Final report

Evidence-based digital traceability trials for beef exports to China - Digital/ physical supply chain verification

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Abstract

This project has demonstrated a fully integrated beef supply chain traceability solution that connects Macka's Australian Black Angus Beef (farmer and exporter) consumer-ready meat packs to Chinese and other International retailers and end-consumers. This Supply Chain Traceability project initiative was intended to review the barriers and opportunities of using a blockchain enabled supply chain traceability technology to connect the physical end-to-end beef supply chain with the digital supply chain. The focus of this project initiative was to introduce a number of "evolving" trials through which the technology could be assessed, reviewed, and enhanced. Every trial had a specific requirement and outcome expectation. After every trial a lessons-learned session was established to assess what could be improved for the next trial, allowing the operational and technology teams to deliver a "workable" solution which meets today's continuously evolving supply chain model. Macka's Australian Black Angus Beef through its blockchain-enabled supply chain traceability technology partner, Aglive (and its partner technologies) has been able to capture the various processes and hand-offs in the supply chain from Paddock to Plate, highlighting a pragmatic, trusted and effective approach to connect this extraordinarily complex beef supply chain with a digital traceability solution.

Executive summary

Background

Aglive, its Supply Chain Traceability Capturing and Reporting Solution, and AgliveTrust, its Consumer Product Verification, solution with embedded licensed mobile eNVD, is fully focussed at re-connecting the farmer with the end-consumer. Aglive achieves this through using a smart tags/ RFID/ QR codes and/ or label IDs in combination with 'digital twin' (blockchain) tokens. This identification process was developed using various application platforms and tools under licence or under contract with third party system and software firms.

Objectives

The project's primary objective was to further understand the intricacies of the physical beef supply chain, allowing the Aglive supply chain traceability solution to meet these complex process components and ensure that its solution fits these requirements, further increasing the usage of such solutions across the beef supply chain, supporting the elimination of food fraud and increasing the efficiency (speed, accuracy and quality) of the beef product through its supply chain from origin to the end-consumer.

Methodology

The objective was met through the introduction of a series of farm to consumer-ready product (through further processing facility in Australia) to end-consumer traceability trials in the Macka's beef export to China (and other international markets) supply chain. To evaluate the Aglive supply chain traceability solution for achieving the objectives of traceability from Paddock to Plate, various lessons-learned sessions were initiated to ensure that every trial was improved for the next trial, delivering a more holistic, effective, and pragmatic solution which supports user-adoption across the industry. To further strengthen these trials, an independent report was created by Macquarie University to assess its opportunities and potential benefits as well as the challenges, barriers, and risks from the perspective of the stakeholders in the beef supply chain.

This project did not extend to multiple technology platform evaluations nor multiple supply chains.

Results/key findings

There is a clear demand for a blockchain-enabled supply chain traceability solution (due to its nature that the data in a blockchain solutions cannot be changed) to remediate and ultimately eliminate fraud, increase product quality and providing a closer communication loop between the farmer/ producer and the end-consumer.

In respect to Aglive's Supply Chain Traceability solution, a number of improvements were identified that will further increase the adoption across the physical supply chain partners. During the trials Aglive has established that their technology is solid and leading-edge (from a technical perspective), however, some additional work is needed to increase its usability/ ease-of -use for certain industry users – which are not familiar with such a technology. This is why we recognise that there is a requirement to continuous evolve and enhance the Aglive's Supply Chain Traceability solution, to support an ever-evolving beef industry and macro-economic environment.

Benefits to industry

It is expected that end-to-end supply chain traceability solutions will become more widespread across the beef supply chain, similar to the "NVD" process across the livestock component. It not only provides farmers/ producers increased transparency where their product ends up, while supporting future customer requirements. This transparency is also able to combat food fraud and establish Australia as a true clean, green "red meat" producing nation. This further builds on past MLA research – see: Food without fear rationale - https://www.mla.com.au/research-and-development/reports/2016/food-without-fear-rationale-for-cross--sectoral-partners/ and https://www.mla.com.au/download/finalreports?itemId=3644

Future research and recommendations

During the trials – and the extension to non-China destinations – it was found that other complementary solution components, e.g. cold chain monitoring, pro-active notification management across the supply chain and a number of other elements, had become the norm across frozen/ fresh supply chains. Additionally, Aglive identified the importance of introducing a wider scope of eDocs in its solution to extend its traceability process – through collecting and presenting eDocs – across an ever-growing number of countries/ destinations (incl. Taiwan, UAE, Singapore, etc.), all with their own nuances in documentation, verifications, and traceability process requirements.

Through extending the Aglive solution with these additional components, it was found that Aglive can easily meet these additional regulatory requirements across the international beef supply chain landscape. Our ability to further mature and extend the existing data capturing and presentation ability allows a solid traceability solution from Australia to any destination in the world.

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1. Background

1.1 Aglive and TBSx3

Aglive has been a long-term supporter of, and software partner in, the research, trial, and implementation of the MLA eNVD system. Aglive has previously been involved in MLA-led eNVD system projects from proof-of-concept trials to final production ready and 'MLA Licensed' mobile system that utilises MLA's v3 API's and allows Aglive connectivity to the NLIS / MLA central databases. Aglive's successfully completed MLA Donor Co co-funded projects including:

- P.PSH.0717 A 'Proof of Concept Trial' to demonstrate the feasibility of implementing an electronic NVD system
- P.PSH.0748 eNVD software development (stage 2 upgrade
- P.PSH.0795 eNVD stated-based integration trials

LPA eNVD (incorporating NFAS, MSA, EU and animal health declarations) has been integrated into the Aglive IntegriPro industry platform which includes livestock management and downstream data sharing with processors including NLIS and central database interface. This on-farm management solution has been further extended to capture other on-farm integrity data, captured by the eNVD system.

Late 2019, Aglive merged with industrial blockchain provider TBSx3, which has developed the technology that can protect items from counterfeit or substitution as they move along the supply chain. TBSx3 is currently investing in new leading-edge solution components and has existing patents pending.

In the last 12 months, Aglive has transitioned its IntegriPro solution onto the Sx3 blockchain (advanced TBSx3) platform, creating the leading blockchain enabled Paddock to Plate solution, supporting a trusted, transparent, and traceable supply chain model. This continuous investment and functionality extension will further build on the investment MLA has already made on Aglive's eNVD solution, as it will expand the ability to market Aussie beef to discerning domestic and international consumers.

1.2 Aglive Solution Components

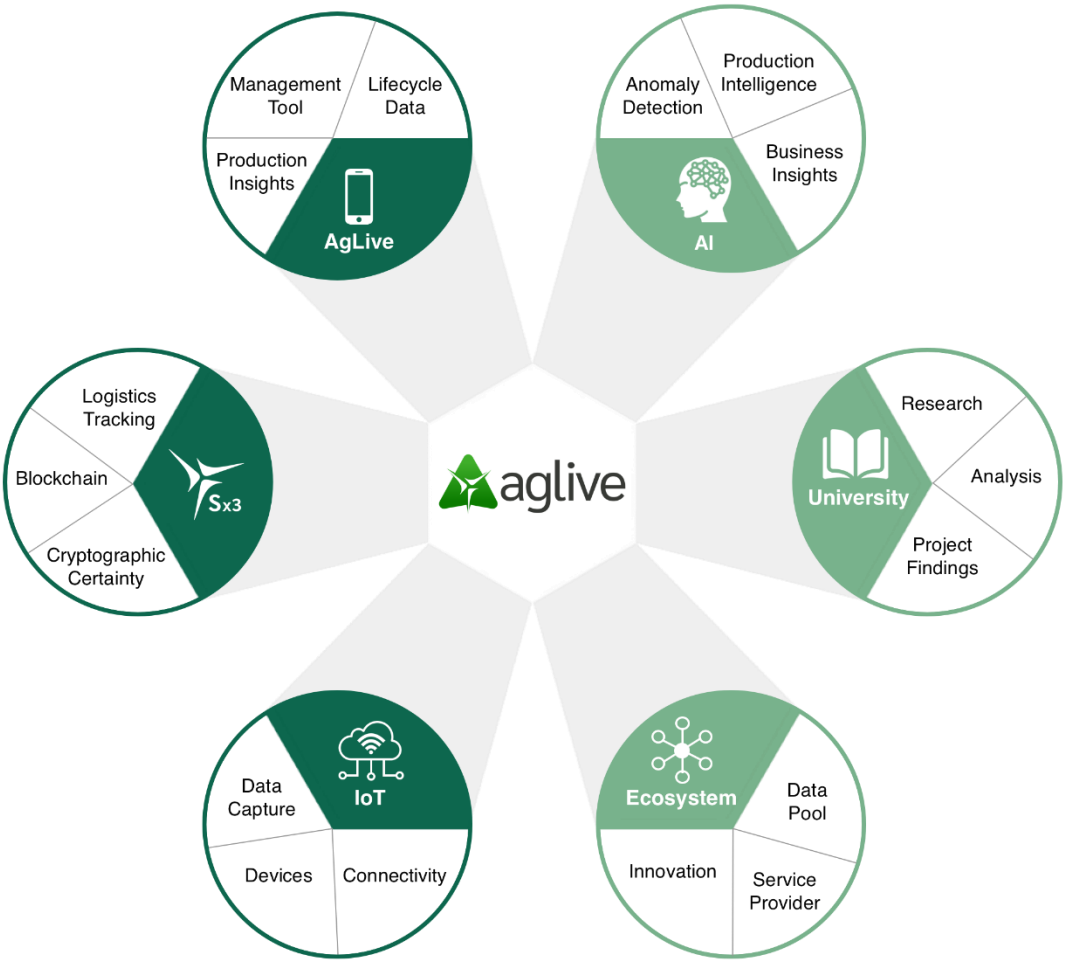
The new Aglive (Supply Chain Traceability Capturing and Reporting Solution) and AgliveTrust (Consumer Product Verification) solutions, with embedded licensed mobile eNVD, is fully focussed at re-connecting the farmer with the end-consumer. We achieve this through using a smart tags/ RFID/ QR codes and/ or label IDs in combination with 'digital twin[1]' tokens. This ID process was developed using various application platforms and tools under licence or under contract with third party system and software firms. Aglive retains all rights (including intellectual property rights) in the Aglive system and our existing web, mobile, and blockchain applications. These rights are retained whether it is used in relation to this project or it is customised and designed to provide traceability for the livestock industry.

The main reason for this full blockchain enablement, is the independent "ease" of connecting with other data sources, incl. Internet of Things (IoT) devices, other on-farm solutions, cloud solutions,

[1] See Digital Twin references: https://en.wikipedia.org/wiki/Digital_twin or https://www.digital.nsw.gov.au/digital-transformation/policy-lab/emerging-technology-guide-digital-twin

(international traceability solutions - Flight Aware Tracker, Marine Traffic Tracker, etc.). The Aglive model is therefore focussed on an industry collaboration model which is able to "connect" with other industry solutions, creating an optimal industry-wide technology model through which farmers, processors, supply chain partners and distribution/ retail organisations are able to connect their current investments to this platform.

Figure 1. Aglive's unique asset management

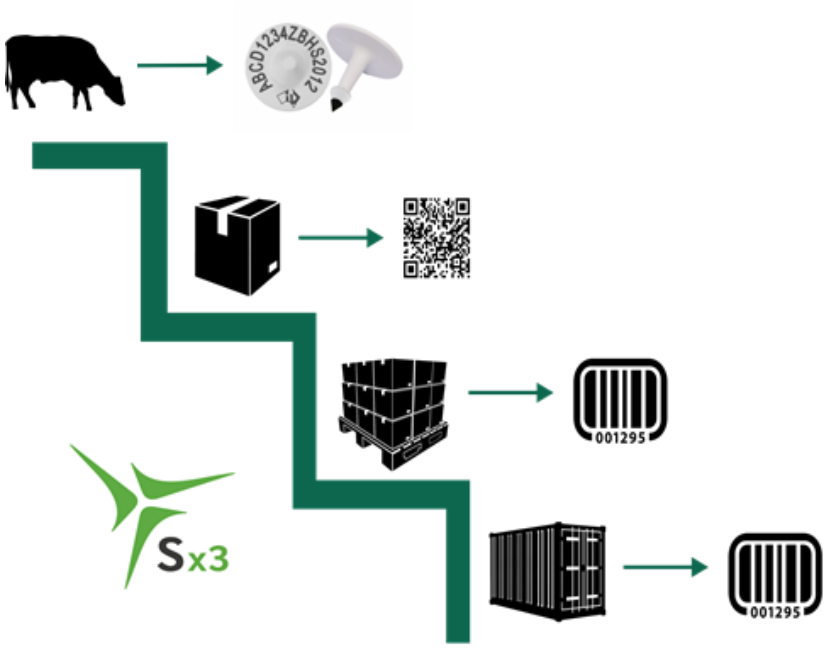


1.3 Connecting the Physical and Digital Supply Chain

Core to the solution is Aglive's ability to connect the physical and digital supply chain. Aglive uses unique digital assets (Fig. 1), blockchain Token ID's, to achieve this. Every item, carton, pallet, container/ AKE/ AVE has its own physical ID, being either an EAN barcode (GS1), QR code (printed on the label), Serial Shipping Container Code (SSCC) label, Airway bill reference, etc. Through the use of Aglive's App – with embedded scanning function – or the participant's own scanning solutions, Aglive is able to connect every physical ID with this unique digital asset. By introducing business rules/ logic and "other data points", Aglive is able to further connect these different physical/ Token ID's to generate a chain of data, supporting the ability to trace the item from "origin to end".

By an additional introduction of Aglive's "Russian doll" concept, the supply chain participant is able to capture the "largest" shipment component, which in turn will automatically capture and transfer the underlying Token ID's along the supply chain (Fig. 2)

Figure 2. The Sx3 block platform



The Sx3 blockchain platform summary:

- Each physical trade item and logistic unit (pallet and containers) has a unique digital asset (Token ID),
- Supply chain partners pass control of the Token IDs along the supply chain,
- Each participant uses an encrypted key to create a new entry on the ledger, record each token movement, and access a 'full copy' of the ledger,
- Token IDs can be linked to industry standard data formats, e.g. SSCC label, GS1 code, etc,
- Sx3 analyses and validates supply chain data before it is appended on the blockchain (Validation is based on a scalable protocol embedded in the blockchain),
- Our customers ALWAYS own their data, as the Sx3 blockchain platform is primarily designed to capture the core supply chain data to conduct the various physical supply chain transfers and monitor the Token IDs, limiting potential data security concerns,
- The Sx3 platform integrates (using standard API) seamlessly with IoT solutions and our supply chain partner's solutions, e.g. warehouse scan guns, label printers, etc. to ensure "our" data collection process uses non-intrusive data capturing solutions to fit with existing processes and technologies.

