DOI: 10.18843/ijcms/v9i2/01
DOI URL: http://dx.doi.org/10.18843/ijcms/v9i2/01

Agility in the Factors Effecting the Quality and Safety of Fish Products

Sashikala Parimi,
Associate Professor,
Department of Operations & IT,
IBS Hyderabad, India

Anusha Sreeram,
Assistant Professor,
Department of Operations & IT,
IBS Hyderabad, India

ABSTRACT

The consumption of fish by humans worldwide is 77%. The demand and consumption of fresh fish has significantly grown during recent years. The future growth is from aquaculture as the global demand for fish continuous to increase. The supply chain of fish is a network which consists of the fishermen, middlemen, distributors, transporters, storage facilities, suppliers, retailers, delivery and selling the product to the consumer. It is necessary to maintain the quality and safety of fish/fish products till the time of consumption by the consumer. The quality and safety of the fish/ fish products may deteriorate due to variations in temperature, distribution channel, transportation, packaging and grading. The purpose of this paper is to understand the impact of these factors on the quality and safety of the fish/fish products and to propose the implementation of the concept of agility into these factors so that the quality and safety of these products is ensured with minimum losses and wastage.

Keywords*: Supply chain management, fisheries, temperature, distribution channel, transportation, packaging and grading, quality, safety, agility.*

Introduction:

The human consumption of world fish production was more than 110 million tonnes i.e 77% in 2006. Fish is considered to be the handiest food which can be used in number of ways and forms. The distribution of fish is mostly as live, fresh, chilled, frozen, fermented, dried, smoked, salted and canned and so on. The quality of fish used in any form deteriorates in quality due to varied temperatures in developing countries. This occurs due to insufficient use of ice, long supply chains, no proper access to roads and electricity. There is also insufficient infrastructure and services in the markets where the fish is sold. The difficulty in the facilities and the market infrastructure for marketing perishable goods are getting limited and overfilled. Because of this though the utilization of live fish which was 60.1 percent of fish destined for human consumption in 2006) or processed by smoking or fermentation (10.0 percent in 2006), there is an increase in the share of frozen products in developing countries with 19 percent in 2006, up 7.3 percent since 1996 and a more substantial increase in prepared or preserved forms (11.1 percent in 2006, up 41 percent since 1996). There is a significant change in the utilization and processing of fish production in the last two decades. The changes include developments in the capability in storage and processing along with key innovations in refrigeration, ice-making and food packaging and fish processing equipment. The Containers with these improved facilities helped in distribution of more live fish for long duration. The fish processing is evolving in many developing countries driven by the demand in the domestic retail industry (FAO, 2008)

Though, in the production of food, India is the second largest producer of fruits and vegetables, second in the production of milk, fifth in the production of eggs and sixth in fish it is not in the top 10 countries in the export of food. This may be because of the uneven supply chain and lack of cold storage infrastructure and an accommodating food processing industry. Due to these reasons the wastage of food is about 20 percent of the foods produced with 4 percent of fish (Viswanadham, 2008).

The food industry is huge and diversified. It is categorized into different segments such as fresh food, organic, processed food and livestock. The strategies of supply chain required for each of these segments is different. The require various procurement and sourcing, inventory management, warehouse

management, packaging and labeling system and distribution system (Georgiadis, Vlachos, & Iakovu, 2005).The supply chain of food products is more complicated compared to the traditional supply chains as there will be issues related to handling, storage time, delivery efficiency which leads to the requirement of advanced modeling techniques (Lütke Entrup, Günther, van Beek, Grunow, & Seiler, 2005). The aspects such as safety, quality and efficiency are considered by some authors in the food supply chain (Minegishi & Thiel, 2000); (Stringer & Hall, 2006); (Van der Vorst, Beulens, & van Beek, 2000); (Van der Vorst, Tromp, & van der Zee, 2005).

Supply chain is defined as a network of interrelated organizations through upstream and downstream links that produce value in the form of products and services to clients in different business processes and activities (Christopher, Logistics and Supply Chain Management, 1992). This approach is closer to that of (Mentzer, et al., 2001) and Stock Lambert (2001). In order to gain competitive advantage it is essential to have an appropriate and effective supply chain in all the different types of markets (Subramani, 2004). The companies in the current scenario develop the activities which are differentiated by increasing demand, wide range of products with good quality, low profit margin and high level of service (Bolwijn & Kumpe, 1998); (Brown & Eisenhardt, 1998). In particular, the process of managing the flow of raw material to finished goods from manufacturer to the end user effectively is the supply chain management (Sen Gupta, Turnbull, & Seamless, 1996). The various stages involved in fulfilling the needs of a customer directly or indirectly include manufacturers, suppliers, transporters, warehouses, retailers and customers. Supply Chain Management is the management of flow of materials across the stages in a supply chain with an objective to minimize the cost (Habib, 2010). In this situation, Logistics and supply chain management have become essential for the companies in cutting down the costs and increasing the service level to achieve competitive advantage, enter the global markets for a stable growth of income and obtain the benefits of globalization

