

SUPPLY CHAIN ANALYSIS IN THE AUSTRALIAN LAMB PROCESSING INDUSTRY

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Abstract

During the last decade, supply chain management has played an important role in enabling many agribusinesses to succeed in their business goals, gain competitive advantage, and improve their business performance. As the result, there has been extensive research into strategic supply chain management with the aim of improving agribusiness performance at each stage of the supply chain. This is because in the current agribusiness world, supply chain activities are crucial in influencing many companies to continuously adapt proper supply chain management practices. The objective of this research was to analyse supply chain performance indicators among Australian lamb processors by using survey data and empirical models. Based on the results of these analyses, alternative configurations for these supply chains were suggested to help enhance the performance of the businesses concerned. The results indicate that food quality and efficiency are significant indicators of competitive advantage for lamb processors.

Keywords: Lamb Supply Chain, Supply Chain Management

INTRODUCTION

The lamb sector in Australia is undergoing rapid change because of globalisation, a highly competitive lamb market (local and export), increased production efficiencies, quicker production cycles and delivery times and consequently reduced inventories, a trend toward more outsourcing of activities, and the rapid development of IT [1]. In this type of business environment, advanced supply chain systems have been observed to have a dramatic impact [2-4]. As a whole-of-chain approach has not yet been developed, such systems have the potential to provide significant contributions to the performance of the Australian lamb industry. This is a similar situation to that of beef supply chains described by Smith [5].

Using data gathered by a survey of lamb enterprise participants, we adopted a regression approach at the exploratory stage of the study to assess which aspects of supply chain performance were critical to lamb processors. The findings of this stage revealed that food quality and efficiency were more important than other supply chain performance indicators. This led to an in-depth examination of these two supply chain performance indicators for lamb processors.

LAMB PRODUCTION AND LAMB SUPPLY CHAINS

The Australian lamb supply chain can be segmented into four levels: lamb production, lamb processing, lamb retailing/wholesaling and final consumers. There are a few fully integrated supply chains linked to the major supermarkets. These have sheep moving from feedlots/farms to processors who transform them into lamb products and organise delivery into the hands of end customers. For the most part, however, lamb supply chains are only partially integrated—involving activities from slaughtering to end customers or from producing to slaughtering. Small and medium lamb enterprises are the main players who contribute to these partially integrated supply chains.

Lamb supply chains can also be classified as aligned or non-aligned. A comparison between them reveals that there are striking differences in their operations. Aligned lamb supply chain management in Australia is associated with highly integrated chains, for example lamb producers/feedlots and other chain partners (processors and wholesalers) need to meet and sustain chain goals such as efficiency and effectiveness. To achieve these goals, aligned lamb supply chains need to have several features. First, all levels of the lamb supply chains get involved in strategic and operational planning processes. In contrast, non-aligned lamb enterprises do not consider these processes. Second, aligned lamb enterprises need to develop trust, awareness (focused on customers' needs), strong partnerships and transparency (information sharing) among the partners. Non-aligned lamb enterprises do not consider information sharing and tend to have secrecy as a general principle of operation. Due to complex groupings of unrelated participants, the level of trust will be inconsistent among non-aligned lamb enterprises. Moreover, non-aligned lamb enterprises do not have chain integration, a customer focus or clear market signals.

Lamb production is the first level of the Australian lamb supply chain. Activities at this level cover breeding, store lamb production, fattening and a limited amount of lot feeding. In 2005, there were 76,662 lamb enterprises in Australia. They produced about 25 million head of lamb with a gross value of production of about \$5.7 billion. Additionally, about 65 percent of production is exported. Feedlots contribute about 27 percent of total lamb production [6, 7].

Lamb is sold in Australia as stud, store or finished stock. There are several methods of selling lamb (depending on the type of stock and market outlet for the stock) [8-11]. They are paddock sale, over the hook, saleyard auction, AuctionPlus (electronic sales), direct consignment, forward contract (contract based make to order) and alliance.

PROBLEM STATEMENT

Combining knowledge of the rapid changes taking place in lamb processing with the supply chain management literature, leads to the following problem statement: “Do attributes such as flexibility, efficiency, food quality and responsiveness influence competitive advantage?”

LITERATURE REVIEW

Qualitative performance indicators

Three qualitative supply chain performance indicators are quality, customer satisfaction and flexibility.

