Final Report

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Supply Chain Automation in the Australian Red Meat Industry

Abstract

The sale and export of Australian red meat downstream of the Processors or abattoirs is an unbelievably heterogeneous set of products. So much so that to conceive of an electronic market for all red meats would seem impossible or at least extremely challenging.

This report describes a project that has risen to this challenge. Supported by the MLA, PrimeX Connect in collaboration with its digital agency, Mentally Friendly, and with the assistance of various industry partners, has completed stages 1 and 2 of a project to move the electronic marketplace beyond proof of concept into a fully-fledged beta trial and onto commercial launch. This has been achieved through intensive research efforts over the last year which cumulated in April 2017 with managers from Argyle Prestige Meat testing the market and providing positive feedback. The scene is now set to move to the next steps that will move us towards a commercial launch.

Executive Summary

This report follows the design and development of an online marketplace for Australian red meat called Prime X Connect (PXC). The export supply chain downstream of Processors / abattoirs is characterised by many styles of doing business, by buyers and sellers from different size organisations with very different needs. This has resulted in a market for red meat that isn't standardised, is complex, operationally inefficient and relies on multiple communication channels. By offering an online marketplace, PXC consolidates and standardises the communication process to ensure that buyers and sellers in the red meat export market come together to conduct business in a more effective, efficient and ultimately more profitable manner.

From a technical perspective PXC is a cloud-based software platform that streamlines an international buyer's search, negotiation and transaction process that drive operational efficiencies and greatly increase Australia's ease of doing business with global buyers' of red meat. PXC improves the ease of doing business with Australian sellers by adding new increased automation between buyer and seller.

By digitising key stages of the supply-chain PXC also contributes to the promotion of premium and safe Australian product internationally, and the traceability and provenance of this product. Transactional data gathered from the platform will enable immediate feedback to sellers and processors about the characteristics demanded by buyer's in individual international markets and result in greater yields for producers.

An important milestone of the project was the launch of a beta pilot version of the online marketplace to understand (a) how buyers and sellers interact digitally in real-time and (b) the impact of this new digital process on their current methods of doing business.

When this type of platform has been introduced in other industry sectors (such as grain, wool, water and livestock), considerable supply chain and operational efficiencies have been obtained, and this has increased overall profitability and customer satisfaction. It is expected that similar results will occur in the beef supply chain over time as more producers and processors are impacted by the platform.

The primary objective of this project was to demonstrate and test the business model of PrimeX Connect (PXC) with a diverse range of market participants. A centralised and transparent marketplace post-processor will deliver these key outcomes:

- Operational efficiencies will be gained by processors of all sizes and result in enhanced efficiency of the Australian red meat supply chain as a whole;
- Business relationships will be easier to establish because both sellers and buyers will be able to discover each other more easily, with available products being searchable and both parties able to negotiate and transact through a common interface in real-time. This will significantly decrease the time to reach an agreement for an order, create an order and fulfil the requirements of these orders;
- Recording of live and historical data gathered by PXC through all stages of the transaction lifecycle (from initial search to a completed order) will provide more accurate and more robust insights into global buying patterns and buying patterns in specific international

markets or territories. This will significantly benefit the Australian industry and supply chain participants and give producers confidence to invest in future stock that is more accurately matched to the demands of the buying community;

- Enable the Australian sell-side community to reach markets and buyers previously unreachable or only reachable in limited amounts but at an increased cost, thereby increasing total industry revenue;
- Establish an independent 'platform as a service' that will support the growth of a vibrant and competitive economic environment for other service providers to benefit from (i.e. logistics, customer service, warehousing, finance, insurance)
- Drive continued innovation and investment in the broader industry; and
- Provide an independent digital platform that will enable sellers to differentiate themselves to the buying community and promote the growth of a value-based trading model.

The software platform for the project was developed in collaboration with Mentally Friendly Pty Ltd, a Sydney-based Digital digital agency. Over the past 18 months, Mentally Friendly worked with PXC staff on the development of the platform from idea through to the pilot launch with Argyle Prestige Meats Australia in April 2017.

During this time Mentally Friendly, in association with PrimeX Connect, have completed a series of stages that have enabled this launch. This has included an agile development methodology to iteratively develop the PXC platform with direct feedback from Australian sellers and international buyers. This approach involved two-week sprint cycles, and was based on a collaborative process around product design and development, with continual inputs from key stakeholders..

The first stage of the design of the PXC platform began with a discovery phase, a series of four structured all-day workshops with daily goals jointly planned and facilitated by Mentally Friendly.

The first workshop was a business audit to understand current challenges, business objectives and KPIS in order to share knowledge on what already existed in the business and industry, as well as the vision for the success of the platform. This was followed by the following work:

(a) an ideation that allowed the team to expand on PXC's vision for success and functional features of the software, as well as identifying and flagging potential blocks, challenges or dependencies;

(b) an internal road-mapping session to synthesise, document the functionality of the initial product release (Minimum Viable Product (MVP));

(c) presenting the roadmap back to PrimeX stakeholders, to review and interrogate the detail of the MVP;

(d) a sprint to set up the foundations of the project and begin validating, visualising and finalising the details and requirements of the roadmap for the pilot project t;

(e) identification of inefficiency in the Australian red meat international trade workflow, centred around the negotiation process that currently involves multiple platforms and mediums. Searching for suppliers and negotiating a deal were identified as critical needs of users , and became the focus areas for prototyping;

(f) usability tests conducted with industry experts including buyers and sellers both in Australia and internationally;

(g) external quality assurance; and

(h) testing the product in a closed beta with a select group of trusted, but real users. The end result of this process is a fully tested prototype market.

One of the major benefits of a centralised and digitised marketplace is the ease with which data on behaviour and transactions can be recorded and, at a later date, interpreted.

Personal data is kept private anonymous. PrimeX Connect adheres to strict consumer privacy laws. The anonymized transactional data can be used to achieve a greater understanding of the macro trends and understanding customer needs will ensure continual and resulting increase in sales.

Organisations are split into two categories on the PXC platform: sellers, who are Australian-based sellers of red meat (i.e. processors and non meat-packing exporters); and international buyers who are purchasers of Australian red meat.

Each organisation will have at least one user assigned to it with no maximum on how many users each organisation can have. It is a minimum requirement that individual users are assigned to an approved organisation on the platform. A proposal is initially generated on the platform by a buyer and then further discussed and refined in collaboration with a supplier.

It is clear that over time vast amounts of data will be recorded by the PXC platform. This could form the basis of numerous types of market reports available to all customers or requested individually.

The cost-benefit analysis conducted within the project indicated that the PXC online marketplace is likely to lead to an expanded export market for Australian red meat. The major beneficiaries of the market expansion will be producers, processors and exporters within Australia. Even using conservative estimates of adoption by potential market participants (12% in 2019; 27% in 2020 and 50% in 2021) and marketing cost advantage (15% by 2019), the discounted net benefit of the project is estimated to be $80.53 million.

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1 Background
1.1 Australian Beef Supply Chain Management
1.1.1 Background and Significance for the Industry

Generally, supply chain management is the integration of suppliers, manufacturing, distribution and customers, in which raw materials run from suppliers to manufacturers who assemble them into finished products and organise delivery into the hands of customers. Integrated supply chain management, a complete linking from producers through to consumers, gives many advantages for companies, including improved delivery performance, reduction of lead time, and reduction of inventory, improved flexibility, responsiveness, efficiency and capacity realisation and improved asset usage.

This research focused on the Australian beef supply chain. The definition of the Australian beef supply chain is the chain or sequence of all activities from the breeding property to the domestic or overseas consumers. Please see Figure 1: Australian Beef Supply Chain Structure.
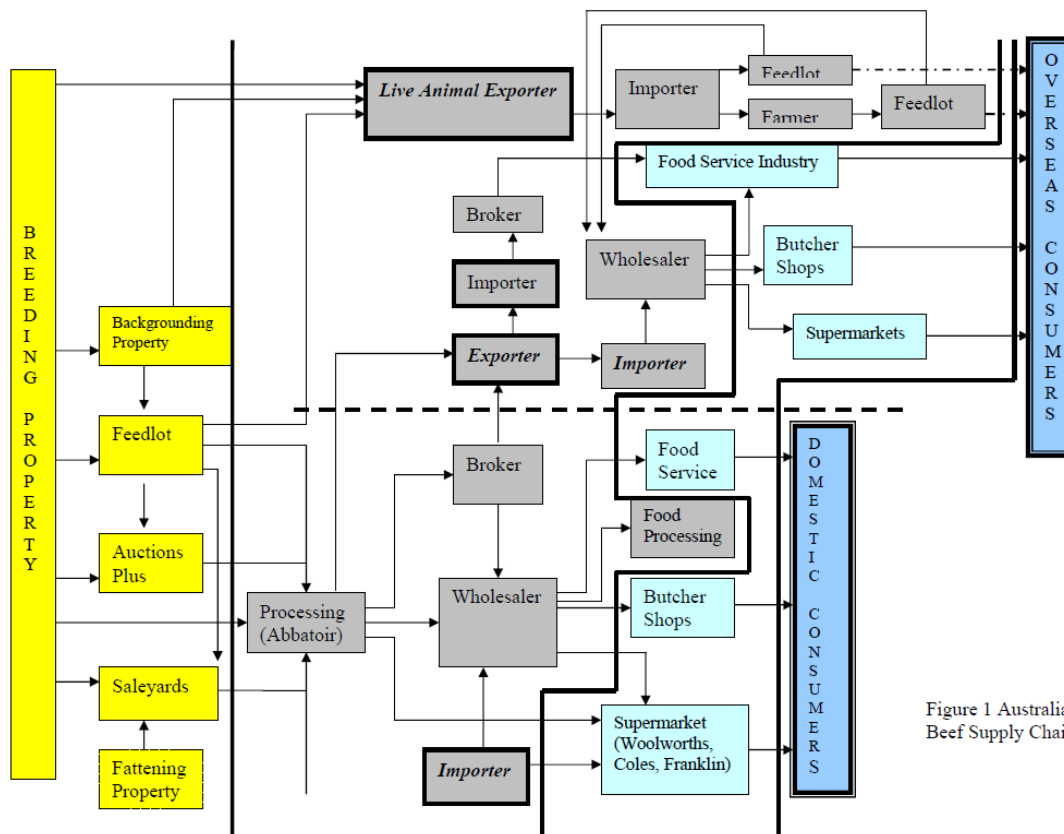
Figure 1 Australian Beef Supply Chain

