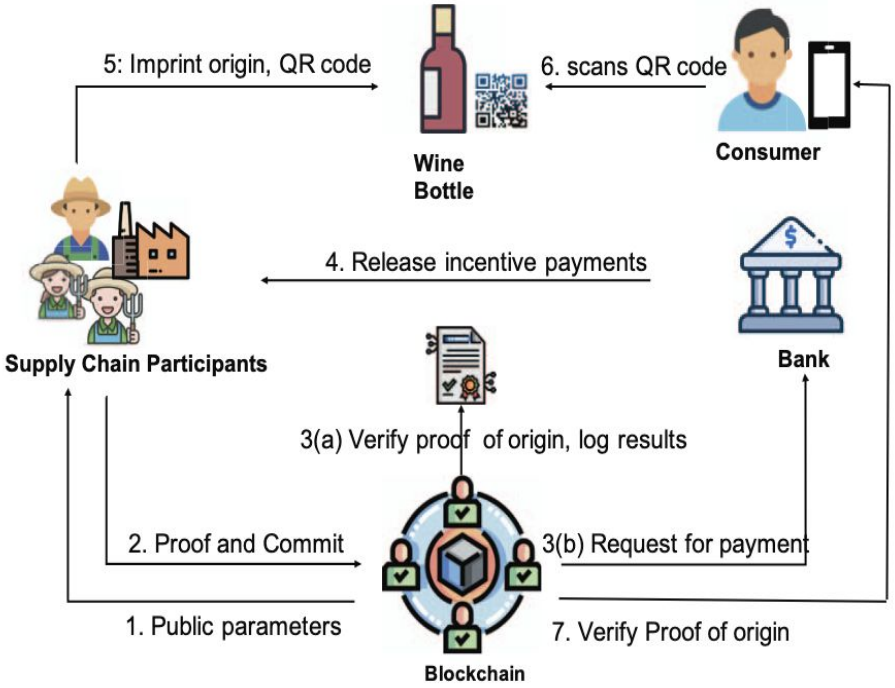
- **Provenance**: authenticity of raw materials, including component suppliers
- **Compliance**: proof of certification of regulatory conditions being met
- **Transparency**: visibility for all parties across the full supply chain
- **Faster Payments**: self-executed smart contracts facilitate automatic payments
- **Reduced Costs**: reducing administration resource cuts costs
- **Improved Accuracy**: digital transactions without human intervention can improve data accuracy

Industry 1/3 - Retail - High Level Overview



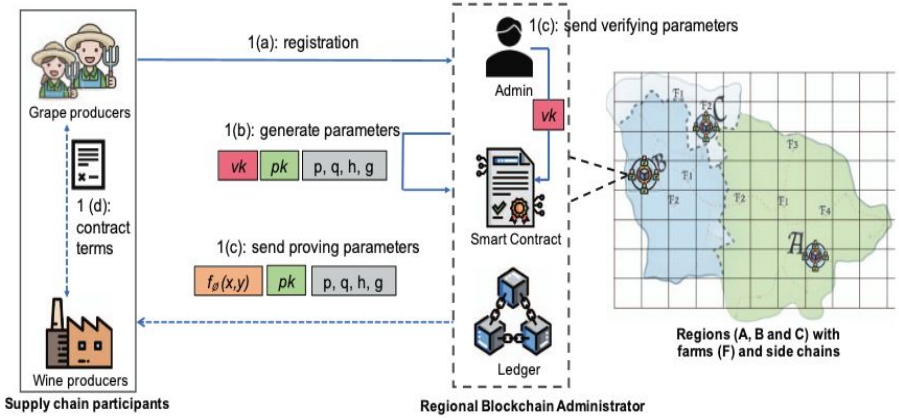
- The supply chain participants log supply chain events on the blockchain using the transaction vocabulary:
- TX_{create} - The producer registers a new batch of commodity on the ledger
- TX_{trade}- The product is sold to an intermediate supplier
- $TX_{produce}$ - The manufacturing unit processes the raw materials sourced from multiple suppliers and registers the final product on the blockchain