Quality

Harland [12] considered that there were three determinants in choosing suppliers at a supply chain level: the abilities to meet the quality standard for the products, to deliver products on time and to provide quality service. In a lamb industry context, supplier performance means how well the breeding property, feedlot, or saleyards deliver sheep to processing or abattoir facilities on time and in good condition. Performance indicators in this context must consider food quality, safety and animal welfare.

Customer satisfaction

Customer satisfaction is an important supply chain performance indicator [13]. Customers should be satisfied with the received products or services. Three elements of customer satisfaction can be considered [14]: pre-transaction satisfaction, satisfaction associated with the transaction and post-transaction satisfaction.

Flexibility

Flexibility can be viewed from various perspectives [15-20]: the ability to adapt to a changing environment, or an attribute of a system technology for coping with the variety of its environmental needs, or the ability of a system to change or react with minimal penalty in time, effort, cost or performance.

Chopra and Meindl [19] defined four dimensions of flexibility in supply chain management as:

- Customer service flexibility, which refers to the ability to fulfil special customer requests or inquiries;
- Order flexibility, which refers to the ability to adjust order size, volume or composition during logistics operations;
- Location flexibility—this refers to the ability to service customers from alternative wholesaler locations or supermarket outlets;
- Delivery time flexibility—this refers to the ability to provide delivery times for customers.

Related to this, Vickery et al. [20] outline five categories of flexibility in supply chains:

- Product flexibility: the ability to customise a product to meet specific customer requirement;
- Volume flexibility: the ability to adjust capacity or resource utilisation to meet changes in customer quantities;
- New product flexibility: the ability to launch new or revised products to the market;
- Distribution flexibility: the ability to provide widespread access to products;
- Responsiveness flexibility: the ability to respond to target market needs.

Flexibility is a potential supply chain performance indicator in this research because the research focuses on whether the Australian lamb industry is able to respond to the variability

in demand for lamb products (either on domestic or world markets). Flexibility in the Australian lamb supply chain can be measured at the functional/hierarchical level (breeding property, feedlot, processors or wholesalers).

Quantitative performance indicators

There are two types of quantitative performance indicators: non-financial and financial measures [21].

Non-financial performance measures [22]

1. Cycle time (or lead time)

Cycle time is an important issue at all levels of supply chain management. Long lead times impair “*the ability of a supply chain to quickly respond to changing conditions, such as changes in the quantity or timing of demand and quality of logistics problems*” [23, p.523]. Lead time can be viewed as process lead time or order-to-delivery time:

- Cycle time of the supply chain process. The definition of cycle time of the supply chain process in a lamb supply chain is the time spent from the breeding property to the processing facility (plant) or the time spent by lamb and mutton products from the plant to the supermarkets or food services.
- Order-to-delivery time. The definition of order-to-delivery time in a lamb supply chain is the time between when the wholesalers or processors place an order and the delivery of lamb product to the processors or wholesalers. The three delivery dimensions are delivery speed, production or processing lead time and delivery reliability [24].

2. Customer service level

There are several supply chain metrics to measure customer service levels:

- order fill rate is defined as the availability of stock level to fulfil the customer demand;
- stock-out rate;
- backorder level is defined as the number of customer orders waiting to be filled;
- on-time delivery is defined as the number of customer orders that are fulfilled on-time (without delay).

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

3. Inventory levels

Inventory is “*the stored accumulation of physical material resources in the operation*” [25, p.231]. There are three major types of inventories in the lamb sector, the sheep supply as raw materials, slaughtered sheep as work in progress (WIP), and finally the lamb or mutton products as the finished products. To achieve high efficiency in the supply chain, the businesses need to keep optimal levels of each type of inventory.

4. Resource utilisation

Generally there are several resources in the businesses such as production and processing or manufacturing resources, storage resources, logistics resources including truck or other type of shipment delivery, human resources and financial resources (working capital). The main objective of this performance indicator in the Australian lamb supply chain

context is to utilise the resources efficiently, for instance to utilise the plant, boning or slaughter facilities efficiently.

Financial performance measures

The objective of measuring financial performance of the supply chain is to maximise revenue and minimise costs ([26-29]. Generally, the financial performance of a supply chain has 10 items [30]: revenue from the goods sold; cost of raw materials; activity based costing such as processing; transportation costs; inventory holding costs; expenditure of expired perishable goods; penalties for inaccurately filled orders; credits for imperfectly filled deliveries from suppliers; cost of goods returned by the customers; and credits for the goods returned to suppliers.

