Master Thesis

Opportunities for Cost Reduction

in Thai Cooperative Beef Production Chain

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MSc program : Management, Economics, and Consumer Studies

Specialisation : Management Studies

Thesis code : MST 80433 (33 ECTS)

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Wageningen, the Netherlands
March, 2012

Abstract

Even though beef is an agricultural product that is not ranked among the top of Thai industries, it certainly is very important in terms of being an additional income for poor farmers who could not make enough from rice growing. Beef fattening became very popular since it significantly increased the income average of the farmers. However, Thai producers still face the problem of rising cost and a more competitive market. The more intense competition is the result of the advent of free trade area agreement (FTA), especially the one with Australia with the tariff of 51 percent being reduced gradually down to 0 percent in 2020. PYK cooperative is one out of three leading premium beef producers in Thailand directly affected byThai-Australian FTA. The price of Australian beef will soon be similar to Thai one. The survival of PYK beef producers then requires many sets of strategies. One important strategy is to effectively reduce the cost of beef production along the whole chain with the quality being retained in the premium class or developed into better quality and pricing, to gain more competitiveness against imported beef. The research is aimed at investigating opportunities to reduce costs along the Thai beef production chain by comparing it with the exported Australian beef chain taking into account process characteristics in terms of function, beef quality and cost structures of each stage throughout the chain. With the use of the literature review on agri-food production chain, beef quality (sensory properties and food safety), and cost management approaches have been studied. The field study at PYK coop's location in Thailand was needed to see actual beef production for the in-depth analyses. The results shows that PYK coop and Australian case are different in all aspects i.e. breed choice, herd sizes, farming practices, slaughtering and processing practice, and transportation practices which affect on final product quality. Best practices at each stage of Australian beef together with strictly quality assurance along the chain are the key success factors. Full support to R&D, education and training, marketing, and subsidies from Australian government and non-government organisations greatly helps Australian beef industry in terms of responding to climate changes and oversea demand. These have not happened to Thai beef industry. Recommendations were made regarding what Thai beef chain can learn from Australian beef chain.

KEYWORDS: Beef production --Beef quality –Activities-based costing—House of Quality – Cost reduction--Thailand –Australia

Summary

The research objective is to investigate opportunities to reduce costs along Thai beef production chain, the case of PYK cooperative which is the leader in producing premium beef in Thailand. The main competitor, Australian beef, with high quality and increasingly cheaper price, thanks to the FTA is comparative case in order to find out what PYK beef can learn in terms of the chain characteristics, beef quality and cost structures throughout the chain. Several sub research questions have been set to help answer the main research question ***"Where and how costs in Thai cooperative beef production chain can be reduced with its quality to be competitive with imported beef?"***. Literature study and empirical study including interviews, observation and documentation were used tofind answers to this questions. It was a pity though that no Australian expert responded to the interview requests. So the analysis of Australian beef production chain needed to be based heavily on literature. In the literature review agri-production chain characteristics, beef quality in terms of sensory properties and food safty, and cost management approaches have been studied. The field study where PYK coop located in Thailand was needed to see actual beef production for the in-depth analyses of beef quality and cost structure. The results can be summarized in three major aspects:

1) **beef chain process characteristics**: The model of Luning and Marcelis (2009, pp.73) is used as a framework of modified beef production chain because it helps filter out complicated part through focusing only on production. It was difficult to reach a conclusion on the process characteristics in terms of function of Australian beef production chain for none of the available literature directly discusses them. Most discuss beef supply chain in a complicated fashion. The exclusion of market channels from production chain in the modified production model helps filter out complicated part through focusing only on production. Overall, beef cattle production practices in Thailand are quite different from the ones in Australia in many ways.

- Cattle production: Cattle are produced by small household farmers scattering around the country. The farmers are comprised of both cow-calve producers and fattening cattle producers (who sometimes also produce calves for more fattening). Feedlots are also part of small household farmers, not clearly large-size specialised beef enterprises as in Australia.
- Cattle breeds: PYK beef cattle are mainly Charolais which is crossbred with local breed to create greater resistance to heat and disease. This has some tradeoff in that the use non-pure European breed affects costs and quality. This breed does not yield a high level of marbling, which is demanded by Thai comsumers. This needs to be compensated by longer fattening period, which drives up feed costs. On top of this is the fact that older cows give lower quality beef in terms of negative smell, tougher muscle, more risk of contamination. In Australia, beef cattle breeds are based on British breeds with which Australia crossbred to develop the genetic pool. The rapid increase in live cattle exports (from 1901 to 2004) is the testament of the success of cattle breed development in Australia (Gong et al., 2007).
- Slaughtering and processing technology: Australian abattoirs use on-the-rail dressing systems, with the hide removed by mechanical hide puller. Employees work from fixed positions along the chain. The average capacity of plants is 400 head per day. A tally system is used to determine the number of slaughtermen employed on the chain for any given daily throughput. The use of mechanical equipment eradicates unnecessary labour requirement. Plus the available workforce is allowed to specialize what they are doing. PYK coop, on the other hand, has the capacity of approximately 80-85 head per day through semi-mechanised

slaughtering. Labour is the major driving force of production. None of the workers have fixed duty. Those who work in the slaughtering line came from different departments – be they, administration, accounting etc. – not directly responsible for slaughtering and processing. These people may not be having sufficient aptitude in slaughter line. Several incentives e.g. cheap beef and extra money are offerred to workers who attend the slaughtering line to have more people to come, so that the work could be finished earlier.

- The transport of live cattle is complicated with requirements based on a number of restrictions and guidelines in Australia. Such complexities are to ensure that the welfare of the animal in transportation exists and that the beasts do not become stressed or hurt and lose condition due to poor handling or negligence. Even though PYK coop is known to be a beef producer with concern for animal welfare, transport of live cattle is left to the farmers who do not have in-depth knowledge about this. However, with the distance of less than 100 km and less-than-an-hour transporting time, restriction on animal welfare is not well heeded by either by the government and the PYK coop.

2) **Beef quality**: With the help of House of Quality (HOQ) model which is a part of Quality Function Deployment Approach (QFD), Thai consumer preferences, perceived beef quality of both cases including factors affecting beef quality in terms of sensory attributes and food safety were revealed.

- Sensory attributes: PYK beef has high tenderness and marbling, which meets the demand of Thai consumers. Imported beef from Australia on the other hand has a high level of leanness. So, PYK is confident that the sensory attributes of its beef have a competitive edge over Australian beef. However, PYK beef has the problem of inconsistency of beef quality in terms of average marbling score in each year. Such inconsistency in beef quality is amidst an intensely competitive market created by Free Trade Agreements (FTA) with Australia which lowers the tariff down to 0% in 2020 and strong marketing practice around the world of Meat and Livestock Australia (MLA). A study by Piggott et al. (1996) as cited by Gong et al. (2007) confirmed that the MLA advertising was related to the increase of beef consumption . With these two reasons, PYK or other producers in Thailand need to be prepared for future competition to survive.
- Food safety: PYK beef lags a long way behind Australian beef. Even though the PYK slaughterhouse earned a national standard and is accepted by Thai consumers, international standard is required for export. Australia, on the other hand, has quality assurance schemes under different frameworks and different aims. Those scheme were administered by government and industry bodies representing producers in Australia, which constitutes one of the key factors of success.

3) **The cost structure**: Both production chains in each function have different shape of cost structure, even though some cost types in some functions are similar.

- Farm function: Labour cost is still popular in the studied functions of both chains.

    - In Thailand: It is no surprise that this cost is high for PYK coop, because all the functions at PYK, be they farm, slaughtering and processing functions, are labour intensive. When the labour costs of farmers were calculated along with farm production, it was found that farmers gained almost no profit. The reason they can still produce is that such

labour costs depend on muscle and strength of family members and do not involve real cash being paid (non-cash cost). Even fattened cattle producers, who superficially seem to make more profit than producers of cow-calves alone, risk being in deficit once labour costs are fully included. The risk is even higher with fattened cattle producers who purchase calves for fattening. The money spent in that purchase immediately turns into costs the producers have to bear. Deeper deficit might even occur if the fattened beef cattle have low marbling quality that only gives lower price or if longer fattening period, and thus more feed, is required to meet PYK coop standard.

  - In Australia: Either with farms that produce backgrounding cattle or fattening cattle, cattle purchases and labour cost in farm function are less important which is different from Thai beef chain. Rather, it is repair and maintenance and feedlot costs that are so. This might be because Australian farms are large scale ones that require help from machinery. (Even smaller Australian farms contain 100-400 head per farm [ABARES, 2011], which is equal to approximately 100 Thai farms [approximately 4 head per farm])

- Slaughtering and processing function: Besides beef cattle purchases, labour cost still plays the important role to both chains.
  - In Thailand: According to many limitatios of cost information accessibility, only labour cost of PYK coop in slaughtering and processing process was examined in details. Though only one function was allowed to study, it generates benefits because employing workers from almost all divisions in every salary level, not fixed positions and number of workers in the slaughtering line doubting that how much realised labour cost is. With the help of Activity-based costing, it was shown that realised labour costs are approximately 18% higher than what PYK estimated. Electricity cost from calculation approximately 28% are lower than what PYK estimated. These figures might be useful for PYK coop to re-think about presenting cost information of slaughtering and processing function or even about proper management.
  - In Australia: Unfortunately, for Australian slaughtering and processing function, it is not possible to study the cost structure in in-depth fashion because there is no available data in details. Cost information gaining from various sources present different data theme e.g. year of data, region (Northern/Southern part of Australia), or sectors etc. which is tough to analyse.

Based on the results of analysis and investigation for opportunities to reduce costs along PYK beef production chain without lowering the beef quality, the following recommendations for PYK arise:

1. To use better breeds with high marling and high resistance to weather conditions and diseases.
2. To produce calves for fattening in-farm in order to reduce cost of cattle purchases.
3. To improve feed both in quantity and quality by grass farming, improving harvesting by-product supporting by research.
4. To train farmers and/or drivers on best transport practice to deliver live cattle.
5. To educate farmers on efficient production practices, market accessibility and industry issues
6. To strengthen marketing strategies by building cooperation among involved actors along beef chain
7. To transfer knowledge to the next generation of workers on beef marketing and beef production/beef quality for promoting purpose.

8. To study feasibility of capital investment in order to enhance competitiveness in terms of hygienic issue and market share expanding.

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Chapter 1 Introduction

1.1 Problem statement

Beef is an important industry in Thailand even though the net revenue generated by it is nothing in comparison to other industries. This is because frozen beef is an agricultural product and involves a large number of people working in it (approximately 1.3 million) (Kankeaw 2010). It was estimated that beef industry will be significantly affected by the advent of free trade area (FTA), especially the one with Australia. This is because Australia is a powerful exporter of beef. Thai-Australian FTA was effective from January 1st 2005, with the tariff of 51 percent being reduced to 40 percent immediately and 4 percent reduction each passing year until the tariff become 0 in 2020 (Angkuro 2008). Imported Australian beef will then be able to compete with Thai beef in the upper market. The prices before FTA commitment and the ones when tariff is 0 are shown in table 1.

	Thai premium beef	Australian grass-fed price in 2007 (tarrif 34.6%)	Australian grass-fed price in 2011 (tarrif 24%)*	Australian grass-fed price in 2020 (tarrif 0%)
Tenderloin	720-810	1,295	1,158	962
Stirploin	500-610	1,095	979	813
T-bone	400-429	735	657	546
Top round	150-180	280	250	208

Table 1 Comparing Thai beef price & Australian beef price

Note: */from calculation
Source: adapted from Anguro, 2007

Even though Thai premium beef can be said to be have an edge in terms of quality (Boonnak et al., 2004), there are uncertainties in many aspects. The first aspect is that high quality beef is produced by small scale famers scattered across the country. Despite their integration in the form of a cooperative, there is still the problem of lacking upstream cattle. Apart from this, neighboring countries of Thailand such as Vietnam buy a large quantity of live cattle from Thailand on monthly basis, 6000 cattle per month in 2009, for example (Kankeaw et al, 2010). This decreased the number of cows in Thailand, especially beef cattle that dwindled greatly in number from 3.25 million in 2007 to 2.02 million in 2009 (Livestock department of Thailand, 2011-2014). Such decrease affected the cost. Limited supply (cattle) drove the price up. It may also be the cause of loss in opportunity cost, according to PYK research by Kankeaw et al, (2010) which concluded that producing calves in farm for fattening actually costs less than buying them from other sources i.e. middlemen or even from PYK coop. The next aspect, the price of imported beef falling down to the same as or lower than that of domestic premium beef after the FTA, Thai beef industry will increasingly lose its competitive edge in particular coming years.

The survival of beef industry in Thailand requires many sets of strategies. One important strategy is to effectively reduce the cost of beef production along the whole chain with the quality being retained in the premium class or developed into better quality and pricing, to gain more competitiveness against imported beef.

This research will try to give the overview of the characteristics of beef production chain in terms of functions in Thailand and also in Australia. The research is going to take premium beef chain, PYK cooperative as a case study in Thailand to investigate opportunities for cost reduction without losing premium quality This will be compared to Australian beef production chain. Conclusions can be

drawn regarding the stages where the costs of beef production chain located and the feasible opportunities for implementation.

1.2 The cases

1.2.1 PYK cooperative

PYK is a major agricultural cooperative and producer of premium beef in Thailand. It was founded in 1980 and is located in the arid North East of Thailand which covers one third of area in Thailand and accounts for 41 percent of Thai agricultural area. Its agricultural produce however accounts for mere 26 percent of national agricultural produce with the lowest growth rate, thanks to aridity and infertile land (The Fifth National Economic and Social Development Plan: 1982-1986, Government of Thailand). Such geographical disadvantages make it impossible for most of the populace in the region, rice growers, to produce a lot. Thus family income, was normally low. However, Thai government saw opportunities in livestock industry in the North East. So the government encouraged and supported them in raising cattle as an alternative source of income. These cattle raising farmers were then integrated into a cooperative. This cooperative received know-how support from the French Government regarding the Charolaisbreed, and financial support in the construction of a slaughter house and cold storage trucks. This way the beef produced by the cooperative is known as "Thai-French beef". Currently, the number of cooperative members is 4,456 from throughout two provinces in the North East region compared to 50 members at the beginning since 1980. Past performance can be said to be very successful. No financial loan was made from any financial institution after the first 5 founding years. More than 300 million baht of revenue was made in 2009 (Committee for constitutional organisation, state enterprise, public organisation and paliament fund affair, 2010), According to the manager of the cooperative, PYK is one of the leading high quality beef producers in Thailand and the model of complete production chain because the cooperative has a system of management in breeding, fattening, slaughtering, processing and distributing to customers i.e. wholesale, retailers etc. Moreover, tracibility system was brought into use to assure consumers of beef hygiene. They can trace back throughout the whole chain. The cooperative has the future goal of increasing the number of members, import replacement production and expand both domestic and international market. Consequently, the study the competitiveness of PYK's beef production chain in terms of cost reduction without the loss of premium beef quality would be very beneficial. Not only will the study concretely help the cooperative adapt in a highly competitive and high production costs environment, the results may be of use for other beef production chain in developing countries in their learning of the costs of each stage along the chain to find where it is feasible to reduce costs without lossing quality.

1.2.2Australian beef production chain

The reason the researcher chose Australia as a comparative case is that Australia is the most important trading partner of Thailand in terms of frozen beef. After an FTA with Australia in 2005, Thailand witnessed increasing import of frozen beef from Australia because of 4 percent yearly reduction of import tariff (Figure 1). The 2008 statistics from Livestock Department of Thailand is shown that more than 70% of Thailand's imported frozen beef is from Australia (Appendix 1).

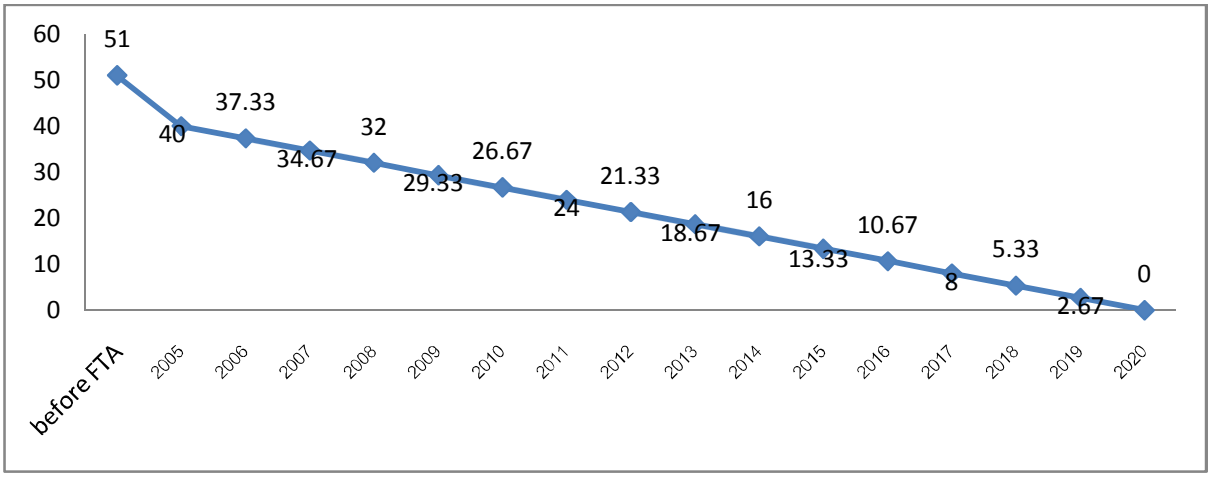


Figure 1 Tarrif reducing according to Thai-Australian FTA in percentage

Source: Thai Customs Department

This way, Thai-Australian FTA inevitably affects Thai beef industry. Australia has high potential in raising cattle with their geography of plain, which lowers the cost. This, coupled with the fact that Australian beef industry has a long history of R&D, makes Australia world's leading beef producer, after the USA, Brazil, EU-27, China, India and Argentina (Appendix2).

1.3 Conceptual design

1.3.1 Research objective

The research objective is to investigate opportunities to reduce costs along Thai beef production chain, the case of PYK cooperative by comparing to exported Australian beef chain taking into account the chain process characteristics in terms of function, beef quality and cost structures of each stage throughout the chain.

1.3.2 Research questions

To achieve the research objective, the main research question has been formulated as following:

"Where and how costs in Thai cooperative beef production chain can be reduced with its quality to be competitive with imported beef?"

As Punch (2005) stated that the general research questions set the frame and direction for us to follow in search of answer. They, however, are not specific, narrow or pinpointing enough to be immediately answered. So, in this research the sub research questions which will be used to answer the main research question have been formulated as follows:

SRQ1: What are the chain process characteristics on agri food production chain perspective that are applicable to beef production chain in terms of functions?

SRQ2: What general meat qualities are used to measure beef quality?

SRQ3: What cost approaches on supply chain measurement are relevant to analyse cost along the beef production chain?

SRQ4: What are the chain process characteristics in terms of functions of Australain beef production and Thai beef production?

SRQ5: What are the specific quality characteristics of Australain beef and of Thai beef?

SRQ6: What are the chain cost structures of Australain beef production chain and Thai beef production chain?

SRQ7: What are the feasible opportunities to reduce costs of Thai beef chain based on the relevant cost management approaches regarding learning from Australian beef?

1.3.3 Research framework

To be able to perform this research in a proper way, a research framework has been created. In this framework it is stated how the end result will be realized. This research will combine a literature study together with an empirical investigation.

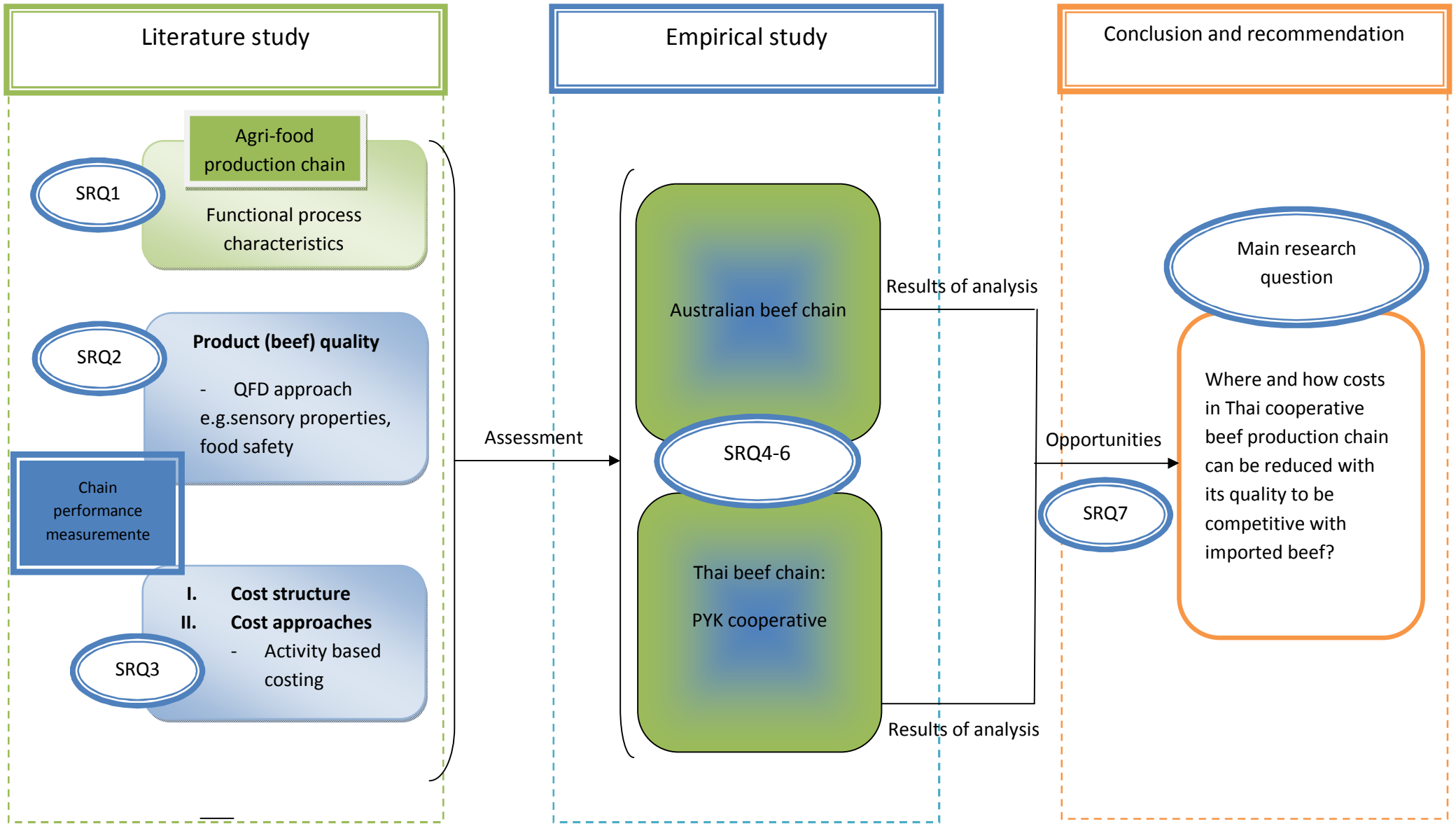


Figure 2 Research framework

1.3.4 Definition of key concepts

FTA: Free Trade Agreements is a legal binding contract on the transaction of goods and services bilaterally between two countries or regionally in terms of Regional Trade Agreement: RTA where signatories agree on opening up (lowering) to each other or one another their trade barrier more than agreed on in the World Trade Organization (WTO) stage. Finally this creates a Free Trade Area in which trade barriers, tariff or non-tariff, are to be eliminated completely. Goods and services of each signatory can be freely transacted across state borders on the basis of comparative advantage (http://www.ftamonitoring.org).

Premium beef: Beef from selected fattened beef cattle that were fed with concentrate and roughage, went through disease prevention programme and were slaughtered in a standardized slaughterhouse (The Thailand Research Fund, 2007).

1.3.5 Structure of the report

This report contains 6 chapters. Chapter one introduces general information as to why study the topic. Section 1.2 is conceptual design of this research includes research objective, research questions, and research framework. Some definitions of key concepts are explained in section 1.2.4. The next chapter is literature study which is the summary of concepts and theories that form the background and framework of this study. These consist of Agri-food production chain (section 2.1), food quality (section 2.2), and cost management approach (section 2.3). Chapter 3 outlines the methodology starting from research strategy in section 3.1 where the case study and data collection strategies are explained. Section 3.2 discusses sampling, while section 3.3 validity and reliability. Limitation of this study is discussed the last section of this chapter 3 (section 3.4). Chapter 4 constitutes the results of the study to show what the researcher has found. Section 4.1 talks about the results from the study of beef production chain characteristics of the two cases (PYK beef and Australian beef). Next section (section 4.2) discusses beef quality of the two chains that is derived from customers' perception and PYK's view. This section misses Australian's view because of absence of response from Australian experts as discussed in Chapter 3. Section 4.3 depicts production chain cost structure of PYK beef while the results of the study of Australian cost structure are in section 4.4. Chapter 5 discusses the analysis both from literature study and empirical results in order to gain more insight as to what we get from them (literature study and empirical results). The last chapter is the conclusion and recommendation, where answers to sub research questions are recapitulated. Recommendations which answer to the main research question of this study are also present here.

Chapter 2 Literature study

After reviewing literature on agri-food production chain, food quality, and cost management approaches which are related to the theoretical framework, this chapter briefly discusses the selected concepts used in this study. This paves to gain more understanding about this study.

2.1 Agri food production chain

Luning and Marcelis (2009) offered an overview of the food supply chain where factors which can influence final product quality are shown. Such model reflects that they believe the physicochemical properties of products for consumption stem from a complex food production chain. The final food quality of such chain depends on various technological conditions and many quality decisions. A chain perspective is needed in this kind of conceptualization because it sheds some light on the 'where and how' of taking design, control, improvement, and or assurance measures to realise physicochemical properties and related attributes that meet consumer demands.

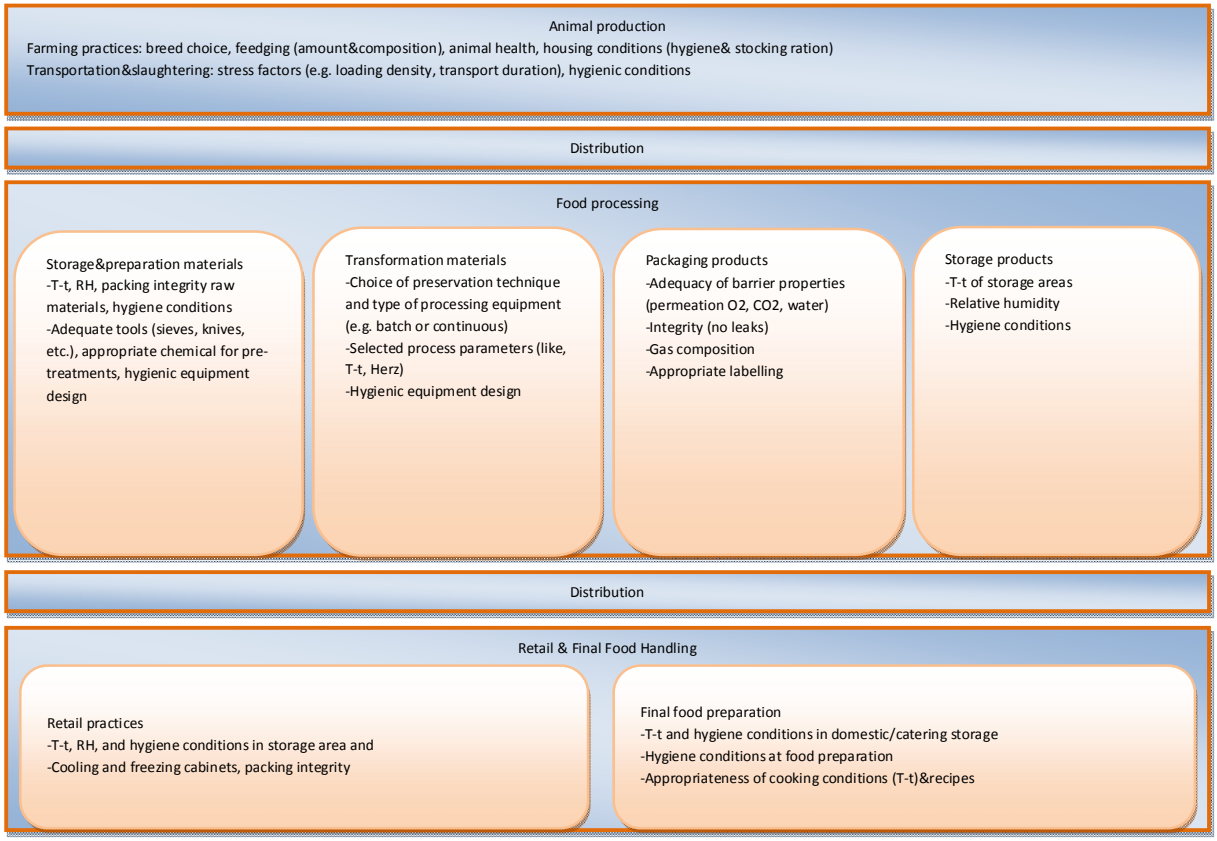


Figure 3 Overview of factors along the food supply chain

Source: Luning and Marcelis (2009, pp. 74)

Luning and Marcelis (2009) begins the explanation of their model with **Animal production** that consists of (I) Farming practices; they mention the condition of the farms where animals were raised are crucial to the physicochemical properties and related quality attributes of both fresh and processed meat, and fish (e.g. safety, texture, taste, health). Precisely, factors at the farming stage are breed, feeding, animal health, housing conditions. (II) Transport and slaughtering practices; stress factors for animals e.g. loading density, loading and unloading facilities, transport duration, mixing of animals and hygienic conditions contribute to the quality of the meat. Secondly, **Distribution conditions**, the transport of products from one actor to another. According to Luning and Marcelis (2009), the factors influencing distribution are similar to those for storage of the specific products which will be discussed together with processing section. **Processing** is the third stage of the model that centers around the preservasion of products to extend their shelf life, improvement of sensory properties and digestibility, including the enhancement of the health effects of food. The main activities of processing consist of; (I) storage and preparation material: temperature and humidity condition, integrity of packaging, and hygiene. These are the common factors that can positively or negatively affect the quality of the products. As said earlier, they are also influencing factors of distribution conditions; (II) transformation materials: the factors influence this step are preservation technique, processing equipment, appropriateness of selected process parameters, and process equipment conditions; (III) packaging the final products: this is very crucial step in food production systems. Poor packaging integrity, inappropriate packaging materials, and improper labelling can negatively influence the shelf life and safety of final products. The last step in processing stage, which is the storage and distribution of final product, aims at maintaining the properties of finished products. The factors playing important roles in maintaining and uplifting product qualities in this step includes storage temperature and duration, relative humidity,a and appropriateness and integrity of packaging materials. **Retail and final food handling** stage of the chain is based rests on such factors as storage conditions of suppliers, conditions in the shop, hygienic handling of personal when slicing and packing fresh products, and packaging integrity.