Today, the direct contribution of the red meat and livestock industry to Australia's gross domestic product is approximately $11.4 billion, making it a significant contributor to the national economy (ABARES, 2015).

On the global export stage, the Australian red meat industry has made a tremendous contribution to the world's need for high quality red meat. The industry makes a vital contribution to Australia's overall trade performance generating 1% of Australia's total GDP (ABARES 2015)

The red meat industry is Australia's largest food manufacturer and a substantial employer in rural and regional areas, directly employing around 200,000 people ((76,800 are employed in farm enterprises with cattle; 43,012 are employed in farm enterprises with sheep and lambs), 53,200 are employed in meat processing and around 24,000 are employed at wholesale and retail).

The Australian Red Meat Industry is undergoing rapid change as a result of globalisation. A highly competitive local and export meat market, increased production efficiency, and a quicker production cycle and delivery times are all contributing factors to this change. A trend towards more outsourcing of activities, and the rapid development of applications dependent on information technology (IT) have also played a role in increased efficiencies.

The sale of red meat downstream of the processors currently takes place through many channels in an inconsistent manner. The process of seller and-buyer negotiation of trade terms to facilitate a sale is highly manual, time consuming, costly and operationally inefficient. This process is different between each buyer and seller across the market. A myriad of tools and technology is used including phone, fax, email, and mobile-based messaging applications.

PXC is an online marketplace that streamlines an international buyer's search, negotiation and transaction process, introduce operational efficiencies and greatly increase Australia's ease of doing business with global buyers of red meat. PXC focuses on improving the ease of doing business by automating the link between buyer and seller, to promote premium and safe Australian product internationally, and the traceability and provenance of this product. Data gathered from the platform will enable immediate feedback to sellers and processors about the characteristics demanded by buyer's in individual international markets.

An important milestone of the project was the launch of a pilot version of the online marketplace to understand and measure (a) how buyers and sellers interact digitally in real-time and (b) the impact of this new digital process on their current methods of doing business.

The data generated in the platform can be shared with individual processors to maximise supply-chain efficiencies and deliver higher margins as inventory is more accurately linked to buyer demands over time. Furthermore, the data can be shared with peak industry associations and Government to ensure that the industry as a whole is benefiting from this information and supply chain innovation.

When similar marketplace platforms have been introduced in other industry sectors, considerable supply chain and operational efficiencies have been obtained, and this has increased overall profitability and customer satisfaction. It is expected that similar results would occur in the beef supply chain over time as more producers and processors are impacted by the platform.

2   Project Objectives

2.1 Project Objectives

The primary objective of this project was to demonstrate and test the business model of PrimeX Connect (PXC). A centralised and transparent marketplace post-processor will deliver these key outcomes:

- Operational efficiencies will be gained by processors of all sizes and consequently result in enhanced efficiency of the Australian red meat supply chain as a whole;
- Business relationships will be easier to establish because both sellers and buyers will be able to discover each other more easily, with available products being searchable and both parties able to negotiate and transact online. This will significantly decrease the time to reach an agreement for an order, create an order and fulfil the requirements of these orders;
- Recording of live and historical data gathered by PXC through the all stages of the transaction lifecycle (from initial search to completed order) will provide more accurate and more robust insights into global buying patterns and buying patterns in specific international markets.This will significantly benefit the Australian industry and supply chain participants and give growers confidence to invest in future stock that is more accurately matched to the demands of the buying community;
- Enable the Australian sell-side community to reach markets and buyers previously unreachable or only reachable at increased cost, thereby increasing total industry revenue;
- Establish an independent 'platform as a service' that will support the growth of a vibrant and competitive trading environment for other service providers to benefit from
- Drive continued innovation and investment in the broader industry; and
- Provide an independent digital platform that will enable sellers to differentiate themselves to the buying community and promote the growth of a value-based trading model.

3   Methodology

3.1 Introduction

The software platform for the project was developed in collaboration with Mentally Friendly Pty Ltd, a Sydney-based Digital digital agency. Over the past 18 months, Mentally Friendly worked with PXC staff on the development of the platform from idea through to the pilot launch with Argyle Prestige Meats in April 2017.

3.2 The Team

Mentally Friendly and PrimeX Connect built a cross-functional team of digital product experts to commence full time work on the design and development of the PrimeX Connect platform. The team structure was as follows:

- Product Designer / Prototyper; Yasin Masukor
- Product Designer: Marcel Jacobs
- Senior Back End Developer / Systems Architect; Thom Vincent
- Front End Developer; Bill Searle
- Product / Project Manager; Alison Bartholomeusz
- Delivery Manager; Gill Costa
- PrimeX Connect Founder & CEO; Michael Chandler
- PrimeX Connect Co-Founder & CTO; Jean-Claude Abouchar

3.3 Development Methodology

The project team used an Agile development methodology to iteratively develop the PrimeX Connect platform. Design thinking techniques such as co-design sessions, client co-location and rapid prototyping were used ensure that the solution being built addressed business and customer needs.

Mentally Friendly worked within 2 week cycles (sprints) and implemented a collaborative process around the user-interface design, feature prioritisation and technical development, with regular collaboration involving all stakeholders and users to test and validate each iteration.

Mentally Friendly approached the PrimeX Connect platform with a fixed cost, fixed timeline and variable scope, with regular working versions of product features released each sprint. This provided stakeholders with the opportunity to review, test and provide feedback, and allowed for continual re- prioritisation of the product features. Sprint meetings included the following:

3.3.1 Project Stand Up

A 15 minute daily meeting first thing in the morning, involving all Mentally Friendly team members working on PrimeX Connect. This was a forum to discuss blocks, talk about accomplishments and progress, and prioritise the 7-8 hours of work that would be done each day.

3.3.2 Project Check Ins

A one hour meeting held twice a week, involving PrimeX Connect stakeholders, all team members at Mentally Friendly working on the project and attendance on a needs basis from Design, Product and Technology Directors.

These meetings fostered openness and transparency, and provided a forum for team members to discuss the product and approaches to building components and functionality on a granular level. The sessions also allowed the team to design elements and agree on key decisions and priorities.

3.3.3   Sprint Planning

A 2 to 4 hour planning session held at the beginning of each new sprint, the sprint planning meeting is attended by the Mentally Friendly team and run by the Delivery Manager and Product Manager. The key priorities for that sprint are discussed, and a sprint goal is set, along with a sprint backlog of user stories that the team commits to delivering.

3.3.4   Sprint Demonstration

A fortnightly meeting at the end of each sprint, lasting for one to two hours, where the Mentally Friendly team presented the work that had been accomplished in that sprint to the wider PrimeX Connect team. During the sprint review, the project was assessed against the sprint goal determined during the sprint planning meeting. Ideally, the team had completed each sprint backlog item brought into the sprint, but it was more important that they achieved the overall goal of the sprint.

The product development lifecycle of PrimeX Connect had three distinct phases; Discovery and Foundation, Production and Beta Release.

3.4 Discovery and Foundation

The first stage of the design process began with Discovery, a series of 8 hour workshops with specific goals that were planned and facilitated by Mentally Friendly. These workshops involved Michael Chandler (CEO) and Jean Claude Abouchar (CTO) from PrimeX, as well as key stakeholders from the industry, including Lachlan Graham, CEO of Argyle Prestige Meats and Steve Harriton of Manildra.

3.4.1   Audit Workshop

The first workshop was the 'Audit Workshop', where the team aimed to understand the current challenges, and expand their knowledge on what already exists in the business and industry, as well as PrimeX's vision for the success of the product / platform. Collaborative exercises and tasks discussed in this workshop included:

Elevator Pitch; Business Objectives; Understanding Relationships; User Profiles and Product Flow.

