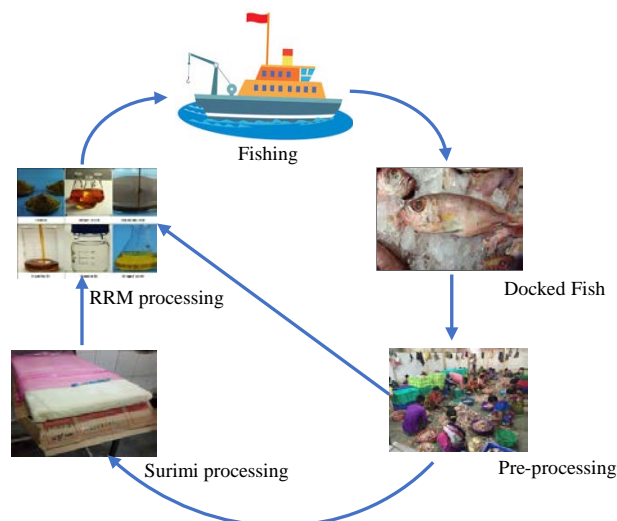


ReValue project Report – Deliverable 1.2

Logistics and Cold Chain Management Concepts

Author(s)

M.S. Dasgupta (BITS Pilani)
Srikanta Routroy (BITS Pilani)
Souvik Bhattacharyya (BITS Pilani)
Abdullah Sultan (BITS Pilani)
Santosh Kumar Saini (BITS Pilani)
Khushboo Gupta (AMITY University)
Nutan Kaushik (AMITY University)
Kristina Widell (SINTEF Ocean)
Guro Møen Tveit (SINTEF Ocean)
Maitri Thakur (SINTEF Ocean)





SINTEF Ocean AS
 SINTEF Ocean AS
 Address:
 Postboks 4762 Torgarden
 NO-7465 Trondheim
 NORWAY
 Switchboard: +47 46415000

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AUTHOR(S)

M.S. Dasgupta (BITS Pilani)
 Srikanta Routroy (BITS Pilani)
 Souvik Bhattacharyya (BITS Pilani)
 Abdullah Sultan (BITS Pilani)
 Santosh Kumar Saini (BITS Pilani)
 Khushboo Gupta (AMITY University)
 Nutan Kaushik (AMITY University)
 Kristina Widell (SINTEF Ocean)
 Guro Møen Tveit (SINTEF Ocean)
 Maitri Thakur (SINTEF Ocean)

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ABSTRACT

This is a summarised report conveying deliverable D1.2 (i.e. Logistics and cold chain management task) of WP1 in the Revalue project. The results mentioned in this report have been derived from the proceedings communicated to the 25th IIR International Congress of Refrigeration, Montreal & 6th IIR Conference on Sustainability and the Cold Chain, Nantes. Food loss due to improper cold chain setups and underdeveloped logistics hold a significant role in any perishable food supply chain. Revamping the entire structure with a large-scale investment may provide a solution but the implementation of such a development is difficult due to highly fragmented supply chain (WP 1 report, 2019). This report explores the potentials of improving the cold chain and associated logistics which will lead to effectual improvements.

KEYWORDS: food supply chain;
 cold chain; supply chain
 configurations



SINTEF Ocean AS
SINTEF Ocean AS
Address:
Postboks 4762 Torgarden
NO-7465 Trondheim
NORWAY
Switchboard: +47 46415000

Enterprise /VAT No:
NO 937 357 370 MVA

PREPARED BY
M S Dasgupta

SIGNATURE
M S Dasgupta

CHECKED BY
Kristina Widell

SIGNATURE
Kristina N. Widell

APPROVED BY
Maitri Thakur

SIGNATURE
Maitri Thakur

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1 Introduction

The growing population and resulting growth of demand in global food market has made countries to intensify production to serve this mounting demand. Continuous cold chain logistics hold a prima face in maintaining product quality and optimum shelf-life along the entire value chain. A cold chain comprises the sequence of logistical activities with controllable variables in the perishable supply chain (Mercier and Uysal, 2018). The necessity of a cold chain gets amplified in a country like India. This happens as it serves a dual role of maintaining its position as a leading global exporter (Setia, 2019) and satisfying the requirements of its mounting population. With an estimated food waste or loss of 40% in the food sector (NAAS, 2019) summing to INR 440 Billion, the requirement of an appropriate and connected cold chain is highly essential. Added derivatives from the Emerson report (2015) clearly indicate a trivial in-country storage capacity of 11% for its self-produced products, obliging the need of a \$6-\$10 billion investment in the cold chain sector (Gonsalves, 2017).

