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Food loss reduction in emerging economies by exploiting short sea opportunities

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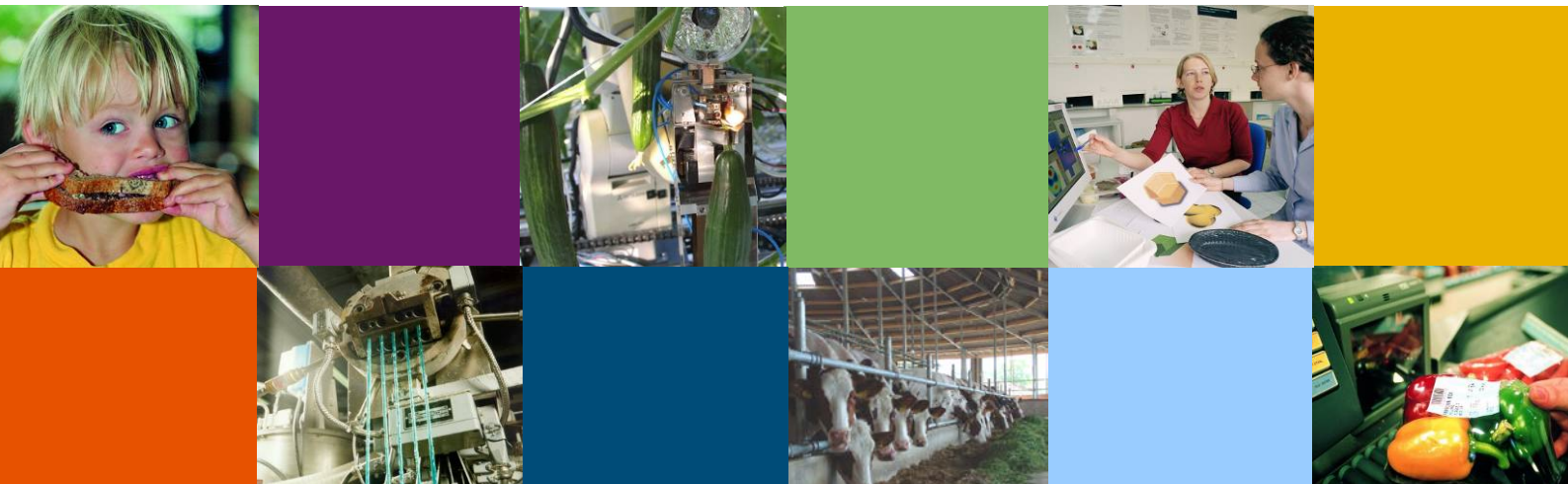

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Abstract

This document is the result of research into the development of short sea shipping supply chains. This research is carried out by Wageningen Food & Biobased Research (WFBR) in 2017 and 2018 in collaboration with the SCA Research and Development in India at the request of The World Bank, who also financed the research

The main goal of this project is to exploit efficient new urban short sea food supply chains within emerging economies that significantly reduce urban food losses and improve business profitability. Therefore, this study covers the development and piloting of a methodology for new short sea urban supply chains in India and its local knowledge transfer by capacity building and setting up partnerships that can implement the newly designed urban food supply chain.

The documented methodology in this report consists of four steps:

1. The selection of product-route combinations resulting in a table including all, from a cost point of view, potentially feasable short sea shipping routes between coastal economic zones(CEZs), and a selection of fruits and vegetable products which are promising and suitable in terms of quality decay to be transported on these routes.
2. With respect to these product-route combinations, the selection of farmer-market combinations is established resulting in a table with the potentially viable combinations of farmers and market players (both by name or pseudonym). This table quantitatively scores both the market player attractiveness and the match between market player requirements and farmer status showing the most feasible farmer-market combination. At this stage the product label and variety are specified.
3. With respect to these farmer-market combinations, an evaluated supply chain design, (proof-of-concepts) with physical design, logistical control, information and organisation designs determined.
4. With respect to these supply chain designs, a pilot setting is created resulting in a proof-of-principle that reduces the risk and uncertainty of the envisioned implementation of a short sea shipping supply chain.

The results of these for steps are:

1. The only product-route combination, that meets all the criteria of the methodology, is the route from CEZ Malabar to CEZ Suryapur for coconuts.
2. The most attractive farmer-market combination is the supply of Tender coconuts from farmer AAR to market player FARMFRESH.
3. Three supply chain design scenarios (ambient, partial cooling, maximum cooling), that differ on physical design only, are feasible from a business perspective. However, the effect of the supply chain design on quality loss could not be determined based on theory alone.

4. A test implementation (pilot setting) was performed to be able to eliminate uncertainties with regard to the effect on quality loss. Through the results of the laboratory simulation it was observed that of the three scenarios, partial cooling and maximum cooling are both feasible for the purpose of this study. The ambient scenario showed that the Tender coconuts will not remain in consumable quality till the end of the duration of the supply chain, and therefore is not feasible.

With regard to future applicability, the developed methodology can be applied to other coastal areas with a similar scope. Additionally, three types of projects with a smaller scope could benefit from the presented methodology as well:

- Operational projects with a specific market player and farmer (group): these projects might be initiated by the private sector that already has a source (farmer, farmer group, region) and the market player (retailer, hotel chain, etc.) in mind.
- Strategic projects to improve a country's food security, food quality or export opportunities: These kinds of projects are usually executed by government bodies.
- Other modalities: Although the methodology developed is dedicated to short sea shipping, it can be applied to other modalities as well. In fact, the methodology can be used to realize a new agro-logistical supply chain in general.

1. Introduction

This document is the result of research into the development of short sea shipping. This research was carried out by Wageningen Food & Biobased Research (WFBR) researchers in 2017 and 2018 at the request of The World Bank, who also financed the research. The researchers involved in this study carried out objective and independent research to realize the project objectives.

This Introduction chapter describes the background of the project (1.1), including the project objectives (1.2). Additionally, it presents a working definition of short sea shipping and the – to be designed – methodology (1.3) and a report structure (1.4).

1.1. Project background

To significantly reduce food losses (1.3 billion ton per year), a lot of research describes important barriers to conquer which will improve the well-being and life standard of many[1].

Some examples: The World bank lists limited access to inputs; high transport and logistical costs; opaque and unpredictable trade policies; costly and dangerous border crossings; and inefficient distribution services as key barriers to reduce food losses (especially considering smallholders) along the African value chain [2]. Another example is the World Bank's conclusion: "If every country improved just two key supply chain barriers even halfway to the world's best practices, global GDP could increase by $2.6 trillion (4.7%) and exports by $1.6 trillion (14.5%)".[2]

Fruits and vegetable losses (harvest to consumption) in emerging economies such as South and Southeast Asia, including India, are estimated to be higher that 50% [1]. Investment in agriculture, improving storage and supply chains is a priority for the World Bank Group to improve food security creating life-long effects on the social, physical, and mental well-being of millions of young people[3].

The above facts are not new, but an additional approach to conquer many barriers to reducing food losses at once is: exploit new short sea opportunities to urban food supply chains, in order to increase food security to these urban areas. Many ports in emerging economies are being developed rapidly, making on-time and reliable shipments from one coastal economic zone (CEZ) to another a valuable concept. Once short sea shipping of food between CEZs is implemented, many logistical and infrastructural barriers could be reduced for a substantial part resulting in significant reduction of urban food supply chain losses. Additionally, new markets can be reached to create new business.

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[2] *http://blogs.worldbank.org/endpovertyinsouthasia/global-supply-chain-barriers-lowest-hanging-fruit*
[3] *http://www.worldbank.org/en/topic/foodsecurity/overview*

1.2. Project objectives

The main goal of this project is to exploit efficient new urban short sea food supply chains within emerging economies that significantly reduce urban food losses and improve business profitability. Therefore, it covers the development and piloting of a methodology for new short sea urban supply chains in India and its local knowledge transfer by capacity building through setting up partnerships that can implement the newly designed urban food supply chain.

A short sea shipping methodology is a tool that facilitates a (potential) business (consortium) in selecting and evaluating a short sea shipping scenario and comparing this scenario with existing supply chains, both on business effectivity and on the effect with regard to the reduction of food losses.

Fruit and vegetable production covers a significant proportion of the total Indian fresh food production. Many smallholder farmers are involved in production and food losses are relatively high among these categories. Therefore, this project focusses on short sea shipping of fresh fruits and vegetables in India. The study will be conducted in close collaboration with policy-makers, local authorities, firms and local organizations.

1.3. Definitions

The definitions of 'short sea shipping' which are used in the context of this project and report are described below.

1.3.1. Definitions of short sea shipping

There is no generally applicable and accepted definition of short sea shipping. Instead, a variety of definitions is in use, often specified for specific (unions of) countries.

The European Commission has defined short sea shipping within Europe as follows [3]:

The movement of cargo and passengers by sea between ports situated in geographical Europe or between those ports and ports situated in non-European countries having a coastline on the enclosed seas bordering Europe. Short sea shipping includes domestic and international maritime transport, including feeder services, along the coast and to and from the islands, rivers and lakes. The concept of short sea shipping also extends to maritime transport between the Member States of the Union and Norway and Iceland and other States on the Baltic Sea, the Black Sea and the Mediterranean.

This definition is formulated by Transport Canada [4]:

Short sea shipping involves the movement of cargo or passengers by water over relatively short distances. It can occur within lakes and river systems and along coast lines. It consists of mainly domestic shipping but can also include cross-border traffic (Canada–US–Mexico). It does not consist of shipping across the world's major oceans.

The Ministry of Shipping of the Government of India presents the following definition in their concept note on the Sagar Mala Project [5].

Coastal shipping, short sea shipping, are all terms to describe a method of freight. Coastal shipping, as is most commonly known, is freight movement that happens on the water without crossing a major ocean or leaving a continent.

The most widely accepted definition of short sea shipping, by the US Maritime Administration, is as follows [6]:
Commercial waterborne transportation that does not transit an ocean and utilizes inland and coastal waterways to move commercial freight.

Because of the general nature of this definition by the US Maritime Administration, this definition of short sea shipping will be the basis for the definition used in this project. However, since this project doesn't include inland shipping, the definition of the US Maritime Administration is adapted in order to exclude inland shipping:
Commercial waterborne transportation that does not transit an ocean and utilizes coastal waterways to move commercial freight.

1.3.2. Working definition: short sea shipping methodology

A short sea shipping methodology is a tool that facilitates a (potential) business (consortium) in selecting and evaluating a short sea shipping scenario and comparing this scenario with existing supply chains, both on business effectivity and on the effect with regard to the reduction of food losses.

The methodology can be applied by any stakeholder that is involved, or ambitions to be involved, in realizing an improved supply chain.

1.4. Report structure

Chapter 2 presents an overview of existing methodologies, their usability and their value related to the goals of this specific project. The literature review shows advantages and bottlenecks related to short sea shipping initiatives and is thereby valuable with regard to additional scoping of this project. Chapter 3 is dedicated to the development of the methodology, including the definition of the criteria which are required to select the most feasible routes and products for short sea shipping.

This methodology is applied to India in Chapter 4. A conclusion is shown in Chapter 5. As the development methodology is applied for the first time during this study, a discussion on learnings and opportunities for further improvements of the methodology itself and future applications of it is presented in Chapter 5 as well.

One could note that the authors have chosen to split the development of the methodology and its application in two separate chapters, The authors have done so because, it is the expectation of the authors that the readers of this report are most likely interested in either one of them as a stand-alone result. However, if both chapters are of value to a reader, it is recommended to read the relevant subparagraphs of both chapters: 3.1, 4.1. 3.2, 4.2. etc.

2. Literature review

Auke Schripsema, Han Soethoudt, Seth Tromp

This chapter contains a literature overview of methodologies (and parts thereof) which support decisions about the use of short sea shipping for the transport of agri-food products.

Very little information was found on short sea shipping *methodologies*. Most literature sources consider specific *aspects* of such a potential methodology for short sea shipping. These aspects can be summarized as follows:

1. Requirements of short sea shipping. These requirements are needed in order to overcome the disadvantages of short sea shipping compared to other transport modes such as road and rail;
2. Advantages of short sea shipping. These advantages represent certain benefits of short sea compared to other transport modes.

These two aspects of a potential short sea shipping methodology are described in section 2.1 and 2.2 respectively.

A decision tool developed by Yonge & Henesey Yonge [7], which contains a list of decision factors supporting or limiting the prospects and opportunities for short sea shipping at an unnamed port in the United States, is described in section 2.3.

In section 2.4, a methodology is described that specifically supports the implementation of short sea shipping for the transport of *agri-food products*.

Section 2.5 discusses in what sense the methodologies (and parts thereof) as described in literature contribute to our interest of developing a methodology that supports the application of short sea shipping of agri-food products. We conclude which specific elements (critical success factors and key performance indicators) as described in literature are relevant for the development of a methodology supporting operational decisions about applying short sea shipping for the transport of agri-food products.

2.1. Requirements of short sea shipping

According to literature, in general, the following requirements exist for introducing short sea shipping:

a. Availability of infrastructure and equipment;
b. Harmonizing administrative procedures and regulations;
c. Overcoming the poor image of short sea shipping;
d. Provision of short sea shipping service which meets shippers' needs.

These four requirements will be described in detail below, including a summary of the related arguments in literature.

2.1.1. Availability of infrastructure and equipment

In order to enable the implementation of short sea shipping, and also to increase its chances of success, sufficient infrastructure and equipment is required, as is described by [8], [9], [10], [11], [12], [13] and [7]. These sources elaborate the following for the required infrastructure and equipment:

1. The width and depth of shipping channels ought to be sufficient for short sea shipping vessels [8];
2. The dock structure ought to be appropriate and up to date [8] and [9];
3. Ports ought to have up to date container handling equipment available [8] and [9], including sufficient crane and stevedore cargo handling capacity [10] and preferably roll on roll off ramps [12] to make certain that there is no capacity limitation [11];
4. Ports ought to be accessible by different modalities [10] and [12], including good access by road [11];
5. A sufficient number of berths ought to be available at ports [10]to make certain that there's no capacity limitation [11];
6. Availability of a computerized management system in ports and electronic transfer of data [12].
7. The described infrastructure and equipment is ideally specifically dedicated to short sea shipping [12] and [13].
8. The ability of ports to handle cargo transported by short sea shipping quickly and efficiently [9], [13] and [7].

2.1.2. Harmonizing administrative and legal procedures and regulations

The harmonization of administrative and legal procedures and regulations, both in terms of removing differences between different modalities and different countries or states, is another recurring requirement for short sea shipping. Proposed measures to meet this requirement, as described by [9], [11], [12], [13] and [7] are:

1. Administrative and bureaucratic procedures for short sea shipping, including clearance procedures of cargo, can be complex and time consuming. Administrative barriers ought to be removed in order to encourage short sea shipping [9], [13]and [22], for example by establishing one stop administrative shopping windows [12];
2. Regulations can be inconsistent between states and countries. These inconsistencies ought to be reduced, and preferably removed altogether, in order to make short sea shipping a more attractive transport option [9]. This can be achieved by an integration of border crossing systems and establishing a multi-national jurisdiction environment [7];
3. Customs procedures are often lengthy for goods transported by means of short sea shipping and ought to be reduced [11], which can be achieved by implementing automation of customs and immigration security systems [7];

4. More restrictive regulations for road transport to make it less competitive to short sea shipping, for example by restricting the number of driving hours and increasing or introducing road haulage taxes [13].

2.1.3. Overcoming the poor image of short sea shipping

In literature are mentions of the image of (short sea) shipping as slow, unreliable, obsolete [6] and old-fashioned [12]. This poor image might be improved by providing better statistical data on the performance of short sea shipping, by developing new marketing and commercial approaches [13], and raising awareness of the available series [7].

2.1.4. Provision of short sea shipping service which meets shippers' needs

Shippers require continuity, stability, variability and door-to-door service with regard to transport services. These requirements have to be met, or shippers have to be selected for whom these requirements don't strictly apply, in order to make the implementation of short sea shipping successful [14] [11].

2.2. Advantages of short sea shipping

Advantages of short sea shipping refer to the benefits which can be achieved by implementing short sea shipping compared to alternative transport modalities.
Throughout literature, these are the advantages which are contributed to short sea shipping:

a. Decreased environmental impact;
b. Better utilization of infrastructure;
c. Potential cost efficiencies;
d. Coastal economic development.

These advantages will be described in detail below. For each advantage, the relevant arguments in literature will be summarized.

2.2.1. Decreased environmental impact

Among others [6], [11], [12] and [7] write about the environmental benefits of short sea shipping and the reduced environmental impact of transport it can accomplish:

- Short sea shipping relies on ships rather than trucks; Ships emit significantly less greenhouse gasses per ton-kilometre, are more sustainable and require less energy. Because of this, short sea shipping is more energy efficient and reduces air pollution compared to other transport modalities [6], [11] and [12].
- Short sea shipping also reduces noise by utilizing ships rather than trucks [6].
- By reducing congestion on roads, short sea shipping indirectly also reduces the greenhouse gas emissions and energy consumption of remaining road transport [6] and [7].
- Due to decreased environmental impact, short sea shipping can fit in with the corporate social responsibility of companies [6].

2.2.2. *Better utilization of infrastructure*

Because short sea shipping utilizes the sea rather than (rail) roads which have to be specifically constructed, this leads to the following advantages as described by [6], [12] and [7]:

- Expansion of transportation network capacity with few infrastructure costs [6], [12] and [13];
- Reduction of pressure on other modalities [12];
- Potential development of peripheral regions [13].

2.2.3. *Potential cost efficiencies*

As described by [15], [16], [11] and [12], short sea shipping provides potential cost advantages. Especially on longer distances, short sea shipping has been shown to be less expensive than transport by road or train, although this cost effectiveness depends on the exact locations and distances along which goods are transported.

2.2.4. *Coastal economic development*

The efficient hinterland connectivity and port led development enable coastal economic development. This includes ship repair, ship building clusters, ship breaking industries, bunkering facilities, container freight stations, dry ports and warehousing facilities. Systematic development of these facilities around ports would power economic growth in the coastal economic region [5].

2.3. A decision tool for the implementation of short sea shipping

Yonge and Henesy [7] have developed a decision tool for the implementation of short sea shipping. It places weights and scores upon a list of critical decision factors that may support the initiation of a short sea shipping project. A comparison between the current and the future probability of success indicates the potential to improve towards a successful short sea initiative.

The list of 20 critical success factors is provided in Table 1. A distinction between requirements on the one hand and advantages on the other hand is presented. Additionally, a distinction between the different types of requirements (infrastructure, administration, image and service) and different advantages (environmental, infrastructure and cost efficiency) that can be distinguished in the former sections is shown in Table 1. The decision tool calculates the probability of success of a short sea initiative by calculating the overall weighted average score on these critical success factors.

Table 1: critical success factors for initiating a successful short sea initiative

Aspect	Type	Critical success factor
Requirements	Infrastructure	1. Integration into multimodal transport chains or networks; "just in time"; hinterland 2. Stimulation of new maritime transport technologies 3. Minimize restrictive labour regulations
	Administration	4. Removal of administrative barriers 5. Integration of border crossing systems 6. Automation of customs / immigration security systems 7. Improvement of transparency in ports, related to tariffs and state aids 8. Minimize administrative barriers because of rather complex documentation and procedures in ports and the veterinary checks 9. Minimize delays in ports
	Image	10. Improvement of image of short sea shipping, increase awareness of full range of service
	Service	11. Creation of reliable statistical market data on existing land transportation, both for commercial development and policy making 12. Improve the regularity of services because of trade imbalances 13. Improve performance by increasing speed, reliability, quality of service and cost-efficiency, improve competitive pricing 14. Decrease susceptibility to inclement weather conditions
Advantages	Environmental	15. Lower energy consumption and better environmental performance in terms of pollution and safety 16. Reduced road congestion
	Infrastructure	17. Increase of the transportation capacity 18. Potential contribution to development of peripheral regions 19. Positive effect on the development of the other sectors such as the port sector and the shipbuilding industry
	Cost efficiency	20. Expansion of capacity with few infrastructure costs

2.4. A short sea shipping methodology for comparing road and short sea transport of agri-food products

Perez-Mesa et al. [17] discuss the benefits of implementing short sea shipping in intermodal transport for fruits and vegetables, with a specific analysis of horticultural exports from southeast Spain. A multi-criteria decision-making model is applied to determine the optimal allocation between land and intermodal transport, including environmental externalities.

Currently land transport accounts for almost 100% of the export flow of fruits and vegetables from southeast Spain. The authors observe a trend that each retail chain will contract a few suppliers that guarantee volume, quality, range, uninterrupted service, food safety and traceability. This will provide a stability of sales, which creates an opportunity for short sea shipping. Ro-ro[4] maritime transport has been selected for implementing short sea shipping, as this system is flexible and better suited to the transport of perishable produce [17].

The most relevant result is that the cost of intermodal transport is 14% lower than land transport, but that the total transit time for intermodal transport is almost twice that for land transport. The decrease of the total cost does not compensate the increase of the total transit time. The number of quality claims is expected to increase, both due to real quality losses and due to demanded discounts for damaged shipments which actually are undamaged, when prices at the destination fall brusquely.

2.5. Summary

Yonge and Henesy [7] have developed a decision tool for supporting the initiation of a short sea shipping project. This decision tool was explained in section 2.3. A benefit of this tool is that the list of critical success factors is a rather generic list, that can be used for different short sea studies as well. However, some disadvantages exist as well. First, the decision tool calculates a simple weighed score, where the distinction between requirements and advantages is neglected. This seems strange because requirements represent necessary conditions, such as the success factor 'demand' is called a 'must have' for any project according to Yonge and Henesy [7]. Therefore, requirements seem to be more important than advantages, which are (only) 'contributing conditions'. The decision tool does not make this distinction.

Second, the tool was developed at a high level. Although the authors suggest that the tool can be adjusted and perfected to consider lower-level weightings and to apply it to other industry stakeholders in determining their considerations to initiate a short sea shipping project, this will demand elaboration in detail of indicators and evaluation. Hence also much additional information needs to be collected.

[4] *Roll-on-roll-off, loading and unloading on wheels*

Third, the decision tool is not specifically focussed on agri-food products, for which shelf life is a critical element of the decision-making process. Agri-food products are expected to demand specific critical success factors.

Fourth, the methodology is restricted to an absolute evaluation of some SSS design. It does not involve comparison to other modalities and hence does not support an investor in decision making in an optimal way.

Another methodology on short sea shipping is presented in Perez-Mesa et al. [18]. They apply multi-criteria decision-making techniques to determine the optimal allocation between land and intermodal transport, including environmental externalities, with a specific analysis of horticultural exports from southeast Spain. This was explained in section 2.4.

The multi-criteria decision-making model covers both costs (including externalities) and transit times, which are both key performance indicators when shipping agri-food products. However, such a multi-criteria decision-making model does not fully cover the need for a methodology that supports the shipper's *operational* decisions whether to apply short sea shipping for transporting a specific agri-food cargo to a specific consignee: first, it starts from an available port infrastructure that is suitable for short sea shipping of perishables. This is understandable in Europe but not in countries with emerging economies in Africa or Asia. Port selection depending on the match between infrastructure and supply chain requirements is part of our envisioned methodology.

Second, the envisioned methodology should be flexible in the context of market requirements that need to be met. In Perez-Mesa et al. [18] they are assumed to be static and high-end.

Third, truck transport in Europe cannot be compared to truck driving in emerging economies in Africa or Asia. State border issues, roadblocks, bad roads, toll, etc., need to be addressed in the envisioned methodology.
From Perez-Mesa et al. [18], the following elements, that are important when developing a short sea shipping methodology with respect to agri-food products, were identified:

- a stability of sales between shipper and consignee increases the opportunity for short sea shipping;
- ro-ro maritime transport is flexible and better suited to the transport of perishable produce;
- the total transit time for intermodal transport is probably (much) higher than that for land transport;
- an increased total transit time is expected to have negative consequences for product losses and quality or discount claims.

Both methodologies described do not incorporate product specific requirements or restrictions of fresh produce. The quality level required at market level has impact on the lead time options and/or necessary technology investment (costs) to guarantee product quality.

Another issue are the investment costs. The two methodologies described include operational costs only, whereas some investments might be needed as well.

Additionally, the need for regulatory reform might exist as a prerequisite to implement a short sea shipping solution.

There are a variety of papers which describe the requirements and advantages of short sea shipping (see sections 2.1 and 2.2 respectively). The requirements are:

a. Availability of infrastructure and equipment;
b. Harmonizing administrative procedures and regulations;
c. Overcoming the poor image of short sea shipping;
d. Provision of short sea shipping service which meets shippers' needs.

The advantages in the literature review described are:

e. Decreased environmental impact;
f. Better utilization of infrastructure;
g. Potential cost efficiencies.

Since none of the described methodologies (or parts thereof) include a tool that facilitates a (potential) business (consortium) in selecting and evaluating a short sea shipping scenario and comparing this scenario with existing supply chains with regard to both business effectivity and the reduction of food losses, the development and subsequent piloting of such a methodology is carried out in this project.

3. Methodology development

Auke Schripsema, Han Soethoudt, Seth Tromp

This project aims to develop a methodology to evaluate short sea shipping scenarios in terms of business effectivity and reduction of food losses. In order to achieve this, the envisioned methodology consists of four distinctive phases:

A. Selection of product-route combinations;
B. Selection of farmer-market combinations;
C. Supply chain design;
D. Test implementation.

Each distinctive phase follows a process that results in input for the next phase. An overview of the processes and results are shown in Figure 1

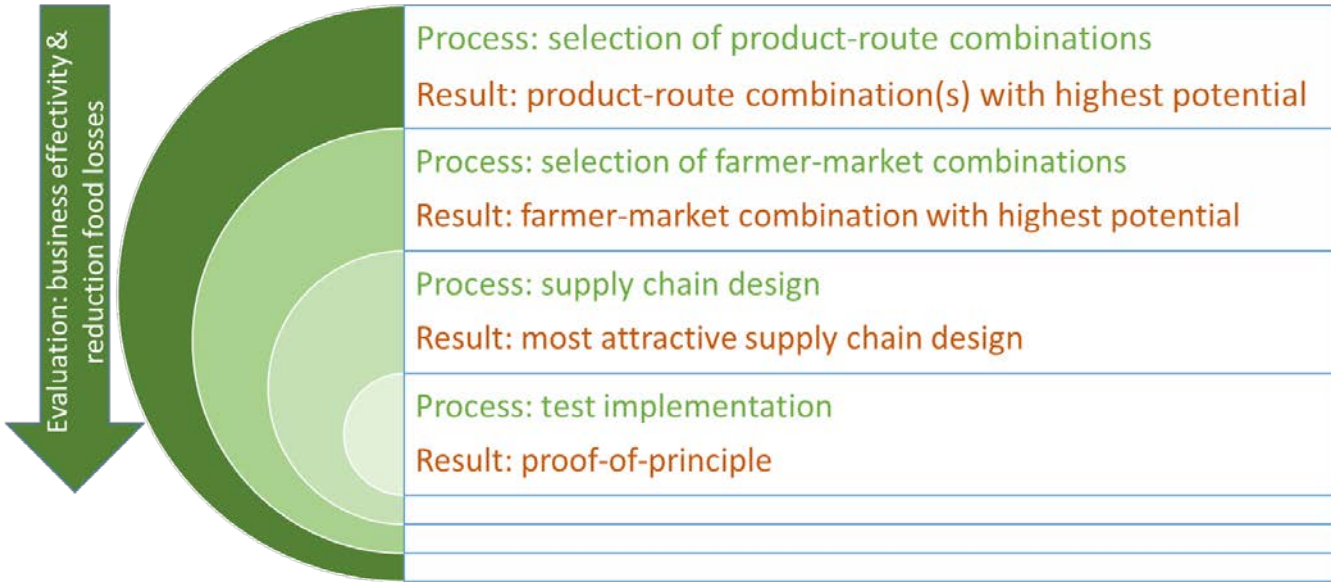

Figure 1: Evaluation processes & results of each phase in terms of business effectivity & reduction of food losses

3.1. Selection of product-route combinations

The first phase of the methodology is dedicated to select the product-route combinations (PRCs) which offer potential for business profitability and the reduction of food losses. A route is defined as a pair of two different CEZs. These CEZs determine the region of both origin and destination of the fresh product which will be transported by means of short sea shipping.