A review of literature shows that literatures relating to the structure or characteristics of agri food production chain are scant. Existing ones revolves mainly around value chain perspective or supply chain perspective. Only Luning and Marcelis (2009) and Knura et al. (2006) seem to be those scholars who discussed production chain characteristics the most. Knura et al. (2006) discussed the characteristics of agri-food production chain in terms of actors e.g. breeder, producer, processor etc. Luning and Marcelis (2009) on the other hand invented a model that concentrates on functions in the chain such as farming, slaughtering, processing etc. Even though the second model of Knura et al. (2006) discusses functions, it does not give as much insights as the one of Luning and Marcelis (2009) that integrates influencing factors on final product quality into the animal production. Luning and Marcelis (2009)'s model is a suitable framework for beef production chain in this study. This is because it takes into account both characteristics and factors that influence animal product quality, which is corresponding to the objective of the study – to maintain beef quality throughout the production chain.

2.2 Food quality

The term quality, both in food and otherwise, has been dened in a great variety of ways (K. G. Grunert 2005a). Luning and Marcelis (2009) have shown a level of their agreement with Grunert through their list of organizations and scholars that provided definitions of (food) quality. Some of those are The International Organisation of Standardisation (ISO), The American Society for Quality Control (ASQC), The Institute of Food Science and Technology (IFST), including Juran (1993) and Deming (1993) etc. Luning and Marcelis ultimately picked a commonly accepted definition that 'Quality is meeting or exceeding customer and consumer expectations'.

Specific to meat quality is the definition as given by Hofmann (1973) as cited by Becker (2000) which said that "quality is the sum of all sensoric, dietetic, hygienic, toxicological and processing-technological characteristics of meat". This quality includes on its definition the element of safety. K. G. Grunert (2005a)reviewed research on consumer quality perception through Total Food Quality Model, following the holistic approach in which food safety is an integral part of food quality, at least to the extent that consumers believe food safety to be a desirable property.

Meat quality on food science literature (Ernst, 1995 cited by Becker, 2000) was put in 4 categories nutritional value, processing quality, hygienic-toxicological quality and sensoric quality. Those categories of quality characteristics are based mainly on laboratory methods and trained experts' opinion (Becker, 2000). Such food science based categorization of meat quality can be said to be inappropriate for this research which has an emphasis on consumer perspective. Product attribute approach is then more appropriate. Becker (2000) mentioned that in the product attribute approach, consumers use 'cues' to evaluate the performance of the product with respect to; (I) Search quality cues (quality in the shop): qualities concerned at the time of shopping: colour, leanness, marbling as intrinsic cues and brand/label etc.; (II) Experience quality cues (eating quality): qualities concerned in conjunction with use or with consumption: colour, leanness, texture, free of gristle, tenderness, smell, flavour, juiciness; (III) Credence quality cues: qualities of concern to consumers including safety, health or other concerns (Becker, 2000) that are not perceived in times of buying or consuming: hormones, antibiotics, fat/cholesterol, salmonella and other bacteria, BSE etc. Northen (2000), using perceived quality approach to product quality, developed a methodological framework to demonstrate the linkages between experience and credence attributes and intrinsic and extrinsic quality cues in the meat supply chain. This can be seen in the diagram below.

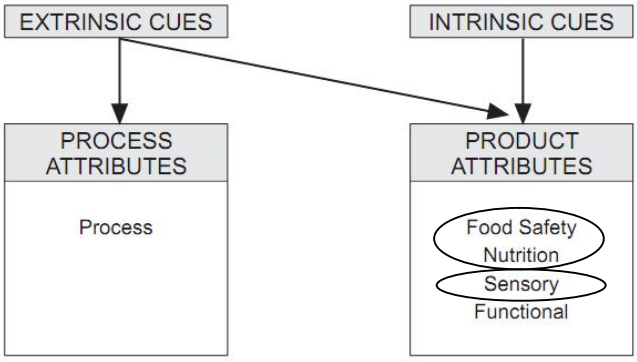


Figure 4 Relationship between cues and attributes

Source: Northen (2000)

Extrinsic cues are packaging materials, communication with shop staff and information/labels provided on or near the product. Intrinsic cues are visual such as colour, leanness, marbling, cut and juiciness, along with non-visual cues such as smell (Northen 2000). Process attributes constitute Animal welfare, Biotechnology, Organic production, Traceability, Growth enhancers, Feed. Product attributes can be divided further into sub-sets of food safety, nutrition, sensory, functional and image attributes, where functional attributes include factors such as `convenience of preparation'.

Northen however mentioned only experience and credence quality cues and excluded search quality cues while (Becker 2000) did so . Northen (2000) opined that process attributes and several types of product attributes (e.g. some food safety and nutrition attributes) is`credence' in nature and should then be regarded as such. In contrast, attributes such as sensory (product) attributes are detectable during consumption and should be defined as `experience' in nature. The embrace of merely two cues should be sufficient and makes sense for the search for quality and experience quality more or less overlap in terms of sensoric attributes. K. G. Grunert (2005a) in support of Northen (2000) said most aspects of food quality are either of experience or credence characteristics, and observed further that the way quality perception changes over time will differ between these characteristics. This study focuses on what consumers can by themselves assess through the experience gained through the use or consumption of the goods i.e. sensory attributes. Anyway, safety becomes an increasingly important factor on consumers decision – as said by Grunert (2005) that credence qualities are of increasing importance in food products. Most health-related and process-related qualities belong to this category. Even though consumers might not be able to assess by themselves while buying or consuming (credence), they can perceived qualities via label or communication with seller etc. The next section elaborates more about sensory attributes of beef in order to find out what kind of sensory consumers generally regard as important and how they do that.

2.2.1 Sensory quality of beef

Watson et al. (2008) reported that sensory quality assessment of beef can be undertaken using either a trained panel of experts or an untrained consumer panel (consumer). The correlation between sensory characteristics of beef assessed by a group of panelist and acceptance by consumers allows the estimation of market demand and expectation (Issanchou 1996).Moreover, the result from a study by Platter et al. (2003)revealed that small changes in sensory quality rating of the consumer have dramatic influence on the probability of meat acceptance by the consumers. For meat and meat's products, texture, aroma and flavor traits are the ultimate criteria that consumers use to decide the sensory quality of meat.

Scientifically, sensory characteristics consist mainly of appearance, tenderness, juicinessand flavor characteristics of meat (McIlveen and Buchanan 2001).Tenderness; consider the hardness or compressibility of the meat when it is first bitten, the number of chews needed before the meat is ready to swallow, the present of gristle.Flavor; assess the overall flavor intensity.Appearance; consider the color of the meat, the density of the meat fibers, the presence of fat or any other surface characteristics.Juiciness; food which causes an increase in fluids slowly and progressively during chewing.

The result of panel test revealed that tenderness and flavor are the most important sensory traits affecting consumer's acceptance (Brewer and Novakofski 2008; Powell et al. 2011). Consumers prefer beef with higher tenderness scores and present their willing to pay more for higher sensory quality of meat in relation to lower tenderness scores(Beriain et al. 2009b) .

Flavor might be one of the most traits, which is very hard to identify. It results from the combination of basic tastes and odor of food. A large number of flavors and aromas have been found in beef (Spanier et al. 1992). Marbling has been reported that it is positively correlated to beef flavor. However, beef flavor intensify was not significantly affected by marbling score given by consumer test (Wheeler et al. 1994).

There is scientific evidence that visual preference of the consumer affects the acceptability of beef (Savell et al. 1989). Meat color is considered to be the first impression for the customers and affects the perception of the consumer on the freshness of meat. It may vary from purplish-red to dark red. However, bright, cherry-red color was much preferred by the US consumers and they are willing to pay more money, in relation with meat with dark red color. Beef with the color neither too pale nor too dark was the most desirable (Killinger et al. 2004).

Juiciness is also important characteristic in beef sensory quality. It is reported that there was a significant correlation between juiciness and hardness of beef (Beriain et al. 2009a). Moderate correlation between juiciness and tenderness has been reported (Brewer and Novakofski, 2008). Thus, it can be summarized that improving juiciness of beef can be affected together with enhancing beef tenderness.

It is clear that different pieces of research identify/study sensory attributes differently. Even in the same research work, in search of consumer preference in different countries, sensory attributes can be defined differently. The example of this could be the work of Polkinghorne and Thompson (2010). They show principal components of selected beef classification and grading schemes in selected countries around the world (Canada, Europe, South Korea, Japan, The Republic of South Africa, USA, Australia). Hence, finding sensory attributes, which are variables in this study, the researcher compiled the sensory attributes studied in related literature as shown in table 2.

To keep the scope of the study of sensory attribute factors as wide as possible, the sensory attributes chosen for this study are the popular ones, which constitute those attributes that scored at least two points in the literature. That is the study of all attributes except for 'gristle'.

Researcher(s) / Sensory attributes	Becker (2000)	Killinger	Killinger	Grunert	Northen	Human et al. (1991)*	Berry (1997)*	Moloney et al. (2001)*	Shao et al. (1999)*	Polkinghorne and Thompson (2010)**	Overview
Colour	√		√	√	√				√	√	6
Texture	√									√	2
Leaness	√				√						2
Gristle	√										1
Tenderness	√	√		√		√	√	√	√		7
Smell	√				√			√	√		4
Flavour	√			√		√		√	√		5
Juiciness	√				√	√	√	√	√		6
Marbling	√	√	√		√					√	5

Table 2 Literature summary which study sensory attributes

Note: * = cited by A.V.A. Resurreccion (2003)
** = summarise from classification of each country which is the most overlaping

2.2.2 Food safety: Consumers' perception

Due to the fact that it might be adversely affecting human health, food un-safety is so far very hot issue concerned by the consumers. The demand of safe food is becoming increasingly (Van Wezemael et al. 2010). Beef marketing sector is very susceptible to food scarce as a result of possible contamination along the production chain. Thus, several international organizations (e.g.FAO/WTO, OIE and Codex Commission) have been established. As a result, regulations and measures have been launched to direct the whole production chain for ensuring beef food safety by such organizations. Contaminants can enter the food chain of beef in several pathways starting from feed formulation up to meat processing or even prior to consuming. As mentioned, the contamination can be early started from the primary stage of the production chain, for instance the contamination of dioxins in feed ingredients which can transfer into animal tissue which finally can be accumulated in the final products (Huwe 2002). Furthermore, the contamination of some vital pathogens for example, Escherichia coli O157:H7, *Salmonella*, *Campylobacter* and *Listeria* in beef may possibly occur since during raising animal in farm, processing step in slaughterhouse and poorly handling during post-slaughter management (Medeiros et al. 2010). These pathogens can possibly cause deadly illness.

Moreover, it is well known that bovine spongiform encephalitis (BSE) has almost totally destroyed the confidence of beef consumption a decade ago(Muringai and Goddard 2011). Also, artificial hormone and antibiotic residues in beef and beef products are much concerned particularly in European Union countries(Verbeke et al. 2007). Therefore, the effective measures are needed to be applied for eliminating all possible contaminants.Physical contamination such as glass in product, the presence of non-specified materials and metal pieces have been reported (Kleter et al. 2009).

Biological and chemical contaminations are impossible to be directly proved and detected by the consumers. Thus, most of them depends on the labeling presented on the package of beef and beef products(Verbeke et al. 2007). Practically, Hazard Analysis and Critical Control Points (HACCP) has been In addition, Risk attitude has been reported the largest impact on household's purchasing decision of beef (Yang and Goddard 2011).The approvals of safe beef are very valuable for the consumer. It has been reported that beef consumers are willing to pay more for the guarantee of beef safety (Klaus G. Grunert 2005b).

It can therefore be concluded that the consumers perceived that beef food safety is the most important because it is related to health of the consumers, which finally results in their purchasing decision.

This study employs QFD approach in the analysis of beef quality of both chain in terms of sensory properties and food safety. The following section discusses the application of QFD.

2.2.3 Quality Function Deployment (QFD)

Cohen (1995: 11) describes QFD as a method for structured product planning and development that enables specifying clearly the customer's wants and needs. Then the method evaluates the impact of meeting those needs for each proposed product or service capability systematically. The important element of QFD is The House of Quality (HOQ) where the customer's wants and needs are displayed along with the development team's technical response to meeting those wants and needs. To be more

specific for food industry, Bech et al. (1997) created a new structure for the HOQ that highlights relationships between sensory attributes, technical attributes and consumer requirements are highly detailed. Many of research works done by Costa et al. (2000) gave results that support Bech et al. (1997) that the modified HOQ is expected to better reflect the specificity of food product development (namely of the food sensory properties) in QFD project. Modified HOQ is shown below:

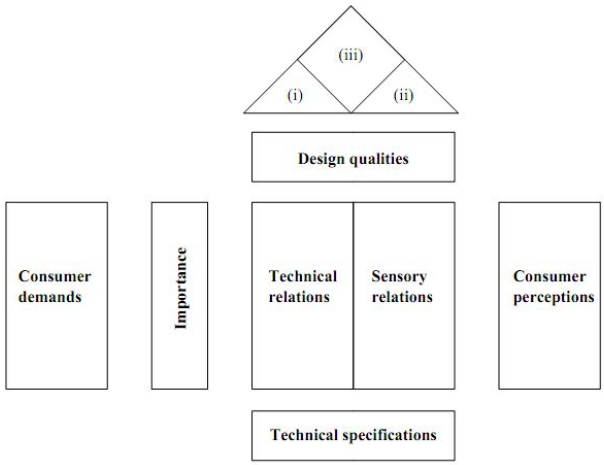


Figure 5 House of Quality
Source: Bech et al. (1997)

The modified model of Bech et al. (1997) can be summarized in the following ways; **Consumer preferences**: the attributes does the consumer evaluate the product on, and what is the relative importance of these attributes; **Consumer's perception**: the extent to which products fulfill the criteria; The middle part of the figure shows that customers' want and need can be transformed into products: technical and sensory ones; The centre of the middle block: the two sets of descriptions are connected; The roof of the house symbolizes the mutual connections between the internal product specifications. The two types of specification gives rise to three kinds of relations: (i) mutual relations between technical specifications, (ii) mutual relations between sensory specifications, and (iii) relations between technical and sensory specifications.
This research work will apply the modified QFD approach to study sensory properties and food safety of beef from consumer perspective. The sensory mentioned here is the one of intrinsic attribute which is inherent to the physical products in the way that makes them noticeable (e.g. texture and odour attributes) or communicated (e.g. safety, health) (Luning and Marcelis 2009, pp. 42). They are the result of physicochemical and other properties of a product (e.g. pH, composition, microbial contamination, etc.). The extrinsic attributes are the production and marketing aspects of a product (e.g. animal welfare, sustainability of production, brand name). This study focus only on the intrinsic attributes (sensory): most consumers in Thailand do not regard extrinsic attributes such as animal welfare as important. Food safety involves what consumers can prove and detect through labeling and communication. The researcher would only roughly group food safety according to literature into

biological and chemical contaminations since it is assumed that consumers do not have in-depth knowledge of food safety.

This study involves an adaptation of QFD by inputting consumer perception on competitor (Australian beef) to compare with consumer perception on Thai beef. This model could look like this.

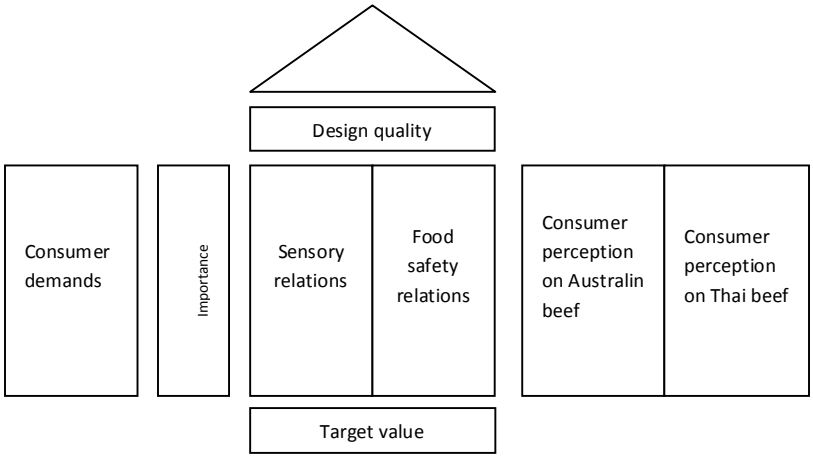


Figure 6 Adapted QFD model adding perception on competitor

However, QFD approach has some limitations. As with food products, a lot of food product requirements, as mentioned by the consumer, are sensory requirements. Although a lot of research has been conducted in this field, it is still difficult to measure them. Besides it is difficult to control them, since they are dependent on multiple variables related to product, production process, consumer, or the surroundings (Benner et al. 2003). This makes the practical use of the complete QFD method very limited (Benner et al., 2003). Most literature thus focuses on the most vital part of QFD, which is HOQ (house of quality). HOQ itself has its limitation in an application with food industry as seen in the inability to complete the 'How much' section (of HOQ). This is because the important product requirements are related with multiple consumer demands. QFD does not provide a solution for this problem (Benner et al., 2003).

2.3 Cost management approaches

After finding out the most appropriate cost tool that fits with the research by reviewing cost approaches literature regarding supply chain costs, activity-based costing (ABC) was selected as a tool to analyse cost along beef production chain.

2.3.1 Activity-based costing (ABC)

Many research works employed ABC in the study of supply chain either in terms of performance assessment such as Aramyan et al. (2006), or in terms of the role of accounting information in SCM as done by Dekker and Goor (2000) etc.. Aramyan et al. (2006) cite many researchers such as Baykasoglu and Kaplanoglu, 2008; Ben-Arieh and Qian, 2003; Gunasekaran and Sarhadi, 1998 etc. These researchers agreed that ABC can be considered as one the most talked about techniques for improving SCM and performance in organisations. Such a complex costing system as ABC is very useful to managers in making important strategic business decisions. The emphasis is put on the existence of cost data in every aspect of decision making process in SCM. ABC is well received in the works of many researchers such as Singer and Donoso (2008), Qianand Ben-Arieh (2008) and Tsai et al. (2008), all of which are cited in Askarany et al. (2010) to be giving more accurate cost estimation. The research of Anand (n.d.)also revealed that the manufacturing firms that embraced ABC were able to establish much more accurate sets of cost information for value chain analysis and supply chain analysis compared to the firms that did not adopt ABC.

Cooper et al. (1992) as cited in Chongruksut (2002) concluded that the ABC system comprises four basic steps:

1. Identify activities;
2. Assign resource costs to activities by three methods: direct charging, estimation or arbitrary allocations;
3. Identify outputs; and
4. Link activity costs to outputs.

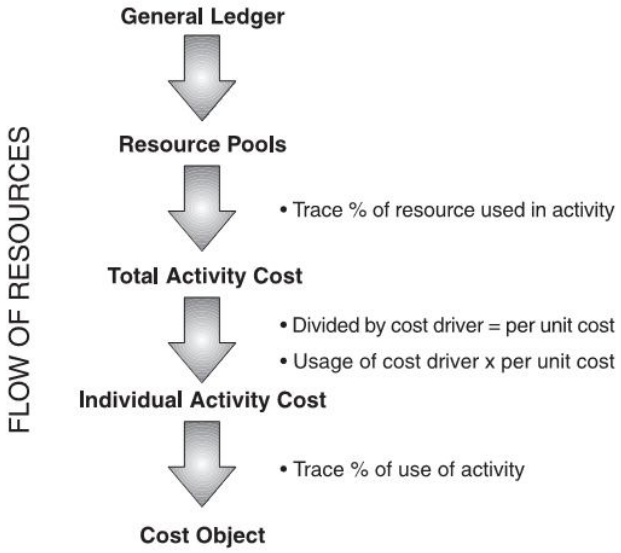


Figure 7 The flow of resource information in ABC

Source: Lin et al. (2001)

Benefits of ABC can be summarized into:

- Helping managers spot original parameters that generate demands on indirect and support resources and thus help them identify and remove non-value-adding activities (Arieh and Qian 2003).
- Providing the accuracy of real indirect cost versus its forecast (Singer and Donoso, 2008 cited by Askarany et al., 2010).
- ABC provides both financial information and cost behavior of different activities throughout their stages of development and progress (Aramyan et al. 2006).

However, ABC has disadvantages in implementation as follow;

ABC however has weak points in that it is costly and time consuming in data collection. The real challenge of ABC in supply chain lies within the determination of cost driver of businesses (Aramyan et al, 2006)

Chapter 3 Methodology

How the research was conducted will be elaborated in this chapter. Starting with the research strategies, then sampling and discussion. Validity and reliability and the limitations of the research are the last issue to be discussed.

3.1 Research strategy

3.1.1 Case study

A case study approach was applied to Ponyangkam cooperative to gain a profound and full insight into beef production chain process characteristics and cost structures that were confined in time and space as Verschuren et al. (2010) mentioned. The researcher's objective was to investigate ***"Where and how costs in Thai cooperative beef production chain can be reduced with its quality still being competitive with imported beef?"*** This intensive investigation needed a variety of sources to obtain the data. The case study was most suited to avoid manipulation of data through triangulation (Yin (2003) cited by Liu (2011). The sub research questions were formulated as illustrated in chapter one to help answering what the researcher wants to investigate. However, the study of Ponyangkam cooperative was not aimed at having the cooperative as the representative of the entire beef production chain in Thailand. Rather, as Ponyangkam cooperative believed, the results of the study more or less might be used for other agricultural cooperatives facing similar problems, even though this is not the major purpose of the research.

3.1.2 Data collection strategy

The methods used to collect the data are described in the next section.

Interviews

The purpose of the interviews in this research was to gain more insights on chain process characteristics in terms of functions, specific beef quality and costs structures. These sets of data were both extensive and in-depth. The interviews used in this study were characterized by being semi-structured, open-ended questions depending on the researcher's particular needs for data. The formulation and the concept related to the questionnarie were shown in table 3. Interviews in Thailand could be divided into four groups: experts on beef production and beef quality, PYK's employees, customers, and farmers. Interview questions were divided into four sets, depending on the area of answer expected from each group of respondents. Questions for experts aimed to draw information on beef production and beef quality. Questions for the PYK's employees elicited the information on beef production chain characteristics, beef quality and cost structure. Customers were asked their opinion on beef quality and how they preserved beef quality before such beef reaches end consumers. Farmers were interviewed on cattle raising including the costs of such raising and how they control quality. The list of interviews is shown in table 4. The interview was conducted in Thai which is the native language of both the interviewees and the interviewer to prevent miscommunication. A recorder was used for cross-checking with the hand-recorded entries. Then the results was translated into English. However, the recording device was used only with experts and PYK marketing director. This was because employees and farmers in Sakolnakorn, which is the rural area feel uncomfortable with recorded interviews. Making note was then the major tool in the interview with these people. Informal conversation helped draw more in-depth information from both employees and farmers in terms of quality control and some expenditure, which were useful in the analysis of data via ABC. The planned interviews with farmers on production costs were

canceled because the marketing director already provided the information on production cost of members on which PYK coop has done a study in 2010. There was then no need to take extra time from the farmers by interviewing them.

	Planned interviews	Realized interviews	institute	location
PYK beef				
Experts	1 expert on beef production	1 beef cattle extension expert	Researcher, Department of Livestock Development	Bangkok
	1 expert on beef quality	1 meat science expert	Associate Professor, King Mongkut's Institute of Technology Ladkrabang	Bangkok
Employees	1 high level executive	1 high level executive	Marketing director, PYK coop	Bangkok
	1 manager	1 aninal husbandary	Academician, PYK coop representative of manager	Sakolnakorn
	1 accountant	2 accountants	PYK coop	Sakolnakorn
	relevant general employees	5 employess	PYK coop	Sakolnakorn
	1 transport officer*	n.a.	n.a.	n.a.
Customers	1 wholesale	n.a.	n.a.	n.a.
	1 supermarket	1 supermarket	Deputy manager	Bangkok
	1 food store	1 food store owner	Owner	Bangkok
Members	2 cow-calves farmers	2 cow-calves farmers	Producers	Sakolnakorn
	2 fattening farmers	2 fattening farmers	Producers	Sakolnakorn
Australian case				
Expert	3 experts on beef production	n.a.	n.a.	n.a.
	1 economist from MLA	n.a.	n.a.	n.a.

Table 3 List of interviews

Note: */This position did not exist in PYK coop

n.a. No interview was done.

aspects	interviewees	questions
Chain characteristics	Marketing director of PYK (Appendix 3)	1. Could you map the beef production chain in terms of function stages according to your understanding? 2. In each function stage, how is food safety and sensory quality controlled? 3. What are some of the limitations in the control of food safety and sensory quality? 4. What are the main impacts on PYK beef if imported Australian beef is in competitive price range? Why?
	Animal husbandary of PYK	1. Could you map the beef production chain in terms of function stages according to your understanding? 2. In each function stage, how is food safety and sensory quality controlled? 3. What are some of the limitations in the control of food safety and sensory quality?
Beef production	Beef cattle extension expert (Appendix 4)	1. What are the key costs in fattened cattle production process? Please identify such costs for each stage. 2. What do you think could be the ways for each stage to reduce costs? Do you think those ways can be done in reality? If not, what could be their limitations? 3. FTA means the tariff Australian beef price is continuously decreased until it reaches 0% in 2020. Do you think this is going to affect Thai premium beef such as PYK beef in any way? 4. The interviews with farmers showed that they are worried about insufficiency of upstream cows for producing calves. How do you think the governmental sector can help them? 5. How do you think the governmental sector can help with cost reduction throughout the fattened cattle production chain? 6.How do you think the governmental sector can help with the development of premium beef quality?
Beef quality	Meat science expert (Appendix 5)	1. What kind of demand in the demand list do you think Thai consumers regard as important? Please give the degree of importance in a 1-9 scale. 2. Which factors affect quality attributes? 3. What do you think of the potential of Thai beef for quality development? 4. What are the limitations of Thai beef quality development? 5. Compare with Australian beef, do you think Thai beef is higher or lower in quality in terms of food safety and sensory quality. Please explain.
	Animal husbandary of PYK	Could you rate how much PYK beef possess these characteristics? (Appendix7)
	Customers	1. Could you rate how much PYK beef possess these characteristics? (Appendix6) 2. Could you rate how much Australian beef possess these characteristics? (Appendix6) 3. How is food safety and sensory quality controlled before reaching the hand of a consumer? 4. What are some of the limitations in the control of food safety and sensory quality? 5. If Australian beef is priced cheaper or equal to PYK beef, do you think more consumers will turn to Australian beef. Why or why not?
	Farmers	1. What do you do in beef cattle farming? How much time in a day do you spend doing so? 2. How many beef cattle do you have? 3. How do you do quality control in terms of safety and feed? 4. How do you transport cattle to PYK? What are the costs in doing so? 5. How do you do quality control during the transport?

