Final Report

AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

Primal to Steak

Traceability – Primal to Steak/Steak to Primal

Project Code
2021-1267

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Date Submitted
23/05/22

Published by
AMPC

Date Published
23/05/22

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1.0 Executive Summary

The primary goal of this innovation theme was to develop solutions (hardware and software) that enable brands (and supply chains) to leverage valued attributes of their supply chain with consumers. Having the ability to provide traceability of primal to steak (or steak to primal) will deliver different value to different supply chains and consumers that might be leveraged from a cost-effective and reliable primal to steak traceability solution.

Value-add attributes could include but is not limited to: providing supply chain stories, forward tracking where product is being consumed (and maybe who by), interacting with consumers (those that are curious and willing to engage), food safety trace back/trace forward enabler, providing other value adds to consumers (i.e. recipes), underpinning and promoting sustainability claims (in the wider sense of sustainability) promotions and food fraud monitoring.

With the advancement of Objective Measurement systems, one day there may be also cut specific cooking recommendations (i.e. times/temperatures optimised) and or quality assurance. These can only be conveyed at the steak level if the primal/carcase measured can be traced to the steak and communicated effectively with the consumer.

This project is well within the scope and capability of Trust Codes' core systems. Trust Codes' approach to research and development for this project includes:

- Can yield be effectively tracked in secondary processing/3rd party cutting rooms?
- Can fraud be mitigated or prevented with traceability and yield management?
- Can primal bags be individually marked and read?
- How will consumers engage with the piece cut (steak)?

The functionality between individual primal and a carton of primals is nearly the same in terms of the Trust Codes platform. Accordingly, we can demonstrate an ability to track a primal to a retail cut using our system.

Despite COVID related delays, which impacted trial and demonstration effectiveness, we have concluded that we are confident a solution can be demonstrated in the near future. This is because we expect to receive and use bags from Sealed Air with the latest iteration of QR printing on the bag.

We also recommend that the approach *accepts excess labels* printed in the cutting room based on our assessment of the risk factors, and therefore traceability will **not** be an effective foundation for anti-counterfeit.

2.0 Introduction

Typically, primals (e.g. 5+ kg in weight) leave Australian meat establishments and exported in vacuum bags. Once in an international location a third party further slices and repacks the primal into retail-ready portions (as depicted below) in a cutting room/secondary process that is not under the control of the Australian producer. It is at this point that some traceability systems do not provide a level of reliable or cost-effective continuous plate to paddock traceability, that AMPC wanted to see more solutions providers develop solutions for.

Leveraging our current technology, Trust Codes worked to solve this problem. The problem essentially sits at the edge of the supply chain where activity is not under the control of, or visible to the Australian meat producer. Trust Codes has an existing technology solution for primal tracking in the plant, and primal>retail cut in 3rd party secondary processors using local edge-based applications meaning we are well placed to assist with the “edge-based” problem.

For this project, Primal > Retail cut tracking, we leveraged the unique QR code on a primal (printed multiple times on the bag to ensure readability) to produce piece cut identifiers in a managed way.

Trust Codes has the capability to install the software locally, which includes a business rules engine that calculates expected yield (min/max) to alert processors to excessive processing from raw materials. To support customers with 3rd party processing which may be offshore, a web version of the application needs to be developed which would be part of an entirely new R&D project. The development of a web application will allow for scale of 3rd party processors to assure Australian provenance and credence claims.

We have completed a data flow design, identified the elements required to build the web application, and tested the principal requirement of driving local printers while managing scaled credential-based logins (this is so that the solution can scale across many Australian producers in many other countries where secondary processing occurs).

We intended to design and test the Yield/Output tracking using our machine learning capability which is a desirable function to manage mass balance transfer/yield to help prevent substitution of primals in a traced product. However, research with customers demonstrated a number of commercial, rather than technical, barriers to applying the algorithmic yield analysis.

3.0 Project Objectives

The objective of this project was to develop and demonstrate to AMPC staff (and potentially one Australian supply chain) the approach by Trust Codes to offer a cost-effective and robust primal to steak, and steak to primal, traceability system, within a demonstration facility (i.e. not within an active supply chain).

The primary goal is to develop solutions (hardware and software) that enable brands (and supply chains) to leverage valued attributes of their supply chain with consumers. The key objective is a traceability system that provides a level of reliable and cost-effective continuous plate to paddock traceability.

Our research and development methodology is centred on improvement on existing, scaled and mature data platforms that are used to manage hundreds of millions of unique digital identities in the cloud every month.

