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Report

Value stream map and supply chain interdependencies in India

Surimi case

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ABSTRACT

This report is a part of WP1 in the Revalue project and presents the findings from process mapping of the Surimi value chain in India. There are many factors which have been identified as critical in maintaining fish and RRM quality. These include fragmented ownerships, fishing area identification, fishing boat and its capacity, boat unloading time and practice, absence of real time information sharing, visual inspections of fish quality at various stages, non-standard cold chain, lack of temperature measurement system, distributed location of operations etc. It was concluded from the process flow charts and cost-responsiveness analysis that the existing Surimi supply chain performance in India can be improved by removing the manual touch points and non-value-added activities. This will have positive impacts on the raw material quality and refrigeration required in the system proportionately.

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1 Introduction

Fishing and allied activities are prominent providers of jobs and sustenance for a large population along the 7500 km long coastline of India. Apart from the catch from open sea, a large share of fish for both domestic consumption and export comes from various inland rivers, ponds and water bodies under culture. It is estimated that about 60% of the domestic population consumes fish (Salim, 2016), however, the annual per capita consumption of fish is only about 8-9 kg, which is well below the global per head consumption estimated at 22.3 kg[1]. The domestic consumption also has regional bias towards fresh catch from inland water sources such as river and farming of fish in ponds. For India, the total earnings from seafood export was $7.08 billion during the financial year 2017-18 (Nambudri, 2018), of which 44% was generated from export of just one single species – white leg shrimp (*Litopenaeus Vannamei*). Whole frozen fish is the second largest export product and contributed to 25.6% in terms of quantity and 10.4% in terms of earning. Among the processed seafood exported from India, Surimi is an important product, which has a value share of 2.5% of total export earnings. Japan is by far the largest importer of Indian Surimi. Considering the large Surimi demand in USA, Japan, China and various European countries, there is a huge potential for growth in Indian export. Market potential of Surimi derived ready-to-eat food made in India also may be explored.

Surimi is processed fish meat that is used as main ingredient of various sea food. In India, Surimi is made from a variety of fish species like Pink Perch, Ribbon Fish, Lizard Fish, bronze croaker, Reef cod, and Crocker Fish (Figure 1.1). Surimi derived products include both traditional Japanese fish cakes and imitation seafood products (e.g. 'crab sticks') which is the most common form in the US and Europe (Mansfield, 2003). Surimi supply chain (SSC) includes all the activities from "Sea" to "Plate" such as inbound logistics, warehousing practices, process sequence, management of rest raw material (RRM) and finally the outbound logistics of Surimi paste and various Surimi products. In India, the marginal fishermen carry out significant portion of fishing for Surimi production with skills often passed down by generations and more often, they remain unaware of innovative technologies.

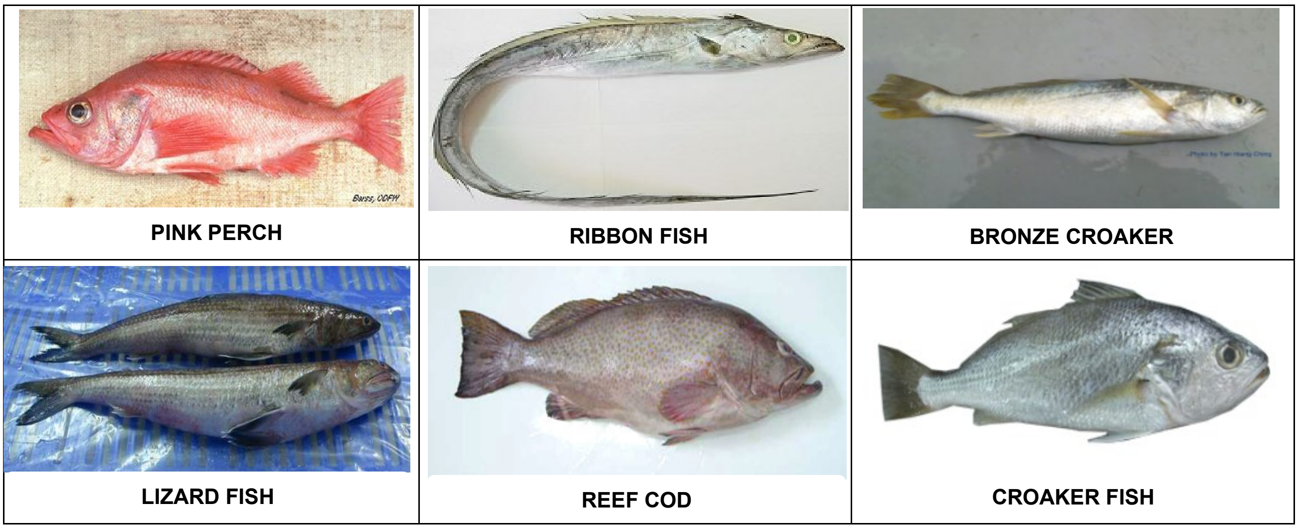


Figure 1.1: Types of fish used for Surimi production

During the processing of fish for Surimi production, the head, gut and skin portion of the fish, termed as RRM, are discarded. RRM is processed by certain secondary industries to make value-added products. Value Added Products generated from RRM can be classified into four major groups, such as plant fertilizers, livestock feeds,

[1] https://ec.europa.eu/jrc/en/news/how-much-fish-do-we-consume-first-global-seafood-consumption-footprint-published

value-added foods, and specialty ingredients. The value addition is minimum for plant fertilizers and maximum in case of value-added foods and specialty ingredients (Torres et al., 2007).

Surimi price in international market is sensitive to quality and seasonal variation of demand and supply. Quality of Surimi is decided based on its colour (whiteness), texture, gel strength and assurance of food safety. It is influenced by complex interactions between natural inputs and their environments, production techniques employed, additives used etc. (Mansfield, 2003). The processing cannot, however, compensate for lack of quality raw material as input.

The quality of input raw material plays a vital role in ensuring the quality of Surimi. This puts emphasis on preservation of fish immediately after the catch. The current study focuses on mapping the supply side of Surimi chain in India that includes all the processes related to fish harvesting (i.e. sea operations), transporting, sorting, and other handling procedures until the fish reaches the Surimi processing plant followed by analysing the SSC in the country in terms of supply chain strategy and developing a Cost-Responsiveness Efficient Frontier curve. Losses occurring in the Surimi value chain need to be identified in order to establish a well sustainable architecture for the Indian SSC. A process flow map is used to represent the process, following which a value stream map is constructed. The value stream map provides a visual representation of the information and material flow taking place in the chain and can help in identifying the various types of wastes involved (Value adding and Non value adding activities).

SSC in India is not well developed in general. Most of the processes in the SSC are not organized including logistics activities of fish raw material, RRM and cold chain management. This has a negative impact on various aspects such as fish quality, cost, profitability and quality of the value-added products. Supply chain strategy is defined as the process of managing organizational resources in a way that best fits its supply chain capability and meets its competitive strategy (i.e. the set of customer needs that the organization wants to fulfil) by exploiting the right balance between efficiency and responsiveness (Khorramshahgol, 2018). Manufacturing firms need to formulate, adopt and implement its supply chain strategy in such a way that it can help firms to increase their competitiveness in today's dynamic, uncertain, and risky business environments (Roh et al., 2014). Although supply chain strategies, in general manufacturing and service sector are well implemented in India, it is not the same for Surimi supply chain.

This report is a deliverable under the project ReValue – *Innovative technologies for improving resource utilization in the Indo-European fish value chains* funded through the INNO-INDIGO Joint Call on Bio economy. This work is a part of WP1 on Cold Chain Management. The structure of the remainder of this report is as follows: Section 2 states main objectives of this study. Section 3 provides a detailed overview of various problems in SSC in India. Section 4 presents the methodology adopted to achieve the stated objectives and other related processes. Section 5 presents the results obtained from the study. Discussion based on the results is given in section 6 while section 7 presents the conclusions from this study.

2 Problem statement

Ensuring uninterrupted supply and maintaining quality of fish from fishing point to final consumption point is a key parameter that will enable Indian firms to compete and succeed in the global seafood market place. Product quality is an important measure of performance in supply chain management (Zahra Lotfi et al., 2013). Fish quality deterioration starts at the minute the fish is caught at sea, and even though preventive measures like iced storage in boat and cold storages on shore are used, additional measures are needed to help maintain and monitor temperature abuse if any during storage in boat and unloading at dock to reduce wastage and ensure food safety. Further, the wash water and the RRM generated at various stages in the industry is poorly utilized but have a large potential for making various by-products and nutrition rich food additives.

With the world population set to approach an estimated 9 billion by 2050, against a background of finite natural resources, renewable biological resources need to be secured for healthy food and animal feed to meet the nutritional requirements of the growing population. Surimi, derived from low value fish, is a valuable source of protein. The quality of the Surimi produced depends on many factors, however cold chain aspects are deliberated in this report.

The level of co-ordination existing between the major stakeholders in the chain is found low and the objectives of each member of the supply chain are competing and conflicting with others. As technology intervention is low in the supply side of the Surimi supply chain, the amount of information shared between the various stake holders is also minimal. As a result the end goal of producing quality Surimi suffers. Each stage tries to maximize its own profits, resulting in actions that often diminish total supply chain profits. The amount of fragmentation in the present state is visible in the VSM and this can assist in making judicious choice of corrective action.

3 Objectives

The objective of the study at hand (T1.1 in WP1) is to comprehend and analyse the various aspects related to the Indian Surimi industry which has a good growth potential both in terms of market volume and market spread. Various stages are to be analysed to reduce the wastage of raw material in the supply side, reduce cycle time as well as to improve productivity and ensure high responsiveness at a low cost.

The inter-relationship between various stakeholders of the SSC is also studied to ensure food safety and security. Appropriate analytical tools such as cost responsive efficient frontier, Value Stream Mapping, and process flow chart are used to analyse the existing Indian Surimi value chain. To make the possible improvements in the cold chain, thermal modelling of the iced storage system in boat and refrigeration system of Surimi processing plant at various temperature will be carried out (WP1-T1.3 Energy efficient refrigeration systems using climate friendly natural refrigerants).

The flow process charts are employed to collect and categorise various processes occurring in the chain. Following which a value stream map (VSM) is generated followed by the application of Kaizens and 5S techniques. Many manufacturers adopt kaizen techniques and 5S practices for maintaining an orderly workplace to achieve significant organizational benefits such as improved productivity, check on quality, cost optimization, waste reduction, elimination of unplanned downtime, enhanced inventory management, employee empowerment, delivery adherence etc. (Bayo-Moriones et al., 2010, Chen et al., 2010, Vinodh et al., 2013 and Randhawa and Ahuja, 2017). The 5S having English meaning of five Japanese words i.e. Seiri (sorting), Seiton (set in order), Seiso (shine), Seiketsu (standardize) and Shitsuke (sustain) has been evolved to use in mid 1950s at Japan for continuous improvement and better safety standards and environment in manufacturing sector through improved housekeeping (Gupta and Jain, 2015).

4 Methodology

First hand observation of process at fish landing site, pre-processing site and Surimi manufacturing plant endowed us with experiential learning. Formal and informal interaction was carried out with various supply chain members, during visits, to collect primary data and literature review was carried out for secondary information. Pre-prepared questionnaires were used to get information regarding the current fishing practices and flow of raw material in the value chain. Time estimates of different activities were captured along the SSC. Temperature was also measured during various activities using a hand-held instrument. The significance of lead time in fishing is prominent owing to the perishable nature of fish thereby demanding a thorough analysis of activities occurring in the value chain. To identify the major time-consuming events in a fishing cycle, a detailed walk through of the various fishing activities was conducted. A process flow map was used in achieving this goal by breaking down the major activities into minor measurable activities that can easily be traced and used to identify the slack time. To reduce the complexity of data collection, the whole fishing activity was divided into four phases: preparatory phase, fishing phase, dock activities phase, activities carried out at de-heading centre to Surimi plant and de-heading centre to RRM plant. Further exploration with regards to temperature maintenance of the raw material was done by measuring temperatures at different instances along the value chain.

The various processes studied were:

- Loading of essential supplies in boat before a fishing trip (for example ice, water and fuel).
- Fishing and other activities on boat.
- De-icing of the catch at the end of fishing trip,
- Manual unloading, weighing, de-heading and gutting, sorting of fresh and waste, stacking of fish and ice in crates, loading-unloading of truck etc.

A structured questionnaire (see Appendix) was developed to collect the quantitative and qualitative information from various stake holders including fisher men and aggregator. Also semi-structured interviews were conducted to understand and capture information related to the various aspects of the processes and practices those are not covered in the structured questionnaire. The data collected was analysed using various tools such as cost responsive efficient frontier, process flow map, value stream mapping etc. It is also used to propose and develop future state map keeping in mind the various factors affecting fish quality depending on the derived conclusions from the current value stream map.

4.1 Cost-Responsiveness Efficient Frontier

The Cost responsiveness efficient frontier (CREF) helps organizations to find the right balance between responsiveness and efficiency, and hence achieve a strategic fit between organizational strategy and supply chain capabilities (Al Husain and Khorramshahgol, 2018). The Cost-Responsiveness Efficient Frontier (CREF) was drawn for the SSC in order to understand the degree of inefficiencies in terms of responsiveness and efficiency. The CREF curve denotes the lowest possible cost incurred in the supply chain/system for developing the required level of responsiveness based on the existing technology (Chopra et al., 2016). While developing CREF in a specific environment, one must estimate qualitatively the cost involved (taken in X-axis with highest value at origin and then cost value decreases) and maximum level responsiveness involved (taken in Y-axis with highest value when X is at origin) that can be developed in that environment. Therefore, the zone below CREF is an inefficient zone, the zone above CREF is impossible and all the points on the CREF are efficient points.

4.2 Strategic Fit

Strategic fit here refers to a consistency between the need of fulfilling supply requirements and supply chain capabilities to achieve strategic fit along the SSC in India to gain competitive advantage. The three steps for developing right supply chain strategy are

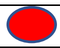
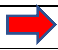
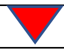
i) Evaluation of Implied Demand Uncertainty (IDU)
ii) Understanding the Supply Chain Capabilities (SCC) in terms of responsiveness
iii) Matching of IDU and SCC (Fisher, 1997).

In the current study, IDU is evaluated based on the level of uncertainty imposed on the SSC while satisfying its supply requirements. It was observed and captured in Indian environment through industrial visits and formal and informal discussions with various supply chain members including key persons such as company owner and plant manager at two Surimi manufacturing plants and one RRM processing plant and also couple of fish aggregators and fishermen at fishing dock.

