

# DEVELOPING A SUITABLE METHODOLOGY FOR INTEGRATED SUPPLY CHAIN ANALYSIS IN THE AUSTRALIAN BEEF INDUSTRIES: A RESEARCH PROPOSAL

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## ABSTRACT

*The Australian Beef Supply Chain is the chain or sequence of all activities from the breeding property to the domestic or overseas consumers. The objective of this research is to describe beef supply chains in Australia and to explore and measure the performance of such chains (i.e. efficiency, effectiveness, and productivity). In addition to this it is to suggest alternative configurations for these supply chains that enhance performance of the businesses concerned and to develop a new design methodology for integrated supply chains based on process modeling, performance analysis and optimization of production and inventory distribution networks.*

**Keywords:** *supply chain, production, distribution networks*

## ABSTRAK

*Tingginya pasokan daging sapi dari Australia adalah salah satu mata rantai dari tingginya pertumbuhan penduduk baik di dalam, maupun luar negeri. Penelitian ini menjelaskan bagaimana mata rantai pemasok daging di Australia termasuk efisiensi, keefektifitasan, dan produksi daging. Sebagai tambahan, penelitian ini juga memberikan beberapa masukan sebagai alternatif yang efektif untuk meningkatkan produksi pemasokan daging. Di samping itu, juga disajikan beberapa metode baru berdasarkan model proses, kemampuan analisis, dan optimalisasi produksi dan inventarisasi jaringan distribusi.*

**Kata kunci:** *mata rantai pemasok, produksi, jaringan distribusi*

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## INTRODUCTION

Supply Chain Management is the integration of suppliers, manufacturing, distribution and customers in which raw materials run from suppliers to manufacturers who assemble them into finished product and organize delivery into the hands of customers. Integrated Supply Chain Management gives many advantages for industries/companies, such as improved delivery performance, reduction of lead time, and reduction of inventory, improved flexibility, improved capacity realization and improved asset usage.

This research will focus on an Australian agribusiness supply chain, the Australian Beef Supply Chain. The definition of the Australian Beef Supply Chain is the chain or sequence of all activities from the breeding property to the domestic/overseas consumers (see Figure 1). The inclusion of overseas customers is necessary given that Australia typically exports about 65% of its production. The eventual target of this research is to suggest the means by which supply chain performance can be improved for key Australian agribusinesses. The steps to achieving this are to describe several supply chains within the beef industry and then to analyze their performance. Using various quantitative and qualitative methods the significant supply chain parameters will be examined to suggest new designs for better integration. The methods used by firms to analyze their supply chains will also be investigated.

