milestone report

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Design led Development of Novel Pack solutions for origin assured High valued export meat products – Smart Packaging Final Report

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Abstract

This report covers:

- Knowledge map and stakeholder interviews on red meat issues. Includes review of outputs from UoM/Mondelez ITR Hub. Review topics include Food Safety vs Food Fraud review, Key Issues with Meat, Market Review, Patent Review, Packaging and Anti-Counterfeiting Technologies review

These different areas of focus were integrated to develop a hypothesized framework to consider for different channels. This initial framework was tested in the marketplace with users of the packaging. This defined the preliminary value propositions for Smart Pack concepts, using the Desirable-Viable-Feasible framework to lead to robust opportunity identification / assessment for products / markets with indications of market size, value proposition(s) and innovation horizon.

This report also covers:

- Using the framework development, three untested packaging concept were developed for two markets (China/ Australia, on line retail ready beef) with preliminary narrative/ persona on the target usage and occasion the concepts would be applied in (ie impact of supply chain on concepts for urban vs rural opportunities). Projected cost benefit analysis for these concepts in terms of wider Australian red meat industry value using the using the Desirable-Viable-Feasible framework to lead to robust opportunity identification / assessment for products / markets with indications of market size, value proposition(s) and innovation horizon.

This will be used to define the preliminary value propositions for Smart Packaging concepts, along with providing a baseline for future technology development and application.

A workshop with Australian red meat brand owners was held to review the key data and technology options. This workshop was lead by MLA and included both technology providers and producers.

As no one specific technology is the answer to these opportunities next steps include:

- A pilot project is being developed to test out backbone technology across supply chain for value determination with a lead set of producers. This will leverage the QR Code/ Barcode technology to see the implications across the supply chain.
- Once this pilot have been completed a Phase 2 project will be develop to leverage this backbone technology and look at addtional key technology development needs across the full technology time horizon.

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1. Milestone description

Final Report

Report on knowledge mapping review and stakeholder interviews, along with value proposition and research design and key findings development of key concepts to understand product-market fit desirability-feasibility-viability elements

2. Project objectives

Project Deliverables

Key project deliverables include:

- Three untested “smart packaging” concepts for red meat will be generated.
- For those categories identified in the project scope, the proposed consultative/iterative process using the Desirable-Viable-Feasible framework will lead to robust opportunity identification / assessment for products / markets with indications of market size, value proposition(s) and innovation horizon. The extensive engagement with MLA’s key stakeholders will enable capture and collation of business needs, which will provide MLA with a valuable fact base for prioritisation of strategic activities which can also be incorporated into key features for early concept development (for this project and others)
- The process and framework developed within this project can be re-applied more broadly across categories / markets to generate an “innovation pipeline” for MLA (and where relevant wider agri-food participants of MLA’s Rural R&D for Profit grant program V.RDP.1000 – see: **https://www.mla.com.au/research-and-development/search-rd-reports/final-report-details/Rural-RandD-for-Profit-Market-and-consumer-insight-to-drive-food-value-chain-innovation-and-growth-Insights2Innovation/3814**).

3. Methodology

3.1 Definitions

Key definitions for this project.
“Untested” is defined as not tested in any supply chain.
“Concept” is defined as an idea or a vision, and definitely not a physical product. Progressing the concept through to a physical prototype or testable product is outside the scope of this Project.
‘Value proposition’ is defined as presenting the opportunity based on a combination of the design led approach – namely, desirable – viable – feasible criteria. In particular, description of which of our customer’s problems is the novel smart packaging helping to solve; which customer needs are we satisfying; and what are the key features of our product/pack/service that match customers’ problems/needs all help present the Product-Market fit desirability element. Overall value proposition then considers the desirable element with the Business viability and Technical feasibility to deliver this. This exceeds therefore simply the cost benefit analysis for a kg of meat affected by issue/problem that has been identified and the $/kg lost or the opportunity cost financial metric

related to the novel smart packaging solution as the "value proposition". It is agreed that quantifying the value proposition will require input from MLA, given their unique access to market and pricing data along with other sub contracted providers (approved by MLA and University of Melbourne) within the project budget as needed.
"Prototype" is defined as a physical, non-functional embodiment of the concept.

3.2 Project Scope

Determination of the scope of the project (ref. Table 1) will be agreed as part of milestone 1 kick off meeting. Table 1: Parameters for consideration during scoping:

Priority area	Options	Focus
Chain	e-commerce, Live export, Chilled, Frozen, Primals, Portioned	Restaurant Primal Retail Ready Online Retail Ready Online Primal Wholesaler Primal
Market	China, UAE, Indonesia	China
Category	Beef- Dry aged, Frozen, vac packed, retail ready Lamb – Chilled, Frozen Offal – Chilled	Beef - vac packed, retail ready Offal – Chilled
Stakeholders	MLA-including staff located in market, Packaging suppliers, Producers, Regulatory, In market packers, Exporters, Logistics, Retailer, Foodservice, Consumer, Regulatory	MLA-including staff located in market, Producers/ Processors, Wholesalers, Retailer, Foodservice, Chinese Consumers, Active Aging, Sustainability
Technology Benefits for Concept Bundles		Blockchain, Green Food Logo, MSA Grading, Anticounterfeiting, Traceability, Eat Now Indicator (ripeness, tenderness), Oxidation (flavour/ odour), Is it what I paid for, Food safety, Temperature control, Education, Shelf Life, Sustainability

Given the number of potential market geographies and complexities of their export supply chains, scope will be determined through analysis of existing market research in conjunction and consultation with MLA's insighst2innovation program. After that, research efforts focused on reviewing the current data available with some customer/market development interviews with subject matter experts, personas and users, then prioritising the innovation opportunity areas in terms of impact. During the initial data review and collation, key scoping boundaries were be set around the depth and breadth of the research (i.e. type of meat, addressable target markets, stakeholders, pains /gains from innovation). Once scope was defined, relevant data was be reviewed and assessed, with a view to creating a knowledge map, and highlighting knowledge gaps. Review / assessment will be against these parameters:

1. Desirability - Product market fit
2. Viability - Achievable revenue and cost structure.
3. Feasibility - Ability to access key resources

Data was be sourced through a combination of desktop research and interviews and included cross sectoral lessons learned analysis from University of Melbourne's Mondelez International's ARC funded Industrial Transformation Research Hub, "Unlocking the Food Value Chain" including;

Consumer Insights into Provenance / Brand Australia,
Packaging Innovation,
Supply Chain,
Market Analytics and
Sensory Capabilities

A number of untested concepts were generated from this research. After some qualification and internal testing, these untested concepts were tested with key stakeholders (Consumers, Retailers and Producers where relevant). An iterative approach were applied with regular reviews scheduled with MLA.

4. Success in meeting the milestone

Framework Development

Frameworks based on kano methodologies have been developed for further testing of the value of various technology benefits. Review with MLA determined key market to consider resulted in a focus on China and Australia. Key channels to consider were on line retail ready. These frameworks have been integrated with the DVF frameworks to define desired benefits, size of prize and technology access. Four key concepts have been developed and analysed for fit to market, value, technology feasibility. An additional simulator tool has been developed for individual companies to use to compare concepts with their individual needs. This allows for the understanding of up to 720 combinations of concept elements. Understanding of the value consumers place on the various technology benefits has created an upper financial limit to the technologies ability to provide the key benefits. This has enabled a better understanding of how to manage technology access.

5. Discussion

5.1 Knowledge Mapping Report

Knowledge Mapping Report

A knowledge Mapping session was held on 7 March 2018. The knowledge reviewed included:

- Food Safety vs Food Fraud review
- Key Issues with Meat
- Market Review
- Patent Review
- Packaging and Anti-Counterfeiting Technologies review

These different areas of focus were integrated to develop a hypothesized framework to consider for different channels. This initial framework is to be tested in the marketplace with users of the packaging.

5.2 Food Safety vs Food Fraud

The food safety and management of food in Australia is a major selling point for export of Australian meat products. HACCAP and control of food processes is critical for the safe supply of Australian food and for brand protection. When considering major incidents of food safety that impact human health, hospitalization or death, most incidents in Australia are those of a failure of compliance or governance of these processes. When considering incidents in other markets such as China or the

Middle East, this changes. For China, the major food safety incidents are driven by food fraud. For the Middle East, the present focus is on creating policies for a "food code". Self-governance of a food safety process is not fulling in place at this time. This means as Australia considers export products a key priority needs to be on anti-counterfeiting effects so that Australian products are not impacted by other countries level of development or enforcement in these areas.

5.3 Key Issues with Meat

Present packaging systems include

- Overwrap
- *High O_2 Modified Atmosphere Pack (80%O_2: 20% CO_2)*
- Vacuum Pack
- *Vacuum skin pack – DARFRESH*
- *MAP/VSP combination – DARFRESH bloom*

Figure 1. Examples of present packaging systems (overwrap, Vacuum Pack, MAP, Vacuum skin pack, MAP/Vacuum Skin Pack combination, Vacuum Pack)

Typical shelf life for these are:

- Domestic Markets: ~3 days for overwrap, ~10 days for MAP, ~3 weeks for vacuum skin pack
- Export Markets: ~12 weeks for vacuum packed, however, many producers would like 20-40 weeks shelf-life.

Oxidation of meat is driven by light and temperature changes. Colour of the meat and refrigeration including supply chain are critical.

From a consumer perspective, consumers want a reliable experience, may be uncertain about what is quality meat, and they want easy to open packaging. When in a store, consumers use colour to determine the quality of the meat. Colour variation of the same meat when placed next to each other, confuses consumers (I.e. dark muscle next to pale muscle is not ok). They are aware of waste in the package and don't want drip in the tray, as this takes them to a perception of lessor freshness.

For retailers, meat displays have not changed much across the past decades. Retailers think they know what consumers want. However, for retailers is it all about shelf life, they want greater than 10 days of shelf life from retail ready packaging. When the meat is perceived to be "off" retailers remove it from the shelf based on the any colour change. The issue is that shelf life is not predictable and use by dates are only estimates and do not indicate the state of the meat. Meat going off on the shelves costs them money. Retailers can consider other options to manage colour of the meat and perceptions of longer shelf life. These can include high oxygen modified

atmosphere packaging, carbon monoxide flushing and vitamin E. However, these are options that will not reinforce high quality meats.

Figure 2 Typical retail displays of meat

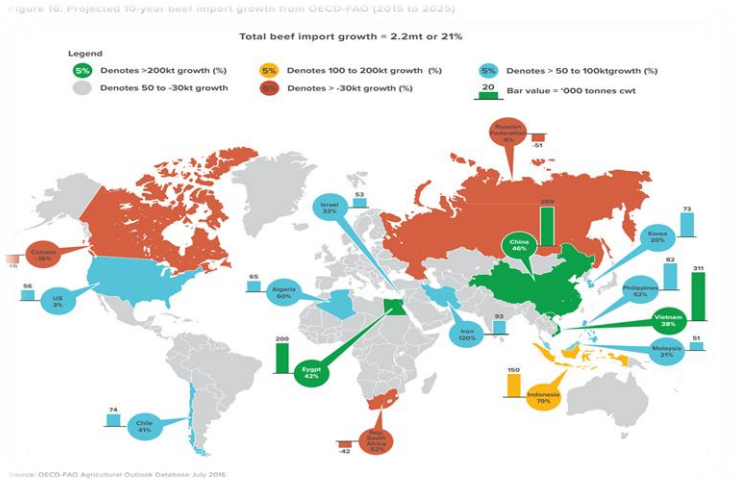
There are a variety of channels to consider that will be impacted by these. These include:

- Restaurant Primal
- Retail Ready
- Online Retail Ready
- Online Primal
- Wholesaler Primal
- Cuts, Primal, Offal

5.4 Market Review

An overview of the market was considered. The largest beef import growth markets are China, Egypt and Vietnam. (see figure 3). The projected growth for China is 46% with a beef import market size of 259,000 tonnes cwt. For Egypt the project growth rate is 42% with a beef import market of 200,000 tonnes cwt. For Vietnam the project growth rate is 38% with a beef import market of 311,000 tonnes cwt.

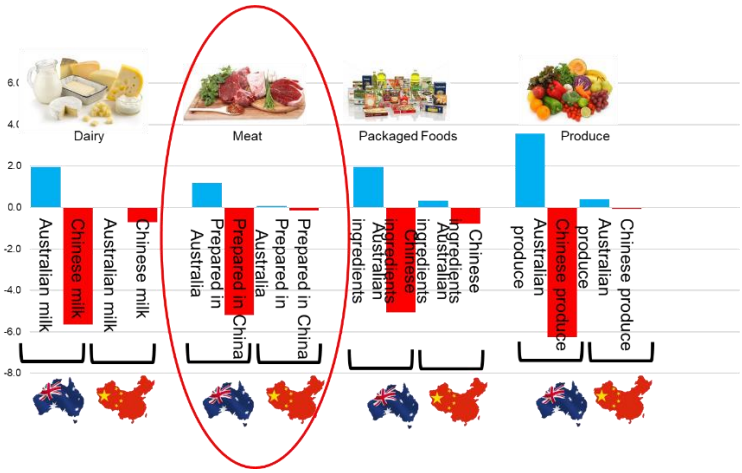
Figure 3 Projected 10-year beef import growth from 2015- 2025.



More in-depth data was considered for China.

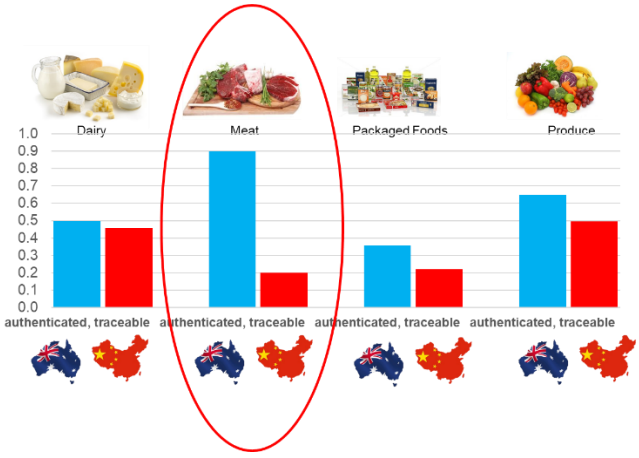
When considering the Value Chain and country of origin, in a study of key attributes for 18 food categories in both Australia and China, in the categories or meat, Australians are more concerned about the country of origin than Chinese. This suggests that the importance of the country of origin as a single key indicator of quality of meat is more important for Australians than Chinese. I.e. there are other benefits that link to quality of meat for the Chinese. (figure 4)

Figure 4 Importance of Country of Origin for Premiumness of Meat vs other food categories. (Concept Database Food Value Chain Study run Jan 2018, 400 consumers across 18 categories of food, 7,200 consumers per country)



Traceability is a more important attribute for meat products than country of origin. (figure 5) This suggests that information on the package beyond the country of origin is key.

Figure 5 Importance of Traceability and authenticity for Premiumness of Meat vs other food categories. (Concept Database Food Value Chain Study run Jan 2018, 400 consumers across 18 categories of food, 7,200 consumers per country)



When considering the supply chain and control of the material during shipping, 80% of the supply chain (around 1,400 importers) today is fragmented and selling to wholesalers (figure 6). This means

there is multiple ownership across the supply chain and this will erode profit margins. When considering cold chain supply capalbities, currently, an estimated 75-80% of cold chain infrastructure in China is of insufficient quality and is significantly overpriced as utilisation is low (fresh meat utilisation is 30% and significantly lags that of developed countries. However, a further US$85 billion is estimated to be required between 2015 and 2025 to improve China's cold chain infrastructure.

- This investment will come via internationally-funded JVs, domestic logistics providers, and retailers and/or branded food manufacturers with their own cold chain capabilities.
- The number of refrigerated trucks in China is expected to increase at a CAGR of 28.7% till 2025 to 1.1 million trucks. (Rabobank, 2015).

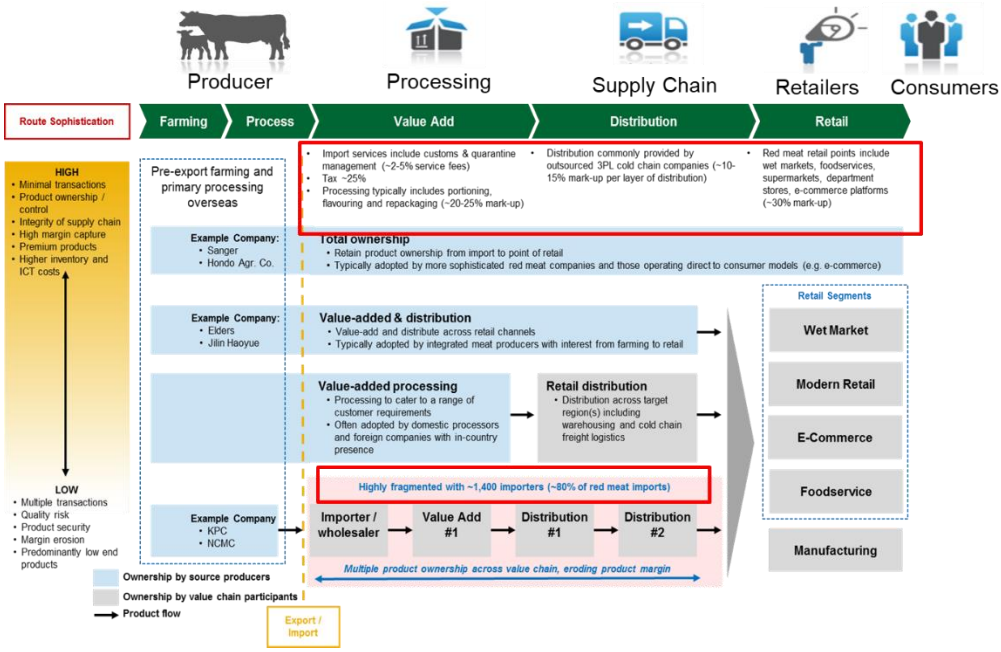
Cold supply chains continue to grow. Supported by heavy incentives (tax, financial, land, etc.) from central and local governments, storage capacity has grown from 12 million cubic meters in 2007 to roughly 100 million cubic meters in 2015. However, Investment in cold chain storage has been predominantly concentrated in eastern provinces and large regional cities. It is robust at the ports but not further into the country. This is an issue, as the larger future growth is expected to be more towards the interior of the country, and less so at the tier 1 cities.

When considering the supply chain there are several questions to address across its various points. These include:

- At the Producer level: Are there unique elements I can leverage to deal with counterfeiting?
- At the Processing level: How might I modify the product/ process/ packaging to help deal with traceability
- At the Supply Chain level: How do I manage and control the product once it leaves the processing plant?
- At the Retailer level: How do I manage and control the product in all channels?
- At the Consumer level: How do I get consumers to know the product's authenticity? How, when to move from insurance to branding?

Each of these will provide inputs to information needed on the package.

Figure 6 Various business models by sophistication along red meat value chain (KPMG Global Strategy Group, 2016).



Key vulnerabilities across the supply chain include:

1. The port of import/export is often the first of many vulnerable points.
    - The perishability of meat places time pressure on suppliers, distributers, and retailers to move the products through the distribution networks quickly to minimise expiry/wastage.
2. The second most common vulnerable point is the interface with purchase (retail) or consumption (foodservice).
    - Lack of promotional support for retail can result in poor sales, so meat is on shelf longer.
    - In foodservice venues, advertised products have often been swapped with lower cost alternatives or counterfeit products.

The Chinese market is currently open to 11 countries: Canada, Argentina, Brazil, Uruguay, Chile, Australia, New Zealand, Mongolia, Costa Rica, Mexico, and Hungary. Red meat demand is forecast to far outweigh official supply – as a result the Chinese red meat market is likely to continue to source a portion of its supply through grey channels despite government crackdowns. (A grey market (sometimes confused with the similar term parallel market) is the trade of a commodity through distribution channels that are legal but unintended by the original manufacturer or trade mark proprietor.) Incentives for grey import remains as tariffs (12-23%) and VAT payments (13%) are not collected via grey channels (DFAT, 2016). Indian origin buffalo currently accounts for largest share of grey imports. Imports from India, Brazil, USA and others typically enter via Hong Kong. This grey channel will continue as an expected additional 763,000

tonne cwe will not be met by approved imports. This means that the ability to manage traceability across the supply chain will be critical to differentiate Australian Beef from other countries.

Australia has a market reputation synonymous with quality, clean, and safe. However, competing countries like New Zealand, Brazil, and those from Western Europe and North America also offer products that are of high quality and clean. (see figure 7,8). Other beef export nations have taken a national sector approach to market their value propositions with specific branding to support marketing. Anecdotally, this has been somewhat successful, for Uruguayan meat which has had significant uptake.

Figure 7 Promotion of Australian beef in China: “Professional and safe production, natural and clean pasture” (Tmall, 2016)

Figure 8 Promotion of Brazilian beef in China: “Temperate climate, High quality pasture, free range environment” (Tmall, 2016)

Table 1 shows key consumers trends that will drive growth of meat. Drivers are increasing affluence, modern retail trade, and westernisation. The shift in the future will involve third tier cities, ecommerce and changing eating habits. Red meat consumption, although still low, has grown

threefold – the majority consumed is in the north and northwest regions of China. Red meat is typically consumed within the foodservices sector.

Table 1: Consumption trends driving growth in red meat consumption (The Futures Company, 2014).

Consumption trends	Now	Future
Increasing Affluence	• Disposable incomes and spending power have risen significantly over recent decades • For **the past 20 years, economic growth has been concentrated in first- and second-tier cities** in the coastal regions	• A new middle class of consumers whose **consumption choices are no longer purely driven by economic concerns** • The geographic centre of middle-class growth is shifting to China's western and northern regions • In **10 years, third-tier cities will be the main drivers of growth**
Growing Modern Retail	• Chinese consumers are buying their everyday necessities – including food – from a **diverse range of retailers** • **Gradual shift away from wet markets with only 23% growth** from 2008-2013, compared with: – **Modern grocery** retailers' sales **growth 69%** – **Supermarkets growth 64%** – **Hypermarkets growth 85%**	• Continued shift towards modern trade as the primary shopping destination for fresh food, including meat products • New opportunities and challenges for meat producers, especially in terms of format and packaging • **E-Commerce for groceries and fresh food is forecast to grow**
Westernisation	• Increasing **westernisation of preferences**, driven by globalisation, and coverage of Western media (sports, film, culture, etc.), has **encouraged Chinese uptake of Western cuisine, including steak** • **High proportion of Chinese travelling / living abroad** is influencing how residents engage with food, whether in terms of cuisine preferences, diet and eating habits	• Despite strong culinary traditions, the scale and duration of the diaspora is forecast to continue influencing Chinese eating habits, presenting new opportunities for nimble suppliers

Within retail there are different forces driving growth. For hypermarkets, ded meat sales are forecasted to grow 9.9% to CNY 14.11B by 2020 to 16% of all red meat sales. This is primarily driven by older consumers and larger households. For online sales, red meat growth is forecasted to grow by 16% to 5.9B CNY by 2020, accounting for 7% of all red meat sales. This channel has a higher spend per month on red meat than in store shoppers. While 2/3 of consumers say they would be likely to use online shopping for chilled and frozen meat, they have concerns about hygiene and freshness.

Key consumer trends that impact red meat are detailed below.

- Meat is a crucial part of diet and growing.
- Red meat faces intense competition from traditional options (pork, chicken, fish, eel, shellfish, duck, goose, frog, dog, turkey, pigeon),
- Imported meat consumers are less likely to eat traditional staples like pork and fish.
- Imported meat eaters are more likely to have a higher monthly spend (avg 200RMB/ month) on red meat. 51 % consume imported meat several times per month.
- Online shoppers spend more per month on red meat than in store shoppers (larger quantity and in bulk),

- Online more likely to buy expensive/ specialist cuts of meat,
- Awareness and consumption of Australian origin red meat is higher than other imported meats. Better in terms of quality, taste and safety.
- 57% of beef consumers are aware of Australian Beef compared to just 32% for non-Australian Beef. However only 32% claim Australian beef is available where they shop,
- Friends and family are most trusted source of information when buying meat (97%) followed by on pack certification logos (91%), brand websites (88%),
- Freshness is the most influential factor in overall meat purchases. Use by date is key indicator for over half of consumers.
- For those for whom freshness is less important, key factors are visibility of blood, ice in pack, animal welfare and product quantity,
- Freshness is less important for imported meat consumers,
- Chilled counter meat dominates sales (73% of total sales) but is expected to decline to 67% of sales by 2020 (10B CNY).
- Packaged and frozen meat are big opportunities. Expected to grow to 7.6BCNY.

The top 5 priorities (aside from freshness) when shopping for meat in Beijing or Shanghai are the Use by Date, Colour of the meat, All Natural/100% Natural, free from additives/ hormones and price. For consumers, there are a variety of consumer targets, these range from demographic segments to mindset segments. Demographic segments include: women, older (45+), young adults (25-35) and young consumers (18-34. Mindset segments include: impulsive cooks, and ethically minded. Each of these may have slightly different drivers.

