Blockchain or bust for the food industry?

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Tom Hollands, Wayne Martindale, Mark Swainson and John G. Keogh explore the benefits and pitfalls of Blockchain.

There has recently been a wave of enthusiasm for applying Blockchain technology in the food sector. This article aims to clarify many of the questions surrounding Blockchain technologies, in particular: is Blockchain the future for the food industry and therefore does my company need a Blockchain? Traceability has been achieved for many years using systems that connect core business processes with strategic management of product and supply

a, namely Enterprise Resource Planning (ERP) platforms. Companies must determine what Blockchains that is different from existing ERP systems and what is the value of using them. Working within a secure tform is mainstream today but this was not the case five years ago.

While ERP systems have significant benefits that can be realised, they are often very expensive to implement, with the cost of implementation linked to the operational complexity. The full costs can range broadly from £150,000 to £1,000,000+ and therefore are prohibitive for many SMEs, which make up 96% of the UK Food industry.

The changing world of cloud and ERP systems

Even with improved scaleability, we will still require robust analysis and audit.

Cloud-based ERP systems are well developed in retail, with Amazon providing the world's second largest service alongside Microsoft and Google. However, these big market share companies are not used in many parts of the world, for example, the Alibaba platform is often described as the 'Amazon of China'. This industry is moving fast and market positioning could change even by the time this article is printed. Indeed, the cloud or real time transaction arena is populated by several smaller companies, which are the 'disrupters' in this fast-evolving retail space[1].

In this arena, Blockchain technologies are seen as having a disruptive effect. Disruptive providers have emerged from the digital currency sector, where there is a requirement to ensure all vendors and buyers know what is paid and received. The alternative is no guarantees on transactions, contracts or due diligence. Blockchain technology can provide this by linking business transactions to verifiable sources of capital. They 'chain' these 'blocks' of information so that trust within the transaction can be established. Currencies, such as Bitcoin, have no central banking mechanism of underwriting risk and Blockchains have provided this endorsement of trust. Until recently there has been little consideration of a potential link between Blockchains and Fast Moving Consumer Goods (FMCG). However, by the end of 2018, the investment in food-related Blockchain technologies and platforms will easily have eclipsed investment in developing any other food sector technologies. This is unprecedented - there is much talk of what Blockchain can do and it is in our interest to be ready to respond as its potential applications will herald a paradigm shift, enabled by the other facets of the 4th Industrial revolution.

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A global food system based on trust

The global food supply chain has become highly complex and often lacks transparency and trust. The emergence of consumer interest in food provenance and authenticity – in response to food crises, such as the Horsegate scandal in Europe in 2013 – has made transparency essential for any brand, whether a large global or local food provider[2]. The larger cloud platform providers, such as IBM, which now reports that over half its revenues are from cloud services, are also lining up Blockchain technologies for the food system. The IBM platform is Food Trust[3] and it has demonstrated the Walmart tracking of mangoes to their source in just over two seconds, where it previously took a week. These high-profile cases send nervous ripples out to business and regulators alike. But the IBM-Walmart tie-up has proved that a use-case driven Blockchain is a must-have for a product safety recall. In fact, Walmart's VP of Food Safety, Frank Yiannas, is critical of regulatory requirements for 1-up/1- down traceability, noting that Blockchain eliminates the delays caused by regulatory compliance to an outdated requirement.

There is no doubt that these examples provide a step change in transparency with an improved window on supply chains that provides revolutionary traceability. It is the ability to follow the movement of a food through the supply

at makes Blockchains so appealing and if a data carrier (barcode or a suitable, as yet, untested e) can provide a link to a product's history and location data for the origin of materials and parts after it becomes even more incisive.

Increasingly, supply chain actors want to know the history of feed, ingredients and foods across the supply chain. The problem arises when this information is created and owned by different actors across different organisations and countries. The scaling of the simple producer-to-manufacturer-to-retailer supply chain becomes more complex as the amount of data associated with it increases. This forces a formalising of data quality so that systems still work together for transactional business across the world. Industry-driven supply chain data and information standards are critical to ensure a common language across supply chains. More importantly, they enable seamless interoperability between disparate technologies.

