Quantifying the benefits of supply chain traceability in Oman's seafood industry

Mohammed H. AlRizeiqi

UCD Geary Institute, Food Processing Policy, Belfield, Dublin4, Ireland.

mohammed.al-rizeiqi@ucdconnect.ie

Vincent Hargaden

School of Mechanical & Materials Engineering, Engineering & Materials Science Centre, University College Dublin, Belfield, Dublin 4, Ireland.

Patrick Paul Walsh

UCD Geary Institute and School of Politics and International Relations, Belfield, Dublin4, Ireland.

Abstract

The seafood industry in Oman accounts for nearly 0.6% GDP (around €540M). Lack of integrated supply chain traceability has resulted in product recalls, waste and exclusion from lucrative export markets. We demonstrate the economic benefits of traceability in the Oman seafood supply chain and highlight some of the implementation issues.

Keywords: Supply Chain Traceability, Fisheries Sector, Developing Economies.

Introduction

The fisheries sector is very relevant to our planet, as water occupies more than 70% of the earth surface and its ecosystem is critical to the whole biosphere. The oceans and seas are tightly linked through economic consumption, production, food security and environmental protection. The Rio+20 World Summit states that the oceans play a central role in planetary survival and human wellbeing (Rio, 2013). Apart from the threat of nature, climate change and global warming may lead to the extinction of many marine species. Concerns about the global state of fisheries resources has highlighted three primary considerations: sustainable utilization, economic efficiency and equity in access to resources (Cochrane, 2000). Marine species are significantly threatened by overfishing and the consequence of this is depletion of fish stocks across the world (Cochrane, 2000). The Food and Agriculture Organization (FAO) estimates that more than 60% of fish stocks are exploited to their maximum sustainable limit, which threatens the existence of certain species. This may have an impact on food security, particularly in many coastal developing countries.

The total global production of fish reached more than 177 million tons in 2012 (FAO, 2012). The global capture of wild fish rose slowly from 81 million tons in 2000 to approximately 90 million tons in 2013. During the same period, there was a rapid increase in aquaculture farming of fish. It increased from 40 million tons in 2000 to 90 million tons in 2013, which accounts for nearly 50% of the global catch, creating another challenge for the environment and biological sustainability. The value from fisheries and aquaculture trade was in the range of US$120 billion in 2011 (FAO, 2013). The product source of more than 80% of this can be traced back to developing nations. However, these countries tend to lack sufficient supply chain process design and control to fully capture the economic value for themselves.

Oman is rich in fisheries and seafood resources. The country has a 3,165 km long coastline with an exclusive economic zone area of 300,000 km^2 from Hormuz in the north to Dhofar in the south. Its annual fish export is approximately 120,000 metric tons (MOAF, 2013). The country began exporting to the US and EU markets in 1986. However, in the last ten years the country has lost most of its share in the Eurpoean market due to many legal and technical issues in the process value chain (FVO, 2006). The Omani government strategy is to develop an efficient fisheries sector both in term of income, output, value added and employment. This would create an efficient sustainable sector for fisheries and job security for local (MNE, 2013).

Traceability in food process value chains has long been used to control and prevent food contamination, improving business efficiency and retaining consumer confidence. There is also an emerging demand for smart package materials for better safety control and traceability of products (Lee et al., 2014).

The main objective of this study is to assess the economic benefits of supply chain traceability in the Omani seafood industry. The Net Present Value (NPV) is calculated for the Oman seafood sector which demonstrates the benefit of the implementation of an integrated traceability system. Seafood traceability is analyzed using both statistical and financial models. This initial study is useful in term of demonstrating the economic benefits of supply chain traceability and how such regulation could improve trade.

Methodology

The Oman seafood supply chain consists of the fish moving through fishermen, processors, wholesalers, distribution centres, retailers and finally end consumers. A semi-structured interview protocol was developed and deployed with quality managers in seafood processing companies. These individuals were selected as they are responsible for finished product safety and quality within each company. A Cost-Benefit Analysis (CBA) model was used to analyse the economic results of the implementation of a traceability system within a sample company "Oman Fisheries" supply chain. In previous studies, Mai (2010) used the concept of CBA in the fisheries supply chain. Both NPV and CBA tests require that costs and benefits be presented in terms of their values from a company's perspective.

An axiomatic approach model gives a more detailed picture of the individual costs and benefits from the implementation of supply chain traceability. Suh (1990) shows both the risk and cost minimizations from the implementation of traceability systems through a functional domain (FD) and physical domain (PD) approach as shown in Figure 1.