Industry 1/3 - Retail - Example



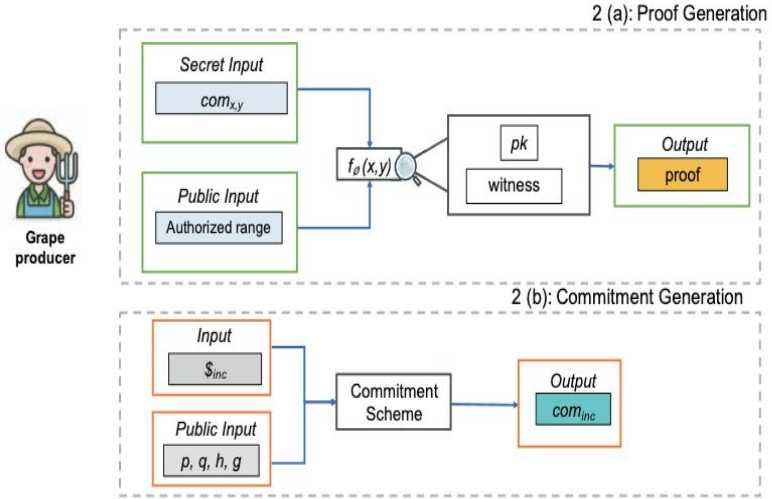
1. Blockchain provider provides initial public parameters.
2. The secret used here is the location of the grapes
3. Zero Knowledge Range Proof is used.
4. Incentive is provided to the seller for proving the location.
5. All the information is printed in the QR Code for the customer to access the details.

Industry 1/3 - Retail - Example



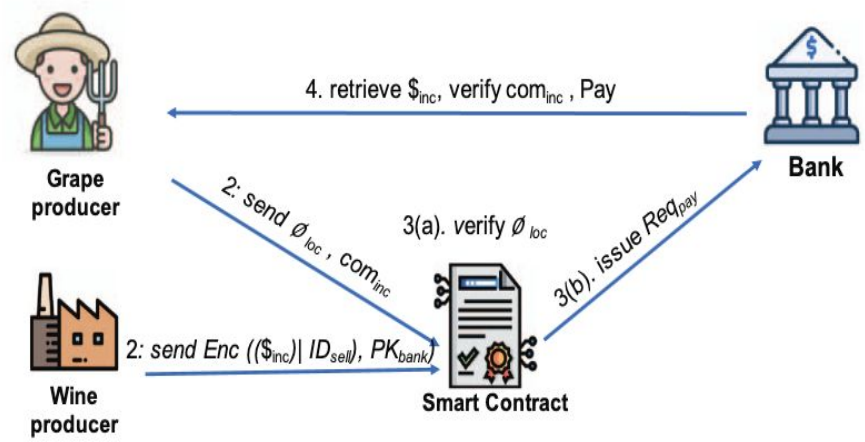
- Multiple regional side chains.
- public parameters generated by blockchain admin.
- Location input from a sensor device is taken in form of a signed commitment to GPS coordinates
- producer uses the signed commitment to produce proof

Industry 1/3 - Retail - Proof commitment



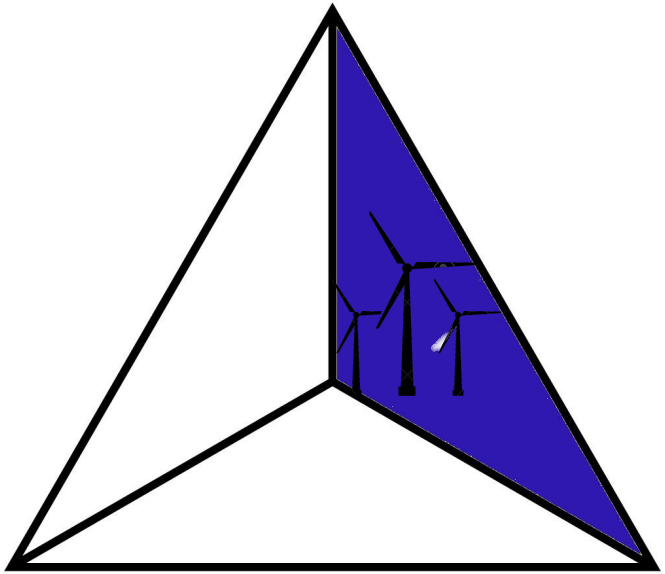
- The proof generation is executed off-chain at the grape producer's end
- Uses $f_\varphi(x, y)$ to map coordinates to an authorised region
- Decomposes the secret into base-u. Producer computes digital signatures on each element
- Witness is generated and the grape producer signs the witness using proving key
- Grape producer generates commitment for the negotiated amount.

