Final report

Implementation of cold chain management through temperature loggers, the cloud, and a predictive model

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Abstract

Shelf life is an important factor in the meat trade, with temperature being the main contributor for long shelf life. MLA in conjunction with University of Tasmania has developed a predictive tool which estimates shelf life of vacuum-packed beef and sheep primals, based on historical storage temperature. By combing the use of real time loggers to remotely capture temperature data and analysing it with the shelf-life model, we can determine the remaining shelf life based on the cold chain. By having supply chain visibility, actions can be taken to improve the cold chain if there are gaps or temperature abuse situations which required product to be diverted or used quickly.
Roughly 65-70% of industry (based on production volume) has adopted this form of technology, however in terms of maximum utilisation of benefits, it is still low. Initial calculation results in $600,000 per annum per plant, disregarding other social benefits such as better stock management and improved trust in supply chain. Other reported benefits of cold change management which cannot be calculated to direct cost saving such as Work with Export food service/hotel customers giving an additional 25 days or changing from Air freight to Sea freight saving of $2-4/kg.
The biggest benefit to use remote logging is to give product owners confidence in the cold chain, and for potential issues are management promptly without negatively impacting the product and customers. It is recommended that remaining processors start reviewing their current cold chain monitoring to identify any gaps and work with providers to build a system, which may include integration via API.

Executive summary

Background

Shelf life (or storage life) has always been important in the meat trade, and is becoming increasingly so, as Australian retailers and importers in overseas countries request information to substantiate company claims about how long their products will remain saleable and increase in export activities such as retail ready.
MLA in conjunction with University of Tasmania has developed a predictive tool which estimates shelf life of vacuum-packed beef and sheep primals. The tool is described in *Shelf life of Australian red meat* and can be used to predict remaining shelf life providing you estimate the bacterial count (TVC) at packing and the time: temperature record during storage. Once these parameters are entered into the shelf life calculator and either lamb or beef is selected, predictions for TVCs and days remaining until detection of a strong odour on opening the pack can be predicted.

Objectives

The desire to gain value for industry by modifying usual industry practices (that result in lack of data retrieval at the end of the journey and lack of ability to interpret the data) results in a number of objectives:

- Implementation of the shelf life calculator for commercial use
- Review existing technologies and work practices as well as emerging technologies and implications to existing work practices for cold chain management.
- Assess the feasibility for the implementation of cold chain temperature traceability technology into the value chain.
- Adoption of cold chain management tools and define performance metrics
- Gain adoption of the technology and discover the benefits that can be obtained

Methodology

Reviewing the landscape of the cold chain management and collection of information including:

- Industry networks, cold chain and freight councils, literature search
- Interview and testimony of users of the systems

Results/key findings

The innovation system highlighted weaknesses in the current system. These were inadequate knowledge of benefits, uncertainties of needs, poor articulation of demand and lack of standards. This analysis provided guidance on the focus areas where we must respond provide human resources, to gain significant adoption.

The uncertainties of needs and poor articulation of demands were answered after the first few industry projects. The benefits, although rough, were able to overcome the poor articulation of the technology. Further projects were to gain a better understanding and clearer understanding of other benefits achievable.

Roughly 65-70% of industry (based on production volume) has adopted this form of technology, however in terms of maximum utilisation of benefits, it is still low. Initial calculation results in $600,000 per annum per plant, disregarding other social benefits such as better stock management and improved trust in supply chain.

Benefits

There have been reports of the temperature abuse claims from customers reducing to 0. For this calculation we keep it conservative and factored in 1 claim per annum, costing of $100,000. This brings the total cost benefit of monitoring and reduced claim to $600,000.

There have also been other reported benefits of cold change management which cannot be calculated to direct cost saving such as:

- On site cold chain management to improve load out temperature (reducing by 1°C gained 14 additional days shelf life in a hotel kitchen)
- Installed a rapid rolling door in a warehouse (reduced fluctuation by >1°C, gained 5.5 days, in the 14 day storage)
- Identifying less than ideal storage temperatures and choosing preferred transport partners who were able to maintain temperature
- Knowing and helping Export markets and customer understand and manage product better (roughly 10% of shipments in export markets experience sub optimal control)
- Work with Export food service/hotel customers (reduced by 1 degree, giving an additional 25 days in the 21 days storage)
- Changing from Air freight to Sea freight (saving of $2-4/kg), sea freighted products arrived at the destination with more shelf life remaining compared to air freight. Due to cold chain of sea freight averaging at -1°C compared to air freight is 3°C.

Future research and recommendations

It is recommended that remaining processors start reviewing their current cold chain monitoring to identify any gaps and work with providers to build a system, which may include integration via API. The biggest benefit to use remote logging is to give product owners confidence in the cold chain, and for potential issues are management promptly without negatively impacting the product and customer. Alternatively, it helps assign the responsibility to the correct segment of the supply chain.

Table of contents

1. Background

Shelf life (or storage life) has always been important in the meat trade, and is becoming increasingly so, as Australian retailers and importers in overseas countries request information to substantiate company claims about how long their products will remain saleable and increase in export activities such as retail ready.

Achievable shelf life data for Australian product is provided in MLA publication, *Shelf life of Australian red meat* (2nd edition)[1]. With storage temperature of -0.5°C, vacuumed beef primals can achieve 160 days and lamb achieve 90 days shelf life.

Various factors contribute to the shelf life of beef and lamb primals, including: ultimate pH, processing conditions (hygiene, ambient temperature) and good quality packaging/seal. Temperature, by far, has the highest impact on shelf life of product. For every 1°C increase the rate of shelf life decreases by about 30%. Controlling temperature through managing the cold chain gives the best insurance for a long shelf life. As short period of temperature abuse may not have a significant impact on shelf life, the ability to access and react to real-time temperature events is a crucial tool for supply chain management.

As long as temperature has been measured, the shelf life impact of the temperature history of the product can be estimated using the shelf-life calculator (prediction tool).

