Blockchain: a framework for membership and access

Introduction
Environmental and societal benefits can result from widespread adoption of blockchain by the food supply chain[1], but in order to avoid confusion the system fundamentals must always be made explicit in the context of the business supply chain. Some sources have conflated benefits and disbenefits of using blockchain to manage the food supply chain and this could ultimately inhibit adoption by food businesses, or worse create a backlash from consumers, which is a significant concern as consumer acceptance significantly influences innovation success.

This article seeks to explain both the ideal and pragmatic blockchain system that is grounded within a nascent theoretical framework. The system needs to recognise the different entities that may ‘access’ and ‘join’ the blockchain (such as businesses and end consumers) as having different motivations and therefore requiring different levels of access to data in the chain. In order to identify the ‘minimum’ benefits of the system and the context in which added value benefits may arise,

Tom Æ Hollands, Wayne Martindale and Mark Swainson explore how blockchain and artificial intelligence can fundamentally transform and enhance the food production and supply chain systems at local, national and global scales.

principles of participation in the blockchain, which are deeply rooted in the sustainability of resources, are discussed.

Blockchain – the fundamentals
At the outset it is helpful to outline the features of blockchain and consider how it functions at a fundamental level.

Blockchain is:
• a read only dataset where every entry is traceable to source
• inherently protected against corrupt data / information
• capable of interrogating data at speed
• highly secure
• permission based.

Elaborating further, categories of data (datasets) are imprinted onto the blockchain and can be traced back to where and when the data was created. The data could be process safety records associated with food production (e.g. cooking time, temperature records, allergenic data associated with ingredients or end products), finance related data, logistics information (e.g. time, location, storage temperature) – anything related to a task, process or operation[2]. Once imprinted, the data cannot be corrupted or altered in any way – ‘the die has been cast’.

Being able to store the data in an accessible format means that it can be examined at speed and therefore decision making can be quicker. Furthermore, permission can be given for other entities also in the same blockchain to view or access any of the data that has been imprinted. For example, a farmer could allow the final customer (who sells to the end user) to access data relating to where and how the food was grown and stored and at the same time prevent another entity on the same blockchain from accessing that data[3]. Data-owning entities in the blockchain need to grant permission for their data set to be interrogated by another entity on the chain.

Finally, the blockchain is a series of ‘blocks’, where the data is recorded using a hash function with timestamps. Once the data is imprinted, identical flawless copies are then distributed throughout the blockchain. This
It is clear that blockchains can facilitate support of regulation and even underpin the formation of future regulations by providing access to real, trusted datasets on a vast scale. This introduces the second principle: as a minimum, all data pertaining to health and safety and environmental sustainability (end user product-service-specific) must be accessible by every entity in the blockchain. Reducing conflict over environmental, health and safety systems will reduce the cost of resources for all concerned parties. This is a ubiquitous, desirable outcome for any business, individual, organisation, entity or government, allowing it to make more of its limited resources for the benefit of many. A supply chain is only as strong as its weakest link; problems generated early on will cascade and create further problems (conflicts) downstream. Inefficiencies of resource use and waste costs can ripple and amplify through the remaining supply chain.

A question that naturally follows on from this is ‘what are the minimum data requirements to meet the second principle?’

Health and Safety data will relate to information required to meet regulations and to demonstrate compliance with all legal requirements at that moment in time digitally captured for a product or a service.

Environmental sustainability related data – will be highly prescriptive and relate to an entity’s consumption of resources: electricity, gas, coal, water, oil (petrol, diesel) and solid fuels (firewood) in universal units. ‘Simple metrics (often already digitally captured) will provide a high-level view of how much resource was utilised in the production/delivery of a product and/or service at the point of consumption.

Having minimum data requirements for fossil fuel consumption (accounts for circa 50% of direct and indirect greenhouse gas emissions) could provide a unified, transparent and accurate measure of the environmental cost of a particular product and/or service and a cumulative total of an entity’s resource consumption.

The 3rd Principle – access requires imprinting new data

The third and final principle relates to the access requirements of the blockchain; entities may join or access the blockchain for different motivations and access does not necessarily indicate that further data will be imprinted. It is possible to access the blockchain for insight without having to directly contribute to its ongoing creation. The last principle resides in this distinction – if an entity’s motivation is to access the blockchain, then it must imprint its own data relating to environmental sustainability and health onto the blockchain; only in this manner has it truly ‘joined’ the blockchain rather than just observing it. This would ensure information symmetry for environmental sustainability and health and safety, which are only applicable in the sole context of an end user product or service.

For a free, open and supported blockchain platform, meeting regulations may not be onerous and a simple registration element, similar to an End-User License Agreement’s (EULA’s) could be adequate to ensure that data digitally captured and imprinted onto the blockchain is accessible to end-users.