The financial performance of a lamb supply chain management can be measured using the following items [7]:

- farm costs including the crop and pasture chemicals, fertiliser, fodder, fuel, oil and lubricants, land rent, water charges, seed, shearing and crutching charges, payments to sharefarmers;
- processing costs including the machines, repairs and maintenance, material handling equipment, wages paid to hired labour;
- livestock materials (drenches, dips etc);
- administration expenses including accountancy fees, banking and legal expenses, postage and stationery, telephone charges, subscriptions etc;
- handling and marketing costs;
- distribution costs including freight;
- slaughtering, lamb purchases, the other livestock purchases and livestock transfers-inwards, and;
- total cash costs and other cash costs.

Table 1 describes the previous studies on supply chain performance indicators. Based on existing and previous studies in different sectors, the most relevant indicators for measuring the performance of the integrated supply chain appeared to be: efficiency (costs, assets, profit, net income, return on investment, waste reduction), customer service, flexibility (volume and delivery flexibility), responsiveness (lead time and on time delivery), reliability, product availability, product and process quality. A review of these studies reveals that efficiency, flexibility, responsiveness and quality should be included in the conceptual framework of supply chain performance indicators for the Australian lamb industry. They are of major importance to the industry. This is because they can capture the characteristics of the lamb supply chain at the organisational level (lamb producers, lamb processors and processors), as well as financial and non-financial indicators. Furthermore, they are easy to quantify. In order to implement this framework, empirical research needs to be performed. Statistical methods were used to examine the influence of several factors, such as efficiency, responsiveness, food quality and flexibility on competitive advantage.

Table 1 Previous studies on supply chain performance indicators

Description	Author
Coordination can improve supply chain performance.	Lee and Billington [31]
There are three supply chain performance indicators: efficiency, customer service and flexibility.	Beamon [32, 33]
Develop a conceptual framework for supply chain performance indicators at three levels: strategic, tactical and operational.	Gunasekaran, Patel and Tirtiroglu [34]
The business process reengineering approach combined with the theory of Analytic Hierarchy Process (AHP) has been proposed to improve supply chain management.	Korpela, Kylaheiko and Lehmuswaara [35]
An overview of supply chain performance indicators and their dimension used in literature from 1987-1993 has been presented. There were 19 performance indicators—most were financial perspectives such as net income or Return on Investment (ROI).	Murphy, Trailer and Hill [36]
Simulation is able to analyse two supply chain performance indicators (quality and short lead time).	Persson and Olhager [37]
Profit, lead time, on time delivery and waste reduction are supply chain performance indicators to improve efficiency and effectiveness. The most influential factor in supply chain performance is lead time.	Li and O' Brien [38]
There are two suggested configurations to improve the efficiency performance indicator: reducing lead time and information sharing.	Berry and Naim [39]
There are several supply chain performance indicators in transportation: responsiveness, reliability, costs and assets, efficiency, service effectiveness for shippers.	Lai, Ngai and Cheng [40]
There are five food supply chain performance indicators: product availability, quality, responsiveness, delivery reliability, total supply chain costs.	Van der Vorst [41]
Lead time and cost are supply chain performance indicators at the retailer level with a single manufacturing level and multiple retailer model. Reducing the set up time, the production time and the number of processors have been suggested to improve supply chain performance.	Eppen [42], Thonemann and Bradley [43]

Table 2 describes studies from 1979 to 2006 on supply chain performance indicators (customer responsiveness, efficiency, flexibility and quality) in manufacturing, food, transport, steel production, horticulture and other industries. Based on existing and previous studies, many efforts have been made to develop performance indicators for various supply chains. Most previous studies have focused on efficiency, and this is reflected in supply chain performance indicators. However, quality has little attention in current or previous studies. Customers have placed strong demands on different attributes of red meat products such as food safety, quality and animal welfare. Thus, food quality needs to be considered in this research.

Table 2 Previous studies on customer responsiveness, efficiency, flexibility and quality

Customer responsiveness	Efficiency	Flexibility	Quality
[32-34, 37-41, 43-48]	[31-34, 36-48]	[32-34, 37-41, 45-48]	[48-51]

There are three previous studies [41, 46, 48] concentrating on customer responsiveness, efficiency, flexibility and quality in food, horticulture and agri-food supply chain management (tomato supply chain). Supply chain performance indicators (stated above) have not yet been applied to the lamb industries.