4.3 Flow Process Charts

A process flow chart is a diagram of the steps involved in a job, operation or process in order to identify the different activities involved in a process by making use of five standard symbols (Table 4.1) for operation, inspection transportation delay and storage (Russel and Taylor, 2008). This chart also provides information such as time consumed to complete each activity and the distance covered during transportation. The productive activities (operations) and non-productive activities (inspection, transportation, delay and storage) of a process can be obtained from its flow process chart. The process can be enhanced by removing or reducing these non-value-added activities from the system.

Table 4.1: Five standard symbols used in flow process chart

Symbols					
Explanation	Operation	transport	Inspection	Delay	storage

4.4 Value Stream Map

Predominantly used as a graphical tool to map the current state, VSM prove handy in implementing improvements and assist in identification and elimination of wastes from the system (Pavnaskar et al., 2003). Besides identifying wastes and value adding activities, the pressing need to improve ceaselessly with changing times is a prerequisite for coping the rising market demands. The initiation of Kaizens or continuous improvement can be attained through process mapping, followed by Kaizen blitz denoting improvements (Engelund et al., 2015). VSM helps in sorting out the value and non-value-added activities (VA and NVA) and aids in the application of Kaizens and 5S techniques to reduce waste, both in terms of time and processes. Rooting its origin to Japan, the term Kaizen has a literal meaning of "change for the better" having gained a worldwide acceptance and Kaizens have seen a remarkable growth (Coimbra, 2013). Classified into Flow and Process Kaizens (Rother and Shook 1999), the former aims at value stream improvements and information flow whereas the latter focusses on people and process flows. A process oriented philosophy by application, it canters on incremental improvement as the key building block of lean thinking (Womack and Jones, 1996). In the current work, Kaizens were identified for improving the Surimi value chain in India as it requires an improvisation with respect to both flows as mentioned above.

4.5 Temperature measurements

a. Surface temperature after unloading | b. RRM Temperature measurement

Figure 4.1: Temperature Measurement

Maintenance of low temperature plays a vital role in the conservation of fish quality from the point of catch till the processing of Surimi. Absence of temperature monitoring system and manual operation, maintaining low temperature holds a critical task in SSC in the Indian scenario. To acquire temperature related information at various stages of the Surimi fish (pink perch in our case) temperature readings were taken at time intervals for fish as well as RRM generated from the same.

A hand-held temperature measuring instrument of SL Technologies make with a temperature range of 0-1200^0C and least count ± 1.1^0C was used to measure the surface temperature of fish as well as RRM at different stages at the dock (Figure 4.1). A portable temperature data loggers of Tzone make having dimension 69mm*33mm*5mm with a temperature range -20^0C -+60^0C and least count $\underline{+}0.5^0$C were also deployed in boats but due to lack of cooperation from fishers, data obtained from the same is found to have limited utility. Fish unloaded from iced cooled state in boat is transferred in an un-iced crates till the point of weighing after which crushed ice is again added. An average rise of 3°C was noted during the transfer of fish from boat to the weighing area. A similar temperature measurement on RRM samples was also carried out. Degrading of RRM was observed to be a common problem owing to lack of proper icing and long lead times for further processing.

5 Results

5.1 Analysing the supply side of the existing Indian Surimi Supply Chain

The Indian SSC (Figure 5.1) consists of independent fishermen group, aggregator, Surimi processing plant, RRM plant and export market. Many logistic activities are carried out between successive stages. The supply process (i.e. fisherman and aggregator) provides raw material (i.e. fish) to Surimi processing plant and is completed when either whole or headed, and gutted fish reaches the processing plant. The wholesaler aggregates the fish from marginal fishermen and carries out de-heading to separate the head and gut from whole fish and the head proportion is sent to RRM plant where it is processed into value-added products such as feed, oil or both.

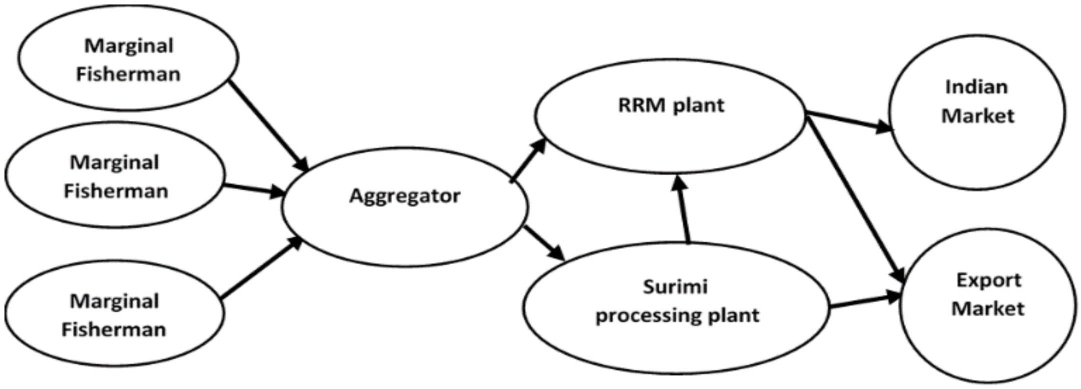


Figure 5.1: Surimi Supply Chain Stages in India

The factors mentioned below denote the various problems witnessed by the supply chain during raw material procurement till the processing of Surimi and other value-added products.

Fragmented ownership: Most of the Surimi processing plants procure fish through a middle man who acts as an aggregator from among various marginal fishermen having only one to five small boats. All members in each stage are independent and there is hardly any coordination between different members in a stage including the fishermen stage. This appears to be same between stages of the supply chain (i.e. fishermen-aggregator and aggregator-Surimi processing plant). Different actors (members within the stage and between stages) operate independently with hardly any real time information exchange and coordination. The objective of every member of the supply chain is to maximise his/her individual gains. This results in a fragmented supply chain ownership. However, a few big players such as Gadre Marine Export based at Ratnagiri have established exclusive contracts with selected fishermen giving them exclusive rights to all their catch. This satisfies a significant proportion of the company`s demand and the remaining is purchased through usual route. Mostly, fishermen sell whole fish at the dockyard to aggregators who supplies de-headed and gutted fish to Surimi processing plants. De-heading and gutting are carried out either in the processing centre near the dockyard or in the processing plant depending upon the demand and workforce availability. The price is decided based on the supply and demand situation and based on limited sensory assessment of fish quality. In addition to the desired fish species used for Surimi production, the total catch of a boat also includes other species that is unloaded and sold at nearby dockyards. This unloading often happens earlier than the fish used for Surimi production and introduces additional lead time.

Fishing area identification: The current method of fishing area identification depends upon mere experience and personnel acumen. To attract the fish population that generally comprises a single variety of fish, fishermen adopt old techniques such as lighting of lamps to attract fishes in the sea and observe sea water coloration that is affected by population of Phytoplankton and Zooplankton (fish food) in that area. Lack of technology implementation in this area contributes to underutilization of existing resources and is a huge obstacle in the growth of sea food industry.

Fishing boat and its capacity: Most of the marginal fishermen use boats having 12-20 in-built compartments with capacities of about 600 kg (fish with ice) each. Fresh catch is stored within layers of crushed ice stuffed in these compartments; melting ice with adequate water drainage facility ensures storage at 0°C for approximately 15 days. Basic sorting of fish is carried out on the boats immediately after the catch. The types of fishing vessels and their capacity is a constraint for the quantity and quality of captured fish due to its size and implementation of on-board refrigeration.

Boat unloading practice: As boat docks, water at varying ambient temperatures is pumped into the compartments in boat for de-icing the fish. De-icing is a necessary to weigh of the catch, as the raw material changes hands from fisherman to intermediate consolidators at this point. The fish is unloaded in a traditional way utilizing buckets (Figure 5.2). The unloading process is slow and clumsy, during which porters wearing rubber boots and gloves are observed to stand inside containers directly over iced fish and scoop out fish using small plastic containers. There is scope of improving the unloading process to avoid physical damage to fish and loss of temperature of storage. Supply chain integration can potentially make the intermediate weighing stage redundant.

<u>Real time information sharing:</u> The real time information related to various parameters of fish and RRM (such as time, temperature log, quantity, quality etc.) SSC are not captured, documented or shared on real time basis. This is unfortunate from the point of view of research and food safety assurance. While at sea, wireless communication devices are used by fishers for communication among boats or with the land-based boat owner. However, no information related to fish quality is recorded or shared with the Surimi processing plant. Possibilities of capturing fish in areas which could be used in future as preferred fishing spots should also be investigated when developing devices for identifying fishing location.

<u>Manual inspections:</u> Manual inspection techniques such as thumb impression test (the impression remains when fish is not fresh while it recovers in case of fresh fish exhibiting good elasticity) and visual inspections (i.e. colour of eyes, skin colour and texture, bulging of eye etc.) are made on fish samples to check quality for both fish and RRM at various stages of the SSC. Manual and casual checks as well as fragmented and competing nature of supply chain actors is likely to aid fish of inferior quality getting through the process. Implementation temperature data logger, RFID tagging etc. likely to help the marginal fishermen fetch good price for their catch and Surimi processors to have prior information about the catch arriving onshore.

<u>Manual touch points:</u> Number of manual touch points is found quite high starting from fish unloading from boat to fish loading on truck and fish de-heading centres / Surimi processing plant. These touch points have direct impact on quality of fish and RRM. It also contributes to waste generation due to exposure to ambient, pilferage, damage and contamination. Therefore, the current study aspires to focus on manual touch point reduction leading to enhanced quality and increased productivity while reducing related wastes.

<u>Temperature measurement system:</u> No temperature measurement system is in place for the entire chain from fishing to Surimi processing plant. Desired temperature of whole fish and RRM is maintained using crushed ice at various stages of SSC. Quantity of ice used is assessed based on experience and observation. The average fishing duration was found to be about 10 days and ice carried on board to maintain the fish at low temperature for this duration may be insufficient due to high heat transfer rate or multiple opening of box etc. Although in most cases, fish was found lumped with ice in the compartments on arrival of boat at dock, we did observe in some cases that the iced compartments were flooded with no solid ice left. The surface temperature of fish measured immediately after unloading was found as high as 9°C in such cases.

<u>Non-standard cold chain:</u> Henceforth the quality lost at sea can never be regained at later steps in the value chain necessitating the maintenance of quality right from the point of haul. Additionally, the manual sorting of fish after hauling, exposes fish to sunlight and hastens degradation. Manual boat unloading process at dock causes delay, decay, potential contamination and pilferage of fish. In Surimi processing plants, all the cooling demands during Surimi processing are met using an ammonia-based vapour compression refrigeration unit. Since the refrigeration system was not designed specifically to meet the multiple cooling demands at various temperature, it was observed generous retrofitting and changes were made to the original setup, evidently the refrigeration system is not operating at its design or optimum condition.

<u>Location of the operations:</u> The basic sorting of fish (i.e. separating the fish from any irrelevant catch and segregating the fish based on size) is carried out manually in the boat at sea. The de-heading and gutting process is carried out by the aggregator (generally located at dock area) or by processing plant in the existing system.

Boat size constraints the practice of on-board de-heading as the RRM generated increases the handling cost as well as decreases the quantity of fresh fish carried due to limited storage constraint. Overcoming the restrictions caused due to the limited boat size, will eliminate few operations on land and enhance the quality collection of RRM along with speed and efficiency. Relocation of Small-scale Surimi and RRM processing plants at a considerable distance from the unloading centres, in such scenarios can reduce the time duration from the point of de-heading, gutting to the processing of Surimi and RRM as it is to be noted that RRM begins to deteriorate after a certain amount of time.

a. Boat with compartments and unloading at dock

b. Manual unloading of fish

c.Fish for weighing

d. Manual heading and gutting

Figure 5.2: Practice and processes at a fish landing centre

5.2 Cost-Responsiveness Efficient Frontier

The CREF was developed for the Indian SSC (Figure 5.3) based on the industrial visits and discussions held with different stake holders including fishermen (see Section 4.1). It was found that the existing position of SSC in India is in the inefficient zone and needs to move from present position to reach the CREF by enhancing both responsiveness and efficiency.

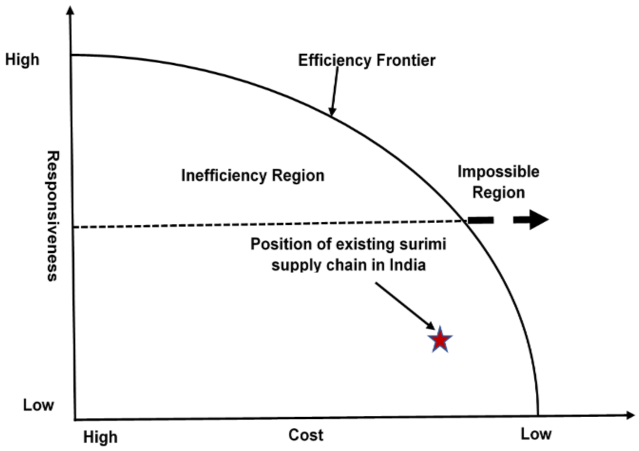


Figure 5.3: CREF of SSC

5.3 Strategic Fit

The various factors such as fishing duration, distance travelled from dock to first fishing point, quantity and quality of fish in a catch, distance travelled between two catches, distance between boats at different point of time, weather condition, and logistics infrastructure make the IDU value quite high due to their inherent uncertainty behaviour (i.e. first aspect of strategic fit). It was also observed that the existing supply chain configurations and practices have high cost of operations and low agility, thus creating the supply chain inefficient. The level of responsiveness achieved in the existing SSC in India was also estimated (i.e. the second aspect of strategic fit). The strategic fit was drawn considering level of IDU and required level of responsiveness. It is shown in Figure 6 in the zone of strategic fit is 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 and found much below point "A" in Figure 5.4. This indicates that the improvement is needed in both dimensions (i.e. cost and responsiveness).

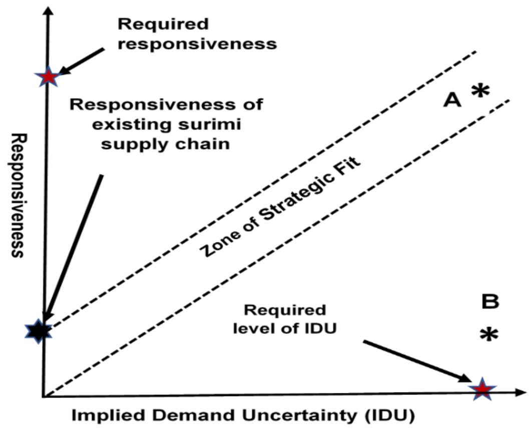


Figure 5.4: Strategic fit of SSC

5.4 Process Flow Charts

The supply side of Surimi value chain consists of various activities and the activities are categorized into five phases (i.e. preparatory phase, fishing phase, dock activities, de-heading unit to Surimi plant and de-heading unit to RRM plant). Process Flow Charts are drawn for each phase (Table 5.1-Table 5.5). In order to provide a detailed view of the process, value stream maps for four stages (i.e. fishing phase, dock activities, de-heading unit to Surimi plant and de-heading unit to RRM plant) of the existing system were also developed.