2. Objectives

2.1 Supply Chain Traceability from Farm to Plate

2.1.1 Consumer verification

The project's primary objective is/ was to undertake a series of paddock (farm) to product (through further processing facility) to plate (end-consumer) traceability trials in the Macka's beef export to

China – and other international markets – supply chain to deliver the following consumer and brand-owner (Macka's) objectives:

- Provide an effective packaging 'marker' – QR code – that contains evidence-based compliance and origin data to underpin the Macka's branded offering with a whole of supply chain traceability guarantee of genuine Macka's Aussie beef,
- Provide a Macka's branded consumer app (optionally delivered via WeChat – depending on the Chinese requirements) enabling Chinese end consumers of Macka's beef products to verify origin and provenance and leave critical end consumer feedback of eating experience and to deliver value-add information, e.g. recipes and cooking information from Macka's,
- Allow the consumer to trust the product they purchase, through providing a secure and verifiable solution that cannot be tempered with to provide provenance and traceability to the farm.

This sought to address the "food without fear" rationalise and enable provisions for Australian red meat to have a traceable 'clean, green and authentic' Australian call out. This further builds on past MLA research – see: Food without fear rationale - https://www.mla.com.au/research-and-development/reports/2016/food-without-fear-rationale-for-cross--sectoral-partners/ and https://www.mla.com.au/download/finalreports?itemId=3644

2.1.2 Supply Chain Transparency and Visibility

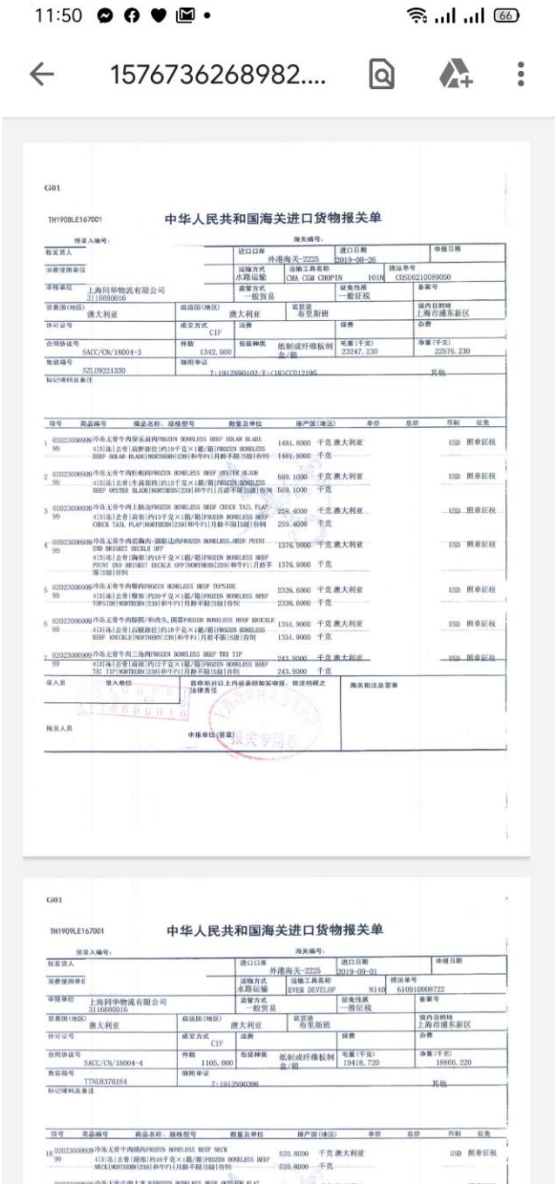
The project has an additional objective, which is to capture the various hand-offs and supply chain data, to provide forward-looking transparency to the various supply chain partners. This allows the supply chain participants to obtain insights in where the shipment is located, allowing various supply chain planning costs to be more accurate, around staffing, etc. The team was also continuously obtaining user-feedback to understand the usability of the User Interface/ User Experience of the Aglive solution, ensuring ease-of-use.

The following additional objectives were further introduced:

- Provide the ability for all supply chain participants to capture and store data (including regulatory/ government documentation – see below), which can be used to replace the paper-based supply chain processes from farm to retailers and their end-consumers,
- Prove that the technology can accurately verify location, identity, and condition of the product as it moves from farm to end retail point, allowing pro-active supply chain management and decision-making to optimise the supply chain processes and reduce bottlenecks,
- Ability to verify quality of the product – through cold chain monitoring – with exception management – supporting the ability to verify if the product "broke" the cold chain parameters or not, allowing a higher confidence in the premium price that has been agreed. The following cold chain criteria were reviewed;-
    - Chilled Foods must be transported, stored, and handled at temperatures never warmer than +5°C and preferably above +0°C (optimum temperature being +3-4°C), and
    - Frozen Foods (including beef products) must be transported, stored, and handled at temperatures never warmer than -18°C (optimum temperature being -12°C)
- Assess and obtain feedback from the various supply chain participants around:
    - Ease of use of the solution,
    - Intuitiveness of the solution and the process,
    - Ability to easily capture, review and "submit" information,

- Visibility of the product, its current quality, performance and other requirements

Figure 3. Chinese WAYBIL/Purchase order document



Ultimately, the trails allowed Aglive to conduct further requirements analysis and understand what data/ information/ insights are important to the supply chain participants, and costs to further develop and scale the platform, while obtaining continuous stakeholder – end consumer and supply chain participants – feedback. It is also critical to understand if the cost versus benefits of the technology including identification of process bottlenecks and/ or reducing the costs of product recalls is an important factor around adoption/ usage of the Aglive solution.

2.2 Trial Components

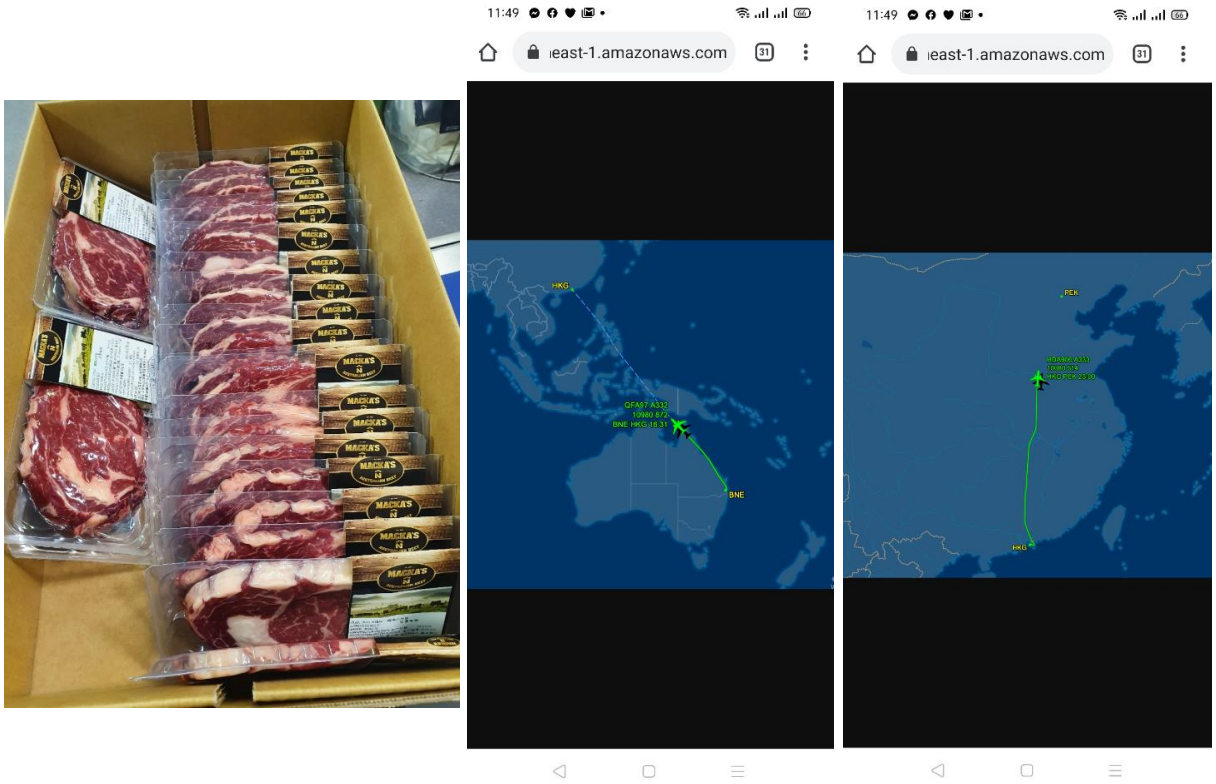
During all trials we have been able to track produce from the farm to the end-consumer, which included the following:

Tria

l 1 had the following process element breakdown (Fig. 4):

- Retail ready products: 480 individual retail-ready products
- Processed through Processor A
- Air Freight Route: Brisbane – Hong Kong – Beijing
- Formal (regulatory) documentation

Figure 4. Retail-ready product shipment



Trial 2 had the following process element breakdown:

- Retail ready products: Full Container (with using the Container ID's support the data capturing process)
- Transported from Farm to Processor A (Fig. 6)
- Processed through Processor A
- Transported from Sydney to Brisbane (Port)
- Sea Freight Route: Brisbane – Shanghai (Fig. 5)
- Transported from Shanghai (Port) to Cold Storage

Figure 5 Trip report by sea

Shown pictures/ documentation:

- Trip report – Farm to Processor A (Fig 6)
- Blockchain hand-off (in TBSx3 app) between the various supply chain participants), able to track the product back to the farm
- Container with the shipment (Fig. 7)

Figure 5 Trip report by sea

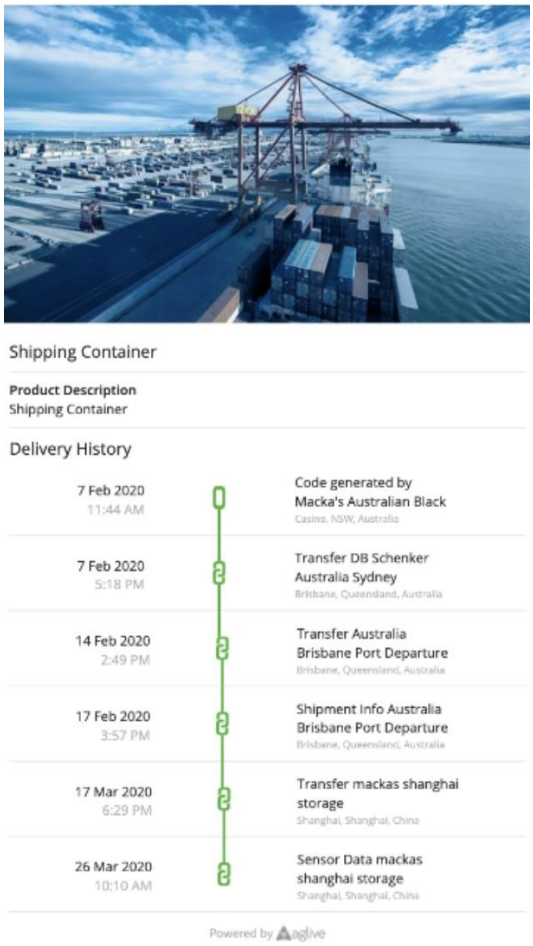


Figure 6. Trip report by vehicle

Trip Report By Vehicle For 29/01/2020

TELETRAC NAVMAN DIRECTOR

Printed for: Graeme Hoare Printed on: 30/01/2020

Vehicle: 27 CF87BT **Group: Martins Stock Haulage**

Total Travel Time: 9hr 57 min **Total Trip Distance: 535.0 km** **Total Stopped Time: 2hr 28 min**

Start Time	Start Location	End Time	End Location	Travel Time	Trip Distance	Stopped For
Wednesday 29 January 2020						
05:41	345 Nicholsons Lagoon Rd, Quipolly NSW 2343, Australia	06:21	[Kallara Feed Lot], Unnamed Road, Quirindi NSW 2343, Australia	40 min	18.1 km	15 min
06:36	[Kallara Feed Lot], Unnamed Road, Quirindi NSW 2343, Australia	06:37	[Kallara Feed Lot], Unnamed Road, Quirindi NSW 2343, Australia	01 min	0.1 km	17 min
06:54	[Kallara Feed Lot], Unnamed Road, Quirindi NSW 2343, Australia	16:01	Hillcrest Ln, Casino NSW 2470, Australia	9hr 07 min	513.5 km	0 min
16:02	Hillcrest Ln, Casino NSW 2470, Australia	16:10	Unnamed Road, Casino NSW 2470, Australia	09 min	3.3 km	1hr 56 min

Vehicle: 56-18 XQ65DE **Group: Martins Stock Haulage**

Total Travel Time: 12hr 33 min **Total Trip Distance: 743.6 km** **Total Stopped Time: 1hr 03 min**

Start Time	Start Location	End Time	End Location	Travel Time	Trip Distance	Stopped For
Wednesday 29 January 2020						
05:00	42 Lynwood Rd, Loomberah NSW 2340, Australia	06:28	[Kallara Feed Lot], Unnamed Road, Quirindi NSW 2343, Australia	1hr 28 min	85.6 km	09 min
06:37	[Kallara Feed Lot], Unnamed Road, Quirindi NSW 2343, Australia	06:39	[Kallara Feed Lot], Unnamed Road, Quirindi NSW 2343, Australia	02 min	0.2 km	16 min
06:55	[Kallara Feed Lot], Unnamed Road, Quirindi NSW 2343, Australia	15:36	Hillcrest Ln, Casino NSW 2470, Australia	8hr 41 min	541.3 km	09 min
15:45	0.27 km WEST of 10615 Summerland Way, Casino NSW 2470, Australia	16:28	[Casino Sale Yards], Dargaville Dr, Casino NSW 2470, Australia	44 min	3.3 km	03 min
16:31	[Casino Sale Yards], Dargaville Dr, Casino NSW 2470, Australia	16:35	[Casino Sale Yards], Dargaville Dr, Casino NSW 2470, Australia	04 min	0.1 km	16 min
16:51	[Casino Sale Yards], Dargaville Dr, Casino NSW 2470, Australia	18:25	267 Armidale Rd, South Grafton NSW 2460, Australia	1hr 34 min	113.1 km	10 min

Figure 7. Container with tracker inside

Trial 3 had the following process element breakdown:

- Retail ready products: 92 cartons with a combination of retail-ready and further processing products
- Processed through Processor B
- Vessel Route: Brisbane – Taiwan – Shanghai

- Formal (regulatory) documentation and stored in a customs' holding location.

Trial 4 has been split into two sections, being Singapore and UAE with the following process element breakdown:

- Retail ready products split across multiple AKE's intended for UAE and Singapore
- Processed through NCMC
- Air Freight Routes:
    - Sydney – Dubai
    - Sydney - Singapore
- Formal (regulatory) documentation.
- Receipt by the "local" distributor.