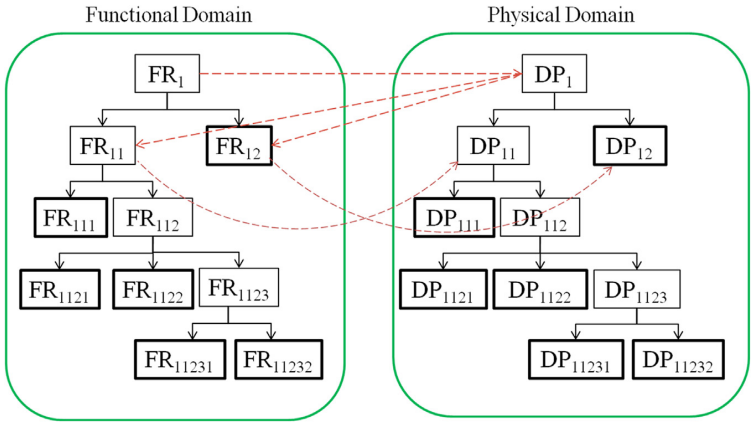

Figure 1 - Mapping of Functional and Physical Domain for the supply chain (Suh, 2001)

Figure 2 shows the initial application of the Functional and Physical Domains to the traceability system. Through decomposition, the customer attributes can be translated to functional requirements. For the seafood industry, the objective of the Functional Domain is to minimize the cost through the traceability system as in Figure.2.

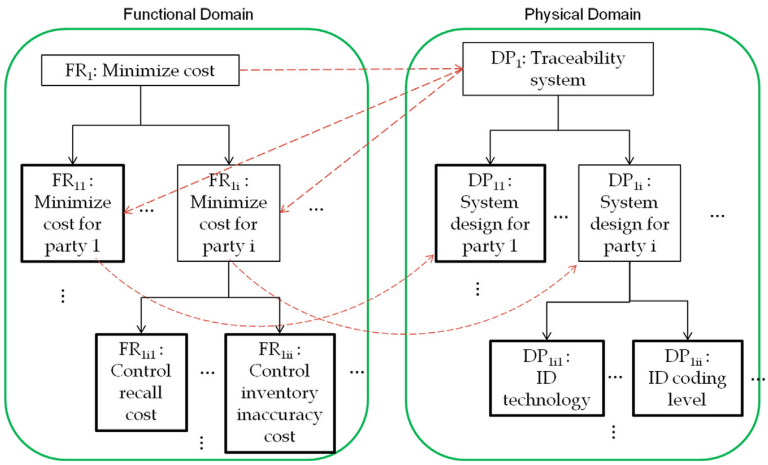

Figure 2 - Design framework for traceability system (Suh, 2001)

Results and Discussion

The supply chain traceability system involves both process chain, technology and human activities. According to EU regulations 178/2002, it is mandatory to print the date of fishing/process information on each fish to be sold in the EU. After captured fish are loaded onto ice, they are transported from the fishing zone to Oman Fisheries and a grading centre. Fish quality and safety is checked first. There is preliminary laboratory testing for pH, Titratable Acidity (TA), Peroxide Value (PV) and Total Microbial Load (CFU) plus other necessary microbial analysis based on the requirements from the export partners. Then the batch goes through a sorting procedure in which typed codes categorize the products. The date and time for the whole process is recorded in portable information technology (IT) systems. All packed seafood is moved to a warehouse for temporary storage under controlled temperature and humidity. Finally, these boxes of seafood are transported to wholesalers, retailers and final customers.

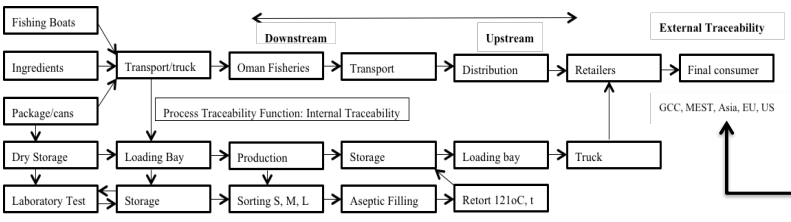

Figure. Oman Fisheries Traceability system structure

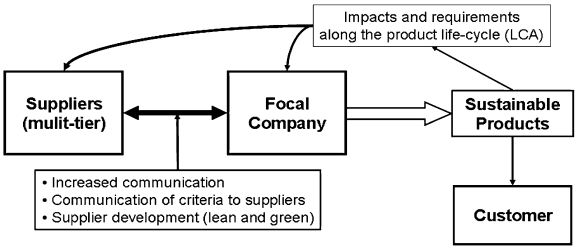

Figure 3 - Oman Fisheries Traceability System Structure

Figure 3 shows the current process map in Oman Fisheries. The traceability system in Oman Fisheries shows all the upstream and the downstream steps of the supply chain. The fish product can be traced back to its original step of harvesting, while any added ingredients would be traced to the supplier.