Table 5.1: Process flow chart for preparatory phase for fishing boat

PROCESS FLOW CHART								
PROCESS: PREPARATORY PHASE FOR FISHING BOAT								
STEP	OPERATION	TRANSPORT	INSPECT	DELAY	STORAGE	PROCESS DESCRIPTION	EXPECTED TIME (MIN)	DISTANCE (KM)
1	●					Unload ice blocks from the truck	80	
2	●					Crush ice	138	
3	●					Load ice in carts	195	
4		●				Transport ice to fishing vessel		0.05-1.2
5				●		Wait for ice supply	43	
6	●					Load ice in the fishing vessel	72	
7			●			Inspect amount of ice loaded	07	
8	●					Load fuel in barrels	43	
9		●				Transport fuel to fishing vessels		0.05-1.1
10				●		Wait for fuel supply	41	
11	●					Load fuel in the fishing vessel	50	
12			●			Inspect loaded fuel	07	
13		●				Transport water in carts		0.05-1.1
14				●		Wait for water supply	29	
15	●					Load water in overhead tanks in boats	46	
16			●			Inspect amount of water loaded	08	
17		●				Transport drinking water in carts		0.05-1.1
18				●		Wait for drinking water supply	56	
19	●					Load drinking water in boats	52	

20						Inspect amount of drinking water loaded	07	
21						Final inspection of boat before dispatch	35	

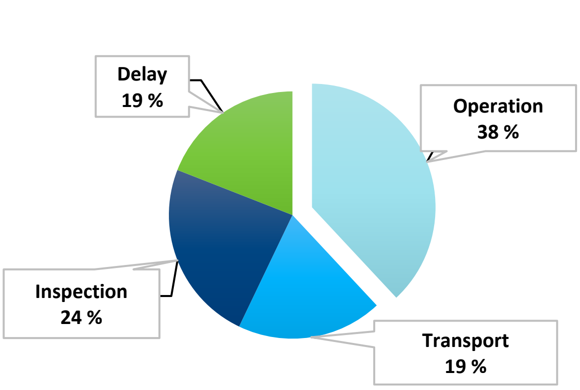


Figure 5.5: Activity share in Preparatory Phase

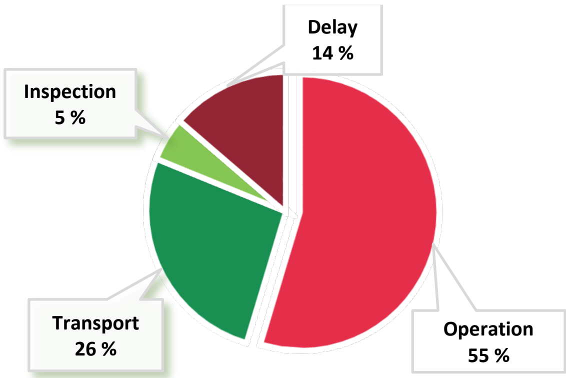


Figure 5.6: Time share in Preparatory Phase

Table 5.2: Process flow chart for fishing operation

PROCESS FLOW CHART PROCESS: FISHING OPERATION								
STEP	OPERATION	TRANSPORT	INSPECT	DELAY	STORAGE	PROCESS DESCRIPTION	EXPECTED TIME (MIN)	DISTANCE (KM)
1						Move from the dock to initial fishing point		20
2						Fishing spot identification	318	
3						Choose fish net type	28	
4						Net dropping	43	
5						Inspection for damage of nets	28	
6						Wait for hauling of nets	167	
7						Hauling of net	57	

8						Basic sorting	36	
9						Delay in loading fish in compartments	20	
10						Filling fish in compartments for a catch	36	
11						Icing of fish	25	
12						Inspection of fish icing	6	
13						Storage of fish in compartments	10080	
14						Inspect if storage is full (25 ton) or maximum fishing duration (21600 min) is reached, If yes go to step 16 otherwise step 15	20	
15						Travel to successive fishing point and repeat step 2-13		19
16						Travel from final fishing point to Dock		700

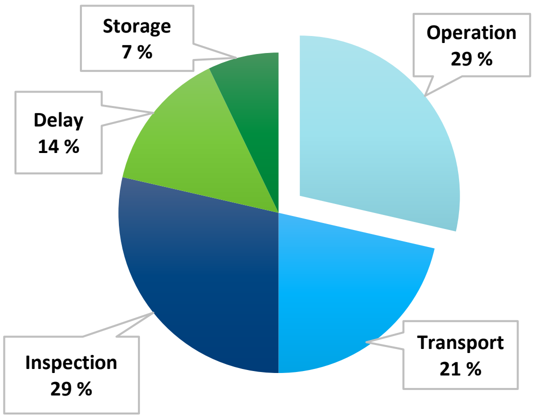


Figure 5.7: Activity share in Fishing Phase

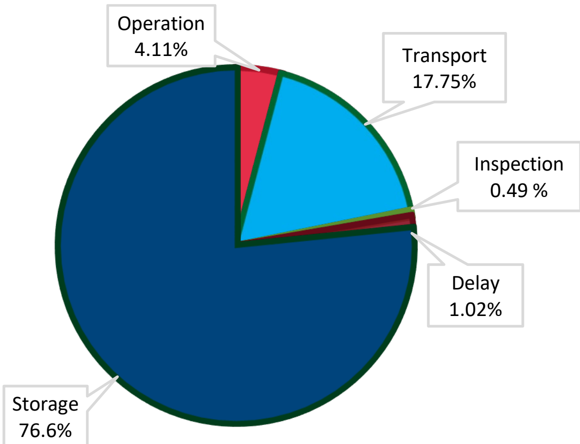


Figure 5.8: Time share in Fishing Phase

Table 5.3: Process flow chart for dock operation

PROCESS FLOW CHART	
PROCESS: DOCK OPERATION	

STEP	OPERATION	TRANSPORT	INSPECT	DELAY	STORAGE	PROCESS DESCRIPTION	EXPECTED TIME (MIN)	DISTANCE (KM)
1						Idle waiting time at dock	218	
2						De-Icing the fish	48	
3						Delay in unloading fish	173	
4						Manual bucket by bucket unloading of fish from boat	250	
5						Storage of fish in carts till full	190	
6						Inspect if the storage compartments are completely unloaded	12	
7						Delay in cart movement	19	
8						Movement of carts with filled fish		0.05-0.9
9						Wait for weighing	32	
10						Manual inspection of fish	08	
11						Weighing one boat catch	77	
12						Wait for icing	10	
13						Icing the fish crates	58	
14						Wait for transportation	48	
15						Loading fish crates in truck	45	
16						Inspect truck	12	
17						Transport to de-heading unit		0.5

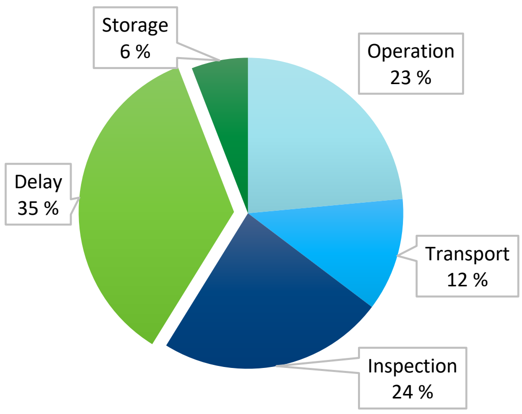


Figure 5.9: Activity share in Dock operation

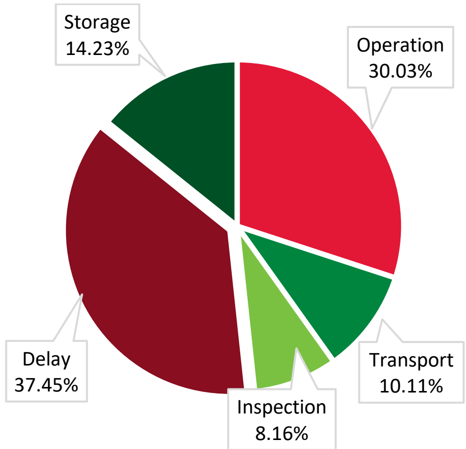


Figure 5.10: Time share in Dock operation

Table 5.4: Process flow chart for De-heading unit to Surimi plant

PROCESS FLOW CHART PROCESS: DE-HEADING UNIT-SURIMI PLANT (Per truck Load)									
STEP	OPERATION	TRANSPORT	INSPECT	DELAY	STORAGE	PROCESS DESCRIPTION	EXPECTED TIME (MIN)	DISTANCE (KM)
1						Delay in Unloading	36	
2						Unloading of fish crates from truck	43	
3						Storage of fish	31	
4						Delay in transfer of fish to working area	18	
5						Inspect fish type	06	
6						Manual transport of fish crate to working area		0.05
7						Removal of Ice	23	
8						Wait for manual de-heading process	13	
9						Manual de-heading of fish lot	360	
10						Inspection of de-headed fish	24	

11						Delay in transfer of de-headed fish from working area	16	
12						Putting de-headed fish in crates	48	
13						Collecting de-headed fish from different de-heading points	60	
14						Icing of fish	33	
15						Transfer of de-headed fish crates to storage area		0.05
16						Inspection of de-headed fish	36	
17						Storage of de-headed fish	48	
18						Wait for transportation	22	
19						Loading fish crates in truck	50	
20						Move de-headed fish to Surimi plant		40
21						Delay in Unloading	20	
22						Unloading of crates from truck	55	
23						Removal of ice from crates	20	
24						Weight, inspect, sort at Surimi plant	63	
25						Storage of fish	389	
26						Delay in processing of fish	25	
27						Surimi Processing	157	

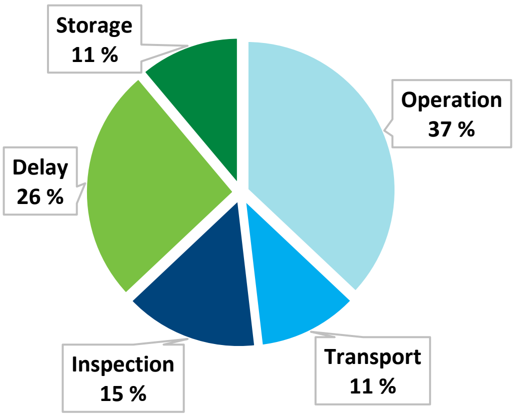


Figure 5.11: Activity share in de-heading unit – surimi plant

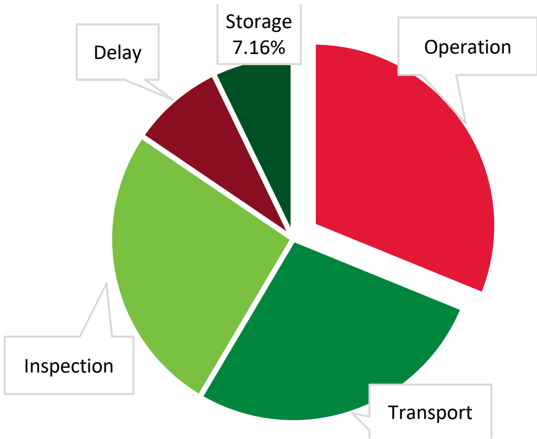
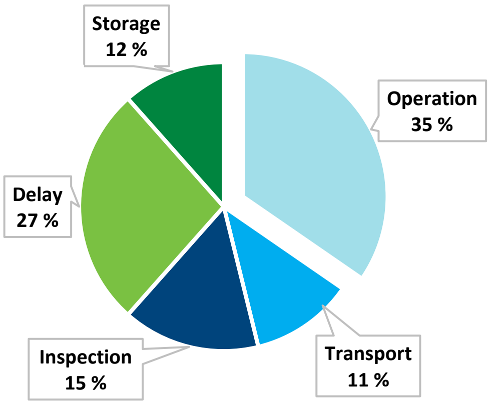


Figure 5.12: Time share in de-heading unit –surimi plant

Table 5.5: Process flow chart for De-heading unit to RRM plant

PROCESS FLOW CHART PROCESS: DE-HEADING UNIT-RRM PLANT (Per Truck Load)								
STEP	OPERATION	TRANSPORT	INSPECTION	DELAY	STORAGE	PROCESS DESCRIPTION	TIME (MIN)	DISTANCE (KM)
1						Delay in Unloading	36	
2						Unloading of fish crates from truck	43	
3						Storage of fish	31	
4						Delay in transfer of fish to working area	18	
5						Inspect fish type	06	
6						Manual transport of fish crate to working area		0.05
7						Removal of Ice	23	
8						Wait for manual de-heading process	13	
9						Manual de-heading of fish lot (per kg)	360	
10						Inspection of de-headed fish	24	

11	○	⇨	□	◗	▽	Delay in transfer of RRM from working area	42	
12	●	⇨	□	D	▽	Putting RRM in crates	48	
13	●	⇨	□	D	▽	Collecting RRM from different de-heading points	50	
14	●	⇨	□	D	▽	Icing of RRM	40	
15	○	➡	□	D	▽	Transfer of RRM crates to storage area		0.04
16	○	⇨	■	D	▽	Inspection of RRM in crates	20	
17	○	⇨	□	D	▼	Storage of RRM	300	
18	○	⇨	□	◗	▽	Wait for transportation	26	
19	●	⇨	□	D	▽	Loading crates of RRM in truck	42	
20	○	➡	□	D	▽	Move RRM to RRM plant		900
21	○	⇨	□	◗	▽	Delay in Unloading	15	
22	●	⇨	□	D	▽	Unloading of crates from truck	42	
23	○	⇨	□	D	▼	Storage of RRM	275	
24	○	⇨	■	D	▽	Inspection of RRM	35	
25	○	⇨	□	◗	▽	Delay in processing of RRM	50	
26	●	⇨	□	D	▽	RRM processing	157	



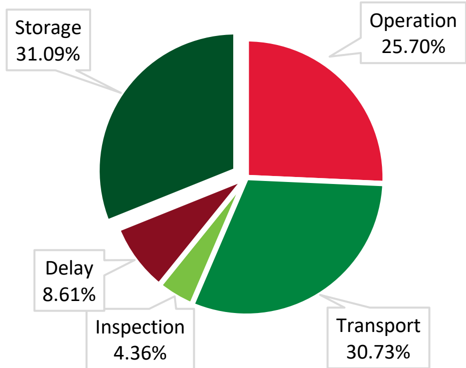


Figure 5.13: Activity share in de-heading unit –RRM plant

Figure 5.14: Time share in de-heading unit – RRM plant

5.5 Developing Value Stream Map for the analysing of Surimi Supply Chain

Based on the distinction of phases stated in section 4 and on derived derivations from process flow charts, existing value steam maps have been constructed, represented in Figure 5.15-5.18.