2.3 Evaluation of Blockchain

Part of the trial was the independent Macquarie Uni evaluation of the Aglive supply chain traceability solution for achieving the objectives of traceability from paddock to plate. This evaluation was split into a literary and practical assessment through which a hypothesis was defined, allowing the researchers to assess Aglive's Supply Chain Traceability solution opportunities and potential benefits as well as the challenges, barriers, and risks from the perspective of the stakeholders in the supply chain.

3. Methodology

3.1 Solution Development and Trials Execution

3.1.1 Solution/ Product Development

To ensure that Aglive continues to be leading-edge with their blockchain solution, supporting scalability and ease-of-use by the various supply chain partners, the Aglive technical team reviewed the existing solution (in January 2020) to assess if the evolving supply chain requirements can be met with the existing solution. During this analysis, a decision was made to transfer the existing functionality to an enhanced blockchain platform, which has the following key benefits:

- It focussed on data capturing and transfers,
- It allows data capturing from multiple external sources (e.g. Escavox for cold chain monitoring), reducing the need for the user/ participant to use (and or get familiar with) Aglive's on-farm management and supply chain solutions,
- It allows a more flexible and secure data capturing and transfer model to drive further benefits for the participants and end-consumer.

3.1.2 Trial Execution

Aglive uses an "agile trail deployment methodology" through which additional components and data solutions are added to the existing physical supply chain, continuously reducing the human intervention of data capturing. This means that ultimately, the originator, supply chain participants and end-consumer will follow the physical supply chain process (and purchase process), without conducting additional steps/ activities.

The focus is even to reduce the number of activities, through using the collected data to conform to relevant documentation requirements, e.g. if the farmer captures all the relevant on-farm management data, then the eNVD/ eHealth record and relevant export and customs documentation, is able to extract this data and auto-populate the questions/ answers to complete the paperwork.

During the various trials, there was a direct impact of COVID and Australia-China trade tensions that provided its own challenges to the execution of the trials. However, the team has worked diligently with the various regulatory organisations and transport providers to complete the trials.

One outstanding element of the trials is the execution of the Further Processing element for Trial/ Milestone 3. Even though the shipment has been delivered to China Mainland, due to some of the above-mentioned challenges, the current shipment is awaiting release. However, the team has captured the relevant Supply Chain Traceability data and is confident that it will be able to track the finished product (Chinese Dumplings) to it's restaurant and/ or retail customers and consumers.

3.2 Evaluation of Blockchain

The various trials were evaluated by the Macquarie Uni research team – aligned with the literary review and hypothesis – to validate if Aglive's Supply Chain Traceability solution is able to verify the beef supply chain fully and effectively, from paddock to Plate. This combination of a literary and practical review allowed the team to assess the potential market adoption opportunities, technology effectiveness, operational adoption (country and user), while ensuring that such a solution has the perceived benefits. These were concurrently validated through the supply chain participant's interviews, while using the literature to conduct a deep dive.

4. Results

4.1 Supply Chain Frozen Beef Traceability (China)

Both trials – based on milestone 2.1 and 2.2. – involved frozen beef, using additional software solutions and variations to track the shipment, its contents – incl. cold chain monitoring/ GPS location – to verify the quality and location of the shipments.

4.1.1 Air Freight

The first stage of the project was conducting an airfreight trial from beef/ meat processor to end-consumer. This verification and validation were conducted on the finished product (retail-ready beef product), which was traced through the following hand-offs:

- Casino warehouse beef/ meat processor (QR code capturing)
    - The retail-product on-farm data was captured and mapped to the individual finished products at labelling stage,
    - The relevant eNVD/ eHealth records were mapped to the retail products.
- The retail product was tracing from Processor A Warehouse to Retail outlet:
    - The retail product was boxed in cartons, which were scanned and captured in the blockchain (with their own QR codes),
    - The cartons were placed in an AKE/ Flight Box, using industry standard "flight" traceability labels, which were mapped back to the individual boxes,
    - Transport was arranged from Processor A to the Airport (DB Schenker) and onto the Flight (Cathay Pacific),

- The cartons were followed from BNE (Brisbane Airport), through HKG (Hong Kong) to PEK (Beijing Airport),
- The cartons were unloaded and transport through Macka's Local Distribution centre to a retail outlet for final distribution to the consumer.

This process was fully traced and tracked through the Aglive solution with the specific QR codes (Fig 8) to enable identification of the individual box.

Figure 8. QR code on carton

4.1.2 Sea Freight

The second stage of the project was conducting a sea freight trial from farm to beef/ meat processor to cold storage in Shanghai (China). The choice to not go all the way to the end-consumer was due to the COVID-19 challenges that were happening at that time. Instead of distribution through a retail outlet, alternative channels were explored to distribute the shipment. This trial included an additional IoT device which was introduced across the shipment to track the cold chain (temperature and location) of the shipment. The process that was taken (with hand-offs) was the following:

- Farm data capturing, incl. eNVD, eHealth record, etc,
- Using a livestock transport organisation to trace the livestock from Farm to Abattoir/ Meat Processor A
    - The GPS data was captured from the existing GPS device that was in the livestock transport truck,
    - The livestock delivery was scanned through the standard process, using Aglive's existing solution,
- The meat processor then used their internal traceability solution to map the "animal" to the retail package which was labelled in their warehouse (incl. QR code capturing),
    - The retail-product on-farm data was captured and mapped to the individual finished products at labelling stage,
- The retail product was tracing from Processor A Warehouse to the Shanghai Cold Chain storage facility:
    - The retail product was boxed in cartons, an IoT cold chain/ location monitoring device was added in the individual cartons, which were scanned and captured in the blockchain (with their own QR codes),
    - The cartons were placed in on a pallet and transported to Brisbane Port to be placed on a vessel,
    - The cartons were followed from Brisbane port to Shanghai Port,

        - Due to COVID-19 outbreak the vessel was laying “in front” of the Shanghai port for several days, before the vessel could dock and the shipment was released,
    - The cartons were unloaded and transported to Shanghai Cold Chain storage centre for either:
        - Further processing through a local manufacturer, or
        - Distribution through a physical or eCommerce platform.

This process was fully traced and tracked through the Aglive solution with the specific QR codes and pallet labels – SSCC – (Fig. 9) to enable identification of the individual box with the individual item within the carton.

Figure 9. Pallet of products with QR codes

Additionally, this trial included cold chain and GPS location tracking of the shipment. The focus was on providing exception reporting when the temperature is outside -18 and +5 Degrees Celsius.

An example of the report is shown attached (Fig. 10). As GPS is captured based on mobile reception (not satellite) for this trail, the IoT device captured the GPS coordinates when the device was within reach.

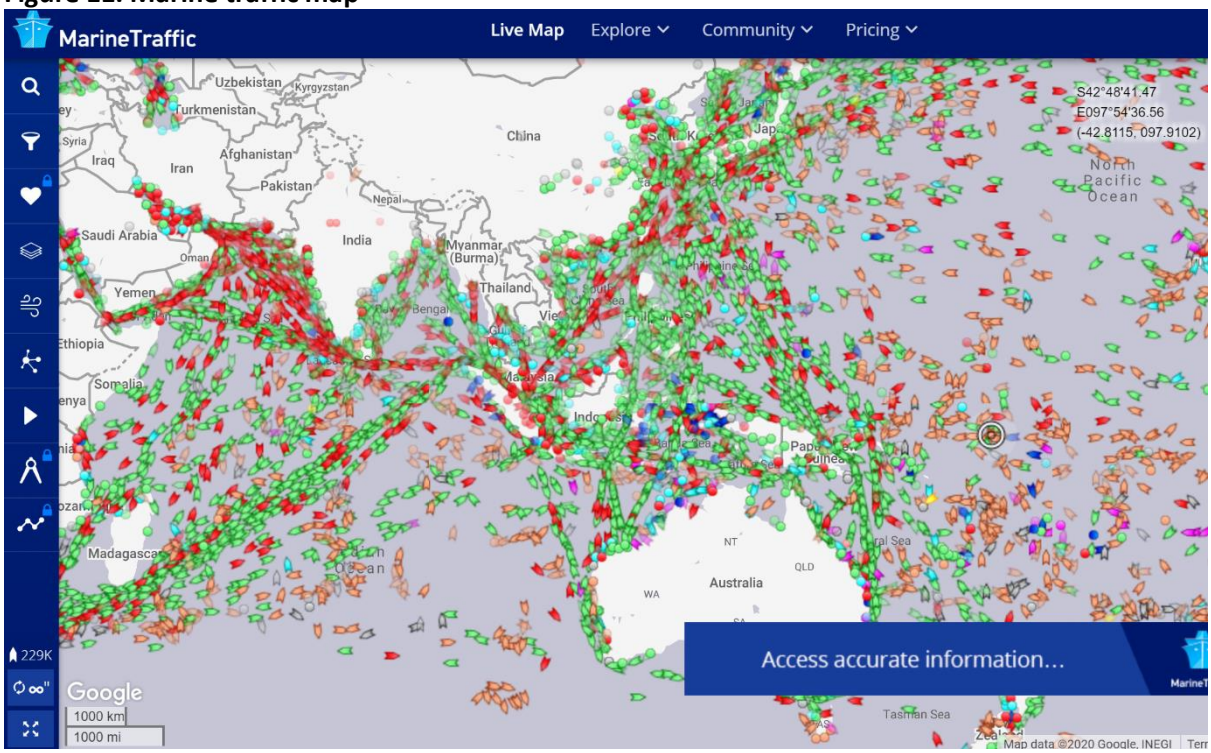
Figure 10. Temperature and location tracking data

	A	B	C	D	E	F	G
1	**Sensor**	**Temperature**	**Date**	**Time**	**Latitude**	**Longitude**	**LocationName**
5	Temperature	0.8°C	16/03/2020	18h25	31.3759	121.4879	Shanghai
6	Temperature	0.8°C	16/03/2020	18h25	31.3759	121.4879	Shanghai
7	Temperature	0.8°C	16/03/2020	18h25	31.3759	121.4879	Shanghai
8	Temperature	1.3°C	16/03/2020	18h20	31.3759	121.4879	Shanghai
9	Temperature	1.4°C	16/03/2020	18h16	31.3764	121.5078	Shanghai
10	Temperature	1.4°C	16/03/2020	18h14	31.3806	121.5276	Shanghai
11	Temperature	1.4°C	16/03/2020	18h13	31.3728	121.5345	Shanghai
12	Temperature	1.3°C	16/03/2020	18h11	31.3661	121.5593	Shanghai
13	Temperature	1.3°C	16/03/2020	18h11	31.3603	121.5782	
14	Temperature	1.3°C	16/03/2020	18h11	31.3603	121.5782	
15	Temperature	1.3°C	16/03/2020	18h11	31.3603	121.5782	
16	Temperature	1.3°C	16/03/2020	18h09	31.3603	121.5782	
17	Temperature	1.3°C	16/03/2020	18h09	31.3603	121.5782	
18	Temperature	1.1°C	16/03/2020	18h06	31.3424	121.6077	
19	Temperature	1.1°C	16/03/2020	18h03	-27.2492	153.2725	
20	Temperature	1.1°C	16/03/2020	18h03	-27.2492	153.2725	
21	Temperature	1.1°C	16/03/2020	18h03	-27.2492	153.2725	
22	Temperature	2.6°C	16/03/2020	17h50	-27.2492	153.2725	
23	Temperature	3.5°C	16/03/2020	17h44	-27.2492	153.2725	
24	Temperature	4.1°C	16/03/2020	17h37	-27.2492	153.2725	
25	Temperature	4°C	16/03/2020	17h31	-27.2492	153.2725	
26	Temperature	4.2°C	16/03/2020	17h25	-27.2492	153.2725	
27	Temperature	4.4°C	16/03/2020	17h19	-27.2492	153.2725	
28	Temperature	4.3°C	16/03/2020	17h13	-27.2492	153.2725	
29	Temperature	4°C	16/03/2020	17h07	-27.2492	153.2725	
30	Temperature	3.8°C	16/03/2020	17h00	-27.2492	153.2725	
31	Temperature	3.3°C	16/03/2020	16h54	-27.2492	153.2725	
32	Temperature	2.9°C	16/03/2020	16h48	-27.2492	153.2725	
33	Temperature	2.3°C	16/03/2020	16h41	-27.2492	153.2725	
34	Temperature	1.4°C	16/03/2020	16h35	-27.2492	153.2725	
35	Temperature	0.9°C	16/03/2020	16h29	-27.2492	153.2725	

* The GPS coordinates of this GPS & Temperature device worked on “mobile triangulation”, which means that the data is collected during the journey but submitted with the GPS coordinates when it was in a mobile receiving area. Therefore, the temperature/ date/ time is accurate, but the GPS shows the Brisbane and Shanghai location (as this is where there was mobile reception). The aim is for our next devices to be “satellite enabled”, providing accurate positioning data as well.

Additionally, we “manually” tracked/ captured data from the Maritime Traffic website (Fig. 11), which for future trials we intend to further integrate with, allowing independent tracking of the various transport methods (this will also extend to “flight aware tracking”)

Figure 11. Marine traffic map



4.2 Supply Chain Frozen Beef Traceability with Further Processing in China

To deliver further confidence of Supply Chain Traceability, Macka's/ Aglive conducted trials with/ without the use of an additional "further processing facility". Macka's/ Aglive introduced a frozen beef shipment with our China Distribution partner Two Hands (https://www.2hs.info) in early November 2020, through the following approach and interoperating model:

- The traceability model was managed on:
    - Cartons – QR codes were placed on carton-level,
    - Container level – Due to the latest Chinese restrictions, no pallets could be used in the container, resulting in ensuring that all the cartons were directly placed in the container,
- Two Hands and Aglive created defined a "connected" physical QR code model which could be read by both Two hands and Aglive during the processing and supply chain process (see below)
- These QR codes were attached to the carton boxes at Processor B (beef/ meat processor with QR code capturing),

Figure 12. Aglive and Two Hands QR code

- The shipment was tracked, using two blockchain providers – Aglive and Two Hands – delivering an interoperable blockchain model, connecting the unique Ethereum Hashtags to the two QR codes (Fig. 12). This resulted in the physical supply chain to be split into two digital supply chain, being;-
    - The Aglive QR code (and #) was used to track the shipment from **Farm to Shanghai**,
    - The Two Hands QR code (and #) was used to further track the shipment – which was split into two separate shipments:
        - from **Shanghai through the Further Processing facility to the end-consumer,**
        - from **Shanghai directly to the end-consumer,**
- The relevant eNVD/ eHealth records were captured on carton level,
- The following supply chain process was followed:-
    - The retail product was boxed in cartons, which were scanned and captured in the blockchain at Processor B (beef processor),
    - The cartons were placed in directly in a container (at Processor B), using industry standard container-codes, which were mapped back to the individual boxes,
    - Transport was arranged from Processor B to the Brisbane port and onto a Vessel which took the following route:
        - Brisbane Port,
        - Taiwan Port,
        - Shanghai Port,
- The container and cartons were unloaded and awaiting customs clearing[2] before being transported directly to Two Hands' Local Distribution centre for transporting to a further processing facility,
- The final product would then be distributed through Two hands' distribution network to various Food Services locations to be consumed by the end-consumer (or directly to the relevant end-consumer).