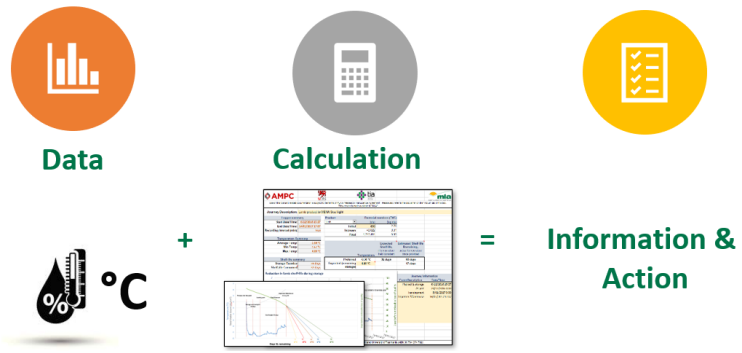
Temperatures of shipments (particularly international shipping) has routinely been measured using data loggers (we refer to them here as ''USB loggers" because they typically have a USB connection for downloading the data), which have frequently not been retrieved from shipments, and when they are, the data are very difficult to interpret. Modern data loggers remove the need to manually retrieve the logger by uploading the temperature data (including relative humidity, light and location) into the cloud via a cellular network. This allows access to the data via the internet by the user who is kept informed of the products condition.

MLA in conjunction with University of Tasmania has developed a predictive tool which estimates shelf life of vacuum-packed beef and sheep primals. The tool is described in *Shelf life of Australian red meat* and can be used to predict remaining shelf life providing you estimate the bacterial count (TVC) at packing and the time: temperature record during storage. Once these parameters are entered into the shelf life calculator and either lamb or beef is selected, predictions for TVCs and days remaining until detection of a strong odour on opening the pack can be predicted. The shelf life calculator and documentation is available on the MLA creative commons site[2].

The combination of using data loggers to measure temperatures along the supply chain in real time, plus the shelf life calculator provides information; Information that can be used to inform action.

[11] MLA publications

[2] Creative Commons Licenses | Meat & Livestock Australia (mla.com.au)



This report reviews:

- Approach taken to understanding how to introduce this innovation to the Australian red meat processing sector; as well as
- Existing and emerging technologies for temperature monitoring and shelf life management, and the benefits of the technology to supply chain actors.

It also provides a basis for economic analysis of the benefits of adoption to the industry.

In measuring benefits of MLA's efforts in the area of "shelf life" it is important to note that benefits have (or will) accrue in three phases, which are all traced back to the original work to define and predict shelf life:

1. relaxation of market access requirements pertaining to maximum allowable shelf life by some importing countries (benefits assessed in 2020 evaluation, and still being added to as additional countries remove these technical barriers to trade)
2. control of supply chains, i.e., cold chain management, as described in this document, in which benefits accrue to product owners, and to the supply chain in general, through reducing product losses and financial claims relating to failure to manage cold chain, resulting in meat spoilage
3. reduction of energy, and waste generation and disposal which have benefits in increasing the available food supply, and environmental benefits from reduced electricity requirement and greenhouse gas generation. This work is just commencing and may result in design of cold chains and product supply to achieve further benefits.

2. Objectives

The desire to gain value for industry by modifying usual industry practices (that result in lack of data retrieval at the end of the journey and lack of ability to interpret the data) results in a number of objectives:

- Implementation of the shelf life calculator for commercial use
- Review existing technologies and work practices as well as emerging technologies and implications to existing work practices for cold chain management.
- Assess the feasibility for the implementation of cold chain temperature traceability technology into the value chain.
- Adoption of cold chain management tools and define performance metrics
- Gain adoption of the technology and discover the benefits that can be obtained

3. Methodology

3.1 Landscape review of Cold chain management systems

The process to review the landscape of the cold chain management and collection of information included:

- Industry networks, cold chain and freight councils, literature search
- Specific requests for information and assistance, related to services provider of technology
- Interview and testimony of users of the systems
- Other specific meetings with the processor

3.2 Barriers to adoption: analysis using sectoral innovation and technological innovation system framework

We used an analysis of the status of development of industry innovation using both sectoral innovation system and technological innovation system frameworks to identify the weaknesses and gaps in the system that were preventing adoption. These frameworks can be used to identify weaknesses in the innovation system at the level of individual projects (or initiatives)[3], which, if not corrected, lead to a failure to innovate[4] (in this case failure to adopt).

Sectoral innovation analyses are based on the operation of the industry sector and separates the actors from the elements of the innovation system. The actors who jointly and individually contribute to the development and diffusion of new technologies are identified. The way that the actors interact with elements of the economic system are then analysed. The analysis identifies weaknesses in the ways that sector actors behave and provides the basis within which governments (or organisations such as MLA) advocate for, form, and implement policies that influence the innovation process.

The technological innovation system framework was developed to explain the nature and rate of technological change. A Technological Innovation System can be defined as 'a dynamic network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure and involved in the generation, diffusion, and utilization of technology'. As with sectoral system framework, the identification of blockages or weaknesses can lead to interventions in an attempt to correct the innovation system problem and ensure that innovation occurs.

[3] Jenson, Ian (2019) Turning Research into Innovation: A Systems Approach to Innovation in Food Safety. Food Protection Trends, vol. 39, no. 5, pp. 420-429, Sep 2019

[4] Ian Jenson, Peat Leith, Richard Doyle, Jonathan West, Morgan P. Miles, (2016) Testing innovation systems theory using Qualitative Comparative Analysis, Journal of Business Research,69(4) 1283-1287

3.3 Cost benefit for implementation of the system

The process of information collection and verification was undertaken as follows:

- Specific requests for information, related to costs of current system including but not limited to cost of hardware monitoring, claims, product wastage,
- Use case of Shelf-life prediction model and benefits from using the model

4. Results

4.1 Cost of cold chain monitoring for industry

The following data were provided by one processor to assist the calculations of costs and benefits for making changes to the current system:
Average shipments Sea freight: 40 – 50/wk (~2000/year)
Number of shipments Air freight: 20 – 30/wk (~1000/year)
Number of Claims related to shelf life/temp abuse per Year– no claims or complaints. Enquiries only – claims directed straight to service kill customers
USB loggers are used per shipment Sea and Air – Sometimes 1 per shipment
Cost of USB loggers - $40 AUD
Level of cold chain visibility: Only at point of leaving establishment and arriving at customer warehouse.