- Women: Meal prep and shopping lies mainly with women (73% claim to be complexly responsible for meal prep and shopping).
- Older consumers (aged 45+) spend the most on red meat (over 200 RMB per month). 36% of over 45's focus this spend on beef. Key benefits are health (heart health).
- Young adults (25-35) are most likely to try new kinds of meat, flavours and recipes.
- Young consumers (18-34) are more likely to agree they rely on time saving products and services.
- Impulsive cooks have a higher monthly spend on meat.
- Ethically minded consumers are willing to pay a premium. Key benefits are animal welfare and environmental sustainability.
- China is top importer of red meat (beef, sheep)
- 80% of supply chain is fragmented and selling to wholesalers
- China: Cold Chain infrastructure is robust at ports cities, but not across the country
- China: Future growth is interior of country
- China: Grey channel will continue driven by demand vs supply

- China: Online is a major opportunity
- China: Anticounterfeiting can drive perceptions of meat quality
- China: Consumers buy fresh meat and freeze it

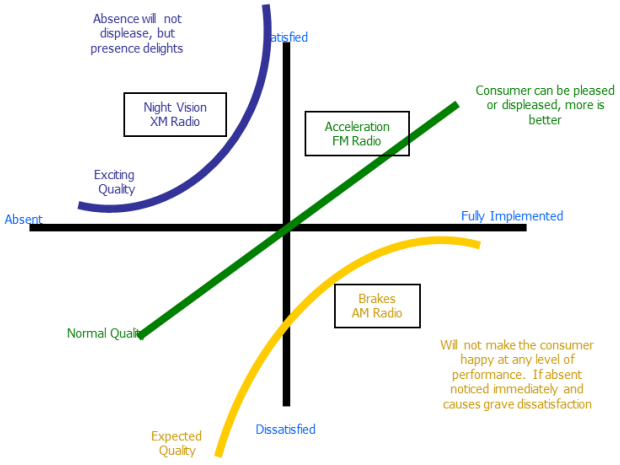
5.5 Frameworks

An overall Framework using Kano models was built to better understand what attributes are likely to drive different experiences of choice. (See figure 9). Kano is a model that was developed based on the fact that not all attributes are equal. Expected attributes (or must have) are attributes that could cause a user to reject the product. In the food industry most of the focus has been in this area. However, there is a limit to how much they will drive satisfaction. Spending more resources will not necessarily result in consumers paying more for a product. Normal attributes (more is better) are attributes that builds a brand, putting more effort into these attributes will drive a high price. Delighter attributes are attributes that drive emotional engagement with the product. These are attributes that users will pay more for. They typically can not articulate them, as they don't know what they are until they experience them. A kano model has been built for each of the channels under consideration. Various technologies (see section 5.7) have been mapped against these to allow for an understanding of how much value they can provide and how much resources should be put into having them applied to the package. (figure 10-16).

Figure 9 Kano Model

- Take care of consumer expectations in sequence from expected to normal to exciting.
  - Expected keeps you in business
    - If not there, consumers may reject the product
  - Normal drives competitive performance gaps
    - Drives consistency and message
  - Exciting drives differentiation
    - Drives brand equity
- New products should:
  - Meet as many of the "Expected" features as is practically possible.
  - Have a few "Exciting" criteria to put you above your competition.
  - Keep "Normal" criteria functional enough to remain positive.
- Kano Analysis changes over time
  - Quality that was exciting becomes normal then expected as the technology matures and features become more common.

- Plotting the Results, Examples



Figures 10-16 show how the technologies and attributes fit the kano model for different channels.

Figure 10 shows the kano model for restaurant primal, along with a potential hero concept. Expected attributes include anti-counterfeiting: is it what I paid for? food safety, and temperature control across the supply chain. Normal attributes include an Eat now indicator to show level of tenderness or ripeness; and oxidation, flavour, odour indicator. Delighter attributes include traceability with provenance and authenticity cues.

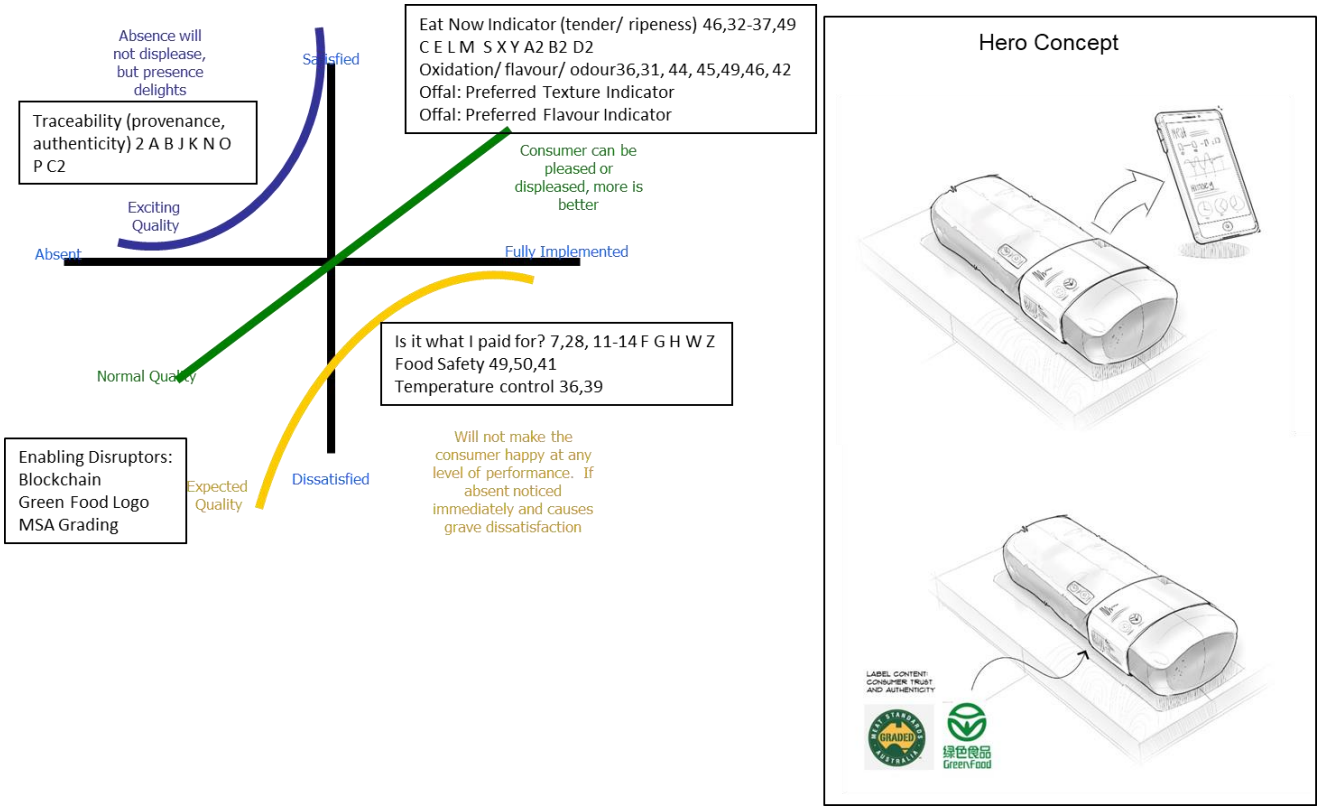


Figure 11 shows the kano model for retail ready, along with a potential hero concept. Expected attributes include traceability, and food safety. Normal attributes include education and intuitively obvious information for the consumer. Delighter attributes include an Eat now indicator to show level of tenderness or ripeness; and oxidation, flavour, odour indicator.

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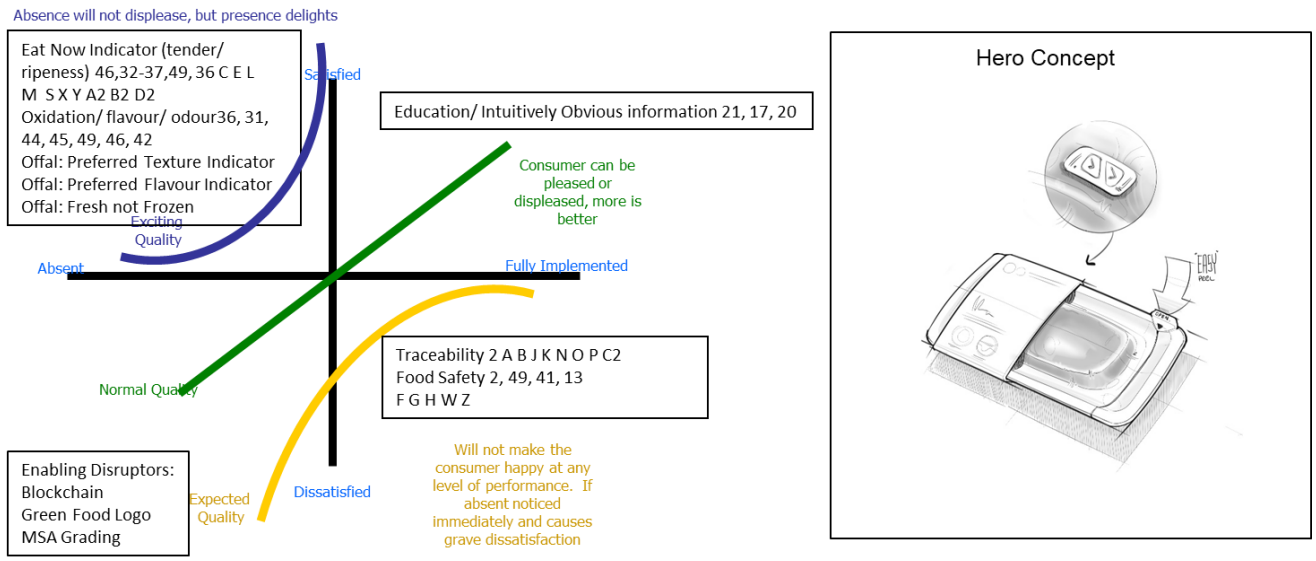


Figure 12 shows the kano model for on line primals, along with a potential hero concept. Expected attributes include food safety, shelf life and anti-counterfeiting. Normal attributes include education and intuitively obvious information for the consumer. Delighter attributes include traceability, an Eat now indicator to show level of tenderness or ripeness; and oxidation, flavour, odour indicator.

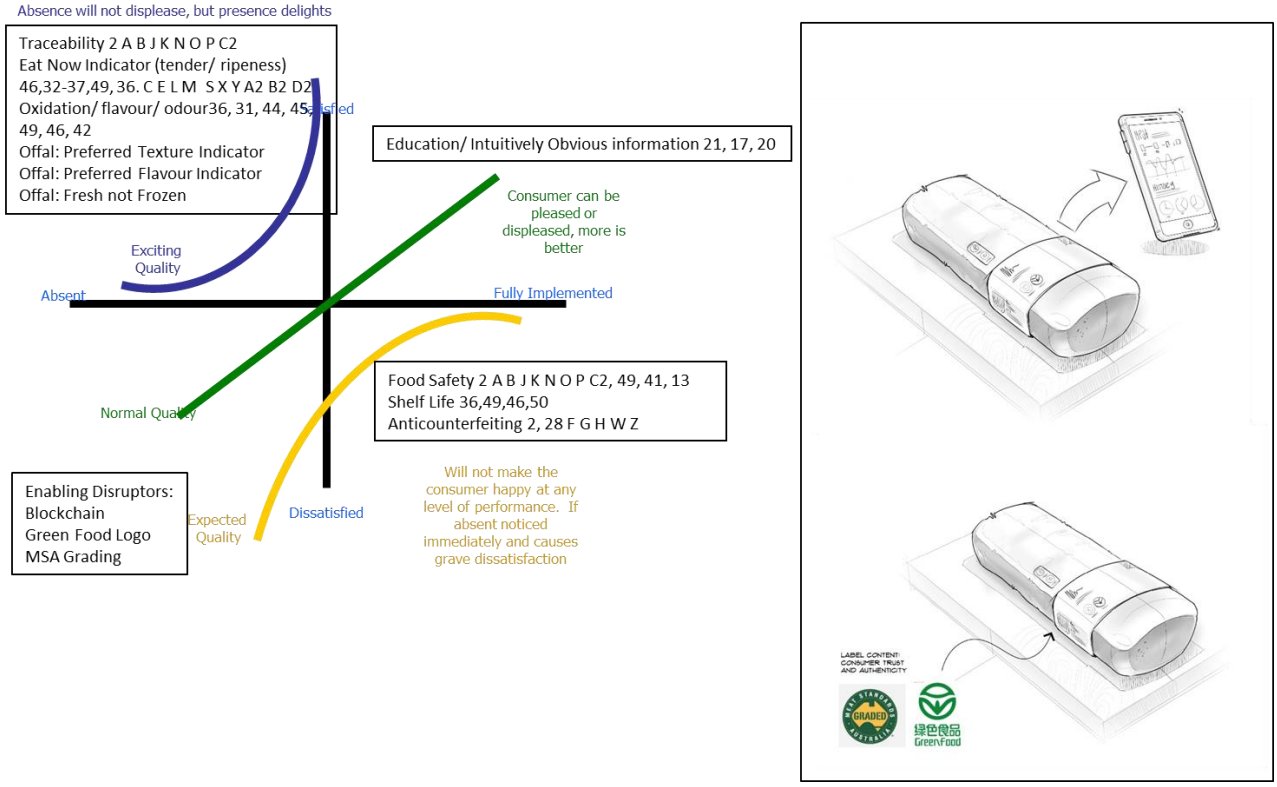


Figure 13 shows the kano model for on line retail ready, along with a potential hero concept. Expected attributes include food safety, shelf life and anti-counterfeiting. Normal attributes include education and intuitively obvious information for the consumer. Delighter attributes include traceability, an Eat now indicator to show level of tenderness or ripeness; and oxidation, flavour, odour indicator.

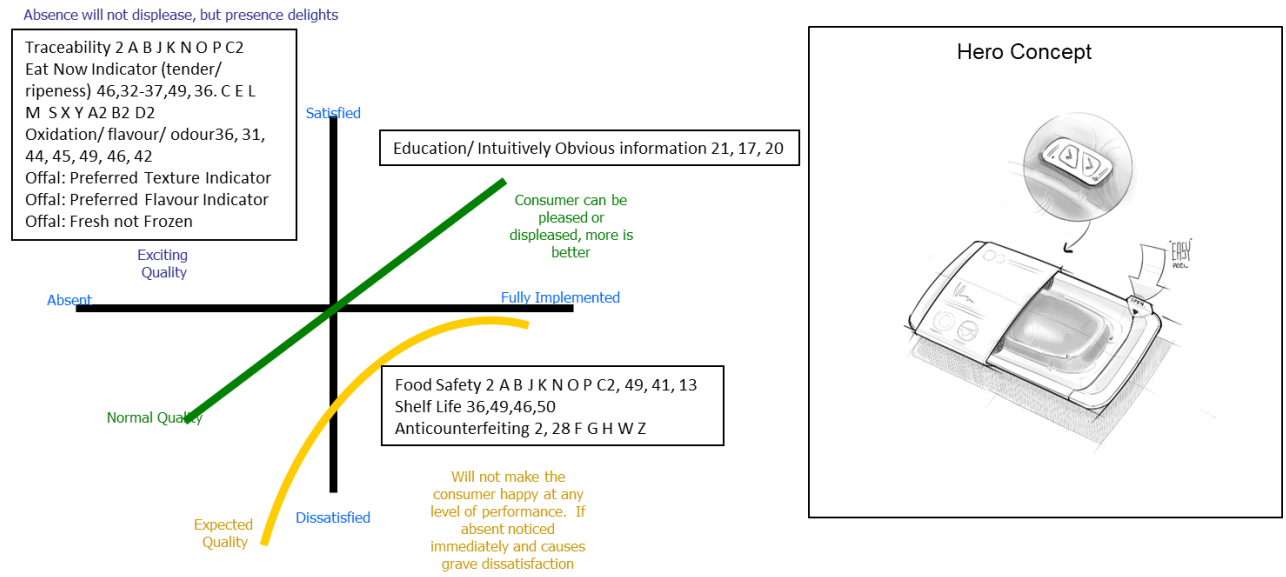


Figure 14 shows the kano model for wholesale primal, along with a potential hero concept. Expected attributes include is it what I paid for? food safety, shelf life, temperature control/purge control and freshness, and anti-counterfeiting. Normal attributes include fresh not frozen. There were no delighter attributes identified.

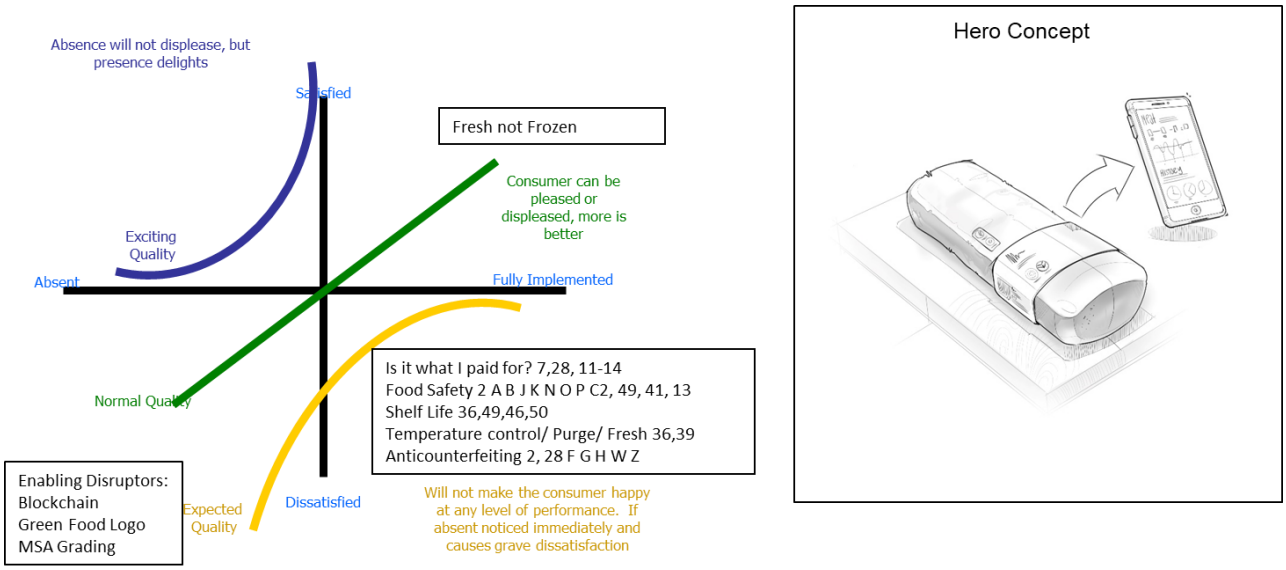


Figure 15 shows the kano model for sustainable packaging, along with a potential hero concept. Expected attributes include sustainable packaging.

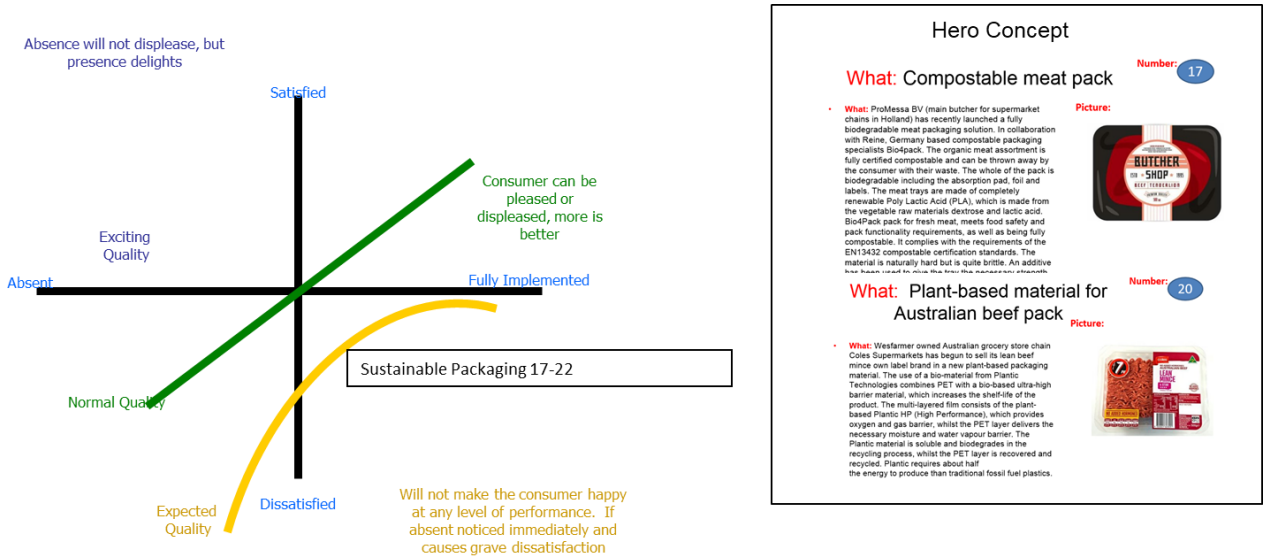


Figure 16 shows the kano model for active aging, a potential hero concept was not developed. Normal attributes include education on the value of meat. Delighter attributes include easy to open packaging, fits in my storage location, portion control, health benefits, and tenderness indicator.

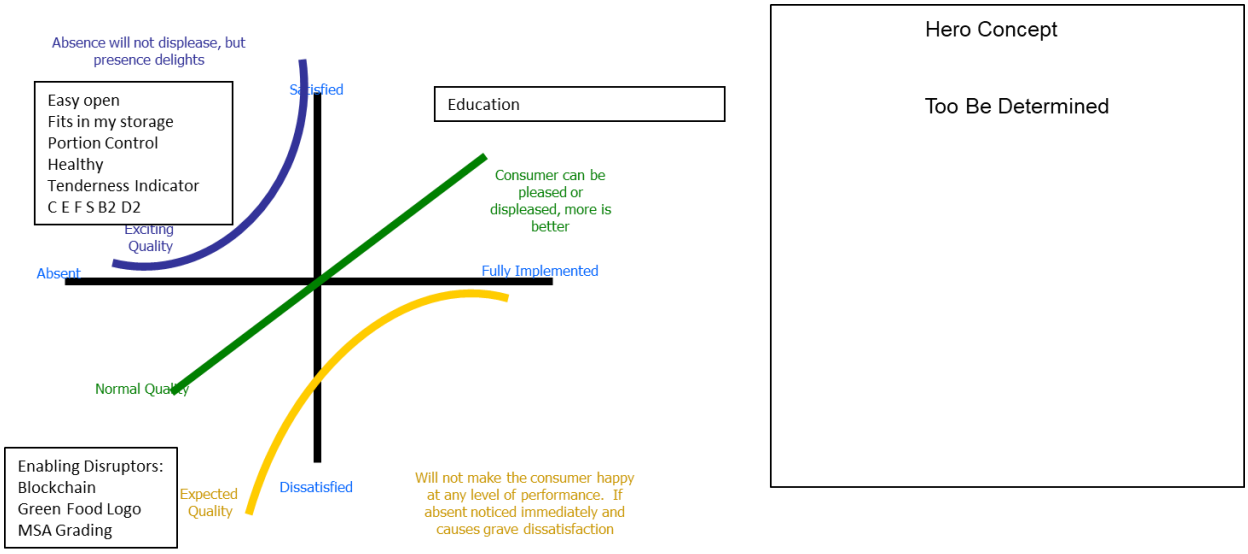


Table 2 shows how these different attributes play across all the different channels. Blockchain, green food logo and MSA grading are disruptive enabling technologies. For wholesale retail ready, this channel is where the potential of loss of control of the brand value of Australia can occur.

Table 2 Attributes vs Channels.

Opportunity Space	Restaurant/ Primal	Retail Ready	Online Retail Ready	Online Primal	Wholesale Retail Ready	Wholesale Primal	Sustainability	Active Aging
Delighters	Traceability (provenance, authenticity)	Eat Now Indicator (tender/ ripeness) Oxidized flavour, Shelf Life Transparency Meat Firmness Offal: Texture Offal: Flavour/ Odour Offal Fresh/ not Frozen	Eat Now Indicator (tender/ ripeness) Oxidized flavour, Shelf Life Transparency Meat Firmness Offal: Texture Offal: Flavour/ Odour Offal Fresh/ not Frozen	Oxidized flavour, Shelf Life Transparency Meat Firmness	Loose control of Brand Value of Australia		Fit with digital lifestyle	Easy open Fits in my storage Portion Control Healthy Tenderness Indicator
Normal	Eat Now Indicator (tender/ ripeness) Oxidation/ flavour/ odour Offal: Preferred Texture Indicator Offal: Preferred Flavour Indicator	Education/ Intuitively Obvious information	Education/ Intuitively Obvious information	Education/ Intuitively Obvious information		Fresh not Frozen	Sustainability practices education	
Expected	Is it what I paid for? Food Safety Temperature control	Traceability Anticounterfeiting Food Safety	Traceability Anticounterfeiting Food Safety	Traceability Anticounterfeiting Food Safety		Is it what I paid for? Food Safety Temperature control Purge Shelf Life		
Enabling Disruptors				Blockchain Green Food Logo MSA Grading				

5.6 Patent Review

A patent database allows for searching of potential patent technology. Within this database, there are **12930** documents in the patent collection and the **4441** documents in the literature publication collection. The value of this database is to provide a heads up on new packaging innovation, so the regulatory process can start early. Key inputs are that shelf life dictated by use by dates is hugely wasteful – shelf life should be dictated by the quality of the product not an arbitrary use by date. E.g. . Move from MAP to pack materials that "actively" control the oxygen levels and thereby growth of bacteria or fungi or confinement odour. Engaging with consumers is paramount – augmented reality, e.g. Near field communication, anti-tampering the authenticity of Australian agri-food products, anti-theft, traceability of handling and distribution are all critical inputs to consumers.

