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Tracing the origin: the use of blockchain in supply chain provenance

Blockchain Technology: Implications for sustainable operations and supply chain management

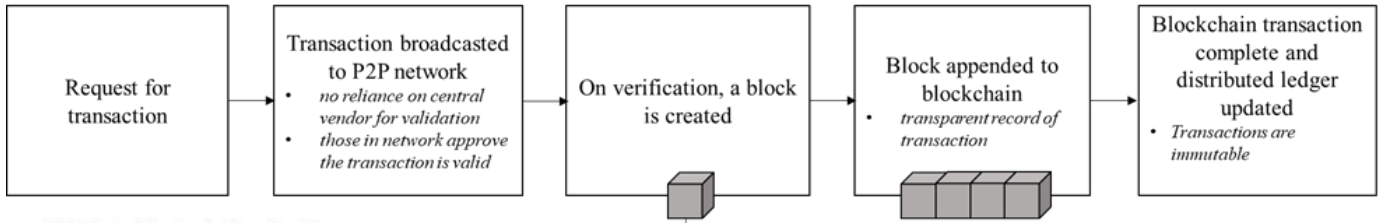

Table 3. Six Key Areas for Future Research with Proposed Research Questions

	Theme	Gap	Example Research Questions
1	Implementation of blockchain in complex supply networks	Lack of studies explaining or evaluating OSCM applications of blockchain technology	*What are the implementation challenges with block chain technology, and how can they be overcome? Further, how can block chain technology be effectively implemented across multiple tiers of the supply chain?*
2	Blockchain technology development for OSCM	Lack of comparison with other OSCM successful or unsuccessful technologies	*If blockchain technology has many of the same characteristics as RFID, how will it succeed where RFID has arguably failed to live up to the original hype? Further, how does the introduction of blockchain technology fundamentally change supply chains?*
3	Incentivising blockchain technology adoption in the supply chain	Lack of empirical evidence to show how companies are obtaining buy-in across the supply chain and who is bearing the financial burden of the implementation	*How can firms incentivize suppliers and other partners in the wider network to introduce block chain technology in order to achieve end-to-end transparency? Further, who should pay for the introduction of block chain technology in supply chains?*
4	Trade-off considerations affecting the adoption of blockchain technology	There is debate on the advantages and disadvantages of implementing blockchain technology but with no universal agreement	*What are the trade-offs involved in deciding whether to implement blockchain into the supply chain, including between:* *- The economic benefits and environmental energy usage?* *- The economic gains and costs of implementation?* *- The economic, environmental and social dimensions of the triple bottom line?* *Further, what characteristics of products, services and supply chains affect whether implementing blockchain is necessary or would payback?*
5	Supply chain relationships (incl. trust and governance)	Work on supply chain trust and governance mechanisms in supply chains remains ongoing and would be complemented by a blockchain perspective	*How does block chain technology impact the relationships between buyers, suppliers and other actors in supply chains? Further, how does the introduction of blockchain technology affect trust and governance in supply chains?*
6	Theory application and development for blockchain	Lack of theory associated with blockchain implementation (although other technology adoptions are well researched).	*How does the study of blockchain technology challenge existing theory on supply chain management?*

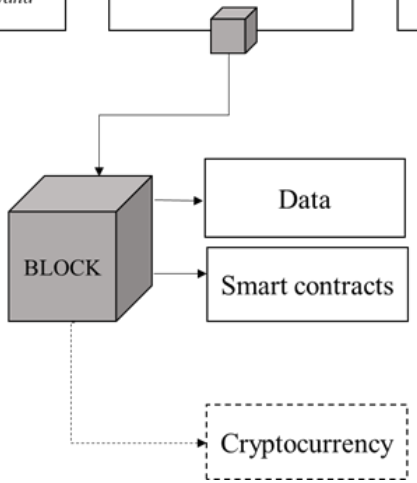

Table 1. The Relevance of the Four Key Blockchain characteristics to OSCM

Characteristics of a Blockchain	Relevance to OSCM
Distributed and synchronised across networks	Global complex supply chains benefit from real time data maintained and accessed by each partner thereby increasing transparency and agility.
Use of smart contracts	Payments are made automatically when data matches, reducing checks, manual processes and human error.
Based on P2P networks	No central authority needed to manage the process, reducing governance requirements and reliance on a single actor.

Table 2. The Potential Use of Blockchain in the Field of OSCM

Uses for Blockchain Technology in OSCM	Explanation and Example	Implementation Considerations
To enhance *product safety and security* by providing records of safety testing.	Security of the drug supply chain could be enhanced through the application of blockchain and smart contracts, e.g. by providing an immutable data ledger between manufacturers, wholesalers, pharmacies, hospitals and patients (Tseng et al., 2018). *Pfizer, AbbVie, Genentech, along with wholesalers AmerisourceBergen and McKesson are all involved in blockchain solutions to help speed up logistics, minimize discrepancies, create potential cost savings from streamlined processes, improve product visibility, and add transparency as products travel through the pharma supply chain to demonstrate compliance with the Drug Supply Chain Security Act.*	Blockchain is expected to succeed where RFID has not. Blockchain may be used to complement RFID capability.
To enhance *quality management* by providing visible and easily accessible information about batches, aiding recalls and improving service.	Paper-based freight documents are prone to loss, tampering, and fraud (Hackius and Petersen, 2017). *Maersk are piloting block chain, in conjunction with IBM, as the costs of shipping-related paperwork is between 15 and 50% of the physical costs of transport (Groenfeldt, 2017). Renault are trialling a digital car maintenance book that provides customers with new services in an ecosystem through blockchain (Renault, 2017).*	Blockchain has the potential to improve the quality of data and its visibility across the supply chain; however, a lack of standards and network speed are currently inhibitors. Standards are currently being generated by institutions such as the Blockchain in Transport Alliance (BiTA).
To reduce *illegal counterfeiting* by providing information of the origin of a product.	Blockchain can strengthen the transparency and traceability of goods in a supply network, thereby countering significant threats to licensing revenue and crew working conditions and safety (Vigna and Hanich, 2017). Examples of goods being traced include food, pharmaceuticals and minerals. *Provenance in UK based start-up is working with businesses to keep track of the origins and journey of a product, e.g. where a product was made, how it moved across the globe, at what temperatures, etc.)* *Blockchain technology is being used to record data, collected on RFID and QR code tags, to manage the flow of tuna from the sea to plate for a pilot scheme being orchestrated by the World Wildlife Fund (WWF) in Australia, Fiji and New Zealand.*	Where IoT can be used, devices must be provided and funded. It may not be reasonable to expect the poorest suppliers to be able to afford this. Even M&S and Primark have only mapped to the 1st tier supplier stage, so full roll-out across the network will raise challenges.
Improve and automate contracts and reduce the need to develop trustworthy *supply chain relationships*.	Blockchain is an emerging technology for managing food safety based on decentralised and transactional data sharing across a network which does not require trusted participants (Tian, 2017). The complexity of manufacturing ecosystems and the lack of visibility of activities across multiple tiers, as demonstrated by on-going food scares across the globe, requires the development of trust in new ways through blockchains and smart contracts (Ganeriwala et al., 2018).	Automating penalties for failing to abide by contractual obligations through smart contracts could lead to commercial issues and the dilution of relational trust. As organisations move their trading model from individuals to rely on the legal system