4.2 Cold chain management systems available

Cold chain management differs from cold chain monitoring through one key feature which is to actively manage and deal with the cold chain in real time. The current systems in the industry are monitoring and historical data analysis. When cold chain data is combined with the shelf-life calculator, the data is transformed to days of good quality the product has remaining depending on the storage history and expected future storage and handling. Real time data can lead to various management options such as diverting to other markets and strengthen the partnerships with export customers to not rely solely on the carton label for shelf life information and understanding the impact of their cold chain on shelf life.

4.2.1 Freight providers for cold chain management

Freight providers have technology to monitoring temperature and majority of freight ships have internet on board, however sharing the data and enabling the service is a decision for the individual companies.

Maersk[5] to date is the only company that offers live tracking and sharing of container temperature monitoring. In addition, it also offers a service called "captain peter[6]" and for a premium it will provide 24/7 customer service and support. This is a great service to use to provide the visibility and management for the container. There are limitations to this service, which includes transhipment to non-Maersk ships and non- Maersk storage/distribution centres would mean you will lose sight of the tracking. It has been reported that the cost between $5,000 -$20,000 fee and a $50 per container cost.

More recently, MSC has started offering the container monitoring and tracking as well for a reported price of $120 per container. However, it still has the disadvantage of needing to use its own network and cannot use other platforms.

Due to the cost and feasibility of research, development and maintenance of a monitoring system and device, other freight and freight forwarders uses independent logger providers. The products listed in Table 4.1 would be close to the major providers to the market.

4.2.2 Independent providers for cold chain management

Common practice of cold chain management is to put 1-3 USB type data loggers[7] ($10-$40) which will record data and are retrieved at the end of their journey for future reference. Unfortunately, this will only allow for retrospective cold chain monitoring providing that the logger is retrieved and can only deal with issues after a major event has occurred.

In recent years, real time data loggers have become readily available and more price competitive ($45 – $70). The real time loggers collect information like USB loggers with additional information such as location, and exposure to light (e.g., from opening a carton) and will periodically send data to the cloud meaning there is no need to retrieve the logger to review the data. Because they remotely send data with time and location you can now directly correlate the data with certain parts of the supply chain.

Real time loggers can be used to track cartons within Australia, during shipment and/or to the wholesaler and end customers. It should be noted that the logger will not transmit when it is on open waters, or deep within the container being buried by other cartons or other containers.

For this exercise, we have excluded data loggers which have reported to last less than 60 days, as most shipments may get close to, or beyond, 60 days, and potentially lose data due to dead battery during reception dead zones; this significantly reduced the list of providers. To further reduce the list, we limited it to loggers which have confirmed API function, if required by the processor to use, however all have their own user interface/dashboard.

[5] https://www.maersk.com/
[6] https://remotecontainermanagement.com/
[7] https://www.sensitech.com/en/products/monitors/conventional/

The following data loggers (Table 4.3) list the current real time loggers in the market that have been trialled by processors.

Table 4.3 List of loggers on the market which have been trialled.

Name	Reusability		Other environmental data			Cost and fees*			Changeable setting	API function
	Single	Multi	Light	RH	Shock	Logger fee	Annual fee*	Data analysis		
Tive 5G[8]	X	X	X	X	X	Y	Y	Extra	X	X
Escavox[9]	X	X	X			Y	N	Included	X	X
Sensitech - TempTale LTE[10]	X		X			Y	N	Extra		X
Frigga logger[11]	X	X	X	X	X	Y	N	Extra	X	X
Roam Bee[12]		X	X	X	X	Y	X	Extra	X	X

4.3 Trial of cold chain monitoring devices

A trial of two easily accessible devices (Escavox and Tive) for industry was repeated across various partners. Both their functionalities are similar and being used by industry. This gives confidence the technology has been adopted, further reducing the risk of uncertainty and technology failure.

This trial did not intensively involve the shelf-life calculator, as the trial was more about the functionality and useability of the real time loggers. The loggers can change the frequency of recording, between 5 – 120 minutes and transmit the data between 5min – 6 hours. There are a few differences between dashboard and reporting consistency.

The overall useability and integration with existing systems demonstrated that both loggers were more than suitable. Both loggers allow for direct access to their dashboard, the ability to send restricted data to external users/customers and ability to automatically send the data to another external system.

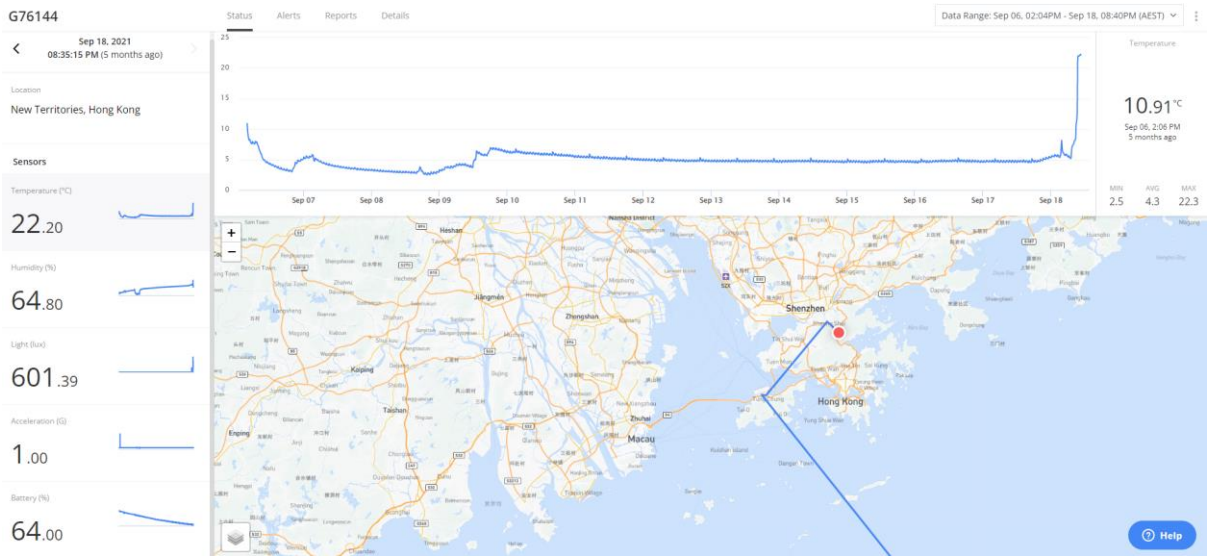
The challenge during the trial was assessing at what point we can identify which products are going on which orders which makes it a challenge when to identify the destination to the logger. This is further complicated with off-site storage facility which decreases visibility. The potential solution was to link the carton number and wait till orders were finalised before assigning, however becomes ineffective in the long term.