Further exploration disclosed that the time spent for the fishing operation is the maximum with duration of 9.33 days, and further processing occurs downstream after the fish is received at the dock. Elements linked to quality control trailed by avoidable waiting times and operations across different points along the chain were found to be the primary shortcomings in the current practice. Preliminary studies conclude that despite the number of VA activities contribute 40.20% and NVA contribute 59.8% in total, the time share contribution for VA is a mere 39.08% whereas the NVA is 60.92%.

The SSC requiring improvements in various facets of its operations require the application of Kaizen. Kaizen being a lean tool has been signified in the form of Kaizen blitz in figures citing areas for improvements. Areas for improvement were identified through personal visits and from discussions done with different stakeholders (i.e. Fishermen, Aggregator, Processors etc.) regarding the current state of the Indian SSC pointing the vital need for improvements in productivity and quality at the supply side of the chain. Additional developments have been discussed in upcoming sections providing a wider outlook in developing the Indian SSC both in terms of productivity and quality.

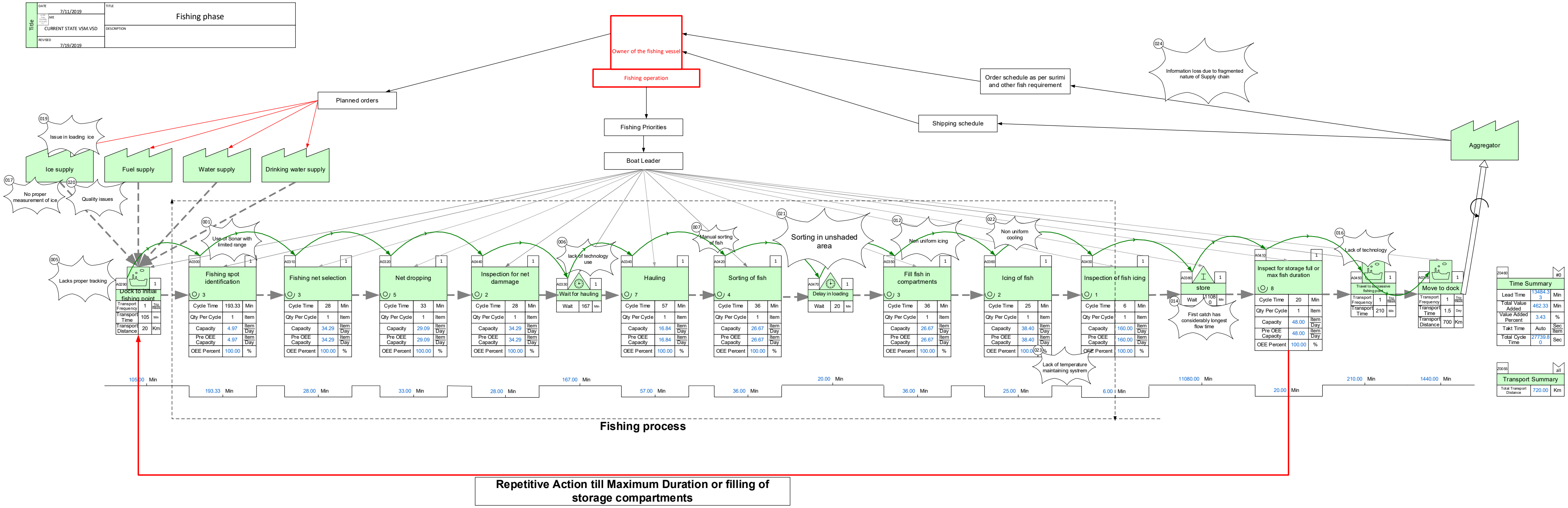


Figure 5.15: Current value stream map for fishing operation

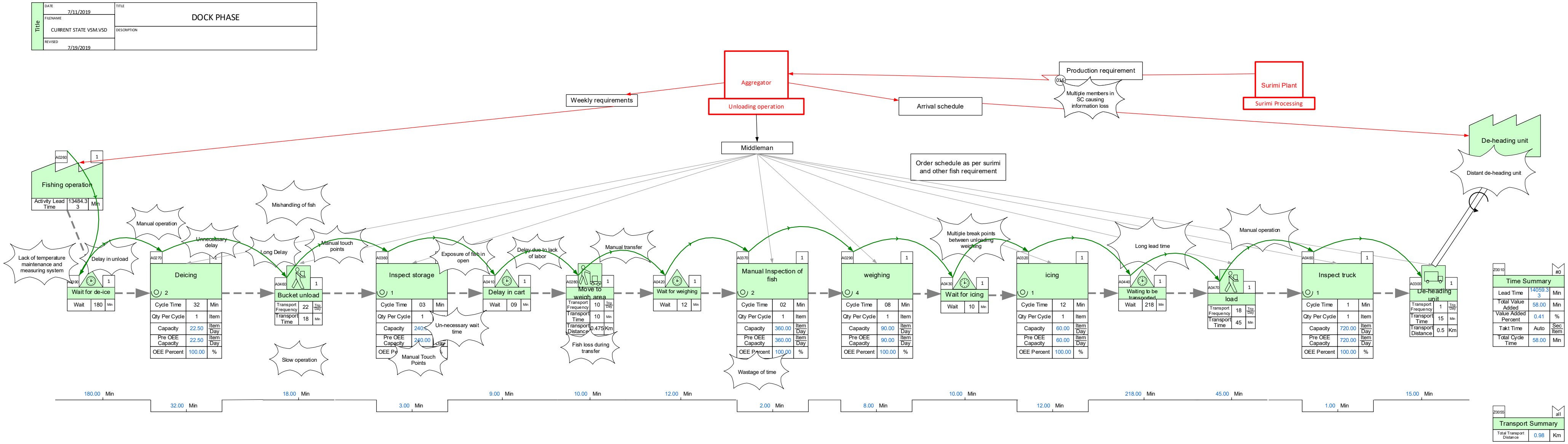


Figure 5.16: Current value stream map for dock phase

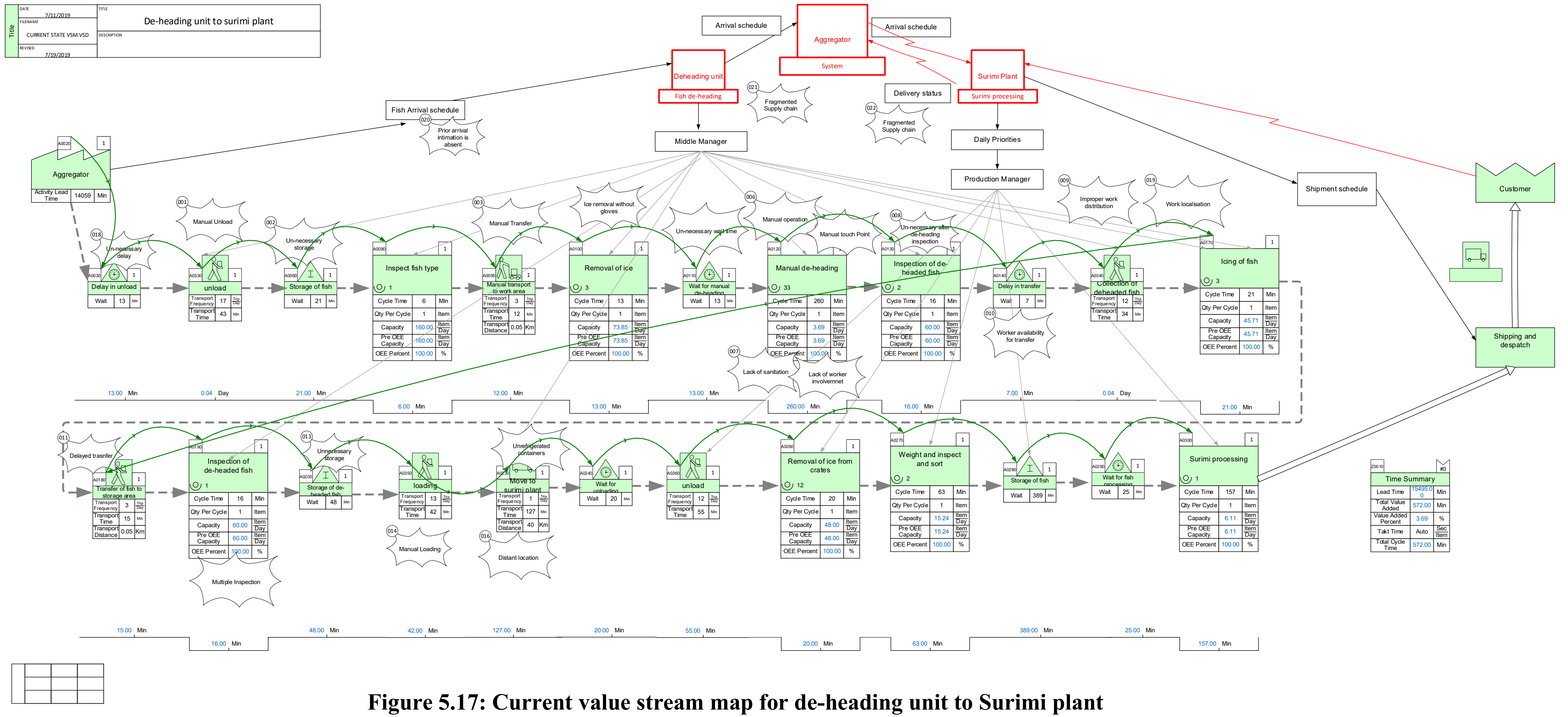


Figure 5.17: Current value stream map for de-heading unit to Surimi plant

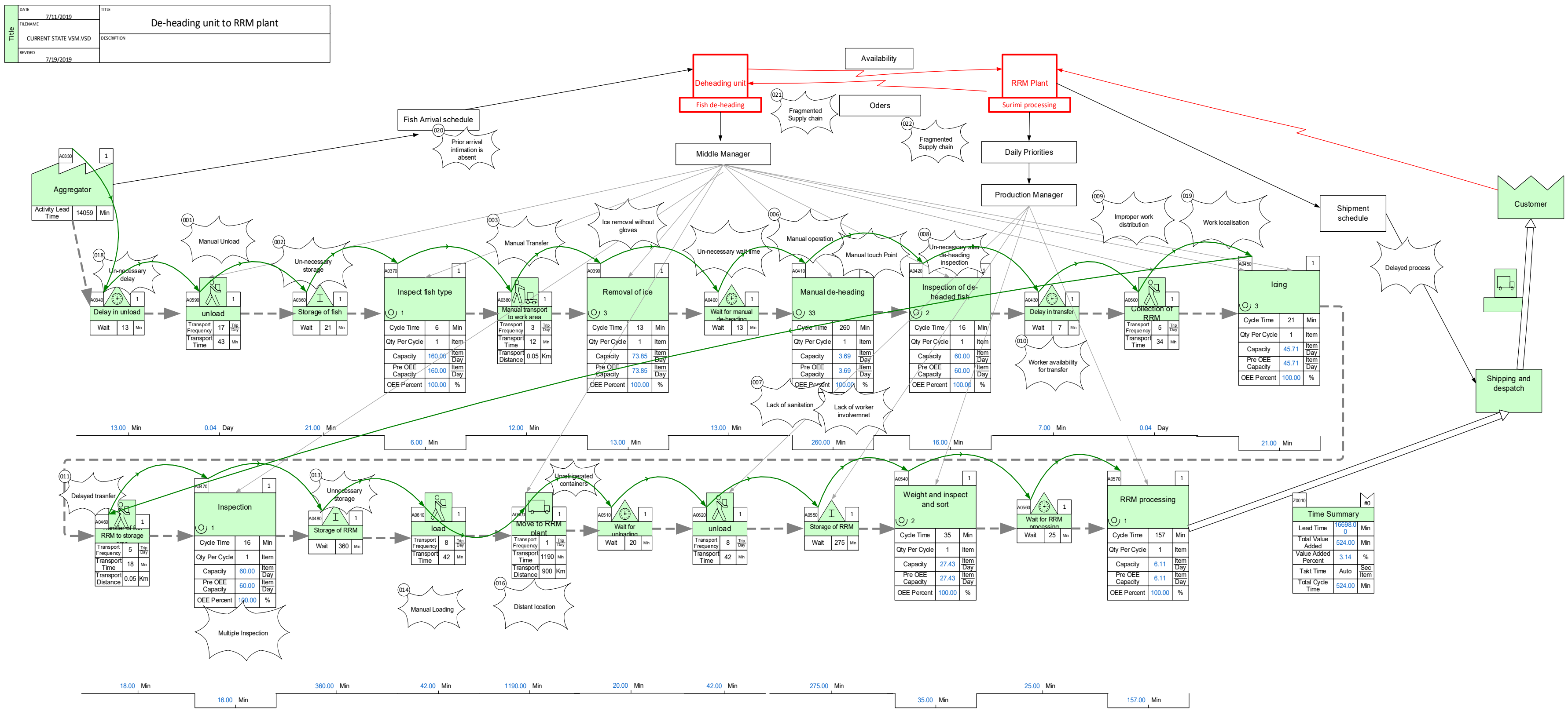
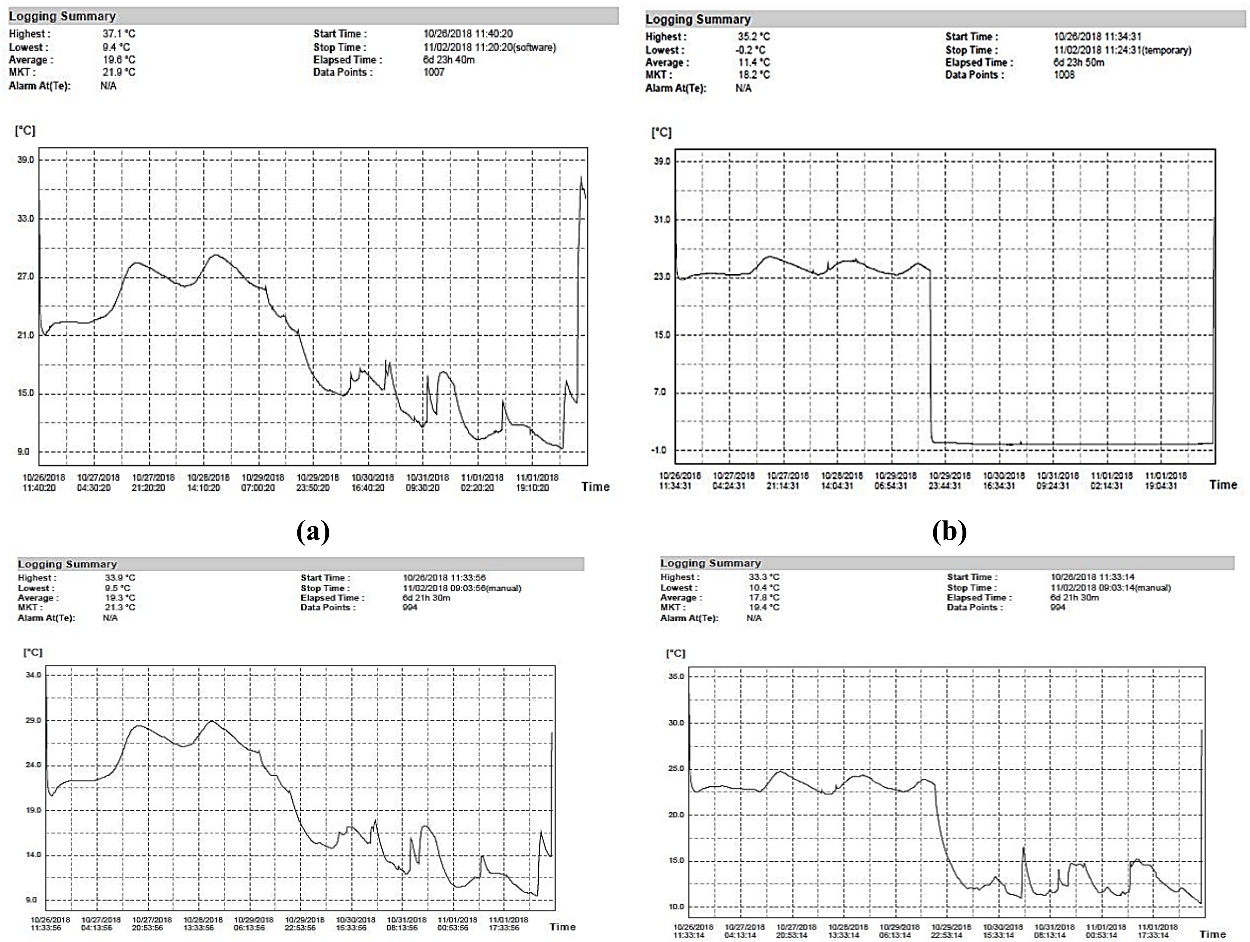