Competitive advantage

The key concern for the Australian lamb industry is developing competitive advantage. Competitive advantage indicates that the Australian lamb industry offers something unique or of particular value when compared with competitors in the marketplace [20, 52-56]. It comprises capabilities that allow an organisation to differentiate itself from its competitors and is an outcome of critical management decisions [54]. Some previous studies on competitive advantage can be seen in Table 3. Most competitive advantage frameworks have been tested empirically in these previous studies. There are several components of competitive advantage frameworks: price or cost; premium prices, innovation, quality, delivery dependability, flexibility, and time. As a result, it is confirmed that this research focuses on four components of the competitive advantage framework: price, quality, sales growth and time-to-market. The previous studies also confirmed that competitive advantage in the businesses (in general) could be achieved by supply chain strategies, co-operation and partnerships among trading partners.

Table 3 Previous studies on competitive advantage

Description	Author
Competitive advantage framework has been tested empirically. There are four elements of competitive advantage: price/cost, quality, delivery, and flexibility.	Vickery, Calantone and Droge [20] Tracey, Vonderembse and Lim [54] Skinner [55] Roth and Miller.[56]
Time-based competition as an important competitive priority is the next source of competitive advantage.	Stalk [57] Vesey [58] Handfield and Pannesi [59] Kessler and Chakrabarti [60] Zhang [61]
There are five elements of a competitive capabilities framework: delivery dependability, innovation, pricing, premium pricing and quality as a value attribute.	Vickery, Calantone and Droge [20] Tracey, Vonderembse and Lim [54] Skinner [55] Roth and Miller [56] Koufteros, Vonderembse and Doll [62] Cleveland, Schroeder and Anderson [63] Rondeau, Vonderembse and Ragu-Nathan [64] Safizadeh et al [65]
Supply chain strategy and supply chain performance can achieve competitive advantage by exploratory study (international survey).	Harrison and New [66]
Co-operation and partnerships among businesses in a supply chain is an essential source of competitive advantage.	Christopher [67]

Research Methodology

A supply chain management survey of the Australian lamb industry was conducted by distributing a mail questionnaire to lamb processors. The survey asked participants in the industry to express their views on various aspects of the supply chain, with focus being placed on the supply chain performance discussed above. The objective was to establish a model explaining the competitive advantage of lamb processors in terms of the various supply chain performance indicators.

The sampling frame was established using the following sources: the AUSMEAT website, Top 25 Ranking red meat producers/lot-feeders and processors by value added (published by the MLA), and Yellow-pages online. The list provides the names, addresses, telephone numbers, persons to contact (which in the majority of cases includes the president, managing director, general manager, or supply chain/operations/production/plant manager). In an attempt to achieve a representative sample, stratified random sampling was adopted, with strata defined by location (state) and size of operation (number of sheep slaughtered). Six hundred questionnaires were mailed out, and 108 (18%) usable responses were obtained.

The effective response rate to the survey was 18%. Cronbach's alpha [68] was used to test internal consistency, and values of 0.60-0.87 were obtained. While 0.70 or above is desirable [69], 0.50-0.60 is considered sufficient [70]. The majority of items in the survey were based on established scales that have already been subjected to tests of content validity [33, 47-49, 71]. In addition, the pre-test confirmed that a group of industry experts viewed the scales used as acceptable.

Discriminant and convergent validity were assessed using factor analysis. Again the results fell within the acceptable range. Finally, multiple regression analysis was performed. Australian lamb processors' supply chain performance indicators (independent variables) were regressed on competitive advantage (dependent variable). This produced a model in which competitive advantage was related to processors' responsiveness, flexibility, efficiency and food quality.

After completing various hypothesis tests, the model that was obtained is shown in equation 1. It shows that supply chain performance efficiency (SCP_eff) and supply chain performance food quality (SCP_fqual) have a significant influence on lamb processors' competitive advantage (Ycomp_adv) (t- statistics are given in parentheses).

$$\begin{aligned} Y_{\text{comp_adv}} &= \alpha + \beta_1 * SCP_eff + \beta_4 * SCP_fqual + e_i \\ Y_{\text{comp_adv}} &= 0.714 + 0.689 * SCP_eff + 0.711 * SCP_fqual + e_i \quad (1) \\ &\quad (3.71) \quad \quad (3.91) \quad \quad \bar{R}^2 = 0.54 \end{aligned}$$

DISCUSSION OF RESULTS

Our study contributes to the field by exploring the relationship between the supply chain performance indicators and competitive advantage of firms in the Australian lamb industry. The findings indicate that the competitive advantage of Australian lamb processors is significantly influenced by process efficiency and food quality. The results of previous research [72] confirm that lean thinking has a strongly positive impact on the efficiency and food quality of red meat enterprises.