The demand and consumption of fresh food has increased globally (FAO, 2009); (Vannuccini, 2004); (World Fishing Net, 2010), for example the fresh fish market has significantly grown in the United Kingdom during recent years (Seafish, 2010). There is a rise in the fresh sea food production from about 45.4 million tons in 1998 to 54.6 million tons in 2007. Out of the fish produced in 2007, the fish which is meant for consumption by individuals was 48.1% in live and fresh form (FAO, 2007). The export of iced fish from Ice land has increased to 43.3% in volume and 37.3% in value in 2008 compared to 2007 (Statistics Iceland, 2009) amounting to about 111.7 thousand tons in 2008 (Statistics Iceland, 2009; (Statistics Iceland, 2010).

Though there is commitment to bring back the global fish stocks to sustainable levels by 2015, the consumption is growing at unsustainable levels. The total supply of food is increasing at a rate of 3.6 percent per year since 1961 whereas the population is increasing at the rate of 1.8 percent per year (FAO, 2011). The future growth is from aquaculture as the global demand for fish continues to increase (FAO, 2009)

The supply chain of fish industry is challenging. Fisheries contribute to the human well-being by not only generating employment to millions but also nutritional value. Fish is an indispensible diet for the poor. The fish is caught in their natural habitat but other food products are produced grown and manufactured. The fishermen are hunters and not manufacturers.

It is necessary for the developing countries like India to adapt to agile, adaptive and efficient supply chain in order to become a leading global food supplier. It is also necessary to improve the technology in cold storage, tracking the products, transit times along the supply chain to achieve a balance between supply and demand.

Literature Review:

An important aspect of logistics is the material flow from supply chain perspective. (Coyle, Bardi, & Jr., 2003), where the emphasis is on the quality of the products delivered to the final customer. If the product is not meeting the specifications it is rejected (Nunes, Emond, & Brecht, 2003), returned (Coyle, Bardi, & Jr., 2003) or recollected in case of a food safety problem (Buhr, 2003); (McEntire, et al., 2010). *Quality management* (quality assurance), is defined as a set of all the activities and functions which helps in attaining the quality in a company", which consist of the technical, managerial and environmental aspects (Huss & Ryder, 2003). The main focus of quality management in the sea food industry technically is the safety, freshness, shelf life and authenticity (Huss & Ryder, 2003). The information flow is important in supply chain management (Coyle, Bardi, & Jr., 2003) to facilitate product traceability as per the legislation (e.g. EU Regulation 178/2002 and US Bioterrorism Act PL107-188) to track and trace the flow and record of the material (EAN, 2002). These aspect help in understanding how helpful are traceability and logistics in fresh fish supply chain.

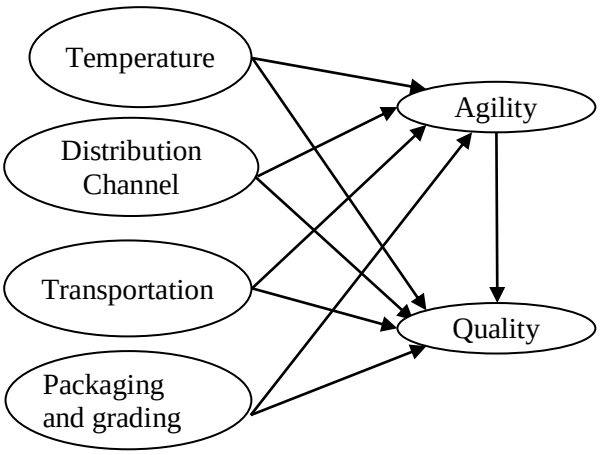
The supply chain is a network of activities from origin through the different stages of production and delivery to final consumers (Porter, 1980). It looks at the every step from raw material to end user with an objective to deliver maximum value at a low cost (Investopedia, 2011). The six drivers of the supply chain considered from the literature are: Facilities, inventory, transportation, information, sourcing and pricing.

