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Will Blockchain Technology revolutionize Supply Chain Management?

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Background

- Over the last decades, Value Chains have become increasingly complex and global
- Climate change and disasters like the Rana Plaza collapse have brought much more attention to social and environmental sustainability of Supply Chains
- Regulators, Consumers, Investors are seeking more transparency of supply chains
- Legislation: ESG Reporting, Supply Chain Due Diligence, Circular Economy Requirements (+ Discussions about obligatory Digital Product Passports)
- (Sustainability requirements seem to drive companies to outsource production to countries with laxer legislation)

Negative Cases

Unternehmen	Jahr	Land	Lokaler Partner	Ereignis
Coca-Cola	2003	India		Umweltverschmutzung, Wasserknappheit
Walmart	2005	Bangladesh		Kinderarbeit
Apple	2010	China	Foxconn	70h-Arbeitswoche, Freitode bei Foxconn
Nestlé and others	2010	Ivory Coast		Kinderarbeit, Sklaverei im Kakaoanbau
Kik and others	2012	Pakistan	Ali Enterprises	Feuer, 260 Tote
Gap and others	2013	Bangladesh	Rana Plaza	Einsturz Fabrik, 1.100 Tote
Apple	2013-	China		Kinderarbeit, Sklaverei
Dyson	2021	Malaysia	ATA	Missbrauch von Migranten

Sources:

Walmart, Coca-Cola, Apple: Torres et al. (2012)

Apple: <https://www.businessinsider.com/apple-knowingly-used-child-labor-supplier-3-years-cut-costs-2020-12> last access 09.03.2022

Nestlé: <https://www.daserste.de/information/reportage-dokumentation/dokus/videos/schmutzige-schokolade-100.html> last access 09.03.2022

Dyson: <https://www.reuters.com/business/exclusive-dyson-terminates-relationship-with-malaysian-supplier-ata-over-labour-2021-11-25/> last access 09.03.2022

Research

In numerous research papers, Blockchain Technology is praised for its potential to increase transparency of supply chains.

But is there any evidence in practice of blockchain technology achieving this?

What characteristics of supply chains limit blockchain technology in achieving supply chain transparency?

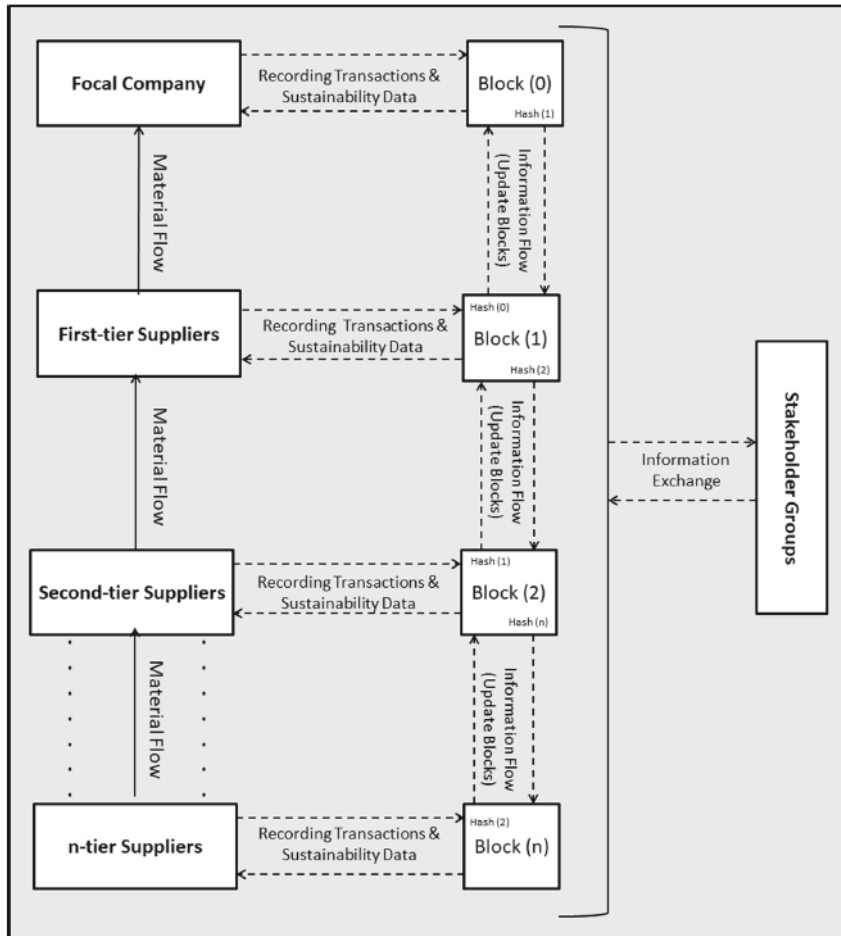
Under what conditions might public blockchain solutions enable supply chain transparency?