During the research phase, we committed to:

- Determining and refining the use case and process flow at various primal>piece cut process and create flow diagrams of that process
- Designing a workflow that can be used in the scenarios mapped out in the step above
- Sandboxing current state applications and assessing the functionality or usability gap
- Agreeing data and process maps
- Determine interface with shop floor systems (eg Emydex; Triton etc)
- Development of a Functional Systems Design (FSD) for enhancements to the Trust Codes applications to achieve the agreed goal

4.0 Methodology

Because Trust Codes already has a primal>retail pack capability, the research and development work has been focused on how we provide secondary processing partners (eg a retail butchery in Singapore) the capability to carry the primal traceability available from Trust Codes marked bags (eg printed by Sealed Air or Amcor, or printed on a Modapack rotary) through to retail packs, after transformative process within the butchery.

This requires development of a front-end application that allows butcheries or retailers for example, to scan the primal or primal carton to associate the primal with the steak.

This approach also requires a hardware partner to provide a label printer that can print the right number of labels. The Trust Codes solution (and advantage) ultimately applies data intelligence to map expected yield to a primal to make sure non-Australian product doesn't get introduced into the value chain when there is enough source data to do so.

Trust Codes has already worked with Sealed Air to uniquely mark bags for primals and with Moda for inline printing trials.

5.0 Project Outcomes

Adding the necessary functionality to existing systems proved to be more challenging than originally planned for- and producing individually marked primal bags was delayed significantly by COVID. The results of the project can be summarised as:

The Process	The process demonstrated as to how the primal information is transferred from the primal to the steak. Hence the process of generating codes (if a ledger solution) or surface application approach or hardware approach.	Trust Codes demonstrated capability to apply a unique identifier to a carton and bag and map that to the output of secondary processing. The initial design of primal bags was sufficient, but Trust Codes designed an approach using unique per bag QR codes and solved readability issues. Our design approach is set out later in this report, and achieved >90% readability in early trials even on complex uneven surfaces created by the shrink process. The third-party cutting room would benefit from a new edge application developed by Trust Codes to deliver the result.
Trace forward and trace back	Demonstration of a simple interface that shows which steak each primal has been sourced from.	Trust Codes demonstrated primal>piece cut traceability for Raw material primals into the cutting room process.
'Alert' of non-traced product (primal and	A demonstration of what is expected to occur in Stage 3 if a 3rd party tries	Trust Codes demonstrated this capability, using yield reporting and smart algorithms

steaks)	to cut a primal into more steaks that is possible for that primal. An example of how someone in the supply chain knows if a primal and or steak has been scanned. The focus here is to think about product substitution as well as the supply chain obtaining information about the 'last mile' of the product.	to determine the alert. However, the practical reality of a cutting room is that labels will be damaged or extra labels will be needed, and this was an opportunity for a bad actor to game the system. At the time of this report, Trust Codes is still analysing the risk factors. Preventing extra labelling would impact cutting room throughput and reflect badly on Australian producers in third party cutting rooms. Accordingly, the answer to this problem is not simply "prevent additional labels or bags being used".
Consumer Engagement	Providing contextual information to consumers relevant to the provenance of the meat.	This is standard Trust Codes functionality. The project also supported GS1 Digital Link using QR as a data carrier for piece cuts.

The agreed deliverables and outcomes for the project were:

A design and application for testing that demonstrates a primal to steak (and steak to primal) traceability solution.	This was achieved- with the limitations we have discussed in respect of reliable yield/output management.
Agile development approach with a longer sprint process to allow for delivery of agreed outcomes.	Trust Codes used agile as much as possible, but with COVID disruptions, we needed to take a hybrid approach.
APIs agreed with 3rd parties within a supply chain to ensure robustness of data.	Trust Codes developed a number of APIs to support this project as an extension of our integration layer
3rd party processors to have a scanner device to capture primal provenance and processing data	Trust Codes tested with mobile devices and scanners from a number of industry leading providers- including Zebra, Honeywell, Datalogic etc.
Training and implementation of the edge (re-processing) solution to ensure end-to-end data flow	Next phase of the project
The Australian source supply chain to implement Trust Codes TCAS to capture primal data to associate to cryptographically unique QR codes on packaging (either pre-printed by Sealed Air or printed on labels using the TCAS Print Service), and to use GS1 standards for carton codes	Next phase of the project
Likely requirement for an API to shop floor processing systems to capture carton data, otherwise the carton GS1-128 code will need to be scanned into the Trust Codes TCAS system.	Next phase of the project

These interfaces may need to be developed for lesser-known shop floor systems	
Resolving the 3rd party transformation/cutting room association from primal > piece cut via a cloud application connected to a local label printer, along with machine learning algorithms to detect excessive yield will provide good guidance to exporters to manage product authenticity where overseas or 3rd party product transformation is not directly under their control.	This was tested, and an edge application was selected for reliability and resilience in the cutting room. The decision was made because throughput and continuity in the cutting room is better served by a local application. Yield management was more problematic as noted above- it was decided that preventing additional labels on piece cuts would not reflect reality.