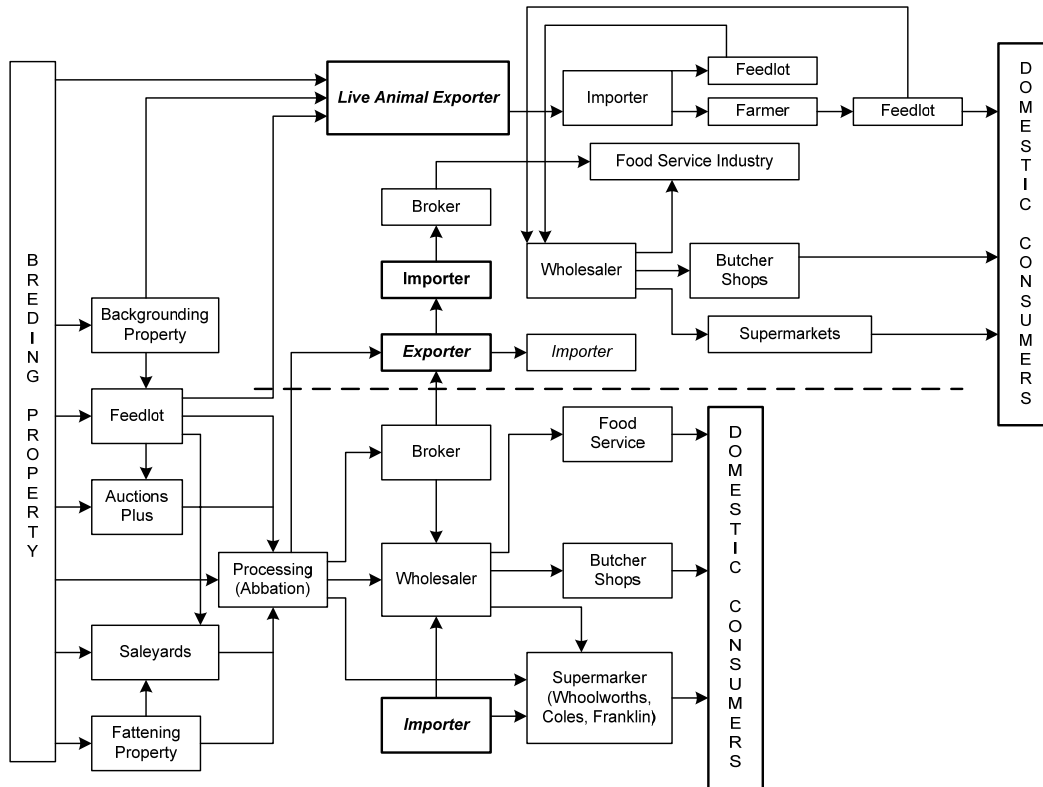


Figure 1 Domestic and International Australian Beef Supply Chain

## Identification of problem

The beef sector in Australia is undergoing rapid change because of globalization, a highly competitive beef market (local and export), reducing production cycle and delivery times and consequently reduced inventories, a general speed-up of the rate of change in the business environment, the trend towards more outsourcing of activities, and the rapid development in IT. In this business environment, advanced supply chain systems have the potential to provide significant contributions to companies, academics and institutions. We also are moving into an era in which consumers of beef are much more sophisticated than before and are demanding particular qualities in the product. This is the case whether the consumer is in Australia or in overseas markets such as Japan, Korea or China. The only difference is that these different markets are demanding different types of quality products. This focus need of consumers is another significant driver of improvement in supply chain performance.

## DISCUSSION

### Definition of Integrated Supply Chain Management

*“Supply chain management is a system of suppliers, manufacturers, distributors, retailers, and customers where materials flow downstream from suppliers to customers, and information flows in both directions” (Ganeshan et.al. 1995: 3).*

According to Ganeshan and Harrison (1995: 2), the definition of a supply chain is a network of facilities such as suppliers, manufacturing, distributions and customers that carries out the functions of procurement of raw materials, transformation of these raw materials into finished products, and the distribution of these finished products into the hands of customers. Supply chain systems have three levels: Strategic, Tactical and Operational. The strategic level is concerned with the long-term planning of the business/company system, such as the number and allocation of factories or plants and warehouses, what is the best sourcing strategy, etc. In contrast the tactical level deals with the mid-term planning such as forecasting and ordering over short lead times. The operational level deals with short-term planning, for example detailed scheduling, inventory and truck loading.

According to the National Research Council (2005: 24-27), an integrated supply chain is:

*“...an association of customers and suppliers who using management techniques, work together to optimize their collective performance in the creation, distribution and support of an end product. To operate an integrated supply chain needs continuous information work flows leading to full visibility along the supply chain, which in turn helps optimize product flows”.*

### Supply Chain Modelling Approaches

Five modeling approaches are under consideration for the analytical component of this study.

#### Supply Chain Network Design Method

This model is used to determine the location of production, stocking and sourcing facilities and paths the products take through them. Geoffrion and Graves (1974) introduced a multi-commodity logistics network design model to optimize the finished product flows from factories to the distribution centers and then to end users. Geoffrion and Powers (1995) later provided a review of the evolution of distribution strategies over the past 20 years, which explained how the lines of the above model can hold more echelons, cross product and service detail. This aspect will probably be important in the analysis of Australian agribusiness supply chains particularly Australian beef industry. It

will considerably enhance the information flows about beef/veal from the production process to the broker/wholesaler and then to the food services/butcher shops and supermarkets such as Woolworths, Coles, Bilo and Franklins.

### **Mixed Integer Programming (MIP) and Nonlinear Programming Optimizing Models**

Mixed integer programming is for vehicle routing and scheduling, facility location and sizing, shipment routing and scheduling, freight consolidation and transportation mode selection (Dong, 2001). Cohen and Moon (1991) developed a mixed integer programming, multi-commodity model to describe inbound raw material flows, assignment of product flows and the specification of production volumes and outbound finished product flows in a production-distribution network.

**Nonlinear Programming (NLP)** is for optimization of a non-linear function subject to non-linear constraints with real variables. Examples of NLP methods are sequential quadratic programming (SQP), the method of moving asymptotes (MMA) and the generalized reduced gradient method (GRG). They can be used for structural design problems (Ghasemi *et al.* 1999). An application of Nonlinear Programming methods to the problem of supply chain design is the pooling problem for a refinery (Fieldhouse, 1993).

Based on the two methods above, the mixed integer programming might be a possible application for the Australian beef industry. The reason is that the method might be good for analyzing the inbound cattle flows, assignment of beef/veal product flows, including the scheduling and shipment or transportation routing, the specification of production volumes and outbound beef or veal product flows in a beef value chain.

### **Stochastic Programming and Robust Optimization Methods**

Stochastic programming deals with a category of optimization models and algorithms in which some of the data may be subject to significant uncertainty. Uncertainty is usually characterized by a probability distribution to describe the parameters (Dong 2001). This type of approach may be particularly relevant to agribusiness firms in which product flows can be of uncertain quantity and quality.

Swaminathan and Tayur (1999) provided stochastic programming models and effective computational measures to minimize inventories of common parts /components, and assess the effect of assembly job sequencing on operational performance. Stochastic programming might find possible application for the beef industry as it can handle aspects such as uncertainty of the beef or veal demand (domestic or internationally) and also the uncertain quantity or quality beef information flows.