The technical patent categories of interest are listed in the table 3 below. The overarching categories include function/ technical features, application areas, materials, manufacturing processes, and formats.

Table 3 Patent categories of interest.

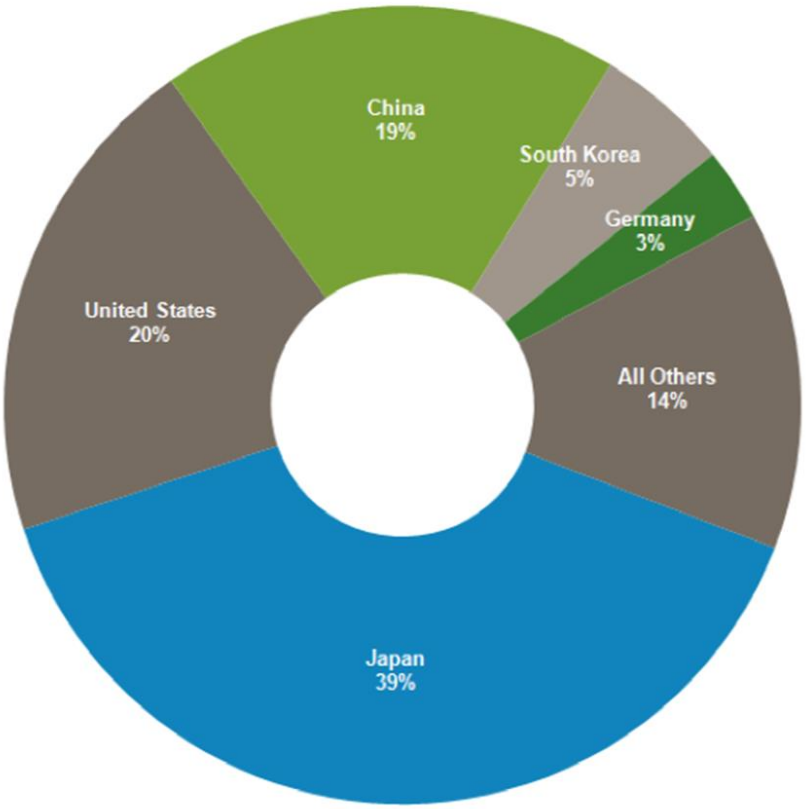
Technical Categories	
1. Function / Technical Features	1.01.01.01 Microbial Growth Sensor
	1.01.01.02.01 Anti-microbial Agent
	1.01.01.02.02 Enzyme based Microbial Inactivation
	1.01.01.02.03 Other Anti-microbial Systems
	1.01.02.01.01 Oxygen Sensor
	1.01.02.01.02 Oxygen Scavenging
	1.01.02.01.03 Anti-oxidation Systems
	1.01.02.02.01 Ethylene Sensor
	1.01.02.02.02 Ethylene Scavenging
	1.01.02.03 Other Gases of Interest
	1.01.02.04.01 Low Oxygen (or Anoxic) Packaging
	1.01.02.04.02 High Oxygen Packaging
	1.01.02.04.03 Vacuum Packaging
	1.01.02.04.04 Other Modified/Controlled Atmosphere Packaging
	1.01.03.01 Temperature Sensor
	1.01.03.02 Thermostatic packaging
	1.01.03.03 Self-Heating/Self-Cooling
	1.01.04.01 UV Blockage
	1.01.04.02 Light Barrier
	1.01.05.01 Moisture Sensor
	1.01.05.02.01 Moisture Barrier
	1.01.05.02.02 Moisture content or humidity maintenance
	1.01.06.01 Odor Absorbing
	1.01.06.02 Flavor Releasing
	1.01.07 Corrosion Inhibition
	1.01.08 Integrity sensor
	1.01.09 Freshness Sensor
	1.01.10 Eating Profile Enhancement
	1.01.11 Migration Prevention
	1.01.12 Pathogens/Microbial Spoilage
	1.02.01 Temperature Sensor
	1.02.02 Physical Shock/Motion Sensor
	1.02.03 Other Environmental Factors
	1.03.01 Tamper-proof
	1.03.02.01 Near Field Communication Enabled
	1.03.02.02 RFID Tags
	1.03.02.03 Printable Electronics
	1.03.02.04 QR Code
	1.03.03 Electronic Article Surveillance
	1.03.04 Wireless Communication Network
	1.03.05 Augmented Reality
	1.03.06 Environment sensing and responding
	1.04.01 Easy Opening of Food Packs
	1.04.02 Easy dispensing
	1.04.03 Portioning/Sizing
	1.04.04 Resealable
	1.04.05 Cook within package
	1.04.06 On-the-Go Enabling
	1.05.01 Recyclable
	1.05.02 Degradable
	1.05.03 Edible
	1.06.01 Value Adding
	1.06.02 Infrastructure Building

Technical Categories	
2. Application Areas	2.01.01 Carcass/Primal Cut
	2.01.02 Fresh Cut
	2.01.03 Frozen
	2.01.04 HPP Processed
	2.01.05 Ready-to-Eat Meats
	2.01.06 Poultry
	2.02.01 Raw Seafood
	2.02.02 Processed Seafood
	2.03 Fresh Pasta
	2.04 Cheese
	2.05 Powder
	2.06.01 Fresh Produce
	2.06.02 Processed Horticulture
	2.07.01.01 Wines
	2.07.01.02 Beers
	2.07.01.03 Other Alcohols
	2.07.02.01 Dairy
	2.07.02.02 Juice
	2.07.02.03 Carbonated Beverage
	2.07.02.04 Water
	2.08 General Foodstuffs
	2.09 Pharmaceuticals
	2.10 Medical Devices
3. Materials	3.01.01.01 Degradable
	3.01.01.02 Non-Degradable
	3.01.02.01 Synthetic / Semi-Synthetic
	3.01.02.02 Natural
	3.01.03.01 Non-Renewable
	3.01.03.02 Renewable
	3.01.04.01 Flexible
	3.01.04.02 Rigid / Semi-Rigid
	3.01.05.01 Transparent
	3.01.05.02 Non-Transparent
	3.01.06.01 Printable
	3.01.06.02 Non-printable
	3.01.07.01 Sensing/Indicating/Monitoring
	3.01.07.02 Blocking/Inhibiting/Reacting
	3.01.08.01 Mechanical Properties
	3.01.08.02 Chemical Properties
	3.01.08.03 Cost
	3.01.09 Edible
	3.02.01 Metal
	3.02.02 Glass
	3.02.03 Paper/Wood
	3.02.04 Other Materials
	3.03 Hybrid Systems
	3.04 Nanomaterials

4. Manufacturing Process	4.01 Blow Molding
	4.02 Injection Molding
	4.03 Extrusion
	4.04 Lamination
	4.05 Coating
	4.06 3D Printing
	4.07 Other Processes
5. Format	5.01 Built-in/Embedded
	5.02 Coating and Edible Film
	5.03 Insert/Packet/Sachet/Patch/Tablet
	5.04 Marinade and Flavoring
	5.05 Label/Printable/Graphics
	5.06 Interaction between Product and Shelf/Environment
	5.07 Lid/Cap
	5.08 Secondary & Tertiary Packaging
	5.09 Other Formats

The database was looked at from a global perspective. The domestic market alone will not generate the necessary type or quantity of innovations required for Asian markets in key areas like packaging, preservation, tamper evidence and provenance. In addition, the size and variety of international markets means that those technologies need to be viewed through a lens of consumer demand, changing needs and age-based considerations. Figure 17 shows the inventive activity by key countries.

Figure 17 Interactive activity by country



From the database, the majority of patents in the dataset (75%) are owned by commercial entities. Academic/Government activity is much lower (7%) however has been steadily increasing over time. The remaining documents in the dataset belong to individuals (18%). There are 11 entities that hold large patent portfolios (have 101 or more patent inventions) in relation to this technology. These relatively large entities hold 22% of the patent landscape. **Toppan Printing** (Japan) and **Mitsubishi** (Japan) have the highest numbers of patents broadly related to this technology. Many of the top entities in the dataset have a clear focus on the Japanese market, as many are based or have originated in Japan. The majority of the top entities also have a substantial cross geographic filing strategy meaning that they are filing in multiple countries, giving a good indication that these companies see the commercial value of this technology. In terms of patent portfolio strength **Tetra Pak** (Sweden) and **Sealed Air** (United States) were deemed the strongest among the major entities in the dataset. Strength analysis is measured by metrics including patent volume, remaining life, geographic filing breadth, patent grant success, high technical breadth and citation frequency.

When considering the literature in the database. Technology associated with **microbial growth sensors, other modified / controlled atmosphere packaging** and **general foodstuffs** can all be seen to be increasing in activity over time. In contrast, there are technology areas that are stagnant or have little to no literature activity occurring. Examples of this include **thermostatic packaging**, **tamper proof features** and **cook within packaging** features. A lack of literature activity could be attributed to perceived commercialisation intent of a specific sub-technology. If there is an opportunity to commercialise or save costs associated with a technology, then it would be more prudent for an entity to protect the innovation via the patent route rather than publish it though literature.

When considering the patents in the database. Technology associated with **self-heating / self-cooling, near field communication** enabled features and **renewable materials** all achieved strong growth recently of between 15% – 17%. Potentially emerging technologies, identified as those recording high rates of recent patent filing included **thermostatic packaging**, **augmented reality** and materials which have **chemical properties.**

Table 4 shows by major patent category the top line findings.

Table 4 patent categories and findings.

Major patent category	Top line findings
Function/technical features	reference to **oxygen scavenging** and '**other' gases of interest**
Manufacturing process	most populated category related to **lamination** technology
Application area	**general foodstuffs** were the most populated category with technology directed toward **pharmaceutical** applications coming in a distant second
Materials	For **materials**, patent technology directed toward **other materials** technology not already highlighted in any other materials categories was the most highly populated
Format	the most active technology areas included those incorporating **label / printable / graphics**

5.7 Package/ Anti Counterfeit Technology Review

A review of 80+ packaging / anticounterfeiting/ packaging trends technologies considering benefits was conducted. These included: Time temperature Indicators, Temperature Sensitive Labels, Time-Temperature Data Loggers, Pressure Sensitive Labels, Bioactive Sensors, DNA Tracing of Beef, Confinement odours, Ethanol Sensing with RFID,, Freshness Indicators , Electronic Nose, Antimicrobial, Antioxidant, Vacuum Packaging, Self-Cooling Food Packaging, Oxygen Indicators Moisture Absorbers, Extended shelf-life, Antimicrobial, Antioxidants , Oxygen Scavengers,, Moisture Absorbers, CO2 releasers, Anticounterfeiting Options (30+), Blockchain, MSA Grading, and Green Food Logo (China). Each of these were put into a 1-page format that focused on **What** the technology was, the **Benefit** of the technology and **Applications**. Each was given a letter or number format in the upper right-hand corner, so that it could be mapped to the kano diagrams.

Each are listed below:

Number: 1

What: Blockchain currency

- **Terms:** Cryptocurrency is a digital currency that functions as a medium of exchange, utilizing the process of cryptography enables users to transact securely using these digital coins. Cryptocurrencies operate on a distributed ledger called a blockchain. Units of a cryptocurrency are tracked through a process known as mining,
- **Terms:** A blockchain is a public ledger of all cryptocurrency transactions. Each group of transactions are referred to as a block, with each block then being combined chronologically into a chain. Information that exists on the blockchain is shared and public, therefore, every node connected to the network, possesses a copy of the blockchain. Each node will be able to have access to all transactions that have or ever will take place on the blockchain. The distributed nature of blockchain technology also means that the database cannot be controlled by a single entity, nor can it easily be hacked as there is not one single point of failure. Unauthorized changes to the blockchain would be unlikely, as overriding the network would require a tremendous amount of computing power.

- **What is VeChain (VEN)?**
  VeChain is a blockchain-enabled platform that is designed to enhance supply chain management processes. By utilizing tamper-proof and distributed ledger technology, VeChain provides retailers and consumers with the ability to determine the quality and authenticity of products that are bought. From product source materials, to servicing history, spare part replacements, every single piece of information about the supply chain movement of a product can be recorded and verified to bring about a supply chain management ecosystem that is secure for all participants.

- **Future:** There is no doubt that blockchain technology can be an important innovation to supply chain management. With a growing list of business partnerships and technological developments, VeChain is positioning itself to be THE disruptive, and innovative force that reshapes the way we think about supply chain management.

Number: 1

What: VeChain

Blockchain Currency

- **How:** A secure supply chain management ecosystem via the method of asset digitization. It enables manufacturers to assign products with unique identities to the platform. Allowing manufacturers, supply chain partners and consumers, to track the movement of products through their supply chain. Making use of its VeChain Identity (VID) technology, to mark and track a product. VIDs are produced using a SHA256 hash function, it generates a random hash value that corresponds to a VID. The VID can then be written into a NFC tag, QR code, or RFID tag, to be used for each product. This method allows for the tagged product and all corresponding information, such as the supply chain activities of the product, to be translated from the real business world into the platform.
  How: Security is maintained on the platform by the use of network nodes. These network nodes can be controlled by businesses and organizations that are directly participating in the ecosystem. Network nodes may provide services such as: quality inspection, wallet services, and may even act as a private key management service provider. The platform will also make use of its own native token asset known as the VeChain tokens (VEN). These tokens will be used as GAS that is needed for smart contract execution. As well as this, VENs will also be used as an incentive mechanism, in that they will be awarded to network nodes that help facilitate the ecosystem via their operation.

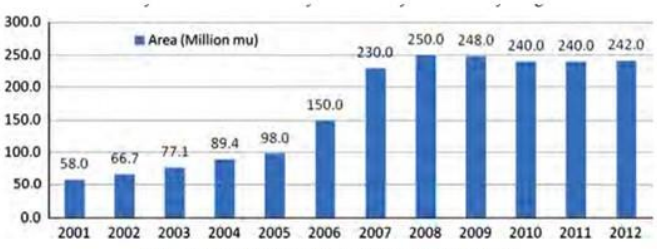
- **Current Partners:** Babyghost, Healthcare Co Ltd, MadeForGoods, BitOcean, Hyperledger, Microsoft, China Unicorn, Jiangsu Printed Electronics Co Ltd, PwC, Directed Imported Goods, Kuehne & Nagel, Renault, DNV GL, Xiamen Innov Information Technology Co Ltd

Number: 2

What: Green Food Logo

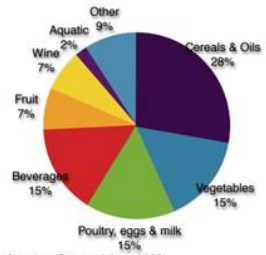
- **What:** "Green Food" is a Chinese food production innovation, and has been described as "one of the most successful eco-labelling programs in the world". Green Food provides a "middle way" between chemical and organic farming. China's development of the Green Food concept resolves issues with both chemical and organic agriculture - for the former by offering reduced pesticide use, and for the latter by providing a stepped pathway for conversion from chemical to organic agriculture while simultaneously providing a Green Food price premium. After 25 years Green Food is well known to Chinese consumers, and is readily available for retail purchase in China. There are two tiers A and AA

- **Can we use it?** In 2006 The CGFDC accredited the Canadian production of 600,000 tonnes per annum of barley to carry the Green Food label. With barley yield in Canada reportedly 2.9 tonnes per hectare this suggests that theGreen Food certified area in Canada is at least 200,000 hectares. Canada's total barley planting is 3.6 million hectares, so the new Green Food certification accounted for 5.6% of Canadian barley production.



Data source: Annual Statistical Report of Green Food (2001–2012)

Covered farmland of certified green food products.



Green Foods by food sector (Source: Lijuan 2003).

Number: 2

What: Green Food Logo

- **History:** Green Food in China dates from 1990. In that year China's Ministry of Agriculture created the Green Food program. Under their control, the China Green Food Development Centre (CGFDC) was founded in 1992, to be "responsible for national development and management of Green Food". The CGFDC owns the Green Food logo, develops and maintains the Green Food standard, coordinates inspections and monitoring, is responsible for certification, and draws income for certification fees.
  Signalling the future direction for Green Food, in 1993, the CGFDC joined the International Federation of Organic Agriculture Movements (IFOAM), based in Bonn, Germany. The CGFDC subsequently split Green Food certification into the two grades, Grade A and Grade AA, in the late 1990s. Green Food certification serves as a reassurance to both domestic consumers, and to international food manufacturers sourcing ingredients in China.

- A (which allows some use of synthetic agricultural chemicals), This is what is domestically known as **'organic'** China
- AA (which is more stringent, allowing less chemical use) This is the **international standard for 'Certified Organic'.**

- **Label:** Food certified under Green Food is labeled with the Green Food-logo both in Chinese and English. It also carries a twelve digit LB-number which makes it traceable and able to verify its authenticity

Green Food logo	Organic & Organic In-Conversion logos
绿色食品 GreenFood	

Number: 3

What: Integrated Printed Electronic System with Rewritable Memory

- **Benefit:** A smart label with memory that strengthens packaging authentication. Printed electronics is a low-cost anti-counterfeiting format for packaging (including refillable formats). The film adds low-cost intelligence to objects or packaging by printing thin circuitry on a flexible substrate.

- **How's it different from RFID / other smart labels?**
  Traditional anti-counterfeiting methods such as invisible ink, holograms and RFID tags can be easily copied/hacked and are often expensive to implement. By integrating this technology with advanced security printing and digital cryptography, the solutions are inexpensive and difficult to counterfeit as every stamp is uniquely encrypted and can only be created by authorized personnel. In addition, key features will work offline. The data is rewritable and can identify if a medication refill has been authorized, shipping tax has been paid, whether a package passed through an authorized distributor. Using a smartphone reader, printed memory tax stamps can be used for track and trace package location, authentication and verification of a product's information.

Picture:

What: Integrated Printed Electronic System with Rewritable Memory

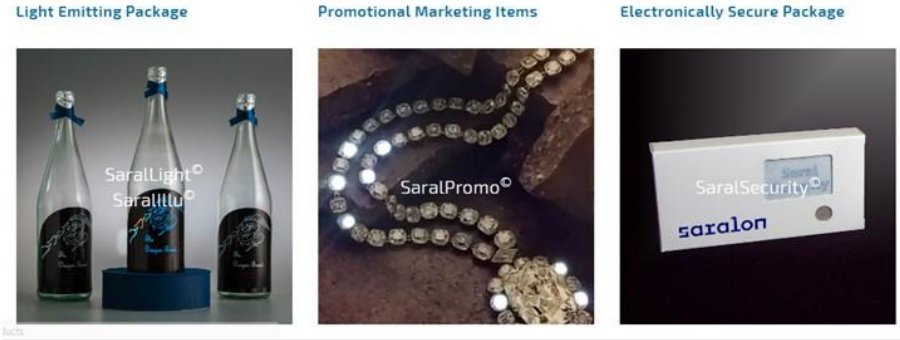
Number: 3

- **What:** Manufactured through a printing process and add low-cost intelligence to objects or packaging by printing thin circuitry on a flexible substrate. The non-volatile memory is delivered in small flexible labels. The labels can be placed on products at any stage of the manufacturing or supply-chain process. Labels can store up to up to 36 bits of information, which enables 68 billion distinct data combinations. Everything from lot codes and serial numbers to expiration dates and geographic IDs can be stored on the labels, and the data is preserved until overwritten within a 10-year span.
- **Commercial Examples:** Xerox Printed Memory in partnership with Thinfilm,

What: Saralon Printed electronics for packaging

Number: 4

- **Benefit:** Innovative Inks are produced by Saralon for creating desired electronic features. Inks are printed one-over-another to produce different electronic devices by using a conventional printing machine in ambient conditions. The printed electronic device is integrated into a package by using conventional technologies. An end-user can interact with the electronics integrated into the package. Electronics on a package make the package more attractive, highly secure and customer interactive. It can also connect a package to the Internet of Things (IoT).
- **Application:** The functional inks for printed battery and printed illuminated displays make a package capable of emitting light. The package can be a paper, cardboard or plastic box, bottle label or even a glass bottle. Or use functional inks for printed battery, printed electrochromic display, printed diode and printed sensors enhance the anti-counterfeiting measures of a package. The package can be a cardboard box, a glass vial, a blister, a sleeve or a tag.



Number: 5

What: Inks (fluorescent)

- **Benefit:** Fluorescence-based oxygen sensors are well suited to be integrated into meat packages since they should remain in operation and be reliable through the supply chain until the point of opening.
- **What:** Special dye molecules display excited states and emit radiation at specific wavelength (fluorescence or phosphorescence) when they absorb light. Quenching of this excited luminescent dye can occur during collision with oxygen molecules. Due to this energy transfer mechanism, luminescence intensity is decreased over time, the degree of quenching is proportional to the concentration of oxygen within the system. Fluorescence-based oxygen sensor consists of a fluorescent or phosphorescent dye which is immobilized in a solid polymer matrix. A dye-polymer coating is applied as a thin film on a device such as an optical fiber

Picture:

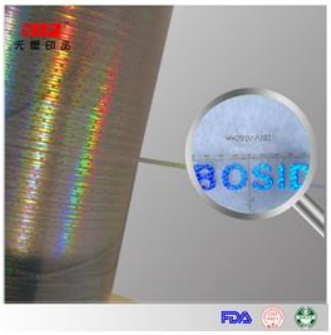
Number: 6

What: Optical variable device Printing;

- **What:** An optical variable device (OVD) is an iridescent image that exhibits various optical effects such as movement or color changes. They can't be photocopied, scanned, accurately replicated or reproduced. Often used as a security device and anti-counterfeiting measure on money, credit cards and government-issued identification cards. They can be created through a combination of printing and embossing.

  OVDs are based on diffractive optical structures. This gives cards the appearance of having different patterns, colors, and designs depending on the amount of light striking the OVD and the angle the OVD is viewed at. Holograms are a type of OVD.

Picture:



Number: 7

What: RDIF/NFC

- **RFID WHAT:** Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. The tags contain electronically stored information. Information flow is one way
- **PASSIVE HF RFID:** powered by the electromagnetic energy transmitted from the RFID reader. Reader range from near, up to 25 meters
- **Active RFID:** own power source. Broadcast range up to 300 meters

- **NFC What:** Growing out of RFID, NFC is method of wireless data transfer for near field communication, that detects and then enables technology in close proximity to communicate without the need for an internet connection. It's easy, fast and works automagically. Powered by the electromagnetic energy transmitted from the RFID reader.

- NFC has three modes of operation: the peer-to-peer mode that lets two smartphones swap data, a read/write mode in which one active device picks up info from a passive one, and card emulation, in which an NFC device such as a smartphone can be used like a contactless credit card.

Number: 8

What: QR codes

- **What:** A QR (Quick Response) Code is a two-dimensional barcode consisting of a black and white pixel pattern which allows to encode up to a few hundred characters. Smartphones and tablets are able to recognize and decode them quickly.

Picture:

- Can direct to:
  - a web address
  - store vCard details
  - Google Maps info
  - Youtube video links
  - Download Apps
  - Spotify playlists
  - Information
  - Augmented Reality Videos
  - Serialisation = Product Validation

Number: 9

What: Tamper proof / evident

- **What:** Anti-tamper devices have one or more components: tamper resistance, tamper detection, tamper response, and tamper evidence. Resistance to tampering can be built in or added to packaging. Examples include:
  - Extra layers of packaging (no single layer or component is "tamper-proof")
  - Packaging that requires tools to enter
  - Extra-strong and secure packaging
  - Packages that cannot be resealed
  - Tamper-evident seals, security tapes, and features
- **Why:** Tamper-evident packaging provides many benefits to businesses in almost every industry. The most evident benefit is security. If you are in the pharmaceutical industry, tamper-evident packaging as well as tamper-resistant packaging are in almost every case a requirement. In other industry it provides security throughout the product's lifecycle including after purchase by a consumer.