Based on the study conducted by (Silva, D.A.M., & Masahiro, 2006), the growth rate of the population and age are the primary factors which have an impact on the demand of fish and fishery products. The study indicates that the developing nations are positive in the growth rate of population with more youth population whose food habits and preferences affect the food demand positively.

Traditions, customs, religious concerns, socio-cultural values and attitude also impact the demand of the fish and fishery products. The eastern countries have high demand on the variety of fish and fishery products compared to the other parts of the world. Countries with more of Muslim population prefer meat products than fishery products (Merriam-Webster, 2010). Sea cucumber and Shark becomes luxury food for Hongkong and China but there is no value for these products in other markets.

The supply chain of sea food starts from sea and end up with consumer markets which are thousands of miles away from the sea. According to (Harland, 1996) a supply chain is network which consists of retailers, distributors, transporters, storage facilities and suppliers who participate in production, delivery and selling the product to the consumer. The supply chain of the sea food is drastically changing because of retailers, increased imports and increased market share. This change continues with the availability of transport at lower cost and increase in aquaculture production and the market becoming global. (Frank & Atle, 2009). A supply chain consists of three major parts such as supply which focuses on the raw materials supplied to the manufacturing units that includes how, when and from which location. Manufacturing which focuses on converting the raw materials to semi-finished or finished products. Distribution which aims at ensuring that these products reach the consumer along an organized network of distributors, warehouses and retailers.

Proposed Research Model:



Propositions:

The supply chain of perishables is vulnerable to the changes in economic blockages, changes in the environment (Evans, 2009). The literature indicates that the food system in future will have to follow the characteristics such as resilience, sustainability, competitiveness and ability to meet the expectations of the consumers (Leat, 2013). The consumers have become conscious on the source and the nutritional value of the food due to the diseases related to food intake (Nepstad et al., 2006),. This led to the demand of high quality and fresh food. In this situation the various strategies of supply chain management such as lean, agile and leagile were considered. There is a need to understand the introduction of agile strategy into the various factors of the supply chain of the fish and fish products.

Temperature:

The important factor that the affects the quality and safety of perishable products is temperature (Jedermann, Ruiz-Garcia, & Lang, 2009), mainly for fresh fish (Olafsdottir, 2005). The irregular changes in the temperature leads to the fast development of some specific spoilage organisms(SSO) and also pathogens (Jol, Kassianenko, Wszol, & Oggel, 2005); (Raab, et al., 2008); (Rediers, Claes, Peeters, & Willems, 2009), which cause problems in safety and quality thus leading to economic losses. Generally the fresh fish is stored and shipped at melting ice temperature temperature (ATP, 2007); (Einarsson, 1992); (Einarsson, 1994); (Panozzo & Cortella, 2008); (Pawsey, 1995) or even below 0 °C, at very low cold temperatures (Olafsdottir, Lauzon, Martinsdottir, Oehlenschlager, & Kristbergsson, 2006); (Sivertsvik, Rosnes, & Kleiberg, 2003) (Stock & Lambert, 2001) so that the supply chain of fresh fish can be good and be safe for some time period otherwise it may face some danger as far as quality and safety is concerned.

P1: Temperature affects the quality and safety of the fish products.

Distribution Channel:

The major activity of the distribution channel is to perform the distribution process from the fisher, Stage one to consumer, the last stage. The various channel members involved are fisher, wholesaler, distributor, retailer, and consumer. The fish is transferred from producers to final consumer. This channel is mostly managed, supported, financed and controlled by the middlemen who are skillful. The fishermen are not educated or knowledgeable to get the best out of the supply chain. The fishermen generally cannot communicate directly with the consumers as this is usually done by the either the middlemen or the wholesaler. Then the retailers show aggressive behavior towards the farmer and sell the fish directly

to the consumers. In this situation there is a need for mediators in the supply chain of fisheries (Monczka, Robert, & Robert, 1994).

The supply is strategically very important in the supply chain as it is a collective objective of every function in the chain. This has relevance in the fish supply chain as it is a blend of sequence of functions which are performed by the participants like wholesalers, retailer, exporter and the fisherman in transferring the products to the consumers both domestically and internationally (Houligan, 1980)

In order to earn reasonably good profit for the quality of fish, famer and traders, the entire distribution channel is divided into buying and selling, auctioning, transportation, grading, packaging, storaging, financing, market information and pricing.

P2: Distribution channel has an influence on the quality of the fish products

Buying, Selling and Auctioning:

The buying or selling of fish is done at a place called fish market where the buyers and sellers come together. The market operates only for few hours in the morning starting from 3 a.m. to 9 a.m. The fish is traded generally at open place which is fixed and so there is no necessity for any stall or preservation system (Houligan, 1980).