Industry 1/3 - Retail - Verification and Incentive



- An on-chain proof verification process.
- The contract uses the verification key against proving key
- A request to bank for incentive payment is generated
- The incentive amounts are kept private from the blockchain network.
- the seller also sends the commitment and the buyer encrypts the incentive amount, and seller's ID using the bank's public key, signs it and sends it to smart contract
- The bank creates a new commitment and compares it with the received commitment and pays the negotiated price to seller if it matches.

Industry 2/3 - Energy



Industry 2/3 - Energy - Introduction

- The energy sector - oil and gas, electricity, renewable energy, and more.
- Critical to the functioning of modern societies - disruption or inefficiency can have significant impacts.
- The energy supply chain involves - exploration, production, transportation, and distribution of energy products - to/from complex hierarchy of stakeholders

Fig: https://theonebrief.com/asia/post/the-headwinds-hitting-the-renewable-energy-industry/

Industry 2/3 - Energy - Why use Blockchain?

The energy sector has been quick to recognize potential benefits

Some unique challenges facing the energy sector are:

- Need to **track and verify** the provenance of energy products
- Ensure **compliance** with regulations

Example - To track origin and destination of energy products, monitor the energy usage of consumers, and verify the authenticity of renewable energy certificates

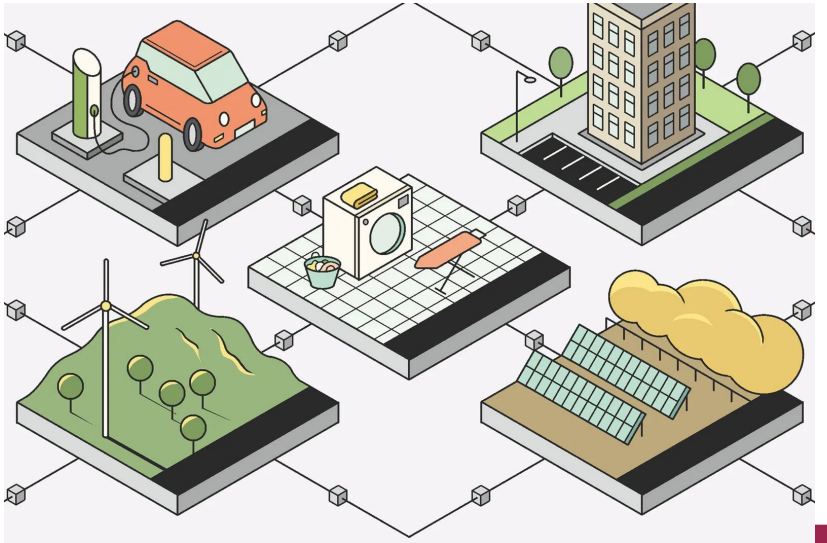


Fig: https://www.wired.co.uk/article/energy-web-foundation-blockchain

Industry 2/3 - Energy - Use Cases

- **Energy trading**: Blockchain can facilitate peer-to-peer energy trading between consumers, allowing them to buy and sell excess energy directly without intermediaries. Blockchain can be used to track the movement of energy resources from production to consumption, ensuring transparency and accountability throughout the supply chain.

- **Grid management**: Blockchain can help to manage the distribution of energy on the grid by facilitating real-time transactions and enabling the integration of distributed energy resources such as solar panels and wind turbines.

Industry 2/3 - Energy - Use Cases

- **Renewable energy certificates**: Blockchain can be used to track and verify the origin and ownership of renewable energy certificates, ensuring that they are genuine and that the energy they represent has been generated from renewable sources.
- **Carbon credits**: Blockchain can be used to track carbon credits and carbon offset projects, ensuring that they are genuine and that they have a positive impact on the environment.

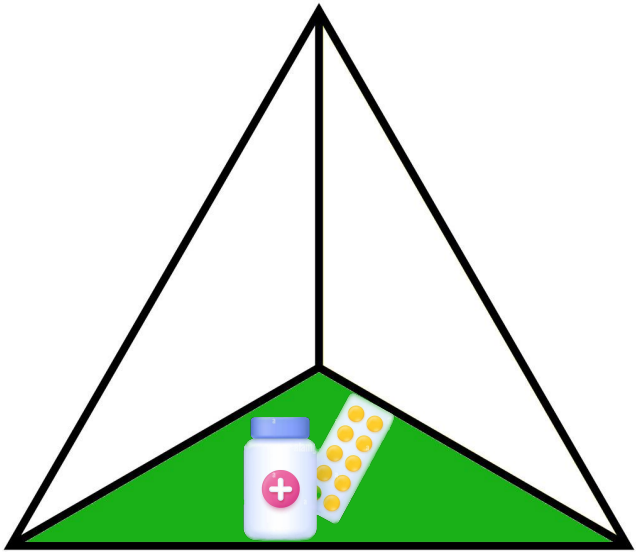
Overall, blockchain technology has the potential to transform the energy sector by **increasing transparency, reducing costs, and promoting sustainability.**