The product-route selection consists of these aspects:

1. Route selection
2. Product selection
3. Initial feasibility check

The selection processes of routes and products are described in section 3.1.1 and 3.1.2 respectively. The initial feasibility check, considered from a cost point of view, is described in section 3.1.3.

The end result of this phase of the methodology is a table including all potentially viable short sea shipping routes between CEZs, and a list and ranking of fruits and vegetable products which are promising, with regard to business effectivity and the reduction of food losses, and suitable to be transported on those routes by means of short sea shipping.
In the output table, pairs of CEZs (origin and destination) are listed including per combination the products that have potential. This table is the basis for the second phase of the methodology, in which suitable farmer-market combinations will be selected.

3.1.1. Route selection

A 'route' is defined as a pair of two different CEZs. These CEZs determine the region of both origin and destination of the products which will be transported by means of short sea shipping. The route selection is divided into four separate topics, namely:

1. Identification of CEZs
2. Determination of port connectivity between CEZs
3. Attractiveness of CEZs for multi-modal transport
4. Existing shipping line connectivity

These topics, and the related criteria, are elaborated below.

3.1.1.1. Identification of CEZs

The purpose of the identification of CEZs is to provide an overview of all existing potential regions of origin and destination for short sea shipping of products in the relevant country. For example in India, a coastal zone (for example one or more districts) is a CEZ if it fits the following three criteria, as defined by the Ministry of Shipping of the Government of India [19]:

a. The region has a coastline with a length between 300 and 500 kilometres.
b. The region includes an inland area between 200 and 300 kilometres.
c. The region includes one, two or three seaports.

In the next steps, this complete list of CEZs will be narrowed down to include only those CEZs which are viable for the implementation of short sea shipping of fruits and vegetable products.

3.1.1.2. Determination of port connectivity between CEZs

After all potential CEZs have been identified, the next step of the methodology consists of selecting only those CEZs which have sufficient port connections to one another to ensure maximum flexibility on potential short sea shipping routes. This starts by identifying the ports which are part of the defined CEZs.

The following two criteria are added, which are based on the judgment of the authors of this report:

d. The number of shipping lines servicing the CEZ is at least two.
e. There is at least one shipping connection to other ports.

These criteria ensure that there is at least minimal connectivity to other ports, and that a replacement connection can be arranged in case the connection of first choice can't be utilized.

The CEZs which don't include ports that meet both criteria regarding port connectivity will be excluded from the remainder of the selection procedure.

3.1.1.3. Attractiveness of ports in CEZs regarding multi-modal transport of fruits and vegetables

This list of potentially suitable ports for short sea shipping is narrowed down further by applying criteria regarding the attractiveness of the ports for multimodal transport. These criteria can refer to Ro-Ro ('roll on, roll off') or reefer transport. In the future, once the concept of short sea shipping is potentially rolled out, a large quantity of Ro-Ro's and/or reefers need to be shipped. With regard to the nature of farming in emerging economies (usually many smallholder farmers[5]) and in order to realize large volumes (multiple containers per week), it is expected that the short sea shipping supply chains will involve combining produce of multiple farmers at a collection point. Therefore, the criteria regarding the attractiveness of CEZs for multi-modal transport are based on these assumptions:

f. The transport from farm to collection point might lead to mechanical product damage, hence sorting should be done at the collection centre and from there produce is transported to the port. The criterion is:
   The length of unpaved roads between collection centre and port is less than 5 km[6].
g. We assume that along the coast most vessels transporting containers are feeder type and carry between 500 and 1500 containers[7]. Based on container traffic statistics[8] the average number of feeder vessels per week in the port can be calculated.
   The number of feeder vessels per week in the port should be at least one.
h. *Availability of cranes, trailers, side loaders and carriers (in the case of container transport) or ships should have a ramp (in the case of Ro-Ro transport).*
i. *Depth of the port and the waterway leading to the port of at least 10 meters[9].*
j. *Availability of power supply units for refrigerated containers in the port or at the nearby the container freight station.*

Note that for Ro-Ro transport the port has no restricting characteristics.

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[5] *Further discussed in paragrapgh 3.3.4*
[6] *Note that the collection point might as well be close to the port, but anyhow we assume that produce not meeting the quality requirements is not shipped.*
[7] https://en.wikipedia.org/wiki/Container_ship
[8] http://ipa.nic.in//showimg.cshtml?ID=217
[9] https://people.hofstra.edu/geotrans/eng/ch3en/conc3en/containership_draft_size.html

3.1.1.4. Existing shipping line connectivity

The final restriction for route selection is the presence of shipping routes. A route between a CEZ of origin and a CEZ of is destination is only considered a viable route in this methodology when it is currently served directly by at least one shipping line.

3.1.2. Product selection

In order to select the types of fruits and vegetables which have the best chance of being successfully transported by short sea shipping, the following criteria are applied:

a. Most produced products per selected CEZ;
b. Sufficient shelf life;
c. Oversupply in the CEZ of production;
d. Undersupply in one of the other selected CEZs.

These criteria are described below in more detail.

The product selection phase ends with a shortlist of fruits and vegetable products, with sufficient shelf life and guaranteed demand, of which there is an abundance in one CEZ with a well-connected port and a shortage in another CEZ with a well-connected port.

3.1.2.1. Most produced products per selected CEZs

The ten most produced types of fruits and vegetables should be identified (in terms of annual quantity in tons produced) for each of the selected CEZs from the route selection phase as described in the former section, including the months of the harvest season[10].

As a production top 10, by default the fruits top 5 and vegetable top 5 is taken. To identify this top 10 in the CEZ, statistical data should be available on such a regional level that the CEZ can be built up by a collection of regions. For example, in India CEZs constitute of a collection of districts, and production data are available on district level. In case the CEZ consists of more than one district, the total production of all districts in the CEZ is calculated for all fruits and vegetables available. Subsequently, the ranking takes place only over the CEZ as a whole.

Note that it's possible that some products are produced in one district and not in another. In this case, zero can be put in the production table for this district before calculating the totals for all products.

[10] *For some districts less than five fruit or vegetable products might be produced. In these cases the list will be shorter.*

Once the top 5 for fruits and for vegetables is determined, an extra column is added to the result table with the months of harvest. This is necessary since later on, when the products with oversupply are derived, wholesale prices will be compared on monthly level between the sourcing area and potential destinations and obviously this can only be done if the product is harvested.

To avoid outliers (e.g. bad climatological conditions in some particular year) the average of the production data available over the most recent three years available is taken. If the data are available for two years, one takes the two-year average, but if only one year of data is available it is necessary to check whether this year is an outlier in the trend. To do so, the data for this particular product are considered over most recent three years on state level for the state the district belongs to. If this particular year where the district data are available is no outlier in the state-wise annual production, one can use this one data point for the analysis. However, if this year is an outlier, the product is deleted from the list and the next one in order is added.

Note that at this moment different product varieties or labels (e.g. ecological) are not taken into account yet. During the match analyses (section 3.2.3), market players and farmers will be evaluated on product varieties and or labels though.

3.1.2.2. Sufficient shelf life

The list of top 10 produce is further narrowed down based on shelf life. The shelf life should be sufficient given the expected transit time to transport the fruits and vegetables for every combination of CEZs resulting from the route selection.

The shelf life of a product restricts the options in the sense that the logistic throughput time cannot be too long. In this step, the shelf life of all top 10 products will be listed for ambient as well as cold temperature conditions. In combination with throughput time calculations some opportunities will be deleted.

When products arrive at the port for sea transport all kind of processes can take place like administrative procedures, phytosanitary check, waiting time for loading or unloading, etc. We call these 'Processes and Documents on Departure' (PDD) and ''Processes and Documents on Arrival' (PDA). We assume that the lead time between farm and the logistic hub at the port is one day. Doing so the throughput time from farm to buyer is determined, and it is done in a product-independent way.

The on-land throughput times are independent of the connection between two ports.

3.1.2.3. Oversupply in the CEZ of production

The list of suitable products is further narrowed down based on oversupply (so risk of having food losses is mitigated) in the CEZ where the relevant product is produced. This is checked for each product on the list. Therefore, three kinds of data are required for every product:

i. Population in every district within the CEZ (latest data available)
ii. Average of production data available over the most recent three years available in these districts
iii. Average monthly consumption on a national level (latest data available)

To calculate i, the population of all the districts in the CEZ are added to the CEZ total. The latest data available are used, only one year. In order to support a sustainable short sea supply chain, in step ii the average production data available over the most recent three years available will be calculated, including the months of harvest. Data of the most recent three years are necessary to reduce the risk of considering an exceptional period (for example because of extreme weather conditions) that influences the production data significantly and might lead to incorrect (un)selection of the considered produce. These production data are available from 3.1.2.1. The production per capita *per month in harvest time* is compared to the average consumption per month on national level, to check if there is an oversupply. It is called a case of oversupply if the annual production per capita per month in harvest time is at least twice the average monthly consumption.

3.1.2.4. Undersupply in one of the destination CEZs

The product list is further narrowed down based on undersupply in one or more of the selected destination CEZs. In this methodology, undersupply is related to the wholesale market prices. For the sourcing CEZ as well as the destination CEZ the average monthly wholesale prices available over the most recent three years are determined, based on a large wholesale market located in one big city (more than 1 million population) within 200 km to 300 km[11] from the production area (sourcing CEZ) and the port (destination CEZ). Three years of wholesale market prices are necessary based on the same reason as for the production data (3.1.2.3). For example, in India, 'undersupply' could be defined as cases with a monthly-average difference between sourcing CEZ and destination CEZ s of at least 1,000 INR / quintals[12]. By taking such a high threshold value, it is assumed to obtain only one or two feasible cases.

Remark: note that undersupply is not really the driver for business here. The *price difference* between the wholesale markets is key to the opportunity. Nevertheless, the assumption is undersupply and relatively higher prices are correlated.

[11] *Note that the city could be in another CEZ.*
[12] *1 quintal = 100 kg*

3.1.3. Initial feasibility check

Finally, the product-route list is further narrowed down based on financial feasibility and competitiveness to road transport. Therefore, in this section, the feasibility of short sea shipping is considered from a cost point of view. In addition, the competitiveness in relation to trucking is carried out with respect to costs and lead time.

3.1.3.1. Financial feasibility

The financial feasibility of short sea shipping should be determined by comparing the prices of the relevant product for both the wholesale market where it's currently sold and the new wholesale market where the product is potentially sold instead. In order to make the change to a new wholesale market feasible in terms of costs, the additional revenue which is earned by selling at a new market must be larger than the increase in logistical costs of shipping the container with these products to this new market. Total logistics costs of short sea shipping are collection transport from farmers, all costs relating to shipping and documents, and inland transport from port to major city. This should be compared to the transport costs of directly trucking from the sourcing area to the current wholesale market (nearest big city).

3.1.3.2. Competitiveness

Cost and lead time have been calculated for the supply chain involving short sea shipping. These two indicators should be researched for trucking as well and be compared.
Eventually some indications on percentage-wise losses can be found in literature. It is expected that truck transport leads to more mechanical product damage than short sea shipping.

3.2. Selection of farmer-market combinations

The starting point for selecting suitable farmer-market combinations are the product-route combinations as the result from the product-route selection (see 3.1). A product-route combination is a combination of a product and a route, where a route is defined as a pair of different coastal economic zones (CEZs). These two CEZs determine the (foreseen) regions of origin and destination for the involved product. So, the product-route selection has shown that it is promising to apply short sea shipping to transport the identified product from the origin CEZ to the destination CEZ.

A farmer-market combination (FMC) is defined as a combination of a farmer (group) with regard to the product under consideration (incl. variety and label) within the CEZ of origin, and a market player(s) (customers such as retailers, restaurant chains and hotel chains) within the CEZ of destination. Within a farmer-market combination, farmers and market players are mentioned by name or pseudonym.

The selection of suitable farmer-market combinations consists of three aspects:

1. Market research;
2. Farmer research;
3. Match analysis.

The interdependency between market research, farmer research and match analysis is visualized in Figure 1. These interdependent aspects of the phase of selecting suitable farmer-market combinations are elaborated in section 3.2.1, 3.2.2 and 3.2.3 respectively.

The end result of the farmer-market selection is a table with the potentially viable combinations of farmers and market players within the selected CEZs, with respect to the selected product. This table quantitatively scores both the market player attractiveness and the match between market player requirements and farmer status. The highest combination of these two scores is to be considered as the most feasible farmer-market combination, as the market player attractiveness is large, and the farmer status meets the market player requirements most. This output is the basis for the supply chain design.

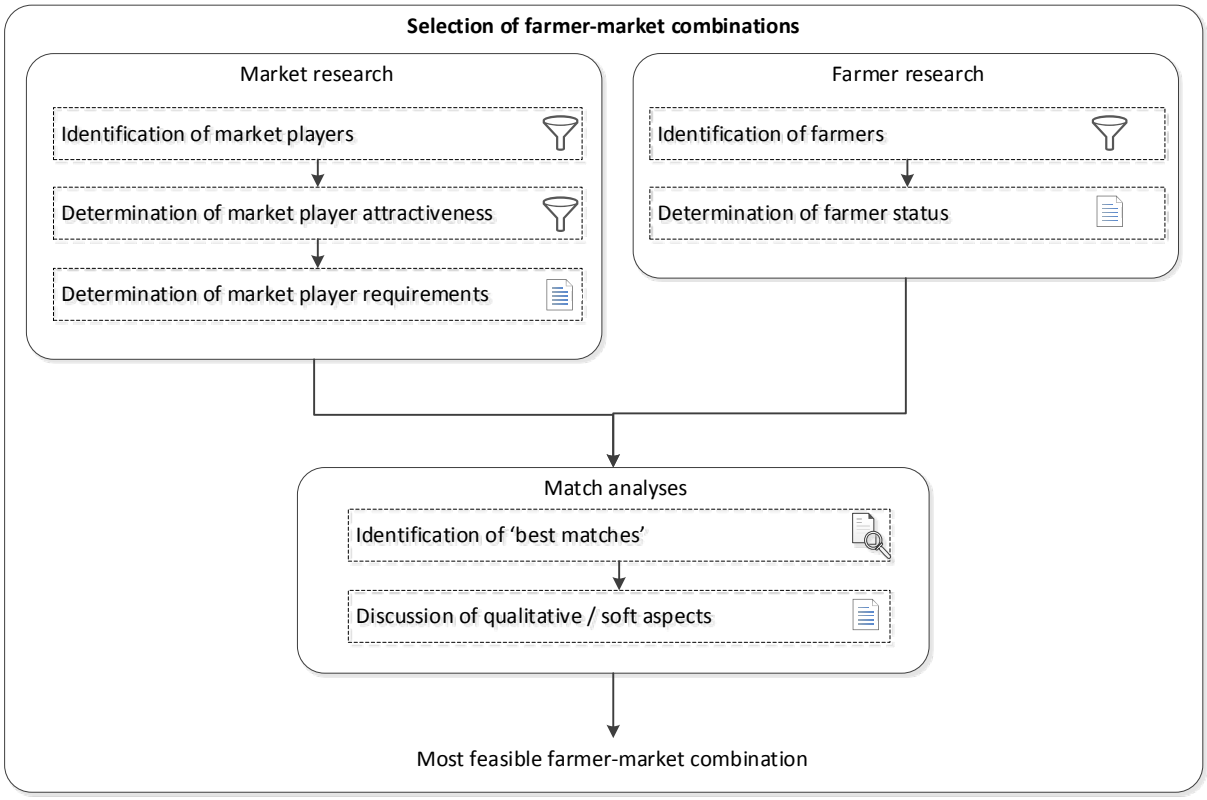

Figure 2 Interdependency between market research, farmer research and match analysis.

To illustrate the expected output of the farmer-market selection, a hypothetical table showing a single product variety and label is shown below (Table 2). The figures shown are fictional. In this example, the farmer-market combination of Mr. Mango-Mango Juice Production Company Z is scored most feasible. This is the case because the Mango Juice Production Company scores a high market attractiveness, and there is a high match between this market player and the farmer Mr. Mango.

The approach to calculate the figures will be described later in section 3.2.

Table 2 A hypothetical output table presenting on the one hand the market players with a high market attractiveness and on the other hand the estimated matches between 4 farmers and these 3 markets

Organic Keith Mango			
Market players →	Online retailer X	Hotel Chain Y	Mango Juice production company Z
Market attractiveness (%)	75	79	79
Farmers ↓	*Match between farmer and market player (%)*		
Mr. Mango	20	51	***89***
Mango farmers united B.V.	30	35	12
Mango Delicious Company	85	78	66
The Mango Start-up	12	22	18

3.2.1. Market research

Market research is divided into three separate topics as shown in Figure 2, namely:

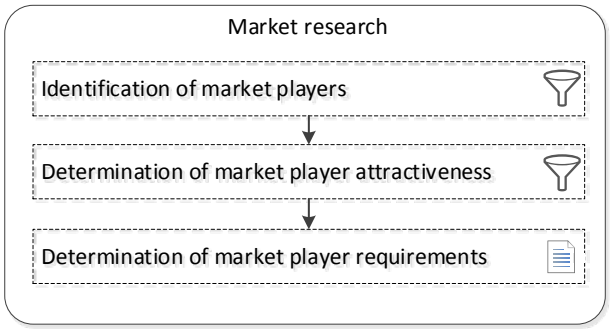

Figure 3 Market research

The identification of market players (3.2.1.1) results in a list of potential customers (market players). Determination of market player attractiveness (3.2.1.2) results in a split up of this list: market players that are not attractive and will no longer be taken into account. Market players that have a sufficient attractiveness will be part of the study that results in market player requirement listing (3.2.1.3).

Both the market player attractiveness score and the listed market player requirements will be input for the match analysis.

3.2.1.1. Identification of market players

The purpose of the identification of market players is to provide an overview of potential customers (retailers, fast-food chains, etc.) within the CEZ of destination. To realize the objective of a reduction of food losses, these customers should be willing to and capable of being a part of a long-term partnership in the supply chain using short sea shipping transportation. The potential of a partner (group) increases if their mind-set is on:

- Buying sufficient volume for short sea shipping: minimal one 20-foot container per order;
- Setting up long-term partnerships with the famer to jointly realize more benefits of added value (=market driven supply chain), instead of buying whatever is on the open market;
- Selecting suppliers based on quality, reliability and price, instead of only on price;

In order to identify such market players, two approaches exist:

1. Use the network of a local project partner for consulting market players for interest in additional suppliers (e.g. off-season demand) of product(s) bought elsewhere currently, or new suppliers of product(s) that are not in their buying portfolio yet. Additionally, the willingness to source through short sea shipping transportation needs to be present.
2. Consult wholesale markets in urban areas around metropoles: In the urban area of the wholesale markets, retailers, foodservice companies and other outlet organizations can be identified by interviewing wholesale market representatives. The gathered 'leads' can be used to contact market players for interest in additional or new suppliers that can deliver through short sea shipping transportation.

In contrast to most earlier steps in this methodology, the market-player identification is not aiming at realizing an all comprehensive list of all existing market players. The aim is to find sufficient market players to be able to select promising farmer/markets during the match analysis (3.2.3).

In the next step, this list of market players will be narrowed down to include only those market players which are attractive in general terms.

3.2.1.2. Determination of market player attractiveness in general

After potential market players have been identified, the next step of the methodology consists of determining the attractiveness of these market players in general terms. In order to achieve this, these market players will be interviewed[13].

The general market player attractiveness is assessed by relevant attractiveness criteria (example in Table 3), such as:

1. From what type of supplier does the market player usually source his products?

[13] *Chapter 4 refers to appendices showing both interview questions and results*

2. Which are the current expected sales and purchase prices of the considered product (the product selected during the product-route selection)?
3. During which calendar period is the considered product currently sourced by the market player?
4. Which sales trend exists during the sourcing period? For example, significantly increasing, slowly increasing, stable, slowly declining or significantly declining.
5. If relevant, how is the market player's attitude towards the considered product as a new product to its assortment?
6. What is the estimate of the volume of the considered product that the market player expects to sell in a specific time period (month/week)?
7. How does the market player want to pay the purchases price to his supplier(s)?
8. What type of logistical information is currently shared by this market player with his suppliers?

To be able to score the overall market player attractiveness next, the following steps take place (example in Table 3):

1. Determine the range of possible answers to each criterion;
2. Arrange these possible answers with respect to attractiveness;
3. Assign a score to each possible answer;
4. Assign a weight to each criterion;
5. Perform the market player interviews[14] and collect the answers;
6. Score the answers from the interviews and determine the general attractiveness of each market player (weighed score sum).

At step 5 the market players are interviewed, such that to each market-attractiveness criterion one of the possible answers is attributed. In order to determine the overall attractiveness of the interviewed market players, the weighted sum of all criterion scores is calculated at step 6.

An example of the outcome of step 6 is the following table (Table 3), which is the hypothetical result of having interviewed three market players. Note that next to the overall market player attractiveness score, also the data completeness is relevant in selecting the most attractive market(s). Each row on the left represents one market player attractiveness criterion. The possible answers are arranged with respect to attractiveness, and to each possible answer a score is assigned. The range needs to be the same for all criteria (0-4 in the example of Table 3). To each criterion a weight factor is assigned. The three columns on the right cover three market players (Mr Mango, Mango Farmers United B.V., Mango Delicious Company) for which, where possible, the relevant criteria were scored. Finally, the total weighed score is calculated for each market player ('total'). This total score is compared to the maximum possible score given the available answers ('score'). Moreover, the percentage of assessed criteria is calculated for each market player ('completeness').

[14] *Chapter 4 refers to appendices showing both interview questions and results*

Only those market players which are considered to be sufficiently attractive are selected for the next step: determination of the market player requirements.

Table 3 Determination of the overall attractiveness of the interviewed market players

Market Characteristics						weight	Mr Mango	Mango Farmers United B.V.	Mango Delicious Company
sourcing stakeholder	local market	online retailer	trader	APMC	farmer	1	3	3	4
	0	1	2	3	4				
sales / purchase price	< market price	market price	constant price	average price	> market price	3			1
	0	1	2	3	4				
sourcing period	not applicable (n.a.) (year round supply)								
	n.a.	n.a.	n.a.	n.a.	n.a.				
trend	decreasing	fluctuating	stable	increasing		1			
	0	1,33	2,67	4					
like to add product	none	one	> one			1			
	0	2	4						
volume estimate/wk.	< 100 kg	100-200 kg	200-500 kg	500-1000kg	>1000 kg	1			4
	0	1	2	3	4				
process of payment	online - 7 days	cash - 7 days	online - direct	cash - direct	advanced	3	0	3	4
	0	1	2	3	4				
information sharing	none	rejects	indent	order	planning	2	1		4
	0	1	2	3	4				
total							5	12	31
maximum							24	16	40
score							21%	75%	78%
completeness							43%	29%	71%

3.2.1.3. Determination of market player requirements

In order to determine the requirements of these market players towards their potential suppliers, the interviews with the market players (3.2.1.2) cover the assessment of relevant market player requirements as well. For example:

1) Product variety and label (e.g. organic)
2) Product requirements, such as:
    a) Firmness
    b) Shape
    c) Product packaging
    d) ….
3) Delivery acceptance
4) Delivery frequency
5) Product requirements such as:
    a) The way of transportation to the market
    b) Transport packaging

An example of the outcome is the following table (Table 4), which is the hypothetical result of having interviewed one particular market player, who is interested in the considered product 'organic vine tomato':

Table 4 Examples of market player requirements

Issue	**Market player requirements**
1. Product variety and label	Organic vine tomato
2. Product requirements	
a. Firmness	High
b. Shape	Round (not oval)
3. Delivery acceptance	Rejects what is not ok
4. Delivery frequency	6 to 7 days a week
5. Logistic requirements	
a. Way of transport to the market player	Open truck
b. Transport packaging	Crate

<u>Price check for specific product variety and label</u>

For the product involved, an initial financial feasibility check was done in section 3.1.3.1. However, this initial check took place on the general product level, not on the level of the product specific variety and/or label. Therefore, the financial feasibility of short sea shipping should be checked again by comparing the product prices and logistical cost of the relevant product variety and label in the same way as described in section 3.1.2.1

The market player requirements are input for the match analyses in section 3.2.3.

3.2.2. Farmer research

The farmer analysis is divided into two separate topics as shown in Figure 1 and Figure 3.

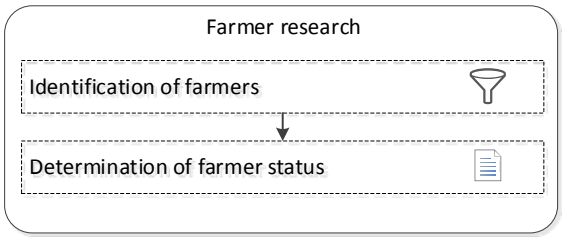

Figure 4 Farmer research

These two topics, and the related criteria, are elaborated below.

3.2.2.1. Identification of farmers

The purpose of the identification of farmers is to provide an overview of potential suppliers (farmers, farmer groups, etc.) within the coastal zone of origin. The potential of a farmer (group) increases if their mind-set is on:

- Selling sufficient (consolidated) volume for short sea shipping: minimal one 20-foot container per customer order;
- Selling directly to customers to jointly realize more benefits of added value (=market driven supply chain), instead of selling on the open market;
- Selecting customers that focus on quality, reliability and price, instead of only on price;
- Setting up long-term partnerships with customers.