A pragmatic approach

Current technologies are enabling the use of blockchain to manage food supply chains; a pragmatic approach is required to ensure that this technology is successfully adopted. Any such systems must be wholly and fully compliant with local laws and regulations, therefore, regulators and policy makers must understand how they operate and function. It is clear that blockchains can facilitate support of regulation and even underpin the formation of future regulations by providing access to real, trusted datasets on a vast scale. This can help to determine what impact policies have on a complex system – it is a whole new operating environment for policy makers, industry, academia and other stakeholders. In fact, there are many legal health and safety aspects in relation to food, work, transport etc. for which organisations are compelled to demonstrate due diligence, which almost always requires capturing some form of data. A next step is making that data accessible to the regulator and other stakeholders on the blockchain, instead of just archiving the data away onto desktop, enterprise network or an email inbox.

Imprinting data onto the blockchain is relatively easy, especially with the Internet of Things (e.g. mobile devices) and Application Programming Interfaces. Generating data has never really been a problem for organisations/entities; the challenge has been to access good, reliable, meaningful and trustworthy data in significant quantities using the right tools and analysis. Blockchain and AI will radically reduce this challenge and facilitate transformative actions but only if the data imprinted is accessible. Accessibility must be within the confines of the current legislative and legal requirements/ frameworks and at the very least offer the same protections in terms of data privacy and security – with the benefit of blockchain being secure.

Ensuring the sustainability and health of any entity, be it a business, country, consumer or government, can be achieved through reducing information asymmetry, which reduces resource waste resulting from known and pre-warmed/predicted deviations that can be gleaned from deployment of an array of meta-linked artificial intelligence (AI) devices accessing vast datasets. It is essential to recognise that culture and human interaction is just as important as technical information in the blockchain because bad data can become a reality through
malicious activity or errors.

The emergence of Industry 5.0 provides enabling technologies to support industry to better integrate social and environmental priorities into its strategic planning using a systemic approach. Industry 5.0 focuses on human–machine–interaction, smart materials, digital twins, data management technologies, AI, automation and improvements in utilisation. These approaches are being evaluated and an example is the use of Virtual Research Environments to determine the risk of food borne illnesses and to identify their sources. The requirements for data collection and robust analysis of risk data are most important; the analysis methodology is key to incisively identifying the risk.

We have recently published a study that demonstrates the value of connectivity calculations in providing a measurement of association between different locations. It is important to consider location because most information in supply chains is characterised by a time and geographic location in distribution, retail or even within a factory. While Virtual Research Environments have been tested for food incidents, availability, quality and timeliness of data is critical. Open science offers many opportunities to provide supporting data but the credibility of the data is important so we need to be cautious but also open to ideas.

By setting out a minimum number of parameters from the outset, it is expected that such a complex system will start to self-organise and evolve in terms of the range of datasets required to be imprinted, to whom access should be given and what tools of analysis are used.

Needs vary with size and motivation

Some entities, especially larger ones, will require access to many types of data sets from other entities in the chain, but all data will not be accessible to all entities, as they may not have the necessary permissions and in some cases permission may need to be sought through a 3rd party, for example where branding is concerned. In this situation, information will be asymmetrical and can result in increased levels of conflict and inefficiencies in resource use. Some system actors are likely to accept that information asymmetries will manifest in some relationships between entities. In other relationships information symmetries will flourish due to a shared basis of values and understandings. However adopting the principles described above will also ensure that the minimum shared values of health and safety and sustainability, the most pressing needs of our time, will be accessible.

Self-organising blockchain nexus

By setting out a minimum number of parameters from the outset, it is expected that such a complex system will start to self-organise and evolve in terms of the range of datasets required to be imprinted, to whom access should be given and what tools of analysis are used. This evolution will be driven by transparency, benchmarking and collaborative innovations and will be facilitated by access to better, richer and greater quantities of quality data in the blockchain nexus.

Information symmetries will be based on shared values and outcomes and will ultimately disrupt current ways of thinking as new patterns are identified. Although adoption of blockchain will vary between categories of entities and as populations shift, so too will the direction of evolution. This is to be expected as the blockchain nexus is a digital representation of interactions between businesses, consumers and other organisations, which are constantly in a state of flux.

Changing behaviour

For the end consumer, in order for the whole system to drive down resource waste and address climate change, a feedback loop is essential in line with principle two. An entity ultimately has the power and influence to change its own behaviour and having access to the real cost of its cumulative actions facilitates positive change. There are many value added benefits that can be built on this fundamental blockchain nexus – this is an area we will explore in a follow up article.

Conclusions

Confusion and confusion about the potential of blockchain for managing food business supply chains can occur due to a lack of fundamental understanding of what the system can achieve as a minimum. In such circumstances expectations and interests can be mismatched. The underpinning premise of our rationale is that when entities are provided with reliable, truthful and meaningful information on resource consumption (and associated ‘costs of conflict’), they will maximise the benefits from use of this data and facilitate other entities to do the same. This is made possible through a shared set of values allowing the vision holders to align the rules of the ‘game’ with the interests of survival of the human race and other species – likely to be seen as a reasonable approach given the world’s current climate plight.

References and article available online at onlineibrary.wiley.com/doi/10.1002/fsat.3501_13.x

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