Given the initial trials of clear primal bags with a black or blue coloured QR code (repeated 3 times on a fixed length bag) produced <70% read rates, Trust Codes proposed and tested a revision of unique per bag QR codes. The landing point for pre-printed, unique per bag, QR code, is a QR code repeatedly printed 5 times on a white strip near the centre of the bag. This produces readability of >95% in trials. With the QR code being pre-printed on the bag, it does not contain product information and is not a GS1 Digital Link format. Printing bags at the bag supplier and getting delivery to Trust Codes was delayed to the point it could not be demonstrated within the project window.

We have demonstrated using the carton to identify primals- the functionality per primal differs because the content of the primal is not contained in the GS1 128 barcode. We have not demonstrated a primal bag > retail cut yet because we have had to re-design process flows to accommodate recent GS1 standards such as GS1 Digital Link, and provide flexibility to support pre-printed bags (a licence plate system) and printing in line.

In the case of in-line printing (using Moda for example), we have proven that product information can be included in a GS1 compliant QR code and a resolver is not required.

A key process challenge has been oriented on useability of the system for customers of Australian meat producers.

We intended to design and test the Yield/Output tracking using our unique machine learning capability which is a desirable function to manage mass balance transfer/yield to help prevent substitution of primals in a traced product. However, research with customers demonstrated a number of commercial, rather than technical, barriers to applying the algorithmic yield analysis.

Our risk considerations were centred on our review of relevant factors during the research phase of this project;

a) Expectations that traceability **will not interfere** with secondary processing throughput- therefore our business logic cannot stop the processing line. Stopping processing could reflect badly on Australian producers. Accordingly, users must be able to print labels over and above yield tolerances to deal with label damage, failure etc. This creates both a yield, but also an anti-counterfeiting algorithm issue. We have not been able to reliably avoid this risk at this stage.

b) Australian producers want to ensure traceability applies to their products and the system does not allow other product to be introduced into the process- either by mistake or deliberately for economic gain.

c) We can expect a myriad of weigh scale systems in smaller secondary processing. This creates complexity about how to manage printing a unique label. Integration with Moda, Bizerba, Mettler Toledo, Wedderburn etc is manageable for larger secondary processors.

d) Delivery from the Cloud without an edge application will not be reliable enough to support busy cutting rooms and introduces technical risk factors that require more self-service and KYC functions to be useful.

Because the unique coding of primals was delayed, we did not get enough data points to fully address these considerations quantitatively.

6.0 Discussion

The results of the experiment are;

a) Logical traceability from primal to retail pack is achievable- either at individual primal level, or aggregated into a carton with a GS1-128 barcode.
b) Physical traceability is partially achievable- extra labels must be available to deal with label loss/damage etc and this introduces a risk to the process. Denying a cutting room access to extra labels is inconsistent with the reality of the physical process and would reflect badly on suppliers because of the economic costs of throughput impact.
c) The system will work in high trust environments. In low trust environments, more work needs to be done to prevent misuse of traceability labels

7.0 Conclusions / Recommendations

Despite COVID related delays, which impacted trial and demonstration effectiveness, we are confident a solution can be demonstrated in the near future. This is because we expect to receive and use bags from Sealed Air with the latest iteration of QR printing on the bag.

The functionality between individual primal and a carton of primals is nearly the same in terms of the Trust Codes platform. Accordingly, we can demonstrate an ability to track a primal to a retail cut using our system.

The use case will depend on the ability of the 3rd party cutting room to deploy a local application- delivery from the Cloud introduces significant risks which we identified in our research and development. We will continue development and we recommend that we work with a local Australian producer to pilot the system once we have a reliable supply of QR coded primal bags, or alternatively we can work with a customer of Moda to identify the primal in-line.

We recommend that the approach *accepts excess labels* printed in the cutting room based on our assessment of the risk factors, and therefore traceability will **not** be an effective foundation for anti-counterfeit.