In order to identify suitable farmer (groups) two approaches exist:

1. Use the network of a local project partner for consulting farmers for interest in additional customers (e.g. retailers, hotel chains, etc.) of product(s) sold elsewhere currently. Additionally, the ambition to source through short sea shipping transportation needs to be present.
2. Consult product related association(s) and gather 'leads' that can be used to contact farmers for interest in additional customers that can be supplied through short sea shipping transportation.

The aim is to find sufficient farmers to be able to select promising farmer-market combinations during the match analysis (3.2.3).

3.2.2.2. Determination of farmer status

For each identified farmer (or farmer group), the current status is determined with respect to the market player requirements as identified in 3.2.1.3. The market player requirements cover criteria as mentioned earlier in paragraph 3.2.1.3 :

1) Product variety and label (e.g. organic)

2) Product requirements, such as:
    a) Firmness
    b) Shape
    c) Product packaging
    d) ….
3) Delivery acceptance requirements
4) Delivery frequency requirements
5) Product requirements such as:
    a) The way of transportation to the market
    b) Transport packaging

In order to determine the farmer status, the following steps will take place:

1. Perform open interviews (questions below) with the farmers to achieve answers for each market player requirement;
2. If relevant, collect comments about each answer;
3. Fill a table with the answers and comments to each market player requirement.

Possible interview questions related to each market player requirement are:

1. Product: Which product variety and label are produced?
2. Product requirements: What firmness and shape are produced?
3. Delivery acceptance: Which types of packaging are currently applied by the farmer? What are the farmer's expectations when the market players reject (parts of) the delivery?
4. Delivery frequency: What delivery frequency is currently achieved by the farmer?
5. The way of transport to the market: Which way of transport is currently applied by the farmer to the farmer's market/customers? Which transport packaging?

An example of the outcome of these interviews is the following table (Table 5), which is the hypothetical result of having interviewed one particular farmer.

Table 5 Example of farmer status determination with respect to the market player requirements

Issue	**Class**	**Comment**
1. Product variety and label	Regular	n.a.
2. Product requirements		
a. Firmness	High	
b. shape	Oval	
3. Delivery acceptance	Always	Delivery to APMC[15]
4. Delivery frequency	1 or 2 per week	n.a.
5. Logistic requirements		
a. Way of transport to the market	Open truck	Pay for transporter
b. Transport packaging	loose	Mostly packed loose, seldom crates

Just like the market player requirements, these farmer characteristics are input for the match analysis in section 2.1.3.

3.2.3. Match analysis

The match analysis is about determining the match between the market player requirements and the farmer status for each farmer-market combination. Therefore, the market player requirements and the farmer status are input for this third and final aspect of selecting suitable market-farmer combinations.

The match analysis is divided into two separate topics as shown in Figure 4.

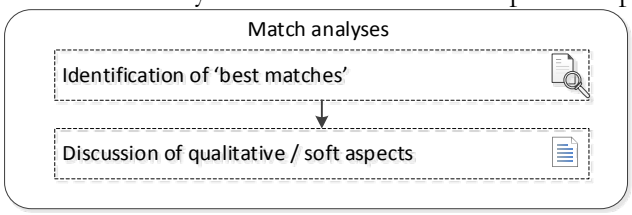

Figure 5 Match analysis

To illustrate: if the requirements of five market players and the status of five farmers are identified, then 25 (5 x 5) matches will be scored and weighed. The 'best match' is the market-farmer player combination with the highest weighed match score. Additionally, the match scores and/or weight factors can be adjusted due to qualitative / soft elements as is explained in the next sections

3.2.3.1. Identification of the 'best match'

With respect to each market player, the following steps take place for each market player requirement:

1. Determine the range of possible answers for each requirement;
2. If possible, arrange these possible answers with respect to effort, investment etc.;

[15] *Agricultural Produce Market Committee: general name for a wholesale market in India*

3. Derive classes of answers, that match with market classes;
4. Fill a table according to this classification.

For example, with respect to the market requirement 'delivery frequency', this could be as follows:

Table 6 The market requirement 'delivery frequency' is elaborated in this table

Market requirement example: delivery frequency		
	Action	*answer*
Step 1	Determine range of answers (e.g. times per week)	1,2,3,4,5,6,7
Step 2	Order these answers	Is done
Step 3	Eventually, derive classes of answers (to reduce the amount of answers)	(1-2), (3-5) and (6-7) times a week
Step 4	Fill table according to classification	Fill in the class for delivery frequency

Subsequently, the steps to realize a match score with a particular farmer are:

1) For each market requirement, calculate the quantitative difference between the market requirement and the farmer status (market score – farmer score = GAP score);
2) Weigh each market requirement and multiply with the GAP scores to gain the weighted GAP scores;
3) Sum both the weighted GAP scores and the maximum weighted GAP scores;
4) Calculate the total GAP score as a percentage (sum weighted GAP scores / sum max weighted GAP scores);
5) Calculate the match score (100%- GAP).

As an example, Table 7 shows this process for FMC: Mango Delicious Company - Mango Juice production company Z:

Table 7 Calculating the match scores

Issue	**Market player**	**Score**	**Farmer**	**Score**	**GAP**	**Weight**	**Total weighted GAP**	**Max. weighted GAP**
Product variety and label	Other variety	4	Regular	2	2	3	6	12
Product requirements								
a. Firmness	High	4	High	4	0	3	0	12
b. Shape	Round	4	Oval	2	2	3	6	12
Delivery acceptance	Always	4	Always	4	0	1	0	4

Issue	Market player	Score	Farmer	Score	GAP	Weight	Total weighted GAP	Max. weighted GAP
Delivery frequency	6 to 7	4	1 or 2	1	3	1	3	4
Logistical requirements								
a. Way of transport to market	Open truck	2	Open truck	2	0	1	0	4
b. Transport packaging	Crate	4	Loose	2	2	2	4	8
TOTAL					9	14	19	56
GAP (%) (total weighted GAP / Max Weighted GAP)								**34**
MATCH (%) (100%-GAP)								**66**

Finally, a table is composed of which each column represents a market player (and a quantitative estimation of its general attractiveness, as a result from section 3.2.1.2). Each table row represents a farmer. In each cell, the match percentage is provided. 'Best matches' are combinations of market players with high general attractiveness and farmers with high match percentages with respect to these market players. An example of the output is the following table (Table 8).

Table 8 Example of the identification of the 'best matches'. 'Best matches' are combinations of high attractive market players and farmers with high match scores with respect to the market player requirements of these market players.

Organic Keith Mango			
Market players →	Online retailer X	Hotel Chain Y	Mango Juice production company Z
Market attractiveness (%)	75	79	79
Farmers ↓	*Match between farmer and market player (%)*		
Mr. Mango	20	51	***89***
Mango farmers united B.V.	30	35	12
Mango Delicious Company	85	78	66
The Mango Start-up	12	22	18

To summarize, first market players are analysed on market attractiveness, and hereafter these market players are matched with farmers. These two scores together (on market attractiveness and on match) determine which farmer-market combinations are considered to be promising, probably together with qualitative aspects (soft elements) as is described in the next section.

3.2.3.2. Discussion of qualitative aspects (soft elements)

The farmer, the market player or the project partner that executes this methodology might have some qualitative preferences. These could lead to an adjustment of the 'best' matches as occur from the match analysis. Examples of qualitative aspects are:

- Trust. Example: in general, a market driven chain requires more volume than one farmer can offer. If so, several farmers should cooperate in order to satisfy the market player. Such a cooperation is based on trust, which is for example violated if one or more farmers decide to sell elsewhere for a higher spot price.
- Risk attitude. Example: in most cases investments are required. Sometimes small (like buying plastic crates) and sometimes big (like a storage facility) investments. Farmers act differently at this point and like-minded ones should cooperate.
- Ownership/responsibility. Example: what happens if the produce is rejected at the distribution centre of the market player, because of bad product quality? Who is responsible? The truck driver (organization), the shipping line or the farmer? And who owns the product at that time?
- Short term vs. long term orientation. Example: in most cases short and long term are related to the return-on-investment (ROI).
- Niche-oriented vs. competition. Example: a niche market has a threshold risk when entering the market, but once successful it has in general not much competition in the first part of the life cycle. The growth is slow. In an existing competitive market, volumes tend to be much bigger, but as a consequence the market player requirements are strict, since the market player is depending on it.

Based on the match analysis between farmers and market players, and a discussion of the qualitative aspects, the most promising farmer-market combinations are finally selected. So, the end result of the farmer-market selection is a table including all potentially viable combinations of farmers and market players (both by name) within the selected CEZs, with respect to the selected product. This table will be input for methodology phase C: Supply chain design.

3.3. Supply chain design

Starting point of supply chain design are the promising farmer-market combinations. Each promising farmer-market combination is a 'best match' between a farmer (group) and a market player, including the consideration of qualitative aspects. For each farmer-market combination a short sea shipping supply chain will be designed, which is feasible with respect to cost and product quality.

The supply chain design is about the logistical concept of the future supply chain. It points out logistical aspects to consider during the design of the future short sea shipping supply chain. These aspects are relevant for:

1. Emerging economies in which it is common practice that the majority of farmers are smallholders that are not able to individually ship multiple containers of produce annually;
2. Supply chain actors that have, in contrast to Western economies, none or limited experience with market driven supply chains. Most actors in emerging economies are linked to a wholesale market nearby: farmers push their produce to the wholesale market, buyers buy here as well. The implementation of any short sea shipping supply chain solution will probably be one of the first times that most supply chain actors will face a market driven supply chain.

One or multiple supply chain designs (scenarios of the future short sea shipping supply chain) can be developed. Each supply chain scenario will be described according to four levels: the physical level, the logistical control level, the information level and the organizational level. The different scenario(s) will be evaluated afterwards on cost and product quality.

To illustrate the supply chain design, the example below is introduced (Table 9).

Table 9 Example of a promising market-farmer combination

Short sea shipping from Mango Farmers United to Hotel Group The Fresh Experience
Hotel Group The Fresh Experience is profiling themselves on the exclusive fresh breakfast services they offer to their premium clients. Unfortunately, the availability of fresh mango of sufficient quality is very scarce during the winter. The current source of fresh mango is from local sources that sell their produce to the local wholesale market. A representative of the hotel group visits the market twice a week to buy the highest quality available. During the local harvest season, the quality is high, and the prices are low. It is the other way around during off season periods (winter). Now, a new opportunity has arisen: a new source, Mango Farmers United, 4500 km away from the hotels, can deliver high quality mango during the winter. Mango Farmers United has a considerable oversupply during winters, with low prices and even the risk of food losses as a consequence. It seems promising to transport these mangos from Mango Farmers United to Hotel Group The Fresh Experience via short sea shipping. Conventional road transport will take three weeks of transit times due to border passing, with serious consequences for product quality. Short sea shipping demands a 1.5-week cold supply chain, as part of which the mangos are to be transported by a 20ft or 40ft reefer container or by a temperature-controlled truck (roll on, roll

off). However, it is even unclear whether the mangos will survive a 1.5-week journey in a reefer container.

The design aspects at the physical level, the logistical control level, the information level and the organizational level are described in sections 3.3.1, 3.3.2, 3.3.3 and 3.3.4 respectively. After a supply chain is (re-)designed, it will be evaluated by interviews and desk study with respect to cost and quality loss (3.3.5).

The end result of the supply chain design is one or more evaluated supply chain scenarios, where each scenario consists of a logistical concept of a supply chain making use of short sea shipping.

3.3.1. Physical design

Physical design is about the managed system, so about the supply chain partners and the primary transformation processes they are to perform. The physical design is visualised by the sequence in time of these primary transformation processes, and the actors allocated to these processes. An example is visualized in Figure 5.

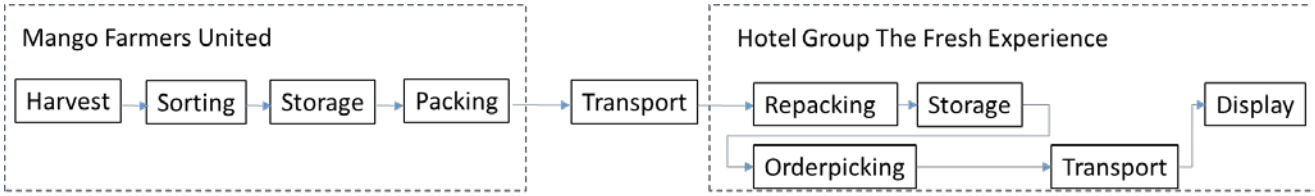

Figure 6 Physical design: the primary transformation processes that take place within the managed system, and the actors who perform these processes.

3.3.2. Logistical control

Logistical control is about the managing system, which aims at realising a certain system output (end products delivered to the supply chain's customers) by adjusting certain control variables, whilst dealing with non-manageable inputs such as demand.

The managing system is about how to control the product flow within the supply chain in an efficient and effective way. Examples of logistical control concepts are:

1. The position of the Customer Order Decoupling Point (COPD): see below for an explanation;
2. Cross docking: Eliminating the storage of products at the market player's distribution centre by transferring, re-consolidating and distributing products within 24 hours to the market player's outlets;
3. Continuous replenishment: The inventory of the market player is managed by more frequent and smaller deliveries from the supplier, based on actual sales and forecasted demand.

Customer Order Decoupling Point

An important characteristic of the logistical control within a supply chain is the extent to which customer orders penetrate the supply chain. The Customer Order Decoupling Point (CODP) separates the part of the supply chain oriented towards customer orders from the part of the supply chain based on planning. Downstream of the CODP the material flow is controlled by customer orders and the focus is on customer lead time and flexibility. Upstream towards suppliers, the material flow is controlled by forecasting and planning, and the focus is on efficiency (usually employing large batch sizes).

In our example, the CODP is located at the central storage of the Hotel Group The Group (Figure 6). Here customer orders (orders from the individual hotels) arrive and order picking takes place. The central storage of the Hotel Group places its replenishment orders at the storage of Mango Farmers United (Figure 6).

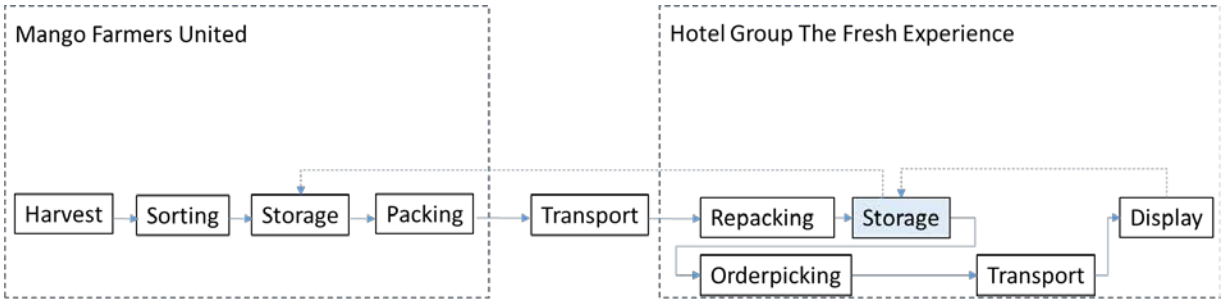

Figure 7 Logistical control: the location of the Customer Order Decoupling Point as part of the managing system. Customer orders for new mangos are send from the individual hotels to the central storage of the Hotel Group. Here order picking takes place.

Fresh food supply chains might benefit from the shifting of the CODP upstream. Because of the detection of inefficiencies due to repackaging of products in the supply chain, the information exchange of customer wishes to the farmer group might improve performance. For example, by connecting farmers to customers so that products can be packed directly according to final customer wishes. This might reduce food losses at the customer as well. However, it increases the lead time of the customer order (Figure 7).

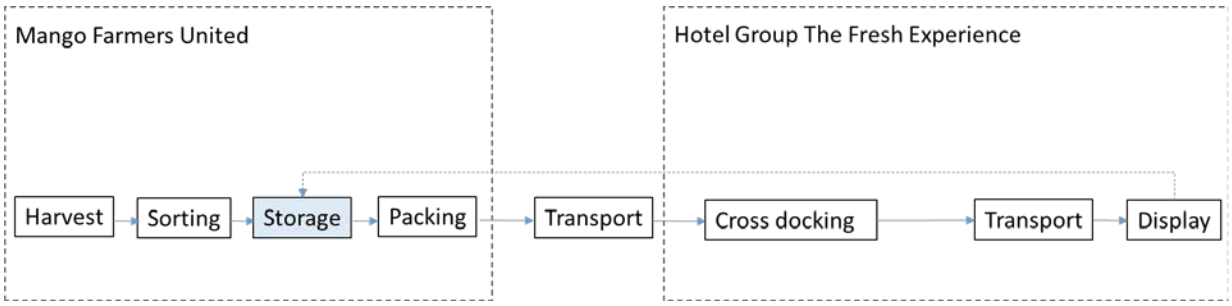

Figure 8 By shifting the CODP upstream, products can be packed directly according to final customer wishes.

3.3.3. Information

The managing system takes decisions on the basis of available information. The information system's task is to register the relevant internal data, partner data and external data and to convert it to control information (Figure 8).

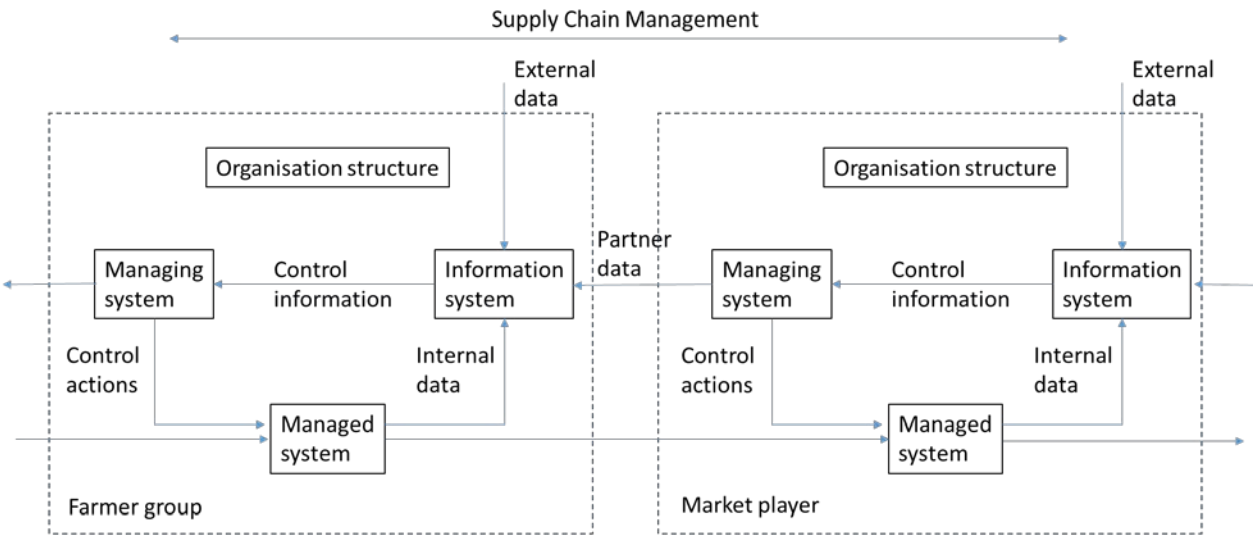

Figure 9: Information: Information is collected and shared within the supply chain

At the information level, the following design issues are relevant:

- Which (transactional data) is relevant to whom? (day, hour, shipment, type, #, etc.)
- Who is the owner of this data?
    - Which system registers this data?
    - Can external partners access this data?
- Does the available data need any processing?
- Which decisions need to be made after obtaining the (optionally processed) data?
- Can the collection of this data lead in the long term to supply chain optimization, making use of analytical systems (e.g. forecasting, location/allocation decisions)?

For example, in case of our example the information design is as follows:

1. Ordering from hotel at the central storage is done by phone. Such an order consists of day, product, and quantity.
2. Ordering from the central storage of the Hotel Group at the farmer group is done by phone as well. Such an order consists of day, product, and quantity as well.
3. The order data are processed and transformed into order picking data, dependent on product availability and priority rules.
4. Based on the order picking data, order picking and distribution take place.
5. Point-of-sale data are collected both at storage of the farmer group and at the central storage of the Hotel Group. Based on these historical point-of-sale data, growing and harvest planning at the farmer group is supported.

3.3.4. Organization

Organization of fresh food value chains is about how to connect farmers to market players, in order to achieve a market driven supply chain. Basically, one can distinguish between three different agricultural farming systems:

1. Smallholder farming system[16];
2. Medium scale/entrepreneurial farmers;
3. Industrial farmers.

This distinction is partly based on the availability of land size for farming, but moreover on the business orientation of farmers.

There are 500 million smallholders worldwide, and smallholders represent the majority of farmers in the world, especially in non-western economies including emerging economies. Therefore, the organization of the value chain often falls or stands with organizing multiple smallholder farmers in such a way that a market player can be served effectively. This paragraph describes options and topics to consider during the organizational design of the fresh food value chain.

There are very important and distinct differences between smallholders which can be categorized as follows[20]:

- Smallholders with less than 1 hectare and an income below the poverty line of $1.85 a day. This is the biggest group of smallholders. They are net consumers of food instead of producers. For them agriculture is their fate rather than a profession by choice. It is the most vulnerable group;
- Smallholders with 1-2 hectares, the second biggest group. They are commercially active in loose value chains and have some production surpluses;
- Smallholders with more than 2 hectares, only about 7 % of the smallholders. Those farmers are commercially viable with reliable production surpluses, in some cases they are even entrepreneurial farmers. These farmers are active in tight value chains.

Table 10 Types of smallholder farmers within emerging economies (adopted from Nico Roozen, Solidaridad, March 2016[20])

	Traditional Smallholders		Potential to become entrepreneurial farmers
	a. Subsistence/non-commercial farmers	b. Commercial in loose value chains	c. Commercial in tight value chains

[16] *There is no unique and unambiguous definition of a smallholder. Often scale, measured in terms of farm size is used to classify farmers. As a result of this households with less than a threshold size of 2 hectares are often stipulated as smallholders. However, across countries, the distribution of farm sizes depends on a number of agro-ecological and other conditions. (FAO 2010, Policies and institutions to support smallholder agriculture. Committee on Agriculture, 22nd session).*

Strategy	Farming for survival rather than choice	Looking for diversification	Business orientation
Land Size	< 1 ha	1-2 Ha	> 2 ha
Engagement with markets	Buyers of food	Some surplus of food + cash crops	Reliable surplus of food
Number of families (in mn)	300	165	35

Business orientation

Multiple options exist to organize the connection between smallholder farmers and market players in emerging economies. Four options are described below. In practice, these options are implemented solely or as a hybrid connecting the best characteristics of multiple options.

3.3.4.1. Bilateral relations between individual farmer and market player

As one smallholder is in general not able to sell large quantities, this option is not applied often. In case it is applied, this usually involves smallholders with potential to become entrepreneurial farmers or to smallholder farmers that sell a relatively unique crop[17].

Advantages

- Relatively simple to organize;

Disadvantages

- Large market players need to setup many bilateral relations with smallholder farmers to obtain the right volume at the right time.

3.3.4.2. Contract farming

In contrast to bilateral relations, contract farming formalizes (contracts) the agreements agreed upon. Usually, these agreements relate to a prefixed price, volumes / period, delivery dates and quality. Even financial commitment may be involved of the market player to the farmer before growing.

Advantages

- Fewer food losses as no crop is planted before financial commitment of the market player;
- Financial security for smallholder farmer.

[17] *For example: specific berries considered as superfoods in Western Economies that are only grown in the himalayas by smallholders due to environmental factors.*

Disadvantages

- Price fluctuation will disadvantage the farmer when prices rise and the market player when prices drop;
- Large market players need to setup many bilateral relations with smallholder farmers to obtain the right volume at the right time[18].

3.3.4.3. Lead farmer

This option can be applied once a market player has relatively challenging market requirements like large demand and high-quality restrictions (e.g. an overseas export market delivered to by reefer transport). Multiple smallholder farmers deliver directly after their harvest to a (much) larger farmer that is already connected to the market player. In addition to market connectivity, the lead farmer's role in this value chain is to evaluate whether the quality of the just harvested produce is equal or higher than the market requirements. If so, the smallholder farmer will receive a (contracted) price from the lead farmer that is usually higher than the local price. Hereafter, the lead farmer will sell the produce to the market player.

If not, the smallholder needs to sell his produce to any local market player or the lead farmer will buy it for a relatively low price. Once the lead farmer buys the produce, this farmer will sell it to a local market player like for example a juice processor.

Additionally, the lead farmer is usually involved in education of the smallholder farmers to enable them to reach the relevant market requirements. This way of working is often initiated by NGOs.

Advantages

- Enables smallholder farmers to reach lucrative markets offering relatively high prices;
- Easy knowledge transfer from lead farmer to smallholder farmers

Disadvantages

- It might still be difficult to meet market requirements, because a lack of product quality;
- Opportunity for a lead farmer to squeeze the smallholder farmers (price-wise);
- In the initial phase, preferably a lead farmer with a mind-set on social responsibility needs to be found.

3.3.4.4. Cooperation[19]

This option organises smallholder farmers in farmer groups (cooperations). Jointly, one or multiple market players are served. Often, a board of representatives of the farmers is appointed that organizes negotiations with market players, internal farmer education, joint purchase of farmer inputs and joint transport to market players.

By uniting, usually power balance is realized between multiple smallholder farmers and relatively large market players.

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[18] *Note that this option is referring to an individual farmer. In practice, also a farmer cooperation can apply contract farming.*

[19] *Cooperations were successful in Westerm economies, but now seem to lose effectivity. In Western economies a shift from cooperations to contract farming can be observed. This leads to relatively lower prices for farmers and more profits for retailers. Consortia that are considering to implement this option are advised to make a more profound study on this matter.*

Additionally, it provides opportunities for smallholder farmers to gain additional added value by selling to market players instead of middle men who may require provisions.

Advantages

- Power balance leading to a robust and future proof value chain;
- Enables smallholder farmers to reach lucrative markets offering relatively high prices;
- Smallholder farmers can focus on their core competence: farming.

Disadvantages

- Often, consolidated produce of multiple smallholder farmers leads to a batch that has no uniform quality (which often is a market requirement);
- Smallholder farmers will face the temptation of selling to a middleman instead of via the cooperation (which might have obligations to market players).

To illustrate, with regard to the mango case (Table 9), Mango Farmers United (a cooperative) was founded to be able to jointly deliver mangoes to reach lucrative markets offering relatively high prices. Hotel Group The Fresh Experience (4500 km away) has shown interest in buying mangos from the cooperative, because they face low quality and high prices during their winter. In the farming area, during this period of the year, it is harvest season resulting in oversupply and a drop in prices.
The cooperative (one of the described options of organizational design) is enabling Mango Farmers United and Hotel Group The Fresh Experience to set up a lucrative supply chain leading to high benefits for both. Additionally, it leads to reduction of food losses as a solution is found to consume the oversupply in the farmer area.

3.3.5. Supply chain evaluation

After a supply chain is (re-)designed, it will be evaluated (by interviews and desk study) with respect to cost and quality loss. This is done in order to check which supply chain scenario is (if at all) feasible with regard to cost and product quality.