This is where Blockchain systems offer unique characteristics by comparison with ERPs. Blockchains can communicate efficiently across all enterprise management systems and, in some cases, legacy problems are eliminated. The IBM and Microsoft Blockchain platforms are GS1-compliant and utilise the joint GS1/ISO standard for interoperability called EPCIS. A Blockchain that is EPCIS enabled is a key differentiator because it can 'talk' to other GS1-enabled Blockchains and GS1-enabled traceability systems. A Slovenian company, Origin Trail, provides a Blockchain-neutral middleware or data protocol that is 100% aligned with GS1 and helps companies to quickly establish themselves as industry standards compliant and interoperable. Standards-based solutions provide the answer to the question of whether you need a Blockchain or can utilise other existing traceability systems that provide supply chain transparency through their usage of GS1/EPCIS. The decision may lie in the complexity of the supply chain and how 'deeply' a manufacturer or producer can control its products. It is quite common for a brand owner to lose sight of its products when it is using multiple distributors, resellers or retailers.

The need for Blockchain technologies

Scaling food supply data is critical in supply chains with multiple exchange partners and where data exchange protocols vary between partners resulting in data being managed differently. GS1 standards enabled Blockchains can cut through this chaotic situation because they provide a method of uniform data input (master data, transactional data and event data) and transfer, which will identify, share and defragment the data siloes. A GS1-enabled Blockchain can provide a line of sight through a supply chain that is not blocked by different transfer protocols and data standards.

Risk reduction strategies within the global food supply chain are focusing on reducing waste, improving product recall effectiveness, reducing natural resource usage and greenhouse gas emissions etc. The indications are that Blockchains may also have a role in supporting these strategies. However, the ultimate focus must be on reducing the risk of harm to consumers and improving overall consumer trust in the food industry. This is often lost in the maelstrom of issues that are associated with framing risks and futureproofing a company by undertaking foresight plans.

Recall actions and processes

Where Blockchain technology will be most useful is still uncertain, but food recall deserves specific mention because it is often associated with complexity in tracking forward and tracing backward in an urgent recall situation. As lives may depend on the speed of execution, Blockchain technology has the ability to improve the traceability and accountability as well as reducing the risks related to human health and safety. In doing so, it can significantly reduce the risk of a costly, multi-week recall process to determine the source and location of contaminated inventories. The key benefits are that it reduces the time required to trace raw material components and products from days to seconds. Typically British Retail Consortium (BRC) certificated businesses must achieve traceability within 4 hours – a Blockchain can achieve this in seconds but without the intensive labour element.

Food recalls typically occur because of mislabelling (in particular mislabelling of allergens, which must be notified on-pack with nutritional declarations)[4], process mishaps with foreign objects entering the product, human error or poor hygiene and food safety standards compliance. It has been estimated that the actual cost of a recall can reach several million pounds and damage a brand's reputation and consumer trust in the product[5]. Blockchain facilitates the recall process but does not reduce the risk of a recall occurring. A properly configured Blockchain

ever, give the manufacturer access to the most recent data, including time and date stamps of key steps and who carried them out. This level of accountability may have a positive effect on reducing some ecalls over time.

Caution is necessary if Blockchains claim to solve issues of food authenticity and provenance and to ensure product safety, because the only practical and legal way of ensuring these is by inspection, audit and analysis.

Data, inspection and Blockchains

Critical control points in any supply chain include those peripheral to food processing, such as warehousing, where co-mingling becomes a risk.

Blockchain technology can improve data interoperability across and between supply chains, but the communication and actions associated with these transfers remain critical. Blockchain will not be able to change responses and actions as these remain at the heart of developing competitive advantage in any food business. In short, Blockchain is a 'carrier' of information, it does not 'define' the content.