Cold chains require added robustness in terms of continuity when fresh products with short shelf-life such as fish are handled. India's share of fish discards sums to an annual loss of Rs 15,000 crore (Mishra, 2013). Banu and Lunghar (2019) cited inadequacy in cold chain being one of the major reason. Cold chain requirements get further enlarged when processed seafood products like surimi are involved. Sharing 2.5% of the total processed seafood export earnings (Dasgupta et al., 2019), Indian surimi is made from low-cost underutilized fish species. Basically, surimi is deboned fish flesh, washed with water and blended with cryoprotectants to provide an extended frozen shelf life (Park et al., 1997). The process of surimi production is generally witnessed by the production of head and viscera termed as Rest Raw Material (RRM) usually discarded as waste or processed by specific secondary industries.

This report highlights the use of lean management techniques in preserving the surimi cold chain and improving associated logistics with reduced dependence on refrigeration, considering the high implementation costs and inherent age-old infrastructure.

2 Problem statement

Reduced level of coordination and fragmented nature of the Indian Surimi Supply Chain (SSC) cause a complete dependence on Third Party Logistics provider and condensed cold chain robustness reducing efficiency. Hence, the existing level of supply chain uncertainty prevailing and the hold time (inventory time) along the supply chain are discussed. Hence, this assists in gaining adequate idea regarding sector specific improvements to be carried out in the SSC. This report directs towards attaining a continuous cold chain and provides a set of corrective actions.

3 Objectives

The objective of T1.2 in WP1 is to understand and analyse the various aspects related to the logistics and cold chain in the Indian surimi industry. Various stages are analysed to improve the existing cold chain and ensure high responsiveness at a low cost.

The connection and dependencies between various stakeholders of the SSC (WP 1 report, 2019), holds the major problem causing logistics and cold chain required to be maintained across the value chain. Hence, this problem increases the logistics cost. Appropriate analytical tools such as Supply Chain Response Matrix (SCRM) and strategic fit diagrams are used to analyse the existing Indian surimi value chain. The outcomes of the study visualise the current level of cold chain with improvements and level of responsiveness required in terms of logistics. This report provides adequate information on cold chain improvement, highlighting the logistic responsiveness required for the SSC to be efficient.

4 Methodology

Information acquisition was initiated by visits to fishing docks, pre-processing, surimi processing plants and RRM processing centres followed by semi-structured interviews carried out with supply chain stakeholders.

SCRM and strategic fit diagrams were developed from derived information to provide a clear representation of the hold time (inventory time) occurring across the supply chain. The results obtained were subjected to a 5W2H (i.e. What, Why, Where, When, Who, How and How often) model to identify and rectify existing problems. Illustrated in Figure 1, the model is applied to the identified issues to assist in Kaizen decision making by identifying the root causes. Comprising a set of questions of 5W2H, the method expands the scope for Kaizen enactment aiding in the implementation of the most substantial improvement. The conclusions derived have been used as struts for structured improvements called Kaizens. It aims to remove wasteful activities and propose cost-effective adaptable developments by standardizing operations. Considering adaptability of improvements in the Indian stance, a survey was carried out by undertaking discussions with supply chain stakeholders covering fishers, processors and aggregators. The solutions obtained could be effectively applied in the Indian SSC and thereby improving the cold chain with minimal effort and expense..