## Heuristic Methods1

Using heuristics is another method of analyzing supply chain alternatives and decisions. A heuristic is merely any intelligent approach that seeks good solutions. Useful heuristics become “rules of thumb”. Mathematical programming methods usually are used to solve strategic and higher levels of tactical supply chain planning. Such methods generally work only for solving linear and some integer-based models, commonly used in strategic levels of planning. Tactical and operational models are usually not linear and are much too complex to solve using mathematical programming methods. For this reason, heuristic methods have had fairly limited use (Dong 2001), but may be relevant to the Australian Beef Supply Chain because the beef value chain (from breeding property to end customers) might be analyzed using strategic, tactical and operational models which are deterministic.

## Simulation Based Methods

*“Simulation is the imitation of the operation of a real world process or system over time. Simulation is an indispensable problem solving methodology for the solution of many real world problems. Simulation is used to describe and analyze the behavior of a system, ask “what if” questions about the real system, and aid in the design of real systems.”*

*“A discrete event simulation model is conducted over time (“run”) by a mechanism that moves simulated time forward.” (Banks, 2000:10)*

Law and Kelton (1991) define an event as an instantaneous occurrence that may change the state of the system. It is a perturbation that induces change, and simulation models trace out the consequence of such a change on one or more simulated outcomes. A comprehensive supply chain model can be established using simulation-based methods. This can be used for strategic and operational planning. Simulation-based methods can assess the effectiveness/performance of a pre-specified policy before developing new ones. In recent years, the purpose of simulation as a method of analyzing the problems of organizational decision making has gained considerable momentum (Feigin *et.al.* 1996; Kumar *et.al.* 1993; Malone and Benton 1997). Towill *et.al.* (1992) used simulation to evaluate the effects of a diverse supply chain approach to an industry facing an increase in demand. Wikner *et.al.* (1991) used the simulation method to analyze interventions to supply chain configuration. The purpose of this method is to eliminate demand amplification in three levels of the production distribution system, to develop information flow through the supply chain, to reduce the delays and to change the ordering policies and the local decision rules.

Facing an increased demand Towill *et.al.* (1992) used the simulation method on Forrester’s supply chain “Beer Game” as a dynamic modeling supply chain design, in order to evaluate the effects of a diverse supply chain approach on demand amplification.

The purpose of this simulation was to eliminate intermediate levels, to make point of sales data available along the chain and to reduce lead time.

Towill (1996) used simulation techniques to show how industrial dynamics models can support supply chain re-engineering. In addition, Towill investigated the impact on the supply chain of different operation strategies such as to eliminate the distribution echelon of the supply chain (including the distribution function at the manufacturing level), to develop information flows, to implement Just In Time (JIT) in order to eliminate delays and vendor integration, and finally to change the ordering policies and local decision rules. To improve business performance can be accomplished by a better use of resources (Towill, 1991, 1996). Towill and Del Vecchio (1994) applied filter theory and simulation. This research evaluated the filter characters of supply chains in order to explore the different supply chain responses to randomness of the demand model. Then using simulation to allow for these responses, the smallest safety stock to achieve a significant desired service level can be identified. Tzafestas and Kapsiotis (1994) used a combination of analytical and simulation techniques to explore supply chain systems in order to reduce lead time and cost and improve the overall performance of the supply chain.

The simulation method probably is relevant to the Australian beef industry because simulation based methods can assess the performance (the effectiveness and efficiency) of the beef value chain then it also might be used to reduce demand amplification at every level. Furthermore, it might be used to develop beef/veal information flows through the chain, reduce delays and finally change the ordering policies/local decision rules.

## **Objectives**

1. To describe agribusiness supply chains in the Australian beef sector and to explore and measure the performance of such chains (i.e. efficiency, effectiveness and productivity).
2. To suggest alternative configurations for these supply chains that enhance performance of the businesses concerned.
3. To develop a new design methodology for integrated supply chains based on,
  - a. process modeling of integrated supply chain design.
  - b. performance analysis and optimization of production and inventory- distribution supply chain networks.
  - c. simulation modeling and analysis of integrated supply chain networks.

## **Methodology**

To obtain a preliminary description of the supply chains to be analyzed, a survey method will be adapted to interview key personnel in the agribusiness firms concerned. Data will then be obtained showing the quantity and types of beef flowing through

various points in the supply chain. These data will assist in the further refinement of the supply chain model developed from the survey. Construction of various quantitative models of the integrated beef supply chain can then commence. As the works proceed the many quality aspects of beef production, distribution and consumption will be revealed. Several of these lead to the study of contractual relationships between participants in the chain and the idea that there will be crucial focus points within the chain where product specification is significant. Finally a complete model incorporating all the above factors will be developed using a method selected from those reviewed in Section 2.

## CONCLUSION

This research could give some benefits to the Australian Beef Industry such as achieving business objectives/management goals business growth, profitability, market share and customer satisfaction (high customer service), low inventory stock levels (inventory reduction), fulfillment cycle time reduction, increased forecast accuracy, overall productivity gain, improved capacity realization, improved flexibility, improved reliability, improved asset turns and improved responsiveness.

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