The two key performance indicators are defined as follows:

- Cost: these are defined as the sum of operational cost prices of the chain of post-harvest physical activities (the managed system as defined in 3.3.1) of supplying 1 kg product from the farmer to the market player;
- Quality loss: defined as the loss of product quality during the total time between receiving the order at the farmer and product replenishment at the market player (order lead time). This quality loss can be translated into both economic loss due to downgrading and economic loss due to product loss (waste).

Please note here that the supply chain evaluation cannot (always) be a quantitative analysis. It might be based on (an) estimation(s) by (product or supply chain) expert(s). Therefore, it might occur that crucial information is lacking (input for the test implementation, chapter 4) or that interview results show a range of expected quality loss instead of exact figures.

3.3.5.1. Cost

Operational cost calculation is performed according to activity based costing:

1. Estimate the average order size (kg);
2. List all post-harvest physical activities in the right sequence;
3. Calculate the cost for each activity, taking into account the average order size;
4. Add it all up and divide it by the average order size.
5. Evaluate total costs with regard to business profitability

This results in the total cost per kg produce.

3.3.5.2. Quality loss

Quality loss can be estimated making use of an estimation of the lead time of each activity and the storage and transport conditions (mainly temperatures).

Lead time is calculated according to the following steps:

1. Give the average order size (kg);
2. List all post-harvest physical activities in the right sequence;
3. Calculate the lead time for each activity, taking into account the order size, including waiting time between and during activities;
4. Estimate the storage temperature for each activity;
5. Estimate the quality loss for each activity;
6. Add it all up.

The total lead time and the storage conditions of the short sea shipping supply chain need to be such that a minimum acceptable product quality can be guaranteed to the market player.

If available, one can work with variations (in lead time, temperature, initial product quality and/or quality-decay model) in order to calculate the probability/fraction of product loss. This process is shown in Figure 9 in which these variations lead to different points in time when the (un)acceptance limit is reached.

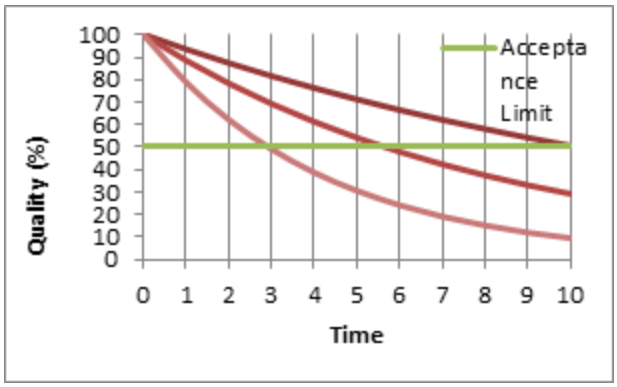

Figure 10: quality decay model

In evaluating food losses in (short sea shipping) supply chains, two aspects need to be taken into account:

1) Market acceptance: does the market player accept arriving deliveries? In other words: does a delivery meet the product-quality requirements that were agreed upon?
2) Economic value decrease: Has an economic value decrease taken place because of product-quality loss? For example: a wholesaler might accept a shipment of mango with some little brown spots on it, knowing that this batch will be sold for a relatively low price or knowing that there is not a single mango available out on the market, so he will be able to make a proper margin.

Note here that in successfully implementing a short sea shipping supply chain as a totally new concept in the country to which this methodology is applied, the 'market acceptance' is critical. Non-acceptance of a significant part of shipments will lead to a failure of the implementation. A 'decrease in economic value' might be accepted but will indicate opportunities for improving the short sea shipping supply chain.

The most attractive supply chain scenario in terms of cost and quality will be the input for the test implementation (section 3.4).

3.4. Test implementation

This section is about conducting a test transportation by short sea shipping. Starting point is the supply chain design. A direct implementation of this supply chain design usually comes along with a lot of risks and uncertainty, especially when a new concept, like short sea shipping, is implemented for the first time. The supply chain actors may be located at long distances from each other, which might lead to a barrier with regard to the build-up of trust. Without trust, direct investments by the supply chain actors might be considered a bridge too far.

If the concept of short sea shipping is experienced as risky, goes along with uncertainty and needs trust among supply chain actors (which is expected during any first implementation in any country), a test implantation can be organized to validate the supply chain design in practice. This section covers the steps to be taken when organizing such a test implementation:

1. Scope;
2. Test implementation team;
3. Measurement protocol.

These steps are described in section 3.4.1, 3.4.2 and 3.4.3 respectively.

3.4.1. Scope

The test implementation will demonstrate the possibility of physical distribution (against acceptable costs and quality loss) from farmer to market player, making use of short sea shipping. It focusses on a demonstration of the concept, to show its potential to the supply chain actors.

Additionally, as part of the methodology, the test implementation focusses on needs for test implementations as concluded from the supply chain evaluation (3.3.5) which was done in order to conclude which scenario is most feasible for implementation. During the supply chain evaluation, data is collected, assumptions are made, and analyses are performed considering the scenarios set in the supply chain design. However, the supply chain actors (farmer group, market player, logistic service provider) that will finally implement the short sea shipping supply chain might feel uncertain on specific aspects. Therefore, it can be decided that these aspects are tested during a test implementation.

3.4.2. Test implementation team

The ambitioned supply chain actors of the supply chain design are not necessarily the actors that need to execute the test implementation. In practice, a consortium can agree to limit the amount of supply chain actors.

For example, with regard to the Mango example (Table 9), the ambitioned final implementation after a successful test implementation might involve reefer transport of 4500 km, while the test implementation is a test in a laboratory simulation of this supply chain. This means that the test implementation does not require the involvement of the logistical service provider.

Additionally, as usually multiple stakeholders might be cooperating for the first time, it is advised to document the roles and responsibilities.

3.4.3. Measurement protocol

The test implementation is to demonstrate specific aspects of the supply chain design as agreed upon by the supply chain actors involved. To execute the test implementation, it is advised to define Key Performance Indicators (KPIs) first, describe the way of measuring these KPIs in detail second and plan measurements last. Combined, this forms the measurement protocol.

With regard to physical distribution, KPIs relate typically to costs and quality loss, the amount of food losses (e.g. in kg), market player acceptance (e.g. yes or no), and consumer experience (e.g. excellent, average, low, unacceptable).
The measurement planning is usually by day during the entire test implementation.

Day	**Measurement**
1	1
2	2
3	none
4	1,2

4. Methodology application

Fruits and vegetables comprise a substantial share of the total Indian fresh food production. A large number of small Indian farmers are engaged in this production, and it has been noted that their corresponding food losses are estimated to be upward of 50 per cent [1].

This study explores short sea shipping opportunities for urban food supply chains in India to help identify possible obstructions in its agro-food logistics system. Utilising more efficient urban short sea food-supply chains is expected to:

i. significantly increased profitability of farm produce for the farmer;
ii. reduce food prices in urban coastal areas for the consumer;
iii. reduce food losses in post-harvest supply chains (currently estimated to be over 50 per cent) in the country.

The Government of India has shown strong intent towards exploiting its underutilised coastline for domestic transport of cargo through the Sagarmala initiative under the Ministry of Shipping [21]. The comprehensive programme aims to tap the potential of India's coastline and inland waterways to create opportunities for port-led development in India.

This project will therefore focus on using short-sea shipping for transport of fruit and vegetable produce in India.

Results in this section reflect the distinct phases of the proposed methodology for short sea shipping as elucidated in Chapter 3 applied to the specific case of fruit and vegetables in India.

The results helped deduce the selection of possible product route combinations (PRC) and the cost benefit analysis of each of the PRCs to arrive at a selection of one or two PRCs for implementation going forward.

A market-based approach has been taken to determine the optimal allocation between land and intermodal transport. Environmental externalities were also observed during the application of the methodology.

The results are shared in the following sections:

- 4.1: Selection of product route combinations
- 4.2: Selection of farmer-market combinations
- 4.3: Supply chain redesign
- 4.4: Test implementation

4.1. Selection of product-route combinations

4.1.1. Route selection

In order to arrive at possible 'routes' (as defined under 3.1.1 of Methodology development) for the transportation of products by short sea shipping, CEZs with shipping line connectivity and requisite logistical infrastructure were determined in this section. Additionally, total turnaround time between origin and destination CEZs for farm-to-retailer supply chain was also deduced.

4.1.1.1. Identification of CEZs

The first step to route selection was to identify all Indian Coastal Economic Zones (CEZs), the ports that fall within each CEZ, and the states in/across which they are located as per the country's current sea route possibilities (Table 11).

Below is the list of all existing ports in each of the CEZs and corresponding states where they are located.

Table 11: Identification of 14 Coastal Economic Zones with States and Ports[20]

Sr.no.	CEZ	State	Ports
1	Kutch	Gujarat	Kandla, Mundra
2	Saurashtra	Gujarat	Pipavav, Sikka
3	Suryapur	Gujarat	Dahej, Hazira
4	North Konkan	Maharashtra	JNPT, Mumbai
5	South Konkan	Maharashtra, Goa	Dighi, Jaigarh, Mormugao
6	Dakshin	Karnataka	Mangalore
7	Malabar	Kerala	Kochi
8	Mannar	Tamil Nadu	Tuticorin
9	Poompuhar	Tamil Nadu	Cuddalore
10	VCIC South	Tamil Nadu	Chennai, Ennore, Kattupalli
11	VCIC Central	Andhra Pradesh	Krishnapatnam
12	VCIC North	Andhra Pradesh	Visakhapatnam, Kakinada
13	Kalinga	Odisha	Paradip, Dhamra
14	Gaud	West Bengal	Kolkata, Haldia

[20] *Ministry of shipping government of India, National perspective plan April 2016 (shipping.nic.in)*
http://www.bestcurrentaffairs.com/list-coastal-economic-zones-india
Ministry of shipping government of India, Sagarmala Review: Port led Industrialization Dec 16 2016 (shipping.nic.in)

Figure 10 shows a geographical map of India's coastline displaying all 14 CEZs.

CEZs Kutch, Saurashtra, and Suryapur fall in the state of Gujarat. The state of Maharashtra has a long coastline that constitutes of CEZ North Konkan as well as part of CEZ South Konkan. CEZ South Konkan also includes the state of Goa. CEZ Dakshin is located in the state of Karnataka, and CEZ Malabar in the state of Kerala. These are the CEZs on the west coast of India.

On the east coast, Tamil Nadu state has CEZs Mannar, Poompuhar, and VCIC South, CEZs VCIC Central and VCIC North are located in the state of Andhra Pradesh, CEZ Kalinga is in the state of Odisha and CEZ Gaud is in the state of West Bengal.

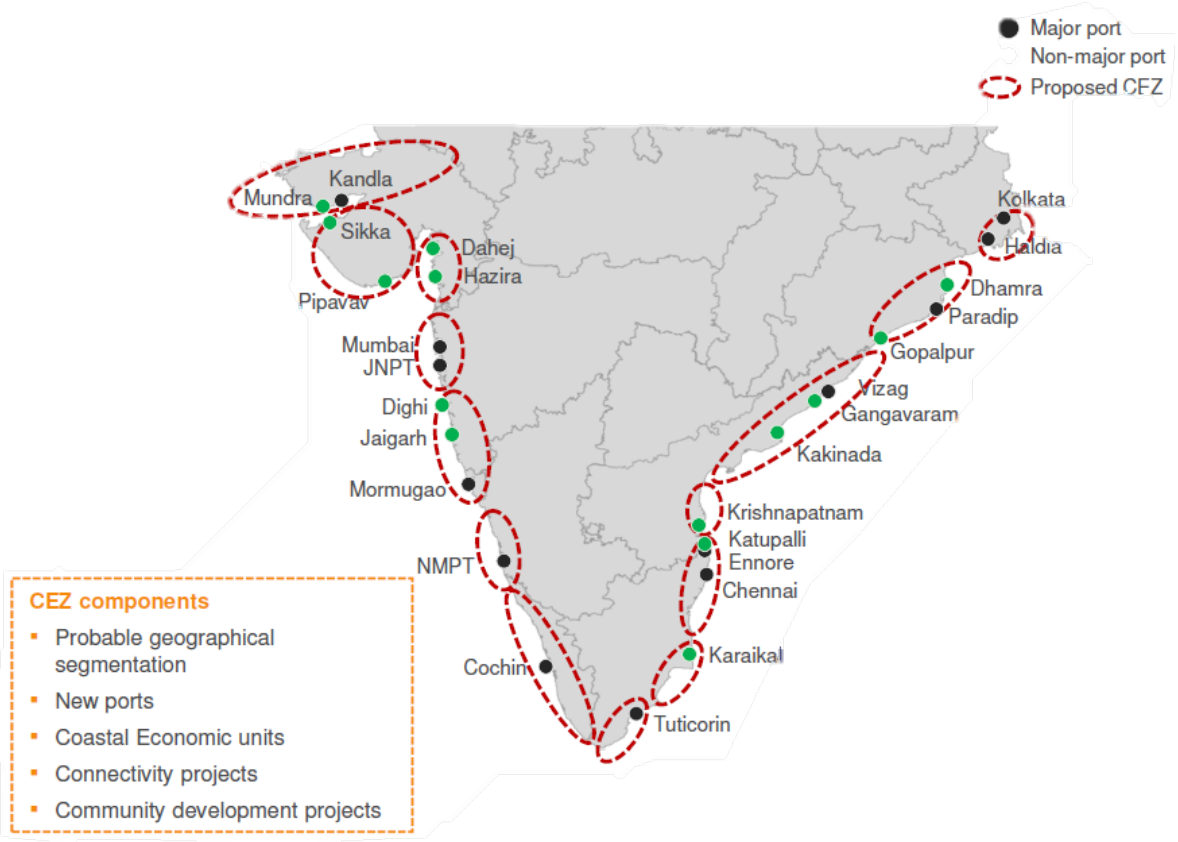

Figure 11: Map of Indi's coastline displaying all 14 CEZs comprising all coastal districts and relevant ports.

In India, CEZs have already been defined as per the notification issued by the Government of India: A set of ports and districts near the coast constitute a CEZ and collectively meet the following three criteria, as defined by the Ministry of Shipping, Government of India [19]:

a. The region has a coastline with a length between 300 and 500 kilometres;
b. The region has an inland area between 200 and 300 kilometres;
c. The region includes one, two or three seaports.

Since the selection criteria correspond to Indian definitions, all 14 existing CEZs meet the first three criteria a, b, and c (Table 12).

Table 12: Output of first step of the methodology, i.e. application of criteria a, b, c [19].

Sr.no.	CEZ	State	Ports	Criteria		
				a	b	c
1	Kutch	Gujarat	Kandla, Mundra	x	x	x
2	Saurashtra	Gujarat	Pipavav, Sikka	x	x	x
3	Suryapur	Gujarat	Dahej, Hazira	x	x	x
4	North Konkan	Maharashtra	JNPT, Mumbai	x	x	x
5	South Konkan	Maharashtra, Goa	Dighi, Jaigarh, Mormugao	x	x	x
6	Dakshin	Karnataka	Mangalore	x	x	x
7	Malabar	Kerala	Kochi	x	x	x
8	Mannar	Tamil Nadu	Tuticorin	x	x	x
9	Poompuhar	Tamil Nadu	Cuddalore	x	x	x
10	VCIC South	Tamil Nadu	Chennai, Ennore, Kattupalli	x	x	x
11	VCIC Central	Andhra Pradesh	Krishnapatnam	x	x	x
12	VCIC North	Andhra Pradesh	Visakhapatnam, Kakinada	x	x	x
13	Kalinga	Odisha	Paradip, Dhamra	x	x	x
14	Gaud	West Bengal	Kolkata, Haldia	x	x	x

Key: 'x' CEZ meets criteria

In the next step, this complete list of CEZs will be narrowed down to include only those CEZs which have the requisite shipping line connectivity. For the next step and steps the results of one step is an input to the next. Therefore the following process is applied to the results and inputs of every step:

1. If a port does not meet even one of the criteria in every step, then the port is excluded from further consideration.
2. If the CEZ under consideration has one port that does not meet the criteria but others do, then that particular port is excluded and other ports of the CEZ and the CEZ continue to be under consideration.

4.1.1.2. Determination of port connectivity between CEZs

In the next phase, CEZs with adequate inter-port connectivity were identified out of all the potential short sea shipping routes. Ports and respective CEZs (Table 12) were further narrowed down to include only those with viable shipping connections (Table 13).

For this, the following two criteria about port-to-port cargo shipping connectivity were applied:

d. The number of shipping lines servicing the CEZ is at least two;
e. There is at least one shipping connection to other ports.

Indian Coastal Logistics policies and laws are still being modified to fully realise the potential of the Sagarmala Coastal Initiative of the Ministry of Shipping, Govt. of India[21]. Under existing laws only ships registered in India, i.e. the ships that carry the Indian flag, are permitted to carry domestic cargo along the Indian coast[22]. Ships bearing flags of other nations, i.e. ships registered in other countries, are permitted to move only international cargo or empty containers along the coast.

Having said that, foreign shipping companies can register vessels in India. Even if the parent shipping company isn't Indian, if its vessel is registered in India, it is permitted to transport domestic cargo along the Indian coast.

Shipping lines change their schedules from time to time based on demand. Also, some shipping lines – whether domestic or international - may service certain ports, however their vessels only carry bulk and do not carry containerized cargo. Moreover, the methodology also takes into consideration that the shipping line should carry reefer cargo containers. Therefore, shipping line connectivity is evaluated by only considering those vessels and respective shipping lines that can carry reefer containers.

It would be ideal for Indian Coastal Logistics if more options of connectivity were available between the ports along the Indian coast for ships registered in India and other countries alike, but since that decision is under review, in applying the methodology two scenarios were considered:

1. International flag-bearing vessels along with Indian flag-bearing vessels are allowed to carry domestic cargo along the coast;
2. Only Indian flag-bearing vessels are allowed to carry domestic cargo along the coast.

The set of criteria was applied to both scenarios, and results to arrive at the most viable short sea shipping routes were subsequently tabulated.

Scenario 1- International flag-bearing vessels along with Indian flag-bearing vessels are allowed to carry domestic cargo along the coast

Several ports are serviced by Indian flag-bearing vessels as well as one or more foreign flag-bearing vessels. These cumulatively help various ports meet criterion d, that of at least two shipping lines servicing the CEZ. The results from criteria d and e are found in Table 13 below:

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[21] *http://shipping.gov.in/showfile.php?lid=2422*
http://pib.nic.in/newsite/PrintRelease.aspx?relid=159037
[22] *http://shipping.gov.in/showfile.php?lid=2229 (pg 1)*
http://lawmin.nic.in/ld/P-ACT/1958/A1958-44.pdf (pg 178)
The Merchant Shipping Act 1958, 2011, Universal Law Publishing Pvt Ltd (pg 187)

Table 13: Scenario 1- Identifying CEZs with at least two shipping lines and at least one inter-port shipping connection23

Sr.no.	CEZ	State	Port	Criteria	
				d	e
1	Kutch	Gujarat	Kandla	x	x
			Mundra	x	x
2	Saurashtra	Gujarat	Pipavav	x	x
			Sikka		x
3	Suryapur	Gujarat	Dahej		x
			Hazira	x	x
4	North Konkan	Maharashtra	JNPT	x	x
			Mumbai		x
5	South Konkan	Maharashtra, Goa	Dighi		x
			Jaigarh		x
			Mormugao		x
6	Dakshin	Karnataka	Mangalore	x	x
7	Malabar	Kerala	Kochi	x	x
8	Mannar	Tamil Nadu	Tuticorin	x	x
9	Poompuhar	Tamil Nadu	Cuddalore		x
10	VCIC South	Tamil Nadu	Chennai	x	x
			Ennore		x
			Kattupalli	x	x
11	VCIC Central	Andhra Pradesh	Krishnapatnam		x
12	VCIC North	Andhra Pradesh	Visakhapatnam	x	x
			Kakinada	x	x
13	Kalinga	Odisha	Paradip		x
			Dhamra		x
14	Gaud	West Bengal	Kolkata	x	x
			Haldia	x	x

Key: 'x' CEZ meets criterion | __ Criterion not met

Among the results in Scenario 1 (Table 13), the ports of Sikka, Dahej, Mumbai, Dighi, Jaigarh, Mormugao, Cuddalore, Ennore, Krishnapatnam, Paradip and Dhamra did not meet criterion d.

The criterion was applied to the entire CEZ, so even if only one of the ports in the CEZ met the criteria, the CEZ continued to be included in the final result. Thus, CEZs South Konkan, Poompuhar, VCIC Central, and Kalinga did not meet criterion d. Even though Sikka port did not meet criterion d, Pipavav port did, thus CEZ Saurashtra met the criterion with two shipping lines

[23] *Appendix 1*

serving it. Similarly, even though Dahej port in Suryapur did not meet criterion d, Hazira port did; JNPT in North Konkan was serviced by shipping lines carrying containerized cargo; and both Chennai and Kattupalli ports compensate for Ennore port's lack of shipping line serviceability.

Ports such as Mumbai, Mormugao and Paradip have shipping line connectivity. However, the shipping lines that service these ports only carry bulk vessels, and not containerized cargo.
All ports were observed to have connectivity to at least one other port and therefore all CEZs met criterion e[24].

Scenario 2- **Only** Indian flag-bearing vessels are allowed to carry domestic cargo along the coast

Several ports are serviced by Indian flag-bearing vessels by the state-owned Shipping Corporation of India as well as one or more private domestic ship operators. Therefore, various ports met criterion d, that of at least two shipping lines servicing the CEZ. The result of application of criteria d and e is in the Table 14 below:

Table 14: Scenario 2- Identifying CEZs with at least two shipping lines and at least one inter-port shipping connection[25][26]

Sr.no.	CEZ	State	Port	Criteria	
				d	e
1	Kutch	Gujarat	Kandla		x
			Mundra	x	x
2	Saurashtra	Gujarat	Pipavav	x	x
			Sikka		x
3	Suryapur	Gujarat	Dahej		x
			Hazira	x	x
4	North Konkan	Maharashtra	JNPT	x	x
			Mumbai		x
5	South Konkan	Maharashtra, Goa	Dighi		x
			Jaigarh		x
			Mormugao		x
6	Dakshin	Karnataka	Mangalore	x	x
7	Malabar	Kerala	Kochi	x	x
8	Mannar	Tamil Nadu	Tuticorin	x	x
9	Poompuhar	Tamil Nadu	Cuddalore		x
10	VCIC South	Tamil Nadu	Chennai		x
			Ennore		x
			Kattupalli	x	x
11	VCIC Central	Andhra Pradesh	Krishnapatnam		x

[24] Appendix 2
[25] Appendix 1
[26] Appendix 2

Sr.no.	CEZ	State	Port	Criteria	
				d	e
12	VCIC North	Andhra Pradesh	Visakhapatnam	x	x
			Kakinada	x	x
13	Kalinga	Odisha	Paradip		x
			Dhamra		x
14	Gaud	West Bengal	Kolkata	x	x
			Haldia	x	x

Key: 'x' CEZ meets criteria | __ Criteria not met

When criteria d and e are applied to the results in Table 14, it is evident that criterion d matched most CEZs because apart from Shipping Corporation of India (SCI), other private shipping lines also operate between several ports subject to availability of cargo.

However, the ports within the CEZs which were not connected by at least two shipping lines included Kandla port in CEZ Kutch, Sikka port in CEZ Saurashtra, Mumbai port in CEZ North Konkan, entire CEZs South Konkan; Poompuhar, & Kalinga, Chennai and Ennore ports in CEZ VCIC South, and the Krishnapatnam port in CEZ VCIC Central (Table 14).

All ports have connectivity to at least one other port and therefore all CEZs meet criterion e[27].

At this stage, the list of CEZs with good connectivity was sifted out. Remainder CEZs, after the application of these criteria, were to be the input for the next step of the methodology. The next phase of CEZ selections refereed to multimodal transport infrastructure and capability for each port and the respective CEZ to which it belongs.

4.1.1.3. Attractiveness of ports in CEZs regarding multi-modal transport of fruits and vegetables

A further deep-dive was carried out into the list of CEZs with good connectivity by applying criteria for attractiveness of multimodal transport and availability of relevant infrastructure. These criteria further restrict the list of potential ports for short sea shipping. Below are the five additional criteria to which the list in Table 13 and Table 14 is subjected:

f. The length of unpaved roads between collection centre and port is less than 5 kilometres;
g. The number of feeder vessels per week in the port should be at least one;
h. Availability of cranes, trailers, side loaders and carriers (in the case of container transport), or ships should have a ramp (in the case of Ro-Ro transport);
i. Above 10 meters draft at all ports;

[27] *Appendix 2*

j. Availability of charging point for the reefer container at the Container Freight Station (CFS). It should be noted here that shipping infrastructure in India is being developed rapidly.

The approach of evaluating CEZs based on two different scenarios will continue for the above criteria as well.

Scenario 1- International flag-bearing vessels along with Indian flag-bearing vessels are allowed to carry domestic cargo along the coast

Table 15: Scenario 1- results of CEZs with shipping connectivity, to which criteria f to j regarding multimodal transport is applied

Sr.no.	CEZ	State	Port	Criteria				
				f	g	h	i	j
1	Kutch	Gujarat	Kandla	x	x	x	x	x
			Mundra	x	x	x	x	x
2	Saurashtra	Gujarat	Pipavav	x	x	x	x	
3	Suryapur	Gujarat	Hazira	x	x	x	x	x
4	North Konkan	Maharashtra	JNPT	x	x	x	x	x
6	Dakshin	Karnataka	Mangalore	x	x	x	x	
7	Malabar	Kerala	Kochi	x	x	x	x	x
8	Mannar	Tamil Nadu	Tuticorin	x	x	x	x	x
10	VCIC South	Tamil Nadu	Chennai	x	x	x	x	x
			Kattupalli	x	x	x	x	x
12	VCIC North	Andhra Pradesh	Visakhapatnam	x	x	x	x	x
			Kakinada	x		x	x	x
14	Gaud	West Bengal	Kolkata	x		x		x
			Haldia	x		x		

Key: 'x' CEZ meets criteria | __ Criteria not met

With reference to scenario 1, criteria f to j is applied to the list of CEZs with good connectivity. It is observed:

f. To prevent mechanical product damage, it is assumed that sorting should be completed at the collection centre and from there produce is transported to the port. As a swiftly developing country where close to 110 km paved roads are constructed per day (400000 km district level roads constructed between years 2001 and 2011 alone)[28], data on road density is constantly changing. This would also mean that there is high likelihood of ports being connected to major districts inland via roadways. For the purpose of this study, therefore, it was assumed that all roads between

[28] http://rural.nic.in/sites/presentations.asp

the farm and port are paved or contain less than 5 kilometres of unpaved roads (usually from the farm to the nearest paved road). Therefore, we note that all ports and respective CEZs meet criteria f in Table 15 above.

g. This criterion is applied on the assumption that most vessels transporting containers along the Indian coast are feeder type and carry between 500 and 1500 containers[29]. The average number of feeder vessels per week at the port were calculated based on container traffic statistics[30]. Several shipping lines connecting the ports in these CEZs do run weekly feeder vessels, which is, in essence, criterion g. It is advantageous if feeder vessels are used as they can carry less number of Twenty-Foot Equivalent Unit (TEUs) more frequently and faster. Many feeder vessels that run between the ports also carry bulk cargo exclusively and therefore may not be suitable for this methodology which needs container movement of cargo.