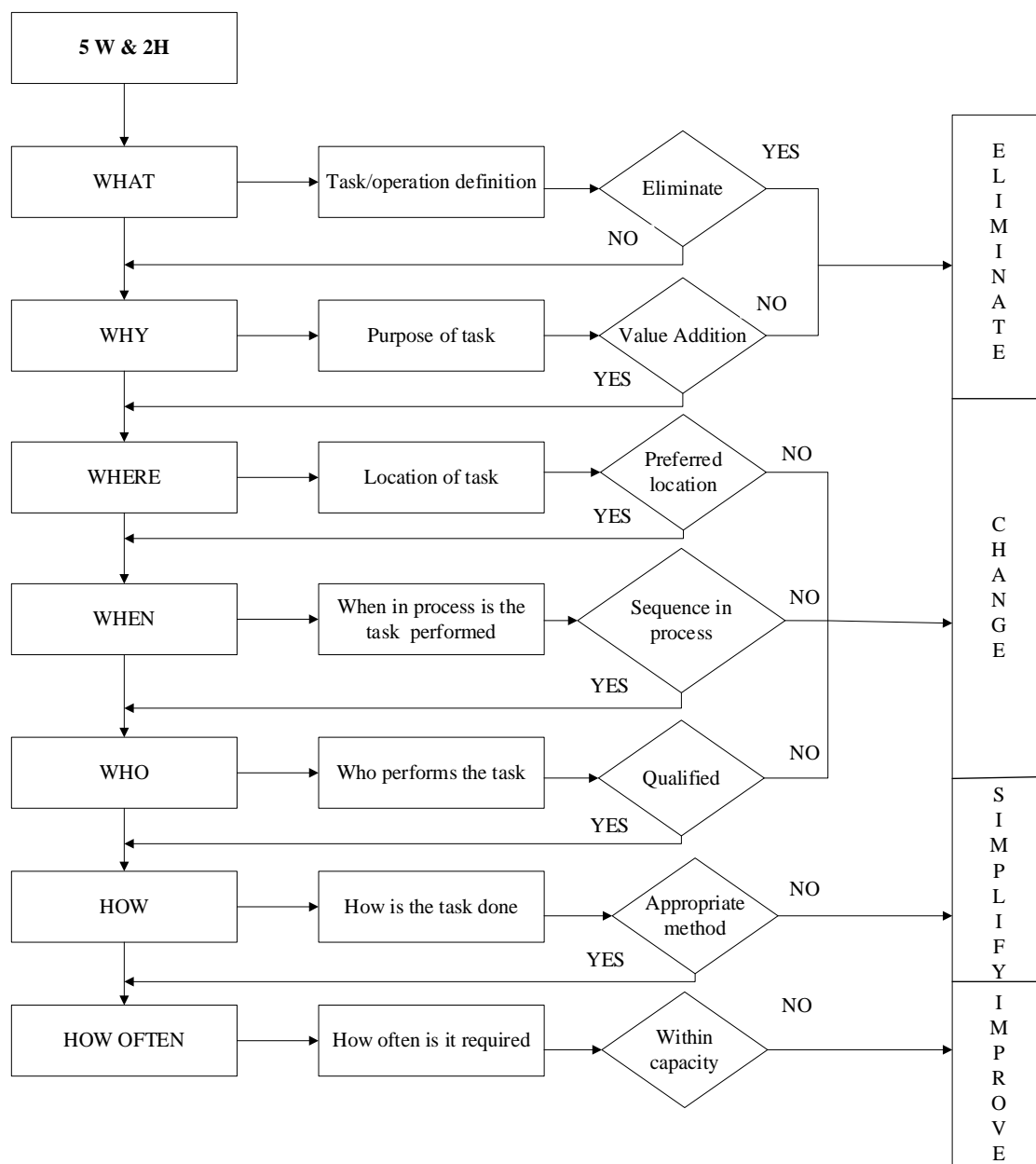


Figure 1: Adopted 5W2H model (Source: 2015 Quality-One International)

5 Results

5.1 Assessing logistic requirements using strategic fit diagrams

Discussions held with supply chain stakeholders enable evaluation of the existing Implied Demand Uncertainty (IDU) that captures various uncertainties and requirements. The strategic fit diagram constructed considering IDU and supply chain capabilities (Figure 2). The inherent uncertainty behaviour, high operations cost and low agility make the IDU value quite high making supply chain operation inefficient. The level of responsiveness achieved in the existing SSC in India was also estimated (i.e. the second aspect of strategic fit). Figure 1 shows the zone of strategic fit at point “A”. The level of IDU and present agility when mapped in the same graph, the location is point B which is not in the zone of strategic fit. It is significantly below the point “A”. This indicates that the improvement is needed.

