DESIGNING BLOCKCHAIN USE CASES TO DELIVER GREATER SUSTAINABILITY IN THE FOOD CHAIN





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Foreword

IBM IBM.

The food supply chain is one of the most complex and fragmented of all supply chains. Production is found all over the world and many intermediaries make it difficult for retailers, wholesalers and public procurers to identify, trace and control food from its origin. Axfoundation is exploring the potential of blockchain technology to improve traceability and transparency in supply chains. To learn more, Axfoundation invited a broad spectrum of Swedish food companies to be part of a collaborative process around three supply chain use cases in order to find sustainable solutions. You find the result from the process in this report. Axfoundation firmly believes that collaboration and transparency on these complex issues are key. We therefore hope that this report will contribute to an increased understanding of the potential for blockchain solutions in supply chains and the need for a collaborative approach on traceability and transparency.

One-third of all the food, and half of all the fruits and vegetables produced globally go waste. A large portion of this wastage happens even before it reaches our kitchens. Wastage happens at every step of the food supply chain - farm, transport, packaging, storage, distribution and retailing. Food safety incidents result in wilful destruction of large amounts of consumable food. Such wastage is unfortunate in a world still not free from hunger. The complex and chaotic global supply chain, with its little visibility and transparency and lot of guesswork is the root cause. IBM predicts that in 5 years by uniting 3 powerful technologies - blockchain, IoT and AI - we will create a near zero wastage food supply chain that delivers fresher food to our kitchens. At the core of this is blockchain, which will deliver unprecedented visibility through the supply chain. Combined with IoT and AI, this will convert the supply chain into a demand chain, ensuring that the right amount of food is produced and shipped efficiently to the place where it is most needed. The technology is there and the participation of leading players in this process gives us hope that the collaboration will soon come, to build a near zero wastage global food supply chain.

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In the food industry, consumers and public stakeholders alike increasingly want greater provenance on the products bought and greater transparency from the companies that are supplying them. This requires information from multiple sources; physical operations, financial and information flows, and increasingly, from social and ethical behaviors. We believe that this complex network of tangible and intangible requirements can only be delivered through the innovative application of converging technologies like blockchain. Addressing real industry challenges for the benefit of all stakeholders.

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Opening doors to greater trust and food sustainability

Across the globe, consumers are demanding to know more about their food - where it came from, the effect of its production methods on our planet, and how workers and animals were treated in the process. In fact, a survey reported that 70% of consumers said they want retailers to be more transparent about their sustainability efforts¹.

Sustainability is no longer a bonus; it's an imperative for both the consumers who demand it and for future business models.

A digital food supply chain powered by blockchain enables new levels of trust and transparency across the food ecosystem, increasing awareness of sustainability opportunities and practices during each step of the food chain.

FULL TRANSPARENCY

With end-to-end transparency, users can guarantee provenance and gain a clearer view of where inefficiencies and bad practices exist across the entire supply chain.

CERTIFIED RESPONSIBLE PRACTICES

Farmers, producers, and other food actors can automatically digitize and easily share audits, certificates, and other records proving that they use and promote sustainable and ethical practices.

FOOD CONFIDENCE AND TRUST

By capturing every step and transaction in the food supply chain and sharing all information through a secure, distributed, immutable ledger, participants in the blockchain network can trust the promised quality and provenance of the goods they handle. With the practical application of blockchain technology, we are opening the doors towards improving trust and transparency from seed to farm to fork.

¹ Hartman Group, National Syndicated Research: Sustainability 2017 Report: http://store.hartman-group.com/content/Sustainability-2017-Overview.pdf

Harnessing the potential of blockchain

ADDING TRUST AND TRANSPARENCY...

More trust or trustless?

Traditional supply chains typically develop over time. Participants join or leave. New ways of working emerge. Processes and systems adapt to market changes and competitive challenges. Yet with these many changes, some supply chain problems are constant.

Business interactions are often inefficient, vulnerable to changes, expensive, and often subject to complex compliance requirements. Transactions are complex, and data is duplicated manually, which increases the possibility of human error or fraud. Add to that all the intermediaries along the way, and it becomes apparent why the lack of trust among members of a supply chain is wide-spread.

Blockchain provides all parties with the visibility into all relevant transactions to finally solve the supply chain problems that the industry has been facing for decades. It enriches business networks with a shared, replicated ledger that supports shared visibility to a single version of the truth, thereby greatly increasing transparency.