Continue…

aspects	interviewees	questions
Cost structure	Accountants	The researcher asked for expenditure documents and inquired about costs shown in such documents.
	Employees	1. Please explain in detail each steps in completing this job. 2. How many workers are needed in each step? How long does each step take? 3. Please describe the area used for slaughtering and processing. 4. Please describe electrical equipment including their power consumption used in slaughtering and processing. 5. Where are the products transported to? How is it done? What costs does it incur? How many workers are involved? How long does it take for each round of transport? 6. How is quality control done during the transport? Etc.

Table 4 Questions for Thai interviewees

In section 3.3.1, the researcher planned to get results of Australian beef production characteristics, Australian beef quality and costs of Australian beef production chain from Australian experts. The questions to be used in the interviews of these experts were in line with Thai case. The Australian experts'interview would be used tosupport/argue the results from the literature to make the overall results richer. All contact attempts – on these experts from many agencies relating to livestock production in Australia such as Meat Livestock Australia (MLA), Cattle Council of Australia, Australian Meat Industry Council (AMIC) etc. or even lecturers who are experts on beef production in many universities in Australia – failed. The best way to answer SRQ 4 then should be desk research. This is the most prominent weakpoint of the study.

Observations

The research was conducted at site where the head office (at Sakolnakorn) and branches (Sakolnakorn and Bangkok) of the cooperative are located. The observations included these locations. Farmers' places at Sakolnakorn were planned for a visit if necessary. Once the researcher was at the head office, no official/workers were available to take her to such farms. A trip alone would be largely difficult and dangerous. The aim of obseravtions in the research was to have first-hand experience with participants about how the PYK beef production worked to find out the beef production characteristics in details. Moreover, the researcher could record information as it occurred and unusual aspects could be noticed during observation Creswell (2009). The example could be how farmers treated their cattle when unloading them at PYK slaughterhouse. This method proved to be very useful especially when it came to data collection on activities in slaughtering and processing function. The researcher observed the entire function including what kind of activities occurred, their order of occurring, time consumption, the amount of resources consumed, be they the number of workers or of electrical devices, etc. This data was then used to find costs through ABC. However, this method (observation) was only applied to PYK coop which is located in Thailand. There were time and budget constraints and limitations in the access to Australian private farms, which prevented using observation with the Australian side. This study was thus designed to find out an Australian beef production chain as a whole based mainly on academic research that should have been supplemented by interviews on Australian experts, which failed as mentioned in the section above.

Documentations

To analyse costs in the beef production chain, financial data was needed. For PYK beef production chain, 2010 PYK's study report and 2010 PYK annual report were provided. Cost information from PYK's study was used to analyse farm function cost structure. PYK annual report was used to analyse cost structure of slaughtering and processing function. This research studied only beef product which was the main product of PYK coop. There were additional documents provided e.g. salary and wage lists, carcass price lits etc. As mentioned in the limitations in the previous section, Australian beef needed to base heavily on documentation. This method was conducted to anaylse all aspects related to sub research questions i.e. beef production chain characteristics, Australian beef quality control, and Australian beef production chain cost structure. The documents were collected in various options. Public documents were one of the many documents that were collected. This includes statistics e.g. ABARE and official published documents (e.g. MLA). Academic research was the other kind of document, which has been done by others on Australian beef industry. The validity of these sources may be lost because of time difference. For example, MLA document provided cost information of overall of processing function of 1996, which was very dated but the only one available on cost information of overall of processing function.

3.1.3 Combining quantitative and qualitative strategy

Combining the two types of data - quatitative and qualitative - was possible for any empirical study in any proportions, and we can do so when appropriate Punch (2005). Quantitative data was used in cost structure part to analyse costs along the beef chain. The rest was qualitative data which contributed to beef production characteristics and beef quality.

3.2 Sampling

Respondents were first selected by purposive sampling based on specialist knowledge on the field. This allowed the researcher to be able to describe a phenomenon which was relatively unknown (Kumar, 2005 cited by Liu (2011). Starting with the high level executive of PYK coop involved the most important person who could provide the overall view of PYK beef production chain. This person was asked to introduce other respondents from PYK's network which was snowball sampling. So, the marketing director was the first contacted person who was in the high level position of PYK coop. A formal appointment with the marketing director was arranged by phone. The interview was carried out both in a university where she was a guest lecturer and PYK's branch. Both are in Bangkok. She was asked to introduce her colleagues at Sakolnakorn where PYK head office is located in order that the researcher could conduct the field study. In addition, she was asked to introduce PYK's customers in all 3 sectors that included wholsale, supermarket, and food store.

The expert on meat science was the second person who was needed for an interview in order to get more specific information concerning consumer demand toward beef quality. She was selected based on her specialization and direct experience on PYK beef. The appointment was arranged by e-mail and the interview was carried out at the university she was working for.

After revising the questionnaire according to the expert's view, the interviews with PYK's customers were conducted. There was one respondent from each group (owner or manager). The researcher managed to interview one respondent from each group which was the owner of a food store and a deputy manager of a supermarket. The selected respondent from food store sector was the one who has long been a PYK customer and who happened to also know well Australian beef as a consumer. These qualifications were well suited for the researcher's interview on perception on both PYK and

Australian beef. The selected respondent from supermarket sector was from the supermarket that was PYK's biggest customer with 18 branches in and outside Bangkok. The said supermarket also sold Australian beef, which allowed the respondent to relate the views on both kinds of beef well. The researcher did not interview the manager of a wholesale: the appointment was cancelled and the coordinator (the marketing director of PYK) terminated all correspondence with the researcher.

Next step, the researcher made an appointment with the animal husbandry official of PYK in Sakolnakorn who was introduced by the marketing director. Employee and farmer interviews were conducted at the site. Snowball sampling was used again from the animal husbandry official's suggestion. The researcher looked for two types of farmers who were cow-calves producers and fattening cattle producers.

The expert on beef production was selected by purposive sampling on the basis of his direct experience toward beef industry in Thailand and his work with PYK coop as a government official.

As for Australian beef qualities, the researcher planned to interviewed Australian experts. None of the interview requests was responded as mentioned in section 3.1.2.

3.3 Validity and reliability

3.3.1 Validity

There are two concepts measuring the validity of the research, internal and external validity. Internal validity is the establishment of a causal relationship and that enables the researcher to draw conclusions from the results (De Vaus, 2001, pp.27). This research conducted observation, interviews, and documentation to analyse and find out the results relating to beef production chain characteristics of PYK coop. Different informants from different actor units; PYK, academic unit, government unit, farmers, and customers, were interviewed to gain more insight balancing the results. These methods helped increase validity of the study. However, since Australian beef production was based heavily on only literature without supporting from any Australian informants, validity could deteriorate. External validity is the extent to which results from a study can be generalised beyond the particular study (De Vaus, 2001, pp.28). It is hard to say that external validity exists in this study. To be representative as Thai beef production chain is not the aim of this study since the beginning. However, since there are other premium beef producers copying PYK's production form to run their business, this study might be or might not be generalizable to those producers. Further research would help to support the research's generalisation.

3.2.2 Reliability basically means consistency. Consistency over time is ususlly expressed in the question: if the same instrument were given to the same people, under the same circumstances, but at a different time, to what extent would they get the same score? (Punch 2005). The same results were what should happen with PYK beef production chain characteristics, if there were another research team doing exactly what the researcher did including observing interviewing PYK personnel. This was because chain characteristics followed the steps the coop had been having for a long time set. As with PYK beef quality, the use of semi-structured questionnaire might not produce the same result from other sets of customers/respondents or from the same respondent in much later time – because the beef quality could change. This issue could be solved by conducting consumer behavior research with a sample size large enough to be the representative of consumer perception in general. This research paper however did not have its intention of being consumer

behavior research due to time constraint. The researcher attempted to offset such limitations by interviewing respondents who could answer for the majority of most [end] consumers. Such respondents included a manager of the supermarket that was PYK's biggest customers. A wholesale manager, however, could not be contacted. So their data was absent. Apart from this, there was only one respondent from food store. Even though this person has been a long time customer of PYK, it was not sufficient to be a representative sample. With the factors mentioned above, conformability was difficult to come by. The analysis of cost structure using ABC might not confirm similar figure, except in terms of qualitative cost structure. The details of the results of cost analysis in this fashion were not dependent on the researcher and the research process alone. What also matter included willingness to give information, availability of employees and sensitivity of cost information that PYK is willing to discuss.

3.4 Limitations

This section explains limitations that occurred in the research process which can be divided into ones that originated from the researcher and ones that did not originate from the researcher.

The researcher did not have any background in the field of agriculture, especially when it was related to animals. This research work was her first study which was rather deep on animals in terms of production and quality. It required a lot of extra effort to understand specificity in animal science to explain beef production and beef quality in the way that facilitates the readers' understanding. Apart from this, the researcher's knowledge in accounting was not solid enough to be able to employ such a sophisticated tool as ABC in detailed and in-depth analysis of costs. She, as a non-specialist on accounting, however put out a piece of research that was easy to understand to both herself and other non-specialists on accounting. This however might not have be sufficient, considered purely from the perspective of accounting accuracy.

Culture was the limitations that did not originate only from the researcher. Thai culture, in which the researcher grew, could be said to be high power distance between senior and junior, teacher and student etc., which influenced the researcher's lack of dominant control in the interviews in both time and content. The interviewees tended to say what they wanted to say rather than what they were asked of. Interruption would be considered very impolite. The interviews were then very time consuming, especially when coupled with transcribing and extracting relevant points out of the sea of words in the transcription.

The interviews of respondents in the rural area where PYK coop is located went on without the use of a recorder. Only informal conversations and note taking were used to conduct those interviews to ease the feelings of the interviewees. This low degree of formality might affect the credibility of the research work. One must accept, however, that such informal conversations produced in-depth and detailed information. Sometimes, the interviews with employees about some particular cost in the annual report gave unclear data. The case in point was the interviews with accountants who could not explain certain figures because the former head of department was transferred to work in Bangkok. Accounting at PYK was done by on-the-job-trained accountant who did not have a high level of education. Consequently, as said above, they could not explain some figures to the researcher.

Culture also affected the number of respondents especially in the customer's part. The only channel of communication to contact the respondent was through PYK marketing director. The missed interview with the manager from wholesale was not only because of the cancelled appointment and termination of communication, but also the perceived inappropriateness in directly contacting the wholesale manager. Such inappropriateness stemmed from two reasons. Firstly, business information was hardly accessible without personal relationship (eg. between the PYK marketing director and the wholesale manager). Secondly, bypassing the PYK marketing director would be very likely to cause "face losing" effects and thus angering effect to her, which would affect the researcher negatively in the future. The number of respondents on a low side could be said to be a weak point of this research paper.

Time constraint and budget constraint were yet another limitation for the study of Australian beef. With budget constraint, the researcher could not do a field study in terms of observation or interview in Australia. So the interview of Australian beef industry experts on production, quality, cost structure and production chain was planned to be done via Skype or phone (or e-mail if necessary). After approximately one month and a half of failed contact attempt with any private or state organization or university in Australia, the researcher resorted to documentation method for data collection with no supporting data from any Australian experts. The results of the study were then not as strong as it should have been. On top of this, some available data was not soundly comparable to the one from Thai case, either in terms of time or format difference.

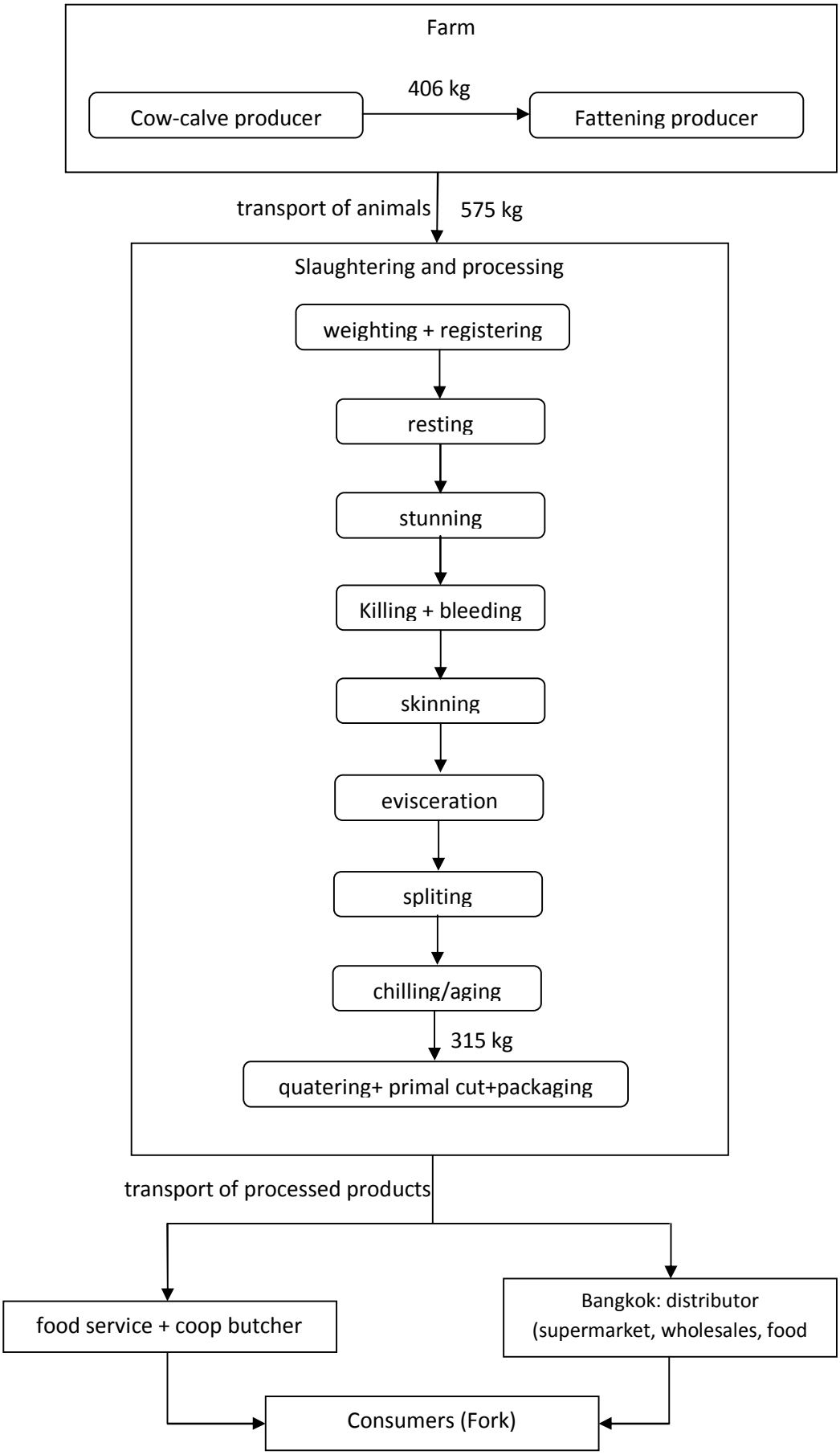
Chapter 4 Results

4.1 Beef production chain characteristics

4.1.1 Thai beef: PYK beef case

The researcher selects the production chain that is mapped together with cooperatives'' animal husbandry officer (Appendix 8) together with the part on sources of beef cattle as mapped by the marketing director (Appendix 9), to answer SRQ4 **"What are the chain process characteristics in terms of functions of Australian beef production and Thai cooperative beef production?"**as completely as possible. The production chain characteristics shown in the two maps are corresponding, except for two things: (1) the section between the farm and stall, where the marketing director showed two sources of cows – the ones which grown up in farmer's stall and the ones which are bought for fattening. The researcher did not include this part (in the map) because on the day the cattle were transported for slaughtering, the researcher was observing at the cooperative (2) The researcher describes in greater detail the section of processing in the slaughter house according to what she has observed.

The production mapping as adapted against Luning's model (also used to answer SRQ1) represents the production chain of PYK coop as shown in figure 8.



Fiuger 8 PYK beef production chain in terms of function

PYK beef chain description

Farm production:

Breed choices: PYK coop mainly uses only Charolais that is European breed. Charolais breed are rapid growing, big size, tender muscle. For an increase in resistance, Charolais has to be crossbred with local marbling breeds or Brahman, which have low or non-existent marbling.

Production system: There are two main beef production types in farms. 1) cow-calve production 2) purchasing animal for further fattening. The researcher interviewed two farmers who do cow-calve production and two who purchased cows. Those who do cow-calf producing farmers, each has 1 – 2 cows and approximately 4 fatten cattle. These farmers put their best effort in having the breeder for safekeeping. Those who purchased own 5-6 cattle each. Both groups of farmers do not have a clear idea of beef quality control. They only feed the cows with concentrate bought from the cooperative. The cattle are also fed on cane molasses and rice straw. Water supply is freely available for the animals. Relieving heat for them by washing them is also done. From time to time the cows are taken out for a walk to reduce stress. Hygienic control is done by keeping the stall dry most of the time.

Animal's health is taken care of by having officials from the cooperative and from the department of livestock constantly checks up on the cows which includes, for instance, deworming, vaccination and treatment.

Animal transportation: The transportation of bulls chosen for slaughtering to the cooperatives' slaughterhouse is done by cooperatives' members. The vehicle used could either belong to the members or cooperatives. There are concerns on quality control during the transportation, by washing and cleaning the cows, not cramming them in a vehicle, transporting during morning or late afternoon hours to avoid the heat stress of the animals. All these reduce stress on the cows which is related to beef quality. The cooperatives issued the regulation that the transport needs to arrive at the cooperatives before 6P.M. to allow sufficient resting before slaughtering at 10 A.M., following morning.

Once at the cooperative, the members need to put their own cows in stalls by themselves. The owners know their own cows best and tend not to scare them into hurting themselves, which directly affects the quality of the beef. For instance, the cow that has its leg broken needs to be immediately taken to be slaughtered. This yields low quality beef because the cows is stressed by the injury and lack of rest, not to mention the unusable beef from the injured area. When this happens, the cooperatives stand to lose. This is because it bought the cows at a specified price, but with lower quality and weight (minus the injured area) of carcass. The beef derived from this particular cow will then be sold at the price of lower grade beef.

Slaughtering and processing: This function can be divided into the following steps

1) Weighting and registering: check if a cow is the same cow as the one ordered. If it can be verified that it is not the same one, the cow in question will be rejected. Verified cows will be weighted and registered before slaughtering.

2) Resting: Thai law states that animals are to rest for at least 12 hours before the slaughter. PYK requires the animals at least 15 hours of rest, during which only clean water is allowed.

3) Stunning: After the rest, cows will be taken into slaughtering cage one at a time by being led or gently sprayed at with water. Scaring or beating them into the cage is prohibited. Once in the cage, the animal will be shot with a tranquilizer.

4) Bleeding: Main artery at the neck of a cow is cut. Then a pulley is used for lifting up a cow's body with its head pointing down toward the ground to allow blood to flow out. Then the head is removed.

5) Skinning: Put the cow's body down on a steel carriage, clean, remove the shank, skin, split open the torso, hang up to skin the back.

6) Evisceration: Remove entrails for veterinary inspection before proceeding to entrails section.

7) Splitting: The carcass is to be split into two parts along a spinal cord for further veterinary inspection, after which cleaning and weighing follows and certificate of origin are given to each part.

8) Chilling/aging: Aging to done where the room temperature is between 2-4 C˚ for seven days to make the beef more tender.

9) Quartering and primal cut: The two parts are then cut into four parts of two hind quarters and two fore quarters. Each of these four parts is then labeled. Then 23 primal cuts are made and have primal cut labeled on them.

For safety control, the cooperative makes sure that no part of the cows comes in contact with the ground to reduce possible contamination. Knives and other equipment are constantly submerged under boiling water to eradicate germs.

Transport of processed products is done in two ways:

1) Transport to coop shop (Sakolnakorn) by the farmers' own trucks

2) Transport to coop shop (Bangkok, Huahin) by logistic company

In each transport, quality control of the beef is priority, with the beef being kept under 2-4 C˚ all the time.

Retailing e.g. coop shop, food store, supermarket, wholesale

1) Coop shop: The cooperatives have their own butcher shop where customers both from Sakonakorn and Bangkok come to buy beef.

2) Food store: The cooperatives own a restaurant with the main sales being steak and other PYK beef dishes.

Customers who own of a food store also come to buy here

3) Supermarket: The main buyer in this category is Villa market superstore, to which the cooperative deliver the beef.

4) Wholesale: The major buyer, Betagrow, have their vehicles pick up the beef at the cooperatives, office in Bangkok.

As with quality control before reaching the consumers, the interviewees emphasize temperature control and the amount of beef being sufficient only for a week of sales.

4.1.2 Australian beef case

Desk research on Australian beef production chain to find out beef chain characteristics in terms of function revealed that there is no literature that directly talks about such chain. Most talk about supply chain instead of production chain and in terms of sector (AACM, 1996) stakeholder (LAA, 2009) or product flow ((Cox et al. 2003)) etc. instead of function. The chains discussed ranges from very simple to some very complicated ones. In an attempt to answer SRQ 4 **"What are the chain process characteristics in terms of functions of Australian beef production and Thai cooperative beef production?"**, where Australian beef chain is concerned, an adaptation of chain characteristics that are suitable for this research work will be done. The researcher aims not to present a complicated beef production chain. Rather, she has a goal of identifying chain characteristics that can be divided into main functions. These main functions can then be analyzed for involved costs. However, as mentioned earlier, there is no literature that directly discusses chain in terms of function. The closest one to chain functions can be said to be supply chain in terms of production push that is adapted from WY Associates (2009) by Department of Agriculture and Food (2011) for use in the research 'Supply Chain Performance of the Australian Beef Industry'. Figure 9 depicts a simplistic presentation of the production pushed beef supply chain in Australia.

Figure 9 Australian beef industry production pused supply chain

Source: Adapted from WY & Associates (2009)

However, since this research work is based on the framework provided by production chain of Luning and Marcelis (2009). It is necessary to adapt the above chain to fit in the framework of Luning model. Thus only the main stages of the chain would be studied by grouping suppliers, production and feedlot into 'Farm' which is primary production. Transport, Processors, Wholesalers, Exporter, Retailers (butcher, supermarket), and Consumer (Fork) remain themselves. Sale and Marketers is not included in the adapted chain since they are assumed to be part of wholesale, export and retail. Therefore, the adapted Australian beef chain characteristics can be represented by the chart below.

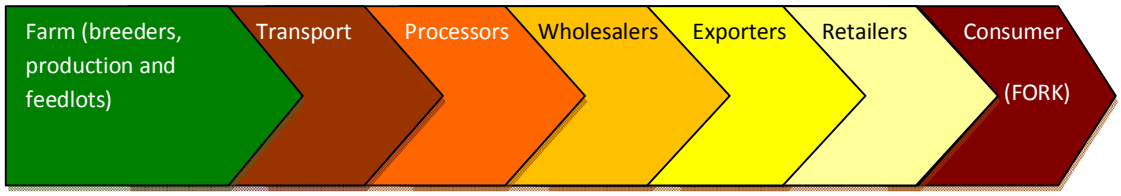


Figure 10 Modified Australian beef production chain

Source: Adapted from Department of Agriculture and Food (2011) and Agri-production chain of Luning and Marcelis (2009)

Australain beef chain description

1. Farm

This stage, cattle breeding and fattening, is the beginning section of the beef supply chain Jie et al. (n.d.).

1.1 breeding

There are two main group of Australian cattle breeds: temperate breeds (Bos taurus) and tropical breeds (Bos indicus). Most Temperate breeds are concentrated in southern Australia where rainfall is high. Tropical breeds' habitat on the other hand are the high-temperatures North (Cox et al. 2003).

Table 5 shows the breed composition of the current Australian beef herd, with Hereford, Brahman and Indicus/Taurus Cross being the three major breeds.

Breed	1990	1994	1997	2000(p)
Hereford	26.7	22.1	19.7	11.2
Angus	4.2	5.7	9.0	9.1
Other British Breeds	11.2	6.8	6.5	5.8
European Breeds	3.1	1.3	0.6	2.1
Brahman	8.8	13.4	17.4	13.2
Santa Gertrudis	2.8	3.8	5.2	5.0
Other Tropical Breeds	6.3	4.0	4.6	6.2
British Breed Cross	1.1	9.6	11.0	11.0
British/European Cross	7.4	5.2	4.2	5.5
Indicus/Taurus Cross	22.8	19.2	14.6	26.4
Other*	5.5	8.9	7.1	4.6

* Includes mainly dairy breeds used for beef production and dairy/beef cross cattle.
(p) Preliminary.

Table 5 Breed composition of Australian beef

Source: ABARE (2001) cited by Cox et al., 2003

Breeding properties are where cattle are bred, while production and fattening process are carried out in breeding properties, fattening properties and in feedlots (Cox et al., 2003).

1.2 production system

There are two systems of beef production in Australia: northern and southern. The northern system (Queensland, the Northern Territory and upper regions of Western Australia) involves cattle farming in large and extensive cattle stations which allows the cattle to graze on native pastures at very low stocking densities. This system has its output mainly as manufacturing beef destined for the United States, lot-fed beef and live cattle exports. On the other hand cattle in the southern system graze more intensively on smaller farm holdings that had been sown with introduced pastures and fodder crops. The southern system produces smaller, younger animals largely for Australian domestic market and higher quality stock for the Japanese market.

Livestock can be sold to either an abattoir or a feedlot or fattening property. The former directly processes it. The latter further feeds and fattens it for selling to the former (Cox et al.,2003).

1.3 feedlots

Feedlots are intensive cattle operations where cattle are fed a grain-based diet. The feedlots are located predominantly in Queensland and New South Wales - often close to grain producing areas (LAA 2009).

In Australia cattle are 'finished' in a feedlot for at least 70 days in order to be labeled as 'grain fed'. Cattle arrive at the feedlot with a live weight range from 300 to 450 kilograms and are slaughtered for market at weights ranging from 600 to 750 kilograms. The feed conversion rate is approximately 8 kilograms of grain consumed for a 1 kilogram weight gain of the beast (LAA, 2009).

LAA (2009) indicate that the actual time beef cattle spend in the feedlots depends upon two main factors: the source of the beast (whether from the northern or southern regions) and the selected market or end-consumer. Beef cattle destined for export usually spend at least 120 days in feedlots and up to 400 or more days if the meat is destined for the Japanese market as Wagyu-type (marbled) beef (Australian Wagyu Association 2008 cited in LAA, 2009).

2. Processing and packaging

Almost all abattoirs use on-the-rail dressing systems, with the hide removed by mechanical hide puller, and employees working from fixed positions along the chain (AACM 1996). A "tally" system is used to determine the number of slaughtermen employed on the chain for any given daily throughput. The tally for a plant is influenced by the layout of the dressing floor and its equipment (AACM International, 1996). This is when cattle are turned into carcass, primal beef and veal products. Such process from which meat and other products such as offal and hides are derived from cattle is done in an abattoir (also referred to as "meatworks" (Cox et al., 2003). Boning out is also done primarily at the abattoir where the animal was killed (Jie et al., 2003). Increasingly, the beef processing sector, in an attempt to add value and improve margins, and also to be in response to end user demand, is moving to cutting and further processing. Generally, 15-20% of a carcass is turned into steak cuts. The other 80-85% is sold as cheaper meat products. The modern retail of beef relegates butchery by first turning a carcass into primal cuts and then, with improved packaging techniques, to shelf-ready retail packs. Some abattoirs took further steps in response to retailers' demand in making products such as boneless joints, oven ready packs, hamburger patties, and salami and sausages (Gong et al. 2007).

3. Transport

Australian domestic transportation or export of meat is done in a chilled or frozen condition (Gong et al.,2007). Domestically, the transport is from an abattoir to a retailer (butcher shop or supermarket) or to a wholesaler who in turn sells it to retailers or restaurants (Cox et al., 2003). Such transport is carried out through refrigerated trucks with the surface temperature of the hanging carcass not exceeding 7°C (Jie et al., 2003). Once arrived at the destination, meat will be unloaded from the truck and placed into chilled storage as quickly as possible with minimal exposure to outside air or heat. As for export to foreign markets, meat is transported by ship or plane, with the latter gaining more popularity through the speed and convenience it offers (Cox et al., 2003). Meat is loaded into a large refrigerated box known as a container which is transported to the airport or a port by a truck (Cox et al.,2003).