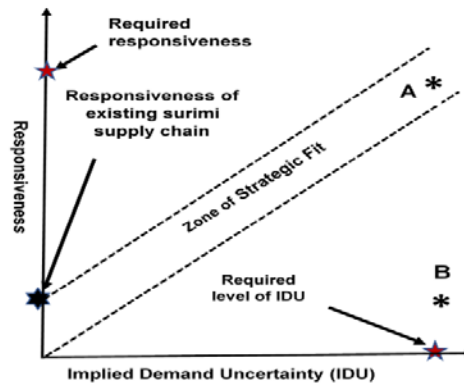


Figure 2: Strategic fit of SSC

5.2 Assessing the cold chain issues in the SSC

Introducing improvements in the surimi production requires gaining, visualizing and prioritizing different zones such as (fishing, dock phase pre-processing and processing of surimi and RRM). Shelf life is dependent on lead time and inventory maintenance and it plays a critical role in the quality of the product. SCRM developed based on derivations from visits and interviews is represented in Figure 3. The variability involved in the supply chain activities are included (WP1 report, 2019). The diagram represents lead time on the horizontal axis and amount of standing inventory (in days) on the vertical axis. Results denote a total of 11.71 days with a cumulative inventory time of 9.37 days. The cumulative inventory specified includes transportation, storage, delay etc. occurring along the SSC. The sizeable standing inventory requires controlled temperatures for maintaining the harvested catch. Further evaluation denotes the use of crushed ice for maintaining temperatures, absence of precise logistics along the value chain in total affecting product quality. Table 1 provides a representation of allied issues occurring in the entire supply chain. These issues include poor market connections, meagre access to information and technology, cognizance deficiency, inaccessible government resources together with limited incomes across the entire surimi supply chain. The cold chain in the SSC needs to be upheld. The inefficiency cold chain impedes the added value (Bogataj et al., 2005) and it creates product loss/wastage. With majority of value degradation found to occur in the post-harvest phase (Ames et.al., 1991), investment in refrigeration might seem the quick response offering multidimensional benefits (Bharti, 2014). However, the existing fiscal obligation in the Indian scenario needs to be foreseen as the dominant barrier to implementation. The current work focuses on operational improvements considering cost as a key role in introducing developments (Lopez et.al, 2013).