The four typical fundamental mechanisms of blockchain technologies are: the shared ledger itself, a method for consensus, smart contracts, and efficient ways to enforce some degree of privacy. These mechanisms enable greater provenance to where products are

BLOCKCHAIN'S VALUE PROPOSITION

Verified origin of data: Although blockchain doesn't guarantee that the uploaded data is correct, it always provides a clear audit trail showing who uploaded it, and when. Actors are clearly tied to their actions and root causes can be traced.

Trusted processes (or workflows): Blockchain and smart contracts make it possible to automatically track the progress of the flow of goods. They give visibility to all parties on the status of the goods.

Therefore, it's often said that "the internet was built to move information, but blockchain is built to move value."

sourced from, immutability and finality. They ensure that transactions cannot be changed or added to by anyone. Blockchain achieves that without any of the checks and controls needed today.

... TO OUR FOOD

What if every inch of your food's journey from its origin to your shopping cart was recorded in a single, shared ledger?

The food supply chain is an extremely complex and dynamic web of physical, information and financial flows. Increased globalization has led to a scenario where goods move through different geographies before reaching the shelves in the store. And not only the supply chain is intricate: A seemingly simple product may be the result of a complex chain of processes. At the same time, consumers have become increasingly interested in the sustainability of their products and demand to know where their food comes from - an almost irreconcilable situation. Just imagine that when you wanted to buy or sell Swedish lake fish, that you knew who caught that particular fish and what part of the lake it came from. Imagine that no fish was caught and wasted. This is where blockchain's unique value proposition comes into play. Why is it so powerful? A verified origin of each piece of data makes

it possible to track a product through a very complicated ecosystem while also respecting the privacy of the actors.

One example: You can trust that your fish was caught in a Swedish lake, even if you don't see all the intermediate steps, because there is an unbroken chain of events linking the moment it is caught by the fisherman to your purchase at the store. You can trust that only as many fish are caught as will be sold, because blockchain can enable matching of supply and demand every day.

Trusted processes bring new opportunities for automation and optimisation in the supply chain while allowing ethical claims to be verified, and provide digital proofs of fair trading practices.

Another example: If most workers on a Moroccan strawberry farm log their hours according to their contracts, a retailer can trust that the working conditions meet the standards he expects of his suppliers. This is not to say blockchain can solve all problems. Many challenges can be addressed in other ways and with other more established technologies. Instead, we have to understand what it is about the problem that makes blockchain such a good potential answer. That is why we set out on this endeavor to explore the possibilities for this promising technology in three focus areas: Moroccan strawberries, Swedish pig meat and Swedish lake fish. You will learn more about our approach and our results in this report. 🕅





Photographer: Ulf Berglund

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Designing blockchain-enabled solutions for food industry challenges

With every new example of blockchain solutions in the real world, it's becoming clearer that blockchain technology holds the potential to disrupt and transform businesses and industries alike. It delivers new sources of value, while also creating greater efficiency and effectiveness in the complex global food supply chains that we depend on.

Of central importance, however, is not the technology nor its potential to disrupt entire industries. Use cases are. New value opportunities unveil themselves when we define and understand real use cases. In any blockchaininspired journey, the first and most important question is: "What problem are we trying to solve?" That problem needs to be one that can benefit from the strengths of blockchain technology, and the changes in trust that it can generate. Even then, many challenges embedded in the food industry can only be addressed by a combination of technologies. And without shifts in the way the market works, these challenges may remain highly resistant to being solved.

So, any journey exploring the value of blockchain must start with an open mind. Before thinking about solutions, we must truly understand the problem at hand. We must first embrace the real issues and pain points that participants in a food chain face – and seek to determine what a better future could look like. Only then can we investigate if and how blockchain can enable that future.

WHAT WE SET **OUT TO ACHIEVE**

With this thinking in mind, Axfoundation set out to better understand blockchain's potential. They invited three wellknown interested parties to propose real use cases for investigation: Oxfam, the MSC (Marine Stewardship

Council) and RISE (Research Institutes of Sweden). Oxfam wanted to look into securing better social compliance and working conditions, particularly in the Moroccan farms and fields that grow strawberries for Swedish consumers. For MSC, it was the opportunity to improve the awareness of provenance for lake-caught Swedish pike perch. For RISE, it was the challenge of highlighting the market potential of Swedish organic pigs, reared to very high animal welfare standards.

The investigation would not be a paper exercise though. Instead, Axfoundation encouraged a broad group of public enterprises and private businesses to participate in a design phase. Their goal? To discuss and share the pain points and

opportunities for change. And the more participants, the richer the insights and deeper the understanding participants were able to achieve. This helped to create and sustain real consensus of the potential solutions. Equally important it helped participants determine for themselves how blockchain could potentially be a fit for their own businesses.