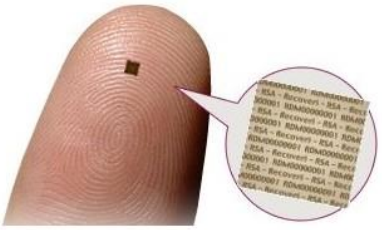
Picture:

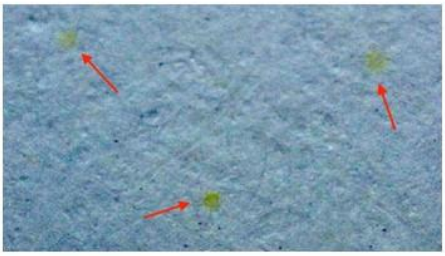
Number: 10

What: Microdot printing

- **What:** A microdot is text or an image substantially reduced in size onto a small disc to prevent detection by unintended recipients. Microdots are normally circular and around one millimetre in diameter but can be made into different shapes and sizes and made from various materials such as polyester or metal. The name comes from the fact that the microdots have often been about the size and shape of a typographical dot, such as a period. Microdots are, fundamentally, a steganographic approach to message protection.
- Printer steganography is a type of steganography – "hiding data within data" where tiny yellow dots are added to each page. The dots are barely visible and contain encoded printer serial numbers and timestamps. Unlike many forms of steganography, the hidden information is not intended to be available from a computer file, but to allow serial number and time of printing to be determined by close examination of a printout.

Picture:



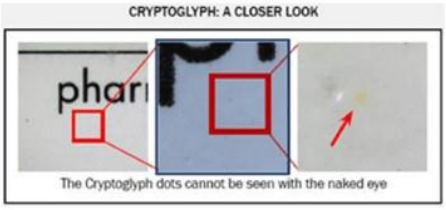


Number: 11

What: Cryptoglyph

- **What:** Cryptoglyph (Crypto = encryption, glyph = marks), which combines two elements: Printing of invisible micro-points over the entire surface of the primary or secondary packaging, such as the blister foil for foods and pharmaceuticals. As these dots are invisible and spread on the whole surface of the packaging, it is impossible to replicate or to erase them. The invisible micro-points contain encrypted information, which can only be deciphered by using the encryption key. The micro-points are integrated in the package design before printing and are invisible to the naked eye and difficult to distinguish, even with a magnifying glass, as the dots are confused with the imperfections found in all printed material structures and thus effectively camouflaged.
- The Cryptoglyph detection process can be performed using a smartphone or scanner. To avoid having the encryption key made available in the field, a digital image of the packaging is sent to a processing system located in a secured area, via mobile data transmission networks. Once analyzed in this safe and secured area, the result is sent back to the field controller. This two-way communication process ensures the full security of the encryption system and allows instant consolidation of the field track and trace verification tests.

Picture:



Number: 12

What: Taggants

- **What:** Taggants are uniquely encoded materials or chemistries that are virtually impossible to duplicate. A taggant is like a fingerprint—a unique signature of identity to which customers assign meaning. Taggants can be overt or covert and are used for a wide variety of applications. They serve four main purposes, Proof of ownership, anti counterfeiting, tracking and monitoring
- **How:** **Physical**, eg mircodots, **Spectroscopic**, eg dyes that fluoresce in different regions of the visible spectrum. **Chemical**, similar to optical but using trace minerals as the marker. DNA, based on DNA oligonucleotide fingerprints, could be natural, synthetic or a combination

Picture:

- **Summary:**

Coding Type	Advantages	Disadvantages
Physical	Simplistic analysis Inexpensive	Limited coding capacity Less covert
Spectroscopic	Simplistic analysis Inexpensive	Subject to counterfeiting Limited coding capacity
Chemical	Analysis sensitivity More covert	Prone to misidentification Incomplete recovery
DNA	High coding capacity Low toxicity	Expensive analysis Possible degradation

Number: 13

What: Taggant MicroDOT

- **Use:** Identification
- **MicroDOT:** MicroDOTS are tiny metallic particles that are chemically etched with a unique identification code. All MicroDOTS within an individual kit have the same unique code; each kit has a different unique code. They are nearly invisible to the naked eye and can be read with any simple hand-held magnifier of 60x or higher
- **Why:** The unique code is registered against the owner of the kit. The code provides a direct link between the owner of the kit and the assets to which they are applied. When applied to items of value, they are used to provide irrefutable proof of ownership via the unique code. MicroDOT partners with luxury brands to develop innovative overt and covert security systems for their individual protection needs.

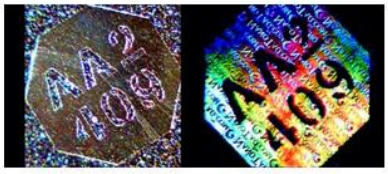
Picture:

Number: 14

What: Taggant Nanotags

- **Use:** Identification
- **Nanotag:** NanoTags are octagonal pieces of microscopic nickel – 6 to 10 microns thin and ranging from 0.3mm to 0.5mm wide. An individual NanoTag features a micro-image of a personalised brand, created to order. This is a hologram-like nano image displaying changes of colour under different viewing angles. Technically not a hologram, it is known as a Modulated Diffraction Grating (MDG). A real hologram viewed under a microscope becomes a meaningless grey mass of micro-particles, but by contrast, a NanoTag reveals the branding in fine detail and brilliant colour
- A Security Identification Code (SIC) is etched physically through the body of the nickel tag. The same SIC is repeated through the thousands of NanoTags contained in each personalised set or batch of NanoTag products, mixed with special proprietary adhesives or embedded into the body of plastics. Once the mixture of tags and adhesive/plastic becomes dry and solid, the NanoTags become fully resistant to water, most chemicals and environments. NanoTag supersedes competing microdot technology which is based on a plastic substrate

Picture:

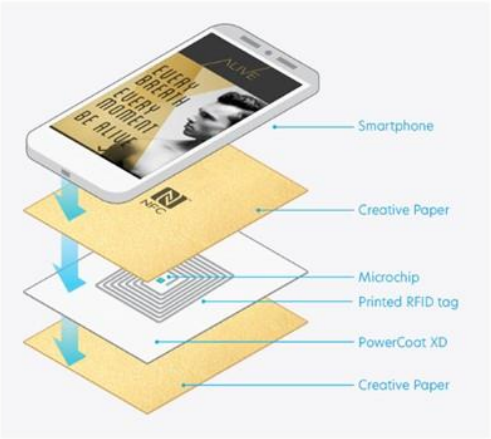


Number: 15

What: Powercoat by Arjowiggins

- **Benefit:** PowerCoat® is a unique, flexible paper formulation that allows the printing of complex electronic circuitry directly onto paper, ushering in the next generation of smart products for many industries.
- **How:** A sheet of PowerCoat comprises 3 layers of paper: two layers of our conventional creative papers encasing a layer paper with pre-printed RFID circuitry and a silicon chip. The 3 sheets are then laminated to create a sheet of "connected" PowerCoat Alive. The result is an NFC-ready paper that can be programmed to trigger a multitude of functions on any NFC-enabled device.
- By enabling smart functionality that consumers can interact with and offering a more immersive brand experience. Eg scanning to receive the latest instore promotions. Or added functionality eg point of sale packaging with integrated LEDs that light up or food packaging that can communicate the freshness of its contents to your phone. Detailed analytics, allow you to track the success of your campaigns in real-time.

Picture:



Number: 16

What: Multi-layer material from agricultural by-products

- **What:** A compostable multi-layer material made from agricultural and forestry by-products is under development as an alternative to oil-based plastics. Researchers from Finland are developing a solution that has a number of applications for food packaging including meat. The material looks and performs like plastic but is made from cellulose-based raw materials, which, of course, are renewable, recyclable and biodegradable. Can also be made from by-products such as rice straw, sugar cane, textile waste and agricultural residues. The material exhibits good gas, grease, mineral oil and moisture barrier properties. It's is comprised of two complementary wood cellulose. The first is a fibrous cellulose(HefCel) combined with a plastic type cellulose (MMCC). VTT has combined them into a compostable three-layer film that has overcome the moisture sensitivity typically associated with fibrous cellulose films

Picture:

What: Compostable meat pack

Number: 17

- **What:** ProMessa BV (main butcher for supermarket chains in Holland) has recently launched a fully biodegradable meat packaging solution. In collaboration with Reine, Germany based compostable packaging specialists Bio4pack. The organic meat assortment is fully certified compostable and can be thrown away by the consumer with their waste. The whole of the pack is biodegradable including the absorption pad, foil and labels. The meat trays are made of completely renewable Poly Lactic Acid (PLA), which is made from the vegetable raw materials dextrose and lactic acid. Bio4Pack pack for fresh meat, meets food safety and pack functionality requirements, as well as being fully compostable. It complies with the requirements of the EN13432 compostable certification standards. The material is naturally hard but is quite brittle. An additive has been used to give the tray the necessary strength.

Picture:

What: Zubex biodegradable film

Number: 18

- **What:** Monterrey, Mexico based Zubex has developed a biodegradable film suitable that is claimed to be 100% degradable. The film is suitable for meat and cheese products and the degrading process takes just over two years – about 26 months – in a landfill. The co-extruded material is made from a range of polymers including PE and polyamide. Two options are available – a meat casing film as well as shrinkable bags. Mexican brand owner Qualtia Alimentos has been one of the first companies to use the casing for their premium meat brand Zwan. Disposable covers for these products has always been an environmental issue so the Zubex solution helps to reduce the waste waste generated by provide degradability properties. The material is able to maintain its properties throughout the supply chain journey. Once it has been discarded in landfill it is slowly converted into CO2 or methane gas.

Picture:

What: Nanoscale clay tubes

Number: 19

- **What:** Scientists at Sabanci University in Turkey have developed a new material that promises to protect food through a new process that helps to reduce bacteria growth as well as over-ripening. The initiative incorporates nanoscale clay tubes, which are hollow tubes made from clay. These prevent oxygen from permeating the film, while also stops water vapour and other gases from escaping. Current cling film products suffer from contamination from bacteria and permeability to water vapour and oxygen. They also accumulate ethylene, which is released naturally by the food. The nanoscale stops ethylene from building up by absorbing it. Carvacrol oil is added which helps to kill off microbes. In tests, the new film improved the shelf-life of wrapped tomatoes, bananas and chicken compared with normal polyethylene and further development work is ongoing. Significant testing still needs to take place before this initiative can be commercialized

Picture:

What: Plant-based material for Australian beef pack

Number: 20

Picture:

- **What:** Wesfarmer owned Australian grocery store chain Coles Supermarkets has begun to sell its lean beef mince own label brand in a new plant-based packaging material. The use of a bio-material from Plantic Technologies combines PET with a bio-based ultra-high barrier material, which increases the shelf-life of the product. The multi-layered film consists of the plant-based Plantic HP (High Performance), which provides oxygen and gas barrier, whilst the PET layer delivers the necessary moisture and water vapour barrier. The Plantic material is soluble and biodegrades in the recycling process, whilst the PET layer is recovered and recycled. Plantic requires about half
the energy to produce than traditional fossil fuel plastics.

What: Edible packaging made from milk protein

Number: 21

Picture:

- **What:** Washington DC based American Chemical Society has recently announced the progress of a food packaging development made from milk protein. The material is edible and is being seen as a potential long term replacement for plastic film that is used for products such as cheese and meat. The protein-based pack is biodegradable as well as being edible. It is also claimed that it has the potential to keep its contents fresher than plastic. The film's protein is casein and bonds tightly, so much so that the packaging could improve oxygen barrier properties 500 times more than conventional plastic packaging. The researchers are currently testing applications for products in single-serve, edible food wrappers. The film apparently has little taste although flavours as well as vitamins could be added if required

What: Compostable pack, biobased foam product

Number: 22

Picture:

- **What:** Global chemical giants Basf is busy expanding its range of foam products with the introduction of a compostable foam called ecovio EA. The main areas of use for ecovio is usually plastic films such as organic waste bags and for agricultural products. ecovio is primarily biobased and can be used as a compostable packaging solution as a paper-coating, for shrink films, for injection moulding products and in this case foam packaging. The foam's properties make it particularly ideal for transport packaging where a high level of impact resistance is important. ecovio EA is the first expandable, closed-cell foam material which is biobased and certified compostable.ecovio EA is being seen as suitable as a reusable container for fruit / vegetables, fish and meat products

Number: 23

What: Expandable foam meat packaging

Picture:

- **What:** Erze Ambalaj is one of Turkey's largest food packaging companies and is Turkey's largest Expanded polystyrene (EPS) packaging business. It has partnered with Dutch biochemistry business Parx Plastics to create a new version of expandable foam packaging that improves food safety by reducing salmonella and listeria in meat packaging. The antimicrobial packaging solution not only reduces contamination but also helps to prolong product shelf life. This is achieved through bio-mimicry where a trace element is added to the packaging to prevent bacteria from proliferating. Over a 24 hour period, the packaging development reduces bacteria on food products by as much as 97%.

Number: 24

What: Irreversible heat-activated ink

Picture:

- **What:** Thermochromic ink experts Chromatic Technologies Inc. (CTI) have announced a breakthrough innovation with the introduction of a new solution to identify evidence of tampering. Tamper Alert is an irreversible, heat-activated ink technology with potential applications in industrial products, pharmaceuticals, food and electronics prone to theft and counterfeiting. The ink is irreversible and is used to show a product has been tampered with or has undergone temperature changes that will impact on the quality of the product. CTI has developed a narrow activation window where the alert transitions from colourless to full colour within a range of just 10° C. This compares with traditional irreversible technologies that require a much higher transition window of up to 50° C. CTI have perfected an ink that changes only the one-way. Tamper Alert is available only in water-based applications.

Number: 25

What: Twist and lock pack

- **What:** Wisconsin based Plastic Ingenuity have been on the innovation trail again with the introduction of an easy-to-use twist-and-lock pack that also has a unique, tamper-evident security tab. The twist and- lock function is situated between the lid and base and the user pushes the lid down and twists to lock it in place. The process of unlocking is also straight forward. They twist it back and then lift it off. When the pack is opened for the first time, the snap breaks indicating that it may have been tampered with.

Picture:

Number: 26

What: Hologram cap

- **What:** German packaging business KISICO has nearly 70 years of experience in developing and producing caps and closures for many different fields of application. They have tapped into this experience with the development of a hologram topped cap they have called the HologramCap. Breakthroughs in nanotechnology has allowed the business to create the innovation, which has many applications for anti-counterfeiting and brand enhancement opportunities. The hologram is fully integrated in the production process of the cap. This means that no additives, inks or labels are required to deliver the effect. The technology can be applied to any existing cap and the hologram design can be personalised to meet the needs of the brand owner. The solution will be of interest to the pharmaceutical industry as well as other high value products. The HologramCap uses technology developed by Swiss brand protection business Morphotonix.

Picture:

Number: 27

What: Fluorescent ink

- **What:** Plastic packaging specialists Spectra Packaging have announced the development of a covert print technique to combat the threat of counterfeiting. The business' new ink has an illuminate fluorescent print that is invisible to the naked eye. It is only revealed when exposed to ultra violet light. As well as this fluorescent ink the business has also created a product called Chameleon, a print finish that changes colour depending on the angle viewed. This acts not only as an additional brand feature to deter counterfeiters, but also as an engaging pack enhancement in its own right.

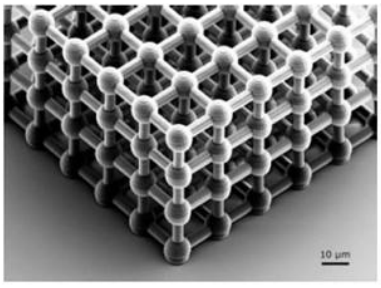
Picture:

Number: 28

What: 3D micro-printing

- **What:** Researchers from optics business Zeiss have worked alongside Karlsruhe Institute of Technology (KIT) in Germany to develop an anti-counterfeit technology using 3D micro-printed structures. The development could result in the replacement of conventional 2D holograms microstructures. The new security feature has been created using a technique called multistep 3D optical laser lithography using a device developed by KIT company Nanoscribe. The use of 3D-printed fluorescent microstructures helps to improve counterfeit protection. This security feature is complex to manufacture making it very difficult to copy. The microstructures take the form of a unique pattern combination made with an acrylate structure and fluorescent quantum dots. These can only be seen using specialised equipment. The new security features have a side length of about 100 µm (micrometre) and are barely visible with the naked eye. The plan is to embed the technology in foil to operate as security tags for branded items.

Picture:

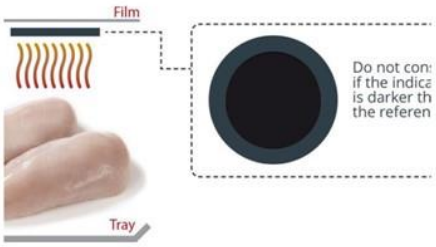


Number: 29

What: Visual indicator label

- **What:** A new label patented by Chimigraf aims to improve chicken produce freshness visual communication. The smart technology Freshcode label is a unique visual indicator, that displays the freshness of chicken breasts. Freshcode has been developed in collaboration with Valencia, Spain based ITENE. It The centre of the Freshcode label is impregnated with an intelligent ink, which captures the emission of volatile gases released as chicken that has been treated with modified atmosphere packaging (MAP) begins to spoil. The intelligent ink gradually changes colour to indicate the level of freshness and the product is no longer suitable for consumption when the label turns fully black. This is a rich area of development: Colour-changing label to help indicate food freshness, Self-adhesive device changes colour to show food freshness, Colour changing packaging indicates if product is fit for consumption and Label changes colour to inform on shelf-life length.

Picture:



Number: 30

What: 360 degree view

- **What:** Chicago-based start-up company PRE Brands has created new packaging to help consumers make their choice of meat from the range. The business' insight that shoppers want to see their cut of meat in full before they buy it has lead to the introduction of a patent pending pack format that delivers a 360-degree view of the contents. The easy-open vacuum pack is attached to a paperboard backer and shoppers can rotate the pouch to see all sides of the meat. A perforated tear line makes it easy to separate the film pack from the backer. PRE Brands worked with the packaging design firm Ciulla for the design

Picture:

Number: 31

What: Three layer film with sensors

- **What:** ASINCAR is a non profit organisation founded by a group of meat industry companies in Asturias, Spain. The organisation was created to represent and support the agri-food industry as well as progress innovative packaging solutions. The group is developing an intelligent pack solution that will allow real-time reporting of the quality of fresh beef as well as predict its remaining shelf life via pack sensors and an external reader. A prototype has been developed and consists of three specific sensors within a three layer film. As meat deteriorates it releases volatile organic compounds (VOx). The sensors are able to detect and quantify the amount of VOx that is being emitted. The innovation will give information about potential breaks in refrigeration to individuals in the supply chain as well as consumers and is an alternative and perhaps more accurate way of assessing the shelf-life of meat compared with the sell-by/eat-by pack markings.

Picture:

What: Time-Temperature Indicators

to monitor the Supply Chain, Inform Customers

32*

Benefit:

- A label that facilitates cold chain monitoring that informs retailers and consumers if a frozen food is still safe to eat. This is an indicator and not in direct contact with the food (smart not active)
- An accumulative temperature indicator, mimics rate of food decay.

Commercial Example:

OnVu™ TTI.

- Based on photochromic spiropyran based inks.
- Label activation is a 4s UV light exposure.
- The rate of photochromic colour change from blue to pale is dependent on the temperature.
- Smart label placed upon food packaging to monitor the cold chain for chilled and deep-frozen food, making the current state of the product visible–the label changes colour depending on temperature. The darker its colour, the better the cold chain has been maintained.
- Acting as a reference, the outer portion of the thermometer is a lighter shade of blue. The cold chain monitor works simply: as long as the centre is darker than or the same as the reference colour, then there has not been any significant interruption in the cold chain, and the best before date shown on the packaging remains valid.
- As time goes by and/or if the cold chain is broken, the colour pales.
- Patent: WO/2006/048412

What: Time-Temperature Indicators

33*

to monitor the Supply Chain, Inform customers

Benefit:

- A label that facilitates cold chain monitoring that informs retailers and consumers if a frozen food is still safe to eat. This is an indicator and not in direct contact with the food (smart not active)
- An accumulative temperature indicator, mimics rate of food decay.

Commercial Example:

Tempix Indicator Labels

Smart label placed upon food packaging to monitor the cold chain for chilled and deep-frozen food, making the current state of the product visible– The line is black and continuous through proper transport.

- If the temperature during transport is breached the line is missing or broken
- The barcode is also partly erased to make it un-scannable
- Not a gradual colour loss
- Irreversible indicator (smart not active)
- www.tempix.se

What: Time-Temperature Indicators

Number: 34*

to monitor the Supply Chain, Inform customers

Benefit:

- A label that facilitates cold chain monitoring that informs retailers and consumers if a frozen food is still safe to eat. This is an indicator and not in direct contact with the food (smart not active)
- An accumulative temperature indicator, mimics rate of food decay.

Commercial Example:

Vitsab TTI Label

- The smart label is activated by producer by pressure to break the seal between the enzyme and the substrate.
- The food degrades at the same rate as the enzyme reacting in the indicator which varies depending on transport temperature and time since activation
- A **gradual** colour loss
- Irreversible indicator (smart not active)
- www.Vitsab.com/en/tti-label/

Vitsab TTI Label

What: Time-Temperature Indicators

35*

to monitor the supply chain, Wicking Styles

Commercial Examples:

- WarmMark is a wick based temperature indicator which when heated **above** a trigger temperature the red dye moves along a matrix. The warmer the temperature the faster the dye travels to indicate brief, moderate and prolonged exposure. These are irreversible indicators and are not used in contact with food. Designed to go on the outside of a box/package. "Place the indicator inside the insulated shipper as close to the product being monitored as possible"
- Cold Mark is a single use, irreversible color change when an item goes **below** the predetermined threshold.
- Monitor Mark(TM) by 3M. Triggered by melting of coloured fatty esters

Features:

- Not for consumers
- Typically used for shipments not individual items

Applicability to Meat

- This type is an irreversible wicking style with relative temperature history of supply chain.
- A relevant for indicator on meat packaging

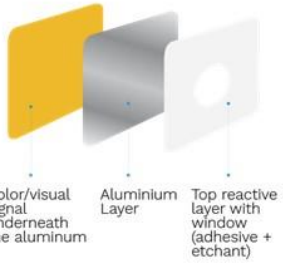
What: Time-Temperature Indicators

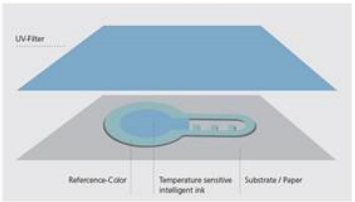
36

to monitor the supply chain and to inform consumer

Commercial Examples:

- Freshpoint Holdings markets labels that change colour over a period dependent on the temperature of the supply chain.
- They indicate to the consumer the freshness of the product.
- Aluminium etchants dissolve an aluminium layer exposing the colour behind
- UV Inks are photoinitiated and then gradually fade (same method as OnVu)
- BestBy is activated by removing a separating layer between cellophane and resealing. The colour fades based on time-temperature.





Features:

- Easy to apply as labels to packaging

Applicability to Meat

- This type is an irreversible indicator (smart not active)
- Relevant indicator for meat packaging

Reference:

http://freshpoint-tti.com/time-temperature-indicators/

"TTI Device", US 2017/0045485 A1

https://www.youtube.com/watch?v=d_l4ywu4Vwo

What: Temperature Sensitive Labels Leuco Dyes (CTI)

37

Commercial Examples

Coors Beer, Coca Cola, Tim Tam's

COURTESY: CHROMATIC TECHNOLOGIES INC.

Patent Examples

"Small scale microencapsulated pigments", EP 2970677 A2

Cautions

- Ink companies aware of potential adverse public opinion due to formaldehydes, phenolics used in Leuco Dyes
- Applications have mainly been on metal glass or thick plastic (PP), however Tim Tam's use thin packaging with sandwich layers of plastic.

Applicability to Meat

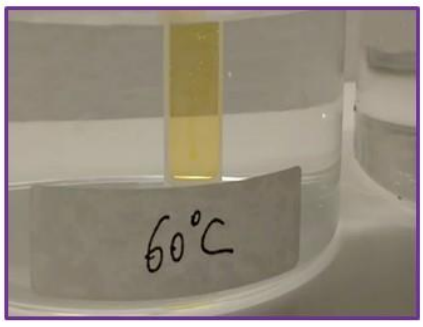
- Consumption: Is temperature a desired consumption criteria for meat (reversible)
- Counterfeiting: Indicator of authentic product.
- This type is reversible so applications for supply chain are not met. May not be as useful for meat packaging.

What: Temperature Sensitive Labels Leuco Dyes (CTI)

38

Commercial Examples

- No commercial examples using simpler reversible non-toxic components on the market



UniMelb Prototype

- Uses less toxic precursors and materials than typical Leuco dyes.
- Prototype to prepare a gel, and a thick film.
- Requiring a stationary phase (polymer matrix for fabrication).
- Reversible and irreversible colour change observed

Applicability to Meat

- Supply Chain: Indicator of temperature breach (irreversible) as with OnVu label
- Consumption: Is temperature a desired consumption criteria for meat (reversible)
- Counterfeiting: Indicator of authentic product.

Cold | Hot | Cold (After 5 cycles)

What: Time-Temperature Data Loggers

39

to monitor the Supply Chain using NFC

Benefit:

- This type of label records temperature data throughout a supply chain and transfer the information using Near Field Communication (NFC) to a smartphone via an App.