[8] https://tive.co/tive-solo-5g/
[9] https://www.escavox.com/
[10] https://www.sensitech.com/en/products/monitors/realtime/
[11] https://www.realtimedataloggers.com.au/products
[12] https://www.roambee.com/sensors/

All the logger companies have an interactive interface called a dashboard, where users can view, input and edit the logger data. Other actions on the dashboard are setting the recording interval of the loggers, sending internals, alerts profile, downloading data and inputting shipment information.

Some dashboards have incorporated the Shelf life calculator, which means the shelf life information of red meat is available via the logger. Alternatively, the user has the option of downloading the logger temperature and manually calculate the shelf life remaining of product. Access to the shelf life calculator is free via MLA Creative Commons link).

The image below shows an example of the TIVE dashboard and also the level of location data:



4.4 Innovation systems frameworks

An analysis of the innovation system using sectoral and technological frameworks was performed to identify gaps or weaknesses in the cold chain management innovation system (Figures 4.0 & Figure 4.1). This analysis was done 6 months after trialling the real time logger technology, as there was limited adoption of the technology and use even after numerous attempts to convey the benefits to industry.

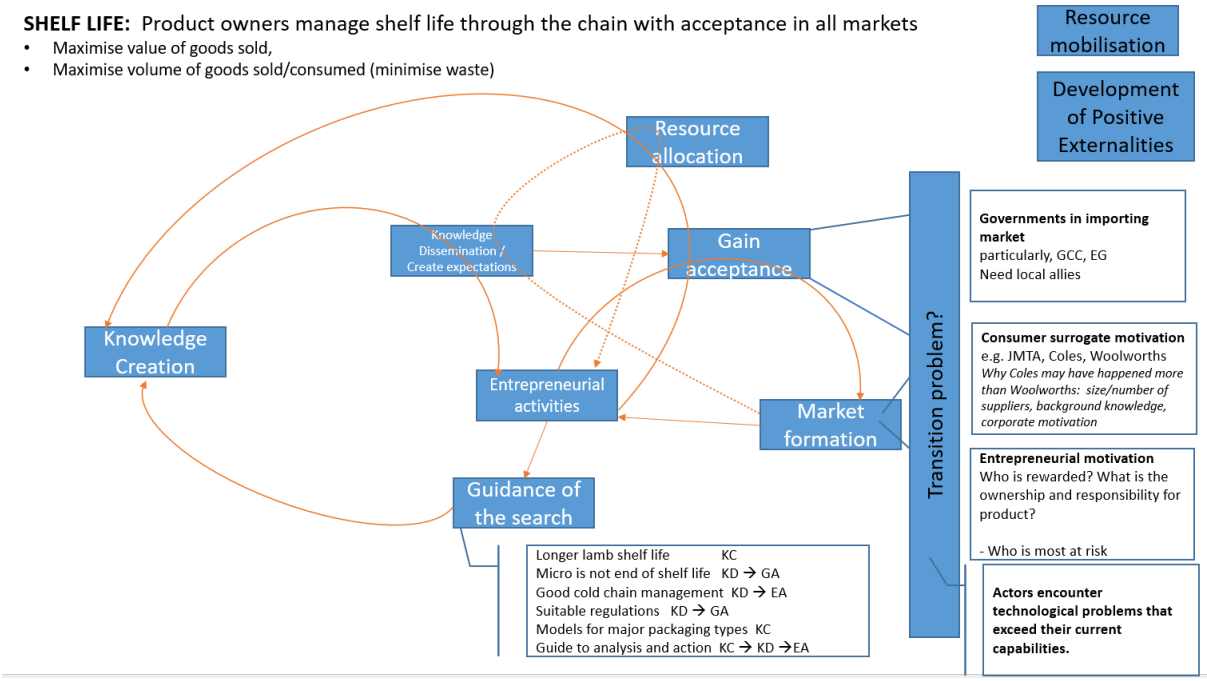


Figure 4.0 - Technological innovation system for cold chain management.

Figure 4.0 was developed through discussion by MLA sub-program staff. The statements in the top left-hand corner identify the goal of innovation and the outcome measures that would have a positive impact on industry performance. The 7 functions on the left hand-side of the diagram need to be strong in order for innovation to result. The arrows indicate how one function can affect another. The notes on 'Guidance of the Search' discusses an important seminal role for MLA, what assets (knowledge, circumstances) exist, which function is represented, and how the function that can be strengthened by MLA's actions. The panel on the right-hand side discusses issues identified for industry to make the transition. Further understanding of these issues would potentially enhance the ability of MLA to intermediate the innovation system. For example, the guidance of search highlighted "good cold chain management" has already finished the Knowledge creation phase and should focus on Knowledge dissemination followed by Gaining acceptance. By using this framework for each topic we can quickly identified where the gaps are.