By connecting the digital supply chain traceability solutions between Aglive and Two Hands, the various physical supply chain participants were able to track the end-to-end product from origin to final destination.

[2] The shipments were kept at Chinese customs for nearly 3 months due to various reasons, incl. Australia-Chinese trade tensions, changes to beef-import regulations, COVID-19, and a number of other elements.

4.2.1 QR Code Learnings

During this trial, both the Aglive and Two hands team identified the inefficiency of adopting a two-part QR code model. This has led to the following proposed amendments to future trials or commercial engagements:

- Any Supply Chain Traceability solutions should be able to "adopt" externally generated QR codes (or other smart labels), supporting:
    - The adoption of industry-leading QR codes (e.g. GS1 – https://www.gs1au.org) or Laava fingerprint codes (https://laava.id) to create a collaborative, but independence supply chain traceability model for the various supply chain participants and end-consumers,
    - The introduction of trusted sources (e.g. locations, businesses, or other trusted sources to commence the traceability) for QR code initiation in their Supply Chain Traceability solutions,
    - The ability to provide end-to-end supply chain traceability with multiple blockchain partners and hand-offs,
    - A method to enable the introduction of two-way communication between the blockchain solutions, supporting continuous updates and information provision to the diverse number of specific clients that either use Aglive's or Two Hands' solutions, e.g.:
        - Aglive provides relevant feedback to the farmers/ brand-owners,
        - Two Hands provides relevant insights/ place of origin data to their end-consumers (and/ or food services establishments)
- A solid commercial model is required to support end-to-end traceability, while enabling a commercial agreement for both Supply Chain Traceability solutions

4.3 Supply Chain Frozen Beef Traceability across SE-Asia and UAE markets

Both trials involved frozen beef, using additional software solutions and variations to track the beef from Australia to Singapore and United Arab Emirates (flights). The UAE has a higher focus on cold-chain monitoring, so in all trials the team introduced the Escavox temperature monitors, further validating and strengthening the cold chain processes. The following process steps were taken to ensure that the Aglive and supply chain participants were able to track their shipment and the cold chain requirements.

4.3.1 Singapore

These shipments (Fig. 13) were executed Late September 2020, during which the Aglive/ Escavox/ Macka's worked with Artisan Fine Foods to track and trace the end-to-end supply chain process from Farm to End-consumer, while also monitoring the cold chain.

The following steps were followed:

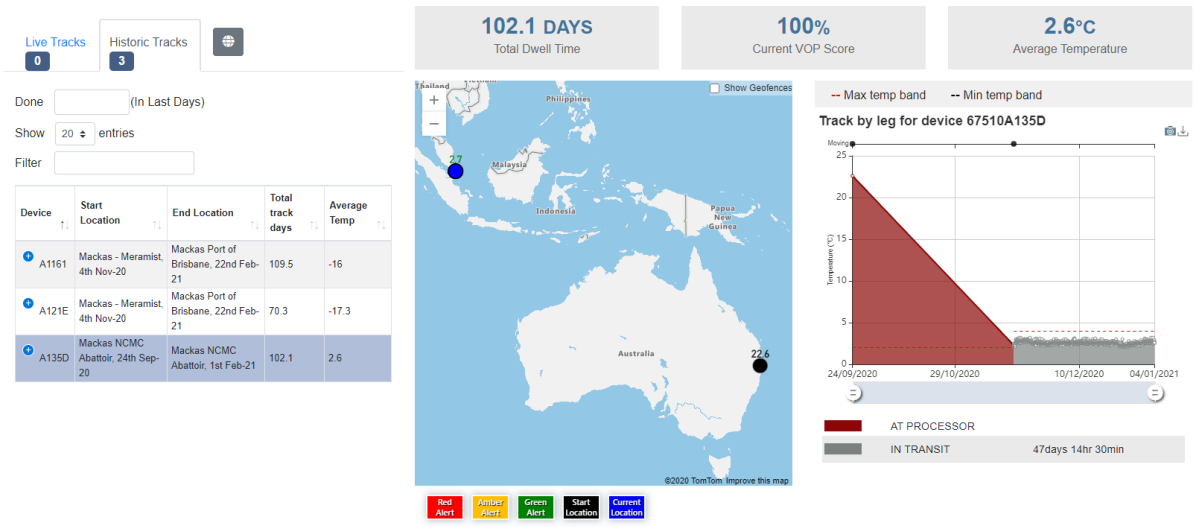
- Macka's Australian Black Angus Beef (Producer/ Brand Owner)
- Processor A
    - Beef abattoir and production
    - Managed the Air Freight from Processor A to Singapore (Logistics component)
- Artisan Fine Foods – Singapore Distributor
    - Receipt of Goods
    - Further distribution into retail

Figure 13 Shipment with Token Id and product information

Token ID	Name/ product	Brand Id	From Company	From Country	creator	To Company	To Country	Transporter	Transport At	count
659e80ee-b5de-4c4c-8f16-c17159933a1e	Beef Flank Portions	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	10/09/2020	4
659e80ee-b5de-4c4c-8f16-c17159933a1e	Beef Flank Portions	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	NCMC	Australia	Benjamin Benn	10/09/2020	4
659e80ee-b5de-4c4c-8f16-c17159933a1e	Beef Flank Portions	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	Artisan Fine Foods	Singapore	Alvin Ngoh	29/09/2020	4
659e80ee-b5de-4c4c-8f16-c17159933a1e	Beef Flank Portions	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	Artisan Fine Foods	Singapore	Yuliya Guseva	30/09/2020	4

During the various shipments, we used an Escavox Cold Chain Monitor – located in the AKE/ AVE's (which are the unit load device (ULD) for airplanes). The temperature monitoring (Fig 14), highlighting how the frozen meat was kept under 3°C – when in transit.

Figure 14. Escavox cold chain monitoring dashboard



The cold chain monitor provides the following insights:

- At processor (NCMC) the cold chain device was located in the carton before it was placed in the chill freezer,
- Once the temperature was on the acceptable level, the cartons were transported into an AKE (at NCMC) and transported to the Airport for further transportation to Singapore.

4.3.2 United Arab Emirates

These shipments were executed in early October 2020, during which the Aglive/ Macka's initiated the following process:

- Macka's Australian Black Angus Beef (Producer/ Brand Owner)
  - Processor A – Beef abattoir and production
- DHL – Export Perishables Operations in Sydney (Logistics)

- Emirates – Air Transport (Air Logistics – Fig 14)

recorded on the blockchain (Fig. 16).

Figure 15. Air transport detail from Emirates

- Distributor Middle East (Distributor)

Figure 16. Summary of the Blockchain data – extracted from the Aglive solution

name	product	brandId	fromCompany	fromCountry	creator	activity	toCompany	toCountry	transporter	transportAt	count
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	1/10/2020	4
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	DHL	Australia	SYD FO	1/10/2020	4
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	Bid Food Middle East	United Arab Emirates	Venson Buri	4/10/2020	4
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	1/10/2020	4
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	DHL	Australia	SYD FO	1/10/2020	4
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	Bid Food Middle East	United Arab Emirates	Venson Buri	4/10/2020	4
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	1/10/2020	4
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	DHL	Australia	SYD FO	1/10/2020	4
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	Bid Food Middle East	United Arab Emirates	Venson Buri	4/10/2020	4
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	30/09/2020	4
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	1/10/2020	4
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	DHL	Australia	SYD FO	1/10/2020	4
Macka's Black Angus 150 Day	Macka's Black Angus 150 Day	5f55bf3abb6fd6000a4e9526	Macka's Australian Black Angus Beef	Australia	Robert Mackenzie	TRANSFER	Bid Food Middle East	United Arab Emirates	Venson Buri	4/10/2020	4

To support the various hand-offs, the team included a "link" with the supporting Electronic documentation for the shipment, incl:

- Official certificate with respect to meat, meat products and edible offal
- Certificate of "halal" slaughter practices
- Certificate of Australian Origin
- Processor A Packing List (Load Out report)
- Commercial Invoice (not included in this report)

Airway Bill Documentation.pdf

The various cartons which show the shipping label and Aglive/ Macka's QR codes (Fig. 17).

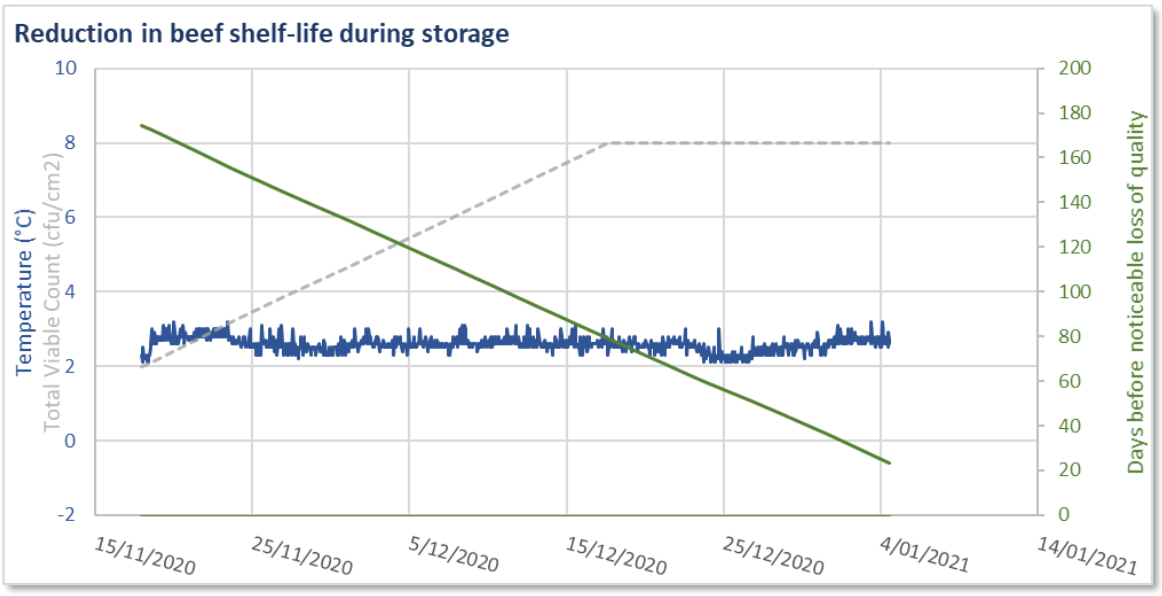
Figure 17. Cartons with shipping label and Aglive/ Macka's QR codes

4.3.3 Cold Chain Monitoring

In the various trials, we have seen the increase of importance of cold chain monitoring as part of the traceability process, supporting the ability to verify the temperature – and especially providing notifications when the product is out-of-temperature-spec" has been a further requirement from our physical supply chain partners. This has allowed us to further assess the Aglive reporting functionality – incl. parameters, exception management and other complementary elements to ensure the quality of the product is maintained during the transport.

In addition, the project team analysed the cold chain data with the MLA/UTAS beef and lamb shelf-life predictive model, which can estimate the remaining shelf life of Vacuumed products based on historical storage temperatures. The data analysed was based on 47 days of storage, with an average temperature of 2.58°C (Fig. 18). It appears that this product was held at the cold store/warehouse the whole entire time, as the GPS location did not show much movement and the lack of temperature variation.
At the end of the 47 days monitoring data, it shows the product had 7 days remaining if it was continued to be stored at 2.58°C before a noticeable spoilage occurs. However if product was to be stored at 1°C it will give the product 12 days life, effectively nearly doubling the storage time.

Figure 18. Cold chain monitoring data from the shelf-life model.



4.4 End to End Supply Chain and Consumer Verification

The various trials identified how important it is to seamlessly connect the digital with the physical supply chain through a non-intrusive process, using existing technologies and enabling the Aglive technology to complement these. This will allow the various supply chain participants to use their own technologies, while Aglive will capture the "relevant" traceability information.
When the user requires to use the Aglive solution – especially in more advanced/ global businesses, we saw that some of the hand-offs were not effectively and accurately captured, reducing "real-time" visibility of the products. By connecting to more external (IoT) services/ solutions, we were able to reduce the reliance on the human component and further drive efficiency and effectiveness through the beef supply chain.

4.4.1 Supply Chain Verification

During both trials, the team worked with existing supply chain partners, DB Schenker and Cathay Pacific, which both are familiar with the process and data capturing requirements. Both parties used the existing Aglive solutions (mobile apps) to capture the relevant hand-off data during the supply chain processes.

This meant that both these trials did not include any full integration with customer solutions/ systems, allowing auto-extraction of relevant data points which would be used to capture receipt/ issuing of the relevant shipment and its contents. Additionally, the current trials didn't include the "split-up of boxes or individual products through-out the supply chain. The trial was intended to follow all the items/ cartons from a place of origin to a destination (single).

Not including these two additional scope items, still showed that the Aglive digital supply chain traceability solution was able to map the physical supply chain accurately and show in great detail the various locations that the shipment went through – with the hand-offs between the various participants – ultimately arriving at its intended end-destination. Additionally, the trial included the opportunity to verify the temperature of the shipment, allowing the brand owner to proof the quality of the shipment (as it was kept within the parameters), adding additional confidence to the effectiveness of the transport.

4.4.2 Consumer Verification

The first and part of the second trial included a consumer verification process (Fig. 19), allowing the consumer to assess the original location, product data and additional support information. This was received with great interest, as this showed very clearly that the product originated from the expected location, creating confidence with the end-consumer around the premium purchase.

Figure 19. Consumer scanning the QR code.

4.5 Evaluation of Blockchain

There is a clear demand for a blockchain-enabled supply chain traceability solution to eliminate fraud, increase product quality and providing a closer communication loop between the producer

and the end-consumer, however, there are concerns around adoption, the costs of such a solution and the lack of "tools" to assist in the adoption of a blockchain-enabled traceability solution. The perceived benefits using the Aglive blockchain solution derived from the interviews were traceability, transparency, and better quality of products. (Data is always owned by the data provider, not by Aglive. Aglive replicates the physical supply chain).

5. Conclusion

During the trials (and the recent pandemic and Australia-China Trade tensions), it has become clear that there is a continuous requirement to evolve and enhance the Aglive Supply Chain Traceability solution, supporting an evolving industry and macro-economic environment. The team has also further realised that there is a continuous need to amend the technical and commercial models, supporting interoperability between Aglive and other blockchain solutions (and complementary IoT technologies) to increase adoption of the digital traceability solution.