Industry 2/3 - Energy - Benefits

Able to create more secure, transparent, and efficient supply chains, while reducing the risk of fraud and errors = lower costs and increase reliability

Enabled the energy sector to explore new business models and revenue streams. For example, blockchain-based platforms can enable peer-to-peer energy trading, where consumers can sell excess energy generated from renewable sources to other consumers. This can help to promote the use of renewable energy sources and create new revenue streams for consumers.

Industry 3/3 - Pharmaceuticals



Industry 3/3 - Pharmaceuticals - Introduction

In this section, we will look at how blockchain technology is being implemented in the pharmaceutical industry and its supply chain management specifically.

The pharmaceutical industry, as we know, is primarily concerned with the **research, development, manufacturing, and distribution** of drugs and other medical products. The global pharmaceutical market was valued at over $1.3 trillion in 2020 and is projected to reach **$1.6 trillion** by 2025, according to IQVIA, a healthcare data and analytics company.

On paper, its size and complexity make it an ideal candidate for the implementation of blockchain technology to **increase transparency, accountability, and efficiency** in its supply chain.

But is it really?

Industry 3/3 - Pharmaceuticals - How does it help?

Enhanced transparency and traceability: Every transaction, transfer, and movement of the product can be recorded on the blockchain, allowing for complete transparency and visibility of the product's journey.

Improved product safety: By using unique identifiers, such as serial numbers or QR codes, that are recorded on the blockchain at the point of manufacture, each product can be verified as genuine throughout the supply chain and can also aid in the detection of any quality issues, such as contamination or adulteration.

Industry 3/3 - Pharmaceuticals - How does it help?

Smart Contracts: Blockchain can automate the payment processes and eliminate intermediaries by using smart contracts that are programmed to execute payment once predefined conditions are met.

Increased efficiency: by streamlining the overall supply chain operations, the supply chain network is sure to be more efficient.

Industry 3/3 - Pharmaceuticals - Beyond supply chain?

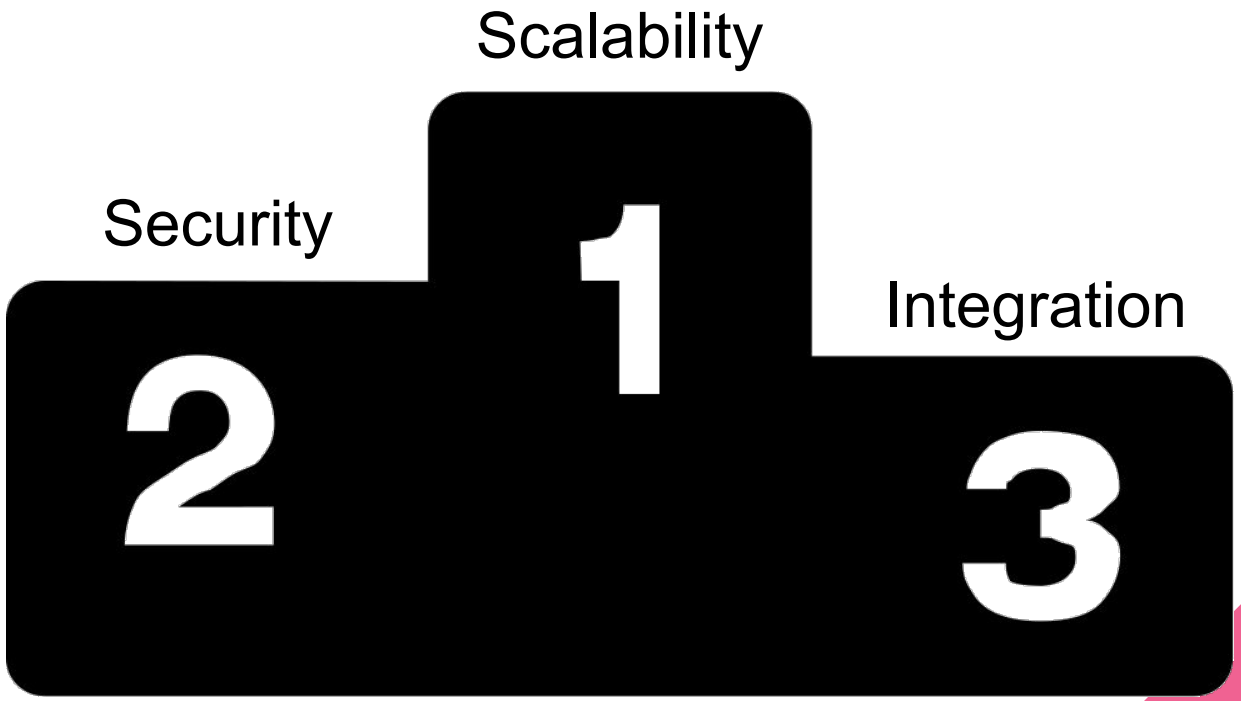
1. **Healthcare:** There are a number of use cases of blockchain in healthcare. Some of them include clinical trials, drug development and medical record management.