4. Beef wholesaling and retailing in Australia

There are two lines of distribution in beef retailing. The first is the domestic market. The products of beef or veal processing may be distributed to a wholesaler or broker. They are then redistributed to a food services sector, butchers' shops or supermarkets such as Coles, Woolworths, BILO, IGA, and Franklins (Jie et al., 2003). The 1980s was a tough time for butcher's when it was the fastest declining segment of the retail industry. Pre-packed, one-stop, convenience led the supermarkets to displace many butchers. Butcher retailing was then forced to redefine its core competency as the provider of personalised and friendly service that a supermarket cannot offer. They also engage in niche markets such as providing organic and chemical-free products (Cox et al., 2003).

5. Exporting

Known widely to be naturally raising cattle with advanced farm management and breeding and processing techniques, the Australian beef industry exports to over 100 countries around the globe in form of either fresh (chilled) or frozen, with a smaller portion exported in processed form. In the environment of growing live animals export, once arrived in target markets, animals are either processed according to local custom, used to stock local feedlots, or, on a much smaller scale, used as breeding stock. Australia exported frozen beef to Thailand for 1,479,186 kg or 281,719,591 Thai baht in 2008, which is the amount that has been increasing dramatically since 2004 (Appendix 1). This is while the Australian beef price has been decreasing gradually according to FTA as shown in table 1 chapter 1.

Quality assurance (QA) is a system that is in place to ensure that all the products meet customers expectation in every aspect. The Australian Beef industry has a QA that covers the entire chain.

As Cox et al. (2003) mentioned, there is quality assurance in every stage of Australian beef production chain

Quality assurance on farms As an island, Australia is fortunate enough to be separated from diseases that as an island nation. The Australian government is determined to keep the situation this way by its strict quarantine measures. Apart from the said government regulations, the beef industry has its own quality assurance using the principles of HACCP. To be part of this program, cattle producers must be in compliance with a strict set of code of practice, which has been put through an independent audit process. Behind this QA is Australia's comprehensive animal identification system which tells of a particular animal from its origin and the introduction of National Vendor Declarations which verify the management and husbandry history of stock prior to sale. A traceability system called the National Livestock Identification Scheme (NLIS), was introduced across Australia in 1998. This system is based on the device attached to a each cow that can transmit data to the reader device. The data is stored in a nation database which is password-protected. The database provides information relating to the animal such as disease and residue status, market eligibility and commercial information.

Quality assurance on feedlots In 1993, the National Feedlot Accreditation Scheme (NFAS) was introduced to meet modern standards in terms of the environment, animal welfare, feeding regimes and freedom from residues. Administered by AUS-MEAT Limited and overseen by the Feedlot Industry Accreditation Committee (FLIAC), the NFAS is a self-regulatory system based on compliance with national standards. Its participants are subject to external audit processes.

Quality assurance with processors Starting in July 1997 all abattoirs are required have their plan looked at by external auditors. Only is they pass, they are allowed to operate. The Australian processing industry also has the measures that require all export abattoirs to follow Standard Operating Procedures for Sanitation (SOPS) that outline strict cleaning and sanitising techniques, and conduct routine microbiological testing.

Quality assurance with delivery Cattle production are in almost every part of Australia, which makes livestock transportation a vital part of the distribution system. Nowadays Australia are well supported by a network of delivery service providers including saleyards, transporters, and live stock exporters. Australian livestock transporters have their customer- focused quality assurance program based on HACCP principles, ISO 9002 and road transport accreditation arrangements. Its coverage ranges from pre- transport preparation of stock, livestock loading, welfare and quality controls to equipment standards and customer service. Export QA exist to ensure beef quality from the farm gate to the final port. Plus, in 1996, the Australian Livestock Exporters Council (ALEC) came up with the Livestock Export Accreditation Program (LEAP) that combines all livestock export standards and codes into a single document.

Quality assurance with consumers Meat becomes contaminated often after leaving the wholesaler or retailer. Regulations are in place to ensure the quality of meat is maintained until to final consumer. Despite the existence of a quality assurance program in areas such as product handling, cleaning, display temperature and even business management, the biggest challenge is to protect consumers from themselves. In Australia, and other places around the world, pre-prepared food is increasingly popular, leading to decline in consumers' skill in cooking and safe food handling. The beef industry has then taken a pro-active approach by educating consumers and food handlers about safe food storage and preparation techniques.

4.2 Beef qualities

To answer SRQ5 **"What are the specific quality characteristics of Australian beef and of Thai beef?"** with the help of answers from the meat science expert on beef quality demands in terms of sensory qualities and food safety show that Thai consumers regard such qualities from highest to lowest importance in the following way: tenderness, marbling, leanness, colour, contamination, texture, juiciness, and smell and flavour. the meat science expert indicated details of demand in each attribute as follows:

ranking	Quality attributes	Consumer demands
1	Tenderness	The more tender the better
2	Marbling	The more marbled the better
3	Leanness	Less leanness
4	Colour	dark red cherry in colour
5	Contamination	No contamination
6	Texture	fine muscle fiber
7	Juiciness	Juicy
8	Smell and flavour	Positively strong smell/flavour

Table 6 Ranking beef quality attributes and consumer demand

In each quality attributes, the meat science expert listed some of the contributing factors.

Quality attributes	Contributing factors
Tenderness	(1) Breeds: Angus only takes seven days to derive tender beef. (2) Age (3) Aging: the longer the aging the more tender, but also the more expensive. The beef of the cooperative takes 14 days of aging (The aging time of longer than 14 days does not significantly increase tenderness) (4) Part of muscle: shank contains more tendon, etc.
Marbling	(1) Breeds (2) Feed (3) Age
Leanness	(1) Feed mixture: high protein helps built muscle while high carbohydrate generates fat (2) Breeds
Colour	(1) Age: older cattle have darker beef. (2) Breeds: Charolais has red cherry beef while Simmental has dark red (3) Feeding on grass makes the beef darker in colour while concentrated feed yields red colour. (4) Maintenance
Contamination	From two sources: raising process (hormone, medication, pesticide, feed, althelmintics); and slaughter process
Texture	(1) Age: the older the cattle, the more coarse muscle fiber. (2) Part of muscle: tenderloin has fine texture while hip has coarse texture etc.
Juiciness	(1) Cattle age: the less of age the more juiciness (2) The higher amount of fat means more juice in the beef.
Smell Flavour	(1) Feed: Grass fed cattle have strong negative smell/flavor. The positive side goes to those feeding on concentrated food (2) Age: Older cattle yield more negative smell/flavour than younger cattle. (3) Part of muscle: parts with fat layer have positive smell/flavor.

Table 7 Factors affecting beef qualities

The information on consumer demands from the meat science expert is used by the researcher to construct a questionnaire for PYK customers. This questionnaire is to measure perceived qualities the customers have toward PYK and Australian beef. Refer to Appendix 6 for the questionnaire.

As mentioned in section 3.3.2 of methodology for study beef quality that this study adapts HOQ model to analyse Thai and Australian experts, answers derived from the experts can be used to complete HOQ model in the following way.

		Animal breed	Feed and feeding practice	Fattening length	Cattle age	healthcare practices	Slaughtering and processing practices	Aging and storing	Thai beef					Australian beef				
									1	2	3	4	5	1	2	3	4	5
sensory atttibutes + food safety	Tenderness	◇	◈	◈	◇	n/a	n/a	◈										
	Marbling	◇	◈	◈	◈	n/a	n/a	n/a										
	Leanness	◇	◈	n/a	n/a	n/a	n/a	n/a										
	Colour	◈	◈	n/a	◇	n/a	n/a	◈										
	Contamination	n/a	◈	n/a	n/a	◈	◈	n/a										
	Texture	◈	n/a	n/a	◇	n/a	n/a	n/a										
	Juiciness	n/a	◈	◈	◇	n/a	n/a	n/a										
	Smell+Flavour	n/a	◈	◈	◇	n/a	n/a	n/a										

Figure 11 Adapted HOQ of PYK beef & Australian beef

Where; ——— Coop's view on PYK beef qualities

——— Food store perception

- - - - - - - Supermarket perception

◈ Factors affecting quality that PYK has achieved ◇ Factors affecting quality and PYK has not achieved yet

n/a = factors do not applicable to the quality

4.2.1 Perceived beef qualities

Perceived Thai beef qualities

Questionnaire respondents consist of food store and supermarket. They rated PYK beef in the same way in terms of colour (mark = 2), contamination (mark = 5), texture (mark = 5) and juiciness (mark = 4). They explained customer perception in the following way;

Colour: Consumers do not agree that PYK beef is of dark red cherry colour. They however describe it as brighter red colour.

Contamination: Consumers trust in the food safety of PYK beef because the beef transform standardized slaughter house with traceability system.

Texture: Consumers absolutely agree that PYK beef has a fine muscle fiber.

Juiciness: Consumers agree that PYK beef has a high level of juiciness.

The other qualities, tenderness, marbling, and smell and flavour, are rated in the same way by both groups of respondent even though with slight different in the marks. The supermarket respondent rated PYK beef one level higher than the food store respondent. Leanness of PYK beef is the quality that both groups of respondent have very different opinion about. The food store respondent perceived that PYK beef does not have a high level of leanness, corresponding well with the rating in Marbling (leanness and marbling has inverse relationship). The supermarket respondent

on the other hand rated leanness highly which is not corresponding with this respondent's marbling rating.

Nonetheless, the two groups of respondent generally have harmonising perception of PYK beef.

Perceived Australian beef qualities

The questionnaire is limited to Australian grass fed beef, since it is the beef that has competitive price compared to Thai beef.

The two group of respondents have a rather different set of perception toward Australian beef. This is especially the case with leanness and colour which were rated 2 (mark =2) by the food store respondent. This respondent did not agree that Australian beef involves a high degree of leanness and that it is dark red cherry in colour. This respondent saw that it has a low level of leanness and that it is red cherry in colour, that is. The supermarket respondent on the other hand perceived that Australian beef contains a high level of leanness and is dark red cherry in colour.

The qualities that the two groups of respondents described similarly are tenderness, juiciness, and smell and flavor. They rated these attributes the same with rather high mark of 4. This shows that they perceive high quality in Australian beef when it comes to tenderness, juiciness, and smell and flavor.

Marbling, contamination, and texture are the quality attributes the two groups of respondents perceive similarly/in the same direction, but with different marks though. Food store respondent totally agreed that Australian beef is high in marbling and that Australian beef is contamination free, rating both qualities 5. As with texture, the respondent regarded Australian beef as having good quality in that it has fine texture.

The supermarket respondent agreed that Australian beef has a high level of marbling and is contamination free. This respondent however rated Australian beef 4 in both. Texture quality is rated in the middle, meaning the beef is neither too fine nor too coarse.

4.2.2 Coop' s view toward PYK beef qualities

The researcher asked the animal science specialist of PYK coop to rate PYK beef quality in order to reflect coop's view on beef qualities of PYK. The judgment of the expert is as follow.

The expert totally agreed that PYK beef has very good smell and taste by rating this attributes 5. Rated 4, which is the reflection of good quality, are tenderness, marbling, contamination, texture, and juiciness. This means PYK beef is satisfactorily tender, contains a lot of marbling, has a low level of contamination, has fine texture and is juicy. Leanness on the other hand is low. The colour of PYK beef is between dark red cherry and pure red cherry.

4.2.3 Discussion perceived and coop's view toward PYK beef qualities

The analyses of both perceived and coop's view beef qualities of PYK reveal that:

As for tenderness attribute and marbling attribute, consumers' perception coincides with Coop's view toward PYK qualities, saying that PYK beef has a high degree of tenderness.

Perception of leanness attribute from food store respondent is in line with Coop's view on quality of PYK in that PYK beef has low leanness, which is naturally inversely related to a high level of marbling. The supermarket respondent described PYK beef as having a high level of both leanness and marbling, which is contradictory to natural inverse relation between the two. The knowledge on this inverse relation, where one is high, the other will be low, is based on answers given by expert on meat science and animal science specialist of PYK coop. The researcher would then explain this line of rating given by the supermarket respondent (both high leanness and high marbling) that PYK beef quality in each lot is not consistent. Such explanation is well supported by expert on beef production from livestock department who said "*…five star hotels and restaurants which cater for high end customers still do not trust beef quality consistency of PYK…*" and by PYK coop 2010 annual report which mentions the members observation in their meeting that "*..carcass quality had been decreasing since 2004-2009…*", and they need more research to investigate the cause.

Colour: Even though consumer perception, food store and supermarket, aligns on the point that PYK beef is not dark red cherry in colour, but more red cherry in colour, colour indicated by specialists of coop is neither dark red cherry nor pure red cherry. The realized colour is more in between the two colour, based on the opinion of expert on meat science that PYK beef is from Charolais breed that naturally yields red cherry beef and that PYK beef is from older cattle which have more marbling, yet with less attractive colour. These two facts combined results in a lessening effect on the colour of PYK beef.

Contamination: Both groups of customers/respondents are confident that PYK beef is contamination free. It is worth noting that animal science specialists of PYK, though believing that PYK beef is contamination free, are not as confident as the above customers (who believe PYK beef is without both bio and chemical contamination). This can be seen from their rating which is lower than that of the customers. Such rating of those specialists can be explained that in the eyes of academicians, PYK production process still has more room for improvement. Experts of livestock department are coming from the same point of view, recommending that even though PYK slaughter house already meets national standard, it should be made to meet international standard, saying that "*…PYK still cannot reach high end customers who are five star hotels and restaurants because they do not trust food safety of PYK because they requires international standard…*". PYK nonetheless has no plan to beef up its slaughter house standard, for the belief that the slaughter house they have is sufficient. Thai consumers already trust in the food safety of PYK beef because there is a traceability system in place. The interview with PYK specialists however revealed that the system is not used with all the cattle of the cooperative members. Only some sampled cattle are treated with such system. It can be said that this traceability system is not yet successful. Plus, most Thai consumers do not have any awareness or idea of what traceability system is.

Texture: perception from customers and coop's view on PYK beef quality in terms of texture agree with each other. Difference in degree of agreement exists though. Consumers totally agree that PYK beef has fine texture, finer than suggested by realized texture, which accords with what the specialist of coop said, that older cattle beef have more coarse texture. And PYK uses older cattle for beef.

Juiciness: Juiciness is the only one attribute perceived and realized quality match, even with the same score in rating – that PYK beef is high in the level of juiciness.

Smell and flavour: both perceived and coop's view on beef qualities in this attribute show that PYK beef has good smell and flavor. It is worth nothing that the food store consumer/respondent still rated the beef less than the supermarket respondent or the specialist of coop. This can be explained that food store is the closest to end consumers since they cook for them. They then directly experience the smell and flavor of the beef and constantly hear feedback from those end consumers. This enables them to evaluate the smell and flavor more correctly and in a more detailed way. Supermarkets or the coop are not directly related to cooking the beef. They are more related to a cook or the supplier of a cook. So their (supermarket and coop) evaluation might not be as accurate as that of the food store.

4.2.4 Factors affecting qualities

The researcher analyzed data from expert on meat science, director of PYK coop and animal science specialist of PYK coop in order to complete HOQ model. Design quality, analyzed along with perceived and coop's view on beef quality of PYK beef, can be discussed in the following way.

There are 5 factors affecting tenderness, namely animal breed, feed and feeding practices, how old the cow is, and aging and storing. PYK coop achieved in feed and feeding practices, aging and storing. PYK beef has attained a high level of tenderness by feeding the cows with molasses for a period of six months before slaughtering – a practice that helps increasing tenderness. Aging is done according to international standard that is between 14-21 days. Factors yet to achieve are animal breed. Based on the opinion of the expert on meat science, the breed used by PYK does not yield a high level of marbling, where marbling helps make the beef tender. That breed still needs to be further mixed with a local breed which does not have any marbling anyway, for heat and disease resistance effects. The other factor that still needs improvement is the age of the cows. Younger cows give more tender beef. The age factor is crossed with the breed factor in that the breed used is not known for marbling. So longer fattening time is required, which make the beef tougher. Nevertheless, consumer perception shows that they are satisfied with the tenderness of PYK beef. So it can be said that the current practice of PYK is sufficient in retaining beef quality. The time spent in fattening and aging add up the cost though.

Marbling attribute depends on four contributing factors (that will make it higher). PYK coop achieved 3 of them, namely feed and feeding practice, fattening length, and cattle age. Animal breed is the only factor that still hinders the development of marbling, for the same reason mentioned in tenderness section above. Cattle age turns out to be the factor that helps increase the level of marbling, with the average fattening time 12-14 months (This makes the cow 3.5-4 years of age before slaughtering). As it turns out, marbling in PYK is satisfied.

Leanness depends largely on breed and feed and feeding practice. The cows PYK use is a cross with local breed, which gives high level of leanness. Thai consumers prefer marbling to leanness. What PYK do in reducing leanness and increasing marbling is to feed the cows with high carbohydrate to build a fat layer and moderate protein to build muscle. This makes PYK beef with a low level of leanness, as supported by the description of realized quality and food store consumer's perception in section 4.2.1 and 4.2.2. The reason the supermarket consumer perceived PYK to be high in leanness could be because inconsistency of beef quality in each lot of beef. Such inconsistency might have stemmed from feed and feeding practice of some farmers who did not use feed that is based on the cooperative's formula.

The only factor PYK coop could not achieve so far in improving the colour of the beef is to have younger cows for slaughtering. Even though European breed beef is red cherry in colour, long fattening period for more marbling has a lessening effect on the colour of the beef. Again, marbling itself has a side effect of colour brightening. Apart from this, the use of concentrated feed makes the beef colour more attractive than grass feeding. Aging at the PYK coop includes standardized temperature control, length and hygiene, all of which allow the beef colour to be able to bloom again when put on sale. The consumers do not perceive the colour to be dark red cherry even though the realized colour is between dark and pure red cherry colour. This can be explained that most Thai consumers are familiar with beef sold in ordinary Thai market, which is dark in colour. So they tend to see beef that is not quite as dark (PYK beef in this case) in a positive way.

Contamination: PYK coop does not have any problem in food safety, considering feed and feeding practice, healthcare practice, and slaughtering and processing practice. PYK beef production is free from Hormones or Growth promotants & Antibiotics. Concentrated feed used is contamination free. Beef processing and cut is hygienically done in a nationally standardized slaughter house, Random inspection of microorganism and other contamination is in place. Thai consumers are very confident in the safety of PYK beef. In the researcher's observation however, no worker at the coop washed up/took a bath before starting working in the slaughter house. All they did were only changing clothes and shoes and putting on hair cover. During slaughtering and processing, they walked back and forth between slaughter section and outside all the time, without changing their shoes. In the interview with specialist of coop, she revealed that she was not certain the workers took a bath at home before coming to work. The overall condition of the slaughter house is old because it was in service from the time PYK was established. Even though tools and equipment in the slaughter house were replaced from time to time, the floor and sewer system have been in service for a long time and look rather filthy. The expert from livestock coop was once reminding the PYK about the need to change on these things.

The breed PYK coop uses for crossing with the local breed gives fine textured beef. But older cows have more coarse texture. Thai consumers however have positive perception toward this attribute. The use of younger cows will result in finer texture though.

Contributing factors to juiciness are the length of time PYK coop use in fattening the cows with the help of molasses. This creates more fat in the muscle. This fat retains water in the beef during cooking process. Even though the cows used are older, feed and fattening length can save the day. This is reflected in the customers' satisfaction and the corresponding coop's view.

The only factor that requires improvement is the age of the cows before a slaughter. As the expert said, older cows have beef that smell negatively strong. PYK is not yet able to improve this aspect (age of cows) of their beef, for the longer fattening period and use of molasses are aimed at increasing marbling, which builds more fatty acid that smells good in a cooking process.

4.3 Chain cost structure: PYK coop

This section is to find out chain cost structure of PYK beef and Australian beef to answer SRQ6 **"What are the chain cost structures of Australian beef production chain and Thai beef production chain?"**. In the analysis of the cost of PYK beef production chain, the application of ABC is used as

stated in section 3.3.3. This is to find out the cost of each function of the chain in detail. The Australian beef chain will be mentioned later in section 4.4**.**

4.3.1 PYK beef: Slaughtering and processing costs using ABC

PYK beef production chain characteristics derived from the answer to SRQ4 in section 4.1.1 is used for setting boundaries in the analysis and identification of the major processes within each function. The interview and observation during field study revealed that cost information on farm function already existed based on the study done by PYK coop in 2010 provided complete overview of a cost structure of farm function, the details of which is in section 4.3.2.

Functions that can be analysed by ABC are slaughtering and processing function. The disadvantages of ABC which are complexity, time consuming and high cost as mentioned in section 2.3 are witnessed first-hand by the researcher. Apart from this, non systematic data collection and the employees' limited ability to give data only rendered incomplete data. The researcher can only put the collected data to best use.

The cost analysis using ABC in this study aims at investigating realised production cost per head of slaughtering and processing function. This function only produce beef carcass. The reason the researcher studied the costs of this function in detail is that from the observation and interviews, she found that the way it works in the slaughterhouse is workers from almost every department of PYK e.g. cutting, administration, accounting, service division come to work in slaughtering and processing function in un-fixed position. The lack of any limitation of the number of people working in slaughtering and processing line leads to 60-70 workers a day attending only to slaughter 80-85 cattle. The researcher then made an assumption that actual production costs in this function is higher than what PYK estimated.

The use of PYK beef production chain derived from answering SRQ1 is employed in breaking down the function into main major processes in order to analyze costs in each major process. There are four major processes in slaughtering and processing function involved in the production. Process descriptions are provided in section 4.1.1 and also summarised in table 8.

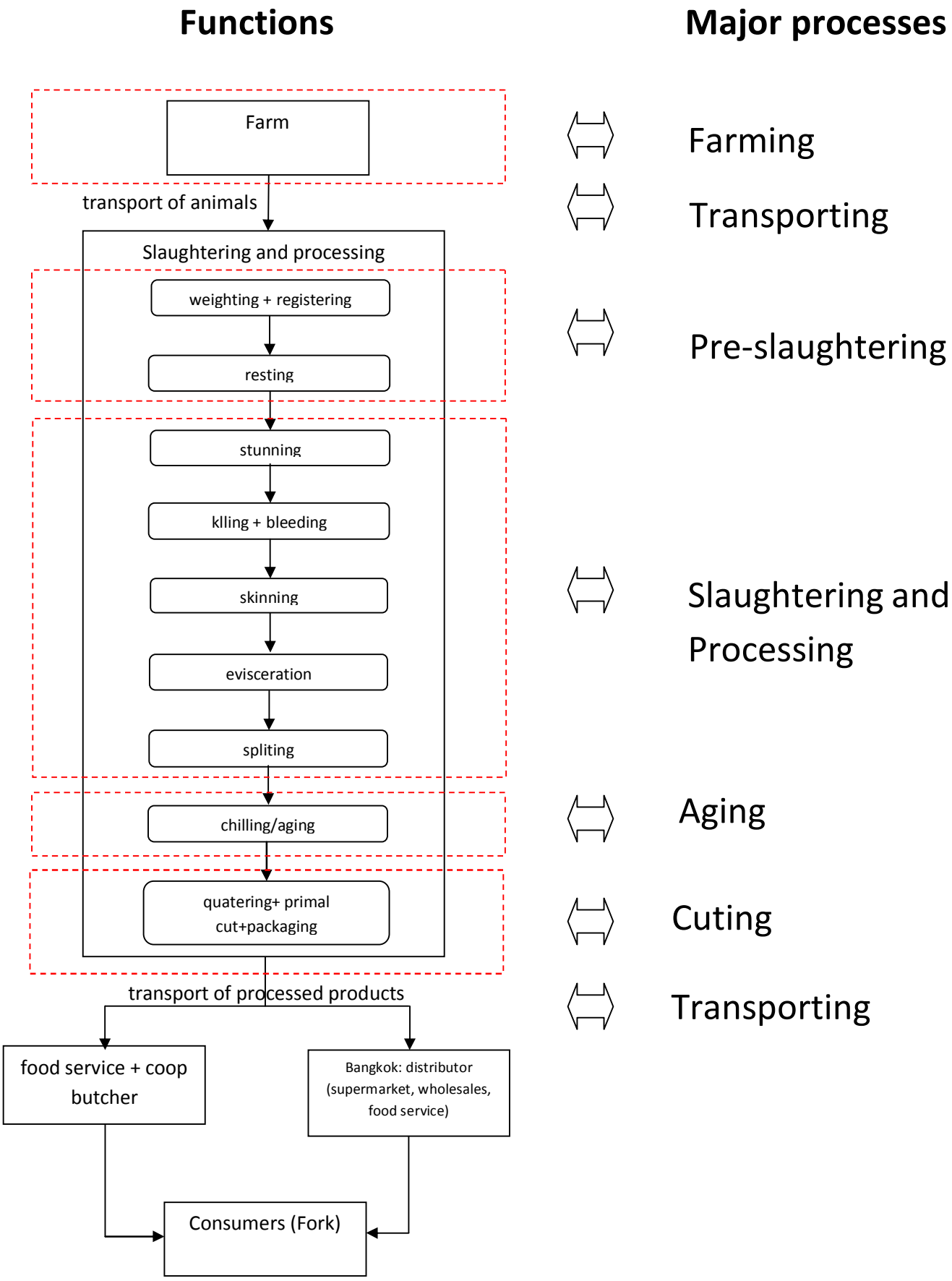


Figure 12 **Major processes of PYK beef production chain**

In each major process of Slaughtering and Processing function consists of activities as shown in table 8.

Major processes	Activities	Descriptions
Pre-slaughtering	Checking	Check cattle history against the order
	Weighting	Weight live cattle
	Labeling	Label live cattle
	Resting	Rest cattle
Slaughtering&Processing	Stunning	Shoot according to halal method
	Bleeding	Cut a head according to halal method
	Skinning	Skin cattle
	Eviscerating	Take off offals
	Splitting	Split hot carcasses
	Washing	Clean hot carcasses
	Weighting	Weight hot carcasses
	Labeling	Label hot carcasses
Aging	Chilling	Age carcasses
Cutting	Quartering+primal cut	Quarter+cut carcasses
	packaging	Pack

Table 8 Activities of each PYK major processes

From table 8 activities of each main process is devided according to the observation which is more details in the figure 12. This is because it is needed for the most analysis of ABC.

Once the major processes were broken down, resource used based on activities in each process was clearly seen by observation and interviews. Labour and electricity are mainly used in all functions. So, the labour cost analysis is the starting point. Based on PYK's annual report, labour cost in production cost consists of two parts which are salary and wage, and overtime. This analysis is elaborated in section 4.3.1.1. Electricity cost analysis will follow this section later on (section 4.3.1.2). To analyse labour cost using ABC is supported by LaLonde and Pohlen (1993) citing Cooper (1988, pp. 45-54) "ABC is a technique for assigning the direct and indirect costs of an organisation's resources and subsequently tracing the costs of performing these activities to the products, customers, or distribution channels consuming the activities". So, ABC can be applicable to both direct and indirect according to this statement. Salary and wage, and overtime is direct labour cost in this function. They will be analysed separately.

4.3.1.1 Salary & wage

Before showing the calculation, there are some points need to be informed.

- Salary&wage cost per unit used in the calculation are not from the PYK annual report, but from the calculation based on salary&wage lists in order to reflect actual production cost as much as possible (Appendix 10). How to calculate average salary and wage is show below to make more understanding.

  There two types of labours; 1) employees who earn salary monthly
  2) daily workers who earn daily wage

For example: in pre-slaughtering process, only workers from service division work in this process

	employees	Daily workers
Number	8 labour	7 labours
Normal rate	(see the lists in Appendix10)	157.00 baht per day
Average rate	5,940.00 per month	157.00 baht per day
Average rate per hour	5,940/26 days/8 hours	157/8 hours
	= 28.56 baht per hours	= 19.63 baht per hours
Weighting rate to make them balance	(8 labours*28.56)+(7 labours*19.63) / (8+7)	
	= 24.39 baht per hour	

Table 9 Average salary&wage calculation of PYK workers

Note; assume working hour = 8 hours and fully used

As for other major process including slaughtering and processing process, aging, and cutting, the same calculation method was employed. The reason the rate in each process are different is that the numbers of departments involved in each process is not the same. For example, slaughtering and processing process involves labour from 3 divisions (admin, accounting, and cutting). The calculation method is similar to the example above, except for using salary and wage and number of labours from 3 divisions.

- In slaughtering and processing process, stunning and bleeding man are not applicable because they are Muslim hired to kill with halal method. They earn fixed salary monthly. These costs are included in slaughtering expenditure (in the PYK report) because they do not have the status of PYK's employees.
- Pre-slaughtering and cutting process is not done in the same day of slaughtering day. So, the slaughtering day includes two major processes; slaughtering&processing, and aging. To inform this first helps make more sense from the results. Or in one slaughtering day, time used will be too high because of the inclusion of cutting process. However, all major processes will be analysed in the same method.