Literature

Construct	Definition	References
Disintermediation	Data integrity is through the network-wide consensus mechanisms, not a trusted 3rd party. Transactions are public and identities are protected	Nakamoto (2008) ; Narayanan <i>et al.</i> (2016)
Transparency	Transactional transparency requires anonymity of identities to protect privacy Transactions transfer electronic assets, not real-world objects	Wang <i>et al.</i> (2020) ; Zheng <i>et al.</i> (2017) ; Scully and Hobig, (2019)
Decentralisation	Decentralised data infrastructure creates robustness, security and availability. Participants free to join or withdraw from the network	Bogart and Rice (2015) ; Schollmeier (2002) ; Sompolinsky and Zohar (2013) ; Zheng <i>et al.</i> (2017)
Immutability	Once validated, data and transactions are secured through the transaction chain	Nakamoto (2008) ; Pournader <i>et al.</i> (2020) ; Wang <i>et al.</i> (2020)

(Bischoff & Seuring, 2021)

Blockchain for Supply Chain



(Najjar, 2021)

- Numerous authors praise blockchain technology for its ability to improve transparency in supply chains, with additional benefits like
 - reducing the need for trust
 - protect from counterfeit goods
 - improve sustainability
 - improved tracking

cf. e.g. (Mahyuni et al., 2020), (Keller, 2022), (Francisco & Swanson, 2018), (Alicke et al., 2017), (Deloitte Development LLC, 2017)

Blockchain Characteristics

<div style="text-align: center;"> Whats (Benefits) </div> <div style="text-align: center;"> Hows (Technical Features) </div>	Decentralisation / Public Distributed Ledger	Timestamped Hash Encrypted Blocks, irreversibly linked to one another, standard transactions	Disintermediation/ Network Consensus	Mining - Proof of Work or Stake
Transparency	+			
Traceability		+		
Immutability		+	+	
Data Security	+	+		+
Speed	+			
Efficiency			+	

Published Case Studies

Case Study	VW & Minespider	Bumble Bee & SAP	De Beers Group	Walmart Mango	FFF Enterprises, INC
References	(Volkswagen AG, 2019) (Minespider, 2019) (BTC-Echo 2020)	(SAP, 2019) (Joo,J.; Han,Y. 2021);	(Verny et. All, 2020); (Smits and Hulstijn, 2020); (De Beers Group, 2022)	(Yiannas, 2018); (Joo,J.; Han,Y. 2021); (Hyperledger Foundation, 2022)	(FFF Enterprises, 2021); (Greco/Petkus/Haensler, 2018)
Scope	From procurement to the recycling process	From fisheries to the end customer	From diamond mine to end customer	From farmers to end customers	From suppliers to customers
Considered features of the blockchain	Immutability, Public Keys	Immutability	Immutability, Decentralization	Decentralization	Decentralization
Aims	Transparency, optimize supply chain, eliminate sources of error, comply with social and environmental standards, increase safety, product traceability	Transparency, product traceability from fishermen to end customers, quality assurance, ecosystem protection	To ensure that the diamonds are not conflict-diamonds, product traceability, ensure authenticity	Faster traceability of food, improve food safety, transparency, advance sustainability, prevent food fraud, increase efficiency	Streamline the procurement process, eliminate pricing errors, eliminate chargeback disputes, increase efficiency
Type of Blockchain	Private Blockchain	Private Blockchain	Private Blockchain	Private Blockchain	Private Blockchain
Stored data	Certificates, Product Passports (Origin of the product, CO2-emissions, licenses, laboratory reports)	Data on origin, processing steps and the fishermen	Global Diamond ID (characteristics of diamonds e.g. color, carat clarity, origin, quality)	General product information (e.g. origin, time of harvest), certificates for safety audits,	Transaction evidence, public data and anonymous evidence of the participant's data ownership
Consensus Mechanisms	Unknown	Unknown	Unknown	Unknown	Proof-of-Authority
Alternatives to Blockchain considered?	No	No	No	No	No