Figure 5.18: Current value stream map for de-heading unit to RRM Plant

5.6 Appropriate temperature measurement system

In order to select the appropriate temperature system, the following initial experiments have been carried out as mentioned.

- As a trial run, four sensors were installed in various containers of one boat with appropriate permission from boat owner at Sassoon Dock in Mumbai before the start of the fishing trip.
- Four sensors (DL1, DL2, DL3, and DL4) were fitted inside the fish containers built-in into the deck of boat at various height along the side walls and bottom of the container. The sensors were set with temperature recording interval of 10 Minutes.
- Time duration of the particular fishing trip was of 7 days (26 Oct 2018 to 1 Nov 2018).
- Sensors DL1, DL3 and DL4 were fixed in side walls of container while DL2 at bottom of container
- The filling of the container with catch (fish) and ice in the compartments during the fishing trip was not predictable. The containers were filled to certain heights, not adequate for the sensor to record meaningful readings. While the one at the bottom (D2) remained immersed in molten ice.
- DL2 and DL4 represents the temperature at the bottom and top of the closed insulated box during a fishing trip. Temperature readings are shown in Fig. 5.19.



(a) (b)

(c) (d)

Figure 5.19: Temperature plots from Sensor (a) DL 1, (b) DL 2, (c) DL 3, (d) DL 4

6 Discussion

Looking at the existing IDU (Implied Demand Uncertainty) and perishable nature of the raw material (fish harvested for Surimi and RRM), we look forward to enhancing the existing level of responsiveness and agility of the SSC. However, the optimum use (change or modification) of the existing technology and practice in the supply chain configuration will not be able to provide the required level of agility and competitive efficiency. This can be attributed to the fragmented nature of the supply chain ownership and long detachment between each stage of the supply chain. Hence enhancing level of efficiency and responsiveness in the current supply chain would come at a higher cost.

Fishing boats having on-board Surimi processing plants is well developed and implemented in in other countries (Kose, 2011). These have the capability to enhance both agility and cost significantly. However, it may not be feasible to adopt the same in India as it has many obvious impediments such as high initial investments and low utilization, adoption and technology risk in Indian environment, eliminating the employability of the marginal fishermen etc. However, the existing practices have to be both efficient and agile with adoption of optimum scheduling and use of resources such as fishing boats, adoption of technology for real time information visibility and developing Surimi/ RRM processing centres in proximity creating an ecosystem of deep localization. To achieve the strategic fit as mentioned earlier, approaches such as 5S practices, logistics optimization and value stream mapping needs to be adopted in the supply chain.

In the Indian context of SSC, fish and RRM are stored at various stages in the chain (such as in boat and aggregator) that are not well managed in terms of location, cold chain and handling etc. Therefore, practices such as 5S and Kaizen should be applied for improved resource utilization and better workplace organisation. The significant proportion of activities carried out in the SSC consist of logistics activities i.e. transportation and storage at several stages along the value chain. It was also observed that logistics (mostly transportation) is not carried out optimally and logistics optimization should be applied for efficient management of logistics.

To improve the responsiveness and efficiency of the SSC as a whole, apart from the integration of the supply chain, actions must be taken to improve the quality of the fish and negate factors that lead to decrement of quality. The main barrier in the SSC is the uncoordinated supply chain and unstructured cold chain which causes increased cycle time, increased wastage of raw material, Surimi of inferior quality and higher cost. Lack of implementation of technology in the supply chain causes most of the activities to occur manually. Since fish is very perishable, adequate measures of temperature control along the entire post-harvest supply chain needs to be ensured to reduce quality degradation. Reduction of the many manual touch points along the supply chain can be a target for improving the SSC. Some measures to control the effect of quality on the fish are as mentioned below.

Based on the generated current value stream maps of Indian SSC, 60 Kaizens covering various aspects are proposed with 26 Kaizens for enhancing productivity, 14 Kaizens for improving quality and 20 Kaizens augmenting both productivity and quality on the entire Surimi value stream. A Likert scale with range 1 to 5 (1 being the least undesirable and 5 being the most desirable) was chosen for categorizing the Kaizens.

The Indian SSC encompasses intra company value addition requiring long distance transportation and high costs. From the unsubstantiated suggestions made, suitable Kaizens were designated centred on ideals obtained from the Likert scale. The recommended improvements are applied at the supply side of Surimi, as the wastes identified are the maximum at the source followed by issues of localisation of RRM plants affecting the efficient utilization of the generated RRM.

The proposed moderations have taken into consideration the effect of different level of mergers on lead time and quality of the final product produced using the VSM tool. The proposed Future Value Stream Map as represented in Figures 8.1-8.12, is based on consideration of Kaizen applicability in three different mergers scenarios in the SC (i.e., No Integration, Partial Integration, and Complete Integration).

The suggested improvements typically aim at reorganization and enhancements of the operation layout and improve quality maintenance followed by a reduction in lead time. Former discussions conducted with supply chain stake holders clearly conclude the fragmented nature of the SSC to the prevailing decline in Surimi quality. To visualize the structure of such a SC, the outcome of mergers has been studied and applied using VSM. 'No integration' is based on the application of simple Kaizens that require no change in the structure in the SSC. Trivial process improvements in terms of improved fishing techniques on sea and improved handling techniques are fused to mend the lead time and improve quality. An overall reduction of 3.9% and 4.4% was witnessed in the delivery time of Surimi and RRM respectively.

Partial mergers control over raw material quality is enhanced as this merger excludes the dock based de-heading operations. A better relation between the processor and the fisher formed by extended contracts improves the level of mutual dependence in business providing sustainability at both ends. Hence enabling the fishermen adopt changes independently, introducing improvements in technology thereby refining the Surimi quality as a result. Further improvements such as integration of the de-heading process into the Surimi processing industry reduces total lead time by 14.1% improving the quality of Surimi produced. Cost of implication into the SC is comparatively higher due to the improved quality and reduced manual touch points. This is in turn balanced by the removal of the intermediate processor improving RRM utilization as the long duration buffers of RRM at de-heading units evident in the current state is reduced due to the swift transfer of the obtained RRM for further processing to RRM processing plants.

Complete Integration / Vertical Integration (VI) unifies the whole process of production right from the point of catch till the production of RRM products. Significant work in industrial vertical integration states a constraint applicability only when the cumulative profits of the same exceed the sum of individual profits prior implementation (Levy et al., 2018). Fernandes et al. (2012) stated that there is a need for a VI supply chains in situations of supply uncertainty for decreasing risk and integrating economic activities. This level of merger is governed by a single top level management (i.e. Surimi processor). Use of dedicated fishermen, reduction in fish store time in boats by using short trip collecting boats, technology up gradation, deep localisation of Surimi and RRM processing plants, superior importance to quality, unbroken cold chain along the stream, reduced manual touch points are certain characteristics of a completely integrated SC. A marked development in VI to upkeep catch quality is proposing an increase in fish collection trips by dedicated boats per fishing cycle. The idea of reducing fish store time is centred on the fact that proper storage conditions can never improve fish quality (Boziaris, 2012) as quality once deteriorated, cannot be uplifted at any point in the SC. Affirmatively, Hall (2012) stated the imperative need for fish to be processed within four days depending on the storage conditions on sea. Hence utilising large quantity of ice to maintain fish quality that has already began deterioration is a fact to be taken into note. Implementation of VI can proportionately improve the Surimi quality as well as improve fishermen economies as adaption of integration vertically proceeds with long term contracts enabling guaranteed returns during each fishing trip thereby shifting risk upstream. This as a result instils a major shift in priority for quality.

7 Conclusions

India is working towards the *Blue Revolution* to meet multi-objectives such as increase in seafood export, enhance food and nutritional security and increase the income of the farmers and upgrade the fisheries sector into a modern industry by adoption of suitable technology integration. The Indian SSC is not well developed. Raghuram and Asopa (2008) pointed out the absence of requisite cold chain infrastructure in the Indian Surimi industry as one of the main barriers for growth. It was felt that even after more than 10 years, the situation is still the same and there is a huge potential for improvements in this industry. Some major conclusions derived from this study are as follows:

- Manual touch points and non-value-added activities form the significant portion of the supply side of the SSC. The flow process charts suggest that it is around 67% number activities are in non-value-added activities (i.e. transport, storage, delay and inspection) while rest 33% activities are value added activities under operations such as sorting, de-heading, icing, weighing etc.
- The SSC is operated at inefficiency zone of Cost-Responsiveness Efficient Frontier which is far from efficient zone.
- Many a time, the quality of the Surimi is not preserved up to the desired level because of various factors such as cold chain infrastructure, scientific management of supply chain operations, fragmented supply chain ownership and lack of coordination in the supply chain.
- Long distance transportation and indecorous cold chain form the significant portion of the supply side of the SSC.
- Proposed SC structures have a significant influence on the lead time
- There is an impulsive need for deep localisation of processing plants for both Surimi and RRM to cut transportation costs.
- The surimi processing activities in Surimi plant are well documented whereas it is not the case in the supply side of Surimi value chain.

8 Further work

As the supply side of Surimi value chain in India is operating far from the zone of strategic fit, the 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. Kaizens identified along the supply side of Surimi value chain should be applied for further improvement. The optimum Value Stream Map needs to be preferred for the Indian Surimi value chain keeping in mind of Indian scenarios. Adoption of results requires critical analysis in terms of cost, barriers, and development of step by step implementation framework. A detailed study on energy efficient refrigeration system using climate friendly natural refrigerants for optimal handling and storage of the fish should be carried out.