Major processes	Activities (1)	Labour cost per hour (2)	Labour cost per min (3) = (2)/60 min	Driver unit= Labour time used per head (4)	cost per activity/head (5) = (3)*(4)
Pre-slaughtering	Checking	24.39	0.407	1 min 1 labour	0.407
	Weighting	24.39	0.407	1 min 1 labour	0.407
	Labelling	24.39	0.407	1 min 1 labour	0.407
	Total per head per process			**3 min**	**1.221**
Slaughtering & Processing	Stunning	n.a.	n.a.	1 labour	n.a.
	Bleeding	n.a.	n.a.	1 labour	n.a.
	Skinning	31.81	0.530	15 min 4 labours	31.8
	Eviscerating	31.81	0.530	2 min 1 labour	1.06
	Splitting	31.81	0.530	2 min 1 labour	1.06
	Washing	31.81	0.530	2 min 4 labours	4.24
	Weighting	31.81	0.530	1 min 2 labours	1.06
	Labelling	31.81	0.530	2 min 1 labour	1.06
	Total per head per process			**76 min**	**40.28**
Aging	Chilling	31.81	0.530	2 min 1 labour	1.06
	Total per head per process			**2 min**	**1.06**
Cutting	Quartering + cutting + packaging	24.86	0.414	90 min 9 labours	335.34
	Total per head per process			**810 min**	**335.34**

Table 10 PYK activity-labour cost allocation in major processes

The calculation from table 10 can be summarised in each process as shown in table 11.

Major process	Salary&wage cost per min	time used per head	Salary&wage cost per head	Salary&wage cost per year
Pre-slaughtering	0.407 baht	3 min	1.221 baht	9,040.29 baht
Slaughtering+ processing	0.530 baht	76 min	40.28 baht	769,127.52 baht
Aging	0.530 baht	2 min	1.06 baht	7,848.24 baht
cutting	0.414 baht	810 min	335.34 baht	2,482,857.36 baht
Total			**377.901 baht/carcass**	**2,797,979.004 baht/year**

Table 11 PYK salary&wage cost allocation in major processes per year

4.3.1.2 Overtime

Data for the analysis of overtime cost was lacking. There was no available data about how many hours the workers worked overtime, and how much the rate was for overtime. Only the total amount of overtime cost was available (441,673 baht/year). This amount of overtime cost is only for cutting process. To calculate overtime cost per carcass is simply done by using the total amount divided by number of carcass per year. The results is 441,673/7404 = 59.65 baht per carcass. Based on the result from table 11, one carcass needs 810 min to be cut in pieces. Time used per head for overtime should be the same. So, overtime per carcass per min is 59.65/1,011 = 0.059 baht per min. This figure will be added in driver unit cost of cutting process as shown in table 12.

The results from labour table 11 are summarised followed major process as follow;

Major process	Labour driver cost per min	time used per head (min)	Labour cost per head (baht)	Activity per year =7404 head (baht)
Pre-slaughtering	0.407 baht	3	1.221	1.221*7404 = 9,040.284
Slaughtering+ processing	0.530 baht	76	40.28	40.28*7404 = 298,233.12
Aging	0.530 baht	2	1.06	1.06*7404= 7,848.24
Cutting	0.473 baht*	810	383.13	383.13*7404=2,836,694.52
Total			**425.691**	**3,151,816.164**

Table 12 PYK activity-labour cost allocation per year

Note: */salary&wage+overtime per min

The results from table 12 show that the activity cost is 425.691 baht per head. The cost analysis in this study is aimed at to investigate the realised production cost per head of slaughtering and processing function. Once the activity cost per head is revealed, activity per year which is number of slaughtered cattle (7404 head) is multiplied to find out activity cost per year (425.691*7404 =3,151,816.164 baht per year)

4.3.1.3 Electricity cost analysis

Electricity is another cost driver in slaughtering and processing function. Analysing electricity cost is a very tough task. There are many electrical equipment items in each major processs. The equipments are different in terms of purposes, electrical consumption, size, time used etc. For example, chillers start up again and again according to their cycle that consumes electricity differently between the starting time and the later time. This also applies to air conditioners, for they also work in cycle. Moreover, data concerning electricity used from the informants is based on their estimation and experience. There are possibilities that they missed some equipment or misestimated.

If PYK wants to know the more precise figure, calculation should be done by an expert with electrical measuring equipment. However, the calculation in this study more or less provides useful information.

Available electrical information was used to calculate needed technical consumption (kwh) of each equipment. The table 13 summarises the results from consumption calculation according to the four major processes.

major processes	electrical equipments	purpose	no.	consumption size	usage time per day	consumption kwh per day per head	electricity costs baht per day (1 kwh =3.423 baht)	operating day per year	electricity cost per year (baht)
pre-	light bulbs	rest cattles	6	36 w	12 hr	2.592	8.87	96.000	851.752
slaughtering	weight scale	No weighting	1	200 w	24 hr	4.800	16.43	365.000	5,997.096
		When weighting		800 w	1 min/head	0.013	0.05	7404*	98.720
					total	**7.405**		**total**	**6,947.568**
slaughtering&	fans	air flow	10	300 w	6 hr	18.000	61.61	96.000	5,914.944
processing	light bulbs	generate light	30	36 w	8 hr	8.640	29.57	96.000	2,839.173
	water pump1	Pump underground water	1	3 horsepower	6 hr	13.428	45.96	192.000	8,825.096
	water pump2	Pump underground water	1	2 horsepower	6 hr	8.952	30.64	192.000	5,883.398
	saw	split carcasses	1	5 horsepower	1.5 min/head	0.093	0.32	7404*	690.423
	hot water machine	clean carcasses + slaughtering area		3 horsepower	1 hr	2.238	7.66	192.000	1,470.849
	weight scale	No weighting	1	200 w	24 hr	4.800	16.43	365.000	5,997.096
		When weighting		800 w	1 min/1 carcass	0.013	0.05	14808**	197.440
					total	**56.165**		**total**	**31,818.420**
aging	chiller1	chill	2	5 horsepower	24 hr	89.520	306.43	365.000	111,845.840
	chiller2	chill	7	10 horsepower	24 hr	626.640	2,144.99	365.000	782,920.883
	light bulbs	generate light	18	36 w	24 hr	15.552	53.23	365.000	19,430.591
					total	**731.712**	2,504.65	**total**	**914,197.314**
cutting	air conditioner	Generate cool air	1	36000 btu	14 hr	37.968	129.96	365.000	47,437.029
	air conditioner	Generate cool air	1	24000 btu	14 hr	25.312	86.64	365.000	31,624.686
	light bulbs	generate light	6	36 w	14 hr	3.024	10.35	365.000	3,778.170
					total	**66.304**		**total**	**82,839.886**
					grand total	**861.586**		**grand total**	**1,035,803.188**

Table 13 Electrical consuming allocation in major processes

Note: */ is number of cattle per year not operating day per year (calculate based on actual usage behavior)

**/ one carcass was split into 2 pieces (7404*2=14808 pieces)

major processes	electrical equipments	purpose	operating day per year	explanation of operating day per year
pre-slaughtering	light bulbs	rest cattles	96	normally PYK operates slaughtering twice a week (2*4*12 = 96 day a year)
	weight scale	Not weighting of cattle	365	the weight scale is turn on everyday
		Weighting of cattle	7404*	the weight scale is used per head (1 time per each beast)
slaughtering& processing	fans	air flow	96	Based on the number of operating slaughtering days
	light bulbs	generate light	96	Based on the number of operating slaughtering days
	water pump1	Pump underground water	192	operating slaughtering days (96*2=192) (before&after slaughtering)
	water pump2	Pump underground water	192	operating slaughtering days (96*2=192) (before&after slaughtering)
	saw	split carcasses	7404*	Based on the number of slaghtered beasts
	hot water machine	clean carcasses + slaughtering area	192	operating slaughtering days (96*2=192) (before&after slaughtering)
	weight scale	Not weighting of cattle	365	the weight scale is turn on everyday
		Weighting of cattle	14808**	the weight scale is used per head (1 time per each beast)
aging	chiller1	Generate cold	365	chillers are used everyday
	chiller2	Generate cold	365	chillers are used everyday
	light bulbs	generate light	365	generate light in chilling room everyday
cutting	air conditioner	Generate cold	365	cutting room is used everyday
	air conditioner	Generate cold	365	cutting room is used everyday
	light bulbs	generate light	365	cutting room is used everyday

Table 14 Operating day explanations of each electric equipment

Note: Operating days per year based on PYK operating twice a week

The calculation of electricity used and electricity cost per year are calculated on the basis of actual use.

How the results in table 13 were calculated can be explained below;

The formulas which were used to calculate the amount of consumption per day or per head were provided by a Thai electrical engineer. The reason both per head and per day exist is that some electrical equipment are shared in certain period of time. So if this is the case, per head consumption cannot be calculated right away. For example, when resting the beef cattle before slaughtering, light is shared among 80 cattle throughout 12 hours. The calculation has to be done per day first. But for weighting scale, the beast is weighted 1 head per 1 time (1 min time used). Electrical consumption for this example is done per head right away. The results in column (3) were calculated from the main formula which is;

Kwh per day = (normal consumption (watt)*time used (hrs)*the number of each (unit of) equipment)/1000

For example;
In pre-slaughtering process, there are six 36-watt light bulbs which are used 12 hours per day, then the electrical consumption of light bulbs in this process is;
= (36 watt*12hrs*6units)/1000 = 2.592 kwh per day
The details in calculation are different depending on available information, nature of use, etc.

For example;
The electrical consumption of the weight scale is divided into two parts because of the nature in which it is used. The weight scale is turned on all the time and all year whether there is weighing or not. When the weight scale is not used, it still consumes electricity approximately 20% of consumption size (1000 watt). 80% of consumption size is consumed when a beast is weighted which spends time 1 min per head.
The main formula is used to calculate weight scale consumption at no-weighting moments is as follows;
= (200watt*24hrs*1units)/1000 = 4.800 kwh per day
The main formula is used to calculate weight scale consumption at weighting moments is as follows;
= (800watt*(1/60)*1units)/1000 = 0.013 kwh per head
When weighting the consumption calculation can be done per head right away.
This calculation is also applicable for a weight scale and a saw in slaughtering and processing process because of their similar nature of use.
The difference in calculation stemming from available information given by employees is when they do not know normal consumption size of some equipment in watt. They estimated them in horsepower unit. This kind of unit has to be converted into watt by multiplying by 746 (1 horsepower = 746 watt).

For example;
A water pump with 3 horsepower used 6 hours per day consumes electricity;
= (3horsepower*746watt*6hrs*1unit)/1000 = 13.428 kwh per day
This method is also applicable to chiller and hot water machine in slaughtering and processing process. But when calculating for chillers, this method needs to time by Ft = 0.5 (Ft is variable cost in

electricity generation, depending on fluctuating price of fossil fuel used in such generation. It is calculated by average per electricity unit).

Another example is the air conditioner consumption size given in btu unit. This can be converted by dividing the btu with 12000 to make btu into ton refrigerant. 1 ton refrigerant consume electricity of 1.25 watt. For air conditioner, the Ft = 0.8 is used multiply the same way as in the calculation of electrical consumption for chillers.
So, the calculation in cutting process for the air conditioner with 36000 btu, 1.5 hrs time used per day per head of carcass is;
= [36000/12000)*1.25watt*1.5hrs*1unit*0.8ft = 4.500 kwh per head
The results from labour table 13 are summarised according to major process as follow;

Major process	Electricity cost per kwh (baht)	Kwh used per day	Electricity cost per day (baht)	Activity per year (depends on operating day of each equipment)
Pre-slaughtering	3.423	7.405	25.347	**6,947.568**
Slaughtering+ processing	3.423	56.165	192.252	**31,818.420**
Aging	3.423	731.712	2,504.651	**914,197.314**
Cutting	3.423	66.304	226.958	**82,839.886**
Total			**658.32**	**1,035,803.188**

Table 15 PYK activity-electricity cost allocation per year

Note: */salary&wage+overtime per min

The total activity cost was calculated along with other costs incurred in this function based on cost information in PYK's annual report. The other costs are simply divided by total number of slaughtered cattle per year (7,404 head). So, production cost of the slaughtering and processing function is shown below;

Cost items	**Production cost per year**
Activity cost	
-labour cost (7404 head)	3,151,816.164
-electricity cost	1,035,803.188
Other production costs	
-Direct material	328,696,294.41
-Cattle procurement	35,750.00
-Slaughtering expenditure	1,167,879.07
-Depreciation	859,819.65
Total cost	334,947,362.23
Production cost per head	45,238.70

Table 16 PYK beef production cost using ABC

Cost items	**Production cost per year**
Labour cost	2,748,570.00
Eletricity cost	1,327,085.62
-Direct material	328,696,294.41
-Cattle procurement	35,750.00
-Slaughtering expenditure	1,167,879.07
-Depreciation	859,819.65
Total cost	334,835.398.75
Production cost per head	45,223.58

Table 17 PYK beef production cost from PYK annual report

The explanations of each cost item are 1) direct material is live cattle. 2) Cattle procurement is the expenditure paid for recruiting good quality cattle to be slaughtered. 3) Slaughtering expenditure is expenditure paid for permission fees, extra money for workers who work in the slaughterhouse (100 baht/head of slaughtered cattle), expenditure paid for killing&bleeding men etc. 4) Depreciation is for the wearing of the equipment.

When comparing the two tables above (table 16 and table 17), it is clear that the activity cost is significantly different for both costs; labour cost and electricity cost. The result proved what the

researcher believe. Labour cost (salary&wage+overtime) calculated by ABC is higher than labour cost in PYK report for 18 %. Electricity cost from calculation is lower than electricity cost from PYK report 28 %. These differentials work their balancing effect into having the calculated production cost per head almost equal to the production cost per head from PYK report.

To make the cost analysis more useful, production cost from table 16 is used to allocate to each major process by separating between fixed cost and variable cost as shown in table 18. For more detailed analysis, activity cost is categorized into labour cost and electricity cost. Labour cost includes salary&wage and overtime. The calculation of percentage from labour time and kwh used in each process helps allocate these two costs.

Allocate of labour cost according to labour cost per head in each major process		**3 min (0.407 baht/min)**		**76 min (0.530 baht/min)**		**2 min (0.530 baht/min)**		**810 min (0.473 baht/min)**	
Allocate proportion of electricity cost according to kwh used per day per major processes	**861.58 kwh (100%)**	**7.41 kwh (0.86%)**		**56.17 kwh (6.52%)**		**731.71 kwh (84.93%)**		**66.30 kwh (7.70%)**	
	Total	**Pre-slaughtering**		**Slaughtering and processing**		**Aging**		**Cutting**	
		F	**V**	**F**	**V**	**F**	**V**	**F**	**V**
direct material (live cattle)	328,696,294.41								
direct labour (salary&wage and overtime)	3,151,816.16		9,040.28		298,233.12		7,848.24	1,534,560.00	1,302,134.52
electricity	1,035,803.19		8,902.35		67,522.01		879,667.62		79,711.20
cattle procurement	35,750.00		8,937.50		8,937.50		8,937.50		8,937.50
slaughtering expenditure	1,167,879.07		261,969.77	120,000.00	261,969.77		261,969.77		261,969.77
depreciation	859,819.65	214,954.91		214,954.91		214,954.91		214,954.91	
total cost	**334,947,362.48**	**214,954.91**	**288,849.90**	**334,954.91**	**636,662.40**	**214,954.91**	**1,158,423.13**	**1,749,514.91**	**1,652,752.99**
slaughtering cost per head per year (include live cattle purchase) (7,404 hd/year)	**45,238.70**								
slaughtering cost per year (not include live cattle purchase) (7,404 hd/year)	6,251,068.07	503,804.81		971,617.31		1,373,378.04		3,402,267.90	
slaughtering cost per head (7,404 hd/year)	844.28	68.04		131.23		185.49		459.52	

Table 18 **Cost allocation to major processes using ABC considering fixed cost and variable cost**

Note : The allocation rate is from table 12 (labour cost) and table 13 (electricity cost)

: Fixed labour cost in cutting process is calculated from salary list of employees in this division. This amount of money has to be paid to employees monthly throughout the year. Variable labour cost is from; total direct labour cost – fixed labour cost = 3,151,816.16 - 1,534,560.00 = 1,617,256.16. This variable labour cost consists of daily wage, overtime, and overhead labour cost working in slaughtering line.

: Direct material purchases are not allocated even if it is variable cost. This is because the amount of this cost is too high, which would make thorough analysis of other cost difficult.

: Cattle procurement is recruiting expenditure that is dependent on the number of cattle recruited.

Note (continued)

: Slaughtering expenditure consists of slaughtering permission fees, slaughtering extra money paid for workers, slaughtering wage paid for killing and bleeding (Muslim) men (fixed at 5,000 baht per man per month, hence 120,000 baht per year), and others (unknown).

: Depreciation is equipment depreciation, which is allocated evenly for each process.

From table 18 fixed cost and variable cost are allocated according to the proportion of labour time used and kwh used together with the consideration of how some costs are actually incurred. For example, there is fixed labour cost in cutting process because labour working in this process consists of employees who earn fixed salary monthly, and daily workers who earn daily wage The results show that cutting process incurs total production cost the most when live cattle purchase is excluded. Major cost of this process is labour cost that is high in both fixed and variable kind. Electricity cost logically plays a major role in aging process, which drives the costs of aging process to be the second highest after cutting process. Labour cost is the highest cost again in slaughtering & processing process. Slaughtering expenditure is the most important cost in pre-slaughtering process. This cost is an indirect one that is allocated equally in the other processes. When live cattle purchase is excluded, production cost of slaughtering and processing function is 6,251,068.07 baht/year (844.28 baht/head). Further cost analysis from the results will be discussed in details in section 6.7 of chapter 6.

4.3.2 PYK beef: other functions costs

Farm function: The researcher presents the data provided by PYK below (table 19 and 20) because of the limitation mentioned in section 4.3.1 and the fact that PYK already has data concerning the Farm costs in 2 ways; 1. production cost for Charolais crosbred bull (born - 1 year) 2. production cost for Charolais crosbred bull (born - 2 year).

unit: baht per head per year

cost items	cash	non-cash	total
concentrate			
roughage			
mineral supplements	323.00		323.00
labour cost		14,250.00	14,250.00
althelmintics, vaccination	250.00		250.00
artificial insemination	274.00		274.00
water and electricity	1,387.00		1,387.00
medical cares	966.00		966.00
opportunity cost (0.75%)		24.00	24.00
variable costs	**3,200.00**	**14,274.00**	**17,474.00**
depreciation of housing		700.00	700.00
depreciation of breeder (cows)		649.00	649.00
fixed costs		**1,349.00**	**1,349.00**
total costs	**3,200.00**	**15,623.00**	**18,823.00**
Selling price	13,062.00		13,062.00
Profit	**9,862.00**		**-5,761.00**

Table 19 Production cost for producing beef cattle (born to 1 year)

unit: baht per head per 2 years

cost items	cash	non-cash	total
concentrate			
roughage			
mineral supplements	578.00		578.00
labour cost		25,500.00	25,500.00
althelmintics, vaccination	350.00		350.00
artificial insemination	274.00		274.00
water and electricity	2,482.00		2,482.00
medical cares	1,340.00		1,340.00
opportunity cost (0.75%)		37.68	37.68
variable costs	**5,024.00**	**25,537.68**	**30,561.68**
depreciation of housing		700.00	700.00
depreciation of breeder (cows)		649.00	649.00
fixed costs		**1,349.00**	**1,349.00**
total costs	**5,024.00**	**26,886.68**	**31,910.68**
Selling price	17,530.00		17,530.00
Profit	**12,506.00**		**-14,380.00**

Table 20 Production cost for producing beef cattle (born to 2 years)

In the research of PYK, farmers are always at loss once the non-cash cost such as labour cost is included. Farmers can still produce calves because that only require labour from family members without the need for financial cost. Farmers normally do not include labour cost and thus feel that calves give them profits.

PYK's study does not show all costs in fattened cattle production. They however provided calculable costs of fattened cattle production. The researcher employed the said data in calculating total cost of fattening cattle per head which is shown in table 21 (details of the calculation of table 21 can be found in Appendix 11).

unit: baht per head per year

cost items	cash	non-cash	total	(%)
concentrate	15,422.40		15,422.40	24.24
roughage	4,356.00		4,356.00	6.85
mineral supplements	2,268.00		2,268.00	3.56
labour cost		14,130.00	14,130.00	22.21
althelmintics, vaccination	528.00		528.00	0.83
artificial insemination				
water and electricity	5,256.00		5,256.00	8.26
medical cares	374.00		374.00	0.59
opportunity cost (0.75%)		211.53	211.53	0.33
variable costs	**28,204.40**	**9,211.53**	**42,545.93**	
depreciation of housing		700.00	700.00	1.10
depreciation of breeder (cows)				
backgrounding cattle*	20,384.33*		20,384.33	32.04
fixed costs	**20,384.33**	**700.00**	**21,084.33**	
total costs	**48,588.73**	**9,911.53**	**63,630.26**	**100.00**

Table 21 Cost of fattening cattle in case buying backgrounding cattle from sellers

(*) average cost of cattle in case of purchase for fattening

During the fattening of cattle, the cost of concentrate is the highest cost the farmer has to bear in case that farmer produce calves by himself. In case of purchased cattle for fattening, the highest cost for on backgrounding cattle. Plus the farmer has to pay for concentrate. This leaves the farmer with almost no profit if the carcasses are low in quality.

The 2010 PYK annual report mentioned that 90.5% of farmers purchased cattle for fattening. Only 9.5% produce calves for fattening. In the former case, the cost is increased for 20,000 baht. Profit depends on how cheap backgrounding cattle can be purchased (table 22) and how well the carcasses sale. This depends on the quality of the carcasses and marbling score (see table 23). In a latter case more profit can be made but this is not popular because of the long period before the return. Plus the purchase of cattle can be paid in installment, even though with some interest rates.

Source of backgrounding cattle	Average price (baht per head)
From members	17,185
From middleman	21,035
From PYK	22,933
Average price	20,384.33

Table 22 Average backgrouding cattle price, farmers buy from various sources

Marbling grade	Buying price (baht per head)
2.5	39,000
3	45,200
3.5	53,200
4	57,400
4.5	59,800
5	62,200

Table 23 Average fattened cattle price, regarding marbling score, farmers receive from PYK regarding

Transport live animal function: Transportation of live cattle from the member's farm to PYK to be slaughtered is the duty of the PYK's members (farmers). Most of the interviewed farmers said that they hire a truck and pull their cattle together. By average 1 truck can carry 8 cattle with the fee shown in table below.

Rate round trip per head;		
15 km	50 km	100 km
100 baht	300 baht	500 baht

Table 24 Live animal transport fare delivering to PYK

Some farmers used their own pickup truck for transportation. They said that 100 km round trip, with 2 cattle require 500 baht. In this case the farmer might have to pay more than hiring a truck because there is depreciation cost of the pickup truck due to heavy load. This is not to mention the opportunity cost in driving back and forth.

Transport processed product (beef): There are 2 ways of transporting beef. First is the transport to coop butcher in Sakolnakorn. PYK uses a pickup truck with cooling room to do such transport everyday, with 1 carcass per day. The cost of each transport can be seen in the table below.

Cost per round trip	rate	Usage	Total costs
Labour (2 persons)	31.81 baht/hr/head	30 min	31.81
Fuel	31 baht per litr	2 litrs	62
Tatal costs			**93.81**

Table 25 Estimated transportation cost delivering to PYK butcher in Sakolnakorn

The above estimated costs are not paid by PYK head office since the labour cost is already included in salary and wage. It could be any worker from any division who transport the carcasses. The researcher then used the same average rate as the one used in slaughtering and processing for calculation. Depreciation cost, traffic fine, car insurance of the truck excluded, the monthly costs of transportation are 2,814.30 baht. The head office gets 4,000 baht per month from coop butcher as transportation costs.

The other transport of beef is to distributor (coop butcher in Bangkok) by outsourcing logistic company which costs 11,900 baht per round. In a month there are 21 rounds of transportation, 30 carcasses per round.

4.4 Australian chain cost structure

Data on Australian beef production chain cost structure is based heavily on literature without supporting from Australian expert, due to the reason mentioned in section 3.3. The researcher attempted to garner as much cost data as possible for each function. The focus was on 2009 data which is the same data year for the study of PYK cost. The garnered data for the Australian case is on farm function, as shown below.

4.4.1 Farm function

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) published the report 'Australian beef: Financial performance of beef cattle producing farms 2008-09 to 2010-11' of which some parts includes data that can be used for the study of cost structure in farm function.

In order to be comparable with Farm cost structure of PYK beef, data on Australian Farm cash cost will be presented. The farms involved here are only small scale ones from northern Australia and southern Australia. 2009 cost data covers 2 periods because ABARES presented the data according to seasonal condition; 2008-09 is in late summer, and 2009-10 is in rains. Finding out average value of costs between the two periods to estimate 2009 cost should make it easier for cost structure analysis once compared to farm function of PYK. Cost average is put in percentage in order that each

cost item could be analyzed for its proportion. The average is also put in Thai Baht according to the exchange rate in 2009 for all 12 months (see Appendix 12). All these are to help facilitate cost comparison with PYK.

Farm cash costs	2008-09 ($ Aud)	2009-10p ($ Aud)	Average costs ($ Aud)	Percentage	In Thai baht (27.11 baht per $ 1 Aud)
Beef cattle purchases	11,421.00	9,800.00	10,610.50	13.11	287,621.65
Chemicals	3,306.00	2,070.00	2,688.00	3.32	72,864.33
Contracts	3,205.00	2,010.00	2,607.50	3.22	70,682.20
Fertilisers	2,255.00	1,450.00	1,852.50	2.29	50,216.21
Fodder	3,511.00	5,110.00	4,310.50	5.33	116,845.87
Fuel, oil and grease	8,385.00	5,960.00	7,172.50	8.86	194,426.87
Handling and marketing	3,284.00	1,960.00	2,622.00	3.24	71,075.25
Hired labour	1,334.00	2,270.00	1,802.00	2.23	48,847.29
Interest	9,786.00	8,580.00	9,183.00	11.35	248,926.03
Repairs and maintenance	10,437.00	9,390.00	9,913.50	12.25	268,727.89
Total cash costs	**56,924.00**	**48,600.00**	**52,762.00**	**65.20**	**1,430,233.60**
Other cash costs	29,517.00	26,800.00	28,158.50	34.80	763,299.97
Grand total cash costs	**86,441.00**	**75,400.00**	**80,920.50**	**100.00**	**2,193,533.57**

Table 26 Average cash cost per farm in northern Australian

Source: adapted from (ABARES 2011)

From table 26 the cash costs farms paid for include beef cattle purchases (13.11%), repair and maintenance (12.25%), interest (11.35%) and Fuel, oil and grease (8.86%). Other cash costs, which is of the highest proportion (34.80%) include stores and rations, seed purchased, electricity, artificial insemination and herd testing fees, advisory services, motor vehicle expenses, traveling expenses and insurance. The report of ABARES however did not take these into the account of total cash costs.

While 'other cash costs' may comprise a relatively large proportion of total cash costs, individually the components are relatively small overall, and as such, have not been listed.

In northern Australia, Small farms grouping by the number of head is 100-400 heads per farm (ABARES, 2011). ABARES did not provide more specific information that can be used for calculating beef cattle per farm. Per head cost could then not be calculated.

Farm cash costs	2008-09 ($ Aud)	2009-10p ($ Aud)	Average costs ($ Aud)	Percentage	In Thai baht (27.11 baht per $ 1 Aud in 2009)
Beef cattle purchases	10,340.00	16,150.00	13,245.00	9.12	359,035.75
Chemicals	6,677.00	9,850.00	8,263.50	5.69	224,000.90
Contracts	5,574.00	6,890.00	6,232.00	4.29	168,932.49
Fertilisers	13,314.00	12,990.00	13,152.00	9.06	356,514.77
Fodder	4,535.00	2,420.00	3,477.50	2.40	94,265.52
Fuel, oil and grease	13,584.00	10,780.00	12,182.00	8.39	330,220.72
Handling and marketing	4,903.00	5,290.00	5,096.50	3.51	138,152.18
Hired labour	3,416.00	3,390.00	3,403.00	2.34	92,246.03
Interest	17,260.00	14,520.00	15,890.00	10.94	430,734.47
Repairs and maintenance	12,604.00	13,880.00	13,242.00	9.12	358,954.43
Total cash costs	**92,207.00**	**96,160.00**	**94,183.50**	**64.87**	**2,553,057.25**
Other cash costs	46,409.00	55,620.00	51,014.50	35.13	1,382,863.66
Grand total cash costs	**138,616.00**	**151,780.00**	**145,198.00**	**100.00**	**3,935,920.91**

Table 27 Average cash cost per farm in southern Australia

Source: adapted from ABARES (2011)

In southern Australia, each small farm has beef cattle around 100-200 heads (ABARES, 2011). The costs of those farms, starting from the highest, consists of interest (10.94%), beef cattle purchases and repair and maintenance (9.12%), fertilizers (9.06%), and fuel, oil and grease (8.39%). Other cash costs in the south are close to northern Australia farms which are 35.13%. Southern Australia had higher cash costs than northern Australia because improving seasonal conditions in the latter half of 2009-10 resulted in increased purchases of beef cattle to rebuilding herds and a large rise in beef cattle purchase expenditure. On top of that, Northern Australia's receding crop sowing area in eastern and southern Queensland regions due to dry conditions led to lower expenditure on cropping inputs, including fertiliser, chemicals and fuel (ABARES, 2011).