Commercial Examples:

Flexstr8

- The label is set using an iPhone or Android setting temp. intervals
- Labels by Felxstr8 can printed using a modified Epson printer and encodes the labels at 30 mm.sec^{-1}.
- Label is adhered to package, container

Avery Dennison TT Sensor Plus

- Near Field Communications, Battery, Temperature Sensor
- The size of a credit card.
- Can be adhered to a package
- Has a unique ID number.
- TT Sensor Plus App on Smart Phone.

Applicability to Meat

- This is designed for producers, suppliers and retailers.
- Applicable to meat but not for individual Ipackaging

What: Pressure Sensitive Labels

40

for novelty, anti-counterfeiting and shock indicators (high pressure)

Applications:

- The most common form is used in high pressure indicators to show possible damage to goods.
- A label that shows package tamper evidence, authenticity or novelty requires much lower pressure triggers.

Commercial Example:

- Shock Labels (Shockwatch): Triggered at different G-forces. Rated based on grams.

Applicability to Meat

- Believed not to be relevant for meat as food pressure/crushing not a major issue
- Pressure for tamper-evidence or authenticity is discussed later

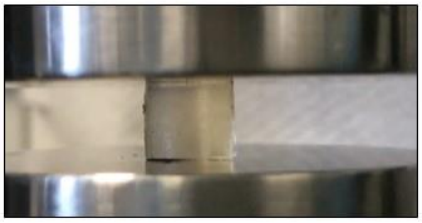
What: Pressure Sensitive Labels

41

for novelty and anti-counterfeiting

Commercial Examples

- High pressure shock markers (previous slide).
- Golf club ink markers for high pressure history.
- No low pressure human triggered indicators.
- No pressure triggered tamper evident closure indicators



UniMelb Prototype

- Early stage development of low pressure colour changing dye-polymer system.
- Existing pressure remains high.
- Targets aimed to trigger: a) below 0.5 MPa or equivalent to a thumb print, or b) below 2 MPa to trigger a thin film or closure being "torn"; c) incorporated into a film which changes color upon excess expansion under meat degredation.

Applicability to Meat

- Anti-counterfeiting: Colour triggering as proof of authenticity
- Novelty to customers
- Intelligent packaging to consumer demonstrating excess degradation.

What: Bioactive Sensors

42

Freshness indicators based on protein food decay

Benefit

- This label known as Mimica Touch (previously known as Bump Mark) which becomes bumpy as the gelatin (protein) breaks down.
- The degradation of the gelatin is said to correspond to the condition of the food contents.

Commercial Example:

- Mimica Touch (patent pending)

Options:

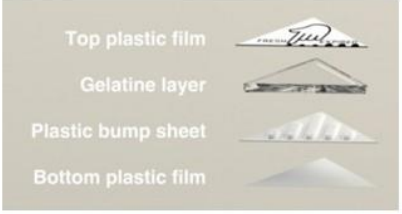
- One simple chemical component (hydrogels: gelatin, agar, carrageen, pectin, konjac, synthetic collagen…)
- Applied external to food a gelatine film
- Permeable top layer exposed to air

Applicability to Meat

- Relevant to meat or any protein based food.
- Simple and effective
- Informs consumer
- May not be cost effective

http://fifty.brunel.ac.uk/discovery-trail/47-a-refreshing-best-before-label/

US 2017/0082589 A1; EP 3151681 A1; Inventor: Pakstaite Solveiga; Owner (US): Mimica Lab Ltd.



What: DNA Tracing of Beef

43

for anti-counterfeiting

Commercial Examples:

- Canadian DNA Traceback is an example of DNA tracking which allows to track the beef form regional farms to the store. www.dnatraceback.ca
- Cattle are reared on approved feed yards and raised to exacting standards. In Canada, cattle are identified by an RFID ear tag and unique ID number which links to the animal's production history.
- Cattle are DNA sampled at harvest, linking genetic information with the animal's production history. Once the beef has been processed, samples are routinely taken from finished products, their DNA code read and matched with DNA from the original animal. This level of precise monitoring verifies the exact origin of your beef and confirms individual meat products are sourced from approved cattle.
- DNA TraceBack enables grocers to tell the story of their meat products with greater precision and accuracy. It connects the beef in store with producers and helps ensure you get the quality eating experience you pay for.
- Patented by Micro Beef Tech. Canada, CA 2660859 A1

What: Confinement odour packaging

44*

For consumer and safety concerns

Background:

This well documented technique either involves absorption of the moisture generated from the meat packaging or the use of sachets or films containing zeolites, cyclodextrins, or other small compound absorbing materials. These are separate to antioxidant, antimicrobials in that they absorb small compounds that result in odour

Commercial Products:

Many commercial examples are in use including MoistCatch; Biomaster; Food-Touch; Sanic Films; Febreze, SANICO

Technologies: Interleavers (layers for absorbtion), antifungal coatings, scavenger films, antimicrobial substances trays and films.

Applicability to Meat

A clear correlation to beef with pads, sachets and packaging films all valid approaches to confine odours.

What: Ethanol Sensing RFID Label

45*

to indicate spoilage

A major cause of fresh fruit spoilage is the release of ethanol. This technology monitors and indicates the freshness of the fresh fruit pieces.

Commercial Examples:

- VTT SusFoflex 2015.

Features:

- A label that changes colour upon excess ethanol vapour in the product headspace. The system contains an RFID tag that transmits the freshness information of the food to a retailer or consumer.
- VTT has also developed O_2, H_2S, ketone and aldehyde detection systems.

Applicability to Meat

Outgases relevant to meat could potentially be developed depending on the technology.

What: Freshness indicators

46*

to indicate shelf life

This example is a label that is activated by the consumer when opening a product package. This then leads to a time delayed colour changing of a label indicating Fresh / Still Fresh / Past Best.

Commercial Examples:

- Novas® Insignia Tech. 2017.

Features:

This is a TTI based on activation time by the consumers and not necessarily the history of the product. It is however applicable to meat products in any form as long as the rate of colour change matches the rate of decay (loss of freshness) of the meat product. This product is useful in reminding a consumer the length of time a product has been opened. Would the simple sniff-look-touch test also achieve this.

Applicability to Meat:

Directly related to the meat industry and could be used for other food products.

What: Electronic Noses

47

to indicate volatile gas/odours

This handheld device detects volatile compounds/gases exuding from the product,

Commercial Example:

- FOODsniffer 2016

Features:

- A spectroscopic chip identifying harmful substances (mycotoxins, allergens and pesticides) in fresh produce at the point-of-need. FOODSNIFFER is field deployable and the result of the integration of three major innovations: silicon photonics, wafer-scale microfluidics and filtration systems, low-power reader controlled by a smartphone.
- Marketed to end-users: consumers, chefs.
- Gives a digital color indication of the freshness of the meat depending on concentrations of the raw meat gas levels.

Patented: WO2015/150880 A1

Applicability to Meat

Specifically designed for raw meat.

Cost $199 per unit.

Number: 48*

What: Antimicrobial Packaging

Extending the shelf-life of food products

Benefit:

Extending the shelf-life of food allows for the reduction in waste, reduced transport and production costs, increased consumer confidence, sustained aesthetic appearance and appeal.

Background:

- A range of antimicrobial packaging films are on the market using difference modes of actions.
- Agion, Biomaster, Ionpure, Surfacine and Irgaguard are all commercial silver glass/zeolite based antimicrobial packaging's.
- Nisaplin® and Novasin® use Nisin a broad spectrum polycyclic antibacterial peptide sourced from a bacterium which inhibits bacterial growth.
- Microban uses Triclosan which the FDA has recently banned in soaps and detergents (still legal in Aus).
- Extracts from natural plant sources, eg cloves, garlic, cinnamon, thyme, horseradish have also been reported.

Applicability to Meat:

All of these products are applicable to meat products and demonstrate longer shelf-lifes.

Biomaster Protected Packages

Nisin, sold as a natural food preservative

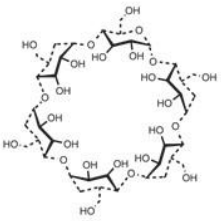
What: Antimicrobial Packaging

49

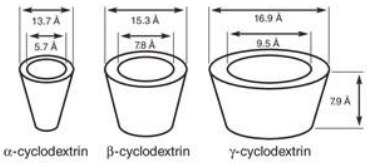
Cyclodextrin facilitated slow release of antioxidant/antimicrobial compounds

Background

One area of research being developed is the use of cyclodextrins (CDs). These have been used commercially in Febreeze air fresheners to capture small molecule 'smells'. There have been many recent publications that use cyclodextrin incorporated into packaging that release small antioxidant molecules into the headspace of food packaging.



Examples include the release of essential oils from star-anise (anethole), oregano (carvacrol), tocopherol (Vit-E), thyme (Thymol). These are typically incorporated into cellulose, LLDPE, gelatin films and showed extension of shelf-life and gradual release over days of the antioxidant/antimicrobials.



Benefits:

Cyclodextrins have world food approvals, and the studies reported, cover typically food safe, biocompostable, natural polymers.

The essential oils have also been widely used in the food industry.

Commercial applications in food packaging films are unknown at this stage.

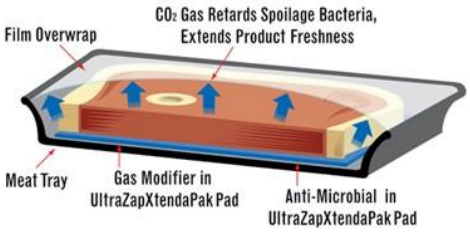
What: Carbon Dioxide Emitters

50*

Extending shelf-life of meat

Background

These decrease microorganism growth and spoilage, reduce the metabolic rate of microbes, preserve food quality and prevent swelling of the packaging. Moisture in the headspace or meat drip reacts with the pads or films producing CO_2.



Benefits:

- Increase the shelf-life of product
- Used in ground coffee, snack foods, nuts, bakery products, dried meat, fresh meats, fish products.
- Low tech., low cost.
- Active technology

CO_2® Fresh Pads

Commercial Examples:

Ageless G; CO2 Fresh Pads, Freshilizer C[1], Freshlock, Freshpax, Ovtene, Standa, Superfresh, UltraZap, Verifraise, Vitalon, FreshCase are all commercial examples,

Mode: typically using chemical reactions to release carbon dioxide when reacted with moisture from the meat.

Chemicals: sodium nitrite, sodium ascorbate /bicarbonate, citric acid, sorbic acid, calcium carbonate

What: Antioxidant Packaging

Number: 51*

Extending the shelf-life of food products

Benefit:
Extending the shelf-life of food allows for the reduction in waste, reduced transport and production costs, increased consumer confidence, sustained aesthetic appearance and appeal. Antioxidants may be synthetic or naturally derived to prevent off-flavour and improve colour

Background:
Many published examples use various antioxidant additives to polymer films for the scavenging of oxygen and radical oxygen species, which lead to lipid oxidation of protein based foods.

Literature since 2015:
Many recent examples typically report the use of essential oils, natural clays and additives, along with biodegradable polymers for extending the shelf life of food. A commercial Example is ATOX

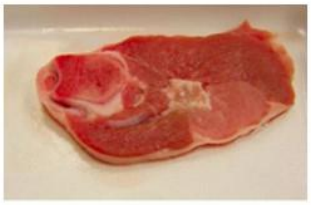
Patents:
A general patent by Intern. Consolidated Business Gp. Covered the use of food packaging comprising a polymeric material and a natural antioxidant. WO 2017/049364 A1

Other Patent Owners (2949 patents): Univ Santiago Chile (WO2016/082053 A1); Guangxi Point Map Pack. (CN105083750 A); Huang Zongkao (CN106553399 A); Kim Jin Woong (KR20160087180 A); Henan Newland Pharm. (CN104691937 A; CN103773002 A); Univ Zhejiang Ocean (CN 104974385A); J-Chemical Corp. (US9056711 B2)

Commercial Example: Addivant's Weston 705, liquid phosphite antioxidant liquid solution for packaging inclusion (EP 2057222 B1).

Relevance to Meat Industry: Very relevant

Control



ATOX 102 AV

Modified atmosphere for lamb meat stored for 11 days at 1 ºC

What: Self-Cooling Food Packaging

Number: 53

Benefit:
A concept that has been around for a number of years but has never really taken off. Most embodiments use metal cans (canisters) containing endothermic heat absorbers. The most common application is for the consumer to cool the food (beer, soda etc.) prior to consumption. More examples of self-heating flexible packaging exist such as Scaldopack

Commercial Examples:
InstaCool Can (Tempra Tech.), Chill Can (Joseph Comp.); Scaldopack (heating),

Patents:
The latest concept patent reported package pouches containing ammonium nitrate, sodium acetate and urea, with the cooling occurring once one of the pouches is manually ruptured. KR 20110002522 A

Source: bestinpackaging.com/2012/12/17/the-self-cooling-technology-anf-the-future-part-3/

Relevance to Meat Industry:
Cooling of meat would be most likely needed during supply chain. There is no real need for consumers to chill temporarily meat prior to consumption or cooking. A self-initiating cooling pouch/container may have more applications, but the cooling would need to cover the time of a temperature event and only occur once during supply.

52*

What: Vacuum Packaging

Extending the shelf-life of meat

Background:

Vacuum packaged meat products is commonplace and leads to extended shelf-life, dramatic product presentation and can be combined with other techniques such as MAP.

Commercial:

- Crovac® Darfresh®, Sealed Air
- Mondini Trave combines the clear thin film top layer and a tray-like bottom layer.
- Improvements using nitrite crystals impregnated in PVC films lead to extended colour and shelf-life.

Benefits:

- Reduces cross contamination
- Faster processing speeds
- Zero film scrap
- Double shelf-life compared to mother bag packaging
- Prevents juices from leaking through seal

Applicability to Meat:

- Directly related to meat industry

Current Technologies used for meat packaging

1. CTI: High Pressure Verification Technology demonstrates High Pressure Pasteurization (HPP) and can differentiate by color intensity, the exposure of <20k, 20k, 30k and >40k psi. CTI are the original manufacturers of Leuco dye thermochromic systems.

2. Freshness Label designed by To-Genkyo changes color based on ammonium release from a beef product. The hour-glass design 'fills' as the product releases gas. It is unclear if this is a design only or has been developed fully to proof of concept. Another Freshness indicator is produced by Vitsab with a green/yellow/red indicator panel

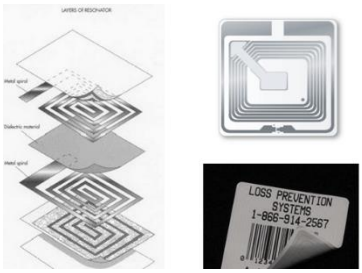
Vitsab®
The sign of freshness

3. Commercially available Freshness indicator is the Insignia Labelling. Sainsbury's used Insignia Labels on their processed pork slices. Insignia Technologies Ltd. uses intelligent plastics and inks to produce simple, cost-effective colour-changing labels for application to packaging. The key component is Insignia's patented intelligent pigments, which change colour in response to changing levels of CO_2 or temperature. Insignia has the ability to develop colour changing labels which respond instantly or over a pre-calibrated time period. The chemical formulation of the pigments can be changed to produce a wide variety of indicators with different sensing properties. Examples include a freshness indicator with a guide for use based in the number of days it has been activated (A)

A second commercial example (B), designed for MAP, uses a single yellow-blue indicator label to demonstrate film leakage, which would be applied to the film upon packaging of the meat. The previous two examples are activated once applied to the packaging at the processing level.

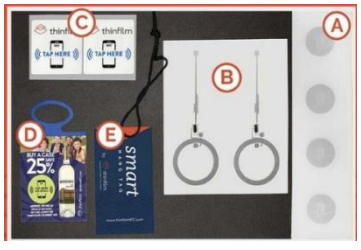
A third type uses the same labels but **consumer triggers** to demonstrate time exposure once opened. The example used is for mayonnaise, which when the lid Is opened the tag covering the indicator is displaced and label activation occurs.

4. Checkpoint RF Labels (EAS Tags & Labels - 4010, 4210) is an example of a microwave safe RF tag that can be scanned to verify authenticity. Inside each Electronic article surveillance is a technology that prevents shoplifting commonly used in retail stores with an alarm that sounds if detected upon leaving the store. Checkpoint **Radio Frequency** (RF) label or hard tag is a resonator, a device that picks up the transmitted signal and repeats it. The Checkpoint antennas or gates also contains a receiver that is programmed to recognize whether it is detecting the target signal during the time gaps between the pulses being broadcast by the gates. This signal is generally at 8.2 MHz, but it can be anywhere from 8.0 to 9.5 MHz depending on the needs of the retailer. Sensing a signal during these intervals indicates the presence of a signal being resonated (rebroadcast) by a security label or tag in the detection zone. When this occurs, the Checkpoint System sounds an alarm; in most Checkpoint systems, the alarm sound is accompanied by flashing lights.



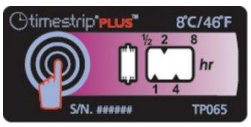
5. Sanitrace is an example of an **QR Code** tracking system. It is used to track the product and consumers can receive a notification text if the beef is recalled.

6. Thin Film Electronics ASA offer a range of near Field Communication devices. These can be used for tracking, weblinks to tell the brand story, brand protection, use-by-date checking, e-commerce for reordering and links to customer loyalty programs. Marketing packages offer a range of design and ideas for marketing from drink coasters to tap here labels, tear resistant tags and basic NFC tags for applying to plastic or paper for proof of concept marketing.



7. **Data Loggers** which track humidity and temperature during a Supply Chain are commonly used. These are however expensive at between US$30 for a 60 day logger (PAKREC022) to a larger re-useable version (SHOREC001) at US$65. Emerson has a range of examples including bulky USB linked loggers (A), thinner NFC data loggers (B) which can be either single or multiple use however all of these are added to larger containers to track the time-temperature of a bulk delivery and not individual items.

8. **Time Temperature Indicators.** Many examples of wicking or capillary movement of inks along a scale are available which indicate whether the supply chain has exceeded optimal conditions. These show a total representative condition however are relatively inexpensive. Tempix is a good example which can be applied as a label directly to packaging, while Timestrip (US$1.60ea for 500) and Cryopak (US$9 ea. for 100) and WarmMark by 3M examples are bulky and more likely to be packed with larger quantities of product. These all need to be activated at the packaging stage



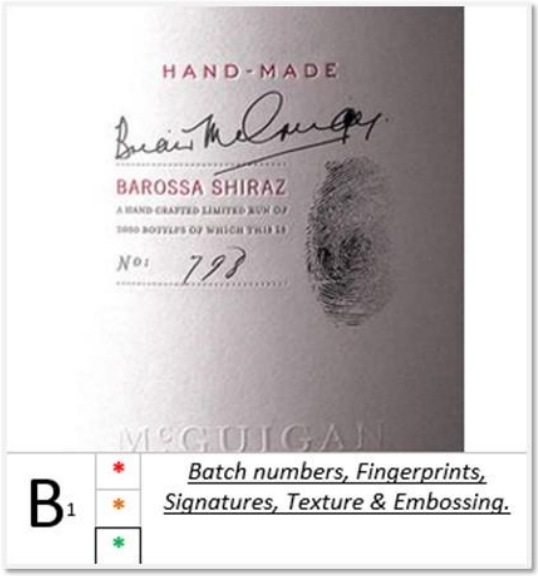
9. **Thermometer Labelling.** These label devices change colour with temperature and are simple thermometer replacements. Examples are 3Ms TLCSENN199 ($1.15ea.)

10. Other examples include: O2xyDot and Ripesense Sensors which are ethylene scavengers and not suitable for meat; Mitsubishi's Moisture and Oxygen Scavengers; Antimicrobials by Agion and Biocompostable Packaging by Bio4Pack

A1

Void Pantograph, Security Paper
For: Revealled Validation
Forces to re-engineering

2



B1

Batch numbers, Fingerprints,
Signatures, Texture & Embossing.

3

C1 — *Recongisable Unique Packaging (For: Consumers Validation Fights: Re-engineering)*

4

D1 — *Destructive Packaging (For: Consumers Validation Fights: Reuse)*

5

E_1

Unique Shaped Product
(For: Consumer Recognition)
(Patent-protectable)

6

F_1

Mould-In Branding
(For: Consumer Recognition)
(Patent-protectable)

7

G_1 Stamped Patterns or Branding (Patent-protectable)

8

H_1 Non-repeating Tessallation Patterns, Chair Substitution Tiling, Aperiodic Tiling

9

I 1	*	One Product with Varied Packaging Sleeves (For: Consumer Options Creates: Complexity)
	*	
	*	

10

J 1	*	Watermarks / Reflective White Ink (For: Consumer Validation) (Creates: Hidden Elements)
	*	
	*	

11

K1 | * | * | *

Miroprint
(For: Consumer/Business Validation)
(Against: Hard to forge)

12

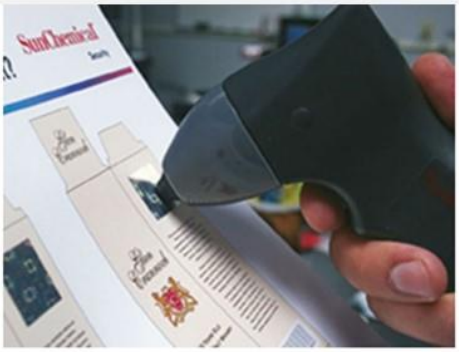
L1 | * | * | *

Thicker Inks - Printed Textures
(For: Consumer Validation)
(Against: Hard to Forge)

13

M_1	* * *	*OVI (Optically Varaible Inks) (For. Showing a large colour shift for validation)*

14



N_1	* * *	*Covert Taggent Inks and Readers (For: Product Tracking and Validation) (Protects Supply Chain)*

15

O_1

Invisiable Ink (UV activated)
Post-production Stamps
(For: Covert Insurance)

16

P_1

Visible and Invisible Fibers
(For: Consumer Detection)
(For: Covert Insurance)

17

Q_1

Thermochromic Inks (For: Brand Building Against: Fast fraud)

18

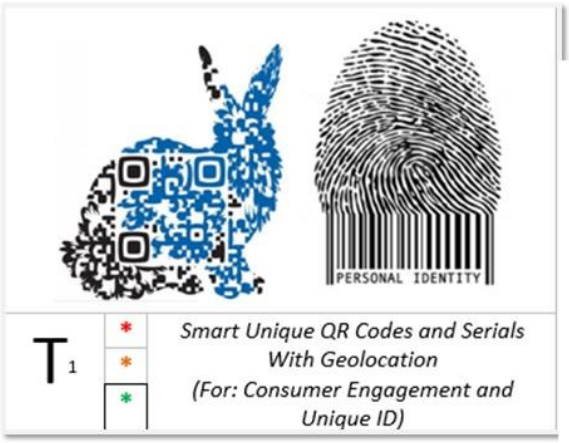
R_1

3D reflective holographic lens image using transfer technology on laminate (For: Consumer Trust and Layered Complixity)

19


Colgate
EXTRA WHITENING
SENSODYNE
S1
Branded Holographic Stickers / Foils or Codes
(For: Consumer Validation and Trust)

20


PERSONAL IDENTITY
T1
Smart Unique QR Codes and Serials With Geolocation
(For: Consumer Engagement and Unique ID)

21

U_1 *Covert Ultra High Frequency RFID Chips (For: streamline supply chains without direct scanning)*

22

V_1 *NFC Programmed Chip OR Sticker Multi-use Scan, Can detect and report number of scans (For: Consumer/Business Interaction)*

23


W1
Printed Memory, Sensing, Wireless Labels
(For: Manufacturing and Supply Chain Tracking and Insurance)

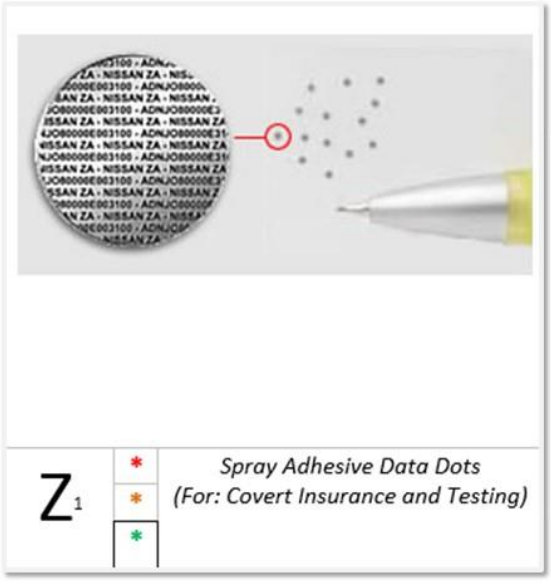
24


Eleaf
Security Code
S/N: 695691641573
X1
Destructive Scratch Layer, Reveal Unique Code.
Scan QR and Enter in Code and Serial to verify product and get rewards
(For: Consumer Validation)