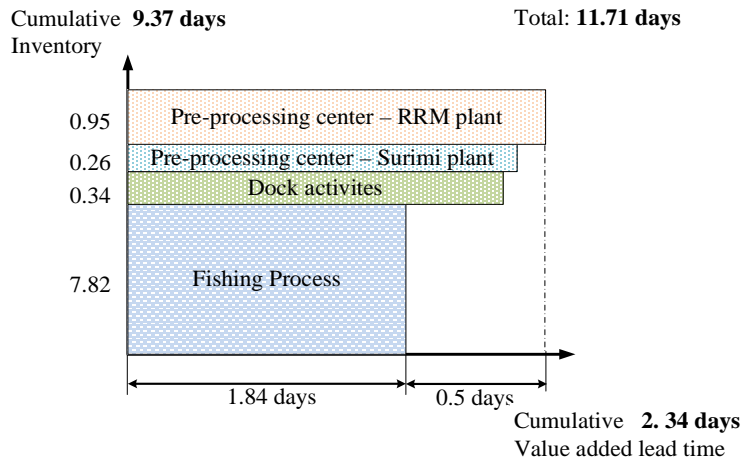


Figure 3: Supply Chain Response Matrix of Indian SSC

Table 1: Cold chain issues in the SSC

S.no	Supply chain stage	Issues
1.	Onboard Issues	<ul style="list-style-type: none"> • Manual fish sorting in unshaded areas • Manual icing leading to improper cooling • No proper means to check storage temperature. • Icing process not instantaneous • Absence of onboard refrigeration entails the onboard carrying of ice prior fishing • Frequent exposure to atmosphere during repeated fish loading in storage containers.
2.	Dock Issues	<ul style="list-style-type: none"> • Long waiting time for de-icing. • Unloading done in exposed atmosphere • After de-icing, fish remains un-iced till weighing operation • Transfer of catch from boats to shaded area in non-insulated exposed containers. • Dock operations done in a broken cold chain • Unloaded fish containers iced just prior loading • Longer delays during absence of logistics • Continuously intermittent cold chain
3.	Downstream Issues	<ul style="list-style-type: none"> • Proper temperature maintenance amidst fears of lot rejections • Erratic temperature maintenance on RRM • Long distance transfer of RRM in trucks lacking insulation from the ambient atmosphere • Frequent halts of transport trucks at state borders affecting RRM quality (even if Reefers are used).

6 Discussion

Observations clearly indicate the pressing need to shift supply chain responsiveness. Though the term responsiveness covers a wide range of issues, logistics holds a vital position. Previous working reports also suggested importance of logistics and need of localization for agility. Ensuring improvements require the implementation of techniques that are easily applicable and acceptable. This holds important in a country like India, where adoption of new technologies is low because of high implementation cost in addition to other issues (Rao, 2007 and (Kenton, 2019)). Thus, the Indian SSC needs to be catered using a structured management philosophy that enhances both customer value and eliminates wastes existing in the system without adoption of new technologies. The principles of lean, according to Womack and Jones (1996), require the application of specific lean tools (Dean and Bowen, 1994) to handle the issues of quality control and waste elimination. Signified as “the change to improve”, Kaizens aim towards a culture of continuous change to evolve towards the best practices (Rodriguez et al., 2018). Hence the execution of Lean-Kaizens in improvising the existing cold chain structure of the SSC comes into operation (Kumar et al., 2018).

Based on the derived supply chain issues, added understanding into the surimi and RRM utilization is obtained using a 5W2H model (Klock et al., 2016).

Primary investigations conclude a visible absence in the standardization of activities, thereby depicting a weak cold chain (Ashok et al., 2017). Preserving product quality being the prime objective in a cold chain, requires concentrated improvements. Operational implementation of crucial Kaizens proves decisive in the effective functioning of the SSC. Kaizens with a focus on quality (KFQ), Kaizen focus on productivity enhancement (KFPE) and both KFQ & KFPE have been proposed. Table 2 lists the source of some of the prominent problems affecting cold chain performance in the supply chain. The solution to the problems mentioned is worked out based on suggestions derived from various stakeholders through semi-structured interviews. The execution difficulty is assessed qualitatively in terms of Low (L), Medium (M) and High (H).

Apart from the recommended operational reforms, structural modifications in the supply chain can also drastically renovate the level of dependence on the cold chain. Responsive terrestrial logistics prove essential in a robust cold chain linking supply chain members at the expense of economy and energy. Improvisation by localization reduces reliance on logistics, creating a cold chain that is robust and in togetherness offers reduced production lead times with the entire supply chain positioned in proximate localities.

Table 2: Problems, Causes and Solutions for existing surimi cold chain scenario in India