Storage and Handling:

Since fish is a perishable product it requires a proper storage depending on the seasonal demand. Generally crushed ice is used in peak season. This influences the price of the fish as the price for the crush ice changes in various seasons and due to shortage. Mostly river water where chlorine is not used is used for making the ice which results in the grimy and unclear appearance (Houligan, 1980).

Most of the fish processors are specific for a particular kind of raw material. It is necessary to maintain the supply of fish continuously. The storage and transportation of fish is to done by the fishing container which has to be refrigerated at optimal storage temperatures and proper handling procedures to ensure high quality and safety of products (Madsen, 2005).

Transportation:

The mode of transportation for perishable products such as fresh fish is usually by Air as it is faster compared to other modes of transport (James, James, & Evans, 2006); (Simpson, Almonacid, Acevedo, & Cortes, 2003). There would be changes in the temperature during loading, unloading, storage and holding the product (Brecht, et al., 2003); Nunes *et al.*, 2003), as almost 80% of the time in transport is unprotected (James, James, & Evans, 2006). The other mode of transportation of fresh fish is by sea where the product is stored in refrigerated containers so that minimum required temperature for the complete journey is taken care (Sea fish, 2010). Air shipment is predominantly used for shipping portions of fresh fish whereas container shipping is used for Whole fish (Seafish, 2010) as the portions of fresh fish are more vulnerable to spoilage microbiologically compared to whole fish due to contamination (Einarsson, 1992). IN the recent time due to technically developments the portions of fish are also transported using containers (Seafish, 2010). It has been studied and modeled that the products/boxes which have more free surface are sensitive to temperature changes (Moureh, Laguerre, Flick, & Commere, 2002) found that the top corners of a pallet were the most sensitive regions to the surroundings and studied the use of insulating pallet covers for shipping heat-sensitive foodstuffs in ambient conditions

There should be a trade-off among the various modes of transport based on the quality and safety regarding time, temperature, customer requirement, economic efficiency, efficient packaging. Though the transportation through Air is faster compared to other modes of transport, it is quite expensive and also unsafe during ground and flight operations with changes in the temperature (Simpson *et al.*, 2003). Apart from this even though Freighter flights are more fuel efficient than passenger flights, but is affected by fuel prices as it is much larger part of total expenses (Morrell, 2008). Sea transportation is much cheaper means of transport and is temperature controlled during the whole logistics inside refrigerated containers (James, James, & Evans, 2006).

P3: Mode of transport affects the quality of fish products

Packaging & Grading:

The packaging of food is for preserving the food during storage, transportation and distribution which has to be provided by the manufacturing or production centre and plays a very important role in the distribution of the food products. Today's consumer is aware regarding the right to obtain good quality and right quantity of the goods in a good and hygienic package (Toley, 1986). India is dependent mostly on its economy from agriculture which frequently leads to severe shortage. One of the important reasons for this is post-harvest losses and spoilage which is estimated to be around 20% (Veerraju, 1974). It is essential to have proper packaging of food stuffs in the country like India where the temperature varies considerably from subzero to over 50^{o} C and humidity from 10% to 90%. Fisheries play an important role in the economy of the country as they provide jobs to fishermen and one of the sources of foreign currency to the country. Fish is the major source of animal protein for more than one million people out of which 80% are low income category. (FAD/Uorld Bank/UNDP/CEC, 1989). The main markets for

marine products are countries like Japan, US, Europe and Australia where they have stipulated norms and statutory laws of packaging and goods with the concern of public health protection to the consumers. The annual produce of fish in India is 2.93 million metric tonnes, but there was not much focus on the technology of packaging of fish and processed fishery products. Though there is a revolution in packaging and awareness in packaging by other manufactures for their products fisheries sector was accommodating the new packaging techniques and continues to be following the traditional methods (Govindan & Rao, 1987). This was because of the fear that these new techniques would shoot up the cost of fish. They were using the traditional packaging materials like bamboo baskets, wooden boxes, second hand plywood cases, gunnies, palmariah leaves, screw pine mats etc. for packaging of fresh and processed fish for local markets and to a limited extent for the export trade (Rao, 1975). It is very important to implement scientific and functional methods of packaging for products like fish which is perishable and these packaged products have to compete with the international market imported from other countries and the possibility of not getting rejected (Subramanian, 1984). The quality of the product is not increased by good packaging but it prevents the deterioration (Gopakumar, 1993). One-third of the exports coming from the developing countries are spoiled in the transportation. The proportion may not be high in India but it is of concern (Gangadharan, 1982). It is necessary from that the technology of packaging is to be developed for fishery products to improve the shelf life of fish/fishery products which are perishable.