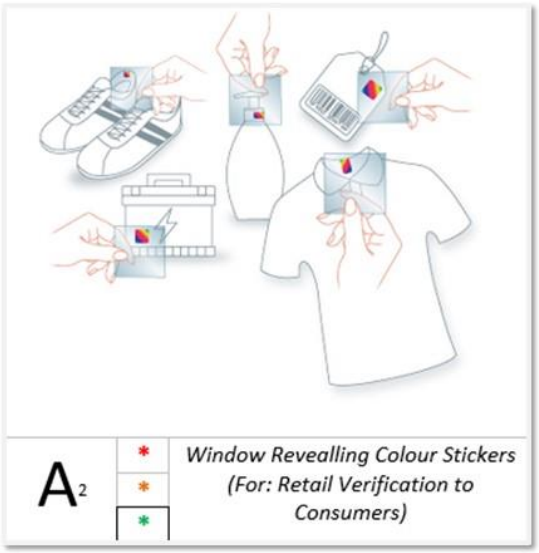
25


AQUA D'OR
CONNECTS THE NEW #PURE
LIMITED EDITION WITH MYPACK® !
CPH
DK
CPH
CPH
DK
DK
Y1
Photorecognition Technology
(For: Consumer Engagement and Ease of Purchase)
(For: accuracy to get results)

26

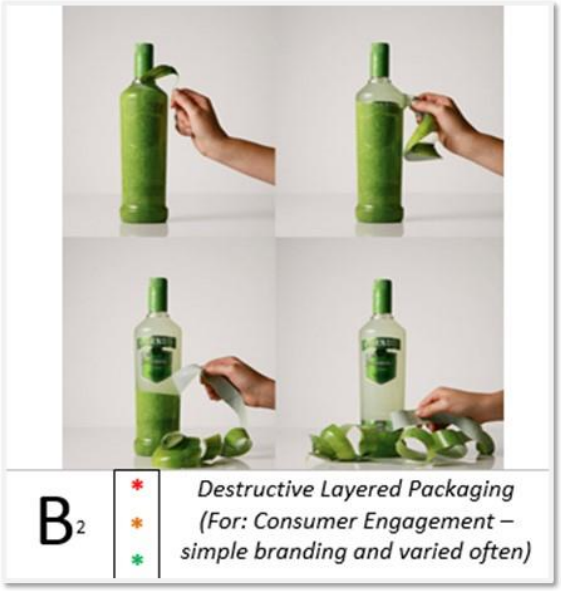

Z1
Spray Adhesive Data Dots
(For: Covert Insurance and Testing)

27



A_2 | * * * | *Window Revealling Colour Stickers (For: Retail Verification to Consumers)*

28



B_2 | * * * | *Destructive Layered Packaging (For: Consumer Engagement – simple branding and varied often)*

29


ID
MaXQ
GS1
Authenticate it
C2
Authenticity Apps for Consumers
(For: Validation of Product &
Consumer Tracking)

30


Maltesers
Ooo!
Push for fun
D2
Simple Electronics/Lighting
(For: Consumer Engagement)
(For: Complexity)

31

Time Temperature Indicator Example Technologies

Summary of TTIs
Smart and Active Pac

5.8 Internet Study Project Scope

Key project scope includes consumer research for on line retail ready e commerce meat products for both Australian and Chinese consumers. This research will be reviewed for against these parameters: 1. Desirability - Product market fit 2. Viability - Achievable revenue and cost structure. 3. Feasibility - Ability to access key resources
Data will be sourced through an on-line conjoint trade off study with consumers of beef products, including in store and on line foreign meat products. The same study will be presented to consumers from both China and Australia with the study translated into the appropriate language. Consumers will represent population requirements of each country population (ie fit to general age, gender, location, etc), so that the sample data can be extrapolated to the entire population. Consumers will cover population requirements of

- **Gender:** Male/ Female mix
- **Age:** 25-65+
- **Location:** State/ Province (% based on population)
- **Living Arrangements:** Who live with and children
- **Household Income:** range of incomes
- **Employment:** range of employment

- 406 consumers in Australia took the study
- 607 consumers in China took the study
- They were consumers of beef at least 1 x month or more.
- Purchasers of foreign meat for China.

From this data, A number of untested concepts will then be generated for this research.

5.9 Key Methods

Understanding Desirability. They key method used was a Conjoint study. This method was used to better understand the value of different parts or elements of the concepts. While a concept test could have been used, (ie creation of 10 concepts and test for purchase intent and uniqueness along with pricing) it would not have shown the individual value of different parts of the concepts. Conjoint has been in use since the 1970's. It involves presenting choices to the consumer and then analysing what the drivers were. It allows for:

- Understand the hidden rules people use to make trade-offs between different product features.

- Quantify the relative values for different features of an offer.
- These values are called part worth's and are relative each other. More positive is better, more negative is worse in comparison to each other.

To develop a conjoint study an experimental design is built. Different categories are considered with variations of different levels within each category.

Understanding Value. They key method used was a partial Van Westendorp pricing model. This involves asking consumers two key questions.

1. What is the price as which this product as described will no longer be a good value.
2. What is the price at which this products quality would be in question.

Answers are provided as a range of prices, of which the consumer chooses one. When these two curves are graphed against each other they show the price consumers are willing to pay. By asking about the six key technology benefits in this way, we can show how much consumers are willing to pay for each of the benefits. The conjoint part worth value can then be used to simulate the market share for each of the concepts that can be created.

Understanding Feasibility. Once the value that consumers are will to place on various technology benefits is determined along with the market share for a given concept. The upper financial limit for the technology benefit will be determined. This sets part of the feasibly assessment, as many of the technologies under review are more expensive than what consumers are willing to pay. This allows for a discussion of future technology development and investment for application based on the size of the opportunity.

5.10 Study Design

An overall Framework using Kano models was built to better understand what attributes are likely to drive different experiences of choice. (See figure 1(. Kano (1) is a model that was developed based on the fact that not all attributes are equal. Expected attributes (or must have) are attributes that could cause a user to reject the product. In the food industry most of the focus has been in this area. However, there is a limit to how much they will drive satisfaction. Spending more resources will not necessarily result in consumers paying more for a product. Normal attributes (more is typically better) are attributes that build a brand. Putting more effort into these attributes will drive a high price. Delighter attributes are attributes that drive emotional engagement with the product. These are attributes that users will pay more for. They typically can not articulate them, as they don't know what they are until they experience them.

Figure 18 Kano Model

- Take care of consumer expectations in sequence from expected to normal to exciting.
  - Expected keeps you in business
    - If not there, consumers may reject the product
  - Normal drives competitive performance gaps
    - Drives consistency and message
  - Exciting drives differentiation
    - Drives brand equity
- New products should:
  - Meet as many of the "Expected" features as is practically possible.
  - Have a few "Exciting" criteria to put you above your competition.
  - Keep "Normal" criteria functional enough to remain positive.
- Kano Analysis changes over time
  - Quality that was exciting becomes normal then expected as the technology matures and features become more common.

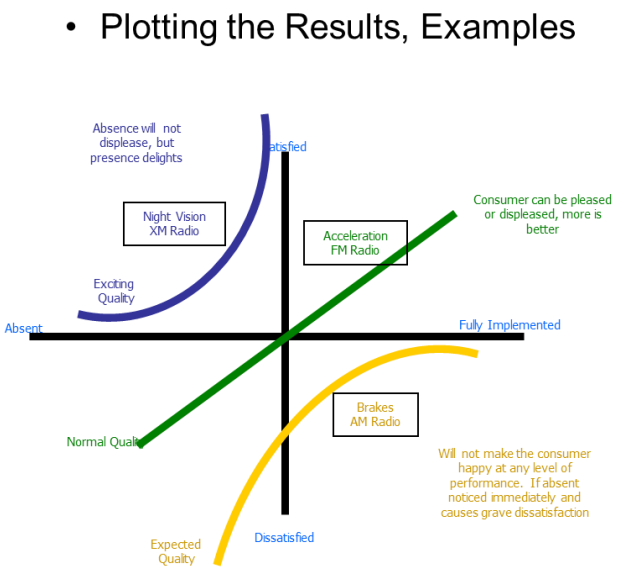
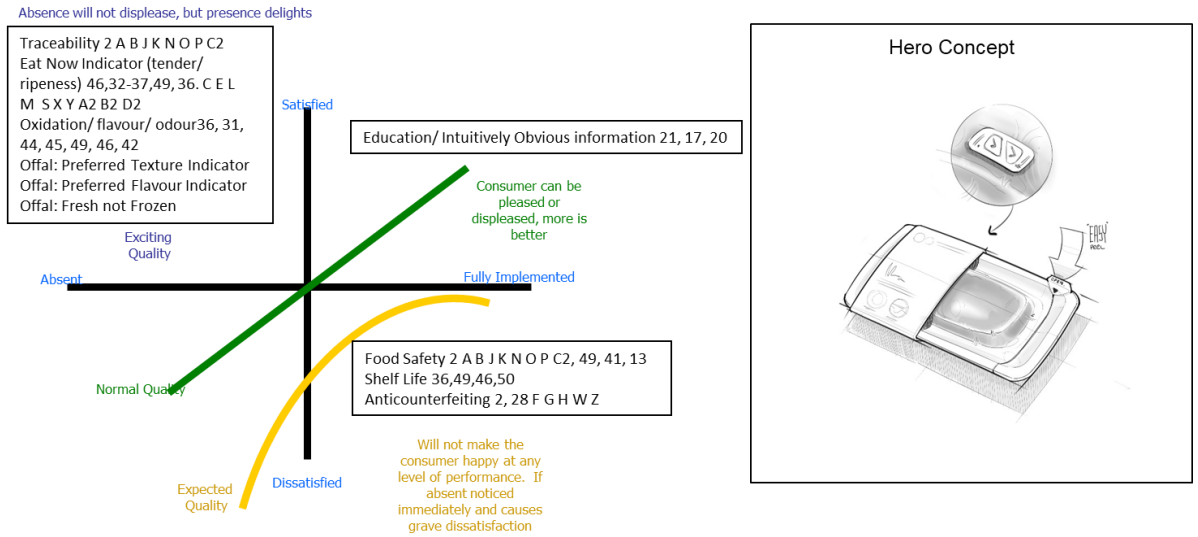


Figure 19 shows the hypothesised kano model for on line retail ready, along with a potential hero concept. Expected attributes include food safety, shelf life and anti-counterfeiting. Normal attributes include education and intuitively obvious information for the consumer. Delighter attributes include traceability, an Eat now indicator to show level of tenderness or ripeness; and oxidation, flavour, odour indicator.

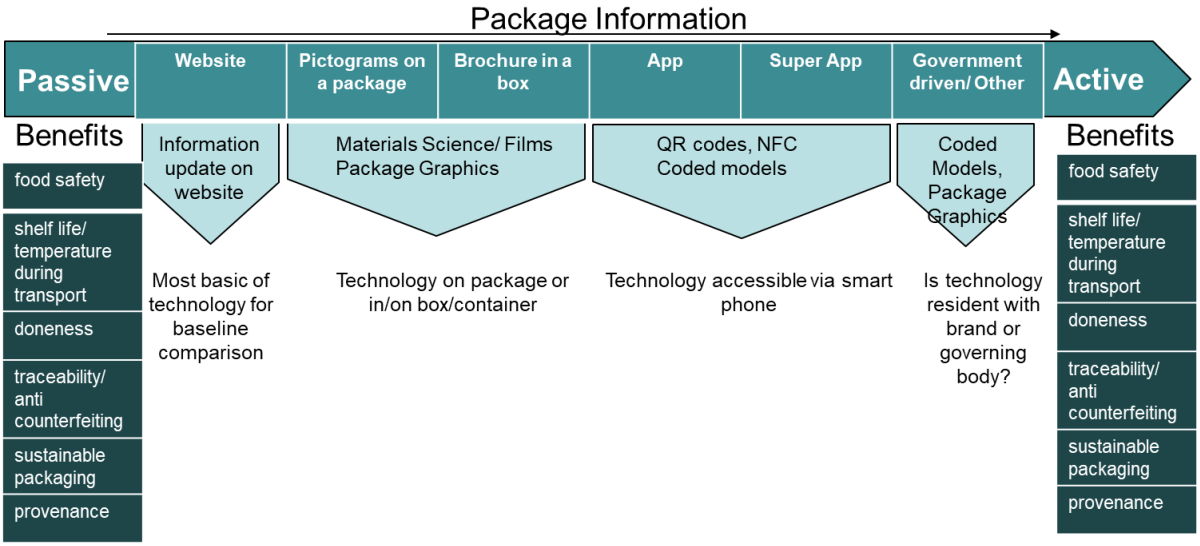
Figure 19. Hypothesised Kano Model for On line Retail Ready



From this model and the review of 75 technologies and 35+ anti counterfeiting technologies to deliver in this area, 36 concept elements were created. These concept elements were considered in terms of information push vs pull to consumers (ie how passive or active the information need to be). Passive to active communication with the consumer allows for six categories to be considered: (see figure 20).

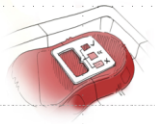
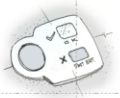
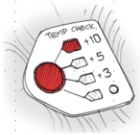
- **A website** that consumer search for, as this is the most basic of information technology. The primary technology needed for this area is IT and updates to a website. This provides a baseline comparison for all other technologies to be compared against. Companies who have limited interest in smart packaging may find this to be a technology option to consider, until they feel the risk has been largely reduced from the market place.
- **Pictograms on a package**, this is a simple means to provide information to the consumer. However, many consumers are already overwhelmed with too much information on the package. The primary technology need for this area is materials science and film development. Design of these packaging graphics is critical to ensure the information is intuitive to consumers. This area has limited technical capalbities for food safe materials to place on a flex package. This primary packaging requires that all materials be food safe.
- **Brochure in a box.** As this is on line retail, the product will likely be shipped in a secondary outer container. This allows for an additional insert or for the information to be printed on the secondary packaging. The primary technology need for this area is materials science and film development. Design of these packaging graphics is critical to ensure the information is intuitive to consumers. The requirement that these be food safe is limited.
- **App/ Super App**. This begins to explore how much technology should be connected to an additional device, typically a smart phone. This allows for more complex information to be provided to the consumer. Most technology leverages QR codes or Near Field Communication devices (NFC). Many companies have already invested in some form of QR Code/ barcode. These technologies under consideration allow for a connection of the package information to primary websites. While these can direct consumer to the website (or particular locations on the website), they can also provide some information to the company on location of where the product is sold and as such can provide authentication, and anti counterfeiting benefits. The Super App looks at technical capalbities that may not exist today.
- **Government Driven/ Other**. This begins to explore the value of government certifications to understand how much value the technology provides to the brand or to the governing body. Are consumer more likely to trust a governing body for this information or can the brand cover all this information themselves?

Figure 20 Packaging Information vs Benefits

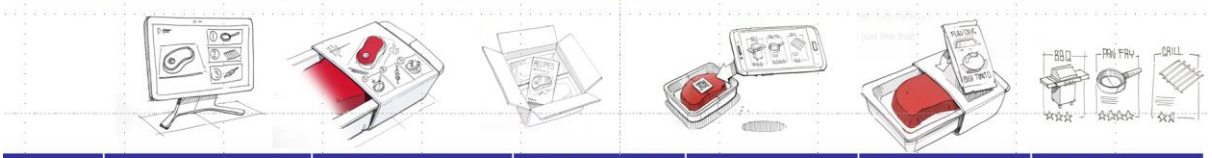


The technology benefits were considered in terms of delivery of food safety, shelf life/ temperature during transport, doneness, traceability/ anti counterfeiting, sustainable packaging, provenance. For the study six levels of each were considered. This resulted in a 6 by 6 matrix design with all elements presented as words and images to provide a clearer description for consumers. (see figure 21)

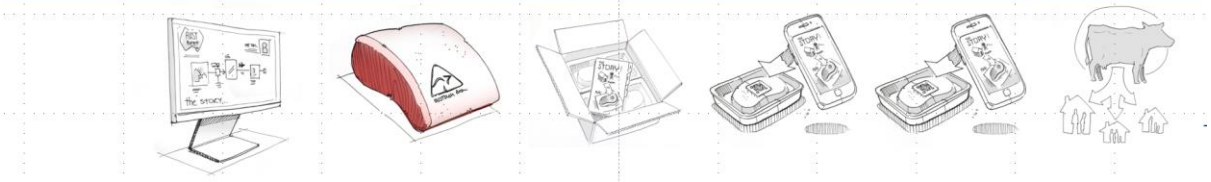
Figure 21 Design of concept element levels for each of the six technology benefits.

	Basic	Pictograph on Package	Brochure in Box	App	Government Certification	Super App
Food Safety	Info on the website shows what the impact of colour of the meat is on how safe it is to cook and eat.	Compare the colour of the meat through the window vs one of the sides of the square to see how safe the meat is to cook and eat.	indicator that changes from gasses given off by the meat, not temp	scan the QR code/ barcode with your smart phone to determine how safe the meat is to cook and eat.	Green food logo on pack	scan the colour of the meat with your smart phone to determine how safe the meat is to cook and eat.
						
	Basic	**Pictograph on Package**	**Brochure in Box**	**App**	**Government Certification**	**Super App**
Shelf Life/ Temp during transport	Info on website gives you typical time frames for how long you can store meat at various temperatures.	On pack label with snowflake symbol or thermometer or similar	A temperature sensor that changes colour irreversibly if the meat has been exposed to an unsafe temperature during transport	A temperature sensor that shows different colours depending on the temperature the meat has been exposed to during transport	scan a code that shows the temp of your meat along its journey at various check points	Scan with your smart phone to determine how safe the meat is to cook and eat. The app's microscope will count surface bacteria
						

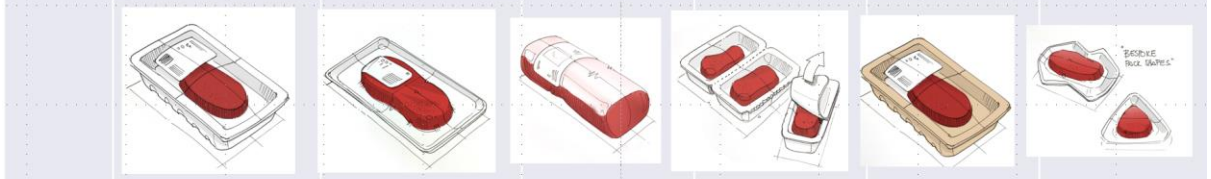
	Basic	Pictograph on Package	Brochure in Box	App	Government Certification	Super App
Doneness/ Tenderness at end, Fit of cut to cooking method, flavour	info on website shows you the cooking methods your cut of meat works well with.	A simple pictogram of methods this cut of meat works well with... choose your cooking method and know your meat will turn out great.	recipe card with cooking/prep instructions for each cut of meat in your order box	The Meat app is designed to help you cook the perfect steak Just enter the degree of doneness, cooking method, thickness of the cut and tenderness you want for your steak.	Open the package and a fresh meaty odour comes out	The Meat app is designed to help you cook the perfect steak - use the app's thermal imagining camera, it tells you when your pan in hot enough to put the steak on



	Basic	Pictograph on Package	Brochure in Box	App	Government Certification	Super App
Provenance / sustainability	info on website shows you where your meat comes from and standard AU farming practices	Australian grown and made branded on the fat side of your meat.	brochure in pack with farm to plate story and other relevant breed info	scan the QR code to find why we think it is important that you meet who and how your meat was handled from the farm to your fork.	scan to find out how sustainable the farming practices are and how you can offset the meat's carbon footprint	Buy a whole cow to share with family & friends. Every cut will be allocated ensuring nothing is wasted



	Basic	Pictograph on Package	Brochure in Box	App	Government Certification	Super App
Packaging sustainability	MAP	Vacuum Skin Pack with tray	full vac no tray bulk	Individual portion pack	bio-degradable packaging	unique shape meat with complete fit to unique tray



	Basic	Pictograph on Package	Brochure in Box	App	Government Certification	Super App
Traceability/Anti counterfeiting	info on website shows you how we packaging and transport the meat	Unique packaging design and branding lets you know your product is genuine	Your order is delivered with microchip that can be scanned to prove authenticity	scan the QR code to find why we think it is important that you meet who and how your meat was handled from the farm to your fork.	enter tracking number for a real-time update of your order and its location	scan the QR code to find out how your meat travelled to you. We can show you every link in the chain as the meat went from farm to fork. Using the latest blockchain technology

5.8 Desired Concepts

When consumers consider food safety as a top of mind consideration, the Australians and Chinese use some similar and some different cues to determine if the meat is safe to eat. Table 5 shows the difference between Australian and Chinese consumers. While both markets look at use by dates, colour of the flesh and smell when opening, Chinese consumers also consider the feel of the meat (ie typically by poking the package), and the colour of the fat.

Table 5 How do you know if meat is still safe to eat?

	Australia	China
Use by date	81%	70%
Colour of flesh	74%	85%
Smell when opening package	73%	68%
Slime on meat	40%	31%
Feel of the meat	32%	58%
Colour of fat	29%	47%
Swollen packaging	26%	40%
Amount of blood leeched from meat	21%	43%
Other (please specify)	1%	0%

When consumers consider online retail ready, for both the Australian and Chinese markets, top of mind concerns are different. When consumers are asked directly, about the barriers to purchase in grocery or on line, their responses are different. (see tables 6,7) In Store retail reflects issues seen in the marketplace. For Australians, in store, the biggest barrier is price. The barrier of availability follows price, but to a much lesser extent. Consumers are fairly satisfied with their meat safety, choices and thus focus on price. For Chinse consumers, in store retail reflects issues they see in terms of availability, freshness, clarity of labelling, such that price becomes a lesser factor. When the same question is asked of on-line retail. We can begin to see where the opportunities open up in this different channel. For Australia, safety during transport, price and freshness are key for on line. For China, freshness and quantity are key for on line. This means that the information provided to the consumers needs to take into account these issues.

Table 6 What are the barriers to purchasing meat from Australia instore?

	Australia	China
Price	60%	28%
Convenience	10%	21%
Availability	20%	43%
Not fresh	9%	18%
It was frozen	9%	40%
Not enough variety of cuts	10%	21%
Not prepared the way I want	9%	13%
Not clearly branded, looks like private label	11%	25%
Don't know how to cook	3%	7%
Not a familiar cut	6%	17%
I don't trust Australian meat	0%	3%
The quantity of meat per package was unsuitable for my needs	7%	9%
Other	17%	1%

Table 7 What are the barriers to purchasing meat online from Australia?

	Australia	China
Price	29%	15%
Convenience	15%	13%
Availability	12%	21%
Not fresh	27%	30%
It was frozen	14%	39%
Not enough variety of cuts	6%	18%
Not prepared the way I want	6%	14%
Not clearly branded, looks like private label	10%	24%
Don't know how to cook	3%	7%
Not a familiar cut	7%	14%
Not sure how to order	14%	8%
Not sure about how safe it is after transport	33%	1%
I don't trust Australian meat	1%	10%
The quantity of meat per package was unsuitable for my needs	6%	34%
The minimum quantity I need to order is unsuitable	14%	7%
Other	18%	4%

While top of mind data can help us understand what consumer think when asked directly, they can act differently when presented with different options. Conjoint give us a better idea of how to predict what will happen when a set of choices are presented to consumers.

The overall objective was to create three desired concepts. Combining this data with the part worth values from the conjoint study, and considering the technology feasibility issues four concepts were created. These four concepts included: (see table 8)

- The top concept for the Australian market
- The top concept for the Chinese market
- The top concept for both markets
- An easy entry concept. This concept covers available technology and information that can be passively presented to consumers. This was created for companies that would prefer to see the market risk reduced before engaging with these technologies.

These concepts assume all technologies are available in the market place. Technical feasibility will impact which of these concepts could be moved forward.

Table 8 four desired concepts.