On a weekly basis, Kandla port is serviced by 3 feeder vessels, Mundra port is serviced by 4 feeder vessels, both Pipavav port and Hazira port are serviced by 3 feeder vessels, JNPT port has 2 feeder vessels, Kochi port has 3 feeder vessels, Tuticorin port has 3 feeder vessel services, Visakhapatnam port is serviced by two feeder vessels, and Chennai & Kattupalli ports each have 2 feeder vessel services. While Kolkata & Haldia port were also served by 2 feeder vessels, but the frequency is once every 15 days, therefore CEZ Gaud does not meet criterion g[31]. Kakinada port in VCIC North also does not meet this criterion.

h. As all ports on the Indian coast considered for CEZ development are modernized, it can be safely assumed for the purpose of this study that the first half of criterion h, i.e. availability of cranes, trailers, side loaders and carriers (in the case of container transport) is met by all ports[32]. There are no scheduled Ro-Ro services at any of the ports on the Indian seacoast[33]. The criterion implies either 1. availability of cranes, trailers, side loaders and carriers (in the case of container transport), or 2. ships should have a ramp (in the case of Ro-Ro transport) should be fulfilled. All ports therefore can be said to be meeting criterion h.

i. In the case of criteria i, which is that the depth of draft at the port should be more than 10 metres, both ports (Kolkata and Haldia) in CEZ Gaud do not meet the requirement. Kolkata port has a draft of 5.5 metres and the draft at Haldia is just about 10 metres[34]. While Kandla port is shallower in terms of draft among modern Indian ports, it still stands at 11.2 metres and qualifies as per the criteria.

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[29] *https://en.wikipedia.org/wiki/Container_ship*
[30] *http://ipa.nic.in//showimg.cshtml?ID=217*
[31] *Appendix 3*
[32] *Appendix 4*
[33] *Appendix 4*
[34] *Appendix 5*, *https://www.searates.com/port/haldia_in.htm/*

j. Criteria j refers to the availability of reefer charging points. Container freight stations (CFS hereon) are established outside all ports for the storage of cargo awaiting customs inspection and other documentation[35]. Charging points for reefers (REFs) can be found at most CFSes. However, the CFS at Mangalore port at CEZ Dakshin, and Haldia port at CEZ Gaud (which does not meet criteria g, h and i altogether) do not offer the facility of charging points for REFs[36].

Scenario 2- Only Indian flag-bearing vessels are allowed to carry domestic cargo along the coast

Table 16: CEZs after the application of multimodal criteria f, g, h, i, and j.

Sr. no.	CEZ	State	Port	Criteria				
				f	g	h	i	j
1	Kutch	Gujarat	Mundra	x	x	x	x	x
2	Saurashtra		Pipavav	x	x	x	x	
3	Suryapur		Hazira	x	x	x	x	x
4	North Konkan	Maharashtra	JNPT	x	x	x	x	x
6	Dakshin	Karnataka	Mangalore	x	x	x	x	
7	Malabar	Kerala	Kochi	x	x	x	x	x
8	Mannar	Tamil Nadu	Tuticorin	x	x	x	x	x
10	VCIC South		Kattupalli	x	x	x	x	x
12	VCIC North	Andhra Pradesh	Visakhapatnam	x	x	x	x	x
			Kakinada	x	x	x	x	x
14	Gaud	West Bengal	Kolkata	x	x	x		x
			Haldia	x	x	x		

Key: 'x' CEZ meets criteria | __ Criteria not met

On application of criteria f to j to Scenario 2, it is found:

[35] *Appendix 6*
[36] *Appendix 7*
Kandla port - www.kandlaport.gov.in
Mundra port - http://hindterminals.com/CFS_Mundra
Hazira port - http://www.parekhgroup.in
JNPT port - http://www.navkarcfs.com
Kochi port - http://www.triway.in
Tuticorin port - http://www.concorindia.com
Chennai port - http://www.triway.in
Kattupalli port - http://tgterminals.com
Visakhapatnam port - http://www.allianceshipping.in

f. As discussed in the previous Scenario, 1, product sorting is assumed to have been completed at the collection centre to prevent product damage before being transported to the port. Also, as stated in the previous scenario, for this study, it was assumed that all roads between the farm and port are paved or contain less than 5 km of unpaved roads (usually from the farm to the nearest paved road)[37].

g. While feeder vessels would be the ideal method of transporting between ports by the short sea routes, in the case of Scenario 2 all shipping lines run cargo vessels between all the ports and not scheduled feeder vessels. But feeder vessels run based on how much cargo is available. It is important to note, however, that there is also significant connectivity of non-feeder vessels between the Indian ports which is not evaluated in the g criteria. It is advantageous if feeder vessels are used as they can carry less number of TEUs more frequently and faster. But we cannot ignore the fact that Indian ports are also connected with non-feeder services along the coast. Therefore, all Indian ports meet this criteria in this scenario on a need-basis.[38].

h. As all ports on the Indian coast considered for CEZ development are modernized, it can be safely assumed for the purpose of this study that the first half of criterion h, i.e. availability of cranes, trailers, side loaders and carriers (in the case of container transport) is met by all ports[39]. There are no scheduled Ro-Ro services at any of the ports on the Indian seacoast[40]. The criterion implies either 1. availability of cranes, trailers, side loaders and carriers (in the case of container transport), or 2. ships should have a ramp (in the case of Ro-Ro transport) should be fulfilled. All ports therefore can be said to be meeting criterion h.

i. In the case of criteria i, which is that the depth of draft at the port should be more than 10 metres, both ports (Kolkata and Haldia) in CEZ Gaud do not meet the requirement. Kolkata port has a draft of 5.5 metres and the draft at Haldia is just about 10 metres. While Kandla port is shallower in terms of draft among modern Indian ports, it still stands at 11.2 metres and qualifies as per the criteria[41].

j. Criteria j refers to the availability of reefer charging points. Container freight stations are established outside all ports for the storage of cargo awaiting customs inspection and other documentation[42]. Usually, charging points for reefers (REFs) can be found at these CFSes. The CFS at Mangalore port at CEZ Dakshin, and Haldia port at CEZ Gaud (which does not meet criteria g, h and i altogether) do not offer the facility of charging points for REFs currently[43].

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[37] *http://rural.nic.in/sites/presentations.asp*
[38] *Appendix 3*
[39] *Appendix 4*
[40] *Appendix 4*
[41] *Appendix 5*, *https://www.searates.com/port/haldia_in.htm/*
[42] *Appendix 6*
[43] *Appendix 7*

4.1.1.4. Existing shipping line connectivity

For the list of CEZs, after the application of criteria pertaining to multimodal transport and associated infrastructure, the existing presence of shipping routes between CEZs of origin and CEZ destinations is considered. Only if the route is served by at least one existing shipping line directly, is it considered a viable route. This methodology step continues to evaluate CEZs under both scenarios for existing connectivity.

Scenario 1

In the case of Scenario 1, potentially viable short sea shipping routes between the Indian CEZ port pairs are shortlisted below (Table 17)[44].

Table 17: Scenario 1- Results of origin and destination CEZ-pairs in which shipping routes are already present[45]

Sr.no.	CEZ	ORIGIN	DESTINATION								
		Port	Kandla - Kutch	Mundra - Kutch	Hazira-Suryapur	JNPT - North Konkan	Kochi - Malabar	Tuticorin - Mannar	Chennai - VCIC	Kattupalli - VCIC South	Visakhapatnam - VCIC North
1	Kutch	Kandla		x		x					x
		Mundra	x		x	x	x	x		x	x
3	Suryapur	Hazira		x		x					
4	North Konkan	JNPT		x	x						
7	Malabar	Kochi		x				x			
8	Mannar	Tuticorin		x			x			x	x
10	VCIC South	Chennai								x	
		Kattupalli		x			x	x	x		x
12	VCIC North	Visakhapatnam		x			x	x		x	

Key: 'x' CEZ meets criteria | __ Criteria not met

Of the CEZ-pairs presented above in Table 17, Kandla port from CEZ Kutch is connected to Mundra and JNPT ports. Mundra (observed to be the best connected to other ports in the CEZ list) has existing shipping routes with Kandla, JNPT (its only port connection from the list), Kochi, Tuticorin, and Kattupalli ports with the exception of Chennai port. In CEZ Suryapur, Hazira port has existing feeder connectivity with Mundra port in CEZ Kutch and JNPT port in CEZ North Konkan. In CEZ Malabar, Kochi port additionally also has a route to Tuticorin port, which in turn also has a route connectivity to Kattupalli. There is also a route from Kochi and Tuticorin ports to Mundra port. In CEZ VCIC South, Chennai port is only connected to Kattupalli. In VCIC North, Visakhapatnam port has connectivity with Mundra port in CEZ Kutch, Kochi port in CEZ Malabar, Tuticorin port in CEZ Mannar, and Kattupalli port in CEZ VCIC South.

[44] Appendix 8
[45] Appendix 8

Scenario 2
For Scenario 2 we have to consider only the Indian flag carrying vessels and therefore the results may be different for some ports.

In the case of Scenario 2, potentially viable short sea shipping routes between the Indian CEZ port pairs are shortlisted below (Table 18)[46].

Table 18: Scenario 2- Results of origin and destination CEZ-pairs in which shipping routes are already present

Sr.no.	CEZ	ORIGIN	DESTINATION							
		Port	Mundra -Kutch	Hazira - Suryapur	JNPT - North Konkan	Kochi - Malabar	Tuticorin - Mannar	Kattupalli - VCIC South	Visakhapatnam -VCIC North	Kakinada - VCIC North
1	Kutch	Mundra		x	x	x	x	x	x	x
3	Suryapur	Hazira	x		x					
4	North Konkan	JNPT	x							
7	Malabar	Kochi	x	x			x			
8	Mannar	Tuticorin	x	x		x		x	x	
10	VCIC South	Kattupalli	x			x	x			
12	VCIC NORTH	Visakhapatnam	x			x	x	x		x
		Kakinada							x	

Key: 'x' CEZ meets criteria | __ Criteria not met

As observed under the results in Table 18 pertaining to connectivity in Scenario 2, all ports with the exception of Kakinada have direct sea route connectivity from Mundra port in CEZ Kutch.

In addition, in CEZ Malabar, Kochi port has a route to Tuticorin port, which in turn also has a route to Kattupalli in CEZ VCIC South and Visakhapatnam in CEZ VCIC North. The connectivity of Kattupalli port to Kochi port by sea route is also present. Visakhapatnam port in VCIC North is connected to all ports with the exception of Hazira and JNPT ports, and Kakinada port is connected only to Visakhapatnam.

Table 17 showcases shipping route connectivity for Scenario 1. Below (Table 19) is the summary of origin and destination CEZs based on existing shipping line connectivity between them.

[46] *Appendix 9, Ministry of Shipping, Government of India, Vision for Coastal Shipping. (shipping.nic.in)*

Table 19: Scenario 1- Summary of results of shipping routes between origin and destination CEZ-pairs

	ORIGIN	**DESTINATION**						
Sr.no.	**CEZ**	Kutch	Suryapur	North Konkan	Malabar	Mannar	VCIC South	VCIC North
1	Kutch		+	+	+	+	+	+
3	Suryapur	+		+	-	-	-	-
4	North Konkan	+	+		-	-	-	-
7	Malabar	+	-	-		+	-	+
8	Mannar	+	-	-	+		+	+
10	VCIC South	+	-	-	+	+		+
12	VCIC North	+	-	-	+	+	+	

Key: **+** Connectivity from origin to destination CEZ | **-** Absence of connectivity from origin to destination CEZ.

Connectivity is measured from origin to destination CEZ based on at least one port from both CEZs having connectivity.

CEZ Kutch has connectivity to CEZ North Konkan, CEZ Malabar, CEZ Mannar, and CEZ VCIC South. CEZ Suryapur has connectivity to CEZ Kutch and to CEZ North Konkan.

CEZ North Konkan has route connectivity only to CEZ Kutch. CEZ Malabar enjoys route connectivity with CEZ Mannar and CEZ Kutch. CEZ Mannar has shipping route connectivity with CEZ VCIC South, apart from CEZ Malabar and CEZ Kutch. CEZ VCIC South has additional (apart from CEZ Kutch) route connectivity with CEZ Malabar and CEZ Mannar.

CEZ VCIC North has connectivity to CEZ Kutch, CEZ Malabar, CEZ Mannar and VCIC South.

For Scenario 2, only Indian flag-bearing vessels shall be considered, and therefore the results may vary for some ports.

Table 18 showcases shipping route connectivity for Scenario 2. Below (Table 20) is the summary of origin and destination CEZs based on existing shipping line connectivity between them.

Table 20: Scenario 2- Summary of results of shipping routes between origin and destination CEZ-pairs

	ORIGIN	**DESTINATION**						
Sr.no.	**CEZ**	Kutch	Suryapur	North Konkan	Malabar	Mannar	VCIC South	VCIC North
1	Kutch		+	+	+	+	+	+
3	Suryapur	+		+	-	-	-	-
4	North Konkan	+	-		-	-	-	-
7	Malabar	+	+	-		+	-	-
8	Mannar	+	+	-	+		+	+
10	VCIC South	+	-	-	+	+		-
12	VCIC North	+	-	-	+	+	+	

Key: **+** Connectivity from origin to destination CEZ | **-** Absence of connectivity from origin to destination CEZ.

Connectivity is measured from origin to destination CEZ based on at least one port from both CEZs being connected.

While several CEZs are observed to be reciprocally connected, that was not the case with CEZ pairs extrapolated below:

Similar to Scenario 1, CEZ Kutch enjoys connectivity to all destination CEZs, i.e. CEZ Suryapur, CEZ North Konkan, CEZ Malabar, CEZ Mannar, CEZ VCIC South, CEZ VCIC North. CEZ Suryapur has connectivity with CEZ Kutch and CEZ North Konkan. Also, identical to Scenario 1, CEZ North Konkan has connectivity only to CEZ Kutch. CEZ Malabar enjoys connectivity to CEZ Kutch, CEZ Suryapur and CEZ Mannar. CEZ Mannar has connectivity to CEZ Kutch, CEZ Suryapur, CEZ Malabar, CEZ VCIC South, CEZ VCIC North. CEZ VCIC South is connected via shipping routes to CEZ Kutch, CEZ Malabar and CEZ Mannar. CEZ VCIC North has shipping route connectivity to CEZ Kutch, CEZ Malabar, CEZ Mannar and CEZ VCIC South.

In the next step, the turnaround time for each CEZ pair shall be explored, not only in terms of port-to-port, but also for the entire supply chain process of farm to consumption.

Throughput time of sea – part of the supply chain

Having arrived at the most viable CEZ- routes, the end-to-end supply chain turnaround time (TAT) for all CEZs is calculated next. Since the resultant sets of CEZs in Scenario 1 and Scenario 2 differ only by two CEZs, namely the addition of CEZ Suryapur and CEZ VCIC North, the origin and destination CEZ results in Table 19 and Table 20 are combined. Total CEZs considered here onwards were therefore seven.

Table 21: CEZ pairs combined from results of Scenario 1 and 2 after deducing connectivity between each pair in days

Sr.no.	CEZ	ORIGIN	DESTINATION									
		Port	Kandla - Kutch	Mundra - Kutch	Hazira - Suryapur	JNPT - North Konkan	Kochi - Malabar	Tuticorin - Mannar	Chennai - VCIC South	Kattupalli - VCIC South	Kakinada - VCIC North	Visakhapatnam - VCIC North
		Kandla		1	1	1	3	3	4	4	5	5
1	Kutch	Mundra	1		1	1	3	3	4	4	5	5
3	Suryapur	Hazira	1	1		1	2	3	4	4	4	4
4	North Konkan	JNPT	1	1	1		2	2	3	3	4	4
7	Malabar	Kochi	3	3	2	2		1	2	2	3	3
8	Mannar	Tuticorin	3	3	3	2	1		1	1	2	2
		Chennai	4	4	4	3	2	1		1	1	1
10	VCIC South	Kattupalli	4	4	4	3	2	1	1		1	1
		Kakinada	5	5	4	4	3	2	1	1		1
12	VCIC NORTH	Visakhapatnam	5	5	4	4	3	2	1	1	1	

The above table shows the number of days at sea between two ports and thus gives port to port transit time. However, the turnaround time (TAT) for each CEZ pair shall be explored, not only in terms of port-to-port connectivity time, but also for the entire supply chain process of farm to buyer. While the results for these calculations were independent of products selected, they were vital to the process of product selection as they were compared to the shelf-life or perishability of the products.

Calculations of Transport at Sea were carried out in three stages. First, the nautical miles between each origin and destination port is tabulated. Then, time taken between the two ports is tabulated in terms of hours.[47]

The knot (/nɒt/) is a unit of speed equal to one nautical mile (1.852 km) per hour, approximately 1.151 mph. The ISO Standard symbol for the knot is kn. The vessel travels at speeds of 18-24 kn, thus its speed is calculated at 20 km per hour for our calculation purposes here. If the TAT is less than 24 hours we have taken it as 1 day and if the TAT is more than 24 hours, then 2 days, and so on.

[47] http://ports.com/

Therefore, the number of hours taken for transport at sea from port to port were converted into, and presented as, the number of days finally. The addition of hours above each 24-hour cycle was rounded off to the next higher integer as an additional day. This was done since sea winds and other poor weather conditions often cause delays to absolute time schedules in shipping and it was better to assume slightly higher turnaround[48]

It should be noted here that the data for the distance between other ports and Hazira port was not available online or from an official source. The source of information is therefore in the form of an interview[49].

Moreover, data for the distance (and therefore Transport time at sea) between the other ports in the selected CEZs and Kattupalli port was not available. The calculation applied therefore is: difference between Kattupalli and Chennai port, 10.8 nautical miles, added or subtracted (depending upon direction from Kattupalli port) from its distance to Chennai to arrive at the distance from each port to Kattupalli port.

While the turnaround time for each CEZ pair is explored in terms of port-to-port connectivity in the preceding table, the entire supply chain process of farm to consumption is much longer, and merits documentation while factoring in logistics. This is represented as a process flow below (Figure 11).

Documentation and processes such as pre-cooling the reefer container, sending it to the farm, at farm sorting, dispatching the container are carried out even before the container arrives at the port. In addition to the port to port shipment, once the products arrive for transport to another port ('Processes and Documents on Departure' - PDD) such as survey inspections, loading container on the vessel, etc. is completed and the same process takes place when products arrive at destination port ('Processes and Documents on Arrival' - PDA). All ports take a procedural one day at the CFS and another day for the carting-loading process –the PDD and PDA was therefore considered to be a standard process of two days each.

Turnaround time for on-land transport was taken as one day each, both, at the port of origin and destination. Considering that the farm and buyer both may be located within 200 km to 300 km of the port, given the criteria that has applied to the CEZ selection, it is determined that a container would take a day to travel this distance.

[48] *Appendix 11*
[49] *Appendix 10*

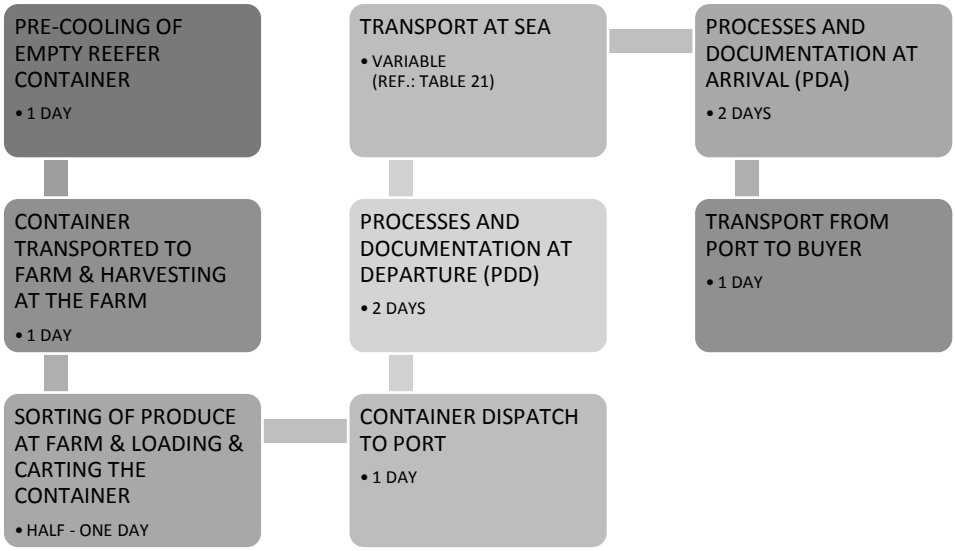


Figure 12: Process flow from farm to buyer.

Despite there being an additional step in the logistics of pre-cooling the container, it does not impact the perishability of the product. The 1 day that this step takes is, therefore, not considered in the total throughput time between each origin and destination CEZ for assessing perishability. While the container travels for a day from the port to the farm, the activity of harvesting and sorting is assumed to have already begun, and therefore it is the harvest stage, from when perishability has an impact on the produce. As the container reaches the farm, the time taken to load the container impacts the perishability of the produce as well.

Port-to-farm, farm-to-port, time taken for documentation at the origin and destination ports, and port-to-buyer transit time were considered constant therefore remain identical for all ports, across all port-to-port results.

A product-independent calculation of turnaround time (TAT) from farm to buyer was thus made (Table 22) to further compare it with produce perishability in the next section of this report.

Each tabulation in this table corresponds to the total TAT between a farm located in one CEZ and a buyer located in another CEZ. Represented below in the table through ports that are 200-300 km from the buyer or the farm. The total TAT is a calculation of the total number of days from port to farm and back, the time taken at the origin port, transport at sea, time taken at the destination port, and time taken for the container to reach the buyer.

Table 22: Turnaround Time (TAT) for selected CEZs (in days).

Sr.no.	CEZ	ORIGIN	DESTINATION									
		Port	Kandla - Kutch	Mundra - Kutch	Hazira - Suryapur	JNPT - North Konkan	Kochi - Malabar	Tuticorin - Mannar	Chennai - VCIC South	Kattupalli - VCIC South	Kakinada - VCIC North	Visakhapatnam - VCIC North
1	Kutch	Kandla		9	9	9	11	11	12	12	13	13
		Mundra	9		9	9	11	11	12	12	13	13
3	Suryapur	Hazira	9	9		9	10	11	12	12	12	12
4	North Konkan	JNPT	9	9	9		10	10	11	11	12	12
7	Malabar	Kochi	11	11	10	10		9	10	10	11	11
8	Mannar	Tuticorin	11	11	11	10	9		9	9	10	10
10	VCIC South	Chennai	12	12	12	11	10	9		9	9	9
		Kattupalli	12	12	12	11	10	9	9		9	9
12	VCIC North	Kakinada	13	13	12	12	11	10	9	9		9
		Visakhapatnam	13	13	12	12	11	10	9	9	9	

As reiterated earlier, pre-cooling of container was not calculated in the CEZ to CEZ TAT since it does not affect perishability. However, it is an integral part of the logistical supply chain and therefore included as part of the process flow in the Figure 11.

This CEZ-level summary concluded the process of route selection. In the next section, as per the prescribed methodology, the process of product selection shall be undertaken, beginning with the identification of products in each selected CEZ along the possible routes determined in this section.

4.1.2. Product Selection

In this section, 'products' (specifically fruits and vegetables) underwent a selection process to determine the fruits and vegetable(s) with the best chance for successful transportation by short sea shipping.

Below are the set of criteria employed for selecting one or two products for consideration:

a) Most produced products per selected CEZ;
b) Sufficient shelf life;
c) Oversupply in the CEZ of production;
d) Undersupply in one of the other selected CEZs.

4.1.2.1. Most produced products per selected CEZs

The product selection process began with identification of top five fruits and top five vegetables produced in each of the CEZs shortlisted in section 4.1.2.

In India CEZs constitute of a collection of districts, and production data was available at district level. Therefore, fruits and vegetables were identified on the basis of annual production in each district.

First, the district-wise production data of fruits and vegetables in each CEZ for the three most recent consecutive years was considered. This data was taken for the most recent three years to rule out any 'bad year' in terms of production lows caused due to climatic anomalies such as drought or flood or even pest attack.

An average of the three-year production data was then derived for each fruit and vegetable per district, and the corresponding seasons/months of their harvest. As some three-year data was not as recent, data from the most recent year, 2015, was checked to ensure that these products are still cultivated in the respective CEZs.

This average is considered to be the annual production of the specific fruits and vegetables in the district.

Post this, the average production data of top five fruits and vegetables for each district was collated in a table at the CEZ level, to arrive at the total CEZ production of the produce.

From the total values of production at the CEZ level, the products were ranked in descending order of production, i.e. 1 to the product with the highest average production quantity, and 5 to the product with the lowest average production quantity.

The top five vegetables and fruits across CEZ Kutch is represented in Table 23.[50]

Table 23: Product ranking for fruits and vegetables in CEZ Kutch[51]

Vegetables	Rank	Production (MT)
Onion	1	61233
Tomato	2	25692
Eggplant	3	26275
Cabbage	4	8715
Okra	5	5443

[50] *Appendix 12, https://data.gov.in/catalog/district-wise-season-wise-crop-production-statistics*
[51] *http://dcmsme.gov.in/dips/2016-17/kutch.pdf*

Fruits	Rank	Production (MT)
Papaya	1	174601
Date	2	102778
Banana	3	70767
Mango	4	50998
Pomegranate	5	24059

It should be noted here, that only one district falls under the CEZ in the case of Kutch. Therefore, production of each product was simply ranked according to its production quantities.

However, products are not ranked at district level, but at CEZ level for their average production.

In the rest of the selected CEZs, several districts fall under each of them. Each product was listed with its average production quantity for each district and added within the product group to arrive at the total annual production quantity (in MT) of the product in the CEZ.

The top five vegetables and fruits across CEZ Suryapur is represented in Table 24.[52]

Table 24: Product ranking for fruits and vegetables in CEZ Suryapur

Vegetables	Rank	Production (MT)
Banana	1	1710119
Mango	2	299568
Sapota	3	118405
Papaya	4	101240
Indian Jujube	5	6923
Fruits	**Rank**	**Production (MT)**
Cucurbits	1	212382
Okra	2	205146
Eggplant	3	151602
Tomato	4	61629
Cauliflower	5	22917

[52] *Appendix 12*, *https://data.gov.in/catalog/district-wise-season-wise-crop-production-statistics*

As an example for the total volume calculation: In CEZ Suryapur, there are three districts: in Bharuch, 1078330 MT of banana is produced on average. In Surat and Navsari, 527789 MT and 104000 MT of banana is produced respectively. Production quantities of banana from all three districts were added to arrive at a total annual production of 1710119 MT/annum to be considered in the CEZ-wise ranking of banana for CEZ Suryapur.