3.4.2   Dreamer Workshop

The second workshop was a 'Dreamer Workshop', which allowed the team to expand on PrimeX's vision for success for their platform, as well as identifying and flagging potential blocks, challenges or dependencies.. This workshop provided an opportunity to commence the ideation and visualisation of what the product functionality could be and how it meets the needs of its intended users.

Some of the exercises conducted here included Headline News, Invoking Emotions, Top Features and Persona Profiles. The documented outputs from the exercises in the first two workshops can be

viewed with file 'PrimeX_Workshop_Outputs_Documentation [live].pdf'.

3.4.3   Roadmapping

The Mentally Friendly team then conducted an internal roadmapping session to synthesise and map out the functionality of the product based off the findings and discussions that were had during the Discovery phase. The output was a high-level functionality Product Roadmap, with Epics, User Stories and use cases.

3.4.4   Realist Workshop

The third workshop, 'Realist', involved Mentally Friendly presenting the roadmap back to PrimeX stakeholders, to review and discuss the detail of the Minimum Viable Product (MVP). The team prioritised tasks together based on value and effort, descoping lower priority features and functionality.

3.4.5   Establishing the Project Foundation

A Foundation Sprint was then conducted to set up the foundations of the project and begin validating, visualising and finalising the details and requirements of the roadmap for the minimal viable product.

The product vision was further defined and the market size and viability was explored, which is documented in 'PrimeXConnect - MVP Production Plan.pdf'.

A product backlog was produced, grouping the functionality of the platform into the below epics, which were further detailed into 120 summary user stories and approximately 400 summary use cases, allowing the roadmap to be accurately estimated. This roadmap is included for reference, 'Primex_connect-roadmap.xlsx'.

First draft user experience designs were created, and included screens, workflows, and content. The purpose was to validate how users engage with the platform, so these user flows were produced for the key points of functionality, and tested and validated with industry professionals.

The following design drafts were completed: the Negotiation Wireframes; Deal Structure; Deal Flow; Negotiation Process; Payment Flow; and Fulfilment Process.

3.5 Production

The production sprints commenced approximately 10 months after the end of the Foundation Sprint, in October 2016. During this time, PXC took the outcomes developed in conjunction with Mentally Friendly back to potential customers and stress tested the hypothesis to ensure the outcomes continued to meet the broader market needs.

The question was asked of the industry, would a transparent online marketplace deliver financial and operational efficiencies to the industry? The resounding response was yes. Prior to commencing development, the roadmap was revisited and refined, with further features descoped. The updated roadmap can be seen in the document titled 'Primex_roadmap_211016.xlsx'. A new estimate was provided and a 12 sprint timeline was created with a beta MVP delivery scheduled for March 2017.

3.6 Rapid Prototyping

Data driven prototypes of low to medium fidelity were developed by Mentally Friendly's designers to rapidly build concepts and functionality. This allowed people to complete real tasks based on their needs, offering more insight than having them look at static designs.

The Discovery phase indicated that the key inefficiency in the Australian red meat international trade workflow was centred around the negotiation process that uses multiple platforms and mediums of communication such as text, email, fax and social networking applications such as WhatsApp and WeChat. Searching for suppliers and negotiating a deal were identified as the key requirements users wanted from the platform, and therefore became the focus area for prototyping.

Over multiple weeks Mentally Friendly produced 12 iterations of a PrimeX Connect platform prototype that combined the conversational nature of negotiating through real time chat, with the formal side of creating a proposal or order confirmation. The prototypes were built and tested with buyers and sellers. Examples of the evolution of these prototypes, the content and functions they included and their usability have been included for reference.

3.7 Usability Testing

Mentally Friendly incorporated usability testing of their prototype iterations as a vital part of the development of the PrimeX Connect platform, enabling the team to gather continuous feedback from actual users at all stages of development. The findings from sessions validated or disproved hypotheses and assumptions made by the product team.

The usability tests were facilitated by a team member, with a script driving the user to complete a series of tasks without instructing them on how to do this. For example, "Can you please search for HAM code 2040G and initiate an enquiry with Sanger Australia to enquire about the cost". The tests were observed in one-way mirrored rooms by the remaining team and stakeholders, who documented and identified roadblocks, opportunities and behavioural insights that were subsequently used to inform further iterations of the prototype through the development lifecycle.

Documented actions and outputs to iterate and refine the functionality, data and details of a usability test session have been included for reference, as well as examples of the user scripts.

Usability testing of the prototype was conducted with industry experts only including buyers and sellers both in Australia and internationally. 8 industry experts reviewed and advised the product during development, and 7 experienced participants formally tested the product:

- Lachie Graham – Argyle Prestigue Meats (Australia)
- Tom Shannon – Argyle Prestigue Meats (Australia)
- Jereon Koldenhof – CAC Holdings Ltd (Hong Kong)
- Bryce Graham – Argyle Prestigue Meats (Hong Kong)
- Tom Redden – Consolidated Food Co (Australia)
- Allie Joyce – Sanger (Australia)
- Campbell Basnett – Sanger (Australia)

- Simon Linke – Samex (Australia)
- Jock Hudson – Teys / Cargill (Australia)
- Jamie Chalmers – Teys / Cargill (Australia)
- Tracy Gong – Arcadian Organics (Australia)

3.8 Design and Development

Once the core components and user experience of the platform had been iteratively explored, tested and validated through prototyping and usability testing, the Mentally Friendly team progressed toward production sprints, producing high-fidelity visual designs and user flows, and developing the front and back end of the platform.

Examples of the final designs have been included. External quality assurance professionals were recruited full time for 7 days to formally test the platform once the production code had been completed and the design polished. Test scripts covering each of the user types and functions of the platform were created, and issues were reported using TrackDucks, a bug reporting tool that allows users to take screenshots of the issues encountered.

3.9 Beta Release

The final stage of development involved testing the product in a closed beta with a select group of trusted but real users. Having built and tested the core functionality of the PrimeX Connect MVP, Mentally Friendly deployed the platform to a closed staging environment for intensive and situational testing in a live operational environment with Argyle Prestige Meats Australia. This was a three week period where Mentally Friendly's development and design team onboarded Argyle's sales team to the platform, observing and supporting users as they tested the platform by conducting their business through the product.

Beta testing uncovered usability issues as they happened, and allowed conclusions to be drawn from user behaviour when used in a live environment for the intended purpose of the product. In this period, the strengths and weaknesses and other observations and learnings informed the prioritisation of the next features for the MVP, and shaped the short and long term strategy of the product build.

Testing during the closed beta period also enhanced cost efficiency by revealing bottleneck areas while the production team was still working on the project, eliminating the need for significant development sprints for existing features once it is deployed to wider users.

4   Results

4.1 Data Sets

One of the major benefits of a centralised and digitised marketplace is the ease with which information on use and transactions can be recorded and, at a later date, interpreted. This information is used to achieve a greater understanding of the market and the individuals within that market with an aim to improve service and, by extension, increase sales.

Every interaction on the PrimeX Connect platform creates a record in the database which can then be used to create reports which provide insights into how PrimeX Connect users trade in Australian red meat. This information could be extrapolated to the wider, off-platform, user base.

All data points are also stored with a timestamp of either when it was created, or when it was last updated. This allows all the data to be filtered to a defined date range and compared against a similar data set within a different date range.

It should be noted that as the amount of deals completed on the PrimeX Connect platform increases, the ability to accurately predict trends in the market will also increase.

PrimeX would also be able to share data sets with Australian suppliers which would allow them to adapt and anticipate the market. Which in turn would make them more competitive internationally.

Although data is gathered on many pages throughout the PrimeX Connect platform, for this report we will focus on the three main areas; organisations & users, proposals, and products. Each area also has relationships to many other areas of data which can in turn be used to generate complementary data sets.

4.2 Organisations & Users

Organisations are split into two categories on the PrimeX Connect platform; suppliers who will be Australian based sellers of red meat; and buyers who will be purchasers of Australian red meat and based overseas.

Each organisation will have at least one user assigned to it with no maximum on how many users each organisation can have. It is a requirement that users are assigned to an approved organisation on the PrimeX Connect platform.

Information stored on organisations is used to identify themselves to potential buyers and differentiate themselves from other suppliers. With this information, PrimeX will be able to generate data sets on how long organisations have been established and where they are based within Australia. It will be possible to generate data sets with organisation relationships with users and proposals. For example; how many users does an organisation employee and provide access to the PrimeX Connect platform, and how many proposals does an organisation work on at any one time.

Information stored on a user is used to identify themselves within their associated organisation and to users from a buyer organisation. It will be possible to generate data sets with a user's relationships with proposals. For example; how many proposals does a user work on at any one time.

Along with specific data sets, it will be possible to provide an overview on how many organisations and users are registered on the Prime X Connect platform and refine that information by the date they were registered. It will also be possible to filter the organisations by whether they are a supplier or a buyer.

4.3 Proposals

A proposal is generated on the PrimeX Connect website by a buyer and then further developed and refined in collaboration with the selected supplier.

Which the exception of delivery and payment related information required by the supplier, the proposal itself does not store any additional data. However, it is still possible to generate some reporting on the proposal itself; how many active proposals does an organisation work on at one time, what is the mean, median, and mode duration of a proposal from being opened to being closed, and what is the most popular delivery method and delivery location by country.