One of the fundamental roles of sales dealings of fish is grading. It is defined as sorting of products based on some standards (Kohls & Uhl, 2005). The fish are mostly graded based on the size and weight. The price of the fish is decided even based on the place.

P4: Packaging and grading influences the quality of fish products

Agile Supply Chain:

According to the definition of supply chain agility, the supply chain has to adjust quickly to the speedy changes in the business environment (Yusuf, Sarhadi, & Gunasekaran, 1999). This idea is extended to agile competitors (Goldman, Nagel, & Preiss, 1995), agile innovations (Wilson & Doz, 20011), agile Business relationships (Preiss et al. 1996), agile enterprises (Goldman & Nagel, 1993); (Lu & Ramamurthy, 2012), agile information systems (Conboy, 2009), agile workforce (Qin, 2010), and agile supply chains (Christopher, 2000); (Swafford, Ghosh, & Murthy, 2008). This is useful for the businesses and firms which are dynamic in environment (Gunasekaran, 1999).

In the case of perishable products, the value of the product deteriorates as temperature and humidity changes with time and the prices also change (Blackburn and Scudder, 2009). The supply chain of perishables is vulnerable to the changes in economic blockages, changes in the environment (Evans, 2009). The literature indicates that the food system in future will have to follow the characteristics such as resilience, sustainability, competitiveness and ability to meet the expectations of the consumers. The consumers have become conscious on the source and the nutritional value of the food due to the diseases related to food intake (Nepstad, Stickler, & Almeida, 2006). This led to the demand of high quality and fresh food. In this situation the various strategies of supply chain management such as lean, agile and leagile were considered. The lean strategy is applied to the markets which are stable which try to reduce cost and increase efficiency by eliminating the waste. The agile supply chain strategy is applicable to the markets which are dynamic which need to be flexible, fast and innovative, assure quality and profitability. With the growing concern in food security, freshness and quality, both lean and agile supply chain strategies are required to manage the supply chain of the industry with perishable products. The consumers demand not only depends on the seasons and weather but also by promotional activities. This increases the demand uncertainty and requires a supply chain which is flexible, fast so that the waste is reduced.

Conclusion:

This study is an attempt to understand the factors which influence the supply chain of fish which has an impact on the quality of fish and fish products. Distribution channel is one of the factors considered to influence the quality of fish. Since fish is transferred from producers to the final consumer and is usually managed and controlled by the middlemen. The fishermen are not knowledgeable to get the best out of the supply chain as they are usually dominated by the middlemen or the wholesaler. Further, it is also necessary to maintain the quality of fish, the distribution channel need to be agile so that the supply of fish is done continuously with proper refrigeration at the optimal storage temperature so as to ensure the quality and safety of fish products.

The transportation of perishable products such as fish is faster by Air compared to other modes of transport but is very expensive. There would also be variations in the temperature during loading, unloading, storage and holding the product. A trade-off can be achieved by being agile in the various modes of transport so that the quality and safety of the fish products can be maintained. .

Packaging of the fish products also plays an important role in the countries like India where the temperature varies which affects the quality of fish products in transportation. Though there are various new packaging techniques by other manufacturers fisheries

sector still follows the traditional methods. This sector has to adopt agility in implementing scientific methods for packaging to compete with the International market so that the product is not rejected due to deterioration in quality. This will not only enhance the quality of fish but also improves the shelf life of fish/fish products.

Based on the literature, the quality of the fish is dependent on the various factors of the supply chain such as temperature, distribution channel, transportation, packaging and grading and various other factors. This study focused on the implementation of agility along with these factors to help in maintaining the quality and safety of the fish and fish products successfully with minimum losses and wastage of the fish and fish products. The future research can be carried out by considering all the factors which influence the fish supply chain and empirically substantiate the various factors influencing the fish supply chain.

References:

ATP. (2007). *Agreement on the International Carriage of Perishable Foodstuffs and on the Special Equipment to be Used for such Carriage.* Geneva.

Bolwijn, P. T., & Kumpe, T. (1998). Marktgericht ondernemen. *Management van continuïteit en vernieuwing, Van Gorcum, Assen*.

Brecht, J. K., Chau, K. V., Fonseca, S. C., Oliveira, F. A., Silva, F. M., Nunes, M. C., & Bender, R. J. (2003). Maintaining optimal atmosphere conditions for fruits and vegetables throughout the postharvest handling chain. *Postharvest Biology and Technology, 27*(1), 87-101.