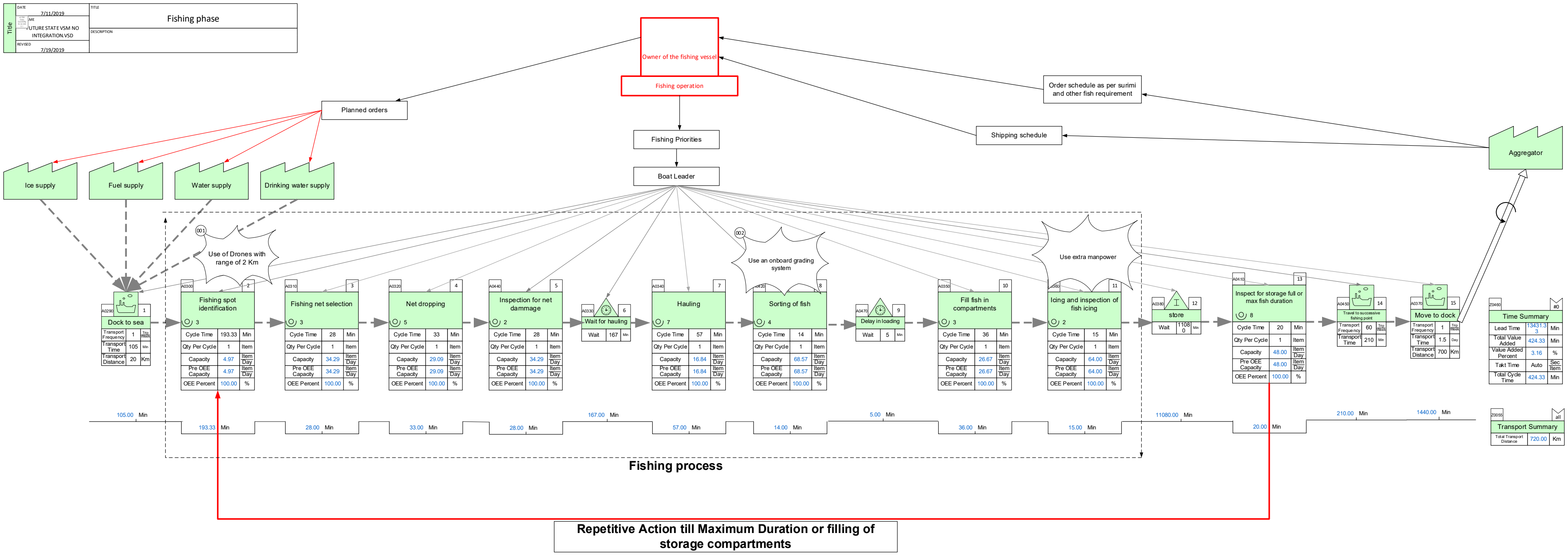


Figure 8.1: Future State VSM (fishing phase) with No Integration

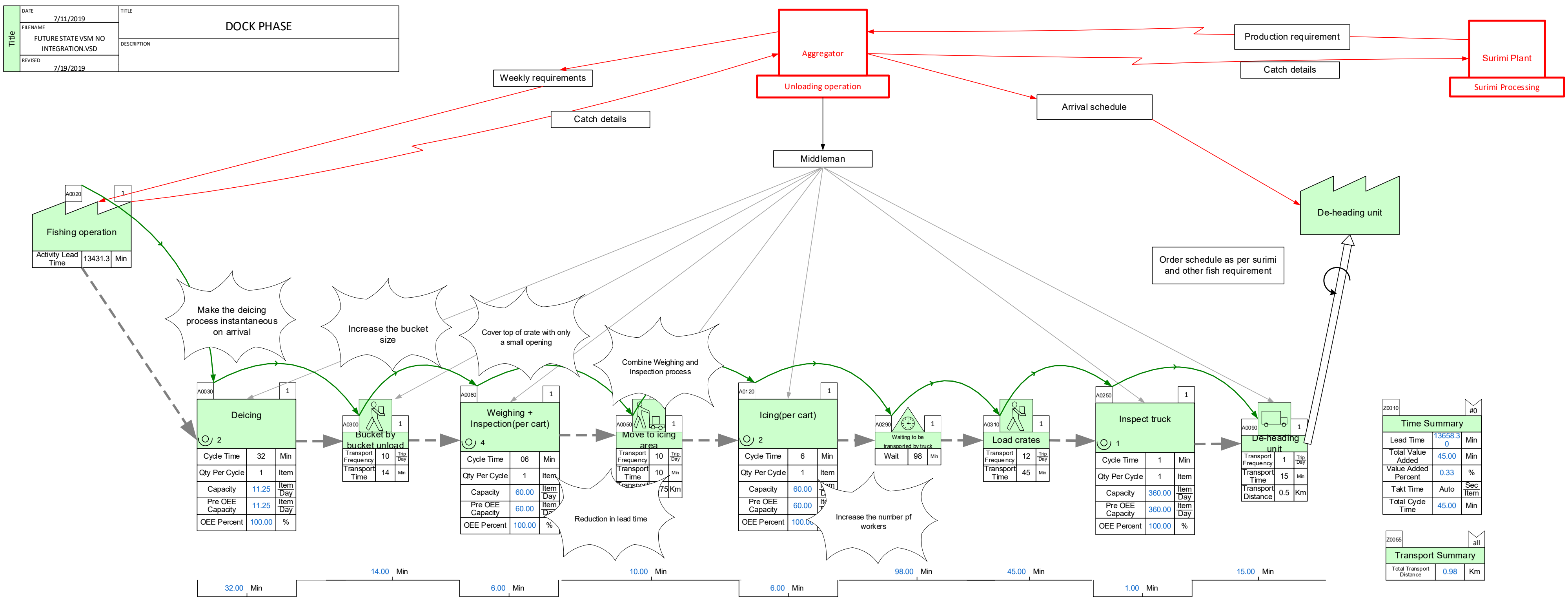


Figure 8.2: Future State VSM with No Integration dock phase

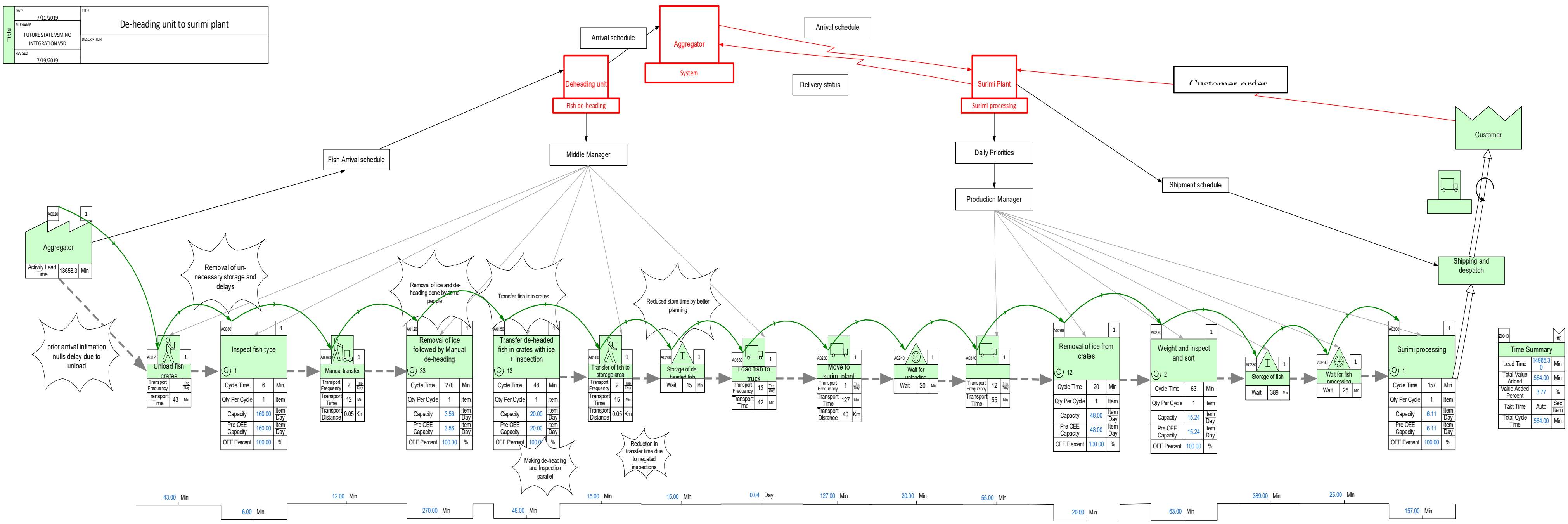


Figure 8.3: Future State VSM with No Integration de-heading unit-Surimi plant

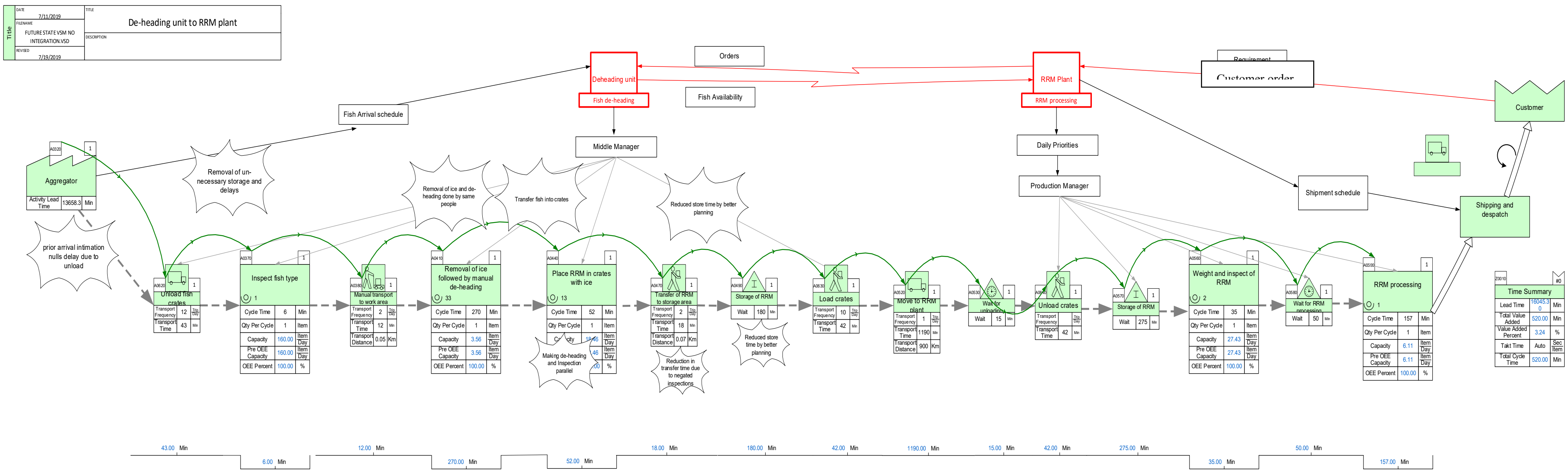


Figure 8.4: Future State VSM with No Integration de-heading unit-RRM plant

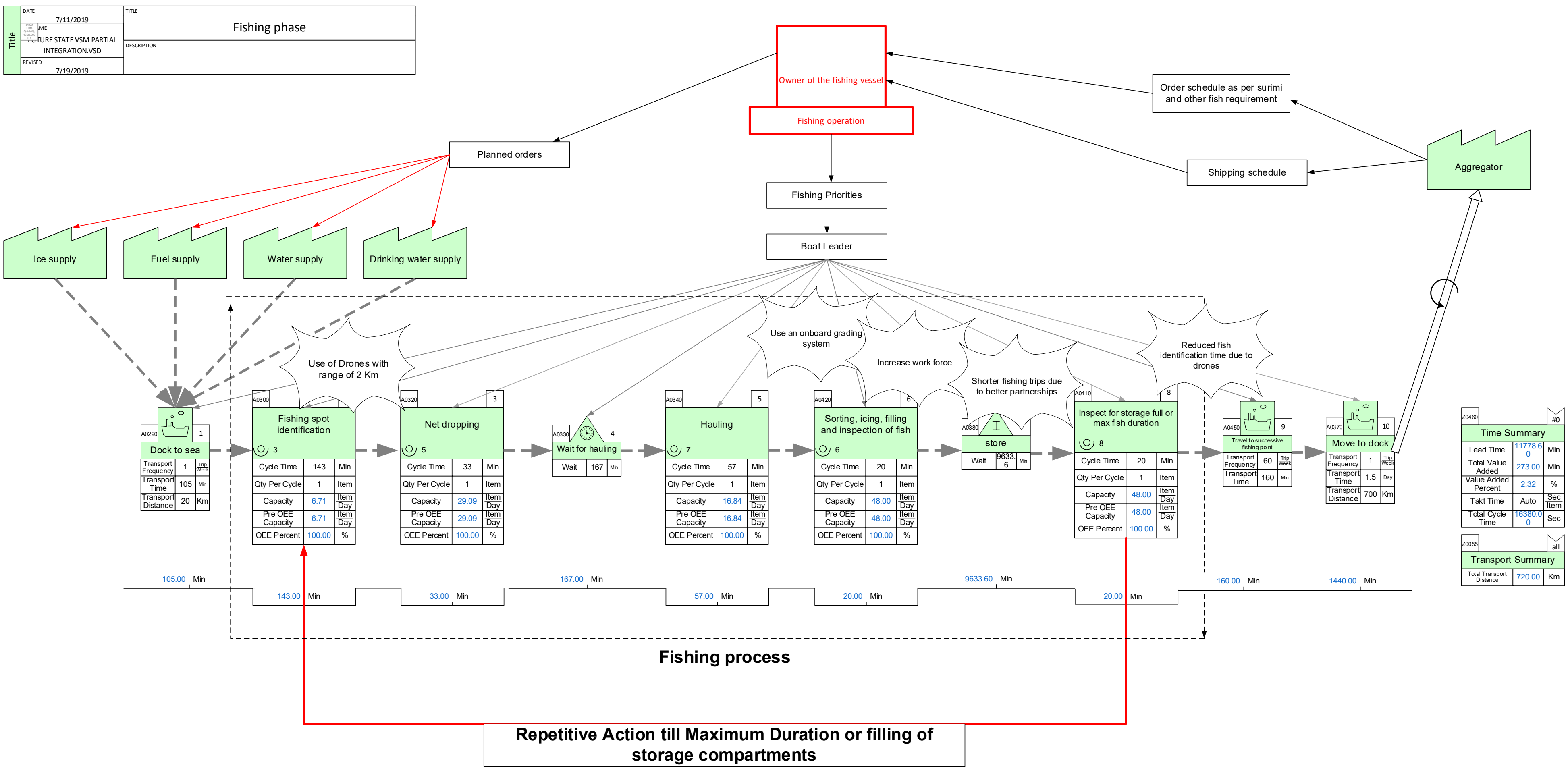


Figure 8.5: Future VSM with partial integration fishing phase

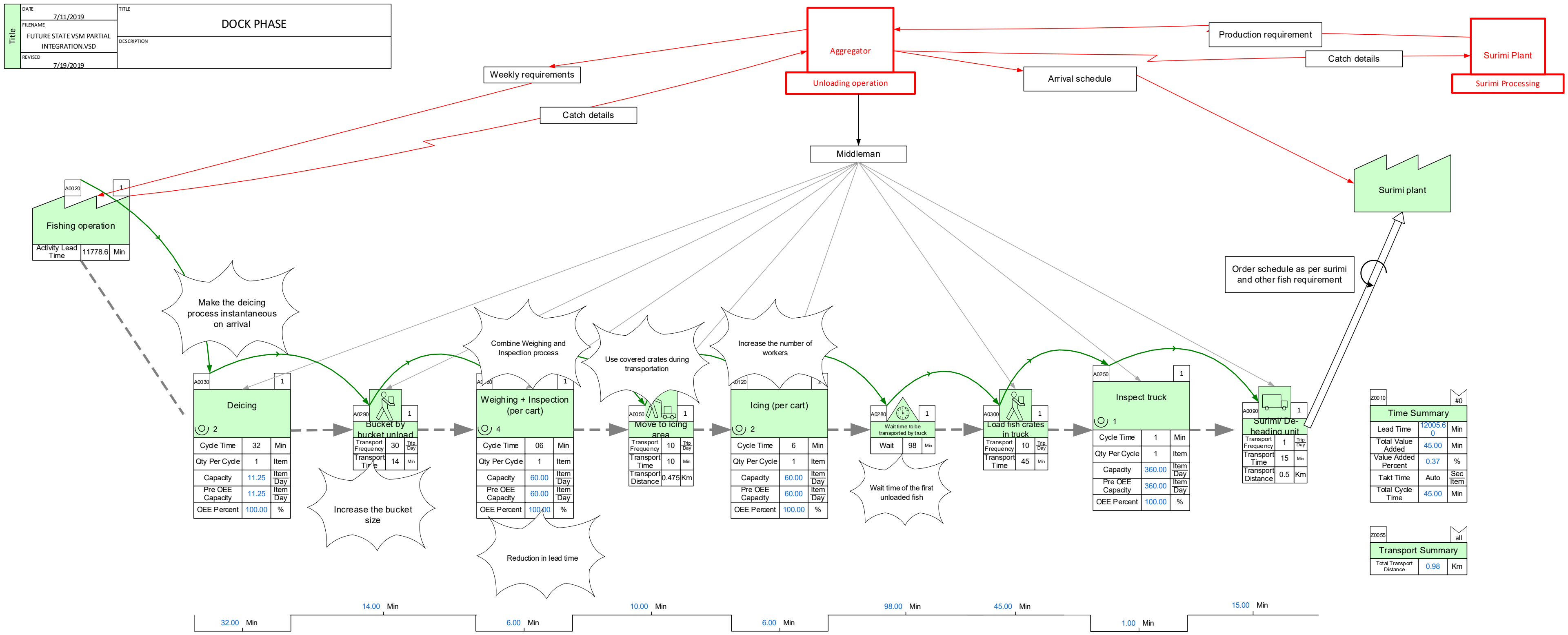