The proposal does have many relationships to other data which can be used to create data sets providing valuable insights into how users and organisation will use PrimeX Connect to negotiate proposals. For example; what is the mean, median, and mode of products attached to a proposal, what is the mean, median, and mode of messages required to complete a proposal, and what is the mean, median, and mode total cost and weight of a proposal.

With the proposal data sets will allow to PrimeX to promote the platform to unregistered buyers from countries which may not order as often as buyers from other countries. The desired effect being that sales of Australian red meat would increase in smaller overseas markets.

Along with specific data sets, it will be possible to provide an overview on how many proposals have been created on the Prime X Connect platform and refine that information by the date they were created. It will also be possible to filter the proposals by their properties. For example; number of products associated with them, destination country, associated organisations, or total value of the proposal.

4.4 Products

Possibly the most valuable data set generated by the PrimeX Connect platform is related to the products which are assigned to each proposal by either the buyer of the seller. A product is defined by a cipher & cut code which is selected by either the buyer of the seller after it has been added to a proposal.

At a minimum a proposal can feature a single proposal, but there is no upper limit to how many additional products can be added to a single proposal. Anecdotal research suggests that proposals consist of many different products in varying amounts.

The product related data saved will allow PrimeX to generate reports on products. For example; what is the most popular cipher of Beef, what is the most popular cut of Lamb, or what is the mean, median, and mode cost of a product.

As each piece of data is recorded along with a timestamp each time it's updated, it will be possible

to compare one data set against a similar data set within a different date range which in turn will allow PrimeX to view trends such as are particular products more popular during different periods of a year. This would be useful as it would allow producers to produce highly demanded breeds in a more timely fashion.

In the future, it may be possible to use the gathered data to suggest similar or related products based on user's previous orders. This will allow suppliers to possibly sell less known or popular cuts.It will also be possible to generate data sets for products removed from a proposal.

Along with specific data sets, it will be possible to provide an overview on how many products have been created on the Prime X Connect platform and refine that information by the date they were created.

4.5 Analytics

In addition to the data sets being generated from the database, a analytics services will be able to provide information on PrimeX Connect's users and how they interact with the platform.

It will be possible to generate data sets on what devices users access PrimeX Connect with (mobile or desktop computer) and how long users typically use for platform for each session they visit.

This would allow PrimeX to analyse how users use the platform and adapt the design and functionality of the platform to increase efficiencies and subscription of the platform throughout the market. For example, if the data suggests that most users access the PrimeX Connect via a mobile phone, then mobile specific applications could be developed to support that need.

5 Discussion
5.1 Beef supply chain performance indicators
5.1.1 Qualitative Supply Chain Performance indicators

Argyle Prestige Meats, located in NSW tested the platform for two weeks from March 27th through to April 7th, 2017 and through this platform, it is confirmed:

1) Real-time online negotiation and trading is more efficient than current industry processes;
2) The improved efficiencies created are beneficial to processors providing product for orders placed via the platform;
3) Buyers and sellers are willing to use this platform to conduct business;
4) The use of this platform provides improved margins to processors and this translates to higher margins to producers down the supply chain.

Based on academic literature review, there are three qualitative supply chain performance indicators:

1. **Quality**

Harland (1996a) considered that there are three determinants in choosing suppliers within a supply chain: the ability to meet quality standards for the products, the ability to deliver products on time without delay and quality service. Previous studies about these issues have provided useful information about purchasing, logistics and supply chain management (Chapman and Carter, 1990;

Freeman and Cavinato, 1990; Willis, 1989; Burt *et al.*, 2003; Ballou, 2004; Vollmann *et al.*, 2005; Heizer and Render, 2005).

Through using this platform, it is expected that Australian Red Meat Industry can have the ability to deliver meat products on time without delay.

2. Customer satisfaction

Customer satisfaction is an important supply chain performance indicator (Lummus *et al.*, 2001). Customers should be satisfied with the products or services which are received. There are three elements of customer satisfaction in the supply chain or operational level (Christopher, 1994):

1. Pre-Transaction Satisfaction: the service elements that occur prior to finished product delivery to customers.

2. Transaction Satisfaction: the service elements directly involved in the physical distribution of finished products to customers.

3. Post Transaction Satisfaction or After Sales Service: the supports provided for finished products while in consumption.

3. Flexibility

When reviewing flexibility in supply chains, issues related to segmentation, measurement, choices, analysis and interpretation of flexibility were shown to be important (Gupta, 2004; Sethi and Sethi, 1990; Sethi and King, 1994; D'Souza and Williams, 2000; Chopra and Meindl, 2004; Vickery, 1999): Three definitions of flexibility result as a synthesis of this work:

- the ability to adapt to a changing environment;

- an attribute of a system technology for coping with the variety of its environmental needs; and

- the ability of a system to change or react with little penalty in time, effort, cost or performance.

Flexibility is a potential supply chain performance indicator to be proposed in this research because this research focuses on analysis whether the Australian red meat industry is able to respond to the variability of demand for meat products (either domestic or world markets) in the supply chain or operational level. Flexibility in the Australian the red meat supply chain can be measured in functional and hierarchical level (breeding property, feedlot, processors, retailers or wholesalers).

5.1.2 Quantitative Supply Chain Performance indicators

5.1.2.1 Cycle time or lead time

Cycle time or lead time is an important issue in all echelons of supply chain management. Long lead times impair *"the ability of a supply chain to quickly respond to changing conditions, such as changes in the quantity or timing of demand and quality of logistics problems"* (Stevenson, 2002, p.523). There are two types of lead times in supply chains:

- supply chain process lead time. This is the time of the flow of meat products from the plant to the supermarkets or food services.

  Through this platform, Supply Chain Process Lead Time can be reduced by 15-20%.

- order-to-delivery time. This is the time spent between the wholesalers or retailers placing their order and the delivery of meat products to the retailers or wholesalers. There are three delivery dimensions: delivery speed, production or processing lead time, and delivery reliability (Coyle *et al.*, 2003).

  Order-to-Delivery Time increased by 10-15%.

5.1.2.2 Customer service level

There are several supply chain metrics to achieve high customer service level:

- Order fill rate is defined as the availability of stock level to **fulfil the** customer demand. Order fill rate can be increased by 10-15%.

- Backorder level is defined as the number of customer orders waiting to be filled. Backorder level can be reduced by 10%.

- On-time delivery is defined as the customer orders that are fulfilled on-time (without delay).

Those supply chain metrics of customer service level are important in relation to efficiency of supply chain performance in the red meat industry.

5.1.2.3 Inventory levels

Inventory is *'the stored accumulation of physical material resources in the operation"* (Johnston *et al.*, 2003, p.231). The three types of inventories in the meat sector are the cattle supply as raw materials, slaughtered or processed carcases as work in process (WIP) materials and finally the beef or veal products as the finished products. To achieve high efficiency in supply chain performance, the businesses need to keep optimal levels of each type of inventory.

5.1.2.4   **Resource utilisation**

Generally, each business in the meat supply chain has a number of resources such as production and processing or manufacturing resources, storage resources, logistics resources including truck or shipment delivery, human resources and financial resources (working capital and stock). The main objective of performance indicators in the Australian meat supply chain context is to utilise the resources efficiently, for instance, to utilise the plant, boning or slaughter facilities efficiently.

Beamon (1996; Beamon, 1998; Beamon, 1999) explored several supply chain performance indicators (quantitative - financial measure and qualitative measures) from many previous studies (see Table 1).

Table 1 Supply Chain Performance Indicators (Beamon, 1996; Beamon, 1998; Beamon, 1999)

Metrics	References
Cost	(Cohen and Lee, 1989; Pyke and Cohen, 1994; Cohen, 1990; Lee, 1995)
Cost and Activity Time	(Arntzen *et al.*, 1995)
Cost and Customer Responsiveness	(Newhart *et al.*, 1993; Towill, 1991; Towill, 1992; Ishii *et al.*, 1988)
Customer Responsiveness	(Lee, 1993)
Flexibility, Range and Response Flexibility	(Voudouris, 1996; Slack *et al.*, 2004)

Those elements above including efficiency (cost and time), customer responsiveness and flexibility are suitable as Australian meat supply chain performance indicators. Table 2 describes the previous studies on supply chain performance.

Table 2 Previous studies on supply chain performance

Author	Descriptions
(Lee and Billington, 1992)	Coordination can improve the supply chain performance.
(Beamon, 1998; Beamon, 1999)	There are three supply chain performance indicators: efficiency, customer service and flexibility.
(Gunasekaran *et al.*, 2001)	Develop a conceptual framework for supply chain performance indicators at three levels: strategic, tactical and operational.