Brown, S. L., & Eisenhardt, K. M. (1998). *Competing On The Edge , Strategy As Structured Chaos.* Boston, USA: Business School Press.

Buhr, B. L. (2003). Traceability and Information Technology in the Meat Supply Chain: Implications for Firm Organization and Market Structure. *Journal of Food Distribution Research, 34*, 13-26.

Christopher, M. (1992). *Logistics and Supply Chain Management.* London: Pitman Publishing.

Christopher, M. (2000). The Agile Supply Chain. Competing in Volatile Markets. *Industrial Marketing Management, 29*, 37-44.

Conboy, K. (2009). Agility from First Principles: Reconstructing the Concept of Agility in Information Systems Development. *Information Systems Research, 20*(3), 329-354.

Coyle, J. J., Bardi, E. J., & Jr., C. J. (2003). *The management of business logistics: A supply chain perspective (7 ed.):*. South-Western: Thomson Learning.

EAN. (2002). Traceability of fish guidelines. *EAN International*, 45.

Einarsson, H. (1992). Predicting the shelf life of cod (Gadus Morhua) fillets stored in air and modified atmosphere at temperatures between -4°C and +16°C. In H. H. (Ed.), *Quality Assurance in the Fish Industry* (pp. 479-488). Amsterdam: Elsevier Science Publishers.

Einarsson, H. (1994). Evaluation of a predictive model for the shelf life of cod (Gadus morhua) fillets stored in two different atmospheres at varying temperatures. *International Journal of Food Microbiology, 24*(1-2), 93-102.

Evans, A. (2009). *The Feeding of the Nine Billion – Global Food Security for the 21st Century. The Royal Institute of International Affairs.* London: Chatham House.

FAD/Uorld Bank/UNDP/CEC. (1989). *The future lies in Research FAD/Uorld Bank/UNDP/CEC report.* Rome: FAO.

FAO. (2007). FAO Fishery and Aquaculture Statistics Yearbook. 101.

FAO. (2008). *Fisheries – The State of World Fisheries and Aquaculture.*

FAO. (2009). *Utilization and trade. Fisheries Issues.* Rome: FAO Fisheries and Aquaculture Department.

FAO. (2011). *Review of the status of the world fishery resources.*

Frank, A., & Atle, G. G. (2009). Introduction To Special Issue: Innovation, Production And New Markets In Aquaculture,. *Aquaculture Economics & Management*.

Gangadharan, P. (1982). Proceedings of the Seminar on Packing and Packaging of Marine Products. *Marine Products Export Development Authority and Indian Institute of Packing*, 45-51. Bombay.

Georgiadis, P., Vlachos, D., & Iakovu, E. (2005). A system dynamics modeling framework for the strategic supply chain management of food chains. *Journal of Food Engineering, 70*, 351-364.

Goldman, S., & Nagel, R. (1993). Management, technology and agility: The emergence of a new era in manufacturing. *Int. J. Tech. Manage, 8*, 18-38.

Goldman, S., Nagel, R., & Preiss, K. (1995). *Agile Competitors and Virtual Organizations: Strategies for Enriching the Customer.* New York: Van Nostrand Reinhold.

Gopakumar, K. (1993). *Fish Packaging Technology (Gopakumar, K., Ed)*, . New Delhi: Concept Publishing Company.

Govindan, T., & Rao, C. (1987). Fishing Chimes. *6*(10), 17.

Gunasekaran, A. (1999). Agile manufacturing: a framework for research and development. *International Journal of Production Economics, 62*, 87-90.

Habib, D. M. (2010). Supply Chain Management: Theory and its Future Perspectives. *International Journal of Business, Management and Social Sciences, 1*(1).

Harland, C. (1996). Supply Chain Management, Purchasing and Supply Management, Logistics, Vertical Integration, Materials Management and Supply Chain Dynamics. In N. (. Slack, *Blackwell Encyclopedic Dictionary of Operations Management* . UK: Blackwell.

Houligan, J. B. (1980). International Supply Chains: A new Approach. *Management Decisions, 26*(3), 13-16.

Huss, H. H., & Ryder, J. (2003). Modern safety and quality assurance methods and systems. In L. A. H. H. Huss, *Assessment and Management of Seafood Safety and Quality.* (pp. 10-13). Rome: FAO: FAO Fisheries Technical Paper 444.

Investopedia. (2011). Retrieved October 2012, from http://www.investopedia.com/terms/v/valuechain.asp.