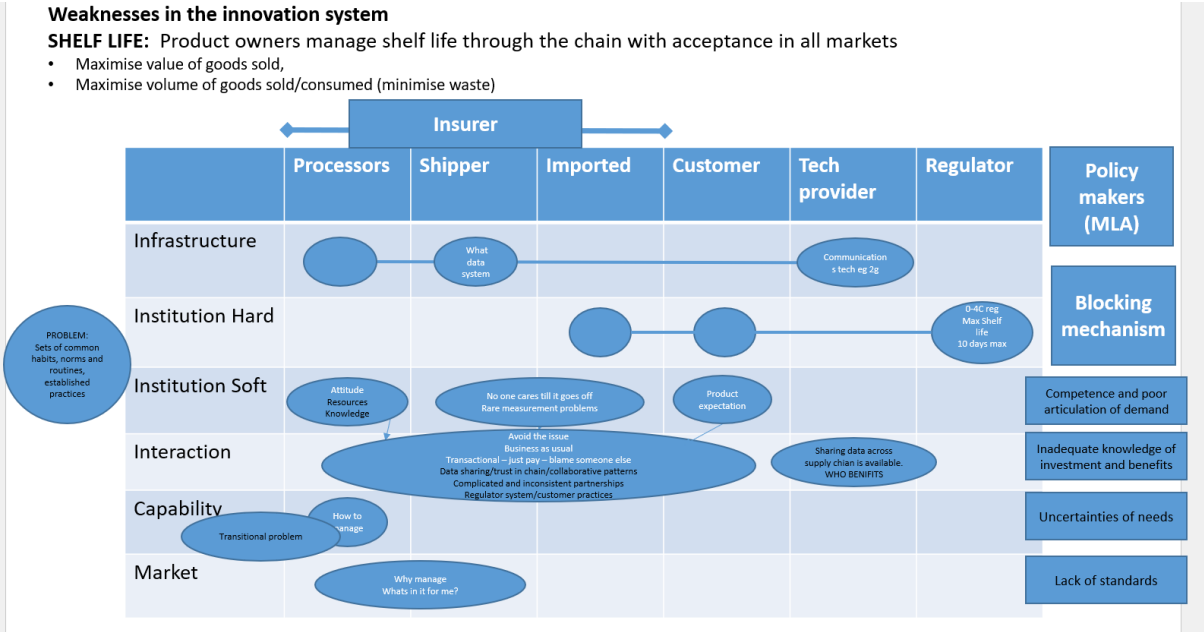


Figure 4.1 - Sectoral innovation for cold chain management.

This figure 4.1 was developed through discussion by MLA sub-program staff. The statements in the top left-hand corner identify the goal of innovation and the outcome measures that would have a positive impact on industry performance. The columns represent the actors involved in this innovation (whether present or not), and the rows represent the elements of the sectoral system. The bubbles and lines in the table represent issues and needs for actors, which may be shared with other actors. On the right-hand side are listed the 'blocking mechanisms' which need to be overcome at a sectoral level to ensure innovation.

In summary, the weaknesses identified were:

- Actors encounter technological problems that exceed their current capabilities – so they aren't addressed.
- Common habits and routines exist within the industry, and therefore, there is inertia that leads to not disturbing the current process, and established practices

These gaps were addressed by:

- Establishing and building a network to develop the knowledge base to disseminate to industry
- Dissemination of knowledge via internal resources (network meetings, networks) and Commercial partners such as the logger providers
- Small pilot trials on loggers to increase knowledge for further dissemination
- Providing ongoing support with technology (consultants)
- Revaluation of knowledge and re-dissemination of new knowledge to encourage processors to follow the leads given by others and obtain more benefits
- Ongoing support analysis with supply chain partners on benefits of technology to inform any weaknesses in the system

5. Key findings

5.1 Innovation system guidance of research

The innovation system highlighted weaknesses in the current system. These were inadequate knowledge of benefits, uncertainties of needs, poor articulation of demand and lack of standards. This analysis provided guidance on the focus areas where we must respond provide human resources, in order to gain significant adoption. Consultancy agreements were used, initially with data logger suppliers, and then with processors to increase knowledge transfer and the support of promoting PIP projects. In addition to the consultancy agreements, partnering with numerous commercial technology partners to further increase the knowledge development, which continued beyond the contracted work.

The uncertainties of needs and poor articulation of demands were answered after the first few industry projects. The benefits, although rough, were able to overcome the poor articulation of the technology. Further projects were to gain a better understanding and clearer understanding of other benefits achievable.

5.2 Current cost to cold chain monitoring

It's been reported that a minimum of 2-4 USB loggers for sea freight and 1 for air freight at the cost of $20 per logger. Bring a total cost of loggers to $100,000/annum. In addition, the average number of temperature abuse claims is 7 per annum (some goes as high as 26 some as low as 3), and cost between $100,000 – $300,000. We used $100,000 as a conservative number (~$5/kg), meaning the total cost of $700,000/annum on product claims.

This brings a total of $100,000 for the cost of monitoring and doing business, however with a net benefit of $600,000

5.3 Benefits of cold chain management

To calculate the cost of product monitoring across supply chain we are limited to independent logger providers as they are flexible and can move with the product relatively easier. Freight companies also offer container cold chain monitoring as well, however the restriction based on the Freight company and visibility will be lost during transhipment, third-party freight providers or once the product is unloaded from the container.

Using loggers will require minimal change to current practice on plant, and the process usually involves the following:

- Ordering the new loggers
- Get training on the platform (30 – 60 minutes)
- Loggers are turned on and used as per current process
- Information such as PO, container ID etc can be recorded into the Logger system, and email alerts can be set up as well.
- Temperature, light and location data can be retrieved at any time via the platform.

Benefits of cold chain management

The cost of switching to remote logger is roughly 25% more (this will depend on the cost and number of shipments tracked). The total cost of $125,000 to track 2500 shipments, however the benefits come from the reduced temperature abuse claims.

There have been reports of the temperature abuse claims from customers reducing to 0. For this calculation we keep it conservative and factored in 1 claim per annum, costing of $100,000. This brings the total cost benefit of monitoring and reduced claim to $600,000.