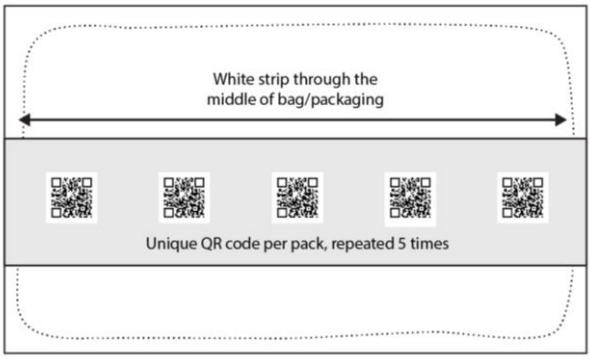
8.0 Bibliography

GS1 AISBL (2020), *GS1 Digital Link Specification* available at - https://www.gs1.org/docs/Digital-Link/GS1_Digital_link_Standard_i1.1.pdf

9.0 Appendices

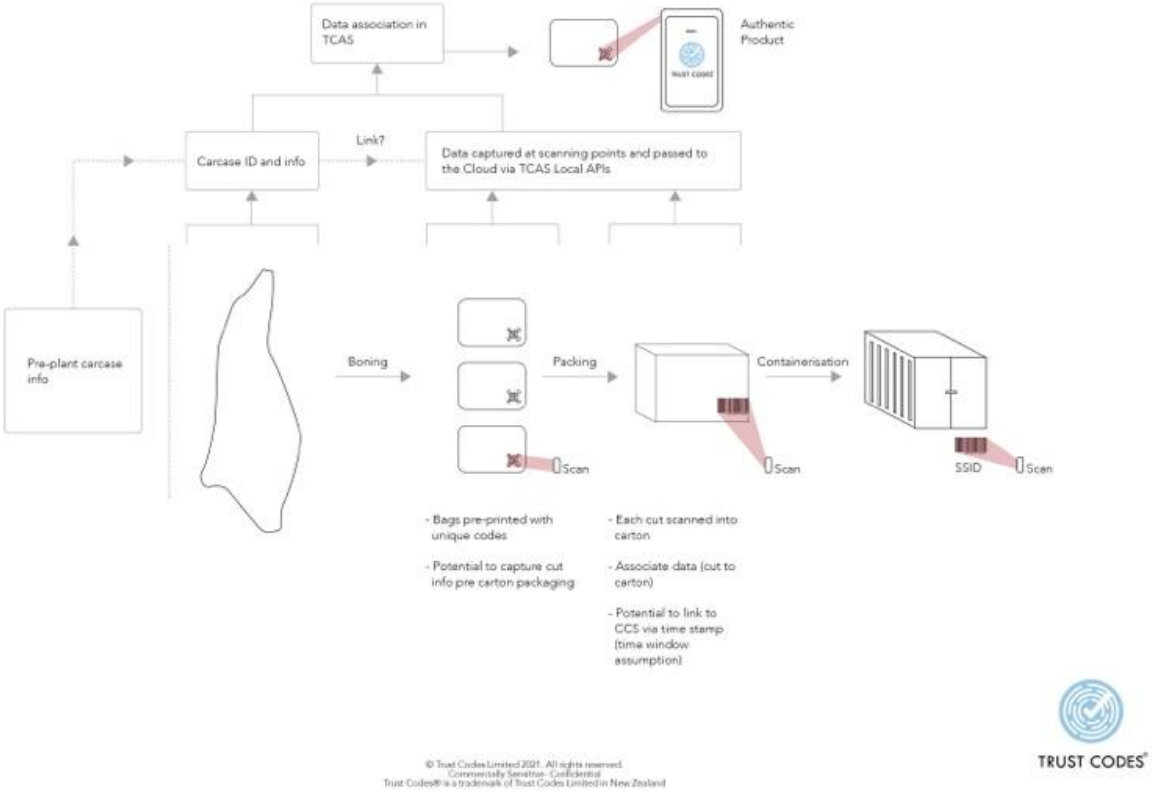
9.1 Appendix 1- Primal Bag Identification

Initial trials of pre-printed primal bag QR codes were partially successful, and a decision was made to printed repeated codes down a bag on a white centre strip to improve readability. The challenge was that printing on clear did not show enough contrast, and QR size needed to be optimised to account for shrink- and the contours of meat needed to be considered. At the time of this report, a sufficient volume of white strip bags had not arrived for testing but other testing shows promising results of >90% readability in line.



Concept Design for fixed length pre-printed primal shrink bag for traceability with repeated codes and white strip. © Trust Codes Limited 2022.

9.2 Appendix 2- Diagram of system relationships



9.3 Appendix 3- Screen Shots of edge application to capture primal identifier and manage output of QR codes for piece cuts