(Korpela *et al.*, 2002)	The business process reengineering approach combined with the theory of Analytic Hierarchy Process (AHP) has been proposed to improve the supply chain management.
(Murphy *et al.*, 1996)	Overview of supply chain performance indicators and their dimension used in literature from 1987-1993 have been presented. There were 19 performance indicators, mostly were financial perspective such as net income or Return on Investment (ROI).
(Persson and Olhager, 2002)	Simulation is able to analyse two supply chain performance indicators (quality and short lead time).
(Li and O' Brien, 1999)	Profit, lead time, on time delivery and waste reduction are supply chain performance indicators to improve efficiency and effectiveness.
	The most influence factor in supply chain performance is lead time.
(Berry and Naim, 1996)	There are two suggested configurations to improve efficiency performance indicator: reducing lead time information sharing.
(Lai *et al.*, 2002)	There are several supply chain performance indicators in transportation: responsiveness, reliability, costs and assets, efficiency, service effectiveness for shippers.
(Van der Vorst, 2000)	There are five food supply chain performance indicators: product availability, quality, responsiveness, delivery reliability, total supply chain costs.
(Eppen, 1979; Thonemann, 2002)	Lead time and cost are supply chain performance indicators at the retailer level with a single manufacture level and multiple retailer model. Reducing the set up time, the production time and the number of retailers of the demand rate have been suggested to improve the supply chain performance.

Table 3 describes the previous studies from 1979 to 2006 on supply chain performance indicators (customer responsiveness, efficiency and flexibility) in manufacturing, food, transport, steel production and horticulture.

Table 3 Previous studies on customer responsiveness, efficiency and flexibility

Customer responsiveness	Efficiency	Flexibility
(Berry and Naim, 1996; Beamon, 1998; Beamon, 1999; Li and O' Brien, 1999; Talluri *et al.*, 1999; Van der Vorst, 2000; Gunasekaran *et al.*, 2001; Thonemann, 2002; Lai *et al.*, 2002; Talluri and Baker, 2002; Persson and Olhager, 2002; Claro *et al.*, 2003; Gunasekaran *et al.*, 2004; Aramyan *et al.*, 2006)	(Eppen, 1979; Lee and Billington, 1992; Berry and Naim, 1996; Murphy *et al.*, 1996; Beamon, 1998; Beamon, 1999; Li and O' Brien, 1999; Talluri *et al.*, 1999; Van der Vorst, 2000; Gunasekaran *et al.*, 2001; Thonemann, 2002; Lai *et al.*, 2002; Talluri and Baker, 2002; Persson and Olhager, 2002; Claro *et al.*, 2003; Gunasekaran *et al.*, 2004; Aramyan *et al.*, 2006)	(Berry and Naim, 1996; Beamon, 1998; Beamon, 1999; Li and O' Brien, 1999; Van der Vorst, 2000; Gunasekaran *et al.*, 2001; Lai *et al.*, 2002; Talluri and Baker, 2002; Persson and Olhager, 2002; Claro *et al.*, 2003; Gunasekaran *et al.*, 2004; Aramyan *et al.*, 2006)

5.2 Cost-Benefit Analysis
5.2.2 Introduction

To assess the likely impact of the introduction of an electronic market of the type proposed by PrimeX is not straight-forward. There are many components of the market that will be affected. Information about impacts on each of these components will be needed for a thorough analysis to be completed.

In the next section the impacts and implications for the various components of the Australian beef supply chain are considered. The objective is to estimate the discounted net benefits to the beef industry. The focus in this section is on the beef industry, not red meat, because of data availability. Hence, the estimates made here will consequently be conservative estimates of the net benefits of the PrimeX R&D investment.

Although it is important to be aware of the way in which the innovation will impact across the supply chain, as suggested by the MLA (2015), *ex-ante* cost-benefit analysis has to evolve in stages as a research project moves through its various phases from conception to ideas development, pilot testing, full-scale mock-up, extension, launch and *ex-post* monitoring.

The same will be the case for the PrimeX research and development (R & D). Hence at this early

stage the *ex-ante* cost-benefit analysis (CBA) will necessarily be based on uncertain information and various subjective judgments. The veracity of such information and judgments will become clear with the unfolding of time, and successive rounds of CBA will provide more accurate estimates of the returns to the investment in the PrimeX R & D activities.

Therefore the estimates provided here are first preliminary estimates that demonstrate possible orders of magnitude of the outcomes of interest, and the primary focus of this section is the method of discovering cost-benefit estimates. Hence there are two objectives of this section: outline the method of obtaining cost-benefit estimates of the PrimeX R&D, and make preliminary estimates of the discounted net benefits.

5.2.3   Impacts of the PrimeX Connect on the Australian Beef Supply Chain

In this section we estimate two scenarios. In the first, the Australian beef supply chain is considered in a future that does not include the PrimeX R & D. Even within this scenario it is probable that electronic marketing of the type envisaged by PrimeX will eventually be introduced. Hence, our perspective is one in which introduction of the innovation and its adoption occurs earlier with the PrimeX R & D.

The benefits of the R & D are then measured by the earlier adoption following introduction of the innovation. Clearly the reduced amount of time to adoption is a parameter that influences the benefits that accrue from the research. Subjective judgment of experts in the field will be required here to provide estimates.
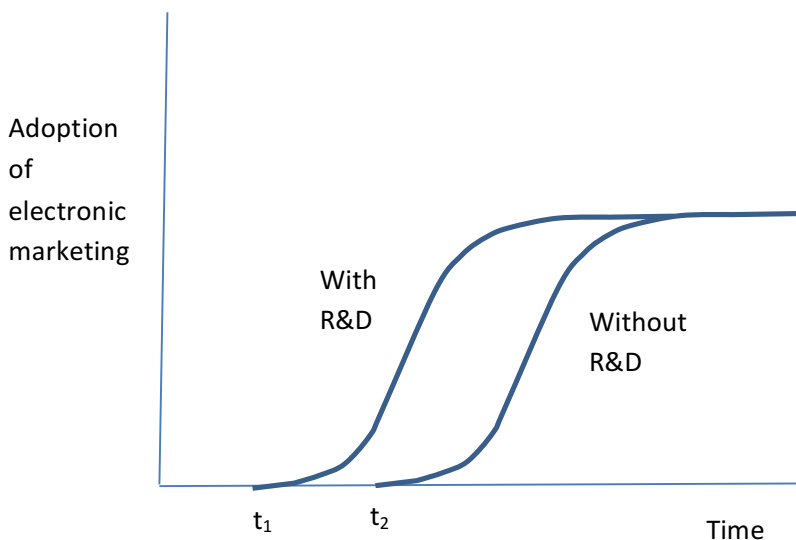
Figure 2: Adoption time paths with and without the PrimeX R&D

Figure 2 shows the time path of adoption in the first scenario (without the PrimeX R & D) and in the second scenario (with the R & D). First adoption occurs in t_2 years from now without the R & D and in t_1 years with it. The difference between the two curves measures the increased adoption as a consequence of the R & D, and this forms the basis of the estimate of the benefits of the R & D.

The introduction of an electronic market in the Australian beef supply chain has an impact on the structure of the chain. Davenport (1993) identified the impacts as initially directly affecting the intermediaries in the supply chain, but then spreading to all participants. Figure 3 shows the structure of the existing beef supply chain without an electronic market component (upper section of figure) and with an electronic market component (lower section).

In the initial situation, the customer (in Australia or overseas) searches out information about beef products available, including prices, quality and other characteristics. Such search can take on various forms, but is usually highly dependent on the use of telephone and email communications.

The introduction of an electronic market affects the consumer purchase process. Figure 3 shows that the key change is in the digitalisation of the marketing component. For consumers, the search cost is reduced. Moreover, the opportunity is opened-up to contact more sellers and this has a tendency to make the market more competitive. On the other hand, consumers often perceive that riskiness is increased when a new marketing approach of this type is introduced.

The role of beef wholesalers will also change because that part of their role in transmitting product information will be reduced. Nevertheless, an efficient process of physical product distribution will still be essential.

The likely changes in the structure of the Australian beef supply chain will mean that the adoption of the electronic marketing products of the PrimeX R & D will have different impacts on producers, wholesalers and consumers. The distribution of benefits across the different supply chain participants is an important consideration.

5.2.4   Estimating the Benefits

While the changing distribution of benefits across the Australian beef supply chain (discussed in Section 5.2.2), following the structural change that is induced by the electronic market innovation, is an important consideration, the initial cost-benefit approach presented here concentrates on the aggregate benefits. Then these benefits are assumed in this first iteration to be distributed between farms, processing and marketing in the proportion that prevails over the long term, about 45%, 35% and 20%, respectively (MLA 2016).

A partial equilibrium approach is employed to estimate the aggregate benefits from diffusion of the electronic market within the beef supply chain. Figure 4 shows the domestic and export markets for Australian beef at the wholesale level. It is generally assumed in this type of analysis that Australia is a price taker in beef export markets.

Hence the export demand curve (D_e) is horizontal (infinitely elastic) in Figure 4. S_0 is the initial export supply curve, and S_1 is the export supply curve after the introduction of the innovation. Prior to the innovation, the amount of beef exported is q_0, and once the innovation is adapted the quantity exported is q_1.

In the domestic market, the demand curve is D_d and the quantity of beef supplied to this market is q_d. Given the price-taker assumption, the equilibrium market price (except for transfer costs) remains at p_0 throughout the innovation process, and the quantity of beef in the domestic market remains

unchanged.