Figure 8.6: Future VSM with partial integration dock phase

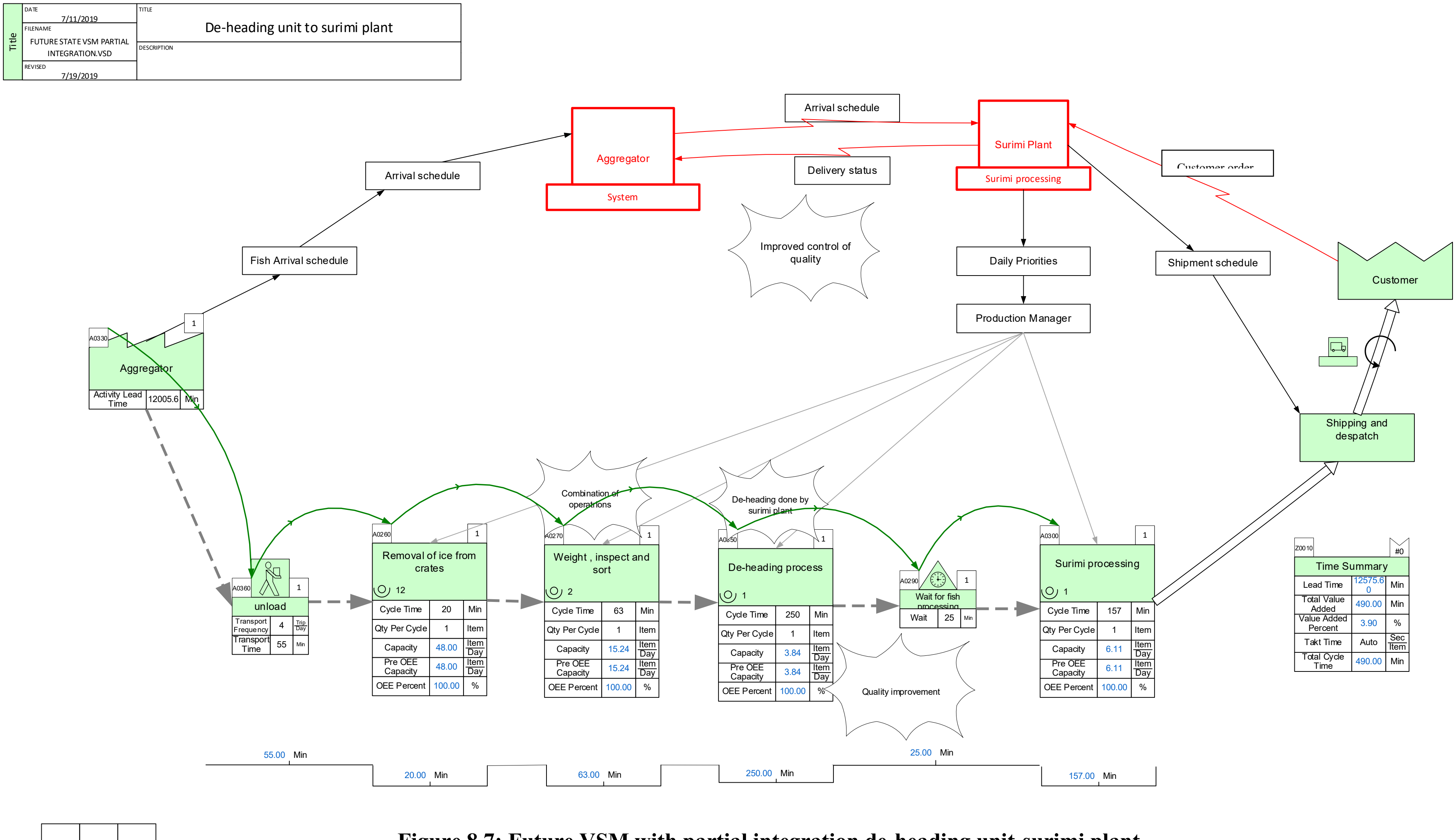


Figure 8.7: Future VSM with partial integration de-heading unit-surimi plant

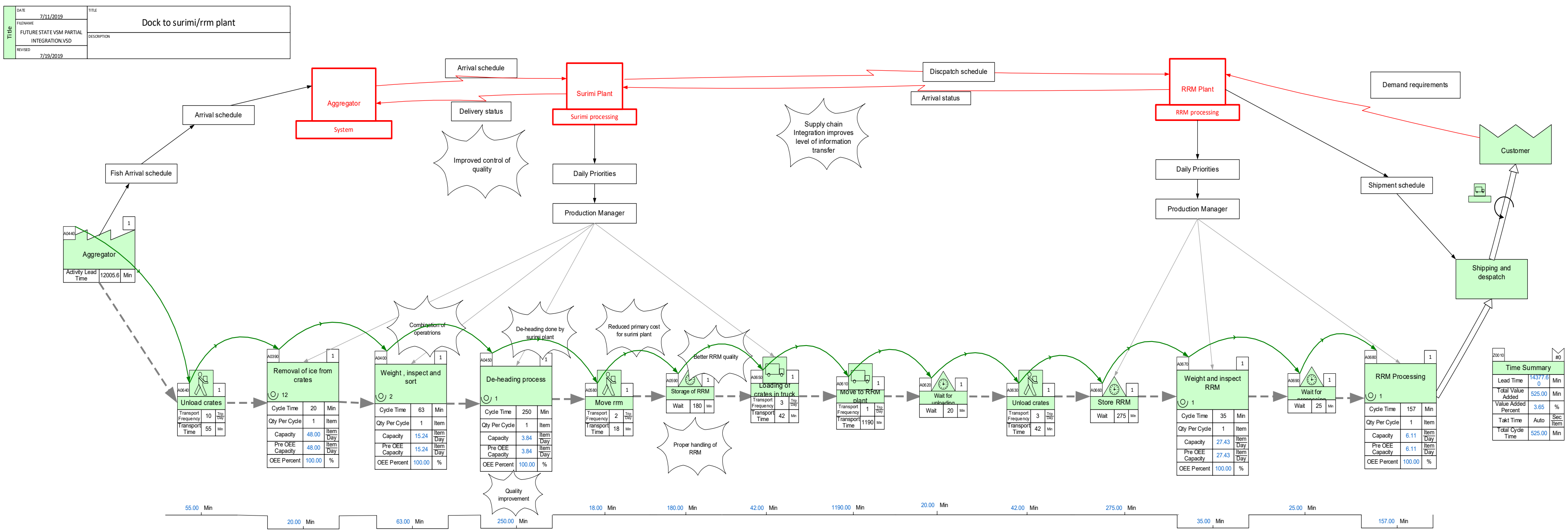


Figure 8.8: Future VSM with partial integration de-heading unit-RRM plant

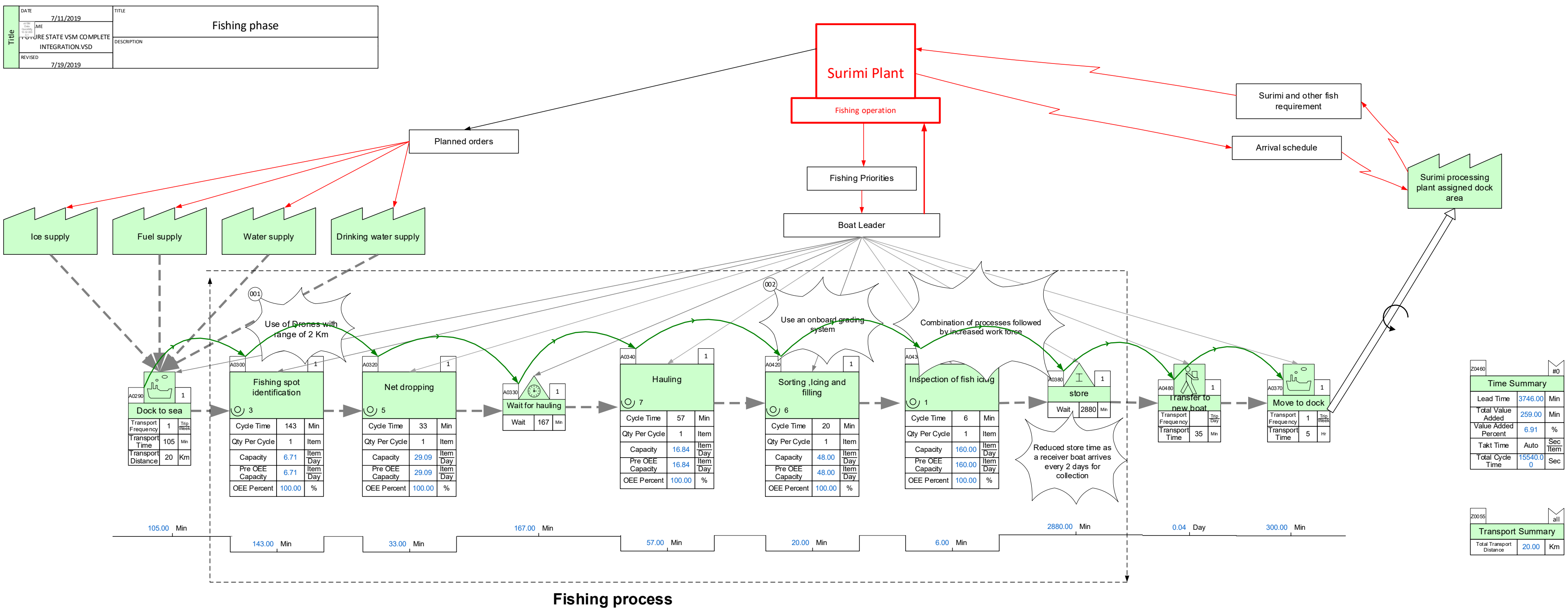


Figure 8.9: Future VSM with complete integration For Fishing Phase

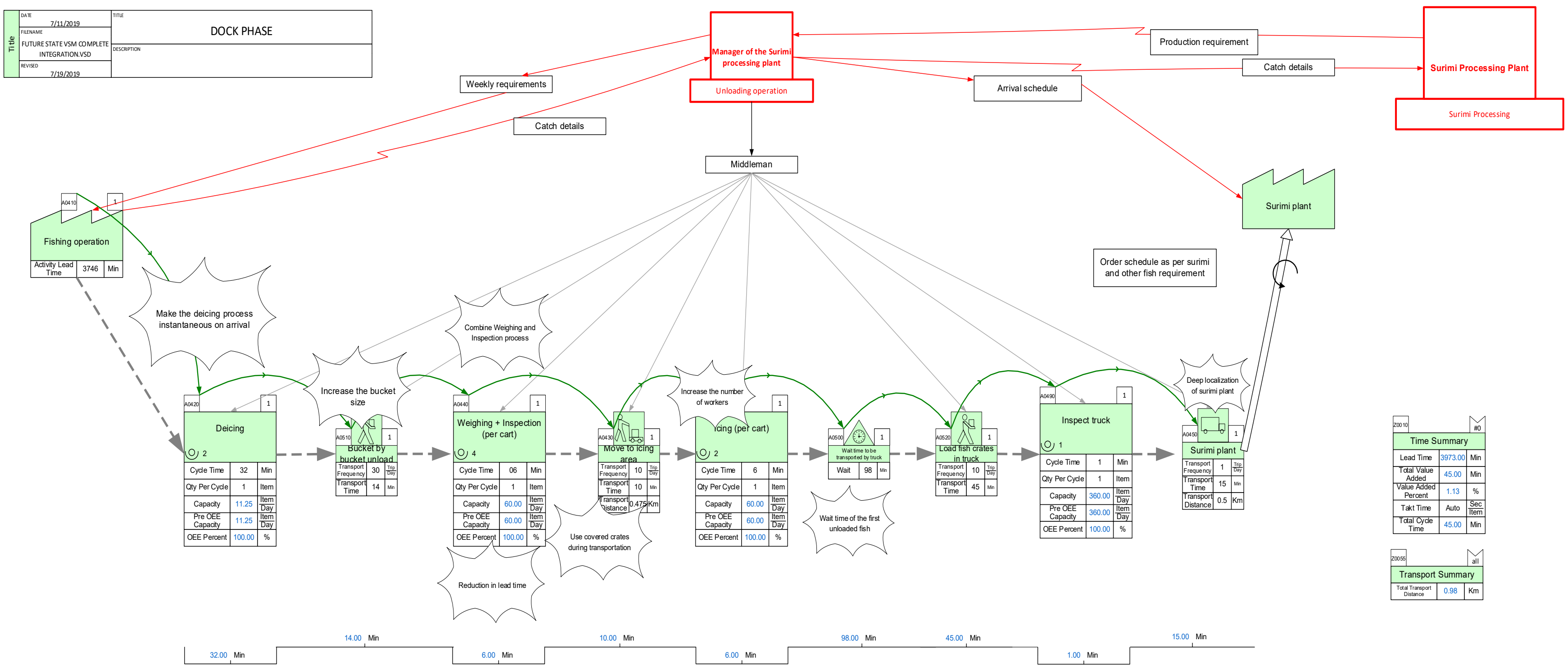


Figure 8.10: Future VSM with complete integration for Dock Phase

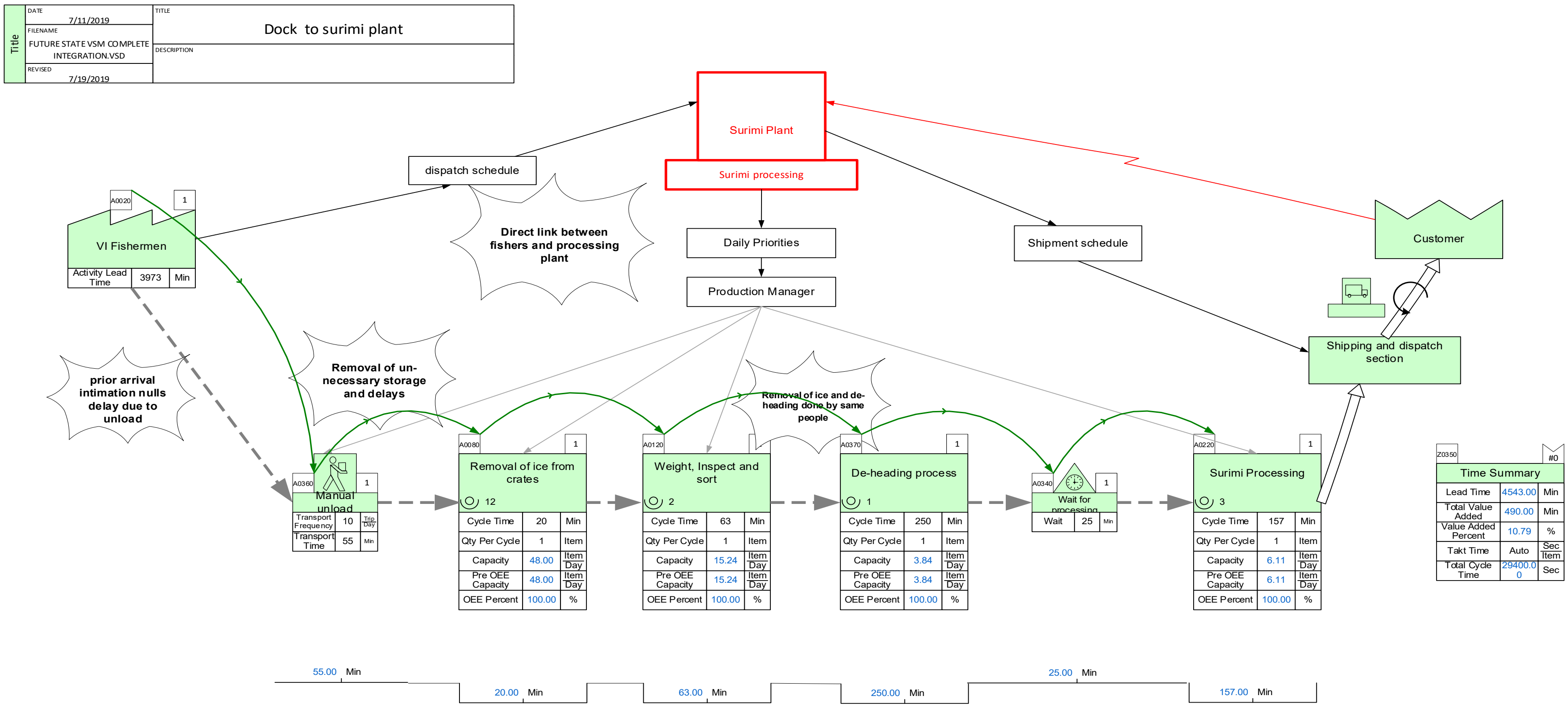


Figure 8.11: Future VSM with complete integration from de-heading unit-Surimi Plant