There have also been other reported benefits of cold change management which cannot be calculated to direct cost saving such as:

- On site cold chain management to improve load out temperature (reducing by 1°C gained 14 additional days shelf life in a hotel kitchen)
- Installed a rapid rolling door in a warehouse (reduced fluctuation by >1°C, gained 5.5 days, in the 14 day storage)
- Identifying less than ideal storage temperatures and choosing preferred transport partners who were able to maintain temperature
- Knowing and helping Export markets and customer understand and manage product better (roughly **10%** of shipments in export markets experience sub optimal control)
    - This further prevents future customer complaints and sets expectations
- Work with Export food service/hotel customers (reduced by 1 degree, giving an additional 25 days in the 21 days storage)
- Changing from Air freight to Sea freight (saving of $2-4/kg), sea freighted products arrived at the destination with more shelf life remaining compared to air freight. Due to cold chain of sea freight averaging at -1°C compared to air freight is 3°C.

Industry members have reported positive change from switching to remote logging. The below are the calculated cost from current to using remote loggers. Because remote logger does not need to be physical retrieved to download the data, there is no risk of data being lost therefore 1 logger per shipment is sufficient to inform any potential issues during shipment. These benefits can be further increased by reducing the amount of remote logging after good cold chain management has been established.

5.4 Case studies, use cases of cold chain management

Numerous use case scenario has been collected during the journey of the logger implementation. These are available in the appendix of the document.

Case study Summary - Are there benefits in tracking the cold chain for red meat:

Easy switch to remote tracking of the cold chain

Benefits of real time loggers over USB loggers for long shipments

Benefits of real time logger versus historical USB logger for sea freight

Benefits of real time logging on customer engagement

Benefits of real time logging for export customers (Food service and retailers)

Benefits of real time logging and shelf life calculator for plant upgrade and improvements

Benefits of real time logging in small retail stores / butchers for production schedule

6. Conclusion and recommendations

6.1 Conclusion

Cold chain management is in the late adoption phase due to the available of remote logging combined with the shelf life calculator. By supporting adoption in the red meat industry using levy and MDC funds for adoption projects (projects such as V.MFS.0446, PIP.0580, P.PIP.0592, P.PSH.1216, P.PSH.1247), we had great success in the adoption, covering roughly 65-70% of Australia production.

Various processors in Australia have already started or remotely logging shipments for more than 1 year. All have reported positive outcome ranging from reduced claims to working with customers to improve shelf life.

Although there are times when data cannot be seen such as out in open water with no cell phone reception, however the data is stored and is sent when the ship is roughly 1 hour from the port. This will give the user information on the shipment and devise any actions, such as alternative markets if the shipment had some unforeseen temperature abuse. This “dead zone” is only temporary as data logger companies are working with individual freight companies to share their satellite internet. Some logger companies currently already can track containers while it’s out in open waters.

It’s predicted in the next 3-4 years the cold chain/traceability market will be matured and data on cold chain should be the norm, but not every country will develop the calculator and the system to avail themselves of the potential benefits. The benefits of adopting this technology to improve and resolve gaps in the supply chain rather than compliance retains a positive relationship between supply chain partners. The ongoing benefit from this will result in customers understanding their own cold chain and the impact on product quality. In addition, by reducing the claims and waste of product, more products will be available for sale ensuring Australian product presence in the marketplace.

6.1.1 Recommendations

It is recommended that remaining processors start reviewing their current cold chain monitoring to identify any gaps and work with providers to build a system, which may include integration via API. The biggest benefit to use remote logging is to give product owners confidence in the cold chain, and for potential issues are management promptly without negatively impacting the product and customer. Alternatively, it helps assign the responsibility to the correct segment of the supply chain.

Other recommendations include:

- Investigate visual indicators allowing employees to make swift judgement on products without the need to rely on the internet.
- Alternative and new cold chain technologies which can communicate where there is no cellular connection
- The information gathered can be used to change shelf life regulations and replace arbitrary ‘best before’ dates with real dates
- Monitoring the reduction in waste due to reduced claims ultimately leading to reduced carbon emissions
- Combining the loggers with additional shelf life models such as retailed MAP or overwrapped products. Potentially leading to a more realistic shelf life best before date.

7. Appendix

7.1 Case Study - Summary - Are there benefits in tracking the cold chain for red meat

Overview

Shelf life has always been important in the meat trade. This is especially true now, as Australian retailers and importers in overseas countries request proof of company claims about how long their products will remain saleable.
Temperature has, by far, the largest impact on shelf life of product. Controlling temperature gives the best insurance for a long shelf life.
MLA with University of Tasmania, have developed a Shelf Life Calculator, which estimates shelf life of vacuum packed beef and sheep primals. The tool can be used to predict remaining shelf life providing you know (roughly) the bacterial levels (TVC) at packing and the time:temperature record during storage.

"We have been able to use this data, to both refute claims, and prevent claims occurring. We cannot overstate the value of this assessment of temperature data." - Processor B

Approach

MLA funded numerous trials with processors using various data loggers available on the market ($50 – $80 each) for their usability, training requirements, and ease of analyzing the data through the Shelf Life Calculator. The concept of actively monitoring and managing the cold chain was explored and the benefits were reported.

Results

Avoided $1456 claims per shipment

Data available 24/7

1 easy process change

Air freight is more susceptible to shelf life loss than sea freight

Gives you options when something goes wrong

1.2% of sea freight on arrival to importing country has last more than 2 weeks shelf life than expected from the shipping time.

Better in market satisfaction (Currently 10% of cold stores have temperature problems)

Conclusions

There are numerous benefits in tracking the cold chain, it is easy to implement, and the return on investment is repaid just by saving one shipment.

"Since we started using real time loggers, temperature abuse claims have reduced to zero." – Processor A

7.2 Case Study - Easy switch to remote tracking of the cold chain

Challenge

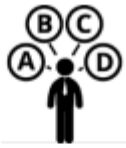
Shelf life has always been important in the meat trade. This is especially true now, as Australian retailers and importers in overseas countries request proof of company claims about how long their products will remain saleable.
Temperature has, by far, the largest impact on shelf life of product. Controlling temperature gives the best insurance for a long shelf life. The current process of monitoring cold chain has been via USB loggers, placed in to cartons during load out. Problematically, this logger data is only accessible once they are retrieved and plugged into a computer.