The Aglive team is continuously assessing the various supply chain channels, processes, and changes, to ensure that the solution is intuitive and easy-to-use by the diverse user group. Our focus is to ensure that the traceability solution can be used by low technology enabled organisations and highly automated customers (where we capture the data through a standard API). Additionally, the team is working collaboratively with other industry partners and technology providers in how we can enhance the solution to ensure that "using the Aglive solution" will provide clear operational/ financial benefits to the various supply chain participants and the end-consumer. Ultimately, the team is working to increase the user adoption, allowing the solution to be intuitive through the onboarding and final use the solution by any organisation, while obtaining direct benefits from using the solution.

This is why Aglive recommends assessing alternative supply chain channels and processes to ensure that the solution can be used for 80% of the export processes (using the 80-20 rule), allowing any user to be confident that the solution will enable full tracking of their product from farm to end-consumer (with/ without further processing)

5.1 Key findings

During the various trials and "lessons-learned session, we have found that there is a clear demand for a blockchain-enabled supply chain traceability solution (due to its nature that the data in a blockchain solutions cannot be changed) to remediate and ultimately eliminate fraud, increase product quality and providing a closer communication loop between the farmer/ producer and the end-consumer.

In respect to Aglive's Supply Chain Traceability solution, we have identified a number of operational improvements that will further increase the user-acceptance and adoption across the physical supply chain partners. During the trials Aglive has established that their technology is solid and leading-edge (from a technical perspective), however – as you expect when working with a diverse group of supply chain partners and technology partners – some additional work is needed to increase its usability/ ease-of-use for certain industry users.

This is why we recognise that there is a requirement to continuous evolve and enhance the Aglive's Supply Chain Traceability solution, to support an ever-evolving beef industry and macro-economic environment.

5.2 Benefits to industry

It is expected that an end-to-end supply chain traceability solution will become the norm to do business across the beef supply chain, similar as the "NVD" process across the livestock component. It does not only provide farmers/ producers increased transparency where their product ends up, while supporting future customer requirements. This transparency is also able to combat food fraud and establishing Australia as a true clean, green "red meat" producing nation. Key themes identified in this report have also been considered in recent MLA/ISC report on traceability system goverence arrangements – see: V.RDA.2006 - https://www.mla.com.au/globalassets/mla-corporate/research-and-development/final-reports/2020/v.rda.2006-final-report.pdf

6. Future research and recommendations

Further Processing Facility in China

Due to the recent developments with the Pandemic and the China-Australia Trade tensions, trial 2 was kept at a cold storage location, before being able to transition to trial 3. The team is continuously working with Chinese regulators to release the shipment, allowing further processing and final distribute the finished product to the end-consumer.
During various reviews, the team made a conscious decision to include a "local" further processing facility in the traceability process, extending the traceability beyond the "retail package" model from Australia. This additional traceability process is a critical element in the continuous verification process, as it's expected that Australian beef will run through "local" further processing facilities, and there is a demand to ensure that the integrity of the product will continue to be kept the same – no mixture or "pollution – from other non-Australian sources/ inferior products.

Extension to other Destinations

There has also been a clear demand from other non-China destinations, which allow the Aglive team to verify the traceability process across a multitude of countries/ destinations (incl. Taiwan, UAE, Singapore, etc.), all with their own nuances in documentation, verifications, and processes. Through extending the solution, meeting these additional regulatory requirements, there is an ability to further mature and extend the existing data capturing ability, allowing a solid traceability solution from Australia to any destination in the world.

7. Appendix

7.1 Final report: Evaluation of Blockchain: Meat Protection Trials Case Study Report

Final report

Evaluation of Blockchain: Meat Protection Trials Case Study Report

Project code: P.PSH.1242

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Abstract

The research objective was to evaluate the Aglive solution for achieving the objectives of traceability from paddock to plate. This includes the opportunities and potential benefits as well as the challenges, barriers, and risks from the perspective of the stakeholders.

A literary and practical approach was taken to understand the current state of the various traceability components, their opportunities as well as challenges. Due to the immaturity of a blockchain-enabled supply chain traceability solutions – most solutions are still in an early or pilot development stage – to connect the physical and digital supply chain, the focus has been on obtain feedback from the pilot trail stakeholders (interviewees).

During the interviews it became clear that there is a demand for such a supply chain traceability solution to provide transparency (end-to-end), supporting food fraud, increase product quality and supporting a better “communication” (two-way) between the producer and the end consumer. However, it also became apparent that certain bottlenecks should be overcome, including a culture change for producers to adopt such a technology, providing a clear cost-benefit for the various supply chain stakeholders, and active Australian government support.

Executive summary

Background

The main focus of the research was to identify the opportunities and barriers for introducing a blockchain-enabled supply chain traceability solution to connect the physical and digital supply chain. To provide a clear insight in this problem statement, a literary and interview methodology was used across the various supply chain stakeholders, including producer, sales & operations (Int.), meat processing plant, logistic provider, Distributor (Shanghai, China), consumers, and the MLA (industry body).

The result of this research will be used as feedback for both the MLA and Aglive to assess how the outcomes can be incorporated in future initiatives/ solution developments, to further reduce/ eliminate the barries and introduce this technology across the wider beef farming community (and its partners)

Objectives

The research objective was to evaluate the Aglive supply chain traceability solution for achieving the objectives of traceability from paddock to plate. This included the opportunities and potential benefits as well as the challenges, barriers, and risks from the perspective of the stakeholders in the supply chain.

Methodology

A combination of a literary and practical review was conducted to assess the potential market, technology, adoption (country and user) and the perceived benefits. These were concurrently validated through the interviews, further conducting a deep dive of the literary findings.

Results/key findings

There is a clear demand for a blockchain-enabled supply chain traceability solution to eliminate fraud, increase product quality and providing a closer communication loop between the producer and the end-consumer, however, there are concerns around adoption, the costs of such a solution and the lack of “tools” to assist in the adoption of a blockchain-enabled traceability solution.

Benefits to industry

It is expected that an end-to-end supply chain traceability solution will provide producers increased transparency where their product ends up, supporting future customer requirements. This transparency is also able to combat food fraud and establishing Australia as a clean, green “red meat” producing nation.

Future research and recommendations

Future research should validate the conceptual model with more data from future trials, including a quantitative survey to better understand the ongoing opportunities and barriers for Aglive.

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8. Background

1.4 Aglive

Aglive[3] developed the world's first electronic National Vendor Declaration (eNVD) app in consultation with the MLA (Meat and Livestock Association[4]). In 2015, Aglive was issued a trial licence by the MLA, however the full production licence was issued in Feb 2018i as the first provider of an electronic National Vendor Declaration for use by producers and processors in Australia. Aglive's eNVD underpins the LPA Quality Assurance program and provides complete traceability of livestock, from farm to stockyard, feedlot, abattoir, and exporter. By creating a simple to use, electronic version of the National Vendor Declaration.

TBSx3[5] is a technology platform designed around three concepts: Cryptographic Certainty, Logistics Tracking and Blockchain Technology.

Aglive and TBSx3 merged in December 2019 under the name Aglive (supported by the Blockchain technology Sx3) to develop an industry-first end-to-end paddock-to-plate solution that will strengthen trust in beef industries around the world. The merger gives Aglive the expertise and technology to be able to digitise their food supply chain process, making it more transparent, traceable, and immutable[6] (See Appendix 8.1 for the process map).

1.5 The Trials

Aglive ran several trials during 2020; however, due to COVID-19 and the political situation, the trials were modified. The first trial was a partial supply chain process (test case) and is therefore not included in this research paper. The 2nd and 3rd trials were split into a number of different supply chain trials, aligning with the nature of the shipment and the various supply chain participants.

8.2.1 Trial 1: November/ December 2019

- Desk trial of the end-to-end supply chain traceability model through creation of different users, hand-offs, and verification processes (out-of-scope for this research)

8.2.2 Trial 2: January 2020

- Supply Chain Traceability with Cold Chain Monitoring (frozen) through the use of IoT and Blockchain,
- The route involved: Macka's Farm – livestock transport – abattoir/ meat processor – finished product transport – DB Schenker – Sea Freight Australia (Brisbane) to China (Shanghai) – Chinese Customs – Macka's China Distribution Centre – Chinese Supermarket (On-line).

[3] Aglive's background: https://aglive.com/about-aglive
[4] Meat & Livestock Australia: https://www.mla.com.au
[5] TBSx3's background: https://tbsx3.com
[6] https://www.cryptoninjas.net/2019/10/15/aglive-to-merge-with-tbsx3-bringing-blockchain-trust-to-beef-supply-chain/

8.2.3 Trial 3: February – March 2020

- Supply Chain Traceability with Cold Chain Monitoring (fresh) through the use of IoT and Blockchain,
- The route involved: Macka's Farm – livestock transport – abattoir/ meat processor – finished fresh product transport – DB Schenker – Air Freight – Cathay Pacific Australia (Brisbane) to Hong Kong to China (Beijing or Shanghai) – Chinese Customs – Macka's China Distribution Centre – Chinese Supermarket (On-line).

See Appendices 8.2 and 8.3 for additional details about the trials. Macquarie University Business School has evaluated the Aglive solution from the perceptions of the stakeholders along the supply chain to understand the benefits and limitations.

This research will be used to further reduce/ eliminate the limitations of such a blockchain-enabled supply chain traceability and assess further benefits for the beef farming (and other affiliated) communities.

9. Objectives

There are significant problems in the food supply chain involving counterfeit goods and food. Fake or counterfeit food has not only significant issues for health but also the reputation of the supplier and the country of origin. For example, in 2018, more than a quarter of commercial honey brands were found to have potentially been watered down with sugar cane, corn syrup or other products. Fake honey is problematic because Australia is the fourth largest exporter of honey in the world, so authenticity about how pure honey products is important for the market and reputation of suppliers and the country (Zhou, Taylor et al. 2018).

The export red meat market is a significant Australian export. According to MLA's data Australia was the third-largest beef exporter in 2018, behind Brazil and India. The export industry was worth over $17 billion and employed over 405,000 people in 2018/2019.

Australia is consistently one of the top beef/ meat, sheep meat and goatmeat exporters globally; however, competition in the international marketplace is intensifying. The increased competition means that Australia's producers need to be even more focused on meeting consumer needs while increasing productivity and efficiencies through the supply chain (Meat & Livestock Australia 2019). Very importantly, this includes the ability to trace the product (meat) from paddock to plate.

An ABC investigation in November 2019 claimed that every second kilo of beef exported to China from Australia is possibly fake (Adams 3 November 2019). Therefore, how can we ensure that the product is authentically Australian?

The generic supply chain consists of production, processing, distribution, retailing and consumption. Blockchain in the food supply chain holds great promise, but some significant challenges and barriers need to be overcome. Examples include regulation, technology infrastructure, technology skills, scalability, cost, and privacy (Kamilaris, Fonts et al. 2019).

The research objective was to evaluate the Aglive solution for achieving the objectives of traceability from paddock to plate. This includes the opportunities and potential benefits as well as the challenges, barriers, and risks from the perspective of the stakeholders.

Research Questions

The overarching research questions are:

- What are the opportunities and benefits for the stakeholders of the supply chain to adopt the Aglive solution?
- What are the challenges, barriers, and risks for the stakeholders of the supply chain to adopt the Aglive solution?

During the research, these objectives were met, and the research questions have been answered.

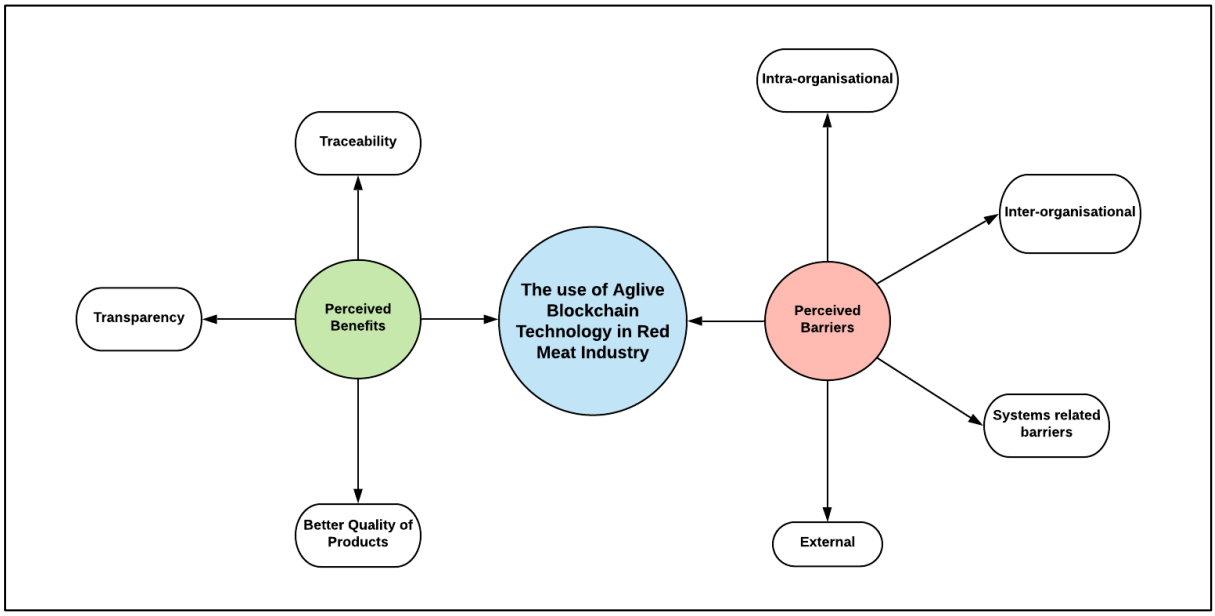
10. Methodology

10.1 Research design and methods

10.1.1 Research design

The study used a conceptual framework developed from the literature to evaluate the Aglive trials by examining the strengths and limitations of using Blockchain in the supply chain for achieving the objectives of traceability and transparency using stakeholder theory. Figure 1 shows the conceptual framework blockchain evaluation adapted from Saberi, Kouhizadeh et al. (2019) and Kamilaris et al. (2019).

Figure 1: Conceptual Framework of the Aglive Blockchain Solution



10.1.2 Method

The study was a pilot study using qualitative methods (Creswell, 2014). The data included:

- Semi-structured interviews with stakeholders,
- Documents and articles on the supply chain and blockchain technology from stakeholder organisations.

The interviews were conducted over Zoom and lasted between 30 and 45 minutes. The interview questions were designed to identify the opportunities and benefits, and the challenges, barriers, and risks for each of the stakeholders of the supply chain in the Aglive solution trials. The interviews over Zoom were transcribed, and additional notes were taken during the interviews. The guideline for interview questions is in Appendix 8.4.