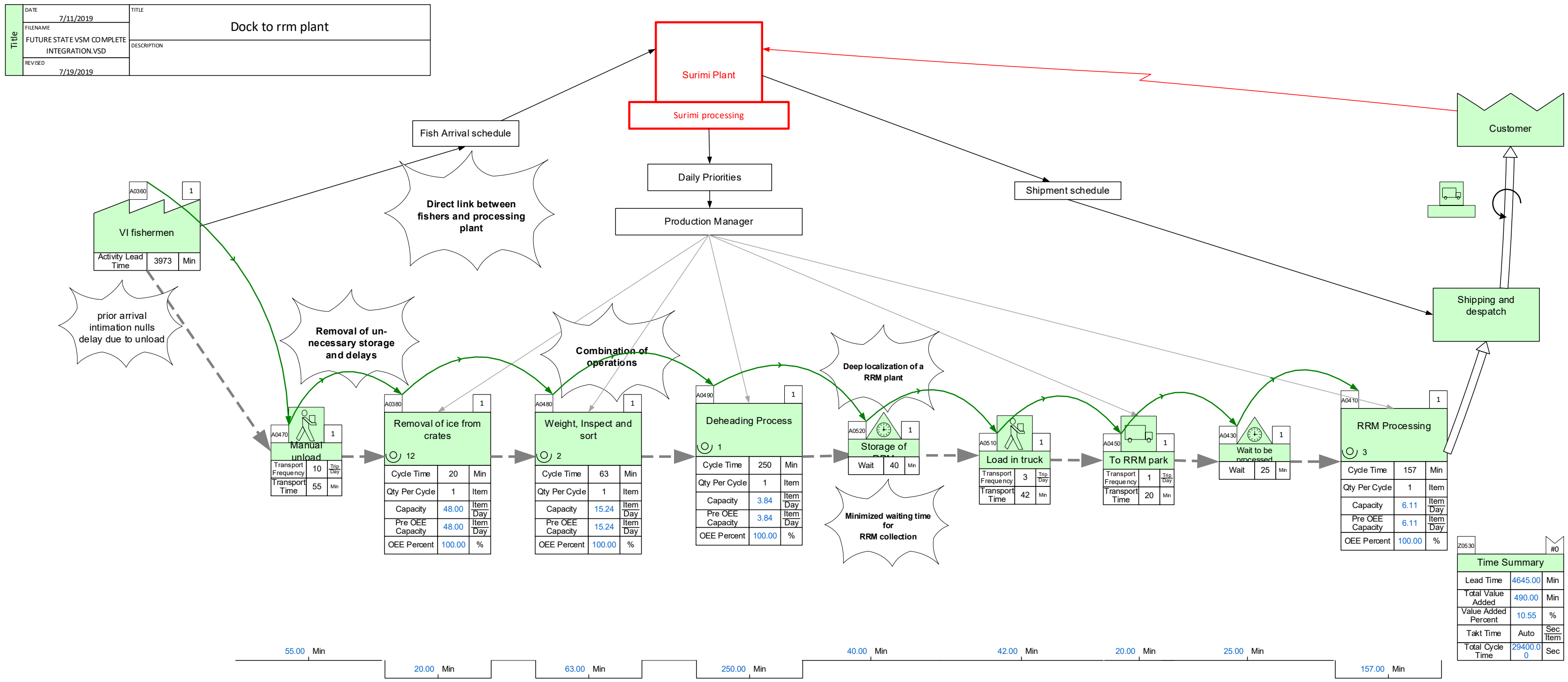


Figure 8.12: Future VSM with complete integration from de-heading unit-RRM Plant

9 References

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APPENDIX

A.1 Non-Vertically Integrated Fishing (Fish harvesting by Marginal Fishermen and fish purchased by Processing Plant from Aggregator)

Processing Plant and Fishing Locations	
Name of the Processing Plant	
Address of the Processing Plant	
Contact Person(s)	
Fishing Location(s)	

Supply Chain Configuration (from fish harvesting to fish purchasing)							
Members	Number	Capacity (kg)	Activities (processes) carried out with sequence	Condition of Fish			
				Input quality requirement	Input quality measurement	Output quality requirement	Output quality measurement
				Storage requirement (if any)	Temperature measurement system	Temperature at input, output and storage	Impact of quality on price
Fishermen							
Aggregator							
Processing Plant							
Challenges							
SOP: Standard Operating Procedure (if any) for operations							

Fish						
	Seasonal variation					
Fishing Duration in a year (with start and end time)	Location of the fishing point	Fish harvesting rate	Fish species available	Average shelf life	Size and its range (mm)	Weight and its range (gm)
Challenges						

Fishing Boat							
Storage process (Open space or boxes)	Full load (kg or boxes)	Cooling process (Ice slab or Refrigerated)	Details about Ice Slab and supplier	Refrigerant used	Cooling Capacity (KW or Ton or No. Ice slab)	Fish catching and handling equipment (s)	Persons per boat
No. of boats in a group	Average Utilization of person	Challenges					
Fish Box: Fish holding capacity (kg); material used; weight of the box; *Ice Slab*: Weight (kg) and duration (hours) of stay as ice							

Time and distance (in Sea)				
Average Onward Journey (km and days)	Average Return Journey (km and days)	Actual fishing duration (mean and standard deviation in days)	Average waiting time (Hours)	Average flow time (Hours)
Challenges				
Average flow time: average time between beginning of fishing and selling to consolidator or processing plant; Actual fishing duration (days): Average time between start of fishing and completion of fishing (i.e. move from fishing location to dock); Average waiting time: Average time between reaching dock and selling to consolidator or processing plant				

Time and distance (on Land)					
Distance between dock and actual point of selling (i.e. aggregator or processing plant) (km and days)	Number of storage point(s); distance	Average storage time(s) at storage points (mean and standard deviation in Hours)	Temperature at critical points till processing plant	Average waiting time in processing plant (Hours)	Average flow time in land (Hours)
Challenges					

Fish wastage (kg) at various stages just before processing for Surimi					
Locations	Reasons	Wastage (kg)/incoming fish	Waste management route (causes)	Types of waste generated (with composition)	Challenges
Fishing locations					
Boat during transit					
Fish unloading at dock					
During Logistics (dock to next stage)					
Aggregator					
Processing Plant					
	Challenges				
For example: Fish wasted because of non-purchase at aggregator or processing plant or due to quality or storage capacity					

Communication and co-ordination						
Stages of supply chain configurations	Communication devices used	Information captured (i.e. quantity & quality of fish, boat reaching time at dock etc)	Real time information visibility	Average capacity utilization (Boat, storage capacity etc)	Flexibility	Challenges
Fishermen						
Aggregator						
Processing Plant						

Pricing						
Members	Quality Parameters such as Temperature	Instrument used for checking	Price mechanisms adopted	Relationship between quality parameters and price	Price per unit	Challenges
Fishermen and Aggregator						
Aggregator and Processing Plant						

Cost information at Fishermen end					
Fixed cost	Operating cost	Logistics cost	Waste management cost	Revenue	Profit
Cost information at Aggregator end					
Fixed cost	Operating cost	Logistics cost	Waste management cost	Revenue	Profit
Cost information at Processing Plant end					
Fixed cost	Operating cost	Logistics cost	Waste management cost	Revenue	Profit

A.2 Level of vertical integration at fishing point

- The processes those can be carried out at fishing locations (with not much investment and modifications) which are presently happening at processing plant.
- The modifications needed in the present practice both for company owned fishing and non-vertically integrated fishing.
- The impact on quality, cost incurred due to modifications, cost reduction, enhancement of shelf life, RRM collection and disposal etc. due to proposed method(s).

A.3 Information to be collected for each process at Processing Plant

(i.e. Deheading and gutting; Washing; Fish Washer Machine I; Fish Washer Machine II; Deboner/meat separator; Stirring Tank; Rotary Screen; Bleaching Tank; Rotary Screen; Stirring Tank; Rotary Screen; Refiner; Screw Press; Mixer and Surimi forming and filling)

Each Process related information at Processing Plant								
Input material (Ton)	Output material (main product) (Ton)	Yield (%)	Detail of co-streams/ by-products produced such as quantity, yield etc.	Processing time (hrs)	Equipment (s) used for processing	Refrigeration system details	Input Temperature (^{0}C)	Processing Temperature (^{0}C)

Output Temperature (^{0}C)	Storage (Waiting Time (hrs))	Shelf Life of product from each process	RRM(s) generated and quantity w.r.t input material	Chemical Composition of each RRM	Form/state of different RRM (s)	Equipment(s)/ process used for RRM(s) collection

SOP for handling RRM(s)	Present use of RRMs	Potential use RRMs (i.e. food and feed)	Environmental impact due to current of RRM(s) disposal system	Revenue generated due to its use for value added product

Disposal cost of RRM	Challenges for handling the RRM(s)	Volume of wash water	Chemical composition of wash water (lipids, proteins etc)	Present Treatment/ Disposal process

Disposal cost of wash water	Environmental impact due to current wash water disposal system	Challenges for handling the wash water

A.4 Vertically Integrated Fishing (Company Owned Fishing)

Processing Plant and Fishing Locations	
Name of the Processing Plant	
Address of the Processing Plant	
Contact Person(s)	
Fishing Location(s)	

Supply Chain Configuration (from fish harvesting to fish purchasing)							
Members	Number	Capacity (kg)	Activities (processes) carried out with sequence	Condition of Fish			
				Input quality requirement	Input quality measurement	Output quality requirement	Output quality measurement
				Storage requirement (if any)	Temperature measurement system	Temperature at input, output and storage	Impact of quality on price
Fishermen							
Processing Plant							
Challenges							
SOP: Standard Operating Procedure (if any) for operations							

Fish						
	Seasonal variation					
Fishing Duration in a year (with start and end time)	Location of the fishing point	Fish harvesting rate	Fish species available	Average shelf life	Size and its range (mm)	Weight and its range (gm)
Challenges						

Fishing Boat							
Storage process (Open space or boxes)	Full load (kg or boxes)	Cooling process (Ice slab or Refrigerated)	Details about Ice Slab and supplier	Refrigerant used	Cooling Capacity (KW or Ton or No. Ice slab)	Fish catching and handling equipment (s)	Persons per boat
No. of boats in a group	Average Utilization of person	Challenges					
Fish Box: Fish holding capacity (kg); material used; weight of the box; *Ice Slab*: Weight (kg) and duration (hours) of stay as ice							

Time and distance (in Sea)				
Average Onward Journey (km and days)	Average Return Journey (km and days)	Actual fishing duration (mean and standard deviation in days)	Average waiting time (Hours)	Average flow time (Hours)
Challenges				
Average flow time: average time between beginning of fishing and selling to consolidator or processing plant; Actual fishing duration (days): Average time between start of fishing and completion of fishing (i.e. move from fishing location to dock); Average waiting time: Average time between reaching dock and selling to consolidator or processing plant				

Time and distance (on Land)					
Distance between dock and processing plant) (km and days)	Number of storage point(s); distance	Average storage time(s) at storage points (mean and standard deviation in Hours)	Temperature at critical points till processing plant	Average waiting time in processing plant (Hours)	Average flow time in land (Hours)
Challenges					

Fish wastage (kg) at various stages just before processing for Surimi					
Locations	Reasons	Wastage (kg)/incoming fish	Waste management route (causes)	Types of waste generated (with composition)	Challenges
Fishing locations					
Boat during transit					
Fish unloading at dock					
During Logistics (dock to next stage)					
Processing Plant					
	Challenges				
For example: Fish wasted because of non-purchase at aggregator or processing plant or due to quality or storage capacity					

Communication and co-ordination						
Stages of supply chain configurations	Communication devices used	Information captured (i.e. quantity & quality of fish, boat reaching time at dock etc)	Real time information visibility	Average capacity utilization (Boat, storage capacity etc)	Flexibility	Challenges
Fishermen						
Processing Plant						

Pricing						
Members	Quality Parameters such as Temperature	Instrument used for checking	Price mechanisms adopted	Relationship between quality parameters and price	Price per unit	Challenges
Fishermen and Processing Plant						

Cost information at Fishermen end					
Fixed cost	Operating cost	Logistics cost	Waste management cost	Revenue	Profit
Cost information at Processing Plant end					
Fixed cost	Operating cost	Logistics cost	Waste management cost	Revenue	Profit

A.5 Level of vertical integration at fishing point

- The processes those can be carried out at fishing locations (with not much investment and modifications) which are presently happening at processing plant.
- The modifications needed in the present practice both for company owned fishing and non-vertically integrated fishing.
- The impact on quality, cost incurred due to modifications, cost reduction, enhancement of shelf life, RRM collection and disposal etc due to proposed method(s).

Processing plants may have both non-vertically integrated fishing and vertically integrated fishing. For these plants, both questionnaires will be used and also some additional information such as volume of fish collected from each type will be captured.

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