Problems identified	Root Cause	Kaizens	Level of Improvement	Cost of Implementation	Execution Difficulty (L/M/H)
Exposed transfer of Ice from trucks to boats	Lack of covered and insulated carriages for ice transfer	Cover top of the cart using a tarpoil sheet to prevent exposure and maintain temperature	KFQ	Rs 0.07/Sq. Meter (tarpoil sheet)	L
Extensive exposure of fish in an open environment	Manual sorting in an exposed area	Carry sorting operation in a shaded area	KFQ	Insignificant	L
Extensive exposure of fish in an open environment	Manual sorting in an exposed area	Sorting using an on-board grading system	KFQ & KFPE	Rs 2,75,302.00/PC	H
Inadequacy in chilling of fish	Icing being momentary and manual causes non-uniform cooling	Place ice blocks along container walls to provide better thermal insulation	KFQ	Insignificant	L
Unequal fish icing	Non-uniform manual icing	Join all containers with a pressurized ice distribution system connected to the central ice storage container.	KFQ & KFPE	Rs10,000/unit	H
Delayed fish icing	Reduced workforce for sorting and icing	Use dedicated personnel for instantaneous icing	KFQ & KFPE	Insignificant	L
Inability to check and control fish storage temperature	Absence of a centrally monitored temperature measurement device	Use on-board temperature sensors to note deviations, and nourish ice accordingly	KFQ	Rs 12000/pc (data logger) +Rs 800/sensor	M
Large quantity transport of thermally unrestrained ice	The long process flow time of catch first caught	Use gathering boats for fish aggregation and proceed to the dock for evading degradation due to scarce cold chain	KFQ	Rs 20-30 lakh (Per mid-sized boat)	H
Recurrent atmospheric exposure during stacking	Storage container design causes atmosphere exposure	Ensure appropriate fish-ice packing through a piece loading to minimize the degree of exposure	KFQ	Insignificant	L
Large quantity transport of thermally unrestrained ice	The long process flow time of catch first caught	Setting up an offshore surimi plant	KFQ	Significant cost	H

Delayed unloading of fish at the dock	Absence of general resources (i.e., Workforces, cart, truck) for fish unload	A prior intimation of arrival schedule	KFQ & KFPE	Insignificant cost	L
Exposure operation post-de-icing	A bucket by bucket unloading process interrupts the cold chain	Alter existing container designs to separable containers, preserving an unbroken cold chain	KFPE	Significant cost	H
Delays in fish transfer to weighing area	Diminish time for cart fill and transfer to the weighing area in the unchilled state	Use RID pumps for fish transfer without disrupting the cold chain	KFPE	Significant cost	H
Inessential catch weighing process	Time-consuming operation causing recurrent exposure	Structure intrinsic weighing gauges in each container	KFQ & KFPE	Significant cost	H
Transport fish to processing plants	Use of non-reefer transport	Localization of processing centres near dock areas	KFQ & KFPE	Significant cost	H
RRM preserved in an erratic temperature environment	Pre-processing centres lack integrated cold chain	Shift deheading operations into surimi processing plants	KFQ	Insignificant cost	H
Inefficient RRM management	Fragmented members consider quality at the least	The amalgamation of pre-processing centres into a single facility (i.e., RRM park) promoting resourceful utilization	KFQ & KFPE	Significant cost	H

7 Conclusions

Supply chain structure plays a crucial role in determining the level of efficiency and responsiveness required in catering to the cold chain requirements. With processing facilities and transportation being critical drivers of supply chain structure, it hence remains purely decisive for determining the supply chain strategy. Managing the cold chain in India requires a multi-facet growth dispersing across various extents devoid of sole upliftment of a single probable. The introduction of Lean-Kaizens can effectively reduce the extent of reliance on refrigeration in a cold chain. It can enhance the supply chain performance and reducing colossal dependence on massive investments on cold chain infrastructure transition.

Some major conclusions derived from this study are as follows:

- Long distance transportation and indecorous cold chain form the significant portion of the supply side of the Indian SSC.
- Proposed supply chain structures have a significant influence on the lead time and hence need to be reduced.
- There is an impulsive need for deep localisation of processing plants for surimi to improve responsiveness and cut transportation costs.

8 Further work

As the supply side of surimi value chain in India is operating far from the zone of strategic fit and required level of cold chain, efforts should be made to shift the operating point towards zone of strategic fit. Thus, the analysis of the surimi value chain should be made with an aim to improve efficiency and responsiveness. Localisation and adoption of modern technology(s) can enhance the required level of efficiency and responsiveness. A study along these directions should be carried out considering various issues such as transition cost, impediments, socio-economic impact and implementation framework.

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