Table 1 shows the interviewee participants:

Table 1: Research Participants

Code	Description	Participant
Interviewee 1	Production	Owner Meat production / farming
Interviewee 2	International Sales & Operations	Sales and Marketing
Interviewee 3	Meat processing plant	Meat processing and manage the production
Interviewee 4	Logistic provider	Finished product transport
Interviewee 5	Distributor – Shanghai	Product's consumer (Customer & Processing Plant)
Interviewee 6	Distributor – Shanghai	Potential Future Customer
Interviewee 7	Industry Body	Industry Body
Interviewee 8	Customers	Networking and connecting Australian producers with potential customers and updating the regulation of China's Governments

Data from semi-structured interviews from the stakeholders were analysed using NVivo 12. The data were triangulated with other sources such as documents and articles on the supply chain and blockchain technology, industry reports, competitor websites and other documents publicly available.

Initial themes, data coding, and keywords were generated from the conceptual framework based on the stakeholder theory and potential barriers drawn from blockchain studies (Saberi et al., 2019; Kamilaris et al., 2019; Wang, Singgih, Wang, and Rit, 2019).

10.1.3 Practical considerations

The trials were evaluated after they had taken place. In the future, we envisage that once the conceptual framework is validated, we will be able to assess live trials.

11. Results

11.1 Literature Review

11.1.1 Blockchain

Blockchain underpinned the first cryptocurrency, Bitcoin (Nakamoto 2008). A blockchain is a digital ledger where a network of computers maintains transactions. Each transaction is a block, and each block is managed through a software platform that allows the data to be transmitted, processed, stored, and represented in human-readable form. Each block contains a header with a timestamp, transaction data and a link to the previous block. A hash gets generated for every block, based on its contents, and then becomes referred in the heading of the subsequent block. Any manipulation of any block in the chain would result in a mismatch of hashes in all subsequent blocks (Kamilaris, Fonts et al. 2019).

Although Blockchain was initially used for financial transactions and records, in more recent times, there have been other applications that have experimented with the technology. For example, administrative records, smart contracts, digital authentication, and signature systems, verifying and tracking ownership of intellectual property rights and patent systems, electronic voting and tracking of goods through the supply chain (Kamilaris, Fonts et al. 2019).

The literature on Blockchain and the supply chain show that there is great potential to resolve issues such as traceability. However, issues remain including technical aspects, education, policies and regulatory frameworks (Kamilaris, Fonts et al. 2019).

11.1.2 Supply Chain

The food supply chain is complex and involves many stakeholders with different maturity levels such as farmers, shipping companies/ airlines, wholesalers and retailers, transport, distributors, and consumers. The generic agri-food supply chain phases are:

- Production/ Farming,
- Processing,
- Logistics & Distribution,
- Retailing,
- Consumption. (Caro, Ali et al. 2018, Kamilaris, Fonts et al. 2019)

Supply chains are cumbersome and inefficient. Transactions are vulnerable to fraud, there is little transparency, consumers are unaware of the origin of products and risks as well as costs are high (Kamilaris, Fonts et al. 2019). Walmart was an early adopter and piloted using Blockchain in the supply chain of pork and mangoes in the Chinese market (Kamath 2018). Kamilaris, Fonts et al. (2019) investigated existing blockchain projects in the agricultural supply chain including soybeans, grains, olive oil, turkeys, mangoes, tinned pumpkin, pork, sugar cane, beer, beef, chicken, cannabis, wood, seafood, table grapes, organic food, food waste, water and rice. The objective for using Blockchain included traceability, supervision and management, waste reduction and environmental impact. The Blockchain technology solutions have varied in the level of success, however, it is unclear if some of these projects are ongoing or had ceased.

11.1.3 Cold Chain Monitoring

The cold chain is responsible for ensuring that perishable food is preserved and transported at the optimal temperature to slow biological decay to ensure the quality and safety to the consumer

(Mercier, Villeneuve et al. 2017). According to Tesson, Federighi et al. (2020), in Europe each year, meat is associated with 2.3 million foodborne illnesses, with many of those from beef. The Quantitative Microbiological Risk Assessment (QMRA) model, first used to measure water safety, is used as a risk assessment tool for food, including beef (Tesson, Federighi et al. 2020). Contamination by a pathogen may occur at any stage of the supply chain, therefore knowledge of the whole paddock to plate cold chain is essential for the quality and safety of meat (Tesson, Federighi et al. 2020).

Optimal temperature monitoring is a prerequisite for cold chain management and thus for the production and supply of high quality and safe products as well as for the reduction of waste and economic losses. Food regulations in different countries require temperature monitoring. For example, European food law requires the identification and specification of temperature monitoring systems which allow optimal control of the temperature conditions in meat supply chains (Mercier, Villeneuve et al. 2017).

11.1.4 Benefits

Blockchain applications can improve traceability because each item can be tracked, leading to transparency, significantly reducing the costs of the monitoring processes. Traceability may lead to a reduction in operational, financial and insurance costs and the ability to deal with fake products (Queiroz, Telles et al. 2019). For example, blockchain technology enables Walmart to trace and validate the pork products transported from a farm owned by the Chinese meat producer Jinluo to Walmart's distribution centre in Beijing. The purpose is to ensure that the food products consumed by consumers are safe and authentic (Kshetri and Loukoianova, 2019).

Blockchain can increase transparency, traceability and sustainability and has the potential for using smart contracts. For example, smart contracts can automate payments as well as validate transactions and help eliminate food fraud (Astill, Dara et al. 2019). Trust between entities is also a benefit because a blockchain system is credible and secure. However, trustless systems are challenging to achieve because many processes in the supply chain need to be decentralised, there may be malicious intent from entities, or the buyer may doubt the credibility of the product (Shahid, Almogren et al. 2020).

11.1.5 Barriers and risks

The disruption to the supply chain as a result of Industry 4.0 and emerging technologies such as Blockchain and IoT may result in disintermediation resulting from smart-contract adoption (Queiroz, Telles et al. 2019). Therefore, this research adopted the framework by Saberi, Kouhizadeh et al. (2019) to show the potential barriers for Blockchain adoption in the Supply Chain.

Olsen, Borit, and Syed (2019) showed that in the red meat supply chain, the barriers include fraud by replicating the product and packaging without proper food safety assurances (such as fraudulent health certificates or documentation, products produced without an inspection, illegal slaughter) and fraud in finished products (e.g. the presence of illegal veterinary medicine, undeclared substance to improve the appearance of shelf-life products such as colourants). Other challenges relate to infrastructure in supporting blockchain technology such as the accessibility to mobile devices and internet, reluctance by some industries to share access to their data, data entry issues and the regulatory environment (Hancock, 2019; Kamilaris et al., 2019).
The potential of Blockchain in the agricultural supply chain revolves around two key benefits, traceability, and transparency.

11.1.6 Traceability

There are laws, regulations and standards relating to traceability in supply chains, including food. For example, ISO 22005:2007 Traceability in the feed and food chain and ISO/DIS 22095 Chain of custody — General terminology and models that is currently under development[7] (Olsen and Borit 2018).

The definition of traceability is problematic because different definitions apply in legislation and standards. For this study, the definition of traceability uses the Olsen and Borit (2018) definition: "*the ability to access any or all information relating to that which is under consideration, throughout its entire life cycle, by means of recorded identifications*". A traceable resource unit (TRU) is well-established term that refers to any traceable unit including a trade unit such as a bottle or bag, a logistic unit such as a pallet or container or a production unit such as a lot or batch (Olsen and Borit 2018).

11.1.7 Transparency

Bouzembrak, Steen et al. (2018) developed a text mining tool to collect food fraud articles. The authors found that the three biggest fraudulent items were meat, seafood, and milk. The use of blockchain technology can provide transparency in information sharing, such as improving the distribution of the products and price transparency (Hancock, 2019). The technology can provide an efficient solution to the urgent need to improve the traceability of food-related to its safety and transparency (Kamilaris et al., 2019), and enables the company to record every event or transaction within the supply chain distribution (Kshetri and Loukoianova, 2019)

11.1.8 Chinese Market

In big agricultural markets such as China, traceability is a preventive strategy for the quality, safety and authenticity of food items (Tse, Zhang et al. 2017). Chinese consumers tend to distrust locally produced food and consider it inferior to imported food from countries that have strict regulations around food safety, for example, Europe. The identification and authenticity of products is key to building trust with Chinese consumers (Kendall, Naughton et al. 2018).
There is complexity around the regulatory environment in China because the quality and safety of food are managed by different government departments that are not integrated (Tse, Zhang et al. 2017). Kendall, Kuznesof et al. (2019) found that food fraud (authenticity, safety, quality and reliability of food) is a primary barrier to the attainment of safe food and is prevalent in the minds of consumers. That is, brand reputation and trust influence the purchasing decisions of consumers in China.

Blockchain may be a solution for the Government to better track, monitor and audit the food supply chain manufacturers by authenticating transactions (Tse, Zhang et al. 2017).

11.1.9 Vietnamese Market

The issue with counterfeit goods is not just a Chinese phenomenon. Other countries, such as Vietnam have experienced similar issues around the authenticity of food (Veitnam Investment Review 2018). Some food safety issues in Vietnam are related to lack of ethics of specific food value chain stakeholders and the difficulty in managing food in wet markets and from smallholder production (Nguyen-Viet, Tuyet-Hanh, Unger, Dang-Xuan and Grace, 2017).

[7] https://www.iso.org/standard/72532.html

Food fraud also has been reported widely in other developing countries, for example, Pakistan, Brazil, and India have reported milk adulteration usually for financial gain or due to poor hygiene conditions of processing, storage, transportation, and marketing (Handford, Campbell, and Elliott, 2016).

11.1.10 United States of America Market

The United States of America (USA) market also suffers from food fraud problems. The Washington Post reported that fraudulent activities had been found in food products such as fruit juice, olive oil, spices, vinegar, wine, spirits, and maple syrup, and appears to pose a significant problem in the food industry. Victims range from the shopper at the local supermarket to multimillion companies, including E&J Gallo and Heinz USA. For example, the expensive "sheep's milk" cheese in a Manhattan market was made from cow's milk and a jar of "Sturgeon caviar" was Mississippi paddlefish. Some honey makers dilute their honey with sugar beets or corn syrup but still sell it as 100 per cent pure at a premium price (Layton, 2010). Food fraud is also in the seafood supply chain industries which involve importers, to fraudulent activities at individual restaurants or grocery stores (Fox, Mitchell, Dean, Elliott, and Campbell, 2018).

Food distribution such as cattle, egg, and poultry production industries have become the focus of attention around the use of blockchain technology to prove provenance, compliance, authenticity, and quality. The governments in states such as Colorado and Wyoming encourage the use of blockchain technology for the beef supply chain (Bumblauskas, Mann, Dugan, Rittmer, 2020). Retail giants such as Walmart are working on the utilisation of blockchain technology to solve food safety problems and build more transparency in food production including their beef products (Kamath, 2018; Polasek, 2019)

11.1.11 Theory

Stakeholder theory argues that every person or group involved in the activities in an organisation do so to obtain benefits. Stakeholder theory overlays the conceptual framework of benefits and challenges in the research design section.

11.1.12 Relevance and Importance of the Research

Studies relating to blockchain and supply chain management (SCM) integration are limited because many applications are either in the pilot stage or just beginning (Queiroz, Telles et al. 2019). There are behavioural, organisational, technological, or policy-oriented aspects that are yet to be resolved (Saberi, Kouhizadeh et al. 2019). Furthermore, many blockchain providers offer their services for the supply chain, such as Walmart, PWC, and KPMG, which are attempting to dominate the market.

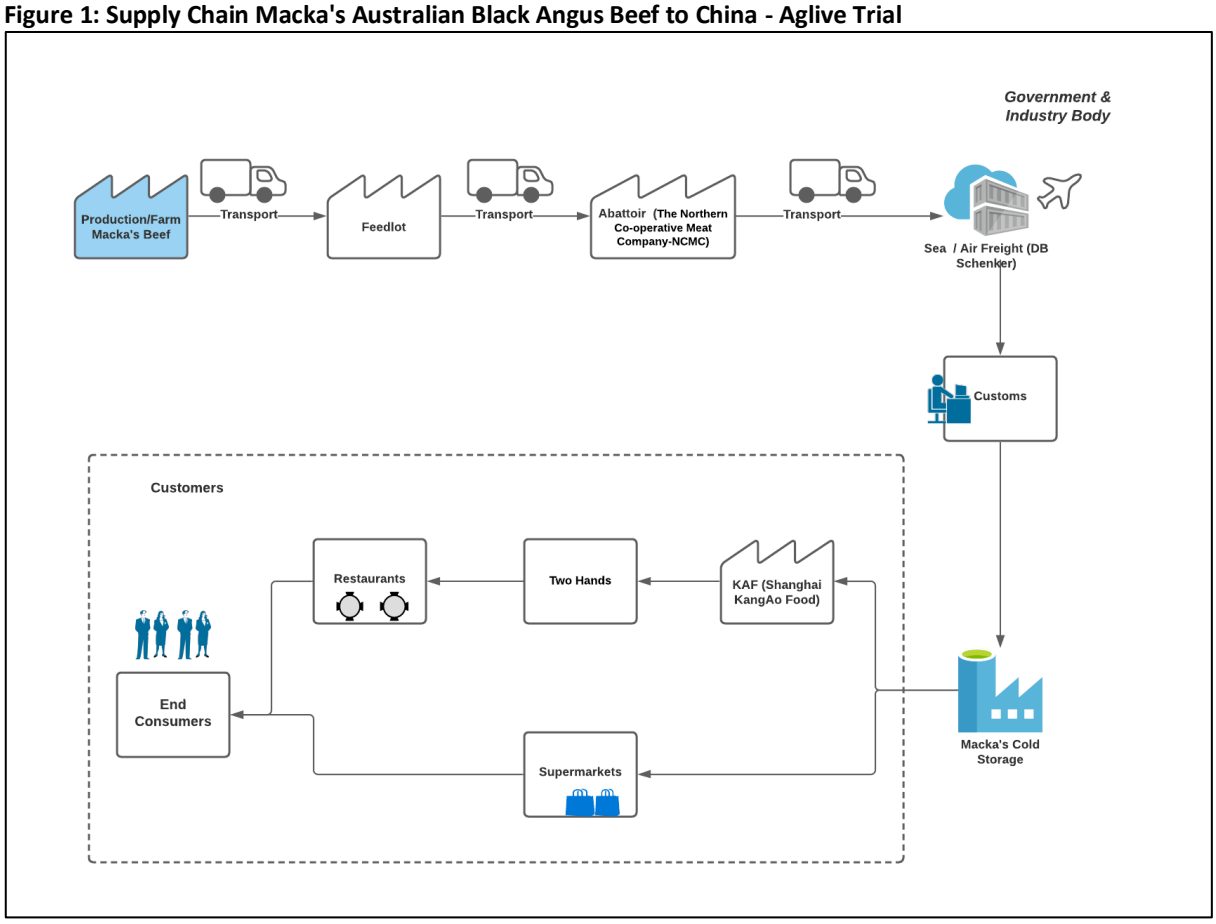
Aglive, as a blockchain application provider, has to highlight their competitive advantages to be able to take a position in the blockchain market by understanding the opportunities and barriers in the food distribution industry, particularly high-quality beef for overseas markets such as China.