"It was really simple, 1 hour of training was all that was required." - Processor A

Approach

MLA funded trials with processors using various real time loggers currently available on the market, to assess switching out the USB loggers. The real time loggers were evaluated on their ease of use and the process needed to implement the change.

Results



Dashboard and monitoring are easy to use

24/7 access to data

Simple process change

Options to integrate with current systems

Conclusions

Real time loggers require simple training to use the dash board. Overall the loggers are easy to use and the process change is easy to implement. It is as simple as replacing the current USB loggers and filling the shipment information directly into the dashboard.

"The team turn it on like usual and fills out the information in the dashboard" - Processor B

7.3 Case Study - Benefits of real time loggers over USB loggers for long shipments

Challenge

Long shipments are a particular challenge for exporters trying to guarantee product quality without knowledge of product temperature- therefore USB loggers are used within shipping containers. Problematically, once these loggers reach their destination country, they are sometimes retrieved but the data is never downloaded or used. When customers complain it is therefore difficult or impossible to know whether the quality has been impacted by shipping temperatures.

Objective:

1. Commercial trial of real time loggers for usability, and tracking performance, from plant to customer in long shipments

Learning

1. Both loggers can remotely send data inside a container reliably when close to the container wall and in areas of good mobile phone reception. The platforms are also relatively user friendly with only a short training period
2. Use of the real time data loggers resulted in higher customer engagement as the loggers were able to alert customers to potential product quality hazards during shipping.

Outcome

Both types of data loggers are capable of tracking the whole chain and data for both is available online. Deciding factors come down to price, logger dashboard preferences, and types of measurements, such as light, relative humidity and shock.

The following outcomes were observed when adopting the use of real time loggers:

1. High risk shipments with a history of temperature abuse claims should have a remote logger
2. Information for QA and sales team is easily accessible
3. Sales team are alerted by the system of problem shipments in real time

"Logging has provided us options on shipments which have experienced some temperature abuse"

Direct benefits

The following benefits and impact of the loggers were observed from the trial:

1. Reduction in claims from 20 to 5 temperature claims worth >$150,000 over a one year period
2. 3 potential shipments diverted during transport to other markets- to be used quickly or used for frozen product, value of shipment saved >$500,000

Indirect benefits

Other outcomes:

1. Increased confidence in shipments to distant markets such as USA and EU
2. Data is always available for review against claims
3. Higher engagement with customers and increased customer understanding of the importance of temperature control

7.4 Case Study - Benefits of real time logger versus historical USB logger for sea freight

Challenge

USB loggers are being used for all shipments when leaving the plant- sometimes up to 3 USB loggers are used within a container- however once these loggers reach their destination country they are retrieved but never downloaded or used.

Objective:

1. To confirm the technical feasibility of the real time logger companies to provide real time information without the need to recover the logger for sea freight
2. Commercial use of single use loggers to track shipments from the plant to the customer

"Since we started using real time loggers, Temperature abuse claims have reduced to zero."

Learning

1. For sea freight, the loggers are able to remotely send data from within a carton, inside a container, while in areas of good mobile phone connectivity. This means they cannot transmit information when in open waters, or from deep within the container. However, it has been observed that 4 hours before arriving at port, loggers will start to transmit all the data that has been stored during the voyage
2. The loggers are able to be followed through the whole supply chain until the carton has been opened, or even after that if the loggers are removed
3. Back end access given to the customer resulted in added confidence in the product, and an increase in customer engagement with the data loggers

Outcome

The following outcomes were observed in the process of adopting the use of real time loggers:

1. Each shipment has a remote logger
2. Logistics teams have easy access to information
3. There are customisable, automatic, email templates to anyone including external customers built into the system to notify of any problems with shipments

Direct benefits/Impact

The following benefits and impact of the loggers were observed:

1. Reduction of 1 major claim over a 1 year period for product worth >$100,000 related to temperature abuse- and not including investigation time- for the period of remote logging.
2. The system notified five potential problem shipments so that the company was able to rectify the issue during shipment by notifying the vessel before entering the country, potentially worth $500,000.
3. Since logging started (412 shipments), no claims for temperature abuse to date have been reported. This averages a saving of $1456 per shipment.

Indirect/Other outcomes

1. Minimal disturbance to procedures or changes for the team
2. Confidence in shipments and in customer cold chain (27 shipments had potential issues within the customers' cold chain and were monitored by the team)
3. Data is always available for review against claims, saving time on investigation
4. Claims from our customers are more descriptive when lodged, but to date, temperature abuse has not been used as a claim since we have started using the remote recorders
5. Greater engagement with customers, by actively informing customers of potential product quality concerns in real time

"A container started to get warm out in open water. We contacted the container company whom notified the vessel and the temperature was rectified. The customer was also notified but the product was good on arrival and the customer was very happy with the in-depth tracking our company is supplying with our product. This has built a good rapport between us and our customers."

7.5 Case Study - Benefits of real time logging on customer engagement

Challenge

International shipments are a challenge for brand owners, especially when there are multiple transfer points within the supply chain with the potential to impact on product quality. Customers expect sound quality, and the product to reach the labeled shelf life date, however this does not always happen due to volatilities within the cold chain.

Objective:

Using remote data to understand customers temperature experience

To record temperature during international shipments to determine weaknesses in the cold chain, or other potential causes of shortened shelf life. Provision of the analysed data to customers to help them understand the impact of instabilities within their cold chain, in order to build a stronger relationships across the supply chain

Learning

This visibility has strengthened the relationship with international customers. Data entered in to the MLA shelf life mode has, on a number of occasions, refuted claims, and prevented additional claims from occurring.

"Since we have been able to use this data, to both refute claims, and prevent claims occurring. We cannot overstate the value of this assessment of temperature data."

Outcome

Data has provided customers with an understanding of temperature on the impact of shelf life- resulting in better relationships and the opportunity to protect product from spoilage.