James, S. J., James, C., & Evans, J. A. (2006). Modelling of food transportation systems - a review. *International Journal of Refrigeration, 29*(6), 947-957.

Jedermann, R., Ruiz-Garcia, L., & Lang, W. (2009). Spatial temperature profiling by semipassive RFID loggers for perishable food transportation. *Computers and Electronics in Agriculture, 65*(2), 145-154.

Jol, S., Kassianenko, A., Wszol, K., & Oggel, J. (2005). Issues in Time and Temperature Abuse of Refrigerated Foods. *Food Safety Magazine*.

Kohls, R., & Uhl, J. (2005). Marketing of agricultural products. *Int. J Sup. Chain. Mgt. 9th edition, 2*(2), 315.

Lu, Y., & Ramamurthy, K. (2012). Understanding the Link Between Information Technology Capability and Organizational Agility: An Empirical Examination. *MIS Quarterly, 35*(4), 931-954.

Lütke Entrup, M., Günther, H.-O., van Beek, P., Grunow, M., & Seiler, T. (2005). Mixed-integer Linear Programming approaches to shelf-life-integrated planning and scheduling in yoghurt production. *International Journal of Production Research, 43*(23), 5071–5100.

Madsen, S. (2005). *Fra hav til bord – om fiskens rette behandling.* Fiskecirklen: Online publication.

McEntire, J. C., Arens, S., Bernstein, M., Bugusu, B., Busta, F. F., Cole, M., . . . Ohlhorst, S. (2010). Traceability (Product Tracing) in Food Systems: An IFT Report Submitted to the FDA Volume 1: Technical Aspects and Recommendations. *Technical Aspects and Recommendations. Comprehensive Reviews Food Science and food Safety,, 9*, 92- 158.

Mentzer, J. T., Dewitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. (2001). What is supply chain management? In J. T. Mentzer, *Supply chain Management* (pp. 1-25). Thousand Oaks, CA: Sage Publications.

Merriam-Webster. (2010). *Merriam-Webster Online Dictionary.* Retrieved January 5, 2010

Minegishi, S., & Thiel, D. (2000). System dynamics modeling and simulation of particular food supply chain. *Simulation Practice and Theory, 8*, 321-339.

Monczka, R., Robert, T., & Robert, H. (1994). *Purchasing and Supply Chain Management.* Cincinnati, OH: South- Western College Publishing.

Morrell, P. (2008). *The environmental impact of air cargo. Executive Conference & annual general meeting (EC/AGM) 2008.* Copenhagen, Denmark: The International Air Cargo Association (TIACA).

Moureh, J., Laguerre, O., Flick, D., & Commere, B. (2002). Analysis of use of insulating pallet covers for shipping heat-sensitive foodstuffs in ambient conditions. *Computers and Electronics in Agriculture, 34*(1-3), 89-109.

Nepstad, D. C., Stickler, C. M., & Almeida, O. T. (2006). Globalization of the amazon soy and beef industries: Opportunities for conservation. *Conservation Biology, 20*(6), 1595-1603.

Nunes, M. C., Emond, J. P., & Brecht, J. K. (2003). Quality of strawberries as affected by temperature abuse during ground, in-flight and retail handling operations. In L. M. (Eds.), *International Conference on Quality in Chains. An Integrated View on Fruit and Vegetable Quality* (pp. 239- 246). Acta Hort. (ISHS).

Olafsdottir, G. (2005). Volatile compounds as quality indicators in fish during chilled storage: Evaluation of microbial metabolites by an electronic nose. *PhD thesis*, 103. Faculty of Science. University of Iceland, Reykjavik.

Olafsdottir, O. G., Lauzon, H. L., Martinsdottir, E., Oehlenschlager, J., & Kristbergsson, K. (2006). Evaluation of shelf life of superchilled cod (Gadus morhua) fillets and the influence of temperature fluctuations during storage on microbial and chemical quality indicators. *Journal of Food Science, 71*(2), S97-S109.

Panozzo, G., & Cortella, G. (2008). Standards for transport of perishable goods are still adequate?: Connections between standards and technologies in perishable foodstuffs

transport. *Trends in Food Science & Technology, 19*(8), 432-440.

Pawsey, R. K. (1995). Preventing losses and preserving quality in food cargoes. In J. L. (Ed.), *Food, Nutrition and Agriculture - 15 - Food safety and trade: Food and Agriculture Organization (FAO) of the United Nations.*

Porter, M. (1980). *Value Chain Analysis.* London: Oxford Press Ltd.