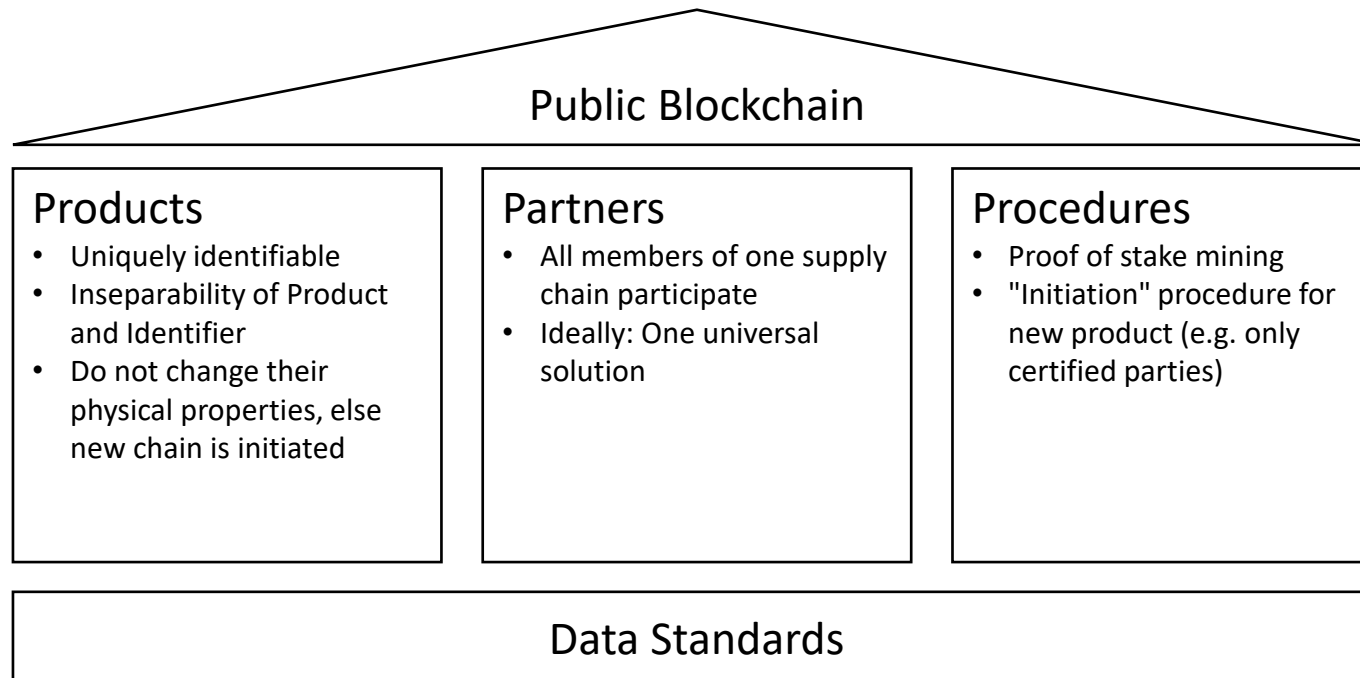
All **private** blockchains, no alternatives (e.g. cloud solution) considered

Challenges in Supply Chains

	Blockchain characteristics	Cryptocurrency	Supply Chain		Comment
Complexity of transactions	Disintermediation (Consensus mechanism)	Non-complex, Stable, Only one type, chains of transactions, symmetric information	Multiple formats, lack of standards, properties of objects represented change in the process, intertwined networks, asymmetric information	(Keller, 2022), (Ahmad, 2019), (Bischoff & Seuring, 2021), (Ghode et al., 2022)	Network consensus impossible or only for superficial information, complete standardisation unrealistic
Type of entity stored	Transparency, Traceability	Currency	Contracts, Information related to physical entities (e.g. location, origin, properties)	(Najjar, 2021)	Missing link between object and blockchain CRITICAL
Need for / Willingness to provide Transparency	Transparency	Desired for transactions, not desired for users	Depending on type of information desired or undesired	(Alicke et al., 2017)	Not all companies, countries likely to join CRITICAL
Participants	Decentralisation	Unlimited number, voluntary participation, balanced power	Limited for each chain, but sometimes unknown (end customers - > unlimited), Participation required, imbalanced power	(Alicke et al., 2017)	Not all companies, countries likely to join, massive data volumes
Underlying behavioural assumption	Immutability, Decentralisation	Opportunism	Trust or Opportunism	(Alicke et al., 2017), (Ghode et al., 2022), (McGrath et al., 2021), (Treiblmaier, 2019), (Keller, 2022)	Less need for blockchain when there is trust, examine cloud solution

Major challenges outside the scope of the technical solution

Conceptual Model: Public Blockchain for Supply Chains



Summary

- No evidence in practice of Blockchain Technology delivering to the promises in Supply Chain Management
- Fundamental characteristics of Supply Chains limit the use of Blockchain Technology
- The suggested conceptual model offers a way forward for public blockchain application in Supply Chain Management, still leaving many questions open (e.g. data volumes, how long to store the information, transparency of sensitive information). The benefits of such a solution need to be looked at in more detail.

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e.g. Yiannas (2018)

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