Direct benefits/Impact

The following benefits and impact of the loggers were observed from 6 months usage (110 shipments):

1. 5 international claims related to temperature abuse successfully defended >$130,000
2. Areas of improvement for international customer's cold chain process identified- such as subpar storage temperature - resulting in future claims and ongoing issues being avoided. Additionally, advice on remaining shelf life of product (valued roughly $20,000/shipment) has already been provided to 5 customers over the course of 4 months

Indirect/Other outcomes

3. Real time logging provides transparency of the cold chain, and therefore builds trust with customers
4. Third party analysis of data (most customers do not have in house expertise) enables customers to refute claims based on cold chain issues within processors' control
5. Likewise, freight carriers have access to data to help avoid potential claims against them
6. Customers have the opportunity to be further informed about the significance of the cold chain and the impact of not holding product at recommended temperatures
7. Customers receive proactive data to assist them to prevent product spoilage and claims- consequently protecting overall brand image as well

7.6 Case Study - Benefits of real time logging for export customers (Food service and retailers)

Challenge

An Australian Abattoir committed to improved product quality throughout their supply chain and into their export customers that consist of wholesalers, retailers, and foodservice. The challenges experienced by these customers are there is no visibility in a complicated supply chain with multiply transfer points. There customers expect product to reach the labeled date and will use product based on a First In First Out (FIFO) protocol, however this does not always reflect the actual product quality due to variabilities within the cold chain.

"The data allows us to know which product to use first, and the problems we had" - Director of Hotel operations

Objective:

How export customers use real time temperature monitoring

In order to build stronger relationships across the supply chain, an Australian abattoir using real time monitoring shared the data to help customers monitor their storage temperature once it reaches their cold store.
In particularly to show how the temperature impacted the product shelf life they purchased. A Five Star hotel chain and a high-end grocery in particular was very interested in their cold chain, and its impact on the product quality.

Learning

- Freight forwarder in Australia was below optimal cold chain
- The storage temperature of product was not ideal 3.7°C
- Defrost cycle of cold room was during busiest period, not allowing sufficient cooling of the room
- FIFO protocol is not always the best stock management

Outcome

- The cold room temperature was reduced by 1°C giving an additional 25 days, in the 21 day storage period. Effectively doubling the amount of shelf life in product.
- Defrost cycle of the cold room was changed to off peak periods.

Direct benefits/Impact

The following benefits and impact of the loggers were observed:

1. Doubling the shelf life on products that's stored in the cold room
2. Better control of storage fridge temperature

Indirect/Other outcomes

1. More confidence in product quality when serving customers
2. No longer using FIFO to determine stock to use first
3. Product last longer and waste less

7.7 Case Study - Benefits of real time logging and shelf life calculator for plant upgrade and improvements

Challenge

Abattoir are committed to improved product quality throughout their supply chain and into their export customers that consist of wholesalers, retailers, and foodservice. The cold chain starts once the product is processed, and the storage conditions has a significant impact based on the time. To ensure that maximum quality is achieved, an abattoir needs to invest in technology and equipment to assist in the improvement of the storage temperature.

Using the shelf life model help me prove the investment for upgrades was worth it – Processor A

Objective:

How abattoir can measure the impact of upgrads

Due to rapid expansion and space constraints all products are stored in a single large chiller with traditional sliding doors. The operations manager wants to install a rapid roller door to improve temperature control. Temperature monitoring was measured for 14 days before and after the upgrade.

DMF ColdSaver door speed roller door. *source DMF international (dmf.com.au)

Learning

- The chiller main entry storage temperature was averaging -0.36°C, after installation it achieved an average of -0.98°C.
- The far wall averaged -0.63°C, after installation it achieved -1.15°C
- Product is usually stored for 14 days before loading out, making storage temperature important
- Rapid roller door cost around $18,000 for installation

Outcome

- The temperature reduced by 0.52°C and halving the standard deviation of temperature (reducing a maximum of 15°C down to max 5°C) at main door.
- Additional 5.5 days, in the 14-day storage period. This may not seem much, but it is 26% more.

Direct benefits/Impact

The following benefits and impact of the loggers were observed:

1. 26% (5.5days) more shelf life on products that's stored in the cold room
2. Saving of 30c/tonne
3. Reduction of 2.6 GHG emissions kg CO2-eq / tonne

Indirect/Other outcomes

1. Confidence in product quality and holding product for longer
2. More consistency in product across the room
3. Overall energy cost will decrease, however it is too early to quantify
4. More confident and opportunities to look at other upgrades on site

7.8 Case Study - Benefits of real time logging in small retail stores / butchers for production schedule

Challenge

Their customers expect product to reach the labeled date and will use product based on the label, however this does not always reflect the actual product quality due to variability within the cold chain and how product is handled. Butchers and small retailers managing product usually use product based on a First In First Out (FIFO) protocol. In addition, butchers will need to be aware shelf life of product once it has been produced.

"Knowing the shelf life of my raw product allows me to have more time to make other products to sell" - Director of Hotel operations

Objective:

How to use real time temperature monitoring and the shelf life model in a butcher/retail store for stock management

Small butchers' shops and retailers traditional use FIFO, in addition need to product shelf life they have to consider shelf life of product on display. By monitoring the storage temperature retailers can improve their stock management.

Learning

- Freight forwarder in Australia has a suboptimal cold chain
- The storage temperature of product was 8°C

Outcome

- The cold room temperature was reduced by 1°C giving an additional 14 days, in the 7 day storage period. Effectively doubling the amount of shelf life in product.
- Defrost cycle of the cold room was changed to off peak periods
- The freight forwarder in Australia no longer leaves product unrefrigerated

Direct benefits/Impact

The following benefits and impact of the loggers were observed:

1. Doubling the shelf life on products that's stored in the cold room
2. No more transport events at the freight forwarder

Indirect/Other outcomes

3. Transparency of own cold chain and storage conditions
4. More confidence in product quality and shelf life
5. No longer using FIFO to determine stock to use first