Qin, Y. (2010). The authority structure of agri-food supply chain. *Future Information Technology and Management Engineering (FITME), 2010 International Conference,, 2*, pp. 193-195.

Raab, V., Bruckner, S., Beierle, E., Kampmann, Y., Petersen, B., & Kreyenschmidt, J. (2008). Generic model for the prediction of remaining shelf life in support of cold chain management in pork and poultry supply chains. *Journal on Chain and Network Science, 8*(1), 59-73.

Rao, C. (1975). Proceedings of the Symposium on Fish Processing in India. *Association of Food Scientists & Technologists (India), Mysore*, 19.

Rediers, H., Claes, M., Peeters, L., & Willems, K. A. (2009). Evaluation of the cold chain of fresh-cut endive from farmer to plate. *Postharvest Biology and Technology, 51*(2), 257-262.

Seafish. (2010). *Outlook for supplies of Icelandic cod and haddock to the UK* (7th ed.). Retrieved Spring 2010

Sen Gupta, S., Turnbull, J., & Seamless. (1996). Optimization of the entire supply chain. *IIE Solutions, 28*(10).

Silva, D., D.A.M., & Masahiro, Y. (2006). Regional preferences in the Japanese Seafood consumption: an empirical analysis of consumer purchasing behavior on domestic versus imported seafood. *Journal of the Regional Fisheries Society, Japan, 46*(2), 83–104.

Simpson, R., Almonacid, S., Acevedo, C., & Cortes, C. (2003). Mathematical Model to Predict Effect of Temperature Abuse in Map Systems Applied to Pacific Hake (Merluccius australis). *Journal of Food Process Engineering, 26*(5), 413-434.

Sivertsvik, M., Rosnes, J. T., & Kleiberg, G. H. (2003). Effect of Modified Atmosphere Packaging and Superchilled Storage on the Microbial and Sensory Quality of Atlantic Salmon (Salmo salar) Fillets. *Journal of Food Science, 68*(4), 1467-1472.

Statistics Iceland. (2009). Statistical Series. *Fisheries. Export and export production of marine products*, 28.

Statistics Iceland. (2010). Iceland in Figures 2009-2010. 22.

Stock, J. R., & Lambert, D. (2001). *Strategic Logistics Management* (4th ed.). Boston, Irwin: McGraw-Hill.

Stringer, M., & Hall, M. (2006). A generic model of the integrated food supply chain to aid the investigation of food safety breakdowns. *Food Control, 18*, 755–765.

Subramani, M. (2004). How do suppliers do benefit from information technology use in supply chain relationships? *MIS Quarterly, 28*(1), 45-73.

Subramanian, M. (1984). Marine Products Export Development Authority and Indian Institute of Packaging. *Proceedings of the Seminar on Packing and Packaging of Marine Products*, (p. 9). Bombay.

Swafford, P., Ghosh, S., & Murthy, N. (2008). Achieving Supply Chain Agility through IT Integration and Flexibility. *International Journal of Production Economics, 116*(2), 288-297.

Toley, V. (1986). Association of Food scientists and technologists (India). *Proceedings of the Symposium on Recent Developments in Food Packaging*, (pp. 37-40). Mysore.

Van der Vorst, J., Beulens, A., & van Beek, P. (2000). Modelling and simulating multi-echelon food systems. *European Journal of Operational Research, 122*, 354–366.

Van der Vorst, J., Tromp, S., & van der Zee, D.-J. (2005). A simulation environment for the redesign of food supply chain networks: Modeling quality controlled logistics. In M. S. Kuhl.

Vannuccini, S. (2004). *Overview of fish production, utilization, consumption and trade: based on 2002 data.* Rome: FAO, Fishery Information, Data and Statistics Unit.

Veerraju, P. (1974). Packaging in Developing Countries, Indian Institute of Packaging. *Proceedings of the Inter Regional Seminar.* Bombay.

Viswanadham, N. (2008). Improving India Food Supply Chain. *Supply Chain Management & Logistics 2.0.* , 28-32.

Wilson, K., & Doz, Y. (20011). Agile Innovation: A Footprint Balancing Distance and Immersion. *California Management Review, 53*(2), 6-26.

World Fishing Net. (2010). *Where next for farmed cod?* Retrieved April 22, 2010, from http://www.worldfishing.net/news101/where-next-for-farmed-cod.

Yusuf, Y., Sarhadi, M., & Gunasekaran, A. (1999). Agile Manufacturing: The Drivers, Concepts and Attributes. *International Journal of Production Economics, 62*(1/2), 33-43.

******