11.2 Interview findings

The red meat supply chain is shown in Figure 2. The Aglive solution was evaluated using the supply chain of Macka's Australian Angus Beef to the Chinese market. Angus beef cattle are weaned between six and eight months to achieve a standard weight in the Macka's farm. The cattle are then transported to the feedlot for an extra 150 days for feeding to gain the standard weight. Then, the cattle are transported to the abattoir for processing. After processing, the processed product is transported by air or sea freight forwarding. The air or sea freight forwarding logistics company

sends the products to the destination (Shanghai, China). After the red meat arrives on the Shanghai wharves, Chinese customs take custody of the product. Once the product has cleared customs, distributors such as KAF take the red meat products according to their specifications, and further process the meat (if required) and distributed to their customers such as supermarkets, Two-Hands, and restaurants. The end consumers are the final component of the supply chain.

Figure 1: Supply Chain Macka's Australian Black Angus Beef to China - Aglive Trial



The overarching themes from the stakeholder interviews are explained in the next section.

12. Findings and Conclusion

The research assessed the benefits and barriers (perceived) for the supply chain stakeholders to adopt the Aglive solution to track and trace their produce. Additionally, the challenges, barriers, and risks were assessed, to provide a holistic picture of introducing the Aglive solution across the end-to-end supply chain.

12.1 Perceived Benefits

The perceived benefits using the Aglive blockchain solution derived from the interviews were traceability, transparency, and better quality of products. (Data is always owned by the data provider, not by Aglive. Aglive replicates the physical supply chain).

12.1.1 Traceability

The interview results show that stakeholders believe that a vital benefit of the Aglive solution is traceability. The components of traceability that emerged from the interviews were:

- The ability to connect each of the stakeholders in the supply chain,
- The potential for scalability,
- The flexibility and autonomy of the Aglive blockchain solution.

The stakeholders believed that producers could benefit from adopting Aglive. However, the trials are still small, so the issues around scalability, flexibility and affordability should be further investigated. The following quotes support these findings:

> *"Having a technology like Blockchain that can store and trace security, the data that is fed into it. And have a system that governs the way that data is fed into what really, what it does is it actually addresses the impact in balance of information between the consumer and the producer" (Interviewee 5).*

12.1.2 Transparency

The stakeholders believed the use of Aglive improves the transparency of the transactions along the supply chain and that Aglive can track each of the red meat products throughout the supply chain. From farmers/producers to the consumer, the trustworthiness of secure transactions is an essential component of transparency. The benefit of Aglive for transparency is that farmers or producers can track the transactions along the supply chain, from paddock to plate. The components that emerged from the interviews relating to Aglive and transparency were:

- Secure and trustworthy transactions,
- Fraud detection,
- Increased efficiency in the supply chain,
- Potential cost savings.

Transparency is critical for dealing with food fraud and a key benefit of using Aglive. One interviewee experienced fraud in the red meat export market. Therefore, in the Aglive trial, it was essential to show that Aglive could achieve the objectives of traceability and transparency.

> *"So when you are so good at something, so many people try to copy that. So you can go to many places and buy fake Gucci bags, or fake diamonds or fake sneakers. Well, that is no different to selling fake meat or fake wine or fake seafood. [...] Now, when you are talking about Australia, New Zealand, probably Canada and some of the US as producing some of the highest quality product in the world. That is not flowing into our pocket, that money is flowing into other people's pocket that say that they are selling an Australian product. And that is why this is so, so important and all the experience food fraud firsthand. […] I had a look in this freezer, and I thought it has got my brand on it, but that is not my packaging. Now that has happened two times and probably more times for me in Asia. I've put a lot of time and money and effort into traceability and I've decided to back this traceability platform." [Interviewee 1]*

12.1.3 Better Quality of Products

The stakeholders believed that the use of Aglive improves product quality. Interviewees agreed that the Aglive solution could prove the authenticity of red meat products. The components that emerged from the interviews relating to Aglive and product quality were:

- Authenticity,
- Brand protection,
- Customer protection,
- Food safety.

The use of the smart label, which cannot be copied, assures that the product is genuine. Interviewees believed that authenticity is essential so that the customer purchases and consumes Australian meat. Aglive helps the farmers or producers to protect not only their brand but also the Australian brand. Aglive also helps the farmers to promote their farms and products. The following quote shows the importance of product authenticity:

> *"Look it [Aglive] has opportunities, probably not so much important us as producers because we already know the traceability, we know where it's coming from. It's more so the consumer on the other end, making sure that the product they received is the product that they've bought." (Interviewee 3)*

Authenticity provides customer protection related to food safety and fair pricing. The use of technology might increase customer awareness since many cases of food fraud in China, such as fake honey, milk, fruit, and meat, have raised significant concerns from the Chinese Government. Interviewee 5 highlighted these problems.

> *"In China, with the infant milk formula business where there were hundreds and thousands of different brands in China of infant formula. Nobody really knew what the packet said, no one really knew. It was just the same thing being sold through multiple channels, multiple packages. After a few poisoning scares, the Chinese Government decided to act by dramatically reducing the number of brands for sale and increasing the security of the product, the ingredients and improving the licensing regulations." (Interviewee 5)*

The next section outlines the perceived barriers from the perspectives of the stakeholder of the Aglive solution.

12.2 Perceived Barriers

Four main themes emerged from the interviews relating to the perceived barriers using Aglive. The four major themes were intra-organisational barriers, inter-organisational barriers, system-related barriers, and external barriers.

12.2.1 Intra-organisational

The interview data showed that intra-organisational barriers include:

- lack of new organisational policies for using technology,
- difficulties in changing corporate culture,
- hesitation to convert to new technology,
- lack of tools for blockchain technology implementation.

One of the critical success factors for the successful adoption of Aglive is management commitment and support. Organisational policies need to align with changes in business process and organisational strategy to take full advantage of Aglive.

For example, Macka's beef is exploring how Aglive and potentially other technologies can improve the supply chain to improve transparency and eliminate fraud. Eliminating fraud will be the key to ensuring that the brand is not compromised. Interviewees 1 and 2 highlighted the importance of Aglive to eliminate fraud:

> *"So a couple of years ago. I put a lot of time and money and effort into traceability, and I have decided to back this traceability platform [Aglive]. [...] I chose this platform because I think that it really was focused on the producer a lot. And then it was designed or is designed for the consumer. [...] So I put my own time and money into this because I have faith in it. And we have got the backing of the industry, New South Wales DPI. Try it and all those things and hopefully organisations like yourself that you see merit to get behind something that is great for Australia and great for Australia and producers. So this is why I've done this." (Interviewee 1)*

> *There's a lot of traceability platforms that are happening at the moment. [...] But as fast as they are getting produced the Chinese are actually copying them. We continually hear from Aglive that there is extensive integrity around the Aglive of technology and it cannot be copied. So, you know, I want to be able to communicate that effectively with and that's something that I talked over with the Aglive but communicate effectively with the stakeholders that are receiving the product and making sure they believe that it is a non-copied traceability platform and it's not manipulated in any way." (Interviewee 2)*

Interviewees believed that the adoption of Aglive might change the company culture and business processes. A change management process will be essential to ensure that stakeholders and their employees can adopt Aglive. Adopting Aglive requires some new skills and expertise to use the technology effectively. Interviewees explained that Aglive captures many data, but there are still

manual processes and other systems that are not integrated. For example, the statement from Interviewee 4 shows this concern:

> *"At the moment, it's still pretty manual and that we would maybe scan a barcode and that barcode within register etc. [...] In order for this to be recognised as a Blockchain that cannot be questioned. That those processes, need to be automatic, they cannot be human intervention. I think it needs to be automated somehow. I don't know how because getting that automation done has been part of the problem of these Blockchain trials that we've been doing." [Interviewee 4]*

Lack of tools for blockchain technology implementation is the other consideration. The problem may occur when not all of the supply chain stakeholders are willing to use the technology because the blockchain adoption will require hardware and software investment, which might be costly. Blockchain needs to align with the whole supply chain network to reap its benefits.

> *"I think that's part of the concern of our business, quite honestly, is who are the leaders at the moment. And how do we know that they are the leaders and obviously we as a business. We would like to work with the companies that are doing the best in this field at the moment. And it is exceedingly difficult because they are literally hundreds of start-ups. You know, like blowing the trumpet about how good they are at Blockchain. And I think part of the problem is trying to understand what that Blockchain means for our business in terms of is it a money generating solution? or is it just going to become a standard that customers expect and that isn't actually going to be revenue-generating." (Interviewee 4)*

12.2.2 Inter-organisational

The interview data showed that the inter-organisational barriers include:

- lack of customer awareness of blockchain technology,
- problems in collaboration and communication among stakeholders,
- challenges in information disclosure between partners in the supply chain,
- cultural differences of supply chain partners.

The findings showed that the customers (the end consumer) were unaware of the functionality of Aglive (and other blockchain solutions). In the Chinese market, the customer was described as cynical because of previous negative press and experiences of the customer relating to massive food fraud or forgery of QR codes or labels.

Aglive and the producers need to convince customers that using the smart label in the red meat export market will guarantee the authenticity of the product by ensuring traceability and transparency.

Collaboration and communication among stakeholders are important because the red meat supply chain involves various stakeholders across multiple countries. Each stakeholder has its own systems, different country and company culture and values. Using Aglive requires supply chain stakeholders to have a common understanding of what data should be held on the Blockchain for efficiency and

effectiveness. Some interviewees raised a concern about how much data from each stakeholder should be shared along the supply chain network because there may be a potential risk that the company's data will be exposed. Interviewee 4 underlined the concern of data sharing with other parties:

> *"I think, quite honestly, where the biggest challenge is going to be is because in order to automate [the supply chain], that we need to have Aglive talking to other systems and that's where certainly we've potentially hit a block. […] Hang on a moment we do not want to be sharing data to an external party that we don't know too much about. Yeah, or whether or not we know something about it. We just don't want to be sharing data with another party." (Interviewee 4)*

Understanding the cultural differences between supply chain stakeholders is essential for ensuring that stakeholders, including the customer, understand the benefits of the Aglive solution. The Australian red meat export market is large, and each market has its cultural practices and norms. In the Chinese context, for example, the gatekeeper is customs before the product can get to the processing facility or the customer. Chinese customers are more trusting or rely on their circle of family, friends, and respected person to buy a particular product, in this case, high-end Angus beef. Therefore, a local technology partner who can develop a blockchain solution for the Chinese market may be required to ensure that the objectives of traceability and transparency are met. The following quotes illustrate the importance of understanding cultural differences.

> *"For Chinese and for Asian culture. The foundation of trust is mouth to mouth. We trust our families and we trust our, our close friends [...].* We trust our family because the Confucius culture and it is about family. *(Interviewee 8]*

> *"I think some Chinese technology companies also show interest in Aglive when I share their business profile and wisdom and they say, maybe they can discuss some cooperation in technology, or in some supply chain solutions or just because for China. They are doing the traceability from downstream to upstream. For the Australia blockchain their do it from upstream to downstream. So in the end, they can come to the middle. So I, my suggestion to Aglive and to other blockchain company who like to find partners, opportunities in China. The first thing is to find a technology partner here because you have to localise your projects and your solutions, even in terms of the language. You have to find a technology company. Which like to help you built up integrate the whole supply chain and the whole information chain. And then secondly, and then you a partner could help who find some application scenarios like the retail, the e-commerce , even some Wechat group and then you can start from some very specific projects and also I think the I talked. I talked to Robert before I said you can not only use Aglive to do beef. You have to put oranges, cherries, wine, and other products from Australia as much as possible. So then now all have the scale of economy." (Interviewee 8)*

12.2.3 System Related Barriers

The interview findings showed four system-related barriers:

- security challenges,
- access to technology,
- hesitation to adopt the technology due to negative perceptions,
- Immaturity of technology.

The implementation of Aglive can be a challenge for some stakeholders in the supply chain due to concerns relating to data security. Aglive has to ensure there is no data manipulation and all the supply chain partners are trustworthy. Although Blockchain provides more autonomous documentation and databases, humans are still involved in data recording. For example, Interviewee 4 described the concern in the following quotes.

> *"I think the business process is. I mean, it is not rocket science at all what we do, quite honestly, and the business process is I think the least of the worries in terms of what needs to be fixed. Yeah, or what needs to be developed not fixed. And I think the IT communication is probably something that is the most difficult to solve because of the number of parties involved.*
>
> *I mean if we look at ourselves as a business. We obviously have, we have a system that there needs to talk to our transporter, our transport system needs to then talk to the port when they are at the port, the port needs to talk to the shipping line. And I am sure there's a number of steps in between that are lift out that I'm not even aware of. And that is just the small section that we control.*
>
> *From an IT point of view because I mean tolls been attacked. I think twice in the last 18 months. DHL has been attacked recently and it's something that we're genuinely concerned about being attacked and I guess because of that, there's a high level of concern associated with any it links with external parties." (Interviewee 4)*

Some interviewees noted that there needs to be a clear business case to adopt the technology, that is a value-add to their supply chain and there is a cost-benefit. To be able to utilise Aglive to its full capacity, all stakeholders along the supply chain need to be able to use the application seamlessly. The immaturity of blockchain technology and lack of standards more generally is a potential barrier to full adoption. The following quotes described the concern.