HOW WE SET OUT **TO ACHIEVE IT**

The design phase looked at the three use cases, which were given the names Strawberries, Pig and Fish, and focused on two core areas of assessment:

Business fit - to understand how blockchain's strengths could successfully address complex business issues. Technical fit - to understand the technical feasibility of a blockchain based solution; given the quality and availability of the required data, and the solution's ability to meet the security, privacy and governance needs of the participants. To build a collaborative and shared understanding of the challenges and opportunities of each use case, we ran Design Thinking workshops. We used this approach to frame the perspective for all participants, giving them a role to play in seeing

Design Thinking helps one take the perspective of the user (or customer) and looks to design solutions that improve the experience for each participant in the supply chain. What an improved experience is, will vary by user and the challenges they face in their role. There is no one answer fits all, no vanilla solution. Trust builds when people realize that others truly understand their situation and are prepared to solve their challenges as well as their own. If change is to be sustainable, it needs to engage and value everyone involved. Therefore, participants diverge to create choices in small groups. And then they converge to update one another on their work and make choices together.

both the challenges and opportunities for change in the use cases from a user perspective. With this mindset they could assess the potential of blockchain in terms of how it would improve their daily lives.

The food chain is a highly complex and consumer centric ecosystem, changing the balance of what is being done today for the benefit of all, is no easy undertaking. But if we start with looking at it through the eyes of the people in the chain then we think we have the best chance to create sustainable and meaningful change. 🕅

USE CASE 1: Strawberries

When Oxfam and Axfood suggested the Strawberries use case, it was not only product traceability that they had in mind. They also wanted to look into securing better social compliance and working conditions, particularly in the Moroccan farms and fields that grow strawberries for Swedish consumers.

Morocco is a major source of high quality fresh and frozen strawberries for European food businesses. The supply chain is well established and effective, but harvesting the crop is still a very manual and challenging task, for both the farmers and farm workers. Visibility into working conditions and compliance to codes of conduct is still largely opaque and there is a growing desire from retail customers and wholesalers to establish greater transparency throughout the supply chain, to ensure that the strawberries they are buying come from farms with the very best social and sustainability practices. When we looked at the business fit, it became apparent that a number of aspects makes it difficult to clearly establish compliance to social requirements, mainly

HALLENGE	Actionable visibility to 'social compliance' for strawberry harvesting and processing in Morocco is very difficult to achieve			
BLOCKCHAIN FIT	Create a shared digital platform for all participants to upload and view information to the process, compliance, working conditions, and enable micro payments			
CHANGE	Significant changes to established ways of working. For example in labour recording, contracting, working conditions feedback and payments			
OVERALL FIT	A Data	Security & Privacy	A Governance	
Some technical feasibility challenges				

because of the way in which farmers, transporters and workers interact with one another.

Their behaviors are driven by a complex set of national, local and cultural conditions. We gained a deeper understanding of the challenges and practices in strawberry harvesting in Morocco. In many ways, the issues around the value of having a contract, of how the social security regulations worked, and the complex dynamics between farmer, worker and transporter made it far less clear what type of data capture would be the most beneficial to all parties. That impacts the technical feasibility of this use case. Overall, as we see in the chart on this page, we identified some challenges



in all three technical categories (data, security & privacy and governance). However, we do expect a blockchain solution to deliver considerable value. There are clear business problems to be solved in an ecosystem where blockchain capabilities can support new innovative solutions. Overall we believe that a blockchain solution can build trust in social compliance, but it will require additional technology to succeed.

RECOMMENDATIONS

So the first step in developing a blockchain solution would be to understand more clearly what data is captured today, how it is captured, by whom, and what triggers the data capture. Is it compliance reasons, working practices, or just when people feel they need to? This could in reality represent a lot of investigation so it would make sense to focus initially on one or two simple types of data that all participants could agree there is a way to capture. We see the blockchain solution being a combination of a data capture mechanism,

We see the blockchain solution being a combination of a data capture mechanism, for example a smartphone based application, with a blockchain ledger to record and secure the information. This information could then be shared with users through an interface to a simple application.

The initial pilot should be focused on testing the technology and ability of the users to interact with it successfully. Learnings could then be used to shape requirements and expected outcomes for a more structured pilot, which should focus on determining the value to the participants

of the new data being captured and how current compliance procedures could be improved. Both pilots should also address how successfully compliance to worker contracts and payment for hours worked can be established in the solution. Blockchain, like any data ledger, depends on the accuracy and completeness of the data uploaded and given our findings on the strawberry use case, this is a significant challenge to the effectiveness of a blockchain solution. Therefore, the initial pilots should also include activities to assess how behaviors at the farm level are being shaped and how a new solution could most effectively impact these behaviors. 🕲

USE CASE 2: Fish

The supply chain process for lake-caught pike perch is a well-established and successful one, but the product is hard to differentiate from the competition. The Marine Stewardship Council (MSC) asked us to look into how to further enhance the value of that specific fish, and how to raise awareness of the provenance and quality of the product.