In a supply chain fully embracing Blockchain, appropriate data can be accessed by any member of the chain. This would significantly reduce the need to work down or up the chain to get relevant product or raw material information. It would allow the particular link to obtain the required data without resources being deployed by the other links to answer the data request. This benefits all members of the supply chain and saves resources that would otherwise have been tied up passing messages up and down the chain.

Fast delivery of data is not sufficient to solve supply chain problems; processes need to be in place to provide change in response to data. GS1 barcodes, for example, are scanned more than six billion times every day and the GS1 Standards-based technology can rapidly trace back to the producer and forward if a data carrier (barcode) is in place. There are cloud platforms that use GS1 standards, such as in South Korea, where the regulators can send an urgent product safety notification to all retailers and within 30 minutes, all point-of-sale transactions related to the unsafe product are blocked, protecting the consumer and the brand. This 'stop-sale' process is then followed quickly by the formal product recall process.

Regulations are critical in this space and where recall is associated with protection of consumer safety, the regulator is likely to be actively involved. Regulations and indeed supplier contracts are in place to control risk and are based on 'mistrust'. In the 'Regulation Mediated Transparency' model (Figure 1), regulation and supplier contracts aim to cut risk to the minimum.

An alternative model is voluntary based trust building strategies and this is where Blockchain and related technologies can provide a significant leap forward from a regulatory compliance and contracts enforcement position. In this model, strategic transparency and identification-based trust can be leveraged through education and bi-directional sharing of information with the supply base (technology-mediated transparency)[6]. For example, a retailer can assure its suppliers that the data shared on the Blockchain would enhance product velocity, increase sales and reduce the risk of harm to consumers. This theoretical model provides a framework in which it is easier to understand how technologies can reduce the information asymmetry across the supply chain and cultivate a whole new level of trust and transparency, potentially all the way to the consumer. However, this is a double-edged sword – such access to data could have unintended consequences, e.g. assisting consumers in boycotting companies, countries or continents if populist rhetoric encourages a buy local/national sentiment.

Caution is necessary if Blockchains claim to solve issues of food authenticity and provenance and to ensure product safety, because the only practical and legal way of ensuring these is by inspection, audit and analysis. Furthermore, human behaviour cannot be standardised or protected by Blockchain technology. There will always

uirement for forensic testing to ensure authenticity and safety. Similarly, Blockchain will not guarantee a luct's true or scientific provenance - forensic testing of the carbon in the product is needed to verify its

provenance claims. This is becoming more critical as an increasing number of products achieve 'designated place of origin', such as Parma Ham or Champaign. According to a Forbes article in 2017[7], up to 30,000 bottles of fake French wine are allegedly sold every hour in China.

The requirement for content or data beyond direct transaction information is likely to become more important if not essential for food and drink products. 'Human input' will still be necessary for the foreseeable future as part of the data collection process and therefore the risk of transcription error onto the Blockchain or deliberate fraud is still possible. Other emerging technologies, such as Internet of Things (IoT), devices and sensors, could transmit real-time data and mitigate the risk of human error or fraud. However, the vast majority of food businesses still utilise spreadsheets or manual processes for their management of such information and therefore industry wide adoption of a 'higher tech' approach is likely to take a long time unless regulatory pressure is applied.

Blockchain also permits 'Watchers' or 'Sentinels' to be deployed. These are smart algorithms/codes that sift through significant data looking for patterns and trends and permitting management by exception. For example, in a cold chain a 'Watcher' could be looking for signs of chill chain failure and alert the supply chain to an elevated risk for the batch of food affected. Or the Watcher could highlight reduced sales for a certain product SKU (Stock Keeping Unit), and perhaps also link to other SKU's that contain the same ingredients, enabling further investigation of a potential quality issue. Such 'sales rate issue flagging' could even be utilised to help prevent retailers and food service operations from a 'stock out' (unexpectedly running out of product), if EPOS data is linked up to the Blockchain.