> *"So my feeling for Blockchain is that they somehow need to be a Bluetooth blockchain. I mean, I am not talking about the technology Bluetooth, but I think you get what I'm trying to say is that there's a standard language blockchain that everybody can talk into. Yes, because IBM are developing a blockchain version, Facebook or Microsoft or developing their Blockchain and they're trying to be competitors against each other to develop the same thing, the same standards and that's never going to work because then you know we never going to have something that talks universally to each other So that I think is problem one that needs to be overcome and then once that problems overcome if we take the example that we looking at now. There needs to be an external database that we all feed into. So,*

for argument's sake. Most shares their portion of the Blockchain. And to a database we share our portion. Somebody else that portrays their portion to a nonaligned database. So the data that is specific to us and that we do not mind other party seeing, we can share into that database as can merge as canned reports, etc., etc. And then that is where the blockchain process happens is in that database. So it is not touching all the independent IT systems." (Interviewee 4)

"The any gaps that you see. Yeah. What do you see, we need to go back to him and say that and advise him because number one we want this to become an industry standard that everyone can utilise? "(Interviewee 1)

12.2.4 External Barriers

The findings showed three external barriers:

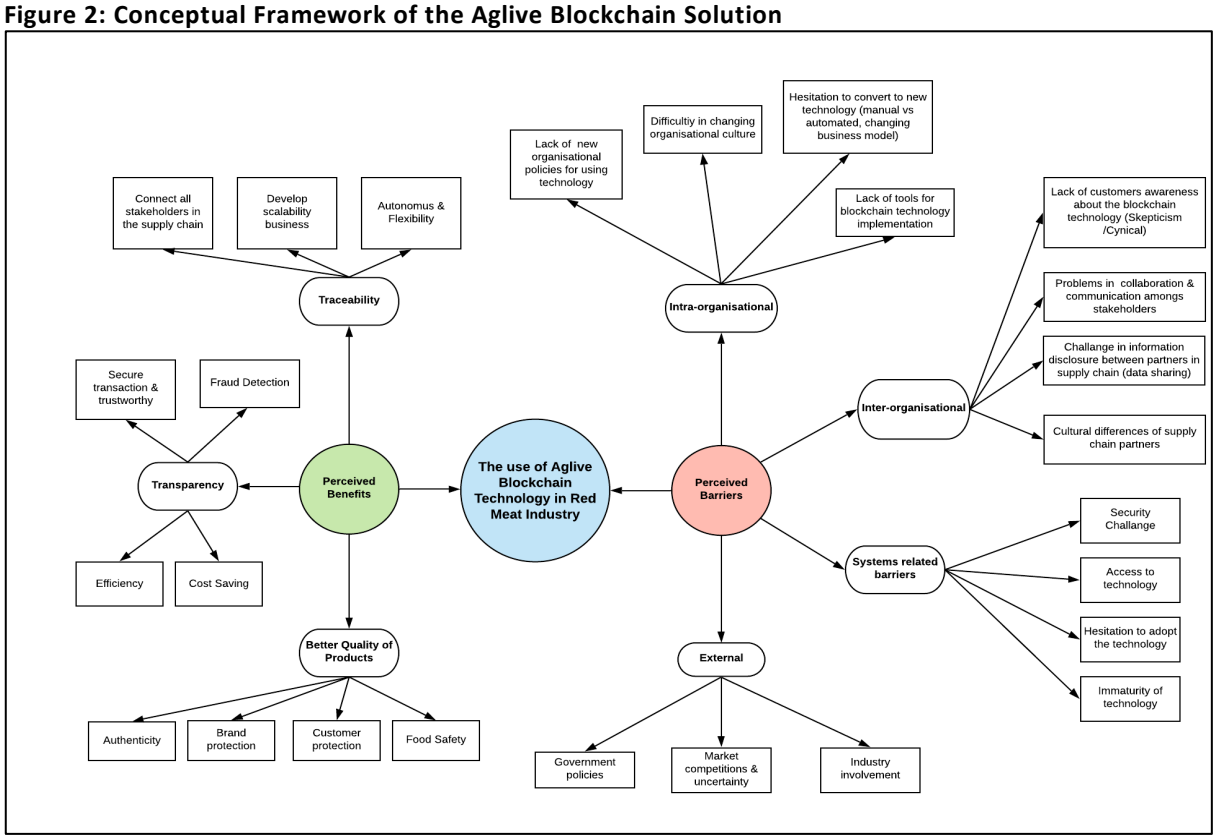
- government policies
- market competition and uncertainty
- industry involvement

All the interviewees believed that Aglive (and Blockchain applications more generally) for the export red meat market supply chain requires Australian government policies and support. As outlined above, the customer is concerned about the origin of the product being Australian, more than from an individual producer.

The polices and regulations of the export market can change depending on the relationship between Australia and the export country and other external factors. For example, Chinese regulations require the red meat product from foreign countries, including Australia, to have a COVID-19 test, that can take up to five or six days to process, delaying the movement of the containers off the wharf. Aglive is developed outside China, which may affect the ability of Aglive to be adopted from farm to plate if stakeholders in China are reluctant to use the app.

Interviewees noted that there is competition among the Blockchain developers who believe they can offer the same functionality as Aglive. Thus, the competitive advantage for Aglive need to be clear and communicated to all stakeholders, including government and industry bodies such as the Meat and Livestock Association (MLA). The conceptual framework is shown in Figure 3.

Figure 2: Conceptual Framework of the Aglive Blockchain Solution



12.3 Benefits to industry

During the literary reviews and the interview sessions, the following industry benefits were suggested by the various stakeholders:

- Introducing end-to-end supply chain traceability will benefit the producers, as they can fully trace where their products are ending up, allowing them – through feedback loops – to obtain supply chain and/ or consumer feedback, further adjusting their farming practices to deliver customer requirements,
- The interviewees highlighted on numerous occasions the importance of trusted and transparent data/ information, supporting fraud detection and elimination (food fraud), which has been a strong focus of Aglive during the development and deployment of their solution,
- Delivering a higher, better quality and fair pricing of meat product has been key feedback of the various interviewees, through providing transparency across all the various process components during the supply chain, the quality and pricing mechanisms can be measured and captured, supporting the focus on ‘clean, green Australian meat” – in-line with fair pricing -, further positioning Australia as a high-quality beef producing nation,

13. Future research and recommendations

Although this was a “small pilot study”, the following are the key recommendations from the literature, stakeholder interviews and supporting documents:

- There are many competitors (and likely to be more) for Aglive. Aglive should clearly articulate and communicate their competitive advantage. The competitive advantage is the consultation with the producers, the industry body and Government (and possibly IT partners in export countries).
- There should be a clear business case presented to each of the stakeholders for the adoption of the Aglive solution. The adoption of Aglive more broadly should be cost-effective and integrate into each stakeholder’s business processes and systems.
- A technology partner in each of the export markets, for example, China, would provide end to end supply chain visibility to ensure traceability and transparency from farm to plate. A trusted local blockchain technology partner would bridge the gap by dealing with cultural and political issues.
- A large amount of data needs to be collected for the red meat export market. It should be clear how Aglive intends to scale the solution so that Aglive is embedded in stakeholder’s systems and processes.
- Government policy and regulations are essential for supporting Aglive’s ability to scale their solution to other red meat markets as well as other export produce markets (e.g. seafood, vegetables, fruit, honey) to protect and market the Australian brand. Aglive should ensure that their solution aligns with the Australian National Blockchain Roadmap as well as ensure that there is input into policy development around Blockchain (through MLA).

Future research should validate the conceptual model with more data from the trials, including a quantitative survey to better understand the ongoing opportunities and barriers for Aglive’s supply chain traceability solution.

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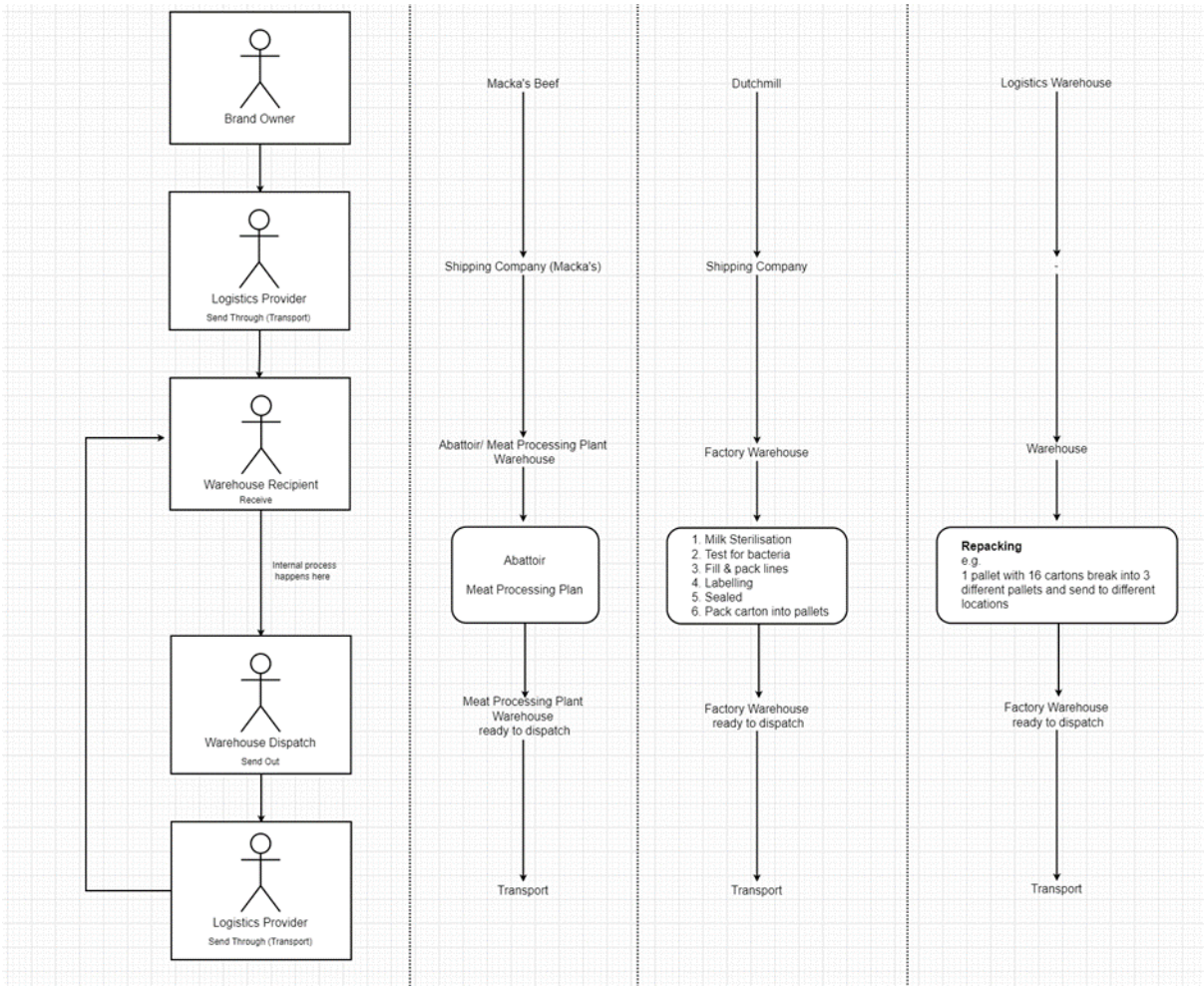
15. Appendix

15.1 Process Map



15.2 Meat Protection Air Trial

Meat Protection Air Trail

TBSx3 Business Area Definition

Purpose of this document

- To identify any business processes, scripts or scenarios for the use of such processes that will need to be established as part of the solution
- To identify much of the business data to be used (created/ manipulated) and through use of the proposed solution
- To assess the impact of the project outcome on the various supply chain partners that need to be managed. Considering new or changed:
  - Operational business process and organisational elements
  - Culture or behaviour
  - Resource activities
- To describe the strategy for deploying the 3 trails and the final solution and/or any increments of it, from a business perspective
- To describe the strategy for training those impacted by this solution

Document Admin

Approved/Accepted by			
Robert Mackenzie Macka's	date	Chris Pienaar DB Schenker	date
Nigel Chynoweth Cathay Pacific	date	Paul Allen Macka's/ Casino	date
Paul Ryan/ Mark Toohey Business Visionary	25-Nov-19	Andrew Dong CTO/ Solution Architect	25-Nov-19
Micha Veen Supply Chain Innovation Specialist	25-Nov-19		

Revision History			
Name	Version	Reason for change	Status
BPS - Draft	v0.1	Create Document	Complete

1

15.3 App Details

aglive

Helping Build a Sustainable Future

Brand Enhancement Trials

Join us in our journey in providing brand-consumer transparency with our true Paddock-to-Plate Technology

The Trial

Meat Protection Air Trial

Aglive and Macka's will work together to conduct a series of air shipment trials. Each trial will expand the scope of the protection and will start to include new features and new trial participants.

The Aim

The end result of this trial aims to prove

1. Brand owners can have confidence their products will safely land at their destination
2. Logistics / Brand protection partners can assure brand owners that their products are safe with them
3. Consumers can trust that the brand they buy is true and genuine

15.4 Interview Questions

General Information

1. *What's your name?*
2. *What's your title?*
3. *How long have you worked in the company?*
4. *Tell us about your role at the company?*
5. *What is your organisation's role in the supply chain (which part)?*

Supply Chain

1. *What technology or paper process was used in the supply chain before blockchain?*
2. *What does your supply chain look like today?*

a. *How much is manually handled?*

b. *How much is digitally handled?*

3. *How does your information flow look like?*

a. *How much data is shared in the red meat supply chain?*

b. *How is the data you collect, stored and shared?*

c. *What databases, inhouse solution or system do you use? Is it centralized or provided by an external party?*

Traceability

1. *How do you value traceability within your company?*

a. *Is it something you prioritize in your business operations?*

b. *Do you believe that blockchain is able to improve traceability in and outside your company?*

c. *How could blockchain improve traceability?*

d. *Is your technology infrastructure sufficient for using blockchain? For example, do you need to improve, update or replace technology?*

2. *What actions are made in case of a product recall?*

    a. *is there any documentation over what routines there are in this case?*

    b. *What trends can you see for the food sector to improve traceability?*

    c. *Is there any technology that you think you could adopt in the future?*

3. *What did your company do to before blockchain was introduced to increase the traceability of red meat?*

4. *How do you collaborate with the other members of the supply chain to increase the traceability of red meat?*

Blockchain

1. *How is blockchain is being used in your organization?*
2. *Intra-organisational barriers:*
    a. *Is there any problem with technological skill and expertise to operate blockchain technology?*
    b. *Is there enough support and management commitment within your organization including the policies related to the use of this technology?*
    c. *Is there any hesitation or resistant to use this technology? What are the reasons or problems?*
3. *Inter-organisational barriers:*
    a. *Is there any problem in the collaboration, communication, and coordination in the supply chain?*
    b. *Is there any challenge in disclosing the information policy between partners in the supply chain?*
    c. *Problem with cultural differences of supply chain partners?*
4. *System related barriers:*
    a. *Is there any problem with the access to technology?*
    b. *Is there any security challenge during the use of blockchain that need to improve?*
5. *External barriers:*
    a. *Is there any support or government regulation related to the use of blockchain in red meat industry?*
    b. *Is there any industry involvement in ethical and safety practices?*
    c. *Is there any problem with market competition and uncertainty in using blockchain?*
6. *Do you believe that your business model has to change with the implementation of blockchain?*
7. *In what way?*
8. *What do you believe are the benefits in implementing a blockchain technology?*
9. *What do you believe are the restrictions in implementing a blockchain technology?*
10. *Do you believe that the use of blockchain enable to reduce the transaction costs?*