We identified the challenges that exist in the pike perch supply chain from lake to shipment from a business point-of-view. There are many areas in which information and activity are captured manually. Digitizing the information flow using a blockchain solution will create shared visibility and trust. We only see some technical challenges where the international exchange of data under European legislation is concerned. Overall, the required data is generally available. And we don't expect any major technical feasibility challenges regarding security and privacy.

RECOMMENDATIONS

There is a clear opportunity with Swedish lake pike perch to build a new kind of capability based on

CHALLENGE	Establishing provenance, quality and condition is a very manual, paper-based process		
BLOCKCHAIN FIT	Create a shared digital trading platform from lake to buyer, which captures and shares all provenance, certification, compliance and supply chain information		
CHANGE	Additional data capture activity and changes in ways of working for fishermen and transporters		
OVERALL FIT	Data Security & Privacy Governance		
Some technica	al feasibility challenges		

blockchain solutions within the value chain.

The capability would be delivered by a blockchain platform acting as a marketplace between fishermen and the buyers of pike perch. It would enable a more accurate matching of supply with demand, greater assurance to the provenance of pike perch, and increased visibility to the movement





and status of the pike perch fish to all stakeholders. We would see this differing from a compliance solution in that it's not about control and fulfilling regulatory requirements. These are important but the blockchain enabled marketplace solution offers much more. For example the opportunity to grow and prosper through greater collaboration, and greater visibility to what is actually happening in the pike perch food chain. The shared, decentralized nature of a blockchain solution and the immutability and finality of the information it holds would also help increase

trust across participants, and willingness to collaborate around common objectives. However some key pre requisites need to be met before taking the next step.

These prerequisites are: - Key stakeholders, in this case the fishermen and auction owners, need to agree on how to fund such a pilot.

- The governance and management of the blockchain also need to be agreed upon. We need to establish what data is required, how it should be shared, how new stakeholders should be onboarded, and who should manage the technical solution. -There needs to be an agreement on a roadmap to engage with other players in the ecosystem, such as the Marine Stewardship Council, buyers, wholesalers, food services, public and industry bodies to name a few. Once these prerequisites have been met we would advocate the setting up of a pilot which set out to validate the business value that a blockchain network could create for participants supplying and buying the pike perch. 🕲

USE CASE 3: Pig

To drive growth and increased value in Swedish organic pig production, both in the home market and for export, greater transparency in the food chain, highlighting the natural strengths of the food chain, is key.

However, that visibility is largely siloed and depends on a mix of manual, paper-based processes and systems. The supply chain is complex with many participants, all dealing with strict regulatory, hygiene, medical, audit, and commercial requirements that have to be fulfilled before the customer buys the product. Put these challenges together and it's clear why managing data captured across the supply chain for the benefit of everyone has proved elusive to date. Even so, the technical fit looks promising. A common system already used by farmers captures data required for initial blockchain development. Adding data to a Blockchain from upstream systems managed by processors, wholesalers and retailers for example, could then provide shared visibility to key data that has value to all participants. It could link technologies together as it grows, which would drive



increased provenance and market value. Overall we see a significant opportunity to create new levels of visibility and transparency within the organic pig food chain by developing a blockchain 'platform' that connects farmers, slaughterhouses, processors, wholesalers and retailers. Adding third parties such as veterinarians, industry bodies, government agencies, and ultimately the consumer would give the platform even more value and enable a

more away from physical and paper-based processes to digital management of the pig food chain.

RECOMMENDATIONS

Our recommendation would be to start small; with two or three types of data that the farmers currently capture that could be uploaded to a blockchain and shared with several downstream stakeholders. A typical minimum viable product (MVP) pilot would



most likely start with a group of farmers on a blockchain, who are able to share data. This wasn't identified as a compelling initial use case, though. Instead a more valuable use would be one that shared data between a mixed group of participants: farmers, a slaughterhouse, a processor, a wholesaler and a retailer - again uploading only a small data set initially. That data set would need to deliver additional value compared to their present situation in the eyes of all parties. However, there would be no need initially to use additional technologies to capture data, so the blockchain setup and onboarding costs would be relatively small. What would need to be agreed though in the setting up of the blockchain network would be questions of