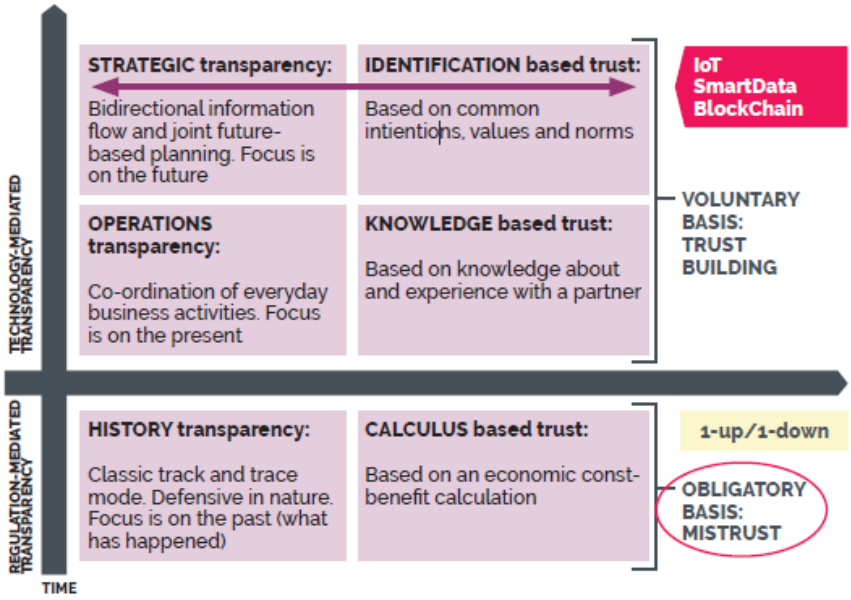

Figure 1 Diagram shows how trust transactions can differ in supply chains and why this is so important to developing transparency and traceability[6].

Certification legacies

The food industry has developed certifications that use a Chain of Custody to determine provenance and fairness. This goes beyond transparency of one-up and one-down in supply chains because the Chain of Custody is cumulative across a supply chain. The approach has been used, for example, by the sustainable Roundtable for Sustainable Palm Oil and Roundtable for Sustainable Soy[8]. This insight into how food certifications have developed might provide a significant application for Blockchain technologies because it is likely that they will strengthen the integrity associated with such certifications because transparency is improved across supply chains. Another example is provided by the measurement of GMO contamination of soy bean crops, which revealed that the supply chain for soy beans is rarely GM soy bean free. It is not known how GMO soy beans enter the supply chain during pressing and milling, but Blockchain could help to resolve this if it is supported by existing forensic analysis of supply chains[9]. Furthermore, the GMO issue has become increasingly important for consumers in the USA and feed supply chains globally.

The issue of slave labour is equally controversial and Blockchain could track payments for work associated with
eople and identifiers, such as biometric data. This would still require inspection so the requirement for
analysis and audit remains. However, Blockchain will provide robustness in determining where data
om; the verification of that data remains an important part of delivering integrity.

Blockchain can also help drive forward the sustainability agenda by helping to track and calculate CO_2 emissions, energy and water consumption and wastage levels.

Conclusions

Blockchain technologies provide potential to defragment supply chain data and show promise in enhancing the transparency of data streams from food supply chains. This is particularly useful where supply is built across several partners and nations and where large amounts of data can become redundant because they are not acted on or are simply lost. Blockchains could become an important addition to existing supply chain management systems that provide food integrity. There is a growing requirement for data carriers (barcodes) to have digital links to descriptive content regarding labour, authenticity and sustainability. It is already apparent that the use of Blockchains can dramatically improve the speed of action in, for example, a product safety recall. With continued enhancements, Blockchains will be of greatest use for food retailers and service providers operating internationally.

The existing use of ERP's and product certifications will not become redundant because there remains a requirement for effective analysis of all claims of food integrity or food credence, such as organic. This requirement holds even if artificial intelligence and machine learning protocols are used to identify threats and vulnerabilities in supply chains. These ERPs could become Blockchain ready because only supply chains that are 'Blockchained' will experience the added benefits. The final part of the Blockchain approach is determining how much transparency is required by consumers. How consumers will interact with Blockchain applications has yet to be determined.

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