Marketing communication
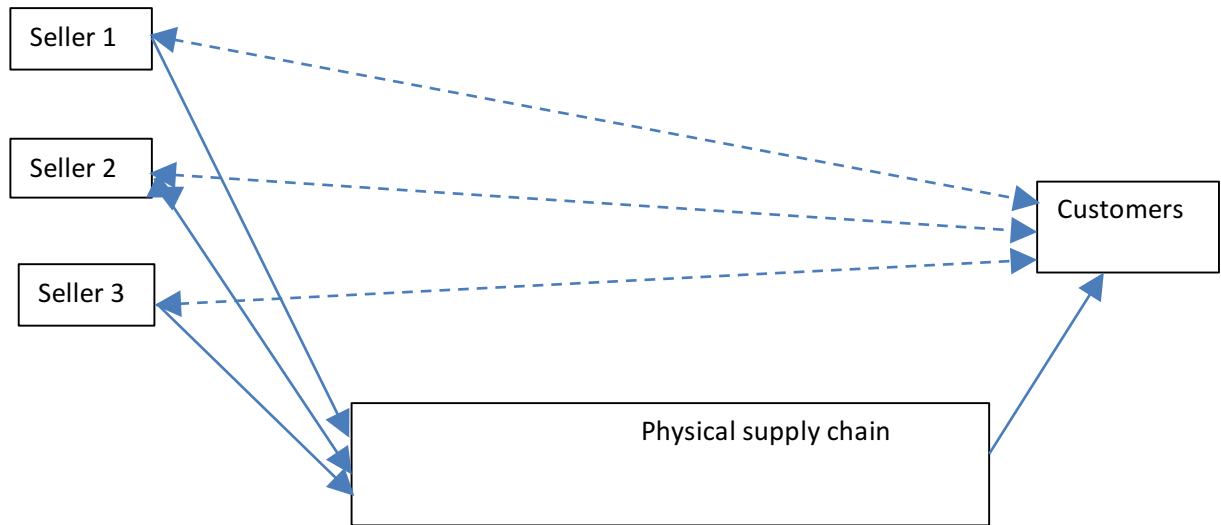
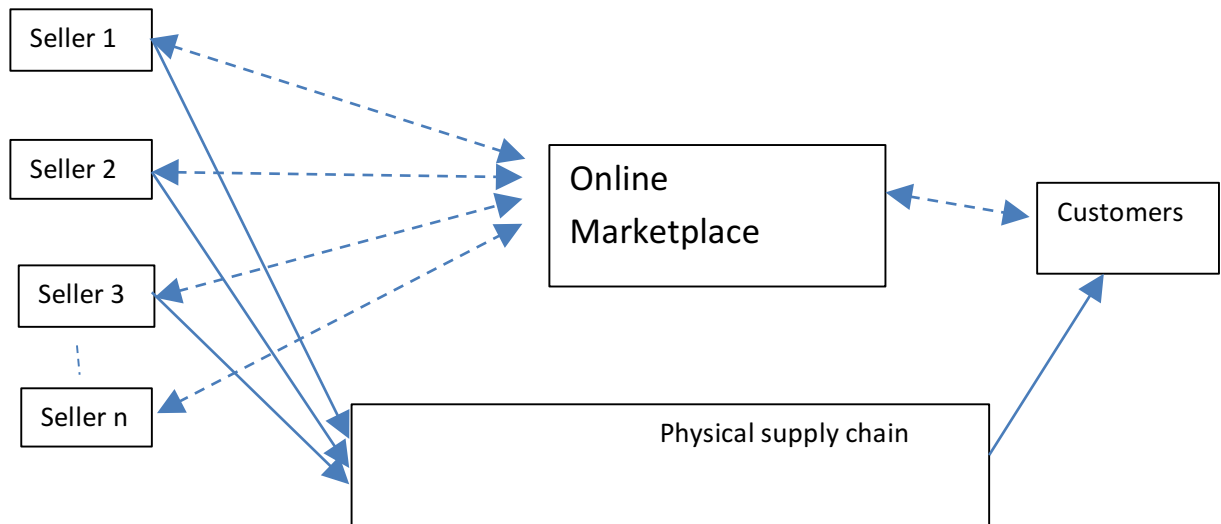# Marketing communication via online marketplace

Figure 3: Structure of Australian beef supply chain with (lower figure) and without (upper figure) an electronic market component

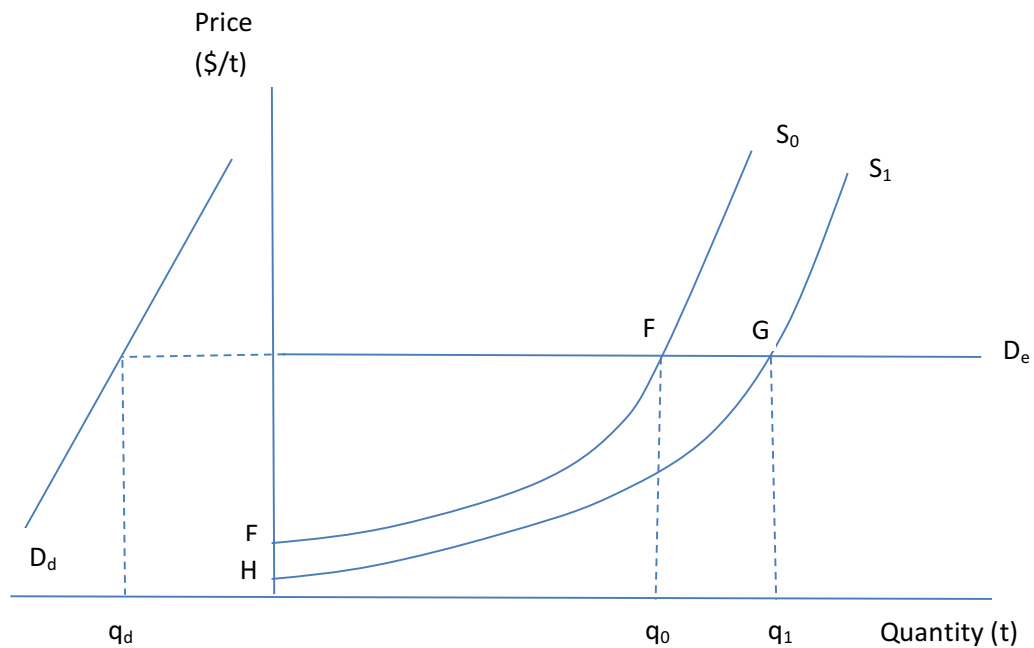Source: Adapted from Strader and Shaw (1999)

Figure 4: Domestic and export markets for Australian beef, with and without an electronic market innovation

In this model, the aggregate benefits of the innovation are measured by the increase in the producer surplus as a result of the supply curve shift from S_0 to S_1. This is the area EFGH in Figure 4. The next step in quantifying these benefits is to obtain estimates of the key variables in the model — p_0, q_d, q_0, q_1, the elasticity of supply, E_s, and the supply curve shift due to the technological innovation.

According to MLA (2016), the quantity of beef exported in 2015-16 was 1.17 million tonnes *swt*, and this represented 74% of production. Hence, q_0 = 1.17 and q_d = 0.41 (26% of production). The total value of exports in 2015-2016 was $8.5 billion (MLA 2016), and, together with the above estimate of quantity, this provides an estimated average wholesale price (P_0) of $7,265/t.

To position the two beef ε p_0 ....pply curves requires an estimate of the prices elasticity of supply (E_s) together with an estimate of the downward shift of the supply curve. There are a number of

published estimates of E_s (Wicks and Dillon 1978) whose median value is approximately 0.6.

For the shift of the supply curve, a reduction in marketing costs of 1% is used. With total marketing costs set at 20% of overall costs, a 1% reduction in marketing costs translates into a 0.2% reduction in overall costs. So the downward shift in the supply curve is 0.2% of $7,265/t = $14.53/t. This provides the relative positions of the two supply curves of Figure 3 and provides an estimate of producer surplus benefit of $9.808 million following a 1% reduction in marketing costs.

The final step in calculating the additional benefits of the electronic marketing innovation is to integrate the above estimate into the adaption process described in Section 2. For demonstration purposes, Table 4 shows one possible adaption path, estimated by PrimeX to 2020, and projected to 2024. The preliminary estimate of the benefits spread over these years is $123.97 million. These are undiscounted benefits.

Table 4: Estimated adoption path, reduction in marketing costs, reduction in overall costs and aggregate producer surplus gain following the PrimeX innovation.

	2017	2018	2019	2020	2021	2022	2023	2024
Adoption								
With PrimeX	1%	6%	12%	27%	50%	50%	50%	50%
Without PrimeX				1%	6%	12%	27%	50%
Gain in adoption	1%	6%	12%	26%	44%	38%	23%	0
Marketing Costs								
Reduction with PrimeX	5%	10%	15%	20%	20%	20%	20%	20%
Reduction without PrimeX				5%	10%	15%	20%	20%
Net reduction due to PrimeX	5%	10%	15%	15%	10%	5%	0	0
Aggregate Change in Costs	0.05%	0.6%	1.8%	3.9%	4.4%	1.9%	0	0
Aggregate Producer Surplus Gain ($m)	0.49	5.88	17.64	38.22	43.12	18.62	0	0

5.2.5 Estimating the Costs

In the cost-benefit analysis of the PrimeX electronic marketing innovation, the costs are the aggregate costs, both monetary and in-kind, to be spent over successive years of the R & D phases. In a similar manner to the benefits the costs could be spread over, say, six years as shown in Table 5. Again, the values shown at this stage are merely indicative of the eventual costs, though the costs to 2017 are actual monetary and in-kind costs.