funding and governance between the participants. For example, who pays for the Blockchain to be set up and who is needed to govern it. If a retailer funded the blockchain, they would probably play a founder role and ultimately would want to extend into other food areas. If, however, the farmers primarily funded the blockchain, it would rather develop into a market solution extending across the organic pig food ecosystem. Whatever the starting point, establishing a common digital platform for sharing pig food supply chain data clearly creates a framework for growth, and the ability to add more technologies (internet of things and artificial intelligence, for example) to the platform and further improve the provenance,

sustainability and safety of the overall value chain. This is not just future thinking. Already Alibaba in China, one of the world's largest pig importer and exporter, is combining AI, sensor based systems, and blockchain to create a holistic 'system of record' for every pig they breed. Creating a blockchain platform now to build learnings to help Swedish farmers and exporters compete in the future may become the key business problem to be solved. 🕅

Reflections

This initiative started with a firm belief. A belief that there are important learnings to be captured and shared on the challenges and opportunities for sustainability and for change in the food supply chain. A belief that this understanding is key to helping a wide variety of businesses in the food industry evaluate how blockchain-enabled solutions can help them address underlying pain points in their supply chains.

What we learnt is that, to improve transparency, one must foster opportunities for greater trust between participants. That the journey to greater sustainability can be supported by the visibility that blockchain-based solutions provide in every activity and every choice in the supply chain.

TRANSPARENCY AND TRUST

Blockchain is a shared ledger, in which all kinds of information can be recorded and shared with everyone who needs it. What is shared, and why, is agreed by all participants and we found through this initiative that this process of consensus building is a powerful way to build trust and a belief in the value of greater transparency. As we follow through with this initiative and reimagine today's business interactions, the need for greater collaboration will only intensify. Blockchains can support it. Algorithms and bots can automate it. But only the people in these supply chains can make it happen – if they are willing to change the way they do things today.

SUSTAINABILITY AND VISIBILITY

What became clear in the process is that there is a rich amount of information available to tap into. We looked at what defines a better experience for supply chain participants, and what value it would give them. We saw how the origin of goods was lost in the purely operational execution of the supply chain: Consumers don't know about the relationship between

fishermen and the types of fish in their lake, between pig farmers and their livestock. They cannot tell how a pig was fed – or how sustainably its food was produced. In short, there is no shortage of information, but the information is invisible and cannot be captured easily with today's systems. With blockchain, it can. And when sustainable practices become visible to consumers who appreciate them, the worth of applying these practices grows - together with the value of the produced goods. That is why we believe making provenance more visible to everyone in the food chain can help deliver greater sustainability.

Five attributes that are fundamental to blockchains have the potential to vaporize the frictions that hold us back today. Blockchain is:

- Distributed and sustainable
- Secure and indelible
- Transparent and auditable
- Consensus-based and transactional

- Flexible and orchestrated We understand though that building a Blockchain are not always going to be the right answer for all problems. Often, leveraging existing, proven and simpler, technologies makes most sense. Where millions of transactions need to be processed by the hour, for example, is not the best use case for blockchain technology today. All transactions need to be confirmed by participants or consensus mechanisms, which take time and are time-consuming to set up. The added value of more secure consensus without a central authority needs to be established. Only then will a blockchain solution make sense. What did we learn that is new? Don't start with a solution; start with a question. Understand the real business problem. Our journey was one of discovery and understanding, one that was instrumental to identify whether

Call to action

Addressing industry-wide problems, tackling some of the challenges that our planet faces demands a concerted action by all stakeholders.

We have demonstrated that blockchain can be a useful new tool in helping to address these issues. Blockchain may not be the whole answer – as we found out through the use cases – but it will be an enabling and ultimately transformational technology to help on the journey to a more sustainable future.

Now, it is up to these stakeholders to explore how this can advance their business and help their trading partners. In Sweden, public, private and not-for-profit businesses already closely cooperate and collaborate. What better trailblazer could one have to tackle

blockchain technology makes sense as an answer. Yet the lesson for the industry as a whole is clear: Blockchain can become the universal digital network or common information infrastructure of the food chain to record and capture what happens in the supply chain. And to then share those insights for real transparency, without the need for every location in the supply chain to build and maintain their own expensive islands of visibility. 🟵

common food chain challenges than a country where building consensus is the natural way of working?

Will it be easy? No. Building consensus and agreeing on governance is hard labour. Ways of working will have to change. And face resistance. But it will be worth it.

Just imagine. Imagine a place where everyone not only knew where their food came from, but what it took to produce it, who was involved, what happened to it at every step of its journey, even as it was happening. Wouldn't that be worth the effort? (S)