The findings of this study that process efficiency and food quality are significant determinants of competitive advantage are in line with the lean thinking philosophy, which is to drive out unnecessary costs and other wastes from the entire supply chain [73-76].

In fact, “*lean thinking could strip 30 percent of the costs from the supply chain between the farm gate and the meat retailer. It needs a culture change in managing the business and a very large commitment, but over the next five years it’s the next major step we can make*” [77, p.12].

Recently, two fundamental lean thinking concepts that have been developed are Takt-time [78], which is for horizontal continuous production flow, and standardised work [78, 79], which is for continuous improvement. Lean approaches have been ignored in the red meat industry [78]. However, this study discovered the key finding that lean thinking has a strongly positive impact on lamb processors’ food quality and responsiveness (by driving out the unnecessary costs and other wastes in the entire lamb supply chain). There are several steps in the lean thinking approach [73, 78, 80]:

1. to determine the value to the final customer, in other words to understand a customer’s specific requirements;
2. to establish a value stream through classification of products that follow similar paths from raw material to the point of consumption;
3. to get single product flow continuously through the value-creating process steps, i.e. eliminating barriers to flow such as bottlenecks and time-consuming work practices;
4. to ensure that nothing is produced upstream until someone down-stream needs it;
5. to pursue perfection continuously by looking for waste, finding new forms of it and tackling it.

In addition, successful lean thinking is based on philosophy, practice and policies [81-84]. There are several lean philosophies, for example, *Kaizen* (continuous improvement) to reduce or eliminate waste and to strive for perfection in internal business processes. Lean practices are tools or techniques in tactical or operational situations, for example, *Heijunka* (levelled production). Moreover, various lean policies have been developed, for example *Poka-Yoke* (mistake proofing), enhanced problem-solving, enhanced employee involvement, visual control, long-term relationships with customers and Total Productive Maintenance (TPM).

This study proposes a lean philosophy, namely *Kaizen* (Plan Do Check Action (PDCA)) as a continuous improvement process for lamb processors and 5-S as a lean practice. Several related initiatives recently used by many organisations practising 5-S are Lean Manufacturing, Total Productive Maintenance, Total Quality Management (TQM), ISO 9001/14000, Just In Time (JIT), EFQM and Six Sigma [85-87].

There is heavy emphasis on the implementation of *Kaizen* and 5-S programs in the manufacturing and automotive industries [88]. However, these programs have not received much attention in the red meat industry. Only red meat enterprises in the United Kingdom have proposed these programs [78]. There are several reasons why these programs are appropriate approaches in links with Australian lamb processors. First, these programs can improve processors’ operational efficiency by reducing wastes. For example, National Foods’ manufacturing plants in Morwell have applied lean practices (5-S; operator maintenance; production levelling; standardised work practices, and product and equipment rationalisation) to improve overall performance. As a result, the outcomes of these programs for the firm have been an improvement in operational efficiency by 55 percent; weekly production plans achieved 95 percent of time; a reduction in man-hours by 12 percent; a reduction in lost time

injury frequency rate by 53 percent; a reduction in the medically treated injury frequency rate by 52 percent; a reduction in sick leave by 5 percent; and a reduction in physical waste by \$20/tonne of product [89].

Second, *Kaizen* and 5-S are simple methods, easy to apply for any size of lamb processors and more practical or tactical rather than strategic. Moreover, the form of implementation of these programs depends on lamb processors' characteristics and their internal business operations.

Kaizen application

Kaizen was established in Japan during World War II. *Kaizen* is defined as 'continuous improvement'. *Kaizen* is a system in which every employee (from top to lower management level) in the organisation needs to be involved to make improvement suggestions on a regular basis for any area of the business. For example in Toyota and Canon, 60 to 70 suggestions per employee per year are written, shared and implemented [90]. Basically, each suggestion is only making small changes on a regular basis to improve productivity, safety, efficiency, effectiveness and reduce waste. *Kaizen* also involves setting standards and then continually improving those standards. To support this, *Kaizen* involves providing the training, materials and supervision required for staff to achieve higher standards and maintain their ability to meet those standards on an on-going basis.