The estimate of cost per head per farm could not be done for the same reason as northern Australia farms. ABARES however provides data on the average number of beef cattle purchases, which should make it possible to estimate the per head price of beef cattle as shown in table 28.

	Northern Australia		Southern Australia	
	2008-09	2009-10p	2008-09	2009-10p
Beef cattle purchases ($ Aus)	11,421.00	9,800.00	10,340.00	16,150.00
No. beef cattles (head)	21	15	18	28
Cost per head ($ Aus)	543.86	653.33	574.44	576.78
Cost per head in Thai baht (27.11 baht per $ 1 Aus)	14,744.04	17,711.78	15,573.07	15,636.66

Table 28 Average beef cattle cost per head

4.4.2 Feedlots

The available feedlot cost data available that is closest to year 2009 data is from the study of LAA (2009), which estimated feedlot costing at mid-2008 prices using MLA Market information for cattle sales, and grain prices for feedlots in NSW, at the end of June 2008. The calculation includes the initial cost of purchasing a 280 kg beast, the NLIS transfer fee, feedlotting for 70 days to reach a finished live weight of 378 kg, transfers to slaughter and sale costs.

Production costs	**$ Aud**	**%**	In Thai baht (27.98 baht per $ 1 Aud: 2008)
Purchase	560.00	60.23	15,668.80
Feedlot cost (grain $380/tonne)	298.00	32.05	8,338.04
Saleyard cartage (average per head)	20.00	2.15	559.60
Vet costs & Additives	12.00	1.30	335.76
Cartage to abattoir	20.00	2.15	559.60
Finance costs (9%over70days)	14.80	1.60	414.10
NLIS transfer fee	5.00	0.54	139.90
Total cost to farmer	929.80	100.00	26,015.80

Table 29 Production costs for domestic yearling steer (approx. 16 months When sold at 378 kg. with fat score 2-3

The table 29 shows that costs of cattle purchase (for fattening) amount to more than half of all costs (60.23%). The second highest costs is for grains, which is major input of feeding (32.05%). This is approximately one third of all the costs. Grain costs has undergone volatile pricing due to increased international demand, the value of the Australian dollar and reduced crop yields due to droughts over the past few years (LAA, 2009).

4.4.3 Processing function

Cost data of cattle abattoir is provided in MLA report by AACM International since 1996. AACM employed 1991-94 data for the analysis and estimation of cost of processing sector. Data from 15 years ago seem so dated (table 30) that the researcher is not certain of its ability to reflect 2009

cost. In terms of details of cost structure of processing function, that set of data is useful in that it identifies different costs in this function.

Unit: ($ million)

Cost items	domestic	% of domestic cost	export	% of export cost	Total cost	% of total cost
Labour	140.7	61.1	599.8	57.6	740.6	58.3
Packaging and transport	3.0	1.3	119.8	11.5	122.8	9.7
Services	20.5	8.9	74.9	7.2	95.4	7.5
AQIS	9.3	4.1	33.0	3.2	42.4	3.3
AMLC/MRC	10.0	4.3	21.4	2.1	31.4	2.5
Interest	6.8	3.9	34.9	3.4	41.7	3.3
Consumables	3.1	1.4	9.2	0.9	12.3	1.0
Repairs and maintenance	27.0	11.7	114.4	11.0	141.4	11.1
General administration	10.0	4.3	33.4	3.2	43.3	3.4
Total	230.4	100.1	1,040.8	100.1	1,271.3	100.1

Table 30 External inputs purchased by the cattle abattoir sector

Source: adapted from MLA (1996)

The table 30 shows that the highest proportion of cost is labour (58.3%). This is follow by repairs and maintenance (11.1%), packaging and transport (9.7%), and services (7.5%). Domestic and export costs were mostly found to be having positive relationship, except for packaging and transport where export costs were found to be much higher than domestic one, which drives up the average.

However, an attempt to find data that will support the data from 15 years ago showed some progress when a report by "Rural Industries Research and Development Corporation (2010)", as prepared by Meateng Pty Ltd., called "Feasibility of Establishing a Northern Western Australian Beef Abattoir" was found. This report is a study of only some regions of Australia. The use of data as a representative of the whole function is then not appropriate. However, the data on cost structure can be used in the purpose of aligning with data obtained by MLA (1996) from 15 years ago. The data provided by the Department of Food and Agriculture (DAFWA) report is the cost estimation in doing an abattoir business starting from year1 to 10 as shown in table 31.

Inputs and cost items	Unit	YR0	YR1	YR2	YR3	YR4	YR5	YR6	YR7	YR8	YR9	YR10
range of seasonal assumptions			start up years			poor seasons		optimal	range of seasonal conditions			
TOTAL COSTS												
Labour	$'000	$8,868	$7,318	$10,342	$13,094	$13,094	$13,094	$13,094	$13,094	$13,094	$13,094	$13,094
Other	$'000	$0	$2,500	$2,750	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
Depreciation	$'000	$1,250	$1,250	$1,250	$1,460	$1,460	$1,730	$1,730	$1,730	$1,730	$1,730	$1,800
Interest	10%	$3,335	$3,210	$3,085	$3,339	$3,193	$3,420	$3,247	$3,074	$2,901	$2,728	$2,648
Total	$'000	$13,453	$14,278	$17,427	$20,893	$20,747	$21,244	$21,071	$20,898	$20,725	$20,552	$20,542

Table 31 Total cost of Australian abattoir when average capacity is 400 head per day, 5 days per week

Source: DAFWA (2010)

In an analysis, the researcher focuses on the optimal year (year 6) by calculating for percentage of the whole costs as shown in the table 32 below.

Unit: $000

Cost items	Cost in optimal year (yr6)	%
Labour	13,094.00	62.14
Other	3,000.00	14.24
Depreciation	1,730.00	8.21
Interest	3,247.00	15.41
Total	**21,071.00**	**100.00**

Table 32 shows labour cost to be having the highest percentage proportion (62.14%), which is similar to the figure of labour cost percentage in MLA (1996), with the MLA setting the same average capacity of 400 heads per day. The reason costs did not change much even after 15 years is possibly the use of fixed position employees in combination with machinery (MLA, 1996). Labour costs include manning for yards, slaughter floor, boning room, by-product handling, administrative duties etc.

Table 32 Total cost of Australian abattoir in percentage

Note: Other costs include consumables, power and water, insurances, statutory, and other.

The data from these two sources did not provide cost structure of processing function that includes livestock costs. The report of Industry Commission in 1994, based on a variety of sources, however summarised the percentages of total cost was attributable to processing and marketing within the Australian meat processing industry. The main input cost of the meat processing industry is livestock, representing three-quarters of the value of meat produced.

Unit: per cent

Component	*Beef*	
	Domestic	Export
Livestock costs		
• Purchases	67	61
• Procurement costs	5	4
Processing costs		
• Labour[a]	10	12
• Materials and services	11	10
• Fixed costs[b]	2	1
Total processing	23	23
Delivery costs	5	12
Total	**100[c]**	**100[d]**

The data in table 33 indicates that processing costs (excluding livestock purchases) in the beef processing sector account for approximately 23 per cent of costs to the point of sale and 23 per cent of the landed cost in one sector of the Japanese export market.

Table 33 Processing cost in Australian beef sector

Source: adapted from Industry commission (1994)

Note: a/ includes labour on-costs
b/ Fixed costs include returns to capital and management
c/ Wholesale value - Metropolitan area.
d/ CIF value- Japan

The data at hand, be it the one from 15 years ago or the more recent one, points to the direction in which livestock purchase has the highest cost proportion, with labour costs being the second highest, in processing function. The cost that is clearly different between domestic and export production is the one of delivery. Export production has approximately 2.5 times higher delivery cost than domestic one because of the costs of transport to overseas markets (Industry commission report). MLA report on the other hand, despite its use of data from the same period of time, gave export production cost figures that are more than ten times higher than domestic production costs.

This could be because MLA combined transport and packaging costs together. There were no details of the ratio of the two.

Chapter 5 Conclusion

The research objective is to investigate opportunities to reduce costs along Thai beef production chain, the case of PYK cooperative by comparing to exported Australian beef chain taking into account the chain process characteristics in terms of function, beef quality and cost structures of each stage throughout the chain. To achieve the research objective, the main research question has been formulated as following: ***"Where and how costs in Thai cooperative beef production chain can be reduced with its quality to be competitive with imported beef?"***. The case study of Thai cooperative is PYK coop, which is the leader in producing premium beef in Thailand. The imported beef case is Australia, the main competitor with high quality and increasingly cheaper price, thanks to the FTA. Seven sub research questions have been set to help answer the main research question. Sub research questions are answered by literature study and empirical study including interviews, observation and documentation. In the literature review agri- production chain characteristics, beef quality in terms of sensory properties and food safety, and cost management approaches have been studied. The field study where PYK coop located in Thailand was needed to see actual beef production for the in-depth analyses of beef quality and cost structure. The research questions and their interesting aspect are shown below.

SRQ1: What are the chain process characteristics on agri food production chain perspective that are applicable to beef production chain in terms of functions?

This question has been answered by the literature study. This is to acquire a framework for analysing beef production. The model of Luning and Marcelis (2009, pp.73) is used in answering this question because this research is focused on beef quality. This model does not pay attention to other overlapping functions the way other supply chain/value chain models do in including market channel. Luning et al. model also offers guidelines in quality control of agri-food products in each step of production, which helps in the analysis of factors affecting quality and safety of each chain in this function. The components of the model are shown in section 2.1.

SRQ2: What general meat qualities are used to measure beef quality?

To answer this question, a literature review was conducted. The focus is put on sensoric quality that consumers can easily evaluate simply by consuming. Food safety was also studied. The 7 types of sensory quality studied that had been derived from different literature/works are tenderness, marbling, leanness, colour, texture, juiciness, and smell and flavour. Food safety studied includes contamiantion both biological and chemical in production chain.

SRQ3: What cost approaches on supply chain measurement are relevant to analyse costs along the beef production chain?

From literature review, many cost approaches are normally used in supply chain analysis. The example of this could be Activiy-based costing (ABC), Total Cost of Ownership (TCO), and Direct Product Profitablity (DPP). It has been found out from the literature review that the cost approach most appropriate in analysing actual beef production cost in this research is ABC. This is because ABC assigns direct and indirect costs to activities consuming resources and tracks the costs to products, customers, or distribution channels, which gives more accurate sets of cost information.

SRQ4: What are the chain process characteristics in terms of functions of Australian beef production and Thai cooperative beef production?

This question is a part of empirical study in the research. To answer this question in case of PYK beef, interviews together with observation at the PYK site were conducted. Results from the interviews and observation were analyzed together in order to map out the production chain process characteristics that are as accurate as possible as shown in section 4.1.1 (figure 8). It was a pity though that no Australian expert responded to the interview requests. So the analysis of Australian beef production chain needed to be based heavily on literature. The results of the literature are adapted into the framework of modified production chain model in SRQ1. It was difficult to reach a conclusion on the process characteristics in terms of function of Australian beef production chain for none of the available literature directly discusses them. The exclusion of market channels from production chain in the modified production model helps filter out unnecessary complication through focusing only on production.

Production

Overall, beef cattle production practices in Thailand are quite different from the ones in Australia in many ways. First, cattle are produced by small household farmers scattering around the country (98% from 1.5 million household farmers). Each household has approximately 4-6 head of cattle . Australian producers on the other hand are larger in regard to their average herd size. The smallest farm (fewer than 100 head of cattle) is only 2% of the national beef cattle herd (ABARES 2011). Feedlots are also part of small household farmers, not clearly large-size specialised beef enterprises as in Australia.

Second, cattle breeds are different. PYK beef cattle are mainly Charolais crossbred with local breed to create greater resistance to heat and disease. This has some tradeoff in that the use non-pure European breed affecting costs and quality in many ways. It does not yield a high level of marbling, which is demanded by Thai consumers. This needs to be compensated by longer fattening period, which drives up feed costs. In Australia, beef cattle breeds are based on British breeds with which Australia crossbred to develop the genetic pool. The rapid increase in live cattle exports (from 1901 to 2004) is the testament of the success of cattle breed development in Australia (Gong et al., 2007).

Slaughtering and processing

Slaughtering and processing technology is another difference. Australian abattoirs use on-the-rail dressing systems, with the hide removed by mechanical hide puller. Employees work from fixed positions along the chain. The average capacity of plants is 400 head per day. PYK coop, on the other hand, has the capacity of approximately 80-85 head per day through labour intensive slaughtering. None of the workers have fixed duty. Those who work in the slaughtering line came from different departments – be they, administration, accounting etc. – not directly responsible for slaughtering and processing.

Even though PYK coop slaughter house has gained a national standard, it is still not acceptable, except for exporting to Vietnam or Cambodia where the slaughter house standards are much lower than in Thailand. Australia on the other hand, has its slaughter houses with international standard, where strict control of quality is in place with Australian Quarantine Inspection Service (AQIS) being a specialized relevant agent.

Transportation

There are two types of transportation along the chain: transport of live animals; and transport of processed products. As with the Australian case, the transport of live cattle are complicated with requirements based on a number of restrictions and guidelines to ensure animal welfare existed. Even though PYK is known to be a beef producer with concern for animal welfare, transport of live cattle is left to the farmers who do not have in-depth knowledge about this. Even this is not taken very seriously by the farmers, with some farmers transporting during the day. Because of the distance of less than 100 km and less-than-an-hour transporting time, restriction on animal welfare is not well heeded by either by the government and the PYK coop.

SRQ5: What are the specific quality characteristics of Australian beef and of Thai cooperative beef?

Expert Interviews from meat science and from PYK coop were conducted to obtain specific PYK beef quality characteristics. The results of such interviews were analyzed together and summarized that PYK beef has high tenderness and marbling, which make an outstanding point of PYK beef. Imported beef from Australia on the other hand has a high level of leanness because it came from grass-fed cattle. In terms of food safety, Australia has quality assurance schemes under different frameworks and different aims, administered by government and industry bodies representing producers in Australia, that constitute one of the key factors of success. In Thailand, the government only set out a broad Agricultural Commodity and Food Standard for practices in a slaughterhouse. An act of legislation that broadly regulates the slaughter and sale of meat is also available.

SRQ6: What are the chain cost structures of Australian beef production chain and Thai cooperative beef production chain?

This question is answered by conducting interview with employees, observation, and documentation. The main cost structure of both production chains in each function has different shape.

Farm function: PYK beef cattle production, the highest cost is labour cost, which is non-cash cost. The farmers did not actually pay since they rely on family labour. The highest beef cattle production cost for Australia is beef cattle purchases. Second in line are repair and maintenance and fuel, oil and grease. These two costs are virtually equally high, possibly because of the large scale farms that employ a lot of machinery and sow crop to produce feed for the cattle.

Fattening production of the two chains have two similar main costs which are beef cattle purchases and feedlot cost (concentrate + roughage). The difference is that the labour costs of PYK that are non-cash are high among all the costs. It is followed by water and electricity that are still part of the main costs. Australian beef on the other hand has high cartage cost. PYK did not include such cost in this function. Even with the cartage cost included, the cost would not be driven up annual costs in any significant way since each farmer transports cattle to PYK only a few times over a relatively short distance.

Slaughtering and processing function of both production chains are similar in that beef cattle purchases constitute the highest costs that is seconded by labour cost. Labour cost of PYK was examined by using ABC. The result shows that labour cost estimated by ABC is higher than PYK

report. Electricity is another major costs for PYK because there are many aging rooms. Even so, ABC cost estimation, with each of the equipment set to fully used, gave the electricity cost figure that is not as high as the one reported in PYK report. A more scrupulous study by experts with the right measuring device should be done to figure out the real cost. For Australia case, deploying machinery in the production process however involves other important costs in the function: repair and maintenance. Transport cost is another major burden for Australian abattoirs especially in export sector.

Transport function is where the detailed data is scant, especially in the case of Australia. This is because it has been included in others function and went through some analysis. Plus transport is the duty of companies. Studying private sector could be very difficult. The same goes with PYK in transporting from the head office in Sakonakon to the distributor in Bangkok, which is done by a logistic company. The only known and available data is the transport fee per round. Transport within Sakonakon only involves one cow per day on a short distance, where the major cost would only be for gas.

SRQ7: What are the feasible opportunities to reduce costs of Thai cooperative beef production chain based on the cost management approach and regarding learning from Australian beef?

The analysis of PYK beef production chain cost by ABC was done only on slaughtering and processing function, due to many limitations of information accessibility, time constraint, and budget constraint. Nonetheless, the analysis showed some opportunities for reducing costs. Labour cost has been analyzed to be higher than estimated by PYK themselves. The use of workers from many departments and salary levels, no specification of the number or positions of the workers, could drive up the average labour costs. However, this study could not conclude that this is opportunities to reduce labour cost learning from Australian beef industry by specifying the right number of workers in slaughtering and processing function, fixed positioning of the workers and factoring in modern machinery. More research on feasibility of capital investment are needed to support decision. In chapter 6 provides more insight about labour cost analysis.

Apart from this, ABC analysis showed that PYK estimated electricity cost much higher than the electricity cost from ABC calculation. Some activities in slaughtering&processing function were revealed opportunity to reduce electricity cost e.g. weighting activity. For key activity i.e. aging, cost reduction might be a difficult task because it requires strict time and temperature control. However, it might be done hiring an energy saving consultant.

There are many aspects that Thai beef can learn from Australian beef e.g. breed choices, feeding practice, transport practice etc. These aspects will be analyse more in chapter 6.

Chapter 6 Analysis and recommendations

6.1 Analysis

6.1.1 Breed choices have impact on production costs and meat quality

PYK coop mainly uses only Charolais that is European breed. The advantages of Charolais breed are rapid growing, big size, and tender muscle. The disadvantages of this breed are it resistance to weather conditions and disease in Thailand. For an increase in resistance, Charolais has to be crossbred with local marbling breeds or Brahman, which have low or non-existent marbling. Crossbreeding then becomes the weak point of PYK. To have beef cattle with high marbling grade to serve Thai consumer demand, PYK's members have to feed the cattle longer. While Australia mainly uses Bos taurus and Bos indicus which are milk cattle breed. It is normal for milk cattle in western countries to be fattened for meat eating purpose. The advantages of Bos taurus are big size, having a thick layer of fat, and heavy weight. Bos indicus is small size, light weight, and having a thin layer of fat. Australian beef industry is very advanced in R&D such as breed improvement, which renders them many advantages. Table 34 shows data on fattening of cattle of both Thai and Australian cases. This table helps make clear how breed choices affect on cost reduction.

	PYK	PYK	Australia*
year	*2010*	*2008*	*2008*
average weight (begin)	406 kg	375 kg	280 kg
average weight gain	169 kg	229 kg	98 kg
average fattening period	12 months	14 months	70 days
weight gain rate	476 g/day	540 g/days	1400 g/day
average weight to be slaughtered	575 kg	604 kg	378 kg
average weight carcass	324.4 kg	340.4 kg	212 kg
total grain consumed	5.4 kg/day	7.5 kg/day**	11.2 kg/day

Table 34 Fattening cattle information, PYK and Australian beef

Source: PYK annual report (2010)

Note: */Australian information is from LAA (2009)

**/standard amount for a 600 kg beast

From table 34, it can be seen obviously that PYK's members spend years of cattle fattening time to create high marbling score. This is because cattle breeds used are not the ones that give high marbling. Beef cattle need to be fully grown, so that intramuscular fat could be accumulated. Moreover, weight gain rate also reflect the weak point of PYK breed used. The rate is only 476 g/day which is 3 times lower than Australian beef cattle. However, this rate depends not only on breeds but also on feed practice as well, which will be discussed in the next section. Moreover, starting to fatten cattle at high weight coupled with long period of fattening make high concentrate cost unavoidable. In addition, beef cattle age at slaughterhouse gate is approximately 3.5-4 years which is too old in the view of expert on meat science. Older cattle yield tough beef, unpleasant smell and high tendency to have disease. It can be learned from Australian case that early start in fattening ,with 5 times shorter fattening period and slaughtering at younger age produce the opposite results as the Thai case.

So, we can conclude that breed improvement is really necessary for PYK coop or for other Thai producers, for that matter, to reduce cost of feeding and to develop meat quality.

6.1.2 Feeding practices have impact on meat quality

Luning and Marcelis (2009) stated that "**The final food quality depends on various technological conditions and many quality decision**". Final food product in this study is beef. In case of PYK beef, there is the issue of quality inconsistency in terms of marbling grade, the prominent quality of PYK beef. The average marbling grade score continually decrease between 2005 and 2010 as shown in the figure below. Marbling score has 5 levels. Level 1 has the least marbling, 5 is the most (figure13).

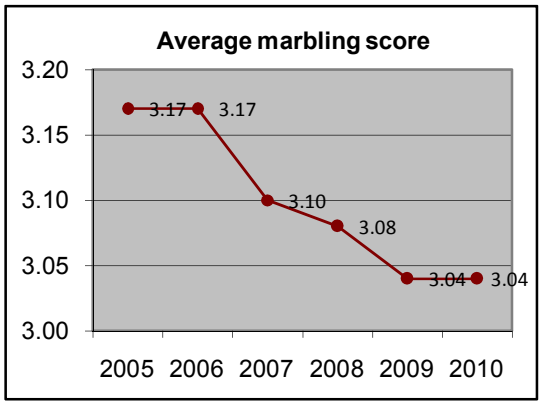


Table 35 Average marbling score of PYK carcass

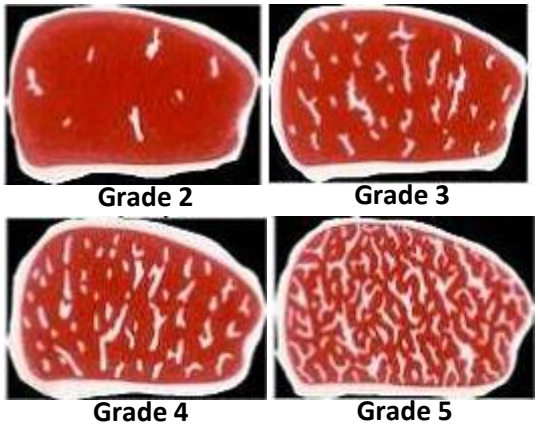


Figure 13 beef characteristics according to marbling score

The interviews and documentation pointed out that the quality drop resulted from farming practices mainly breed, feeding, animal health, and housing condition (Luning and Marcelis 2009). Feeding is the main reason of inconsistency of final product quality. This feeding factors can be divided into 3 subfactors.

1) concentrate source: farmers do not use concentrate of the same quality standard in fattening cattle. They buy cheaper concentrate from outside PYK, self produce concentrate based on different

recipe and quality. Even the same recipe made from the same raw material that come from different sources have different quality.

2) feed quantity: Wanting to reduce concentrate cost, the farmers do not feed the beef cattle to the specify amount that is 7 kg per head per day for 500 kg beef cattle. They may give some substitution feed which might not have good enough quality. 3) fattening length: The length of fattening vary from one farmer

to another. The sale of their beef cattle only happens when the beef cattle reach the requirement. If it does not reach the requirements, farmers need to keep fattening until their cattle pass the minimum quality line. The farmers need to know the exact length of time, requesting PYK to conduct a study to find out optimal fattening length. They ask PYK to study the differences between the length of 8, 9, 10, 11, and 12 months in order to set the exact fattening period. The study on optimal fattening length was requested because farmers did not accept that their feeding practices caused inconsistency on meat quality.

To sum, the strict feeding practice following PYK's production manual could help create the consistency of meat quality and of fattening period.

6.1.3 Consumer preferences and future marketing challenges

The result of expert interview support what was stated in the literature, that consumer preference in different countries, sensory attributes can be defined differently (Polkinghorne and Thompson 2010). In Thailand consumers prefer beef with a high level of marbling and tenderness. In Australia and Europe, consumers prefer lean beef more because of their health concern. Imported beef from Australia that is sold in Thailand has a high level of leanness because it came from grass-fed cattle. This is where PYK and expert agree on that Australian imported beef is preferred by different group of consumers than PYK consumers. They will also correspond in that cheaper FTA-driven price of Australian beef would not pose as much threat to the competitiveness of PYK beef as feared. It is also unlikely that upper market Thai consumers change their taste toward highly lean Australian beef. Nonetheless, Australia engages in promoting and educating consumers from domestic and overseas markets by a major industry body, MLA, which has made great efforts to give Australian beef an image of the one that is nutritious, safe, and high quality product worldwide by various promotional tools, like trade seminars and trade missions. They have also cooperated with the food service sector and retailers to increase sales as well as to encourage and educate consumers. Furthermore, MLA has set up a number of offices around the world to promote Australian beef products (Gong et al., 2007). This public relation aspect is where Thai beef producers have been very weak. Consumers know very little about the safety and quality of even Thai premium beef. This is because there is no industry body or organization that is directly responsible for this. The public relations PYK is attempting to do at the present include the marketing director of PYK appearing on different types of media, attending seminars and giving lectures in universities, etc. This made PYK beef significantly more popular. It nevertheless is no match for demand building of Australian beef by continuously educating consumers and expanding potential markets. There is so far no guarantee that Thai beef in general or even high quality beef like PYK beef could survive such promotional effort. On top of that, there is only one person who can perform public relation duty. That is the marketing director of PYK who cofounded the cooperative and work there from the beginning. She is the only person with enough marketing skill and knowledge to academically present the whole system of PYK production. The problem with that is who will fill in her position after she is retired. The worry of the workers and members can be felt from their expression. The marketing director herself admitted that it is very difficult to find someone with a good knowledge of beef and marketing. This industry needs the work force that is knowledgeable in beef. Mere marketing knowledge will not be able to contribute fully. Fields of knowledge such as marketing, management of computer system etc. depend on only a handful of people. These people are those who cofounded PYK. They are close to retirement. Some of them already resign. This happens without much transfer of knowledge to the latter generation of workers. The lack of knowledge (marketing or managing) among the latter generation workers, coupled with inconsistent marbling quality are the weak point PYK has to should address right away.

In short, consumer preference can be challenged by strong marketing practices. The strengthening of marketing strategy of PYK might help reduce consumer preference uncertainty caused by Australian beef industry. To strengthen Thai beef marketing, support from many agencies is needed. In addition, transfer of knowledge in the organisation is crucial to create the next generation knowledgeable in marketing practices.

6.1.4 Impact of transport practices on animal health and meat quality

Factor influencing this function according to Luning and Marcelis (2009) are stress factors for animal e.g. loading density, loading and unloading facilities, transport duration, mixing of animals and hygienic conditions. For PYK case animals are transported to the slaughterhouse at PYK by farmers on their own truck or a hired truck. These farmers have virtually no knowledge in animal stress reduction during transport. They only know from the advice of PYK that there should not be too many cattle in one truck, that heat should be avoided, and that loading and unloading should be done by the cattle owner to avoid scaring the beasts. The interview with PYK expert on animal science reveals that merely loading the cattle onto the truck already makes them scared because of the change of location. The attempt of the farmers will only relieve the tension. Other factors including transport duration, mixing of animals and hygienic conditions should not cause any problem in this function because of the short distance and time. The cattle are not mixed with the other kinds of animal. As with hygienic condition, PYK advised the farmers to thoroughly clean the cattle before loading. The transport of cattle in Australia is done by specialised companies with strict transport regulation and government control. Apart from this Australia gives a lot of attention to details. Even with quality assurance in the transport function, there are still more study on transporting cattle even to such details as how stressed the cattle are in each turn or break of a truck (results of this study is not yet consistent and still need further study).

So, training farmers and/or drivers on topic 'the best practices on transport of animals' is needed maintain good quality of meat.

6.1.5 Impact of slaughtering and processing practices on food safety

According to literature on food production chain (Luning and Marcelis, 2009), this function has the factors that influence final product quality in the same fashion as transport practices. This is the stress of animals and hygienic conditions. PYK reduces stress of animals by resting them at least 15 hours before slaughtering. This practice is from national law which states that animals are to rest for at least 12 hours before slaughtering. This means it is impossible to reduce costs of cattle resting. PYK provides space for each cow to rest peacefully. The cattle are only allowed water but not feed during this rest period to avoid contamination risk. Moving a beast to the slaughter area is done as quietly as possible without any beating.