The top vegetables and fruits across CEZ North Konkan is represented in Table 25.

Table 25: Product ranking for fruits and vegetables in CEZ North Konkan[53]

Vegetables	**Rank**	**Production (MT)**
Onion	1	2111549
Tomato	2	219718
Fruits	**Rank**	**Production (MT)**
Grapes	1	449061
Banana	2	75223
Mango	3	47053

In the case of CEZ North Konkan, data for annual production is only available for Onion and Tomato among vegetables and Grapes, Banana and Mango among fruits. The product rankings for vegetables and fruits in CEZ North Konkan are therefore limited to 2 and 3 respectively.

The top five vegetables and fruits across CEZ Malabar is represented in Table 26.[54]

Table 26: Product ranking for fruits and vegetables in CEZ Malabar

Vegetables	**Rank**	**Production (MT)**
Tapioca	1	1366279
Drumstick	2	6053
Ginger	3	1543
Sweet Potato	4	220
Fruits	**Rank**	**Production (MT)**
Coconut	1	1438666667
Banana	2	541406
Mango	3	121886
Pineapple	4	60578
Papaya	5	27916

[53] *Appendix 12, https://data.gov.in/catalog/district-wise-season-wise-crop-production-statistics*
[54] *Appendix 12, https://data.gov.in/catalog/district-wise-season-wise-crop-production-statistics*

The top five vegetables and fruits across CEZ Mannar are represented in Table 27.[55]

Table 27: Product ranking for fruits and vegetables in CEZ Mannar[56]

Vegetables	**Rank**	**Production (MT)**
Tapioca	1	119509
Onion	2	20155
Tomato	3	6931
Eggplant	4	3271
Okra	5	2565
Fruits	**Rank**	**Production (MT)**
Coconut	1	243798567
Banana	2	413495
Mango	3	23150
Jackfruit	4	8144
Pomefruit	5	2287

The top five vegetables and fruits across CEZ VCIC South is represented in Table 28.[57]

Table 28: Product ranking for fruits and vegetables in CEZ VCIC South[58]

Vegetables	**Rank**	**Production (MT)**
Eggplant	1	12967
Tapioca	2	5383
Okra	3	4905
Tomato	4	513
Sweet potato	5	393
Fruits	**Rank**	**Production (MT)**
Coconut	1	25849400
Mango	2	93319
Banana	3	64116
Guava	4	800
Watermelon	5	

Of all the data for produce available, production data for watermelon in the corresponding CEZ VCIC South, specifically, is unavailable. Therefore, while it is listed here, there is no production data available for ranking it.

[55] *Appendix 12*, *https://data.gov.in/catalog/district-wise-season-wise-crop-production-statistics*
[56] *http://nhm.nic.in/JIT_Reports/13092015.pdf*
[57] *Appendix 12*, *https://data.gov.in/catalog/district-wise-season-wise-crop-production-statistics*
[58] *https://www.researchgate.net/publication/305766315_Horticulture_Statistics_at_a_Glance_2015*

The top five vegetables and fruits across CEZ VCIC North is represented in Table 29.[59]

Table 29: Product ranking for fruits and vegetables in CEZ VCIC North[60]

Vegetables	**Rank**	**Production (MT)**
Tapioca	1	178077
Tomato	2	100626
Eggplant	3	82754
Onion	4	38222
Okra	5	37376
Fruits	**Rank**	**Production (MT)**
Coconut	1	2051347333
Mango	2	1778262
Banana	3	960437
Papaya	4	144375
Lemon	5	65392

From all of these CEZ-wise production lists, a consolidated list of fruits and vegetables (Table 30) is derived for consideration of perishability threshold in number of days in step b. This consolidated list does not take into consideration the production ranks of the fruits and vegetables in each CEZ-wise list.

Table 30: Consolidated list of all fruits and vegetables for consideration of perishability in criterion b.

S.NO.	FRUITS	VEGETABLES
1	Papaya	Onion
2	Date	Tomato
3	Mango	Eggplant
4	Pomegranate	Cabbage
5	Banana	Okra
6	Sapota	Cucurbits
7	Indian Jujube	Cauliflower
8	Grapes	Tapioca
9	Coconut	Drumstick
10	Pineapple	Ginger
11	Jackfruit	Sweet potato
12	Pomefruit	

[59] *Appendix 12*, *https://data.gov.in/catalog/district-wise-season-wise-crop-production-statistics*
[60] *nhb.gov.in/area-pro/NHB_Database_2015.pdf , midh.gov.in/technology/State-Wise-Horticulture-Status.pdf*

S.NO.	FRUITS	VEGETABLES
13	Guava	
14	Watermelon	
15	Lemon	

Transit times from port to port by short sea shipping routes reveal connectivity of routes and the speed at which products can be transported. It is as important to know the perishability threshold of a product or its shelf life in terms of number of days. The latter determines which products would be most suitable to be transported via short sea shipping while impacting perishability of the product significantly less than existing modes of transport, help contain food wastage and losses and also earning the farmer a better price for his produce.

In step b, therefore, for each product resulting from criterion a., the shelf life of the types of fruits and vegetables is compared to the total turnaround time taken from farm to buyer from one CEZ to another within the selected combination of CEZs in the next step.

4.1.2.2. Sufficient shelf life

In this step, perishability of all products (fruits and vegetables) listed in Table 31 and Table 32 were listed with maximum & minimum days that each product will survive in cold chain. Perishability of the same products under ambient temperatures was also listed (Table 31). India runs warmer temperatures even by night along its coast owing to its geographical proximity to the tropic of Cancer, therefore ambient temperatures for perishability were considered at 30° Celsius.

Average shelf life of fruits was calculated based on the corresponding minimum and maximum value in the third and fourth columns in the tables below in Table 31.

Table 31: Product perishability data of fruits results of step a[61]

S.NO.	FRUITS	REEFER/COLD CHAIN			AMBIENT
		minimum (days)	maximum (days)	opt. T (° C)	30° C
1	Papaya	7	21	7-13	not viable
2	Date	180	360	0	OK, keep dry
3	Mango	14	21	13	not viable
4	Pomegranate	60	90	5-7.2	not viable
5	Banana	7	28	13-15	not viable

[61] http://postharvest.ucdavis.edu/Commodity_Resources/Fact_Sheets/

S.NO.	FRUITS	REEFER/COLD CHAIN			AMBIENT
6	Sapota	14	14	15-20	not viable
7	Indian Jujube	unknown[62]	28	2.5-10	not viable
8	Grapes	30	180	0	not viable
9	Coconut	30	60	0-2	not viable
10	Pineapple	14	28	7-13	not viable
11	Jackfruit	14	28	13	not viable
12	Pomefruit (apple/pear)	30	60	0-4	not viable
13	Guava	14	21	5-10	not viable
14	Watermelon	14	21	10-15	not viable
15	Lemon	14	14	9-10	not viable

Table 31 reveals that among fruits, only dates survive in both cold chain as well as ambient conditions. In the latter case, the product must be kept dry, and humidity must be observed.

[62] *No data found in literature*

Table 32: Product perishability data of vegetable results of step a.

S.NO.	VEGETABLES	REEFER/COLD CHAIN			AMBIENT
		minimum (days)	maximum (days)	opt. T (° C)	30° C
1	Onion	30	240	0	OK, keep dry
2	Tomato	14	35	8-13	not viable
3	Eggplant	7	14	10-12	not viable
4	Cabbage	21	42	0	not viable
5	Okra	7	10	7-10	not viable
6	Cucurbits	10	14	10-12	not viable
7	Cauliflower	21	28	0	not viable
8	Tapioca	Data not available			
9	Drumstick	Data not available			
10	Ginger	180	180	13	OK, keep dry
11	Sweet potato	120	210	13-15	OK, keep dry

In Table 32, only onion, ginger and sweet potato among vegetables survive without cold chain. These products too however, must be kept dry, and humidity must be observed constantly. Data for tapioca and drumstick was not available, therefore the two products were not considered here onwards.

Averages of the maximum and minimum days of perishability threshold were deduced. It was also mandated that products should be of sufficient quality for sale for five days after reaching the market. For instance, if the maximum perishability threshold for mango in cold chain was 21 days and minimum was 14 days, then its average perishability threshold in number of days was 17. In the case of cold chain, the number of days available for logistics would have been 17-5=12 in presence of cold chain.

Since most fruits and vegetables in Table 31and Table 32 above were observed to not survive in ambient temperature, consideration for perishability thresholds for the products was restricted to cold chain.

The maximum perishability threshold in number of days available for fruits after removing the five market days are given in Table 33[63].

[63] *Appendix 13*

Table 33: Perishability threshold of fruits.

FRUITS	Maximum (days)
Papaya	9
Date	265
Mango	12
Pomegranate	70
Banana	12
Sapota	9
Indian Jujube	9
Grapes	100
Coconut	40
Pineapple	16
Jackfruit	16
Pomefruit (apple/pear)	40
Guava	12
Watermelon	12
Lemon	9

The maximum perishability threshold in number of days available for vegetables after removing the five market days are given below in Table 34[64].

Table 34: Perishability threshold of vegetable

VEGETABLES	Maximum (days)
Onion	130
Tomato	19
Eggplant	5
Cabbage	26
Okra	3
Cucurbits	7
Cauliflower	19
Tapioca	Data not available
Drumstick	Data not available
Ginger	175
Sweet potato	160

As mentioned earlier, apart from onion, ginger and sweet potato, none of the products will survive in dry ambient temperatures, and therefore perishability thresholds for all products were considered with respect to cold chain only.

[64] *Appendix 13*

These results were compared with the logistical TATs between CEZs (Table 22) in order to eliminate products that would not meet the perishability threshold.

Since the product must be transported from a specific port in the CEZ, product-TAT combinations are listed port-wise for each CEZ below in Table 35 to Table 44.

Table 35: Product-TAT comparison of fruits and vegetables produced near Kandla port (CEZ Kutch).

Vegetables	**Rank**	**Production**	**Maximum Days**	**Destination Ports where the produce can be shipped**
Onion	1	61233	130	Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Tomato	2	25692	19	Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Eggplant	3	26275	5	None
Cabbage	4	8715	26	Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Okra	5	5443	3	None
Fruits	**Rank**	**Production**		
Papaya	1	174601	9	Mundra, Hazira, JNPT
Date	2	102778	265	Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Banana	3	70767	12	Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli
Mango	4	50998	12	Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli
Pomegrenate	5	24059	70	Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam

Among vegetables, eggplant and okra have very short shelf life. The minimum logistical TATs were calculated to be at least 9 and 5 days respectively. They can therefore not be shipped to any other ports as their perishability threshold is shorter than the logistical TAT to other ports.

Among fruits, papaya has a relatively short shelf life of 9 days. It could therefore only be shipped to Mundra, Hazira and JNPT ports in closest proximity to the Kandla port in terms of logistical TATs.

Table 36: Product-TAT comparison of fruits and vegetables produced near Mundra port (CEZ Kutch).

Vegetables	Rank	Production	Maximum Days	Destination Ports where the produce can be shipped
Onion	1	61233	130	Kandla, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Tomato	2	25692	19	Kandla, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Eggplant	3	26275	5	None
Cabbage	4	8715	26	Kandla, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Okra	5	5443	3	None
Fruits	**Rank**	**Production**		
Papaya	1	174601	9	Kandla, Hazira, JNPT
Date	2	102778	265	Kandla, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Banana	3	70767	12	Kandla, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli
Mango	4	50998	12	Kandla, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli
Pomegranate	5	24059	70	Kandla, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam

From Mundra port also, among vegetables, eggplant and okra could not be shipped to any other ports for the same reason as in Table 35 with reference to Kandla port.

Among fruits, papaya's short shelf life allows its shipment to be limited to Kandla, Hazira and JNPT ports in closest proximity to the Mundra port in terms of logistical TATs.

Table 37: Product-TAT comparison of fruits and vegetables produced near Hazira port (CEZ Suryapur).

Fruits	**Rank**	**Production**	**Maximum Days**	**Destination Ports where the produce can be shipped**
Mango	1	299568	12	Kandla, Mundra, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Banana	2	1710119	12	Kandla, Mundra, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Sapota	3	118405	9	Kandla, Mundra, JNPT
Papaya	4	101240	9	Kandla, Mundra, JNPT
Indian Jujube	5	6923	9	Kandla, Mundra, JNPT
Vegetables	**Rank**	**Production**		
Cucurbits	1	212382	7	None
Okra	2	205146	3	None
Eggplant	3	151602	5	None
Tomato	4	61629	19	Kandla, Mundra, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Cauliflower	5	22917	19	Kandla, Mundra, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam

Among fruits, sapota, papaya and the Indian jujube have relatively short shelf lives of 9 days, which corresponds with the logistical TAT of Kandla, Mundra and JNPT ports in closest proximity to the Hazira port.

The top vegetables grown in CEZ Suryapur, cucurbits, okra and eggplant have shelf lives of 7, 3 and 5 days respectively. The TAT for even the closest port from Hazira port is 9 days, increasing up to 13 days for the farthest port. From Hazira port also therefore, among vegetables, cucurbits, okra and eggplant cannot be shipped to any other ports due to short perishability thresholds in comparison with the logistical CEZ-wise TATs in Table 22.

Table 38: Product-TAT comparison of fruits and vegetables produced near JNPT port (CEZ North Konkan).

Vegetables	Rank	Production	Maximum Days	Destination Ports where the produce can be shipped
Onion	1	2111549	130	Kandla, Mundra, Hazira, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Tomato	2	219718	19	Kandla, Mundra, Hazira, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Fruits	**Rank**	**Production**		
Grapes	1	449061	100	Kandla, Mundra, Hazira, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Banana	2	75223	12	Kandla, Mundra, Hazira, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Mango	3	47053	12	Kandla, Mundra, Hazira, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam

All the top vegetables and fruits grown in CEZ North Konkan have shelf lives of 12 or more days. The logistical TAT from JNPT port is 9 to 12 days to the rest of the ports in the selected CEZ, therefore, all the products growing close to JNPT port could be shipped to those ports.

Table 39: Product-TAT comparison of fruits and vegetables produced near Kochi port (CEZ Malabar).

Vegetables	Rank	Production	Maximum Days	Destination Ports where the produce can be shipped
Tapioca	1	1366279		Perishability data not available
Drumstick	2	6053		Perishability data not available
Ginger	3	1543	175	Kandla, Mundra, Hazira, JNPT, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Sweet Potato	4	220	160	Kandla, Mundra, Hazira, JNPT, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Fruits	**Rank**	**Production**		
Coconut	1	1438666667	40	Kandla, Mundra, Hazira, JNPT, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Banana	2	541406	12	Kandla, Mundra, Hazira, JNPT, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Mango	3	121886	12	Kandla, Mundra, Hazira, JNPT, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Pineapple	4	60578	16	Kandla, Mundra, Hazira, JNPT, Tuticorin, Chennai, Kattupalli, Kakinada, Visakhapatnam
Papaya	5	27916	9	Tuticorin

The two top vegetables grown near CEZ Malabar to be considered for step b, ginger and sweet potato, both have shelf lives far exceeding the logistical TAT to other ports from the selected CEZs in Table 22.

Among fruits however, the shelf life of papaya (9 days) makes the product only suitable to be shipped to Tuticorin port in CEZ Mannar. The other top fruits grown in the region could be easily shipped to all the other ports in the selected CEZs owing to their high perishability thresholds.

Table 40: Product-TAT comparison of fruits and vegetables produced near Tuticorin port (CEZ Mannar).

Vegetables	**Rank**	**Production**	**Maximum Days**	**Destination Ports where the produce can be shipped**
Tapioca	1	119509		Perishability data not available
Onion	2	20155	130	Kandla, Mundra, Hazira, JNPT, Kochi, Chennai, Kattupalli, Kakinada, Visakhapatnam
Tomato	3	6931	19	Kandla, Mundra, Hazira, JNPT, Kochi, Chennai, Kattupalli, Kakinada, Visakhapatnam
Eggplant	4	3271	5	None
Okra	5	2565	3	None
Fruits	**Rank**	**Production**		
Coconut	1	243798567	40	Kandla, Mundra, Hazira, JNPT, Kochi, Chennai, Kattupalli, Kakinada, Visakhapatnam
Banana	2	413495	12	Kandla, Mundra, Hazira, JNPT, Kochi, Chennai, Kattupalli, Kakinada, Visakhapatnam
Mango	3	23150	12	Kandla, Mundra, Hazira, JNPT, Kochi, Chennai, Kattupalli, Kakinada, Visakhapatnam
Jackfruit	4	8144	16	Kandla, Mundra, Hazira, JNPT, Kochi, Chennai, Kattupalli, Kakinada, Visakhapatnam
Pomefruit	5	2287	40	Kandla, Mundra, Hazira, JNPT, Kochi, Chennai, Kattupalli, Kakinada, Visakhapatnam

Among the top vegetables grown near Tuticorin port in CEZ Mannar, and considered for this step, eggplant and okra cannot be shipped to any other ports in the selected CEZs for their shorter perishability threshold compared to the logistical TAT.

Fruits grown in the region, however, can be supplied to all the ports in the selected CEZs by sea route owing to their high perishability thresholds.

Table 41: Product-TAT comparison of fruits and vegetables produced near Chennai port (CEZ VCIC South).

Vegetables	**Rank**	**Production**	**Maximum Days**	**Destination Ports where the produce can be shipped**
Eggplant	1	12967	5	None
Tapioca	2	5383		Perishability data not available
Okra	3	4905	3	None
Tomato	4	513	19	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Kattupalli, Kakinada, Visakhapatnam
Sweet potato	5	393	160	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Kattupalli, Kakinada, Visakhapatnam
Fruits	**Rank**	**Production**		
Coconut	1	25849400	40	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Kattupalli, Kakinada, Visakhapatnam
Mango	2	93319	12	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Kattupalli, Kakinada, Visakhapatnam
Banana	3	64116	12	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Kattupalli, Kakinada, Visakhapatnam
Guava	4	800	12	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Kattupalli, Kakinada, Visakhapatnam

Among the top vegetables grown near Chennai port in CEZ VCIC South, and considered for this step, eggplant and okra, again cannot be shipped to any other ports in the selected CEZs for reasons of shorter perishability threshold compared to logistical TAT.

For the fruits grown in the region, all the ports were found to be viable for shipping owing to their high perishability thresholds.

Table 42: Product-TAT comparison of fruits and vegetables produced near Kattupalli port (CEZ VCIC South).

Vegetables	**Rank**	**Production**	**Maximum Days**	**Destination Ports where the produce can be shipped**
Eggplant	1	12967	5	None
Tapioca	2	5383		Perishability data not available
Okra	3	4905	3	None
Tomato	4	513	19	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kakinada, Visakhapatnam
Sweet potato	5	393	160	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kakinada, Visakhapatnam
Fruits	**Rank**	**Production**		
Coconut	1	25849400	40	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kakinada, Visakhapatnam
Mango	2	93319	12	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kakinada, Visakhapatnam
Banana	3	64116	12	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kakinada, Visakhapatnam
Guava	4	800	12	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kakinada, Visakhapatnam

Among the top vegetables grown near Kattupalli port in CEZ VCIC South, and considered for this step, eggplant and okra met the same fate of not being shippable to any other ports in the selected CEZs for reasons of shorter perishability threshold compared to logistical TAT.

Fruits grown in the region could be shipped to all the ports owing to their high perishability thresholds.

Table 43: Product-TAT comparison of fruits and vegetables produced near Visakhapatnam port (CEZ VCIC North).

Vegetables	Rank	Production	Maximum Days	Destination Ports where the produce can be shipped
Tapioca	1	178077		Perishability data not available
Tomato	2	100626	19	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada
Eggplant	3	82754	5	None
Onion	4	38222	130	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada
Okra	5	37376	3	None
Fruits	**Rank**	**Production**		
Coconut	1	2051347333	40	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada
Mango	2	1778262	12	JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada
Banana	3	960437	12	JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Kakinada
Papaya	4	144375	9	Chennai, Kattupalli, Kakinada
Lemon	5	65392	9	Chennai, Kattupalli, Kakinada

Among the top vegetables grown near Visakhapatnam port in CEZ VCIC North, and considered for this step, once again, eggplant, and okra were found not eligible for shipping to any other ports in the selected CEZs for reasons of shorter perishability threshold compared to logistical TAT.

While the top three fruits grown in the region could be shipped to all the ports owing to their high perishability thresholds, shipping of papaya (ranked 4) and lemon (ranked 5) is limited to Chennai, Kattupalli and Kakinada ports owing to their comparatively lower perishability thresholds in comparison with the logistical TATs.

Table 44: Product-TAT comparison of fruits and vegetables produced near Kakinada port (CEZ VCIC North).

Vegetables	Rank	Production	Maximum Days	Destination Ports where the produce can be shipped
Tapioca	1	178077		Perishability data not available
Tomato	2	100626	19	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Visakhapatnam
Eggplant	3	82754	5	None
Onion	4	38222	130	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Visakhapatnam
Okra	5	37376	3	None
Fruits	**Rank**	**Production**		
Coconut	1	2051347333	40	Kandla, Mundra, Hazira, JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Visakhapatnam
Mango	2	1778262	12	JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Visakhapatnam
Banana	3	960437	12	JNPT, Kochi, Tuticorin, Chennai, Kattupalli, Visakhapatnam
Papaya	4	144375	9	Chennai, Kattupalli, Visakhapatnam
Lemon	5	65392	9	Chennai, Kattupalli, Visakhapatnam

Among the top vegetables grown near Kakinada port in CEZ VCIC North and considered for this step, eggplant and okra cannot be shipped to other ports on account of shorter perishability threshold compared to logistical TAT.

Once again in the case of Kakinada port, the top three fruits grown in the region could be shipped to all the ports owing to their high perishability thresholds, but papaya and lemon could only be shipped via sea route to Chennai, Kattupalli and Kakinada ports because of their lower perishability thresholds in comparison with the logistical TATs.

On the basis of the product results listed in step a (Table 30) compared with results in section 4.1.2 (Table 22), certain product-route combinations were considered invalid. Summary Table 45 lists the fruits which are considered.

Table 45: Conclusions of Product-TAT comparison for fruit.

S.NO.	FRUITS	RESULT
1	Papaya	Met logistic TAT for some or all ports
2	Date	Met logistic TAT for some or all ports
3	Mango	Met logistic TAT for some or all ports
4	Pomegranate	Met logistic TAT for some or all ports
5	Banana	Met logistic TAT for some or all ports
6	Sapota	Did not meet logistics TAT for any port route
7	Indian Jujube	Did not meet logistics TAT for any port route
8	Grapes	Met logistic TAT for some or all ports
9	Coconut	Met logistic TAT for some or all ports
10	Pineapple	Met logistic TAT for some or all ports
11	Jackfruit	Met logistic TAT for some or all ports
12	Pomefruit (apple/pear)	Met logistic TAT for some or all ports
13	Guava	Met logistic TAT for some or all ports
14	Watermelon	Production data is not available
15	Lemon	Met logistic TAT for some or all ports

Among product-TAT comparison for all fruits, papaya and lemon meet the logistical TATs only for a few ports.

Sapota and the Indian jujube do not meet the criteria for shipping to any port.

It should also be noted here that production data for watermelon was unavailable.

A summary with respect to vegetable perishability and logistical TAT comparisons is summarised below in Table 46.

Table 46: Conclusions of Product-TAT comparison for vegetables

S NO.	VEGETABLES	RESULT
1	Onion	Met logistic TAT for some or all ports
2	Tomato	Met logistic TAT for some or all ports
3	Eggplant	Did not meet logistics TAT for any port route
4	Cabbage	Met logistic TAT for some or all ports
5	Okra	Did not meet logistics TAT for any port route
6	Cucurbits	Did not meet logistics TAT for any port route
7	Cauliflower	Met logistic TAT for some or all ports
8	Tapioca	No perishability data available
9	Drumstick	No perishability data available
10	Ginger	Met logistic TAT for some or all ports
11	Sweet potato	Met logistic TAT for some or all ports

Among product-TAT comparison for all vegetables, perishability data for tapioca and drumsticks was unavailable therefore not considered for this step at all.

Cucurbits, eggplant and okra did not meet the logistical TATs to any of the ports in the selected CEZs from section 4.1.2.

All other vegetables met the logistical TAT criteria for all ports across the CEZ selection therefore could be shipped to all ports.

This summary of product perishability-route combination was further refined under step c in the next section, to arrive at products that were in oversupply (as defined in the methodology) in the selected CEZs for shipment to other CEZs.

4.1.2.3. Oversupply in the CEZ of production

To check oversupply of the CEZ-wise products shortlisted in criteria b, production per capita per month for the harvest months for each product was compared to their average consumption per month at the national level. First, the latest population data available from every district within the CEZ was listed (Table 47). Below is the population of all districts in the individual selected CEZs.

Table 47: District-wise population data under each selected CEZ[65]

	CEZ	State	Districts	Population
1	**Kutch**	Gujarat	*Kutch*	2,092,371
		TOTAL		**2,092,371**
2	**North Konkan**	Maharashtra	*Nashik*	6,107,187
			Thane	11,060,148
			Mumbai	3,085,411
			Pune	9,429,408
			Raigarh	2,634,200
		TOTAL		**32,316,354**
3	**Malabar**	Kerala	*Ernakulam*	3,282,388
			Alappuzha	2,127,789
			Kollam	2,635,375
			Thiruvananthapuram	3,301,427
		TOTAL		**11,346,979**
4	**Mannar**	Tamil Nadu	*Kanyakumari*	1,870,374
			Tirunelveli	3,077,233
			Thoothukudi	1,750,176
		TOTAL		**6,697,783**
5	**VCIC South**	Tamil Nadu	*Thiruvallur*	3,728,104
			Chennai	4,646,732
			Kancheepuram	3,998,252
		TOTAL		**12,373,088**
6	**VCIC North**	Andhra Pradesh	*Guntur*	4,887,813
			Krishna	4,517,398
			West Godavari	3,936,966
			East Godavari	5,154,296
			Visakhapatnam	4,290,589
			Vizianagaram	2,344,474
			Srikakulam	2,703,114
		TOTAL		**27,834,650**
7	**Suryapur**	Gujarat	*Dahej*	13495
			Hazira	16724
		TOTAL		**30219**

[65] *http://www.censusindia.gov.in/(S(ogvuk1y2e5sueoyc5eyc0g55))/Tables_Published/Basic_Data_Sheet.aspx*

Next, oversupply of the shortlisted products was determined. The production in kg in each selected CEZ was divided by the number of harvest months to arrive at average production per month (Table 48).