Also shown in Table 2 are the net benefits, or annual gross benefits minus costs, and discounted net benefits (in the final row). The outcome of this preliminary cost-benefit estimation is a discounted net benefit of $80.53 million. Again it must be emphasised that this is probably an underestimate because it excludes red meat other than beef, has benefits estimated on the conservative side, and costs at the upper end of the envelope.

Table 5: Estimating the discounted net benefits of the PrimeX electronic market innovation

	2017	2018	2019	2020	2021	2022
Benefits – Aggregate Producer Surplus Gain ($m)	0.49	5.88	17.64	38.22	43.12	18.62
Costs – Monetary and In-Kind ($m)	1.12[a]	1.10	2.30	2.10	1.80	0
Undiscounted Net Benefits	-0.63	4.78	15.34	36.12	41.32	18.62
Discounted Net Benefits ($r = 10\%$)	-0.63	4.30	12.42	26.33	27.11	10.99

a: Monetary and in-kind costs to 2017

5) Summary

As outlined in the introduction, the two objectives of this section were to demonstrate the cost-benefit analysis method to be applied at successive points during the R & D phases of the PrimeX project, and to provide a preliminary estimate of the discounted net benefits. While the method is considered to be clearly defined, the net benefit estimation will be subject to further refinement as more information comes to light during the R & D work.

The key parameters requiring more precise estimation are:

- Adoption rate and hence quantity of beef expected to be sold through the electronic market
- Length of time before a similar innovation occurs without the PrimeX investment
- Change in marketing costs of a firm using the Primex system

6) Conclusions/Recommendations

The project commenced with the objectives of developing and testing an online market for red meat exported from Australia. Not only has there been a proof of concept, but practical testing with participants in the red meat supply chain has shown that such a market is viable and with additional development funds will be commercially successful.

Not only that, but there will be substantial benefits to producers, processors and exporters in Australia. Using the work completed to date as a foundation, there are now several critical research steps to be completed to achieve a successful commercial launch.

The work of this project points to the future research work to be undertaken to capture the benefits noted above.

PrimeX Connect is now ready for full commercial deployment into the Australian red meat supply chain. A comprehensive go to market sales strategy has been developed and will be executed week commencing May 2017. PrimeX has identified over 30 Australian Processors and exporters of red meat to conduct a month long educational roadshow. As of June 2017, PrimeX, in conjunction with AusTrade and the NSW Chabre of Commerce will be targeting international buyers in key capital cities across Asia, North America, Europe and the Middle East.

PrimeX will also be significantly adapting and evolving the product and service as consumer and user feedback comes in from market adoption. PrimeX has a customer service and support strategy in place to ensure all user feedback is considered and prioritised for further product enhancement.

7) Key Messages

● Conservative estimates of adoption of PrimeX Connect by potential market participants show 12% in 2019; 27% in 2020 and 50% in 2021 and marketing cost advantage (15% by 2019), the discounted net benefit of the project is estimated to be $80.53 million.

● PrimeX Connect has been built by the industry for the industry

● Australian exporters of red meat including beef, lamb and sheep meat will need to adopt a new way of doing business if they are to receive the significant productivity increases and cost reductions as detailed in this report.

● The entire Australian supply chain from farm gate to exporter will see gains in productivity and operational efficiency as a direct result of adopting PrimeX Connect to automate and streamline the search, negotiation and transaction process of a trade.

● The entire Australian sell side has the ability to be searched for and found by the global buying universe thus opening up trading relationships and gaining the associated increase in revenue like never before.

● The global buying community now has choice which will drive efficiency and competition.

● The transactional data acquired by PrimeX Connect will form a powerful tool in providing great detail into drives of historical and future trends and forecast analytics for the industry. Such business intelligence can be shared and leveraged right the way down the supply chain to the farm gate

● A centralised, transparent ecommerce platform dedicated for Australian red meat will significantly increase Australia's competitiveness on the world stage amongst its global export peers such as the USA and Brazil.

● PrimeX Connect can be rolled out internationally to other sell side markets to create a truly global platform for red meat commerce. PrimeX Connect is not just limited to the Australian market.

● PrimeX Connect has been built and can be adapted to any other agricultural commodity that requires negotiation such as cotton, timber, viticulture and minerals.

8) Bibliography

Aramyan, L., Ondersteijn, C., van Kooten, O. & Lansink, A. O. (Eds) (2006). *Performance indicators in Agri-Food Production Chains* Springer-Netherland.

Arntzen, B. C., Brown, G. G., Harrison, T. P. & Trafton, L. L. (1995). Global supply chain management at Digital Equipment Corporation. *Interfaces* 25: 69-93.

Ballou, R. H. (2004). *Business logistics/supply chain management* Upper Saddle River, NJ: Prentice-Hall.

Beamon, B. M. (1996).Performance measures in supply chain management. In *Proceedings of the 1996 Conference on Agile and Intelligent Manufacturing Systems*Troy, New York, NY.: Rensselaer Polytechnic Institute.

Beamon, B. M. (1998). Supply chain design and analysis: models and methods. *International Journal of Production Economics* 55(3): 281-294.

Beamon, B. M. (1999). Measuring supply chain performance. *International Journal of Operations and Production Management* 19(3/4): 275-292.

Berry, D. & Naim, M. M. (1996). Quantifying the relative improvements of redesign strategies in a PC supply chain. *International Journal of Production Economics* 46: 181-196.

Burt, D. N., Dobler, D. W. & Starling, S. L. (2003). *World-class supply management: the key to supply chain management.* New York, NY: McGraw-Hill.

Chapman, S. & Carter, P. (1990). Supplier/customer inventory relationships under just-in-time. *Decision Sciences* 21(1): 35-51.

Chopra, S. & Meindl, P. (2004). *Supply chain management: strategy, planning, and operation.* Upper Saddle River: Prentice Hall.

Christopher, M. (1994). *The strategy of distribution management.* Oxford: Butterworth-Heinemann.

Claro, D. P., Hagelaar, G. & Omta, O. (2003). The determinants of relational governance and performance: how to manage business relationships? *Industrial Marketing Management* 32(8): 703-716.

Cohen, M. A. & Lee, H. L. (1989). Resource deployment analysis of global manufacturing and distribution networks. *Journal of Manufacturing and Operations Management,* : 81-104.

Cohen, M. A., Moon, S (1990). Impact of production scale economies, manufacturing complexity, and transportation costs on supply chain facility networks. *Journal of Manufacturing and Operations Management* 3: 269-292.

Coyle, J. J., Bardi, E. J. & Langley, J. (2003). *The Management of business logistics.* Mason, OH: Thomson South-Western.

D'Souza, D. E. & Williams, F. P. (2000). Toward a taxonomy of manufacturing flexibility

dimensions. *Journal of Operations Management* 18(577-93): 5.

Davenport, T.A. (1993) *Process Innovation: Reengineering Work through Information Technology*. Harvest Business School Press, Boston.

Eppen, G. D. (1979). Effects of centralization on expected costs in a multi-location newsboy problem. *Management Science* 25(5): 498-501.

Freeman, V. T. & Cavinato, J. L. (1990). Fitting purchasing to the strategic firm: framework, process, and values. *Journal of Purchasing and Materials Management* 26(1): 6-10.

Gunasekaran, A., Patel, C. & McGaughey, R. E. (2004). A framework for supply chain performance measurement. *International Journal of Production Economics* 87(3): 333-347.

Gunasekaran, A., Patel, C. & Tirtiroglu, E. (2001). Performance measures and metrics in a supply chain environment. *International Journal of Operations and Production Management* 21(1/2): 71-87.

Gupta, H. (2004). Four dimensional unified inventory control. *Journal of Management Research* 4(3): 171-174.

Harland, C. (1996a). Supply chain management: relationships, chains and networks. *British Journal of Management* 7(63-80).

Heizer, J. & Render, B. (2005). *Operations management.* Upper Saddle River, NJ: Prentice-Hall.

Ishii, K., Takahashi, K. & Muramatsu, R. (1988). Integrated production, inventory and distribution systems. *International Journal of Production Research* 26(3): 473-482.

Johnston, R., Chambers, S., Harland, C., Harrison, A. & Slack, N. (2003). *Cases in Operations Management.* England: Prentice Hall.

Korpela, J., Kylaheiko, K. & Lehmuswaara, A. (2002). An analytic approach to production capacity allocation and supply chain design. *International Journal of Production Economics* 78(2): 187-195.

Lai, K. H., Ngai, E. W. T. & Cheng, T. C. E. (2002). Measures for evaluating supply chain performance in transport logistics. *Transportation Research. Part E Logistics and Transportation Review* 38(6): 439-456.

Lee, H. L. & Billington, C. (1992). Supply chain management: pitfalls and opportunities. *Sloan Management Review* 33(65-73).