PYK embraced halal slaughter method, not to improve final product quality but to make it okay for Muslim consumers. This is one advantage of PYK beef that can serve a variety of consumers with no religious limitation from Muslim who numbered 4 million in Thailand (Pew Research Center, 2009 extract from http://www.oknation.net). The slaughtering process was according to national slaughter standard of which the main hygienic concern is to avoid having carcasses touching the ground after the slaughter. The 30 years of operation take a toll on the hygiene in site and around the slaughterhouse such as in the sewer. The design of the slaughterhouse begins to seem inappropriate in the eyes of modern consumers. The example of that could be the cutting room being in the same area the slaughtering line. This might have to do with both hygienic issue and image of PYK because the customers who come to buy beef at PYK butcher can see through the glass into the slaughtering line. This makes it very important to keep clean according to the national slaughter standard. Such keeping clean does not involve how clean the workers are during the slaughter. It has been found that the workers did not wash up their bodies before entering the slaughterhouse. They only change into the clothes, boots and hairs guard prepared by PYK. In colder

months many workers did not even wash up their bodies and hairs before coming to work at PYK. Sometimes they wore the slaughter boots to the outside of the slaughterhouse and walk back inside. At only one of the many entrances into the slaughterhouse, there is a bowl of water (not even disinfectant) for the workers to put their boots in. There is no guarantee though. The water may not be swapped at all throughout a day.

In processing function, storage and packaging are the main activities. **"Temperature and humidity condition, integrity of packaging, and hygiene are the common factors that can positively or negatively affect the quality of the products"** (Luning and Marcelis, 2009). Aging is strictly controlled according to international standard to improve sensory properties. Temperature control at 2-4 degree and aging period of 14 days are the two things PYK did to make beef more tender and look fresh out of the package into the pan.

Hygienic improvement in the slaughtering and processing function both in the processes and in plant layout, coupled with worker practices are very important on food safety.

6.1.6 Cost analysis using ABC

The analysis of PYK beef production chain cost by ABC was done on slaughtering and processing function, even though there are many limitations to information accessibility. Nonetheless, we can learn a bit form the analysis, which showed some opportunities for reducing costs. Since the stage kwh used of electrical equipments were calculated, it revealed 'waste' in the process easily. The analysis found that leaving the weighing machine on 24 hours per day and everyday of the year means approximately 40 times higher electricity cost than electricity cost of on-when-weighting scale per year (see electricity cost table 13). It is not such a high figure in Thai baht, but there is no need to waste it. Even though this waste of electricity can simply be noticed from the calculation, electricity conservation can also be done in other parts of the slaughtering&processing function. According to the electrical engineer, if the slaughtering&processing system is designed properly, it helps save energy without trade-off with low quality control. This issue has to be considered because electricity is needed for aging which is the key activity that requires strict time and temperature control.

Back to the ABC results, the calculation of electricity cost per year is based on the assumption that the operating days are fully scheduled. The cost from calculation is still approximately 28% lower than the cost from PYK annual report. However, the calculation is only an estimation based on data obtained from informants and observation, misestimation could occur. Precise electricity cost calculation is more complicated. Experts and electrical measuring equipments are needed for analyses. Nonetheless, we learned of the cost difference between calculation and from PYK report. The report shows that electricity cost was 85% of total electricity cost per year in 2010. The informant gave additional information that they never measure this cost for this function. 85% is also from their estimation which is risky of misestimation as well. Is the difference of electricity cost supposed to be examined precisely? Does it matter for PYK? It might matter in terms of establishing more accurate set of cost information – the concept served by ABC, according to Bhutta and Hug (2002). It is not fair for this slaughtering function to keep ignoring this kind of noticeable issue and using 85% to allocate electricity cost to slaughtering&processing function every year, while there are other functions consuming electricity inefficiently. High variable cost raises cost per carcass. Relying on the cost information that is as accurate as possible should help make management more reliable.

Another point learned from ABC calculation is that labour cost of slaughtering&processing function is approximately 18% higher than PYK's estimation. Even though, there is a chance that mistake occurred in calculation, labour cost of this function would be higher than what PYK presented. This can simply be judged by common sense according to how PYK uses their workers. PYK uses workers from many departments and salary levels to work in the slaughtering line, which drives up the average labour costs for slaughtering and processing function. Moreover, PYK has no specification of the number or positions of the workers who already have permanent positions in other departments. These workers then work on the slaughtering line with for some financial incentive and cheap low quality carcasses. So, the analysis could be criticized that it does not require ABC. That is true if we want to know whether realised labour cost is higher. But what this study analyses further would gain more benefits from the ABC results. Does high realised labour cost affect PYK performance? PYK uses 60-70 workers per slaughtering day to slaughter around 80 head of cattle. While Australian processors uses 160-191 workers for slaughtering cattle 400 head per day at optimal year (DAFWA(Wongrusmedeau 2011), 2010).

	PYK coop		Australia processor	
	Min worker	Max worker	Min worker	Max worker
Killed cattle/day	80 head		400 head	
Number of workers	60	70	160	191
Killed/man/day	1.33	1.14	2.5	2.09

Table 36 Slaughtering capacity of PYK and Australian processor

Considering the proportion in slaughtering per man per day, labours of PYK seem to work inefficiently because one man can kill only 1.33 head per day when 60 workers were attending the slaughterhouse, for example. This is while an Australian slaughtermen can kill 2.5 head per day. This does not mean that an Australian worker is more efficient. It is more because an Australian abattoir also uses more machinery equipment than PYK or even other Thai processors. Before drawing a conclusion that labours of PYK are inefficient and/or there are too many labours in slaughtering line, some ways to prove this should be explored. After many attempts to find out what can be done to prove this presumption, the degree of operating leverage (DOL) would be proper tool to examine. The reason to use DOL is that the available data in details from both cases is lacking, particularly in the Australian case. Moreover, PYK and Australian producers are in different circumstance e.g. wage rate, cost of living, exchange rate. To be able to compare both cases from the available cost information, DOL would be suitable in terms of using cost structure information to analyse. According to Wongrusmedeau (2011), DOL is a ratio reflecting profitability of business when sale increases. This can be seen from cost structure of fixed cost and variable cost which are the factors affecting gross profit and operating profit. So, degree of operating leverage is equal to gross profit/operating profit. If DOL of business A is higher than DOL of business B, the profit of A will change in the rate that is higher than B. Cost information from table 18 was used to analyse DOL of PYK as follow;

Sales	362,230,964.62	->information PYK annual report
(less) variable cost of good sold	332,841,674.29	->total cost-fixed cost (**334,947,362.48-214,954.91-334,954.91-214,954.91-1,749,514.91**)
(less) commissions	1,022,087.07	->information PYK annual report
Gross profit	28,367,203.26	(1)
(less) overhead cost	9,272,275.55	->information PYK annual report
Operating profit	19,094,927.72	(2)
DOL	1.49	(1)/(2)

Table 37 PYK degree of operating leverage calculation

From table 37 PYK's DOL = 1.49, meaning that when sales increase in a certain amount, PYK's profit will increase 1.49 times the increased amount of sales.

DOL calculation is also done with Australian case in order to have some benchmark comparing profitability. The information from DAFWA (2011) was selected to analyse because DAFWA report is the most updated information.

Australian case (optimal year)	unit: $000	
sales	35,549.85	->total revenue
(less) variable costs		
cost of goods sold	21,000.00	->annual production*cost per kg (17500*1.2)
labour cost	13,094.00	
water and power	1,000.00	
consumable	500.00	
total variable cost	35,594.00	
gross profit	18,796.85	(1)
(less) fixed costs		
interest	3,247.00	
other	1,000.00	
insurance	500.00	
depreciation	1,730.00	
total fixed cost	6,477.00	
operating profit	12,319.85	(2)
DOL	1.526	(1)/(2)

Table 38 Australian degree of operating leverage calculation

Note: Australian cost information from DAFWA (2010)

Cost information from DAFWA (2010) came from various sources. It is used to estimate processing cost of an Australian abattoir (Appendix 13). To calculate Australian DOL, the researcher had to choose from available cost items associated with the DOL calculation by her own judgment. The discussion with a knowledgeable on accounting person helped construct the DOL calculation as table 38 shown. The calculation was useful in revealing the Australian profitability. An Australian abattoir possesses DOL of 1.526 which is higher than PYK's DOL. It means that Australian abattoir earns more profit when sales increase in the same amount as PYK.

This is the attempt to explain performance of PYK when labours are used unsystematically as mentioned above which drove realised labour cost higher than the presented labour cost in PYK report. The result shows that PYK's DOL is not such a bad figure compared to Australian abattoir. PYK's profitability is still considered good. So, we could not say that the use of labour of PYK is inefficient. Using many workers who do not have high wage translates into PYK's good general performance. This is different from the Australian case in which wage is high making it more efficient to use machinery to assist the production.

The attempt to reduce labour cost in PYK slaughtering and processing function is not necessary as long as business environment is not very dynamic or volatile. But when PYK wants to expand their market, including exporting, research on capital investment, industry management, marketing research etc. might be needed to support their decision. The examples of this could be worthiness in bring in hide puller machine to replace manual work, the improvement of production line into the one with fixed number of workers and their fixed positions/stations. These methods could help reduce cost (on the condition that the sale volume is high enough) along the slaughtering&processing function in the long run even with initial high investment. Besides the reason of efficient operation according to use more capital helping in the operation, food safety is another reason that needs to be considered. At present, consumers are more concerned about food safety. That is why Australian producers are very successful in beef industry. The less contact of hands with processed food, the higher the food safety. PYK should try to balance between cost and quality in the near future.

When the time has come, PYK would need to adjust slaughterin&processing function into a more machinery-assisted one as mentioned above. How will the workers from accounting or administration departments be? Will they constitute disguised unemployment and loss of extra money from slaughtering work? This is managerial issue which PYK has to be considering later on. Those people can be productive working to provide more services to members. For example, issuing loans is not currently done on the basis that settling feed/concentrate debt is already burdensome enough in terms of administrative management e.g. Why is offering more services to farmers so important? Not giving loan creates a vicious cycle of never ending supply insufficiency and poverty. Loaning, apart from being the major objective of a cooperative, has the potential to maintain the number of fattened cows in the system, which saves the PYK from not having enough cattle for slaughter and the market from beef supply inconsistency. This is because whenever a particular farmer is financially tight and can get loans from the coop, he/she will have no need to sell cattle to middlemen before the slaughter time. The farmer who breached the coop regulations in this way will automatically be relieved off their membership. The middlemen will then sell the purchased cattle back to other farmers who want cattle for further fattening, to increase the price. Those farmers then have more costs. If they fail to meet the fattening standard, the price of the cattle will be decreased, driving the farmers into even deeper indebtedness and poverty.

6.2 Recommendations for PYK

From the analysis, recommendations can be drawn as follow;

1. Breeds improvement: Breeds is the weak point of PYK, with the low marling main breed having to be crossbred with local breeds for resistance purposes. The time required for fattening is then longer, which mean higher feed costs.
2. Calves production: Producing calves for fattening can greatly reduce costs because backgrounding cattle purchased from outside for further fattening are normally expensively priced. Help is needed from the governmental sector with artificial insemination and strict calves control measures, the latter being for preventing farmers from selling calves before the time for slaughter. Such measures

might even be applied countrywide with a beef production chain. Grouping initiative is also needed among upstream, middle stream and downstream to build cooperation, trust, relationship, and contract that can make the whole chain more efficient.

3. Feed development: The development of feed both in quantity and quality is another way to reduce costs. This can be done by grass farming, corn farming, improving harvesting by-product to be cattle feed. There should however be studies and research to make sure that such by-products have the right quality as feed before actually using them.

4. Transport: Transport training is what PYK coop can do to increase both quality and efficient use of resources. Training farmers about ways to correctly transport live cattle can help with beef quality. Apart from this, the truck PYK coop uses for transporting feed to the members' farms, instead of coming back to PYK coop unloaded and empty, can be used for transporting cattle. Apart from being maintain meat quality, it saves the farmers' costs by charging the transport fee lower than trucks farmers normally hire.

5. On-farm education: On-farm education is what Thailand can learn from Australia. This is continuous education and training given to farmers on efficient production practices, market access and industry issues etc.. If Thai beef producers in beef production chain receive such education and training, their knowledge and skills will continuously develop which raises the capability and efficiency of the whole chain.

6. Strengthen marketing strategy: Learning from Australia, cooperating with relevant agencies for doing marketing e.g. educating consumers, promoting beef quality in terms of nutritive value and deliciousness etc.

7. Transfer of knowledge: PYK employees need to be trained to transfer knowledge to the next generation of workers. Marketing training is also necessary and needs to be carried out without further ado for, at present, no one has yet to be able to do what the present marketing director does. Also, areas that workers should be trained on include management, accounting, computer and Internet. All these could even save some costs such as communication or the use of paper. Training can either be in form of in-house training, training with outside training agency or granting scholarship to the workers.

8. Others: Considering PYK profitability generated from its cost structure representing by DOL, labour intensive in the slaughtering and processing is still fine in current circumstance. Whenever PYK wants to expand its market share, feasibility research on capital investment might be needed. Labour intensive work in slaughtering and processing function might not be appropriate both in terms of costs and food safety. Machinery should be brought in to assist where necessary, such as hide puller machine. It also helps with food safety since carcasses come less into human contact. This helps build customers' confidence and PYK's marketing opportunities. This point also includes upping the slaughterhouse's standard to the international one so that there could be more acceptance from foreign markets.

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Appendix 1 Statistics of Frozen Beef for Import by Origination

STATISTICS OF FROZEN BEEF FOR IMPORT BY ORIGINATION

ประเทศนำเข้า Import Country		ปี 2547 (2004)		ปี 2548 (2005)		ปี 2549 (2006)		ปี 2550 (2007)		ปี 2551 (2008)	
		ก.ก. Kgs.	บาท Baht	ก.ก. Kgs.	บาท Baht	ก.ก. Kgs.	บาท Baht	ก.ก. Kgs.	บาท Baht	ก.ก. Kgs.	บาท Baht
ยอดรวม	Total	1,711,437	158,928,925	1,581,115	170,803,926	1,842,528	225,650,487	1,921,457	310,907,793	2,125,059	394,595,795
สหรัฐอเมริกา	U.S.A.	2,452	378,809	-	-	56,682	9,020,687	28,441	10,851,947	36,817	13,117,141
ออสเตรเลีย	Australia	1,233,972	108,863,595	1,133,518	116,660,598	1,190,575	142,460,022	1,392,387	217,539,830	1,479,186	281,719,591
เนเธอร์แลนด์	Netherlands	1,414	198,023	-	-	-	-	-	-	-	-
นิวซีแลนด์	New Zealand	437,695	45,255,757	313,671	37,850,901	537,635	63,860,557	424,820	70,368,044	580,101	95,396,079
แคนาดา	Canada	-	-	-	-	2,615	1,147,456	-	-	-	-
อาร์เจนตินา	Argentina	23,231	2,910,153	70,423	8,950,039	55,021	9,161,764	72,719	11,681,719	24,121	3,651,878
ฮ่องกง	Hongkong	-	-	-	-	-	-	1,729	334,955	-	-
อิตาลี	Italy	-	-	10,124	1,767,189	-	-	-	-	-	-
บราซิล	Brazil	-	-	19,260	2,498,243	-	-	-	-	-	-
เยอรมนี	Germany	-	-	31,184	2,556,243	-	-	-	-	-	-
ปารากวัย	Paraquay	-	-	2,617	404,309	-	-	-	-	-	-
ไต้หวัน	Taiwan Province of China	-	-	-	-	-	-	-	-	4,834	711,106
อื่น ๆ	Other Countries	12,673	1,322,588	318	116,404	-	-	1,361	131,298	-	-

Source: Department of Livestock development of Thailand (www.dld.go.th)

Appendix 2 Beef and veal productions

Beef and Veal Selected Countries

1,000 Metric Tons (Carcass Weight Equivalent)

	2007	2008	2009	2010	2011 Oct	2011 Apr
Production						
Brazil	9,303	9,024	8,935	9,115	9,410	9,365
EU-27	8,188	8,090	7,913	8,085	7,850	8,000
China	6,134	6,132	5,764	5,600	5,450	5,500
India	2,413	2,552	2,514	2,830	2,920	2,960
Argentina	3,300	3,150	3,380	2,600	2,550	2,500
Australia	2,172	2,159	2,129	2,087	2,050	2,140
Mexico	1,600	1,667	1,700	1,751	1,775	1,775
Pakistan	1,344	1,388	1,457	1,486	1,450	1,450
Russia	1,430	1,490	1,460	1,435	1,270	1,400
Canada	1,278	1,289	1,252	1,272	1,275	1,275
Others	9,359	9,496	8,961	9,014	9,107	9,047
Total Foreign	46,521	46,437	45,465	45,275	45,107	45,412
United States	12,097	12,163	11,891	12,048	11,556	11,946
Total	58,618	58,600	57,356	57,323	56,663	57,358

Source: Foreign agricultural service, USDA (2011)

Appendix 3 Marketing Director of PYK's interview

1. How do you control the quality of PYK beef in terms of food safety and eating quality before reaching the consumers?

As for Pone Yang Kam orThai-French Beef, quality arises from many factors:

- Production quality starts from the breed used, selecting the animal for fattening, farm management, concentrate/roughageused, disease prevention, transport to a slaughterhouse, standard and controlled slaughtering.
- The quality of PYK management system includes calves and cattle registration, artificial insemination, disease prevention by veterinarians, contamination free production of concentrate, fattened cattle evaluation, traceability system for each piece of beef sold and pricing according to warm carcasses weight and level of marbling.
- The quality of beef that has been hygienically cut and aged according to international standard with random inspection for germs and contamination in the beef.

Beef cattle and Pone Yang Kam beef cattle production

PYK's production goal

1. Producing PYK premium beef that is on par in quality, hygiene and safety with imported beef.
2. Producing Natural Beef that through a system that is fully controlled and inspected. This system starts from the calves' birth, farming, fattening until deriving the premium beef cut that is traceable throughout the production system.
3. Producing beef that is free from Hormones or Growth promotants& Antibiotics.
4. Producing carcasses from a slaughterhouse that attained a standard, under strict supervision of a qualified veterinarian, hygienic management, and appropriate environment.
5. Slaughtering management is under the international standard
6. Scoring quality of beef (marbling score) under the standard method of Beef Standard of Thailand.

Feed and feeding

The cooperatives' members are strongly suggested to establish their own pasture. Therefore, the grass e.g. Panimcum spp. can frequently be "cut and carried" for the animal. The members are provided the concentrate which is well specified the formulation, for fattening animal. The main feed ingredients are cassava chip, rice bran, oil palm kernel cake, cane molasses, urea, salt, oyster shell powder and lime stone powder.

Concentrate specification of PYK's Cooperatives

1. No genetically modified raw materials can be used in the formulation
2. Hormone(s) and growth promoter(s) are prohibited in the formulation

3. Raw materials, derived from bovine animals e.g. blood meal, meat and bone meal and milk powder are inhibited to be used in the formulation.
4. Imported raw materials are prohibited to be used in the formulation
5. No artificial vitamin(s) or trace mineral(s) is used in the formulation.

Cane molasses supplementation was suggested in feeding the animal. This is expected to improve feed palatability and energy supply to the animal. By using this strategy, beef quality e.g. marbling score, tenderness and juiciness is expected.

Animal health management

- When health problems of the animal are observed, the owners (cooperatives' members) are not allowed to treat the animal by themselves. They needed to immediately inform the cooperatives. All medical treatments will be only done by cooperatives' veterinarian.
- Vaccination and deworming for registered calves are frequently taken care of by PYK veterinarian.
- The animals will be castrated, dewormed and vaccinated for hemorrhagic septicemia and foot and mouth disease along with other regular treatments when they are registered for fattening.

Finished animals

When the steers are weighed to 650 kg, the members will inform PYK through the farmers' representative that they would sell them. The benefit to the farmers is calculated on the basis of animal's carcass weight and quality (marbling score). Moreover, the standard methods proposed by the cooperatives e.g. stall cleanliness, fresh grass utilization and the use of the farmers' own farm-produced calves are the criteria for premium payment.

Slaughtering and trimming

The finished steers will be slaughtered in standardized cooperatives' slaughterhouse with standardized procedure. Carcasses will be chilled for 7 day before conducting the inspection and judgment of its quality (marbling score).

Traceability

Traceability of the products is very important issue of major concerns by the cooperatives. The information will be recorded including individual animal background (pedigree), rearing and feeding methods, health management, slaughtering management and product's origin. The main objectives of traceability are to;

1. Inspect, control and improve the quality of the products.
2. Distribute the benefit to the member according to the quality of their operation.

2. Limitations of current traceability

Birth certifications of the animal are often not recorded.

3. What are the main impacts on PYK beef if imported Australian beef is in competitive price range? Why?

The acceptability of PYK beef by Thai's consumers is getting better and better even though the selling price is much higher than Australian beef.

Appendix 4 Beef production expert interview

Beef Cattle Extension Expert: Mr. Sawang Angkuro
Bureau of Livestock Development and Technology Transfer
Department of Livestock Development

General information

According to the department of livestock' 2011 statistics, 1.03 million farmers own 6.5 million beef cattle. The area where beef cattle are most concentrated is the Northeast, with 3.3 cows (50.2%). Then Central Thailand has 1.3 million (18.4%), Northern Thailand 1.2 million (18.4%) and 0.7 million for Southern Thailand (11.2%). Using 2007 when there were 1.37 farmers with 8.8 million beef cattle as a baseline, 6.8% of farmers quit beef cattle business yearly, which causes 9.5 annual declines of beef cattle. Causes of such decline are as follows:

1. Low price of beef: this is because price speculation of fancy cattle especially Hindu-Brazil which is known for aesthetic value. The main focus is not on beef quality .

2. Lack of space: most plains in Thailand have been transformed into plantations for profitable crops such as rice, potatoes, sugar cane, corn, oil palm or rubber trees.

There are two breed of beef cattle the Department of livestock encourages farmers to raise:

1. Tropical beef cattle (Bos indicus) consisting of:

1) Local breed and Indigenous: there are approximately 4.65 of these, or 70.6% of all the cows in Thailand.

2) Brahman breed and Brahman crossbred: approximately 1.78 million o these, or 27.1% of all the cows in Thailand.

2. European beef cattle)*Bos taurus* (**which are** Charolais breed, Tak breed 62.5% + Brahman 37.5% (2), Kampang sean breed) Charolais 50% + local 25% + brahman 25% (Kabinburi breed) Brahman 50% + Simmental 50% (and other breeds. These European breed and other breeds total in 0.15 million, or 2.3% of all the cows.

2. There are two systems of cow raising;

1. Business oriented beef cattle farming (premium beef) involves scientifically correct farming with high cost and systematic production plan for a return high enough to cover high cost of investment. Such investment includes construction of housing, pasture, feed mill and health and feed management. According to 2011 statistics of the Department of livestock, there were 9,092farmers of this kind or 1.0% of Thai beef cattle farming, which includes 103,332 cows or 1.5% of Thai cows in beef cattle farming.

2. Cow-calve production involves beef cattle farming where cows are kept to graze in the open whether farmed or naturally grown grass. This kind of farming could be done on the roadside, open public space, jungle area or rice field after a harvest. Most of Thai beef cattle farming is done in this fashion with 1.26 million farmers and 6.48 million cows. In terms of percentage, it is 99.0 percent of Thai beef cattle farmers and 98.5 percent of cows in Thai beef cattle farming.

Problems of beef cattle farming in Thailand

1. Most beef farmers are small scale, older, less educated and slower in accepting and learning new technology and beef cattle farming technique.

2. Being small scale, which indicates the lack of grouping, makes it difficult for the farmers to engage in quality and production control and networking/linking production and marketing. All these leave the farmers susceptible to price volatility.

3. The spread of foot and mouth disease in Thailand taints the credit of exported Thai beef.

4. During 2006 – 2009, live cows in Thailand were heavily underpriced by middlemen, leading to many farmers deserting beef cattle farming and thus to a decline of the number of beef cattle.

5. The lack of high quality breeder is the continuation of underpriced cattle above. A large number of cattle sold out by quitting farmers, which are high quality breeder, were either sent directly to slaughter houses or exported.

6. Framing space is also lacking. This is because open fields for grazing cattle were increasingly used as plantations of more profitable crops such as rice, potatoes, sugar cane, corn, oil palm and rubber trees.

7. Expensive feed leading beef cattle farmers to abolish beef cattle farming

8. Many slaughter houses in Thailand are sub-standard that assure five-star hotels no food safety of Thai beef, leaving them no choice but to import beef.

1. How do you think the government can help with the chain of fattening production?

On behalf of the government, the Department of Livestock help decrease the cost of โคขุน production in the following ways:

1. Breed improvement: the cows Thai Farmers normally rear for fattening are normally the result of cross breeding with European breed such as Charolais, Tak, Kamphaengsan, Kabinburi, Limousin, Simmental. This cross breeding produces fast growing cows that are large in frame and has high marbling which leads to tenderness. If European blood is too high in the mixture however, the cow will be less or non resistant to tick fever and heat. It will also feed less, causing slower growth. So the Department of Livestock offers the service of breed improvement through artificial insemination between 100% Charolais sperm and a Brahman cow or Brahman-local cow. Tak and Kamphaengsan sperm is also used for artificially inseminating with cows that have higher than 50% European blood. This is to control the percentage of breed mixture to be not more than 75% European, or preferably between 50 – 62.5%.

2. Training: training is offered to farmers or beef cattle cooperatives in the area of feed and feeding practice, nutrients needed by fattened cows, nutrients contained in raw materials for feed, feed mixing/producing from local agricultural by product such as palm, corn trees, fresh corn stover or pineapple skin. This last training sometimes involves insufficient materials in the area, which requires some purchase of materials from elsewhere, leading to inconsistency in material quality and consequently feed quality.

3. Epidemic prevention: in fattening cattle, epidemic prevention is important because if the cattle become sick during the fattening period, their growth will be hindered, which leads to high cost of production. The Department of Livestock then encourage vaccination for foot and mouth disease.

4. Farming system: in the past years, there were problems regarding farming of beef cattle. These include the scarcity of beef cattle, farmers quitting beef cattle farming (stemming from the use of land for more profitable plants such as rubber trees, oil palm, rice, corn, or potatoes). This is not to mention low and volatile price of beef, which leads farmers to sell off their cattle. The Department of Livestock then supports the founding of upstream beef cattle farming group (consisting of farmers who rear cattle for their calves), midstream farming (cow-calve farming produce backgrounding cattle till the weight is 300-350 kg) and upstream farming (fattening cattle farming). Contract farming is also set up to create links between production and marketing. Setting up of downstream to upstream apart from solving the problem of not having cows for fattening or having to buy cows from afar for fattening, builds connection between production system and marketing system. This is because upstream farmers would normally take 1.5 -2 years in rearing the cattle into inseminating and giving calves that ween and weight 150 – 180 kilograms, with the profit of 1,500 – 2,000 baht per cow. The midstream take abouty a year in farming/rearing with the profit of 3,000-5,000baht per cow. Such scenario prompts upstream farmers to quit farming, which reduces the number of cattle.

5. Marketing: Most farmers who do beef and fattened cattle farming are small scale and lack grouping. This makes it impossible for them to have control over production and marketing plan. Out of the currently existing 64 beef cattle cooperatives, there are only four, namely, PYK, Nongsoong etc., that are capable of having control over their production and marketing plan. The other 60 cooperatives are not strong/consolidated enough to engage in production and marketing of beef cattle.

There is no problem regarding premium beef market because there is annual demand for premium beef as high as from 30,000-40,000 fattened cows, while premium beef cooperatives are only capable of supplying as much beef as from 15,000 cows. This is not to mention the demand Vietnamese and Malaysian market have for Thai premium beef, which is as high as from200,000-300,000cows per year. Beef price in those markets are actually higher than in Thai market. The government then has a policy to expand premium beef production mainly through artificial insemination. This has been planned to increase as much as 100,000fattened cows, totaling in the production of 30,000 cows per year – for substitution of beef import into Thailand and for exporting.

2. FTA pushes the tariff on imported Australian beef down until it reaches 0% in 2020. How do you think this will affect Thai premium beef such PYK?

FTA will make Australian beef significantly cheaper. Many government agencies show worries that Thai beef will lose a competitive edge to Australian beef, because the real cost of Australian beef is cheaper than that of Thai beef. PYK beef, even with its current price which is higher than Australian beef price, still sells well because Thai consumers prefer fresh beef that gives out better taste and smell. Moreover, imported Australian beef is grass fed which gives lower quality beef than Thai grain fed premium beef.