Table 48: Total per capita monthly product consumption (in kg) data for selected produce in urban areas in 2011-2012 [66]

Vegetable	Urban (kg/month)	Remarks
Potato	1.612	
Eggplant	0.358	Shall not be considered as it does not meet logistics TAT in terms of perishability
Onion	0.951	
Tomato	0.806	
Cucurbits	0.387	Shall not be considered as it does not meet logistics TAT in terms of perishability
Cabbage	0.271	
Tapioca	n/a	Perishability and consumption data not available
Cauliflower	0.326	
Okra	0.281	Shall not be considered as it does not meet logistics TAT in terms of perishability
Garlic	0.081097	
Ginger	0.07313	
Drumstick	n/a	Perishability and consumption data not available
Sweet Potato	0.009	Data of 2009-10 (2011-12 data not available)
Fruit	**Urban (kg/month)**	
Banana	1.07	Consumption of banana is 6.69 units /month/person. Assuming one banana weighs 0.16 kg, we take consumption in kgs. /month/person as 1.07 kg. (Assumption based on average weight of banana to be around 160 gms[67])
Mango	0.202	
Papaya	0.081	
Sapota	n/a	Consumption data not available
Grapes	0.084	
Lemon	0.123	Consumption of lemon is 2.117 units/month/person. Assuming the average weight of a lemon to be 0.058kgs, we take consumption in kgs./month/person as 0.123 kg[68]
Pomegranate	n/a	Consumption data not available
Coconut	0.755	Consumption of coconut is 0.755 units /month/person. Assuming one coconut weighs 1 kg, we take consumption in kgs. /month/person as 0.755 kg. (Assumption based on average weight of a coconut to be 1 kg/piece.[69])
Pome Fruits (Apple, Pears)	0.195	
Guava	0.088	
Jackfruit	0.008	
Date	0.015	
Pineapple	0.027	Consumption of Pineapple is 0.027 units /month/person. Assuming weight of one pineapple to be 1 kg, we take consumption in kgs. /month/person as 0.027kg. (Assumption based on average weight pineapple to be 1 kg.[70])
Indian Jujube	n/a	Consumption data not available

Products not considered going further are in red text in the table.

[66] http://mospi.nic.in/sites/default/files/publication_reports/Report_no558_rou68_30june14.pdf https://www.iivr.org.in/sites/default/files/Technical%20Bulletins/7.%20Vegetable%20Statistics.pdf
[67] http://www.foodstandards.gov.au/science/monitoringnutrients/ausnut/foodmeasures/Pages/-Fruits-and-vegetable-measures-program--data-table.aspx
[68] http://www.kgbanswers.co.uk/how-much-does-the-average-lemon-weigh/2155453
[69] http://www.clovegarden.com/ingred/coconut.html
[70] http://www.traditionaloven.com/foods/multi-units-converter/pineapple-raw-extra-sweet-variety.html

Since not all products grow throughout the year, the months in which the products are harvested and available in the market for selling are considered. This average production per month was then further divided by the population reflected in Table 47 to arrive at production per month per kg per person.

Above is the data with respect to per capita monthly consumption of the fruits and vegetables (in kg) at national level shortlisted in criteria b (Table 48). The remarks in the tables make it clear why a product was considered or eliminated going further. And the cases in which the data was available in numbers and not in kg, the calculation has also been explained.

Oversupply is said to occur when the production is double or more than the consumption quantity in harvest time.

For e.g. in CEZ Kutch, consumption of onion (all 12 months) x 2 = 1.90 kg/month/person; Production of onion in CEZ Kutch (also harvested all 12 months of the year) = 3.66 kg/month/person. The quantity of production was found to be higher than twice the consumption quantity, therefore onion was considered to be in oversupply in CEZ Kutch.

A summary specifying the CEZs, in which oversupply of fruits is observed, is presented below (Table 49).

Table 49: Summary of CEZs in which specific fruits were in oversupply

CEZs	**CEZ Kutch**	**CEZ Suryapur**	**CEZ North Konkan**	**CEZ Malabar**	**CEZ Mannar**	**CEZ VCIC South**	**CEZ VCIC North**
FRUITS							
Papaya	x	x		x			x
Date palm (date)	x						
Mango		x		x	x		x
Banana		x		x	x		x
Grapes			x				
Coconut				x	x	x	x
Pineapple				x			
Jackfruit					x		
Pomefruit (apple, pear)							
Guava							
Lemon							x

The summary of CEZs, in which specific vegetables were observed to be in oversupply, is presented below (Table 50).

Table 50: Summary of CEZs in which specific vegetables were in oversupply

CEZs	CEZ Kutch	CEZ Suryapur	CEZ North Konkan	CEZ Malabar	CEZ Mannar	CEZ VCIC South	CEZ VCIC North
VEGETABLES							
Onion	x		x				
Tomato	x	x	x				x
Cauliflower		x					
Ginger							
Sweet potato							
Cabbage	x						

The products resulting from step c were further explored across various combinations of routes by applying the criterion d pertaining to the undersupply of products in one or more of the selected CEZs.

4.1.2.4. Undersupply in one of the destination CEZs

Average monthly wholesale prices over the most recent three years were collated in one big city in the sourcing CEZ and destination CEZ each. As per criterion d in the methodology, the big city with the wholesale market must meet two conditions:

i. it must have a population of more than 1 million people;

ii. it should be situated within approximately 200 km to 300 km[71] of the production district.

The list of 17 such big cities that meet the criteria are listed below (Table 51).

[71] *The city could be in another CEZ, as stated in the methodology.*

Table 51: Big cities with population greater than 1 m with wholesale opportunities identified in each corresponding potential destination CEZ

Sr. No.	CEZ	States	List of Cities >1 m and within 200-300 km	Population
	Kutch	Gujarat	No city more than 1 m population within 200 km to 300 km	
1	Suryapur	Gujarat	Ahmedabad	5.6 million
2			Surat	4.5 million
3			Vadodara	2.1 Million
4			Rajkot	1.3 million
5	North Konkan	Maharashtra	Mumbai	18 million
6			Pune	3.1 million
7			Nashik	1.5 million
8			Vasai- Virar	1.2 million
9			Pimpri-Chinchwad	1.7 Million
10			Thane	1.9 million
11			Kalyan-Dombivli	1.2 million
12			Navi Mumbai	1.12 million
13	Malabar	Tamil Nadu	Coimbatore	1.6 million
14	Mannar	Tamil Nadu	Madurai	1.4 million
15	VCIC South	Tamil Nadu	Chennai	7.1 million
16		Puducherry	Puducherry	1.2 million
17	VCIC North	Andhra Pradesh	Visakhapatnam	2.0 million

Simultaneously, various routes between ports from the selected CEZs were also determined based on the port-wise connectivity available (Table 17 and Table 18).

Routes under scenario 1 based on port-to-port CEZ connectivity are listed below in Table 52:

Table 52: Routes inferred from connectivity Table 17 in Scenario 1

Origin	Destination
Kandla - Kutch	JNPT - North Konkan
Mundra - Kutch	JNPT - North Konkan
Mundra - Kutch	Kochi - Malabar
Mundra - Kutch	Tuticorin -Mannar
Mundra - Kutch	Kattupalli VCIC South
JNPT - North Konkan	Mundra - Kutch
Kochi - Malabar	Mundra - Kutch
Kochi - Malabar	Tuticorin -Mannar
Tuticorin -Mannar	Mundra - Kutch
Tuticorin -Mannar	Kochi - Malabar
Tuticorin -Mannar	Kattupalli VCIC South
Kattupalli VCIC South	Mundra - Kutch
Kattupalli VCIC South	Kochi - Malabar
Kattupalli VCIC South	Tuticorin -Mannar

Several route combinations in both Scenario 1 and 2 revealed that the distance between them by road can be traversed more swiftly than the time it would take for shipping by sea between many of these ports. For example, the road distance between Hazira port and JNPT port is 343.9 km, which can be covered in 5.7 hours. At 60 kmph speed as per the port-to-port transit times shared in Table 21 it would take almost a day using the short sea route from Hazira port to JNPT port. Similarly, the road distance between Kochi port and Tuticorin port is 320.6 km and can be covered at a speed of 60 kmph in 5.34 hours. The time taken via the sea route between Kochi port and Tuticorin port is also nearly 24 hours (Table 21).

Therefore, only the route combinations highlighted in yellow in the above Table 52 were taken into account for the purpose of this study.

Criteria d mandated that there must be at least one big city with a population of over 1 million within 200 km to 300 km from the production districts. The national census data revealed that not a single city that met the conditions above was in close proximity to the ports in Kutch – the only district in CEZ Kutch. However, as observed in Table 17 and Table 18, Mundra port enjoys extensive shipping connectivity with other ports across CEZs selected for this study. Therefore, for the purpose of this study, Mundra port was to be considered for districts of CEZ Suryapur (Rajkot is 254.3 km away) as an exception.

Routes based on port-to-port CEZ connectivity in Scenario 2 are listed below in Table 53.

Table 53: Routes inferred from connectivity Table 18 in Scenario 2

Origin	Destination
Mundra - Kutch	Hazira - Suryapur
Mundra - Kutch	JNPT - North Konkan
Mundra - Kutch	Kochi - Malabar
Mundra - Kutch	Tuticorin -Mannar
Mundra - Kutch	Kattupalli - VCIC South
Mundra - Kutch	Visakhapatnam - VCIC North
Mundra - Kutch	Kakinada - VCIC North
Hazira - Suryapur	Mundra - Kutch
Hazira - Suryapur	JNPT - North Konkan
JNPT - North Konkan	Mundra - Kutch
Kochi - Malabar	Mundra - Kutch
Kochi - Malabar	Hazira - Suryapur
Kochi - Malabar	Tuticorin -Mannar
Tuticorin -Mannar	Mundra - Kutch
Tuticorin -Mannar	Hazira - Suryapur
Tuticorin -Mannar	Kochi - Malabar
Tuticorin -Mannar	Kattupalli VCIC South
Tuticorin -Mannar	Visakhapatnam - VCIC North
Kattupalli VCIC South	Mundra - Kutch
Kattupalli VCIC South	Kochi - Malabar
Kattupalli VCIC South	Tuticorin -Mannar
Vizag - VCIC North	Mundra - Kutch
Vizag - VCIC North	Kochi - Malabar
Vizag - VCIC North	Tuticorin -Mannar
Vizag - VCIC North	Kattupalli VCIC South

Routes highlighted in yellow in both scenarios were thus noted to be logistically most viable for short sea shipping, even though shipping connectivity exists in all cases. Based on these routes it was clear that the shipping route modality for produce in oversupply in Suryapur CEZ could be explored to CEZs Malabar, Mannar, VCIC South and VCIC North. Additionally, produce in oversupply from these CEZs to CEZ Suryapur could also be explored for short sea shipping based on price differences between the origin and destination markets.

Table 45 and Table 46 in criteria c list the fruits and vegetables that will survive the logistical turnaround time and are also in oversupply and shall be considered. This led to the consideration of banana, mango, cauliflower and tomato for supply from CEZ Suryapur to other selected CEZs. Mango was eliminated from consideration for development or implementation since its season had passed for the implementation time duration of this project. Thus, banana, cauliflower and tomato were the remainder products for consideration.

The methodology for this project considered wholesale prices in calculating the price difference between the origin and destination markets to deduce presence of opportunities.

As per the criterion d, destination CEZ markets had to have a price difference in the monthly price averages of at least INR 1,000 /quintal in order for the product to be considered for supply from the origin CEZ. Results of the analysis of these product-route combinations (PRCs) are presented in Table 54 to Table 57 below.

The price difference is a necessary condition for the determination of undersupply in the destination CEZ.

The sourcing CEZ particularly must be within approximately 200 km to 300 km distance from the main production area. The large wholesale market at the destination CEZ must also be approximately 200 km to 300 km from the port.

For banana, in the destination markets, data was only available for one month in the case of CEZ Malabar, no data was available for CEZ Mannar and CEZ VCIC South. Those routes were therefore not considered for the shipping of banana.

Therefore, the shipping route between CEZ VCIC North and CEZ Suryapur (Table 54) was explored.

Table 54: Comparison of monthly average prices of banana in CEZ VCIC North and CEZ Suryapur.

	Average price (INR/Quintal)		**Price difference (INR/Quintal)**
Month	**Visakhapatnam**	**Vadodara**	
JAN	123.95	1218.08	
FEB	113.69	1006.93	
MAR	136.39	934.17	
APR	118.76	1030.89	
MAY	128.76	998.78	
JUN	1060	111.78	
JUL	575	595.23	
AUG	190.57	914.29	
SEP	180	809.1	
OCT	161.2	898.02	
NOV	135.71	1151.26	
DEC	144.89	1217.64	
TOTAL PRICE	**2878.35**	**10886.17**	
Avg monthly price	**239.86**	**907.18**	**667.32**

Comparison of both wholesale markets reveals that the average price difference for banana between them was less than 1000 INR per quintal and therefore does not meet the criteria. The PRC was therefore not considered.

For tomato supply from CEZ Suryapur to other CEZs, data availability was only for one month in the case of CEZ Malabar and CEZ VCIC South, and for two months in CEZ Mannar. These PRCs were also therefore dropped.

Next, prices between the wholesale markets in CEZ VCIC North and CEZ Suryapur for tomato were compared (Table 55).

Table 55: Comparison of monthly average prices of tomato in Visakhapatnam in CEZ VCIC North and in Vadodara in CEZ Suryapur.

	Average price (INR/Quintal)		**Price difference (INR/Quintal)**
Month	**Visakhapatnam**	**Vadodara**	
JAN	820.96	115.42	
FEB	-	775.04	
MAR	850	177.17	
APR	850	66.78	
MAY	1088.71	231.11	
JUN	1419.55	480.63	
JUL	1056.81	923.41	
AUG	678.84	422.58	
SEP	802.3	104.85	
OCT	806	93.51	
NOV	666	744.79	
DEC	879.46	78.1	
TOTAL PRICE	9918.63	**4213.39**	
Avg monthly price	**901.69**	**351.12**	**550.57**

Prices between CEZ VCIC North and CEZ Suryapur (Table 55) were compared and the price difference was found, once again, to be less than 1000 INR again, so this PRC was dropped too.

For the supply of cauliflower from CEZ Suryapur to other CEZs, data was not available for CEZ Malabar, CEZ Mannar and CEZ VCIC North to ascertain the price difference against their destination markets. In VCIC South, data was only available for a month in one year. This PRC was therefore eliminated altogether as well.

Here onwards, produce in oversupply from CEZ Malabar, CEZ Mannar, CEZ VCIC South and VCIC North were considered for shipment to CEZ Suryapur.

In CEZ Malabar, coconut, banana, mango and pineapple were considered for shipment to CEZ Suryapur. Data for pineapple was not available, and so was not considered for price comparison. Only a month's data was available for banana; and as stated earlier, the season for mango had already passed. Therefore, the only produce that could be considered for supply from CEZ Malabar to CEZ Suryapur was coconut.

Table 56: Comparison of monthly average prices of coconut in Coimbatore in CEZ Malabar and in Surat in CEZ Suryapur.

	Average price (INR/Quintal)		**Price difference (INR/Quintal)**
Month	**Coimbatore**	**Surat**	
JAN	1016.67	16483.33	
FEB	1109.01		
MAR	1084.71	13915.29	
APR	1109.66	14888.89	
MAY	1203.33	3176.91	
JUN	1174.34		
JUL	1195.15	20554.06	
AUG	1217.41	21282.59	
SEP	1224.82		
OCT	1322.82	19569.75	
NOV	1172.72	18104.21	
DEC	1273.56		
TOTAL PRICE	14104.2	127975.03	
Avg monthly price	**1175.35**	**15996.88**	**14821.53**

This PRC appeared attractive, however, the price information available for coconut in CEZ Suryapur was dated. Data with respect to current prices of coconut in CEZ Suryapur was therefore taken into consideration for comparison between the origin wholesale market in CEZ Malabar and destination CEZ Suryapur (Table 56).

When the average price of coconut in CEZ Malabar (INR 1175.35) and CEZ Suryapur's current price for coconut (2400 INR[72]/month/quintal)[73] was compared, the price difference was approximately 1225 INR, which was still higher than 1000 INR per quintal – allowing the PRC to meet criterion d.

In CEZ Mannar mango, banana, coconut, and jackfruit were eligible for shipment to CEZ Suryapur. However, price data for banana and jackfruit wasn't found and the season for mango had passed, as mentioned earlier.

[72] *The weight of each coconut is approximately 1kg and the price per coconut was 24 INR. A quintal is 100 kg, therefore price for a quintal was (100* 24=) 2400 INR, Appendix 17*

[73] https://www.apmcahmedabad.com/ , http://www.wholesalehub.in

Therefore, the shipment of coconut from CEZ Mannar to CEZ Suryapur was considered (Table 57).

Table 57: Comparison of monthly average prices of coconut in Madurai in CEZ Mannar and in Surat in CEZ Suryapur

	Average price (INR/Quintal)		**Price difference (INR/Quintal)**
Month	**Madurai**	**Surat**	
JAN			
FEB			
MAR	6300.95	8699.05	
APR	6266.67	9731.88	
MAY	5593.75	-1213.51	
JUN	5838.69		
JUL	5637.5	16111.71	
AUG	5770	16730	
SEP	5666.76		
OCT	6375.03	14517.54	
NOV	3644.96	15631.97	
DEC	4347.5		
TOTAL PRICE	55441.81	80208.64	
Avg monthly price	**5544.18**	**11458.38**	**5914.20**

When the average price of coconut in CEZ Mannar (INR 5544.18) and CEZ Suryapur (11458.38 INR) and the current price for coconut (2400 INR) in CEZ Suryapur were compared, the price in CEZ Suryapur was determined to be lower by 3144.18 INR with respect to current pricing. Hence, as the price in the destination CEZ is already lower than the price in origin, the PRC was not considered.

In CEZ VCIC South, only coconut and mango were found to be in oversupply. But mango was not to be considered due to the harvest season and data for coconut was not available. This PRC was therefore not considered.

In CEZ VCIC North, coconut, banana, mango and tomato could have been considered for supply to CEZ Suryapur. However, since Mango season would have passed by the implementation time for the project, comparisons for banana (Table 54) and tomato (Table 55) and have already been made and the PRCs found unviable due to a price difference lower than INR 1000 per Quintal, data for coconut was scarce and available for only three months, this PRC was also entirely dropped.

The analyses of these product routes reveal that CEZ Malabar-CEZ Suryapur for coconut was the only PRC to meet criterion d. Figure 13 below is a visual representation of the selected PRC.

Figure 13: Route map of PRC: CEZ Malabar to CEZ Suryapur by short sea shipping route

The map above shows the route from the source CEZ Malabar to the destination CEZ Suryapur, including the wholesale markets in or nearest to the respective CEZs.

The PRC selected for further analysis is shown in Table 58 below.

Table 58: Selected PRC for further analysis

Origin CEZ	Origin Port	Origin State	Destination CEZ	Destination Port	Destination State	Product
Malabar	Kochi	Kerala	Suryapur	Hazira/Mundra	Gujarat	Coconut

With the identification of a viable PRC the process of product selection is completed. Fruits and vegetables with sufficient shelf life were shortlisted. Of these products, there had to be abundance in a certain CEZ with a well-connected port and a shortage in certain other CEZs with an attractive port.

In the next section, potential markets and farmers for the PRC were identified and scored to arrive at attractive Farmer-Market Combinations (FMCs) for further supply chain design and evaluation. But in this section at least an initial feasibility check was explored from transportation costs and product loss perspectives.

4.1.3. Initial feasibility check

In this section, the cost feasibility of short sea shipping for the selected PRC is analysed. Additionally, its competitiveness is deduced in comparison with road transport – both, ambient trucks as well as reefer vans – in terms of costs, lead time and product losses.

4.1.3.1. Financial feasibility

Cost feasibility of short sea shipping of coconut was determined by comparing wholesale market prices at CEZ Malabar (origin) with prices at CEZ Suryapur (destination) where the product in oversupply is to be sold.

First, the logistics costs for various modes of transport from farm in CEZ Malabar to buyer in CEZ Suryapur were listed (Table 59).

Table 59: Cost of ambient truck, reefer van and short sea shipping from farm in CEZ Malabar to buyer in CEZ Suryapur

Mode of Transport	**Amount (INR)**
Ambient transport - 19-ton of truck load	148000[74]
Reefer transport - 19-ton truck load	222000[75]
Short sea Shipping – 40-ft reefer container[76]	186860[77]

Since the coconuts will be under refrigeration in the case of reefer van and short sea shipping, it is assumed that there shall be no loss incurred on the produce. Therefore, only product loss in the case of ambient trucking was calculated (Table 60).

[74] *http://www.truckbhada.com*
[75] *Assumed at 1.5x cost of ambient trucking*
[76] *Appendix 20*
[77] *Appendix 17*

Table 60: Loss incurred in the case of ambient trucking from farm in CEZ Malabar to buyer in CEZ Suryapur (refer Table 59 for assumption of base capacity)

Loss of produce in road transit	
Loss of produce suffered in ambient road transport currently being used is 10% of total weight in kg	1900
Loss in INR, on sale price @24000 INR per ton	45600
Loss value added to the cost of ambient transport, total cost of ambient road transport in INR	193600

When total loss of produce in ambient trucking is added to its cost, the total expense to the buyer is at 193600 INR.

4.1.3.2. Competitiveness

Price difference between the wholesale markets at CEZ Malabar and CEZ Suryapur is 1225 INR per Quintal as seen in criterion d (Table 56). Basis this amount the additional earning per ton and total earnings for 19 tons of coconut are listed below in Table 61.

Table 61: Additional earnings for the former using short sea shipping to transport the 19 tons of coconuts from CEZ Malabar to CEZ Suryapur

Cost Feasibility Analysis for Short Sea Shipping from farm in CEZ Malabar to buyer in CEZ Suryapur	**Amount (INR)**
Price difference between CEZ Malabar and CEZ Suryapur Markets for Coconut **Per Quintal**	1225
Price difference between CEZ Malabar and CEZ Suryapur **Per ton** (1 ton = 10 quintal)	12250
Total additional earning for seller for 19 tons of coconut	232750
Cost of Short Sea Shipping for 40 ft. reefer container	186860
Net additional earning for 19 ton of coconuts using short sea shipping	45890
Per ton additional earning for farmer	2415

Transit time from CEZ Malabar to CEZ Suryapur by road (ambient trucking as well as reefer van) would take about 7-8 days, whereas the sea route would take 10 days (Table 21). As observed in the above table, despite the marginally longer transport time, the cost of transporting coconuts by short sea shipping is less than the additional profits earned by the farmer from the PRC transaction. Therefore, there is a net earning of INR 2415 per ton (INR 2.66 per kg) for the farmer after deducting all costs.

In addition, with economies of scale there is further opportunity to avail lower shipping costs using the short sea route as the vessel can carry more than one container, whereas the cost reduction opportunity in road transport (both ambient and cold) is unavailable with rising fuel costs.

Additionally, there is no loss of produce in transit in the redesigned supply chain using the short sea shipping method, whereas in the case of only ambient transport 10% loss is expected. Given the short supply of reefer road transport vehicles in India, there is a high probability of unavailability of the same when needed and the farmer may miss the market opportunity or buyer commitment.

4.2. Selection of farmer-market combinations

In the previous phase of this study, the product route combination of transporting coconuts via the short sea shipping route from CEZ Malabar to CEZ Suryapur was selected as the PRC input for this phase of the study.

Figure 14: Route map of PRC: CEZ Malabar to CEZ Suryapur by short sea shipping route

CEZ Suryapur falls in the western-most state of India, Gujarat. The dry coconut or 'copra' is used as a food item and as holy offering in shrines and on special occasions across the country. However, 10 per cent of the total production of coconuts in India is consumed in its tender form. This form of the fruit is a source of coconut water, which is a popular thirst quencher known to possess health and hygienic value and is a popular agrarian business. Virgin coconut oil is also extracted from the fresh kernel without any chemical processing, in turn boasting of rich vitamins, minerals and anti-oxidants, therefore making it a popular oil – whether for cosmetic, food, or industrial use. Most production of coconut is purchased by traders, wholesalers or online retailers. Major urban wholesale markets within the stipulated 200-km to 300-km distance of CEZ Suryapur include Rajkot, Ahmedabad, Vadodara and Surat cities.

An approach guided by the market demand was used to arrive at the most attractive farmer-market combinations after matching market players and farmers who produce/aggregate the coconut crop. The chief operatives within this approach comprise characteristics of the markets, and requirements of the markets that would make them most attractive for the implementation of this methodology.

In the next section, market players who may be willing to procure coconut from CEZ Malabar are identified. To ensure confidentiality as per the request of market players as well as farmers, in this sections of determining farmer-market combinations, pseudo names are used.

4.2.1. Market research

4.2.1.1. Identification of market players

With reference to the product route combination considered promising, various market players were identified in the western part of India, in the 200-km to 300-km area from CEZ Suryapur as defined in the methodology.

The Gujarat market comprises several players selling coconut. To ensure that farmer-market combinations calculated were inclusive of the various market opportunities available to the farmer, various types of market representatives were interviewed (Table 62). Interviews were conducted with market players in Rajkot, Ahmedabad, Vadodara and Surat cities of Gujarat and the Mumbai Metropolitan area.

Even though the market players in the Mumbai Metropolitan Area were not within the stipulated 200-km to 300-km distance from Mundra Port in the destination CEZ Suryapur, they are close to the distance from Hazira Port[78] as it was also concluded to be a possible option for destination in the route selection. Additionally, the shipping line operating the fleet from Kochi port to Mundra also makes a stop at Hazira Port.

[78] *On-land distance from Hazira port to Mumbai is 308.2 km.*

The identified market players expressed interest in additional suppliers of coconuts, and in sourcing the product through short sea shipping transportation.

Wholesale markets, traders, online retail chains in urban areas, retailers, foodservice companies and other outlet organizations corresponding to the potential destination of CEZ Suryapur were identified by interviewing market representatives of the same.

Table 62 Identified market players for coconut corresponding to the destination CEZ Suryapur [79].

Stakeholder type	**Name of Market**	**Location**
Online Retailer	Farmfresh	Mumbai
Online Retailer	Go2fresh	Mumbai
Wholesaler	Sameer	Surat
Wholesaler	LPO	Surat
Wholesaler	Patidar Traders	Ahmedabad
Wholesaler	Sun Traders	Ahmedabad
Wholesaler	Triumph Traders	Ahmedabad
Wholesaler	PP Enterprises	Rajkot
Wholesaler	Gopal Coconut	Vadodara

The identified number of market players was nine. Of these, seven were wholesalers and two were online retailers.

Of these shortlisted, six players (all wholesalers) were unable to purchase large quantity beyond 2 MT, whereas the quantity carried by the 20-ft container is approximately 19 MT. These players were therefore not considered for the purpose of determining the farmer-market combination.

One of the wholesalers from Gujarat, and the two online retailers from the Mumbai Metropolitan area expressed interest to purchase the stipulated minimum quantum. They also displayed willingness to enter into long-term partnerships based on assured delivery and consistent quality of produce and reliable constant supply apart from competitive pricing.