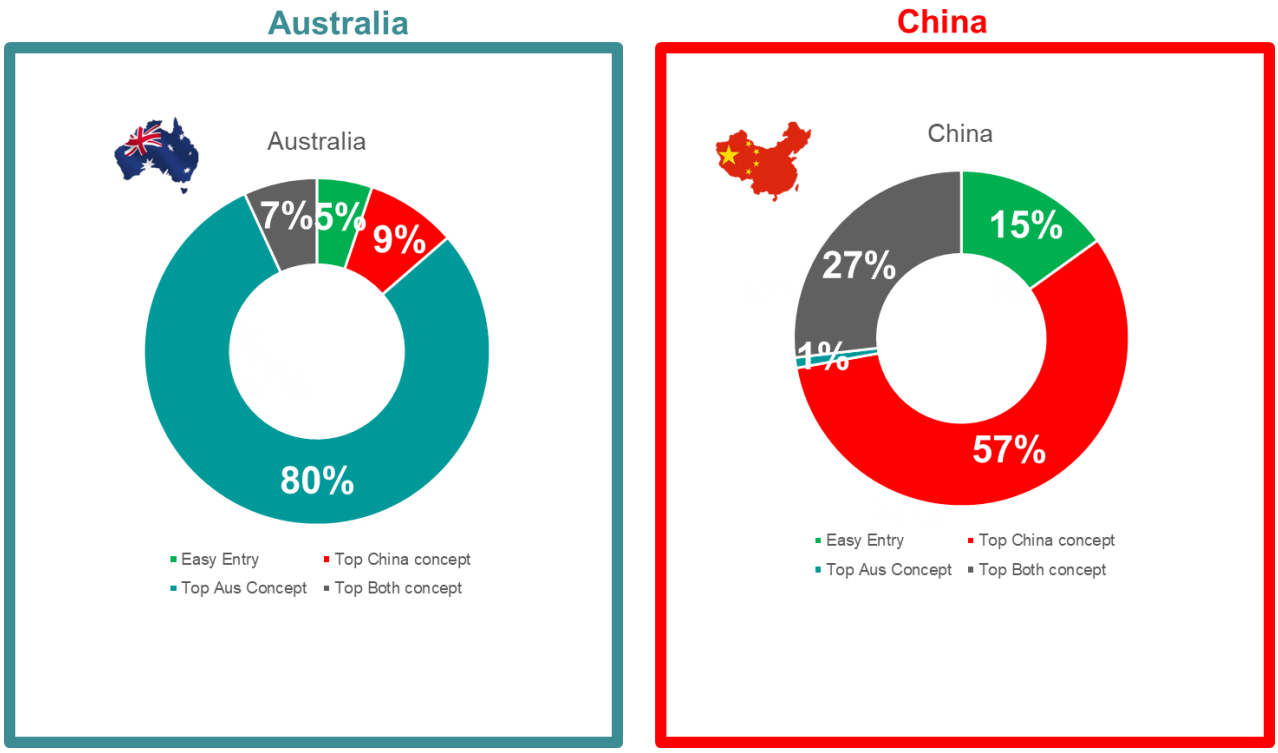
Elements	Top Aus Concept	Top China Concept	Top Both Concept	Easy Entry
Food Safety	**scan the colour of the meat with your smart phone** to determine how safe the meat is to cook and eat.	**Green food logo on pack**	**Info on the website shows what the impact of colour** of the meat is on how safe it is to cook and eat.	**Info on the website shows what the impact of colour** of the meat is on how safe it is to cook and eat.
Shelf Life/ Temp during transport	A **temperature sensor that changes colour irreversibly** if the meat has been exposed to an unsafe temperature during transport	Scan with your smart phone to determine how safe the meat is to cook and eat. **The app's microscope will count surface bacteria**	**scan a code that shows the temp of your meat along its journey** at various check points	**Info on website gives you typical time frames** for how long you can store meat at various temperatures.
Doneness/ Tenderness at end, Fit of cut to cooking method, flavour	**A simple pictogram of methods this cut of meat works well with**... choose your cooking method and know your meat will turn out great.	**The Meat app is designed to help you cook the perfect steak** - use the app's thermal imagining camera, it tells you when your pan in hot enough to put the steak on	**A simple pictogram of methods this cut of meat works well with...** choose your cooking method and know your meat will turn out great.	**info on website shows you the cooking methods your cut of meat works well with.**
Packaging & sustainability	**Vacuum Skin Pack** with tray	**Individual portion pack**	**Individual portion pack**	**Vacuum Skin Pack** with tray
Traceability/Anti counterfeiting	**scan the QR code to find out how your meat travelled to you**. We can show you every link in the chain as the meat went from farm to fork.using the latest blockchain technology	**Unique packaging design and branding** lets you know your product is genuine	**scan the QR code to find out how your meat travelled to you**. We can show you every link in the chain as the meat went from farm to fork.using the latest blockchain technology	**info on website** shows you how we packaging and transport the meat
Provenance / sustainability	**scan to find out how sustainable the farming practices are** and how you can offset the meat's carbon footprint	**info on website shows you where your meat comes from and standard AU farming practices**	**info on website shows you where your meat comes from and standard AU farming practices**	**info on website shows you where your meat comes from and standard AU farming practices**

What is clear from these concepts are that the preferred solutions are different for the different markets. Australians prefer pictographs and apps, not websites or government solutions. They are looking for the information to be more of the mid range of passive to active presentation to them. The Chinese prefer more government and app solutions. For food safety, they want government credibility, otherwise they are looking for a more active, digital information presentation that is not typically resident on the package. This suggest that the Chinese are looking for the package to be closer to the internet of things than the Australians are. Neither market is looking for the information to be on the secondary packaging, but connected to the primary packaging. The

solution that best fits both markets is a variety of website info, pictographs and active digital information. The easy entry concept looks primarily at websites and passive information for the consumer.

When the four concepts are modelled for the two markets using the part worth values, we can see the market share each concept achieves in the respective market in figure 5.

Figure 22 Market share of four key concepts in total market



The simulated market share of the four concepts show that while easy entry as a concept does not require any additional technology investment, its value is 5% of the Australian market and 15% of the Chinese market. This suggests that not investing in technology will put a company at a limited market size of prize advantage to those who do invest. From the market share the top Australian concept shows it will have 80% of the market, but only 1% of the Chinese market. The top Chinese concept while having 57% of the Chinese market will only provide 9% of the Australian market. The top concept for both markets only has 7% of the Australian market and 27% of the Chinese market. These numbers suggest that a single solution will not solve for the greatest market impact. The solution needs to have multiple pathways for resolution.

Size of prize calculations are developed based on the following assumptions. (All dollars are AUD) see table 9.

1. Size of market: Australia: $8,600,000,000 China: $ 781,921,000 (Australian Exports to China) (4)
2. % of market that is online: Australia: 1% China: 5% (5)

Size of online market: (1x2) Australia: $86,000,000 China $ 39,096,050

Growth Rate of online market: Australia: 13% China: 16% (6)

While the size of prize for the various concepts is small, this is due to the limited size of the market with a 13% to 16% growth rate, each market will develop quickly.

Table 9 Size of prize for four concepts

	Size of Beef Market	% of Market on Line	Market Share for concept	Size of Prize for Concept
Australia Market	**$8,600,000,000**	**1%**		
Easy Entry			5%	$ 4,300,000
Top Aus Concept			80%	$ 68,800,000
Top China Concept			9%	$ 7,740,000
Top Both Concept			7%	$ 6,020,000
China Market	**$ 781,921,000**	**5%**		
Easy Entry			15%	$ 5,864,408
Top Aus Concept			1%	$ 390,961
Top China Concept			57%	$ 22,284,749
Top Both Concept			27%	$ 10,555,934

Impact of Urban vs Rural

Given the supply chain issues within China for cold supply chain, it was desired to consider the impact of the top concepts on urban vs rural choices. (Figures 23,24) For both Australian and Chinese consumers, the rural consumer is looking for a more conservative choice than urban consumers. For urban consumers, the access to the internet is key to providing information. Urban consumers are more willing to consider multiple options. The easy entry concept shows more share in the urban locations and typically zero show in rural locations.

Figure 23 Urban vs Rural for Australia

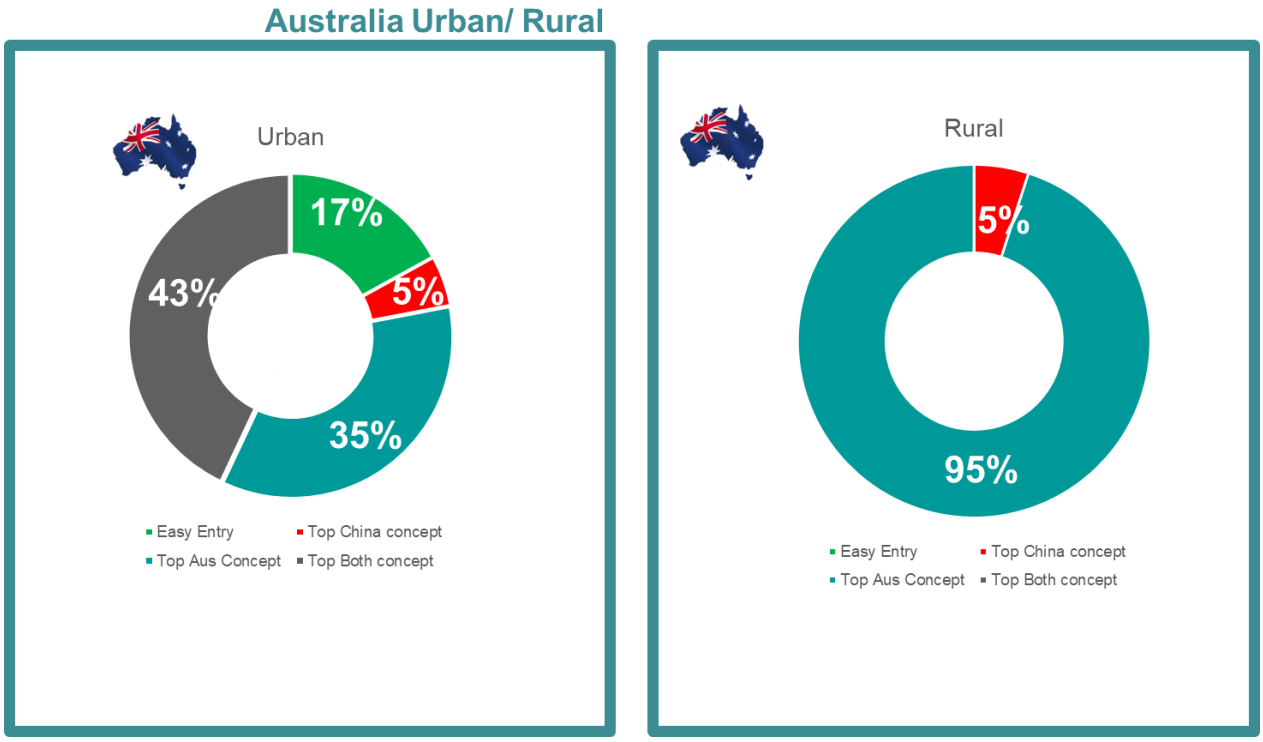
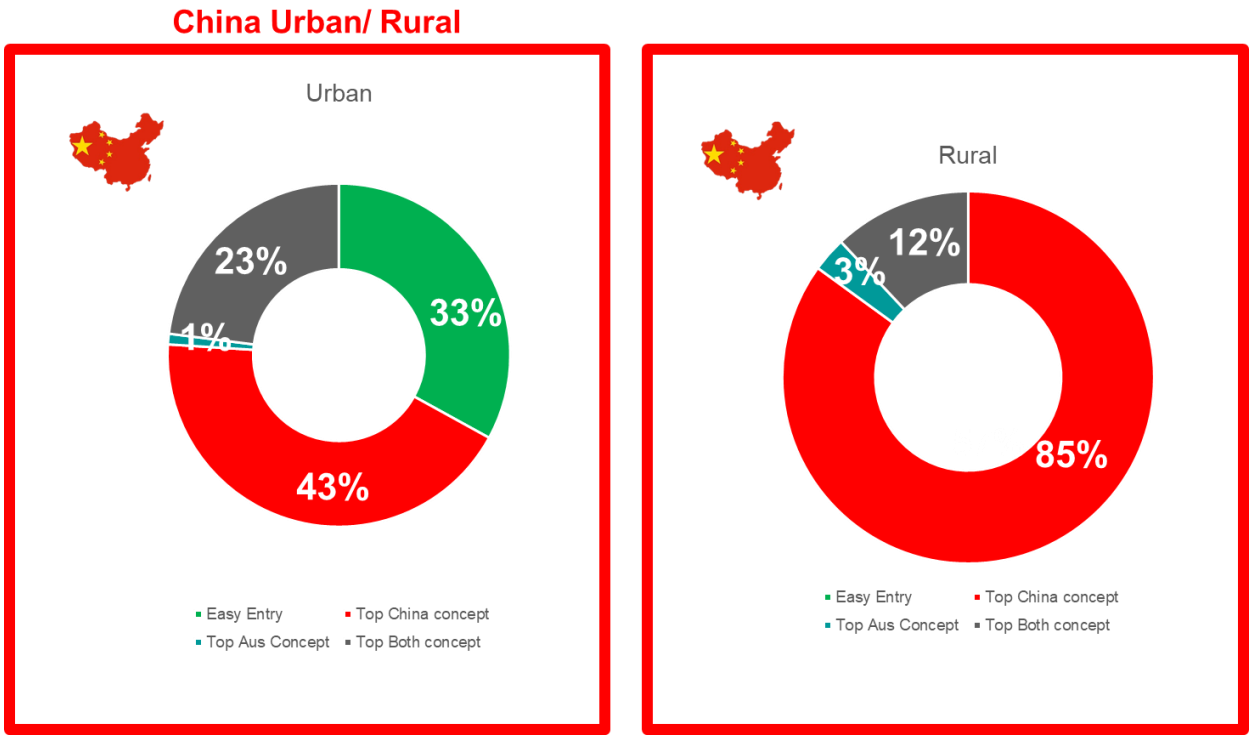


Figure 24 Urban vs Rural for China



All of the potential 720 concepts can be modelled to determine market share for:

- Overall Australia, China Market
- Urban Australia, China Market

- Rural Australia, China Market.

This is located at https://jigsaw-simulator.azurewebsites.net/#/jigsawsimulator/dashboard.

5.9 Value and Fit to Kano Frameworks

The Kano framework gives us a method to consider all benefits/ attributes are not equal, and as such consumers will spend money for attributes to have them or they will assess attributes and choose or reject the product on them.

When considering the six key technology benefits of food safety, shelf life/ temperature during transport, doneness, traceability/ anti counterfeiting, sustainable packaging, and provenance an initial hypothetical kano framework was created. This was tested during the conjoint study and the hypothesized and actual kano framework are show in figures 25 and 26. While kano research has a very specific methodology, much of conjoint (as it is trade off based) can be used to confirm the kano framework.

Figure 25 Hypothesised Kano Model for Online retail ready

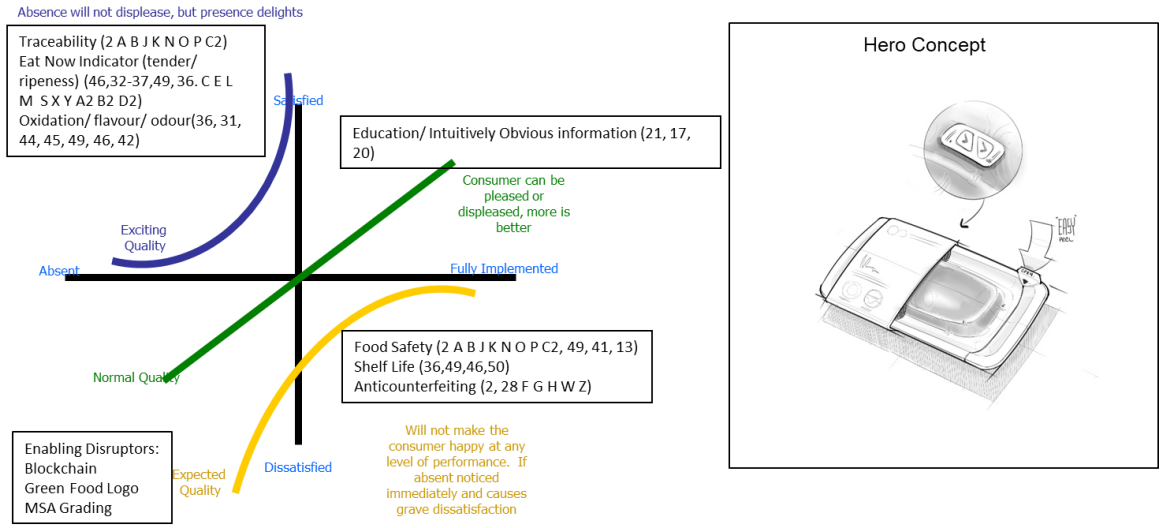
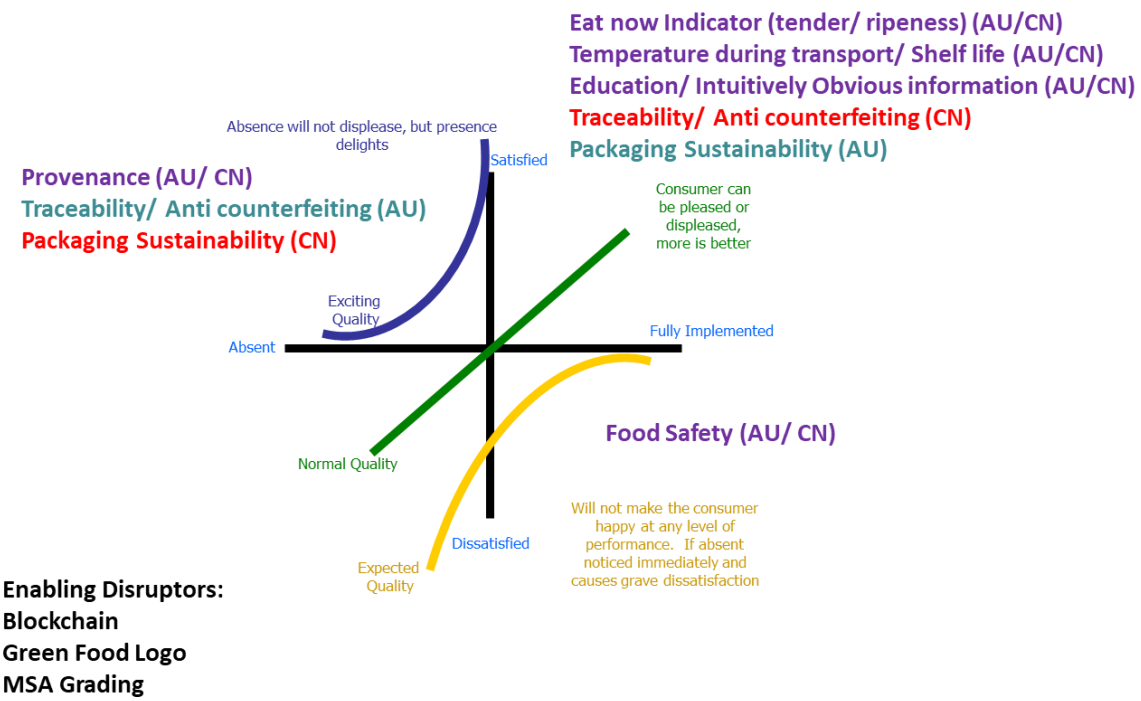


Figure 26 Actual Kano Model for online retail ready both Australia and China. Both countries in purple, China in Red. Australia in Aqua.



The actual kano model shows that food safety is an expected attribute. Consumers are not willing to pay more for it, but could reject the product based on food safety concerns. While Australian food safety is not a major issue. Rejection of product based on this could impact more than just an individual company. ***This would impact "Brand Australia".***

Normal attributes for both Australia and China are Doneness (eat now indicators), temperature during transport/ shelf life, education/ intuitively obvious information. For China, treatability and anticounterfeiting and for Australia, packaging sustainability. This suggest these attributes are ones that consumer will pay for and want more of.

Delighter attributes for Australia and China are Provenance, for Australia Traceability and Anti counterfeiting and for China Packaging sustainability. These are attributes that consumers would like, but may not be aware that they could have. They tend to drive a stronger emotional response to the product than other attributes.

When considering the value and how much consumers are willing to pay for these attributes, the Van Westendorp model provides a range of value. Consumer data was split by Lead users, Mainstream users and Laggards. These are segments of consumers who will actively seek out new benefits (lead users), wait to hear the value of these benefits (mainstream users) and wait until the very end of the benefit value is determined to adopt new benefits. This is based on the Von Hippel Models of adoption of new benefits (3). These consumers were segmented based on responses to the following questions:

- You are often consulted, asked for advice regarding the newest brands, products, services for premium food products?

- You consider yourself to be 'ahead of the curve' when it comes to newest ideas, brands, products for premium food products?
- You are usually the FIRST within your circle of friends to buy, try new products, brands for premium food products?
- You usually purchase the newest and latest regardless of cost for premium food products?
- Learning about new products, services, brands is exciting to you for premium food products?
- You try the newest brands because it insures you are getting the latest and most up-to-date options for premium food products?
- You feel 'left out' if you're not quick to own newest items/services for premium food products?
- Newest products and services most often 'give you what you want' for premium food products
- You make it a habit to keep up-to-date on what's new, what is the latest for premium food product
- You see new products and services as making your life 'more convenient' for premium food product
- Being seen as the 'go-to' mentor regarding new products and services makes you 'feel good' and in the know for premium food products?

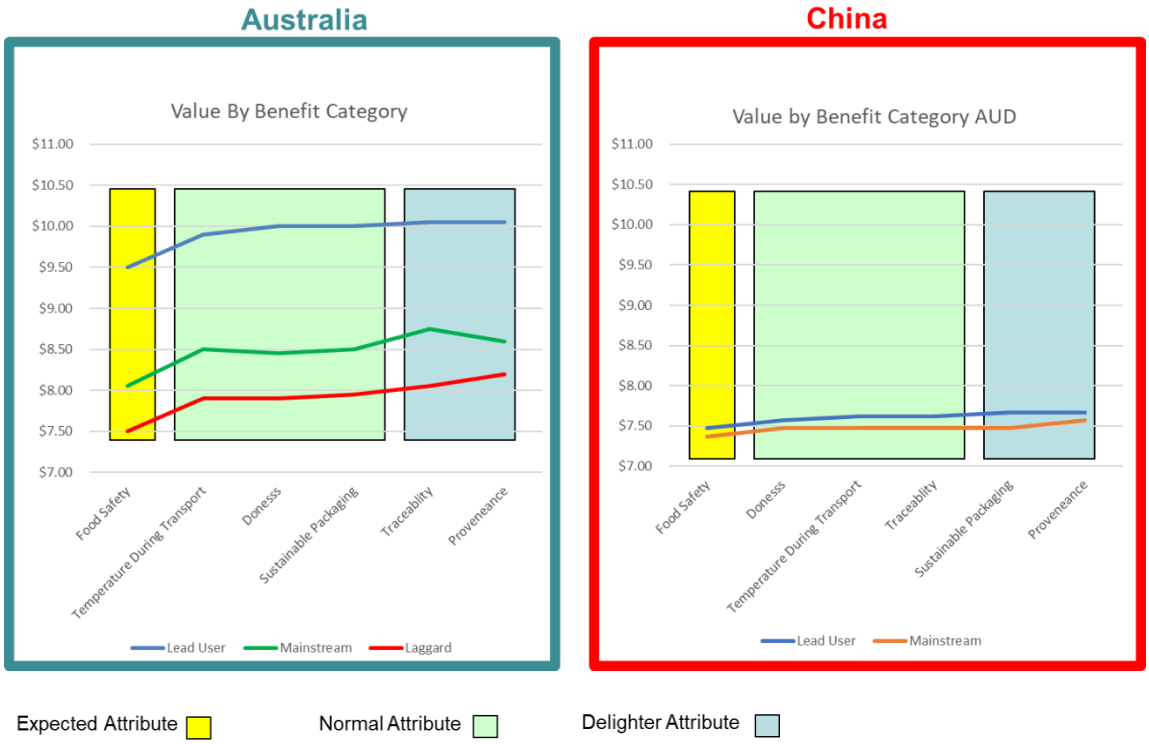
The key method used was a partial Van Westendorp pricing model. This involves asking consumers two key questions.

1. What is the price as which this product as described will no longer be a good value.

2. What is the price at which this products quality would be in question.

Answers are provided as a range of prices, of which the consumer chooses one. When these two curves are graphed against each other they show the price consumers are willing to pay. By asking about the six key technology benefits in this way, we can show how much consumers are willing to pay for each of the benefits**.** By using these segments, we can show the range of price that these technology benefit provide. All values are shown in Australian Dollars in figure 27.

Figure 27 Value by benefit category for Australia and China.



When the value of the food safety benefit is subtracted from the other technology benefit categories, the range of price for the technology benefits can be seen in figure 28.

Figure 28. Additional value by benefit category.

These figures show that Australian consumers are willing to pay more for each benefit category than Chinese consumers. It shows that delighter attributes are worth more to both markets. Independent of the segment of consumers (lead, mainstream or laggard), they in general see the benefits of the technology categories as being worth a similar amount of money.

This data is based on the partial Van Westendorp pricing model. This involves asking consumers two key questions.

1. What is the price as which this product as described will no longer be a good value.

2. What is the price at which this products quality would be in question.

For each technology benefit category, the model looks for the overlap between these two questions. This overlap is the price consumers are most willing to pay. These are shown in Figures 29-34.