Most imported beef from Australia is of standard and utility grade. The premium grade one has its main destination in Japan where it has better price competitiveness. The effects of FTA on this area of competition are then not clearly visible. Australian beef however is going to assert more

of its roles in Thai market because there is not enough production of beef. Whether Thai farmers can produce/supply more beef depends on market mechanism. Even PYK beef is not yet able to reach high end market, specifically five-star hotels and restaurants, because these venues, which cater to high end customers, still have doubt in the food safety of Thai beef. This is because such beef came from slaughter houses that do not meet an international standard and is not consistent in quality of each lot, leading to the use of imported beef.

3. Interviews with farmers revealed that their concerns are the scarcity of upstream cows that will produce calves for further fattening. How do you think the government can help with this problem?

The problems that have always been occurring is the failure of produced claves to enter the high quality beef cattle farming system. The Department of Livestock deals with this issue by setting up upstream, midstream and downstream group, believing that the 64 cooperatives can be a model of networking. This is to be done by having 4 successful cooperatives engage in downstream production, while the other 60 cooperatives work upstream with the help of the Department of Livestock in artificial insemination. The upstream and downstream cooperatives then make a deal of how much the sustainable price per kilogram for the upstream cooperatives would be. The other four downstream cooperatives might be hesitant in making any deal for the fear that calves would be sold to middlemen, and thus jeopardize the price. Such problem could be dealt with by having the upstream signing contract with the downstream that the calves would only be sold to them. If the contract is breached by the upstream, they will not receive further support from the government. PYK itself has measures in reducing the loss of claves to middlemen by increasing the price of 7-10 baht per kilogram for the claves born in the' farmers', in an attempt to encourage customers to sell upstream claves to them, is willing to pay 1,000 baht for each calve. The Department of Livestock once proposed this line of policy where each upstream calf is given 1,000 baht for government approval. The proposal was rejected however for it might constitute price support that affects other agricultural product and instigates injustice in a society.

Networking different parts of production stream is done by segmenting farmers into upstream, midstream and downstream group. The government would support farmers in these groups as long as they follow the contract. If however the contract is breached, the breacher farmers will be relieved off such supported group and replaced by other farmers. This project is already piloted in some provinces in the Northeast of Thailand. Prior to the contract signing, qualities of beef cattle would be specified by both buyers and sellers. The Department of Livestock would figure out what the farmers who are also group members lack, be they, knowledge, vaccine or tag. Such lack is to be compensated. With the above in place, the problem of insufficient cows should be solved. Plus, export to foreign markets of beef can be considered, which also helps reduce unnecessary domestic competition between groups of farmers.

Appendix 5 Meat sciences expert's interview

Assistant Prof. Dr. Jutharat Setthakul, King Mongkut's Institute of Technology Ladkrabang

1. What kind of demand in the demand list do you think Thai consumers regard as important? Please give the degree of importance of a 1-9 scale.

ranking	Quality attributes
4	Colour
6	Texture
3	Leaness
1	Tenderness
8	Smell
9	Flavour
7	Juiciness
2	Marbling
5	Contamination

2. In each ofthe above quality attributes, what do Thai consumers want?

Color: Red cherry color may not be important to Thai consumers. This is because they are familiar with fresh beef with dark-red color as sold in wetmarket (without refrigeration). Premium beef is normally lighter in color than normal beef.

Texture: Most Thai people prefer beef with fine fiber compared with that with coarse fiber.

Leanness: Thai consumers do not like beef wrapped around with fat. They would rather opt for marbled beef. However, since most Thai people are not educated in beef quality and beef consumption, they do not realize that marbling comes with an outer layer of fat. So their consumption is based on what a particular brand has advertised. That they like marbling is not for the marble (fat) *per se*. Rather, it is the tenderness caused by marbling that they aim for.

Tenderness: Thai consumers prefer tenderer beef.

Smell and flavor: Good smell and flavor are what Thai consumers like. Marbled beef usually has better flavor than the beef without marbling because fatty acid creates different odor. Thai premium beef has distinguished odor and flavor. This is because the animals were reared based mainly on molasses which was fed to the cows for six months, which builds a significant amount of fat in the beef.

Juiciness: Thai consumers prefer juicy beef that would not lose too much water through cooking.

Contamination: Thai consumers do not want their beef to be contaminated. Pone Yang Kam(**PYK**) premium beef is trusted by Thai consumers mainly because of the brand itself.

2. Which do factors contribute to quality attributes?

Color: Factors affecting the color of the beef are

1) Animal Breed – Pone Yang Kam beef originates from Charolaise of which the beef color isred cherry andSimmental, dual purposes cattle, of which the beef is dark-red.

2) Slaughtering age – steers lower than three years of age yield beef with pleasant color. As cows get older their beef becomes darker in color. Pone Yang Kam beef comes from steers falling between 3.5 – 4 years old, which can be said to be having passed the optimum age for premium quality beef (quality grade beef come from cows aged around 2.5 years). Pone Yang Kamsteers cannot be of lower age than this before itsslaughtering because they are not of 100% European blood. They are 50% or more Charolaise crossed with Thai indigenous or Brahman or Simmental cattlefor another50%. This cross breeding creates toughbeef with less marbling. This breed however is necessary because of its resistance to heat and disease in tropical climate. The Charolaise itself is not shown for a high amount of marbling. This way, to attain a sizable amount of marbling, the raising time must be increased.Department of Livestock Development, Ministry of Agriculture and Cooperativesis already working on creating the breed that is resistant to heat and well-marbled at younger age. Pone Yang Kam beef that is successful is because the cows used is 50%or more of European blood. But this 50% rate is not achieved all the time. So,longer fatteningperiod is needed, which is also a weakness of Pone Yang Kam beef when compared to Australian beef, which even with less marbling is more accepted.

3) Feed - steers that are fed majorly with grass yield darker color beef, while those fed majorly with concentrate yields beef with more beautiful color. Grass in Thailand is lower in quality than that in Australia. In addition, Pone Yang Kam steers are fed majorly on rice straw. Grass farming has been shown in a piece of research to be unworthy of the investment. On top of the fact that cows need a large amount of water, grass farming also requires a lot of water. So, the use of hay as cheap roughage feed for cows is a way to add extra value to what is left of rice growing. Together with hay, molasses is also used.Thai farming still has the edge over other countries when it comes to the cost of feed, which allows it to compete against them.

4) Maintenance and aging - the color of the beef during the display dependson the management of parts of cows at the times of aging. Hygienic management of beef that is aged between 14 – 21 days allows the beef color to bloom. Pone Yang Kam beef can be managed in this way.

Texture:

1) Age: older animals have more coarse meat

2) Types of muscle: for example, sirloin has fine texture while meat from shoulder has coarse fiber.

Leanness:

1) Feed mixture: Feed that contains urea, which is a good source of Nitrogen, helps build protein in the muscle.

2) Species: the amount of muscle also depends on the species of the cows.

Tenderness:

1) Species: a good breed like Angus has a high level of marbling. Seven days of aging already produces tender beef. Brahman beef on the other hand is still not soft even after 21 days of aging. Pone Yang Kam beef is aged for seven days before primary cutting. The cuts are kept until 14 days before being sold to retailers. Research has pointed out that after even 14 days of more of aging does not make PYKbeef significantly tenderer.

2) Age

3) Aging: the longer the aging, the more tender the beef. But this also comes with more costs and risks. 4)The type of muscle involved in a cut. Shank contains a lot of tendon, for example.

Smell and flavor:

1) Feed: cows that feed only on grass have strong smell and flavorin a negative way.Those that only feed on concentratehave strong smell and flavor in a positiveway

2) Age: older cows have beef with strongsmell/flavour in a negative way 3) Marbling:marbled cuts have positive strong smell/flavor.

Juiciness:

1) Age: younger cow beef contains a lot of water, which makes it juicy. Cooking raw young beef can make it toughfor a lot of water is forced out of the beef in such process.

2) Marbling: fat in beef helps retain water during the cooking process, making the beef juicy.

Marbling:

1) Species

2) Feed

3) Age

Contamination:

1) Farming practice: good farming practices limits a contamination in beef in terms of hormone, antibiotic or pesticide

2) Slaughter process: the hygiene of a slaughter house.

3. What is the potential of Thai beef for quality development?

Higher growth rate and carcass quality attribute to higher percentage of European cattle blood. This however has a tradeoff of the cows having less resistance to Thai climate. Meat quality of Pone Yang Kam beef is comparable to (or better than) imported meat however production cost might be higher because it needs longer fattening period to attain such quality. As a result, production cost including feed and labor cost is also increased. Improvement of animal productivity might result in not only reducing feed cost but also shortening fattening period. In higher competing market in the near future, PYK cooperatives might need out-sources to do marketing meanwhile the cooperatives might only be a supplier to improve performance of its operation.

4. What are the limitations of Thai beef quality development?

Breed: crossing with indigenous cattle for improving disease resistance results in longer fattening period to attain high marbling meat.

Feed: low quality of roughages

Management: reduction in numbers of backgrounder due to the exportation of breeder to neighbor countrieswill affect inputs of cooperatives. Culled dairy cows might be used for producing high quality beef. Higher operational cost throughout the production chain might be improved to increase efficiency of cooperatives' operation.

5. Compare with Australian beef, do you think Thai beef is higher or lower in quality in terms of food safety and sensory quality. Please explain.

In terms of beef quality, Pone Yang Kam beef is likely to be comparable to Australian beef. Imported Australian beef in the form of frozen meat results in darker meat. In addition, moisture loss is a major drawback during defrosted procedure. Therefore, target consumers of PYK might not be impacted by imported meat. However, imported Australian beef, with lower marbling, can affect lower quality meat market e.g., beef from Brahman or Thai indigenous cattle. As well, meat from under-standard slaughterhouse might be much affectedbecause the consumers pay more confident for imported beef. Furthermore, to produce high quality meat, production cost of Australian meat might be much higher than that of PYK because of its higher feed and labor costs.

Appendix 6 Customer interview (supermarket)

- **Deputy manager of Villa Market**

1. Please rate the following statements about the quality of PYK beef by putting a √ in the space Provided

Perceived characteristics	1 Extreamly disagree	2 Disagree	3 Neutral	4 Agree	5 Extramly agree
1. PYK beef has tenderness.					√
2. PYK beef has marbling.					√
3. PYK beef has leanness.				√	
4. PYK beef has dark red colour.		√			
5. PYK beef is free from contamination.					√
6. PYK beef has fine texture.					√
7. PYK beef has juiciness.				√	
8. PYK beef has good smell and flavor.					√

2. How do you do quality control of PYK beef in terms of safety and eating quality before reaching the end consumers?

Temperature control is engaged at all times. The beef unloaded from a transport vehicle will immediately be put to a refrigerating unit. Each beef order is only sufficient for a week's supply.

3. What are some of the limitations in maintaining such qualities?

None

4. Do you think that more customers will turn to Australian beef if it becomes cheaper or as cheap as PYK beef? Why or why not?

Those who are already consuming PYK beef will not turn to Australian one even when it is cheaper. Australian beef has its own group of consumers who prefer imported beef.

5. Do you know of the specific quality of Thai premium beef? If yes, could you rate how much Thai premium beef posses these characteristics.

Perceived characteristics	1 Extreamly disagree	2 Disagree	3 Neutral	4 Agree	5 Extramly agree
1. Australian beef has tenderness.				√	
2. Australian beef has marbling.				√	
3. Australian beef has leanness.				√	
4. Australian beef has dark red colour.				√	
5. Australian beef is free from contamination.				√	
6. Australian beef has fine texture.			√		
7. Australian beef has juiciness.				√	
8. Australian beef has good smell and flavor.				√	

- **Customer interview (food store)**

  The owner of a food store

1. Please rate the following statements about the quality of PYK beef by putting a √ in the space provided.

percieved characteristics	1 Extreamly disagree	2 Disagree	3 Neutral	4 Agree	5 Extramly agree
1. PYK beef has tenderness.				√	
2. PYK beef has marbling.				√	
3. PYK beef has leanness.		√			
4. PYK beef has dark red colour.		√			
5. PYK beef is free from contamination.					√
6. PYK beef has fine texture.					√
7. PYK beef has juiciness.				√	
8. PYK beef has good smell and flavor.				√	

2. How do you do quality control of PYK beef in terms of safety and eating quality before reaching the end consumers?

The temperature of the beef is kept at -20 degree Celsius at all times. When the beef is to be used, it will be defrosted in a microwave oven. This defrosted beef will not be re-refridgerated because that lowers the quality of the beef. Attempts are made that defrosted beef be used within the day of defrosting. The purchase of beef is done in the quantity that would last a week's supply. The beef that is kept for longer than that becomes dry due to moisture loss.

3. What are some of the limitations in maintaining such qualities?

None

4. Do you think that more customers will turn to Australian beef if it becomes cheaper or as cheap as PYK beef? Why or why not?

It is impossible for Australian beef to be cheaper. Personally, I do not think Australian beef can be cheaper. The quality of PYK beef is not comparable to Australian or Japanese beef either.

5. Do you know of the specific quality of Australian beef? If yes, could you rate how much Australian beef posses these characteristics.

Perceived characteristics	1 Extreamly disagree	2 Disagree	3 Neutral	4 Agree	5 Extramly agree
1. Australian beef has tenderness.				√	
2. Australian beef has marbling.					√
3. Australian beef has leanness.		√			
4. Australian beef has dark red colour.		√			
5. Australian beef is free from contamination.					√
6. Australian beef has fine texture.				√	
7. Australian beef has juiciness.				√	
8. Australian beef has good smell and flavor.				√	

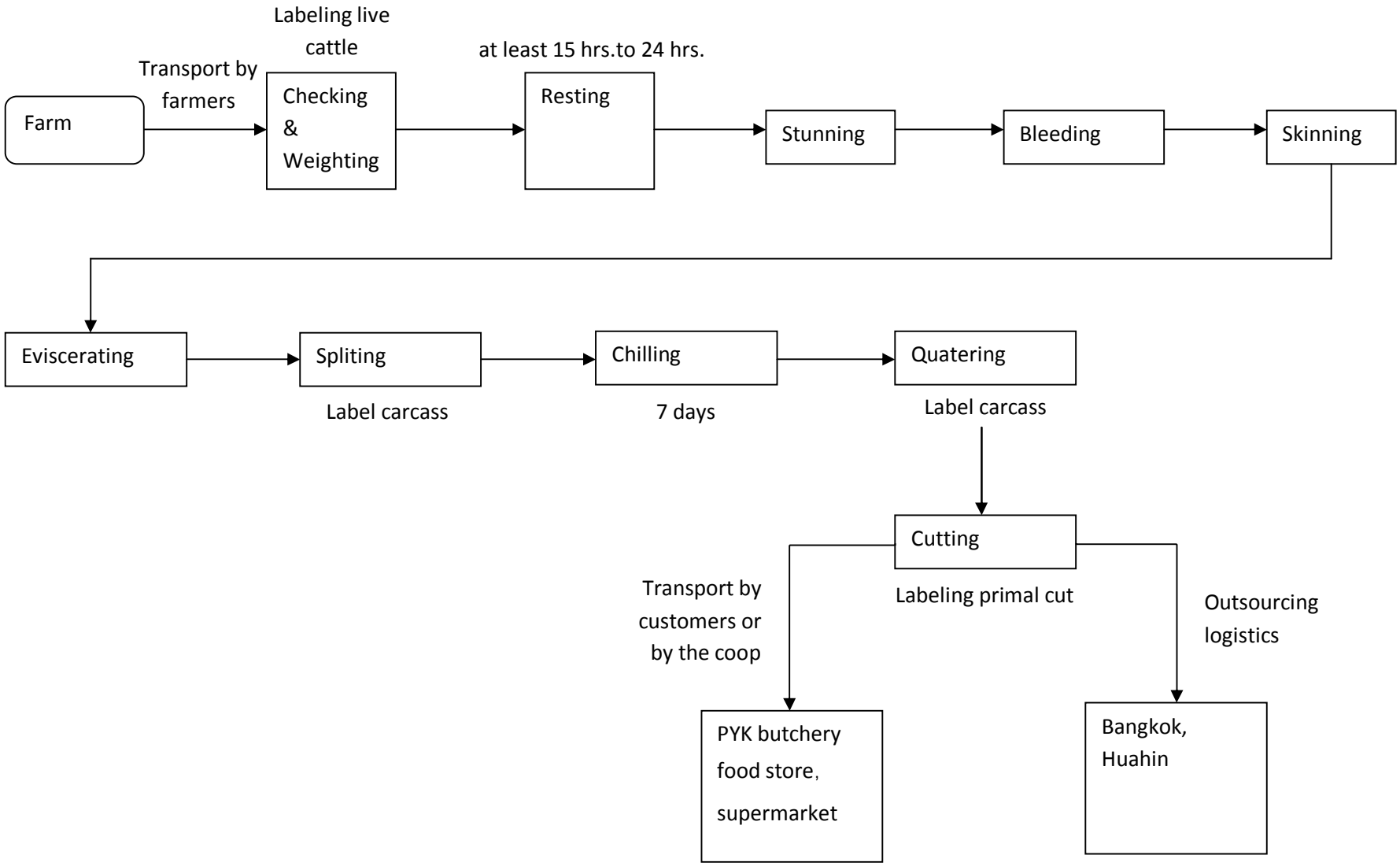
Appendix 7 Beef quality from PYK's view

PYK animal husbandry interview

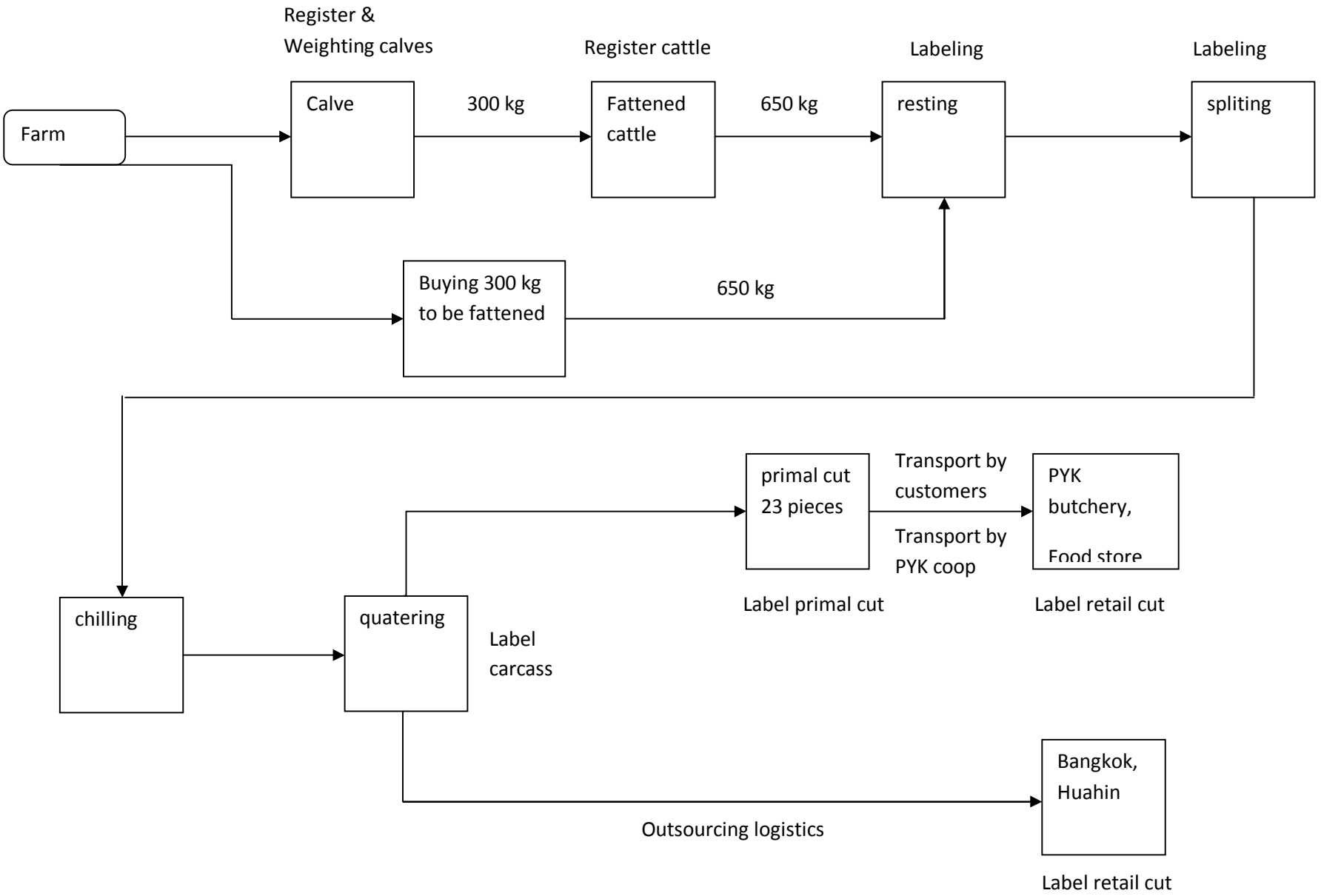
Please rate the following statements about the quality of PYK beef by putting a √ in the space provided.

percieved characteristics	1 Extreamly disagree	2 Disagree	3 Neutral	4 Agree	5 Extramly agree
1. PYK beef has tenderness.				√	
2. PYK beef has marbling.				√	
3. PYK beef has leanness.		√			
4. PYK beef has dark red colour.			√		
5. PYK beef is free from contamination.				√	
6. PYK beef has fine texture.				√	
7. PYK beef has juiciness.				√	
8. PYK beef has good smell and flavor.					√

Appendix 8 The production process map produced by the researcher through field study and observation



Appendix 9 The production process map created by the marketing director of the cooperatives



Appendix 10 Salary and wage calculation used to allocate labour costs

	salary (baht per month)			
	cutting division	admin division	accounting division	service division
	7650	12710	7650	7150
	7830	16980	5490	5150
	6840	12430	5400	6550
	6150	9000	5400	6280
	6550	15060	5310	6410
	6030	7830	5150	5400
	6410	12710		5690
	5490	9430		4890
	5400	9430		
	5590	9650		
	5400	9000		
	5690	8790		
	5590	8200		
	5490	8590		
	5490	6690		
	5490	8200		
	4890	7480		
	5490	5910		
	5400	6150		
	5230	7310		
	4890	5910		
	4890			
avg salary	5,812.73	9,402.86	5,733.33	5,940.00
avg salary per hr	27.95	45.21	27.56	28.56

# of employees	22	21	6	8
# of daily workers	13	0	1	7
daily wage per day	157			
daily wage per hr	19.63			

avg salary and wage per hr for different major processes

1 pre-slaughtering: use only labours from service division

= ((avg salary per hr*# employees)+(avg daily wage per hr*#daily workers))/(#employees+#daily workers)

= ((28.56*8)+(19.63*7))/(8+7)

24.39 baht per hr

2 slaughtering & processing: use 3 divisions (cutting, admin, accounting)

=((27.95*22)+(19.63*13)+(45.21*21)+(27.56*6)+(19.63*1))/(22+13+21+6+1)

31.81 baht per hr

3 aging use the same rate as slaughtering & processing

31.81 baht per hr

4 cutting use only labours from cutting division

= ((27.95*22)+(19.63*13))/(22+13)

24.86 baht per hr

Appendix 11 calculating total cost of fattening cattle per head

cost items	calculation		cash (bath per head)	non-cash (bath per head)	total (bath per head)
concentrate	= amount of concentrate per head per day*(concentrate price per bag/amount of concentrate per bag)*12months*30days	= 5.4*(238/30)*12*30	15,422.40		15,422.40
roughage	= roughage cost per month*12months	= 363*12	4,356.00		4,356.00
mineral supplements	=mineral cost per month*12months	= 189*12	2,268.00		2,268.00
labour cost	=(minimum wage rate per day/8hr)*2labour*12months*30days	= (157/8)*2*12*30		14,130.00	14,130.00
althelmintics, vaccination	= vaccination cost per year	= 528	528.00		528.00
artificial insemination					
water and electricity	= water&electricity cost per month*12month	= 438*12	5,256.00		5,256.00
medical cares	= medical care cost per year	= 374	374.00		374.00
opportunity cost (0.75%)	= variable costs*0.75%interest rate	= 28,204.40*0.75%		211.53	211.53
vairable costs			**28,204.40**	**14,341.53**	**42,545.93**
depreciation of housing				700.00	700.00
backgrounding cattle*	=beef cattle purchase per head from 3 sources/3sources	= (17,185+21,035+22,933)/3	20,384.33		20,384.33
fixed costs			**20,384.33**	**700.00**	**21,084.33**
total costs			**48,588.73**	**15,041.53**	**63,630.26**

Appendix 12 average exchange rate in Thai baht

	2008	2009
Jan	26.7124	23.5535
Feb	28.4452	22.8991
Mar	28.9589	23.8221
Apr	29.3777	25.2985
May	30.4177	26.459
Jun	31.5537	27.398
Jul	32.1896	27.4118
Aug	29.8101	28.4214
Sep	28.0247	29.1316
Oct	23.5994	30.301
Nov	23.0969	30.597
Dec	23.5153	29.9942
average	**27.98**	**27.11**

Appendix 13 Australian abattoir model outcome DAFWA (2010)

Inputs and cost items	Unit	YR0	YR1	YR2	YR3	YR4	YR5	YR6
Range of seasonal assumptions			start up years			poor seasons		optimal
TASK DEFINITION								
Operating parameters								
Operating months	No.		12	12	12	11	11	12
days/week nominal		5	5	5	5	5	5	5
days/week actual			5	3	4	3	4	5
Operating days pa	No.		250	150	200	137	183	250
Shifts per day	No.		1.0	1.0	1.5	1.5	1.5	1.5
Volume of cattle								
- nominal per day	No.		200	300	400	400	400	400
- annualised	No.		49,999	44,999	79,999	54,999	73,332	99,998
- average carcass weight	Kgs/head	250	250	250	250	250	250	250
- yield	% carcass weight	70%	70%	70%	70%	70%	70%	70%
Annual Production								
- meat	tonnes		8,700	7,900	14,000	9,600	12,800	17,500
- offal	tonnes	0.02	1,000	900	1,600	1,100	1,467	2,000
- rendered product	tonnes	0.082	4,100	3,690	6,560	4,510	6,013	8,200
Total product mass	Tonnes		13,800	12,490	22,160	15,210	20,280	27,700
LABOUR COSTS								
Slaughter staff	$'000	$2,085	$2,085	$3,128	$3,892	$3,892	$3,892	$3,892
Boning room	$'000	$4,170	$3,197	$4,657	$5,421	$5,421	$5,421	$5,421
Maintenance	$'000	$765	$382	$612	$765	$765	$765	$765
Administration	$'000	$1,557	$1,362	$1,654	$2,724	$2,724	$2,724	$2,724
Inspectors	$'000	$292	$292	$292	$292	$292	$292	$292
Total	$'000	$8,868	$7,318	$10,342	$13,094	$13,094	$13,094	$13,094
OTHER OPERATING COSTS	$'000							
Consumables	$'000	$500	$500	$500	$500	$500	$500	$500
Power and water	$'000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Insurances, statutory	$'000		$500	$500	$500	$500	$500	$500
Other	$'000		$500	$750	$1,000	$1,000	$1,000	$1,000
Total	$'000		$2,500	$2,750	$3,000	$3,000	$3,000	$3,000

Contiune…

Inputs and cost items	Unit	YR0	YR1	YR2	YR3	YR4	YR5	YR6
range of seasonal assumptions			start up years			poor seasons		optimal
TOTAL COSTS								
Labour	$'000	$8,868	$7,318	$10,342	$13,094	$13,094	$13,094	$13,094
Other	$'000	$0	$2,500	$2,750	$3,000	$3,000	$3,000	$3,000
Depreciation	$'000	$1,250	$1,250	$1,250	$1,460	$1,460	$1,730	$1,730
Interest	10%	$3,335	$3,210	$3,085	$3,339	$3,193	$3,420	$3,247
Total	$'000	$13,453	$14,278	$17,427	$20,893	$20,747	$21,244	$21,071
Annual cattle slaughtered	No.		49,999	44,999	79,999	54,999	73,332	99,998
Cost per kg	$		$1.64	$2.21	$1.49	$2.16	$1.66	$1.20
Margin	15%		$0.25	$0.33	$0.22	$0.32	$0.25	$0.18
Imputed price	$		$1.89	$2.54	$1.72	$2.49	$1.91	$1.38
annual processing cost (less margin)			$14,278,350	$17,426,600	$20,892,800	$20,746,800	$21,243,800	$21,070,800
Revenue (abattoir gate)								
Meat	$/kg	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50
Offal	avge kg/head	20	20	20	20	20	20	20
	$/kg	$3.00	$3.00	$3.00	$3.00	$3.00	$3.00	$3.00
Rendered bi-product	$/head	$33.00	$1,649,974	$1,484,976	$2,639,958	$1,814,971	$2,419,961	$3,299,947
Total revenue (abattoir gate)	$/year		$17,699,926	$16,034,933	$28,439,881	$19,514,918	$26,019,891	$35,549,851