The PDCA (Plan, Do, Check, Act) cycle is very well known in the *Kaizen* problem solving approach. The PDCA philosophy (also known as the Shewhart cycle) was developed by Walter Shewhart, who established the statistical process control approach at Bell Laboratories during the 1930s. That approach also was known as the "Deming Wheel" after Shewhart's student (W.Edwards Deming), who popularised the PDCA cycle. The PDCA cycle is an important part of continuous improvement with the *Kaizen* approach.

Figure 1 shows the steps or processes for a Plan, Do, Check and Action (PDCA) approach for lamb processors.

5-S Application

A 5-S approach is a part of *Kaizen* (continuous improvement system) and also a component of lean thinking. The title 5-S is an acronym for five Japanese words, *seiri*, *seiton*, *seiso*, *seiketsu* and *shitsuke*. A 5-S approach basically focuses on *organisation*, *neatness*, *cleanliness*, *standardisation* and *discipline* [91, 92]. Several authors have different words for 5-Ss [85, 91, 93-95]:

- *Seiri*: sort, sift, clean up, clear out.
- *Seiton*: straighten, simplify, set (in order), configure.
- *Seiso*: sanitise, scrub, shine, sweep, clean and check.
- *Seiketsu*: standardise, sustain, systemise, conform.
- *Shitsuke*: self-discipline, custom and practice.

Ho [92] confirmed that about 80 percent of the Japanese industry in 1995 had implemented 5-S as opposed to 40 percent in the UK. The benefits [91, 96] from implementing the 5-S approach are: improved profitability, efficiency, service, quality; improved employee involvement; better housekeeping; waste reduction; pollution prevention, safer storage of

substances and materials; better health and safety standards and less environmental risks. The findings of the current research with respect to lean thinking would support such a program, particularly for lamb processors. In fact, this approach looks simple and easy, but would need attention to detail for the red meat industry, in particular processors, to deliver high quality lamb to final consumers. Integrating philosophical principles, previous research and the findings of our study, we propose that the application of 5-S to the lamb supply chain should involve the process shown in Figure 1.