Oman Fisheries bears most of the cost of the implementation of the traceability system in its supply chain. Major costs for this system include hardware cost, software cost, personnel cost, and third party service cost. Hardware in the traceability system includes equipment such as barcode tags, barcode printers, computers, and barcode scanner. Software costs include the purchase of software systems and upgrades. There are full time employees dedicated to the operation of the traceability system.

The traceability implementation would cost the Oman Fisheries US$ 30.0 million for the initial investment. The cost structure of Oman Fisheries traceability system is similar from other industry cases. In the cheese industry (Regattieri, 2007), hardware including tags and readers are the major cost of its traceability system. The annual maintenance cost is US$5 million. The benefits include the operational efficiency, increased supply chain confidence through reducing recalls and waste, and through increased market access. Other benefits include improved handling/quality, improved information management and reduced liability insurance. The most valuable benefit is perhaps the increased market share in Oman, Middle East, Asia and to some extent European markets. The traceability system gives Oman Fisheries seafood products added value in a competitive market.

Based on the initial study, the Oman Fisheries would be able to recover all investment within a 3 year period. The Internal Rate of Return (IRR) was 79%. Another obvious benefit of this traceability system is smooth and transparent information exchanged among firms, sorting and grading centres, and retailers. Useful information such as fish quality, weight and freshness can be made available.

In addition, the benefits of implementing the traceability system can be shared across the supply chain. The producer can have higher monetary benefit such as higher revenue from market growth, recall cost reduction, savings from liability cost and personnel savings. Distributors and retailers can avoid wrongfully charged liability cost. A traceability system can increase their operational efficiency. For consumers, the most important thing which a traceability system can bring is products with higher quality and better safety measures.

Conclusion

Traceability is necessary to control seafood contamination, improve seafood businesses and retain consumer confidence. The underlying cause of supply chain disruptions to the Oman seafood industry (e.g. product recalls) can be attributed to the absence of integrated traceability. A Cost-Benefit Analysis (CBA) model was used to analyse the economic benefit of the implementation of a supply chain traceability system. It was found that Oman Fisheries would be able to recover all investment within a 3 year period. In addition, the value added from implementing traceability in the seafood supply chain provides wider economic benefit to a developing nation such as Oman.

Bibliography

Cochrane, K. (2000). Reconciling sustainability, economic efficiency and equity in fisheries: the one that got away? *Fish and Fisheries*, 2000(1), p3-21.

EU (2002) Regulation (EC) No 178/2002 of the European Parliament and of the Council, *Official Journal of the European Communities*, L31/1, p. 24.

FAO (2012) FAO yearbook. *Fishery and aquaculture statistics*. Rome: Statistics and Information Service of the Fisheries and Aquaculture Department.

FAO (2013) FAO yearbook. *Fishery and aquaculture statistics*. Rome: Statistics and Information Service of the Fisheries and Aquaculture Department.

Florio, M. (2006) Cost-benefit analysis and the European Union Cohesion Fund: On the Social Cost of Capital and Labour. *Regional Studies*, Vol. 40(2): 211-224.

FVO (2006) Food and Veterinary Office, European Commission.

Lee, S. J., & Rahman, A. T. M. M. (2014). Intelligent packaging for food products. Innovations in food packaging 2nd ed., pp. 171-209.

Mai, N., Bogason, S. G., Arason, S., Árnason, S. V., & Matthíasson, T. G. (2010). Benefits of traceability in fish supply chains: case studies, *British Food Journal*, 112(9), 976-1002.

MOAF (2013) Ministry of Agriculture and Fisheries annual report, Sultanate of Oman.

MNE (2013) Ministry of National Economy annual report, Sultanate of Oman.

Regattieri, A. Gamberi, M., Mazini, R. (2007) Traceability of food products: general framework and experimental evidence. *Journal of Food Engineering,* Vol 81, pp.347-356.

Suh, N.P. (1990) The Principles Of Design. Oxford University Press, New York.

Suh, N.P. (2001) Axiomatic Design: Advances and Applications. Oxford University Press, New York.

United Nations (UN) (2012) The Future We Want - Final Outcome Document. A/CONF.216/L.1.

WTO (2013) World Trade Organization. Geneva.