Figure 29 Impact for Food Safety

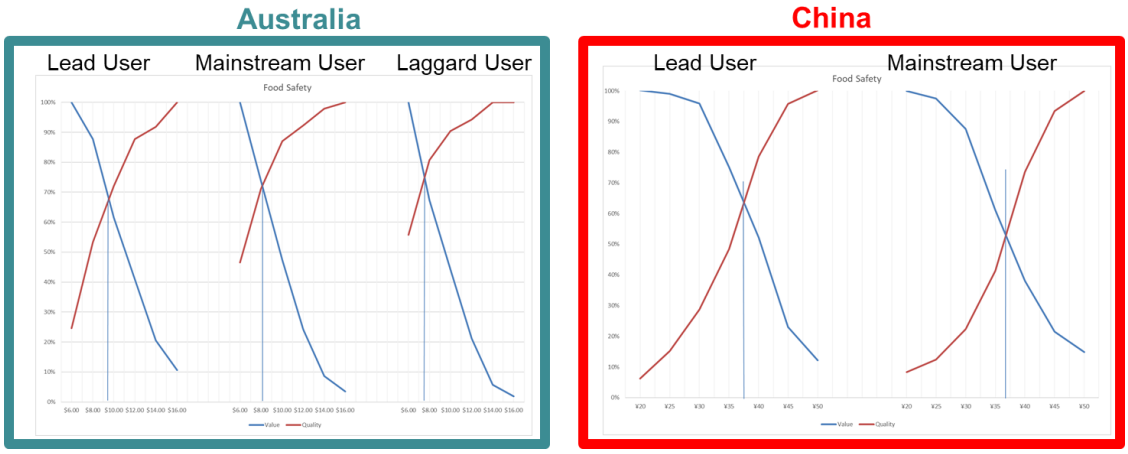


Figure 30 Impact for Doneness

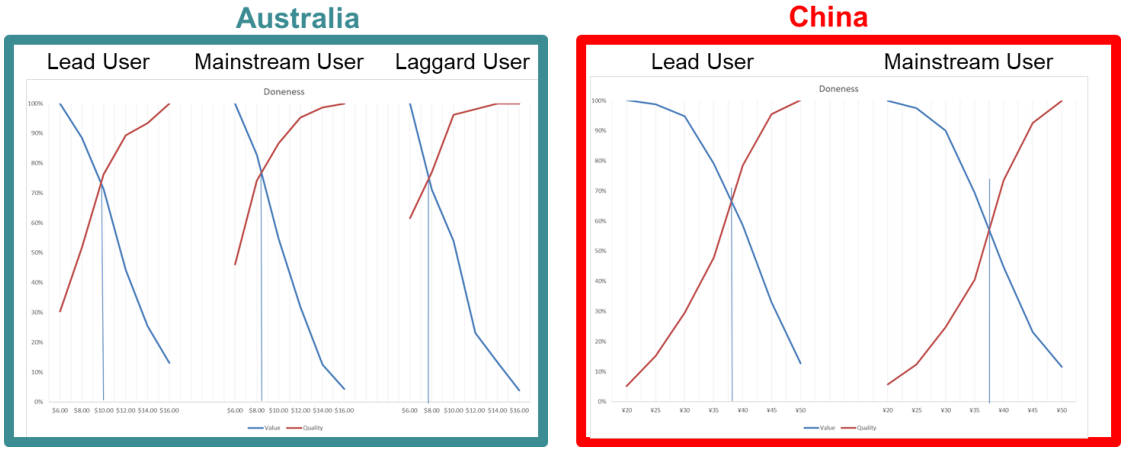


Figure 31 Impact for Temperature during Transport

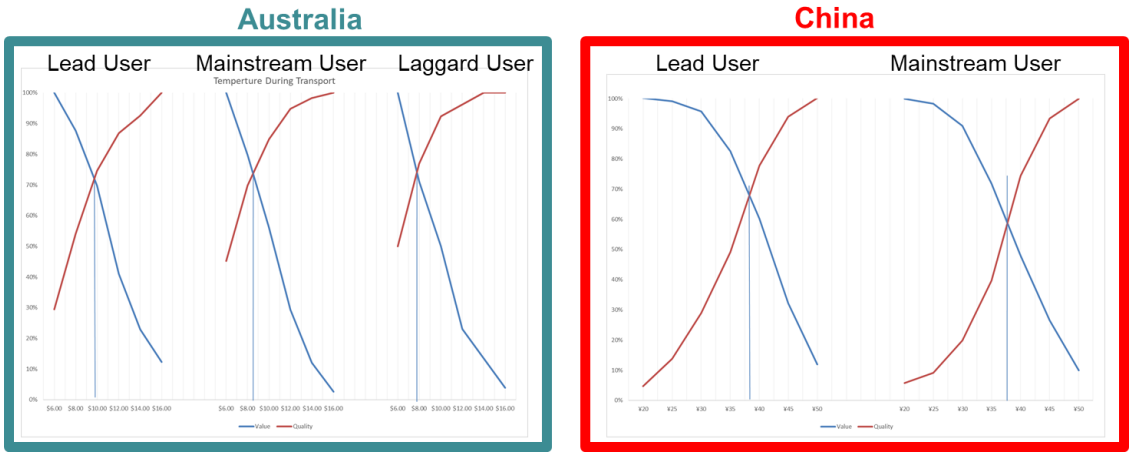


Figure 32 Impact for Traceablity/ Anti Counterfeiting

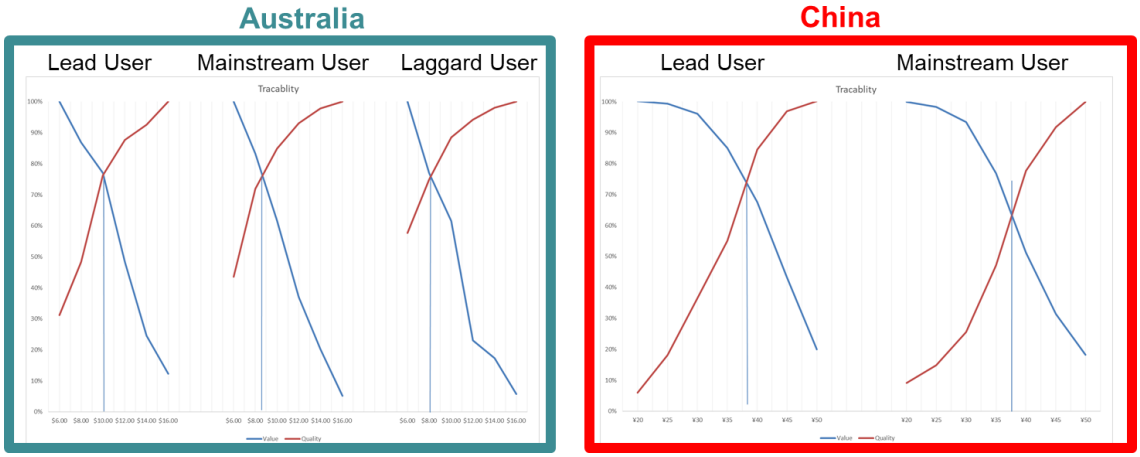


Figure 33 Impact for Packging Sustainablity

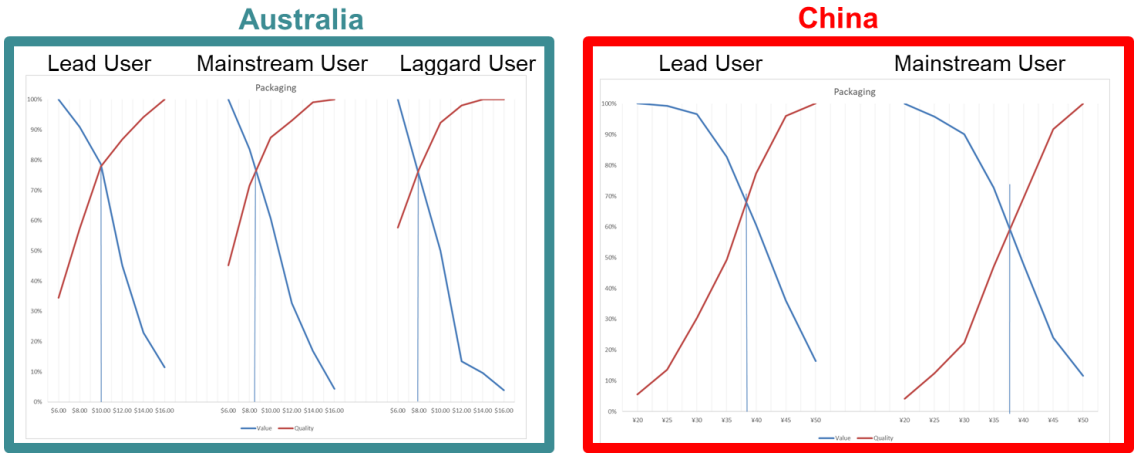
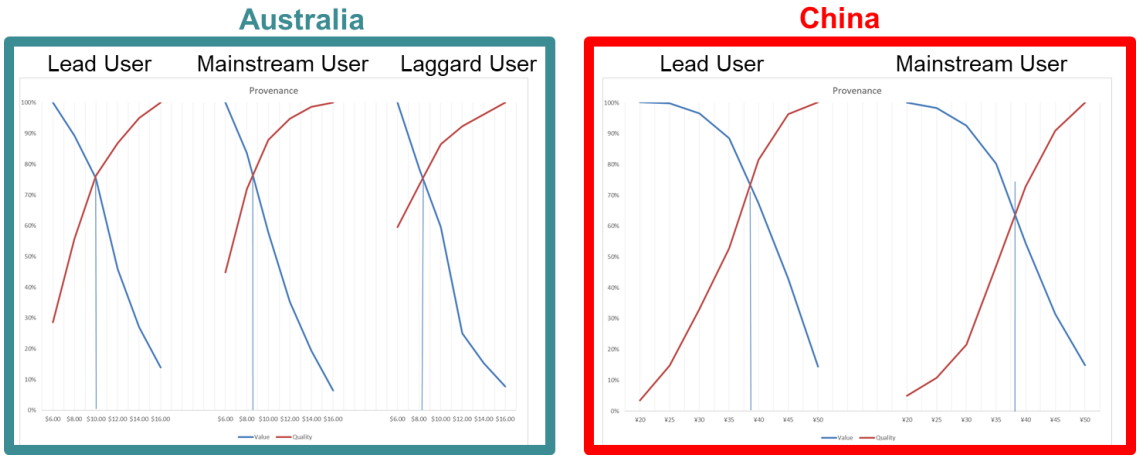


Figure 34 Impact for Provenance



5.10 Feasibility of Technology

A variety of technologies have been considered from the 108 technologies identified. A review of the key technologies available on the market include time temperature indicators, temperature indicators – thermometers, passive RFID temperature indicators, temperature data loggers, freshness indicators, oxygen sensors, oxygen scavengers, moisture scavengers, antimicrobials, biocompostable packaging.

With the upper limit of additional money consumers are willing to spend per package of $0.55-$0.70 for the Australian market and $0.15-$0.20 for the Chinese market, many of these technologies are too expensive for consideration. This drives to a build of technologies as a means to solve for as many of the technology benefits as possible. When the concepts are considered. Only the easy entry concept is technically viable today without any investment. (see table 10) Concept elements that have NFC or QR code technologies, require some investment in measurement of the temperature during supply chain transport and then linkage to these technologies via the internet.

Table 10 technical feasibility for concepts. X= technology not available at this point in time at this cost range.

Elements	Top Aus Concept	Top China Concept	Top Both Concept	Easy Entry
Food Safety	scan the colour of the meat with your smart phone to determine how safe the meat is to cook and eat. NFC, QR X	Green food logo on pack	Info on the website shows what the impact of colour of the meat is on how safe it is to cook and eat.	Info on the website shows what the impact of colour of the meat is on how safe it is to cook and eat.
Shelf Life/ Temp during transport	A temperature sensor that changes colour irreversibly if the meat has been exposed to an unsafe temperature during transport	Scan with your smart phone to determine how safe the meat is to cook and eat. The app's microscope will count surface bacteria X	scan a code that shows the temp of your meat during its journey at various check points NFC, QR X	Info on website gives you typical time frames for how long you can store meat at various temperatures.
Doneness/ Tenderness at end, Fit of cut to cooking method, flavour	A simple pictogram of methods this cut of meat works well with... choose your cooking method and know your meat will turn out great.	The Meat app is designed to help you cook the perfect steak - use the app's thermal imagining camera, it tells you when your pan in hot enough to put the steak on X	A simple pictogram of methods this cut of meat works well with... choose your cooking method and know your meat will turn out great.	info on website shows you the cooking methods your cut of meat works well with.
Packaging & sustainability	Vacuum Skin Pack with tray	Individual portion pack	Individual portion pack	Vacuum Skin Pack with tray
Traceability/Anti counterfeiting	scan the QR code to find out how your meat travelled to you. NFC, QR X You can find out every link in the chain as the meat went from farm to fork using the latest blockchain technology	Unique packaging design and branding lets you know your product is genuine X	scan the QR code to find out how your meat travelled to you. NFC, QR X You can find out every link in the chain as the meat went from farm to fork using the latest blockchain technology	info on website shows you how we packaging and transport the meat
Provenance / sustainability	scan to find out how sustainable the farming practices are and how you can offset the meat's carbon footprint NFC, QR	info on website shows you where your meat comes from and standard AU farming practices	info on website shows you where your meat comes from and standard AU farming practices	info on website shows you where your meat comes from and standard AU farming practices

Food Safety. This is an expected benefit for consumers. This means that is must be addressed or the product could be rejected. As discussed before, this does affect the value of "Brand Australia". Traditionally this has been addressed by expected shelf life models that assume control of the supply chain temperatures. When considering supply chains for export, control of the supply chain temperature over time may be more of an issue. The technology to deliver this data real time is very complex. It requires development of bacteria growth/ time/ temperature/ pH models, these models connected to meat eating quality models (MSA), measurement of time/ temperature in the supply chain, and information flow to the overall models. This is one of the most complex technology issues to solve. Additionally, consumers are not willing to pay for this benefit. This suggests this technology will require a variety of technologies bundeled with each other in order to solve this. Considering how passive or active the information to the consumer should be, a technology pathway would be to keep the information at the passive (website level), until a technology solution can be found. For higher risk options, pallet level time/ temperature indicators are solution, but the data will need to be connected to the internet to provide value beyond an insurance perspective to the consumer.

Shelf Life During Transport. This is a normal benefit and as such consumers are willing to pay some monies per package for this benefit. ie $0.40-$0.50 for the Australian market and $0.10-$0.15 for the Chinese market. Most time, temperature indicators cost between $1.10 to upwards to $200. This suggests these are pallet only options, not individual primary package options. A temperature indicator for cold chain foods (salad) has been developed for a cost of $0.06-$0.07,. Further discussions are underway to determine if an indicator for this application can be developed at the appropriate cost levels.

Doneness. This is a normal benefit and as such consumers are willing to pay some monies per package for this benefit. ie $0.40-$0.50 for the Australian market and $0.10-$0.15 for the Chinese market. Pictographs leveraging the MSA eating quality information could be created, along with website information. Thermal imaging from a smart phone is a $200 (approx.) attachment to a smart phone and as such is not an option.

Sustainable Packaging. This is a normal benefit for Australians and a delighter benefit for the Chinese and as such consumers are willing to pay some monies per package for this benefit. ie $0.40-$0.50 for the Australian market and $0.15-$0.20 for the Chinese market. While most consumers choose either vacuum skin pack or individual packaging, the packaging materials to be used are important to consumers. The issue for this area is that consumers do not see a simple technology pathway forward. For Australian consumers, technology solutions and consumer values get mixed together in terms of what is important to consumers. This means that a single technology pathway beyond recycling and amount of packaging is not clear. (see table 11). For Chinese consumers, technology solutions and consumer values get mixed together in terms of what is important to consumers. This means that a single technology pathway beyond biodegradable packaging and recycling of packaging is not clear. (see table 12).

Table 11 Australian consumers What is it about sustainability and sustainable packaging that is important to you when purchasing meat? Percentages show how many choose the attribute as in their top five concerns.

	Lead Users	Mainstream	Laggard
Recyclable packaging	58%	53%	60%
Concerns about the amount of packaging	54%	47%	62%
Concern about animal welfare	47%	44%	38%
Biodegradable packaging	46%	43%	48%
Better farming practices	41%	43%	37%
If I buy it, I can help change the market	42%	37%	21%
No use of plastic	34%	34%	48%
Minimizes environmental damage	25%	32%	25%
Preserves natural resources	28%	29%	27%
More Ethical	29%	29%	29%
Concerns about climate change	26%	27%	27%
It's the right thing to do	15%	23%	19%
High Price	21%	20%	29%
I feel like I am helping	16%	19%	13%
Helps to manage social, and material resources	12%	15%	8%
I look good in front of others	4%	3%	4%

Table 12 Chinese consumers What is it about sustainability and sustainable packaging that is important to you when purchasing meat? Percentages show how many choose the attribute as in their top five concerns.

	Lead Users	Mainstream
Biodegradable packaging	58%	61%
Preserves natural resources	52%	43%
Better farming practices	48%	48%
Minimizes environmental damage	43%	36%
Recyclable packaging	41%	52%
Concern about animal welfare	41%	37%
Concerns about the amount of packaging	36%	43%
Concerns about climate change	36%	35%
If I buy it, I can help change the market	32%	25%
No use of plastic	32%	37%
More Ethical	25%	25%
Helps to manage social, and material resources	24%	15%
I feel like I am helping	11%	13%
It's the right thing to do	9%	16%
High Price	7%	10%
I look good in front of others	5%	5%

Traceability/ Anti-counterfeiting This is a delighter benefit for Australians and a normal benefit for the Chinese and as such consumers are willing to pay some monies per package for this benefit. ie $0.50-$0.70 for the Australian market and $0.10-$0.15 for the Chinese market. This requires investment in terms of tracking the product through the supply chain. Block chain and other technologies along with QR codes and NFC can begin to address these issues.

Provenance. This is a delighter benefit for both Australians and Chinese. This is the benefit consumers are willing to pay the most for. ie $0.50-$0.70 for the Australian market and $0.15-$0.20 for the Chinese market. This requires investment in QR codes or NFC to connect the package to the internet and website to provide the provenance information. While many consumers are willing to have the information passively provided to them via the internet, greater value in the market place is provided to the concepts that provide the information more actively.

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5.11 Proposed Technology Development Management

The fact that not all these technologies are available today, suggests that a phased technology build across a timeline is needed.

A phased management of technology would include:

Phase 1: Ensure appropriate information is in on a website per easy entry concept. Future technology investment will build on top of this capability. Deeper understanding of provenance key drivers could be leveraged from the ITRP Food Value Chain Hub research.

Phase 2: Investment in available QR code/ NFC technologies to develop IOT (internet of things) connection of package to internet and website capalbities. This will ensure the capability of the package to be the information source rather than just the website. This will allow for the information to be more active than passive for the consumer. As these technologies can provide provenance and traceability benefits. The additional value of this is between $2.7M and $3.9M if all other benefit are in the market place. If this is the primary (only) benefit the additional value is between $31M to 4$4M.

Phase 3: Development of temperature indicators for temperature exposure during transport. A key consideration for consumer from a top of mind perspective and trade off value. Solving this problem allows the consumer to invoke more trust in the "Brand Australia" Meat segment. This technology is under development, but not fully commercialized. This technology is not likely to be food safe, so must be on the outside of the package. Time/ temperature indicators or data loggers could be added to each pallet or on a SPC (statistical process control) basis. This information would need to be connected to a simplistic dashboard website, so that consumers would gain trust that the supply chain process is in control. The additional value of this is between $2.2M and $2.9M if all other benefit are in the market place. If this is the primary (only) benefit the additional value is between $12M to $16M.

Phase 4: Development of bacteria growth/ time/ temperature/ pH models, with these models connected to meat eating quality models (MSA), along with measurement of time/ temperature in the supply chain, and information flow to the overall models. Initial work has started on development of these models. This is a complex information and modelling process to manage. This is not a simple problem to solve. As consumers see this as an expected attribute, it will not add additional value.

Phase 5: Development of *food safe* temperature indicators for temperature exposure during transport. This technology is under development, but not commercialized. Most indicators are not food safe and so can not be placed next to the meat. The additional value of this is between $0.3 M and $0.4 M (additional value size of temp during transport * expected growth rate of market.) If this is the primary (only) benefit the additional value is between $14M to $19M.

Additional Size of prize calculations are developed based on the following assumptions. (All dollars are AUD)

Size of market: Australia: 650,000 tonnes China: 110,059 tonnes(Australian Exports to China)

% of market that is online: Australia: 1% China: 5%

Size of online market: (1x2) Australia: 6,500 tonnes China 5,500 tonnes

Growth Rate of online market: Australia: 13% China: 16%

Food Safety $0.0 additional value

Shelf Life During Transport $0.40-$0.50 for the Australian market and $0.10-$0.15 for the Chinese market.

Doneness. $0.40-$0.50 for the Australian market and $0.10-$0.15 for the Chinese market.

Sustainable Packaging $0.40-$0.50 for the Australian market and $0.15-$0.20 for the Chinese market.

Traceability/ Anti counterfeiting $0.50-$0.70 for the Australian market and $0.10-$0.15 for the Chinese market

Provenance. $0.50-$0.70 for the Australian market and $0.15-$0.20 for the Chinese market.

While the size of the prize may be limited for just a given technology benefit, some technologies can deliver more than one benefit

Table 13 ***Additional*** Size of prize for six technology benefits. Each technology benefit is defined separately from easy entry as a baseline for other benefits. These numbers are additional value for providing these benefits beyond the size of the overall market. Market share value are easy entry plus the primary technology benefit.

	size of market (tonnes)	% online	size of online (tonnes)	Additional Value Low	Additional Value High	Number of packages	Size with only this benefit in market place Low	Size with only this benefit in market place High	Market share	Additional size of prize Low	Additional size of prize High
Australia	**650,000**	**1%**	**6500**			**26,000,000**					
Easy Entry plus food safety				$ -	$ -		$ -	$ -	55%	$ -	$ -
Easy Entry plus Temp during Transport				$ 0.40	$ 0.50		$ 10,400,000	$ 13,000,000	17%	$ 1,768,000	$ 2,210,000
Easy Entry plus Doneness				$ 0.40	$ 0.50		$ 10,400,000	$ 13,000,000	7%	$ 728,000	$ 910,000
Easy Entry plus Sustainable Packaging				$ 0.40	$ 0.50		$ 10,400,000	$ 13,000,000	4%	$ 416,000	$ 520,000
Easy Entry plus Traceability				$ 0.50	$ 0.70		$ 13,000,000	$ 18,200,000	9%	$ 1,170,000	$ 1,638,000
Easy Entry plus Provenance				$ 0.50	$ 0.70		$ 13,000,000	$ 18,200,000	8%	$ 1,040,000	$ 1,456,000
China	**110,059**	**5%**	**5503**			**22,011,800**					
Easy Entry plus food safety				$ -	$ -		$ -	$ -	20%	$ -	$ -
Easy Entry plus Temp during Transport				$ 0.10	$ 0.15		$ 2,201,180.00	$3,301,770.00	22%	$ 484,260	$ 726,389
Easy Entry plus Doneness				$ 0.10	$ 0.15		$ 2,201,180.00	$3,301,770.00	22%	$ 484,260	$ 726,389
Easy Entry plus Sustainable Packaging				$ 0.15	$ 0.20		$ 3,301,770.00	$4,402,360.00	12%	$ 396,212	$ 528,283
Easy Entry plus Traceability				$ 0.10	$ 0.15		$ 2,201,180.00	$3,301,770.00	20%	$ 440,236	$ 660,354
Easy Entry plus Provenance				$ 0.15	$ 0.20		$ 3,301,770.00	$4,402,360.00	4%	$ 132,071	$ 176,094

6. Conclusions/ Next Steps

Completed:

From the Knowledge Mapping next steps included:

		Develop 7 concept bundles for testing using hero concept and additional imagery. Determine value of Disruptive Technologies	Test frameworks and benefits qualitatively through interviews and focus groups	Finalize concept bundles and benefits. Test Quantitatively with consumers for value to determine top 3 concepts.	Review Final 3 concept bundles and benefits for value
Industry	**Complete**		Interviews: Value of Elements Research Design Producers/ Processors (Primals, Retail Ready) Retailers (Retail Ready) On line sellers (Primals, Retail Ready) Chef/ Restaurant (Primals)	One on one interviews with 16 chefs in country and in Australia	Interviews: MLA In market staff Producers/ Processors Retailers On line sellers Chef/ Restaurant
Consumers	**Complete**		Focus Groups: Value of Hero Concept New to Australia Chinese Consumers (Primals, Retail Ready, Sustainability) Older Chinese Consumers (Primals, Retail Ready, Active Aging)	On line Internet study: 400 consumers per country including: Chinese/ Australian Consumers who eat Beef, Australian Beef multiple times a month Chinese/ Australian Consumers who purchase meat from online	
Technology	**Complete**		Technology Review of key technologies that fit in concept bundles: Cost Readiness Purchase market available options for testing		

Four concepts have been developed, these were reviewed in a MLA Workshop with Technology providers and Producers: “High value meat exports addressing food without fear and request their involvement to co-design next stage novel pack design”. A workshop was held in March 2019 with lead producers to socialize the ideas in this report and gain feedback from the various producers. This workshop included key QR code and NFC suppliers to explain the technology and benefits, allowing the producers to consider the value to their business. They will co-design what’s next (to help shape stage 2 prototypes) that would fit along the value chain that smart packaging needs to address.

Next Steps:

A pilot project is being developed to test out backbone technology across supply chain for value determination with a lead set of producers. This will leverage the QR Code/ Barcode technology to see the implications across the supply chain.

Once this pilot have been completed a Phase 2 project will be develop to leverage this backbone technology and look at addtional key technology development needs across the full technology time horizon.

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