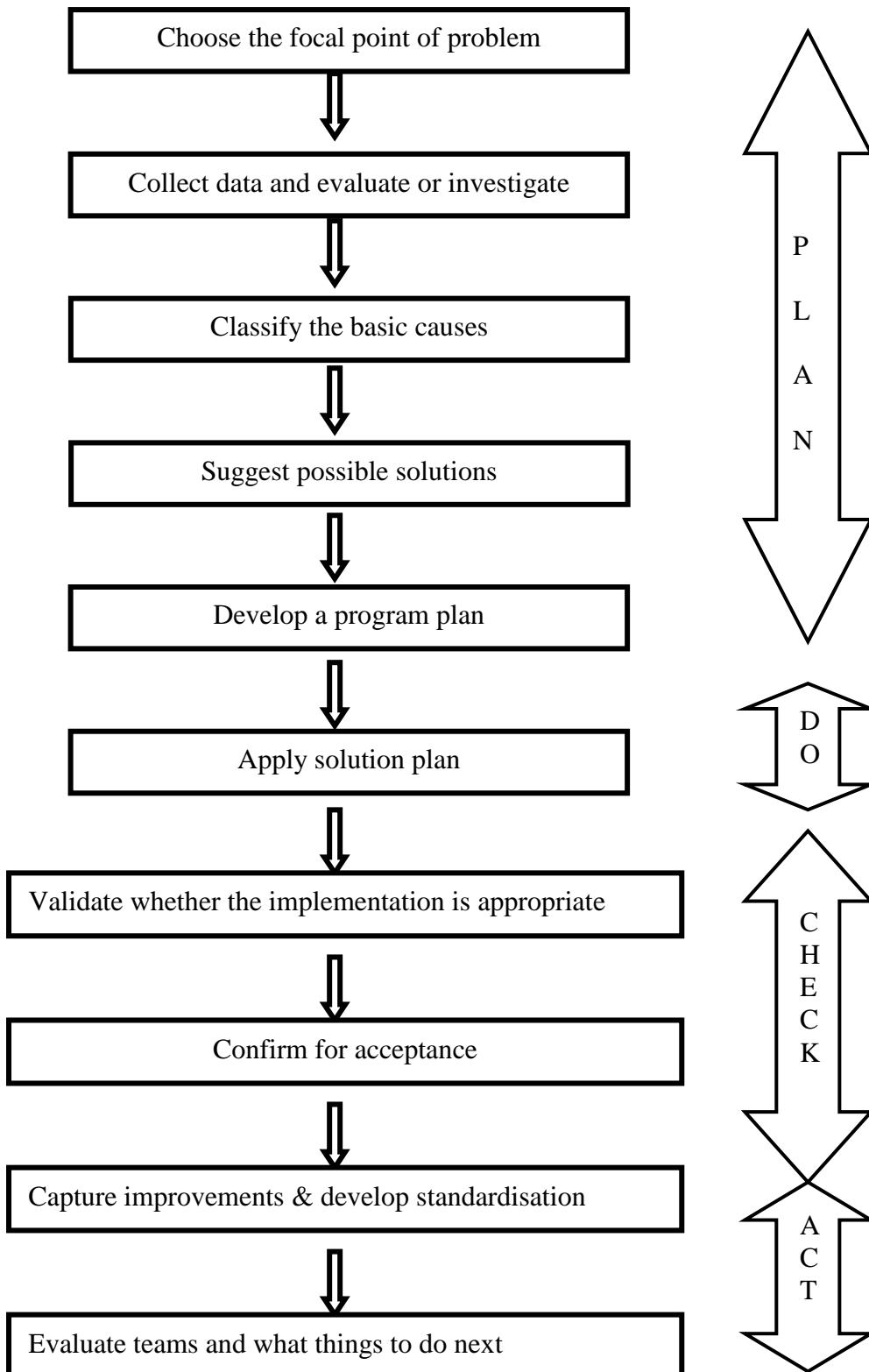


Figure 1 Plan, Do, Check, Action (PDCA) Processes

- *Sorting*: the first step in getting things cleaned up and organised. This step may facilitate the cleanliness and hygiene performance of meat processing plants,

abattoirs, slaughter floors, boning rooms, retail meat outlets, supermarkets, food services and wholesaling workplaces.

- *Setting in order*: organise, identify and arrange everything in a work area, for instance, to check meat temperature regularly from receiving to sale (display cabinet in a butcher shop or supermarket, temperature of cool room, chiller, freezers, refrigerated vehicles).
- *Shining*: regular cleaning and maintenance. This step is important for all workplaces in the Australian lamb industry because it may enhance the highest quality of meat products, hygiene and food safety standards. A simple example of this step in butcher shops or retail meat outlets is that staff need to clean up frequently and do regular maintenance of slicers, cool rooms and display cabinets.
- *Standardising*: make it easy to maintain by simplifying and standardising. To do this, the Australian lamb industry needs to meet occupational health and safety (OH&S) requirements, work instructions or standard operating procedures (SOP), quality assurance requirements, state and federal regulations regarding meat processing, and perform these tasks to production requirements. Occupational health and safety requirements in the Australian meat industry may include: OH&S policies, procedures and programs (Australian Standard for Hygienic Production of Meat for Human Consumption, ANZFA Food Standards Code, Export Control Act); hygiene and sanitation requirements; OH&S legal requirements; Personal Protective Equipment (PPE), which may include requirements for coats and aprons, ear plugs or muffs, eye and facial protection, head-wear, lifting assistance, protective boot covers, protective hand and arm covering, protective head and hair covering, uniforms, waterproof clothing, work, safety or waterproof footwear, as set out in standards and codes of practice [97].

Standard operating procedure may relate to personal hygiene, food preparation and processing, pest control, waste disposal, cleaning, maintenance of premises, product recall, customer complaints and calibration [97].

- *Sustaining*: maintaining what has been accomplished. This step applies when the workplace requirements in the Australian lamb industry stated in the previous step have been achieved. The checklist as a quality control tool is good to use in order to identify which requirements have been accomplished and which ones have not been accomplished, and to focus attention on the next appropriate steps.

CONCLUSION

Our study contributes to the better understanding of the supply chain operation of the Australian lamb industry. We conclude that for lamb processors, two performance indicators (food quality ($r=0.68$) and efficiency ($r=0.55$)) significantly influence their competitive advantage. The implication of this result is that lean thinking seems to be an appropriate approach for improving supply chain performance in the industry. Lean thinking has been discussed in detail as it is significantly related to both efficiency and food quality.

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