Lee, H. L., Billington, C (1993). Material management in decentralized supply chains. *Operations Research* 41(5): 835-847.

Lee, H. L., Feitzinger, E (1995). Product configuration and postponement for supply chain

efficiency. *Institute of Industrial Engineers, Fourth Industrial Engineering Research Conference Proceedings*: 43-48.

Li, D. & O' Brien, C. (1999). Integrated decision modelling of supply chain efficiency. *International Journal of Production Economics* 59(1/3): 147-157.

Lummus, R. R., Krumwiede, D. & Vokurka, R. J. (2001). The relationship of logistics to supply chain management: developing a common industry definition. *Industrial Management & Data Systems* 101(8): 426-432.

MLA (2015), Guide to value propositions and cost/benefit analysis. MLA, North Sydney.

MLA (2016a), Fast facts: Australia's beef industry. https://www.mla.com.au/globalassets/mla-corporate/prices--markets/documents/trends--analysis/fast-facts--maps/mla_beef-fast-facts-2016.pdf (Accessed 4 April, 2017)

MLA (2016b), Retail prices continue upward trend in 2016. https://www.mla.com.au/prices-markets/market-news/Retail-prices-continue-upward-trend-in-2016-17052016/ (Accessed 4 April, 2017)

Murphy, G. B., Trailer, J. W. & Hill, R. C. (1996). Measuring performance in entrepreneurship research. *Journal of Business Research* 36(1): 15-23.

Newhart, D. D., Stott, K. L. & Vasko, F. J. (1993). Consolidating Product Sizes to Minimize Inventory Levels for a Multi-Stage Production and Distribution Systems. *Journal of the Operational Research Society* 44(7): 637-644.

Persson, F. & Olhager, J. (2002). Performance simulation of supply chain designs. *International Journal of Production Economics* 77(231-245).

Pyke, D. F. & Cohen, M. A. (1994). Multi-product integrated production-distribution systems. *European Journal of Operational Research* 74(1): 18-49.

Sethi, A. K. & Sethi, S. P. (1990). Flexibility in manufacturing: a survey. *International Journal of Flexible Manufacturing Systems* 2(4): 289-328.

Sethi, V. & King, W. R. (1994). Development of measures to assess the extent to which an information technology application provides competitive advantage. *Management Science* 40(12): 1601-1627.

Slack, N., Chambers, S. & Johnston R. (2004). *Operations Management* Harlow, England: Prentice Hall.

Stevenson, W. J. (2002). *Operations management.* New York: McGraw-Hill Irwin.

Strader, T.J. and Shaw, M.J. (1999), Electronic markets: impact and implications, in Shaw, M.J. ,

Blanning, R., Strader, T.J. and Whinston, A. *Handbook on Electronic Commerce.* Springer, Berlin. pp 77-98.

Talluri, S. & Baker, R. C. (2002). A multi-phase mathematical programming approach for effective supply chain design. *European Journal of Operational Research* 141(3): 544-558.

Talluri, S., Baker, R. C. & Sarkis, J. (1999). A framework for designing efficient value chain networks. *International Journal of Production Economics* 62(1/2): 133-144.

Thonemann, U. W. a. B., J.R (2002). The effect of product variety on supply-chain performance. *European Journal of Operational Research* 143(3): 548-569.

Towill, D. R. (1991). Supply chain dynamics. *International Journal of Computer Integrated Manufacturing* 4(4): 197-208.

Towill, D. R., Naim, M.M (1992). Industrial dynamics simulation models in the design of supply chains. *International Journal of Physical Distribution & Logistics Management* 22(5): 3-13.

Van der Vorst, J. G. A. J. (2000). *Effective food supply chains: generating, modelling and evaluating supply chain scenarios.* Proefschrift Wageningen [http://www.library.wur.nl/wda/dissertations/dis2841.pdf].

Vickery, S., Calantone, R., Droge, C (1999). Supply chain flexibility: an empirical study. *Journal of Supply Chain Management* 35(3): 16-24.

Vollmann, T. E., Berry, W. L., Whybark, D. C. & Jacobs, F. R. (2005). *Manufacturing Planning and Control for Supply Chain Management.* New York, NY: McGraw-Hill.

Voudouris, V. T. (1996). Mathematical programming techniques to debottleneck the supply chain of fine chemical industries. *Computers and Chemical Engineering* 20: S1269-1274.

Wicks, J.A and Dillon, J.L. (1978), APMAA estimates of supply elasticities of Australian wool, beef and wheat. *Review of Marketing and Agricultural Economics* 46(1), 48-57.

Willis, T. H. (1989). Operational competitive requirements for the twenty-first century. *Industrial Management & Data Systems* 98(2): 83-86.

9) Appendix

a) Additional Reading: Australian Red Meat Supply Chain
   i) List of publications on Australian Beef Supply Chain Analysis (Ferry Jie and Kevin Parton)

Ding, M. Jie, F. Parton, K. and Matanda, M. 2014, 'Relationships between quality of information sharing and supply chain food quality in the Australian beef processing industry', in *International Journal of Logistics Management*, Emerald Publishing, United Kingdom, vol. 25, no. 1, pp. 85-108 ISSN: 0957-4093

Jie, F. Parton, K. and Cox, R. 2013, 'Linking supply chain practices to competitive advantage: An example from Australian agribusiness', in *British Food Journal*, Emerald Group Publishing, United Kingdom, vol. 115, no. 7, pp. 1003-1024 ISSN: 0007-070X

Jie, F. Parton, K. and Cox, R. 2012, 'An agile supply chain analysis of Australian beef wholesalers and retailers', in*International Journal of Agile Systems and Management (IJASM)*, Inderscience Publishers, United Kingdom, vol. 5, no. 4, pp. 297-318 ISSN: 1741-9174

Jie, F. 2012, 'The roles of trust and commitment in the Australian Lamb Retailers/Wholesalers', in *Australian Farm Business Management Journal*, Charles Sturt University, Australia, vol. 9, no. 1, pp. 49-56 ISSN: 1449-5937

Jie, F. 2010, 'Customer relationships strategy: An Australian cattle producers case', in *Australian Farm Business Management Journal*, Charles Sturt University, A F B M Network, Australia, vol. 6, no. 2, pp. 97-101 ISSN: 1449-5937

Jie, F. Parton, K. and Wang, K. 2010, 'Supply chain analysis in the Australian lamb processing industry', in *Proceedings of the 8th ANZAM Operations, Supply Chain and Services Management Symposium*, Kate Hughes, Doug Davis, Peter O'Neill, Daniel Prajogo, Amrik Sohal (ed.), Monash University, Sydney, Australia, pp. 1-19 (The 8th ANZAM Operations, Supply Chain and Services Management Symposium)

Jie, F. and Parton, K. 2009, 'The need for improved skills in the Australian meat industry', in *International Review of Business Research Papers*, World Business Institute, Australia, vol. 5, no. 4, pp. 257-269 ISSN: 1837-5685

Jie, F. Parton, K. and Cox, R. 2009, 'Balanced scorecard for australian cattle producers: An application', in *Australian Farm Business Management Journal*, Charles Sturt University, AFBM Network, Australia, vol. 6, no. 1, pp. 27-40 ISSN: 1449-5937

Jie, F. and Parton, K. 2009, 'The impact of information quality on food quality performance indicator of Australian beef processors', in *Proceedings of the 7th ANZAM Operations Management Symposium*, Soosay, Claudine; O'Neill, Peter & Prajogo, Daniel (ed.), ANZAM, Australia, pp. 251-268 (7th ANZAM Operations Management Symposium)

Jie, F. Parton, K. Jenkins, R. and Cox, R. 2008, 'Improving supply chain performance of the Australian beef enterprises', in *Proceedings of the 22nd ANZAM Conference 2008: Managing in the Pacific Country*, Professor Marie Wilson (ed.), Promaco Conventions, Canning Bridge, Western Australia, pp. 1-14 (ANZAM Conference 2008: Managing in the Pacific Country)

Jie, F. Parton, K. and Jenkins, R. 2008, 'Supply chain analysis of Australian beef retailers/wholesalers', in *Proceedings of the 6th ANZAM Operations Management Symposium*, P. Singh, D. Prajogo, P. Neill and S. Rahman (ed.), University of Technology, Sydney, Sydney, Australia, pp. 1-12 (Supply Chain and Services Management Symposium)

Jie, F. Parton, K. Jenkins, P. and Cox, C. 2007, 'Supply chain performance indicators for Australian beef enterprises: An empirical analysis', in *Proceedings of the 21st ANZAM (Australian New Zealand Academy of Management) Conference*, Chapman, R. (ed.), ANZAM, Sydney, Australia, pp. 1-14 (The 21st ANZAM (Australian New Zealand Academy of Management) Conference)

Jie, F. Jenkins, P. and Parton, K. 2007, 'A systems dynamics approach to modelling in the Australian beef supply chain', in *Proceedings of the 5th ANZAM Operations Management Symposium*, - (ed.), Australian and New Zealand Academy of Management (ANZAM), Melbourne, Australia, pp. 1-12 (The 5th ANZAM Operations Management Symposium)