2. **e-prescriptions:** Blockchain can be used to create tamper-proof records of prescription drug use, helping to prevent abuse and diversion.

3. **Personalized Medicines:** Blockchain can be used to securely and transparently record patient genomic data, allowing for more personalized and effective treatments.

4. **Identity Management:** A blockchain-based system for secure identity management and authenticate manufacturers and distributors in the industry.

Industry 3/3 - Pharmaceuticals - Limitations



Industry 3/3 - Pharmaceuticals - Limitations

But wait, there's more!

Implementation Costs

Adoption

Lack of standardization and guidelines

Industry 3/3 - Pharmaceuticals - Where does it stand?

Based on the reviewed papers, it appears that blockchain is being implemented in the pharmaceutical industry supply chain to varying degrees.

There is a clear requirement for scalable blockchain solutions to tackle different challenges encountered by the pharmaceutical industry and its supply chain management.

To create these solutions, it is necessary for stakeholders to collaborate and conduct additional research to tackle the identified challenges and limitations.

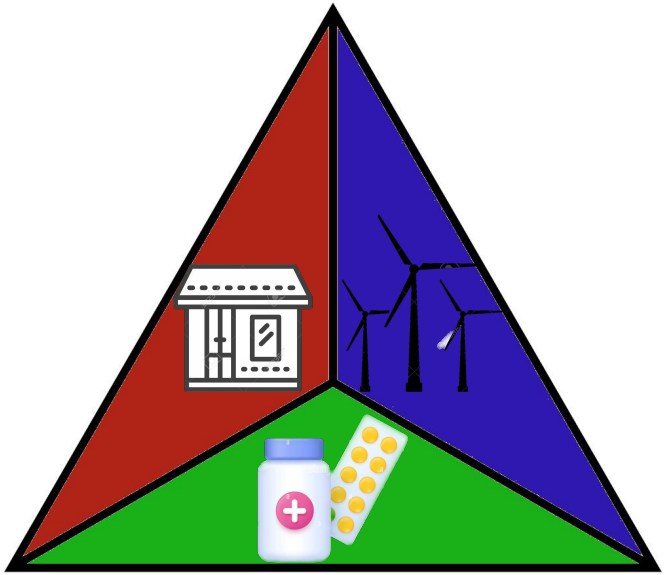
Industry 3/3 - Pharmaceuticals - How’s the future looking?

Based on the potential benefits of implementing blockchain in the pharmaceutical industry, it is likely that more companies will start to adopt this technology in their supply chain operations.

Once more and more companies begin adopting blockchain, it is bound to get streamlined and have some regulations put in place which will ultimately solve majority of the issues.

Investing in and exploring scalable blockchain solutions is worth considering for the future due to their potential benefits in terms of data security, transparency, and efficiency.

Conclusion



Conclusion

- **General Interest** - Industry players across the 3 sectors want to implement blockchain - there is general interest
- **Private Blockchains** - Scale and Privacy are the focus. Public blockchains are not meeting scale demands in some use cases

Conclusion


SUPPLY CHAIN PROBLEMS
SUPPLY CHAIN PROBLEMS EVERYWHERE
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I SENSE A DISTURBANCE
IN THE SUPPLY CHAIN

Q&A