Below are the market players that were identified for the purpose of this study for conducting the farmer-markets match analysis.[80]

[79] *For the purpose of maintaining confidentiality of stakeholders, all names have been changed to pseudo-names.*
[80] *Appendices 2, 3, and 4*

Table 63 Shortlisted market players for coconut corresponding to the destination CEZ Suryapur.

Stakeholder type	Name of Market	Location
Online Retailer	Farmfresh	Mumbai
Online Retailer	Go2fresh	Mumbai
Wholesaler	Sameer	Surat

As stated in the methodology, the aim was to find sufficient market players to be able to identify the most promising farmer-market combinations3.2.3.

After potential market players were shortlisted, the attractiveness of these market players was sought to be identified through a second round of interviews.

4.2.1.2. Determination of market player attractiveness

As referred to in the methodology, markets were measured based on a range of criteria (e.g. information sharing, payment, like to add products, etc.). The category of (potential) markets (e.g. wholesalers, online retailers, etc.) as well as the importance they attached to each of these criteria was determined. Based on consensus among the various stakeholders, weightages were assigned to each of these criteria that can help in the redesign of the supply chain.

Weightage of the criterion affects the final score. Attractiveness of the market is thus determined based on whether high weightage criteria are adequately fulfilled.

Apart from the type of supplier from whom the market players sourced their products, below is the list of relevant criteria considered for the measurement and scoring of market players:

Information Sharing:
What type of information was shared by this market player with their partners at and until the time of the interview? (E.g. None, Rejected, Indent, Order, or Planning)

Payment:
How did the market player want to pay the purchase price to its supplier(s) and when? (E.g. online after 15 days, cash after 15 days, online transfer, immediate cash, or advance payment)

Sales/Purchase Price:
Which were the expected sales and purchase prices of the considered product at the time of the interviews? (E.g. less than market price, market price, average price, or more than market price)

Sourcing Period:
For market players, during which calendar period was the considered product sourced at the time of the interviews? (E.g. not confirmed, after 15 days, after a week, after 4 days, or immediate)
As shortlisted market players indicated during the interviews that they sourced coconuts throughout the calendar year, this criterion is irrelevant. Therefore, this criterion was not scored and excluded from the results and analyses.

Trend of Sales:
Which sales trend existed during the sourcing period? (E.g. decreasing, fluctuating, stable, slightly increasing, or increasing)

Volume Estimate per Week:
What was the estimated volume of the considered product that the market player expected to sell in the specific time period pertaining to this study? (e.g. 500 pieces, 1000 pieces, 2800 pieces, 3500 pieces, or 5000 pieces)

Sourcing Stakeholders:
Varied sourcing players are identified under this parameter to determine which markets buy from which suppliers along the supply chain. (E.g. online retailers, trader, wholesaler, aggregator, or farmer)

Like to Add Products:
This criterion helps to identify if the market is expecting to procure more variety of the same produce. (E.g. none, one, or more than 1)

In the table below, a uniform scoring range (0-4) is assigned to each possible answer corresponding to each of these criteria.

Table 64 Uniform scoring range with each possible answer corresponding to each criterion with the score assigned.

Criteria	Scoring range				
	0	1	2	3	4
Info sharing	None	Rejected	Indent	Order	Planning
Payment	online after 15 days	cash after 15 days	online transfer	Imm. Cash	adv. Payment
Sales/ purchase price	less than market	Market price	-	Average price	more than market price
Trend of sales	Decreasing	Fluctuating	Stable	Slightly increasing	Increasing
Volume est. per week	500 pcs	1000 pcs	2800 pcs	3500 pcs	5000 pcs
Sourcing stakeholders	online retailers	trader	wholesaler	aggregator	farmer
Like to add products	none	-	one	-	more than 1

As indicated in the methodology, for the scoring and determination of the overall market player attractiveness, the following set of steps included:

1. The range of possible answers to each criterion was determined;
2. Possible answers with respect to attractiveness were arranged L to R- least to most attractive;
3. A score to each possible answer (where 0 is least attractive and 4 is most attractive) was assigned;
4. Weightage to each criterion was assigned;
5. During the interviews of the market players, this information was also collected.
6. The answers received from the market players were scored in order to determine their attractiveness (sum of weighted scores).

Below are the scores tabulated and represented as per the example in the methodology. Each table corresponds to one market player of the three considered to be sufficiently attractive and selected for the determination of the market player requirements. The scoring has been carried out based on the ranges defined (also mentioned in the table below) and the weighted sum calculations of the relevant criterion scores of the three market players.

Table 65 Determination of market attractiveness of online retailer, FARMFRESH

	Scoring range					WEIGHTAGE	FARMFRESH	WEIGHTED SCORE	MAX SCORE	MAX. WEIGHT
Criteria	**0**	**1**	**2**	**3**	**4**			(H*I)		(H*K)
info sharing	None	Rejected	Indent	Order	Planning	2	4	8	4	8
payment	online after 15 days	cash after 15 days	online transfer	Imm. Cash	adv. Payment	3	0	0	4	12
Sales/ purchase price	less than market	Market price	-	Average price	more than market price	3	3	9	4	12
Trend of sales	Decreasing	Fluctuating	Stable	Slightly increasing	Increasing	1	2	2	4	4
volume est. per week	500 pcs	1000 pcs	2800 pcs	3500 pcs	5000 pcs	2	4	8	4	8
sourcing stakeholders	online retailers	trader	wholesaler	aggregator	farmer	3	3	9	4	12
like to add products	none	-	one	-	more than 1	1	4	4	4	4
TOTAL								**40**		**60**
MARKET ATTRACTIVENESS (%) (Wt Score/ Max Wt)										**67%**

The total weighted score calculated for FARMFRESH is 40 and the maximum weighted score is 60. Its market attractiveness is therefore 67% (40/60).

Table 66 Determination of the overall attractiveness of GO2FRESH.

Criteria	Scoring range 0	1	2	3	4	WEIGHTAGE	GO2FRESH	WEIGHTED SCORE (H*M)	MAX	MAX. WEIGHT (H*O)
info sharing	None	Rejected	Indent	Order	Planning	2	4	8	4	8
payment	online after 15 days	cash after 15 days	online transfer	Imm. Cash	adv. Payment	3	0	0	4	12
Sales/ purchase price	less than market	Market price	-	Average price	more than market price	3	3	9	4	12
Trend of sales	Decreasing	Fluctuating	Stable	Slightly increasing	Increasing	1	2	2	4	4
volume est. per week	500 pcs	1000 pcs	2800 pcs	3500 pcs	5000 pcs	2	2	4	4	8
sourcing stakeholders	online retailers	trader	wholesaler	aggregator	farmer	3	3	9	4	12
like to add products	none	-	one	-	more than 1	1	4	4	4	4
TOTAL								**36**		**60**
MARKET ATTRACTIVENESS (%) (Wt Score/ Max Wt)										**60%**

The total weighted score calculated for GO2FRESH is 36 and the maximum weighted score is 60. Its market attractiveness therefore stands at 60% (36/60).

Table 67 Determination of the overall attractiveness of WHOLESALER-SAMEER

Criteria	Scoring range 0	1	2	3	4	WEIGHTAGE	WHOLESALER & Trader	WEIGHTED SCORE (H*Q)	MAX	MAX. WEIGHT (H*W)
info sharing	None	Rejected	Indent	Order	Planning	2	2	4	4	8
payment	online after 15 days	cash after 15 days	online transfer	Imm. Cash	adv. Payment	3	3	9	4	12
Sales/ purchase price	less than market	Market price	-	Average price	more than market price	3	3	9	4	12
Trend of sales	Decreasing	Fluctuating	Stable	Slightly increasing	Increasing	1	1	1	4	4
volume est. per week	500 pcs	1000 pcs	2800 pcs	3500 pcs	5000 pcs	2	1	2	4	8
sourcing stakeholders	online retailers	trader	wholesaler	aggregator	farmer	3	3	9	4	12
like to add products	none	-	one	-	more than 1	1	2	2	4	4
TOTAL								**36**		**60**
MARKET ATTRACTIVENESS (%) (Wt Score/ Max Wt)										**60%**

The total weighted score calculated for WHOLESALER-SAMEER is 36 and the maximum weighted score is 60. Its market attractiveness is also 60% (36/60).

The summary of percentage scores is presented in the below table.

Table 68 Determination of overall attractiveness percentage of the interviewed market players

Stakeholder type	Market	Percentage (%)
Online Retailer	Farmfresh	67%
Online Retailer	Go2fresh	60%
Wholesaler	Sameer	60%

While GO2FRESH and the WHOLESALER – SAMEER, both have scored identical market attractiveness, FARMFRESH has higher market attractiveness at 67%.[81]

4.2.1.3. Determination of market player requirements

Since this study takes a market-driven approach, product and logistical requirements are considered from the perspective of the market players to determine the most attractive farmer-market combinations.

Below is the list of relevant market requirements, with explanation, considered for the measurement and scoring of the market players:

Product Variety and Label:
This parameter specifies the variety in which the fruit is required – brown coconut or tender coconut and the label if need be.

Product Requirement:
This parameter identifies what are the exact expectations from the market for product specifications, such as high water-content, minimum scars, natural green colour, etc. for produce.

Delivery Acceptance Logistics:
This parameter identifies how the market deals with delivery of produce - whether it accepts or rejects the produce based on what the farmer is able to deliver.

Delivery Frequency:
This parameter identifies different options of delivery frequency as expected by the market and how it matches with farmer's intention and capability of delivering the product when the market needs it – whether on demand, once a week, twice a week, three times a week, or daily.

[81] *Please note that the conclusion related to these figures is presented in paragraph 4.2.3.1 because it cannot be evaluated in isolation, but in correspondence to the result in the section on match analysis.*

Mode of Transport:
Different modes of transport as expected by the market and as used by the farmer are matched through this parameter - own transport (bike, auto, vans), part truck, tempo, open/ closed trucked.

Packaging:
This parameter identifies either of the two types of packaging prevalent and expected by each market player and what the farmer can offer, i.e. loose cargo, vinyl bag or brown jute bag.

Sourcing Region:
This is a necessary parameter that compares the different options of distances at which the farms are located from the markets for tender coconuts. However, the product-route combinations were evaluated and CEZ Malabar to CEZ Suryapur was already concluded at the end of the product-route selection. The sourcing region is therefore not applicable as a parameter for the remainder of this study and therefore not scored and excluded from the results and analysis.

Like to Add Products:
This parameter helps to identify if the market is expecting to procure more variety of the same produce. E.g. none, one, or more than one.

The table below shows the scoring range assigned to each possible answer, where 0 is for the minimum requirement with least effort and investment, and 4 stands for the highest requirement with proportionate effort and monetary value.

Table 69 Scoring range assigned to each possible answer for market requirement criteria

Criteria	Scoring range				
	0	1	2	3	4
Product variety and label	-	-	Brown coconut	-	Tender coconut
Product requirements	No empty /dry nuts	Green natural in colour & Tender	10% to 20% scar on skin	0% to 10%scar on skin	300-400 ml water content
Delivery acceptance logistics	Rejected	-		-	Accepted
Delivery frequency	On call	Weekly	twice a week	3 days in a week	Daily
Way of transport	-	Own transport (Bike, Auto, Vans)	Part truck	Tempo	Full truck load (Open / Close)
Packaging	Loose cargo	-	white vinyl bag		jute bag
Like to add products	none	-	one	-	more than one

The table below illustrates the scores of each shortlisted market player for the market requirements considered most vital.

Table 70 Score of Market Requirements pertaining to each shortlisted market player

	Scoring range					Online Retailer	Online Retailer	Wholesaler
Criteria	**0**	**1**	**2**	**3**	**4**	**FARMFRESH**	**GO2FRESH**	**Sameer**
Product variety and label	-	-	Brown coconut	-	Tender coconut	4	4	4
Product requirements	No empty /dry nuts	Green natural in colour & Tender	10% to 20% scar on skin	0% to 10%scar on skin	300-400 ml water content	4	4	4
Delivery acceptance logistics	Rejected	-		-	Accepted	4	4	4
Delivery frequency	On call	Weekly	twice a week	3 days in a week	Daily	3	1	1
Way of transport	-	Own transport (Bike, Auto, Vans)	Part truck	Tempo	Full truck load (Open / Close)	4	4	3
Packaging	Loose cargo	-	white vinyl bag		jute bag	0	0	4
Like to add products	none	-	one	-	more than one	4	4	2

As per the methodology, these market player requirements and their scores were input for the match analysis in Section 4.2.3.

4.2.2. Farmer research

As per the results of the product-route selection, the produce considered for shipment is coconut and the product-route combination considered most efficient was from origin CEZ Malabar to destination CEZ Suryapur. In the previous section, the market requirement of tender coconut was identified as Product Variety required by the market players. Therefore, two farmers were identified as potential suppliers of tender coconut in the Malabar region – one in Palakkad and one in Nettoor – both in the state of Kerala (Figure 14) who had the potential to meet the methodology criteria.

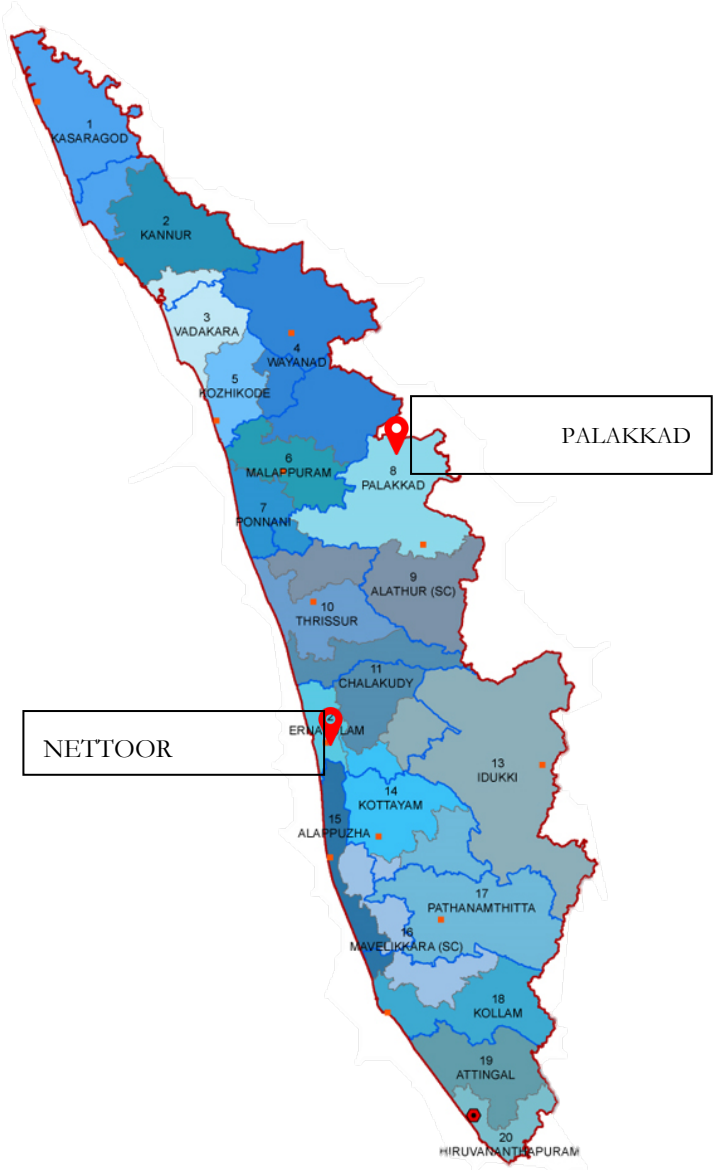


Figure 15 Map of Kerala

4.2.2.1. Identification of farmers

The below table lists the farmers identified and who are willing to enter in a long-term partnership with a market player for transportation through the short sea shipping method for the supply of tender coconut. The production areas lie within approximately 200 km to 300 km distance from the source CEZ Malabar in the southern part of the west coast of India in the state of Kerala.

Table 71 Producers of tender coconuts identified for the study

Stakeholder type	Name of Producer	Location
Farmer & Aggregator	AAR	Palakkad
Farmer	Manu	Nettoor

A decline in production of tender coconut was observed in Kerala and other South Indians states this year, attributed to deficient monsoon in the two previous seasons. Cultivators in Kerala (in CEZ Malabar) were said to be at the receiving end as they depend on the rains for the yield of tender coconuts.[82] Palakkad, which contributes around 12-14 per cent of Kerala's coconut production, witnessed a drastic drop in production due to the drought.[83]

In July 2016, an invasive crop pest – the white fly - was known to have infested coconut groves across Kerala rapidly affecting the production of tender coconuts significantly. The pest was observed to have spread swiftly when the weather was warm and humid.[84]

Given the above two factors, the Coconut produce quantity needed for this project for this specific year was available in comparatively less supply than other years. Therefore less number of farmers or aggregators were able to source the quantum of 19 tons of coconut,

During the market research process, the market requirements had already been deduced. In order to fulfil these requirements, it was a prerequisite of the selected market players that farmers possessed aggregator skills such as sorting, grading and knowledge of packaging as per market player specifications. A second prerequisite of the market players was the ability to communicate in the same language. This was considered important with regards to building trust among both supply chain actors. AAR possessed both these skills[85], and was the only farmer found interested in supplying the minimum quantum of tender coconut and setting up a short sea shipping supply chains. Therefore, AAR was chosen as the farmer for this study.

AAR also met the other the criteria on farmer selection. AAR was:

- capable of selling sufficient (consolidated) volume for short sea shipping, i.e. quantity corresponding to minimal one 20-foot container per customer order (approx. 19 MT);
- fulfilling the condition of taking a market driven approach to supply chain focusing on the market player instead of selling to the nearest (wholesale) market;

[82] http://www.newindianexpress.com/cities/kochi/2017/may/09/coconut-production-on-a-downward-spiral-1603008.html
[83] http://www.thehindubusinessline.com/economy/agri-business/drought-shrinks-coconut-output-in-south-india/article9578040.ece
[84] http://www.thehindu.com/news/cities/bangalore/Whiteflies-plaguing-coconut-plantations-in-south-India/article16794064.ece
[85] Appendix 25

- ensures that the quality specifications of the market player are met sufficiently and consistently apart from providing competitive prices.

4.2.2.2. Determination of farmer status

The current status of the farmer was determined in the context of market player criteria.

Since the study takes a market driven approach, the farmer was expected to meet market player criteria for product variety and label, quality and logistical specifications. The scaling of scores for the farmer corresponding to market player requirement criteria has been done separately.

Below is the resultant table based on the scoring range for market requirement criteria for AAR.

Table 72 Uniform scoring range for farm aggregator assigned to each possible answer corresponding to each criterion.

Criteria	Scoring range					
	0	1	2	3	4	
						AAR
Product variety and label	-		Brown coconut		Tender coconut	4
Product requirements	No empty /dry nuts	Green natural in colour & Tender	10% to 20% scar on skin	0% to 10%scar on skin	300-400 ml water content	4
Delivery acceptance logistics	Rejected	-		-	Accepted	4
Delivery frequency	On call	Weekly	twice a week	3 days in a week	Daily	3
Way of transport	-	Own transport (Bike, Auto, Vans, bullock cart)	small truck	Tempo	Full truck load (Open / Close)	2
Packaging	Loose cargo	-	white vinyl bag		jute bag	0
Like to add products	none	-	one	-	more than one	4

Individual score of AAR corresponding to market players, FARMFRESH, GO2FRESH and SAMEER is given in Table 73.

Table 73 Individual scores of AAR corresponding to individual market player requirements

Criteria	Scoring range 0	1	2	3	4	Online Retailer FARMFRESH	Online Retailer GO2FRESH	Wholesaler /trader Sameer
Product variety and label	-	-	Brown coconut	-	Tender coconut	4	4	4
Product requirements	No empty /dry nuts	Green natural in colour & Tender	10% to 20% scar on skin	0% to 10%scar on skin	300-400 ml water content	4	4	4
Delivery acceptance logistics	Rejected	-		-	Accepted	4	4	4
Delivery frequency	On call	Weekly	twice a week	3 days in a week	Daily	3	1	1
Way of transport	-	Own transport (Bike, Auto, Vans)	Part truck	Tempo	Full truck load (Open / Close)	4	4	3
Packaging	Loose cargo	-	white vinyl bag		jute bag	0	0	4
Like to add products	none	-	one	-	more than one	4	4	2

Similar to market requirements, these farmer characteristics were also considered as input for the match analysis in section 4.2.3.

4.2.3. Match analysis

In both the market identification (4.2.1.1) and the farmer identification (4.2.2.1), interviews and considerations have led to the deselection of some farmers and markets. Three market players and one farmer are still considered as potential supply chain participants. Therefore, match analysis of three farmer-market combination (FMCs) were performed.

Table 74 Three farmer-market combinations (FMCs) included in match analysis

Farmer / Market	FARMFRESH	GO2FRESH	SAMEER
AAR	FMC1	FMC2	FMC3

4.2.3.1. Identification of the 'best match'

The 'best match' (most promising FMC) is identified by:

1) Listing for each FMC, the quantitative difference for each market requirement (market score – farmer score = GAP score);
2) Weighing each market criterion and multiply with the GAP scores to gain the weighted GAP scores;
3) Adding the sum of both the weighted GAP scores and the maximum weighted GAP scores;
4) Calculating the total GAP score (sum weighted GAP scores / sum max weighted GAP scores);
5) Present the FMC MATCH score (1- GAP).

The three individual FMCs are tabulated below for the farmer AAR for tender coconuts with respect to each individual market player.

It should be noted here that the individual farmers from whom the farmer sources part of the tender coconuts can only supply quantities for which small trucks prove to be cost efficient. The Way of Transport criterion therefore shows a gap in all three FMC scenarios.

Table 75 FMC 1: Individual attractiveness of AAR corresponding to requirement criteria of online retailer FARMFRESH

FMC 1: AAR - FARMFRESH						
Criteria	**Market player: Farmfresh**	**Farmer: AAR**	**GAP (Market Player - Farmer)**	**Weight**	**Weighted GAP**	**Max. Weighted GAP**
Product variety and label	4	4	0	3	0	12
Product requirements	4	4	0	3	0	12
Delivery acceptance logistics	4	4	0	1	0	4
Delivery frequency	3	3	0	2	0	8
Way of transport	4	2	2	2	4	8
Packaging	0	0	0	1	0	4
Sourcing region	0	0	0	1	0	4
Like to add products	4	4	0	1	0	4
TOTAL			**2**	**14**	**4**	**56**
GAP (%) (total weighted GAP / Max Weighted GAP)						**7**
MATCH (%) (1-GAP)						**93**

The Match of FMC1 is 93%. As stated at the beginning of this sub-section, the 7% gap is on account of Way of Transport. All three market players, including FARMFRESH stated the requirement for a full truck load (open or closed) under the Way of Transport parameter.

Table 76 FMC 2: Individual attractiveness of AAR corresponding to requirement criteria of online retailer, GO2FRESH

FMC 2: AAR – GO2FRESH						
Criteria	**Market player: Go2fresh**	**Farmer: AAR**	**GAP**	**Weight**	**Weighted GAP**	**Max. Weighted GAP**
Product variety and label	4	4	0	3	0	12
Product requirements	4	4	0	3	0	12
Delivery acceptance logistics	4	4	0	1	0	4
Delivery frequency	1	3	2	2	4	8
Way of transport	4	2	2	2	4	8
Packaging	0	0	0	1	0	4
Sourcing region	0	0	0	1	0	4
Like to add products	4	4	0	1	0	4
TOTAL			**4**	**14**	**8**	**56**
GAP (%) (total weighted GAP / Max Weighted GAP)						**14**
MATCH (%) (1-GAP)						**86**

The Match of FMC2 is 86%. Apart from the gap on the Way of Transport parameter, GO2FRESH also indicated that they would require the delivery of tender coconuts on call, while the farmer can only deliver on three fixed days of the week. Therefore, a gap of 2 (based on the scoring range) exists here.

Table 77 FMC 3: Individual attractiveness of AAR corresponding to requirement criteria of wholesaler, SAMEER

FMC 3: AAR – SAMEER						
Criteria	**Market player: Sameer**	**Farmer: AAR**	**GAP**	**Weight**	**Weighted GAP**	**Max. Weighted GAP**
Product variety and label	4	4	0	3	0	12
Product requirements	4	4	0	3	0	12
Delivery acceptance logistics	4	4	0	1	0	4
Delivery frequency	1	3	2	2	4	8
Way of transport	3	2	1	2	2	8
Packaging	4	0	4	1	4	4
Sourcing region	0	0	0	1	0	4
Like to add products	2	4	2	1	2	4
TOTAL			**9**	**14**	**12**	**56**
GAP (%) (total weighted GAP / Max Weighted GAP)						**21**
MATCH (%) (1-GAP)						**79**

The Match of FMC1 is 86%. Similar to GO2FRESH, SAMEER also indicated the requirement for the parameter of Delivery Frequency of tender coconuts to be on call, while the farmer can only deliver on three fixed days of the week. So, a gap of 2 exists here as well.

Additionally, the gap of 2 is observed for the Way of Transport parameter here as well.

Thirdly, for the parameter Like to Add Products, SAMEER indicated one variety of produce, while the aggregator has more than one variety of produce to offer. So, a gap of 2 is observed for this parameter as well.

It can be concluded from the outcomes that for Packaging, Like to Add Products, as well as Way of Transport, there does exist a gap between the requirements defined by the market player and to what extent the farmer can fulfil these market requirements currently.

The table below summarises FMC attractiveness for the farmer AAR with respect to each market player.

Table 78 Summary of attractiveness of AAR corresponding to all three shortlisted market players

Tender Coconut			
Market players →	Online retailer FARMFRESH	Online retailer GO2FRESH	Wholesaler SAMEER
Market Attractiveness (%)	**67**	60	60
Farm Aggregator ↓	*Match between farmer and market player (%)*		
AAR	**93**	86	77

Observed from the above three sets of resultant tables, it is evident that FMC 1, i.e. farmer AAR's supply of tender coconuts to market player FARMFRESH, is the most attractive farmer-market combination as it has the highest match score. Moreover, the market player of FMC1 (FARMFRESH) also has the highest Market Attractiveness score.

4.2.3.2. Soft elements

The farmer, market player or project partner that executes this methodology might have qualitative preferences. This could lead to an adjustment of the 'best match': FMC1.

The soft element observed to be a limiting aspect during this study is communication between the farmer and the market players. Market players shortlisted for the purpose of this study do not buy from farmers directly in current supply chains on account of the language barrier and trust deficit due to cultural differences and physical distance.

The primary reason is on account of the drastically distant geographies where the source and destination CEZs are situated

Figure 13: Route map of PRC: CEZ Malabar to CEZ Suryapur by short sea shipping route

As a multilingual country, India actively speaks 122 languages.[86]

Trust between stakeholders located in physically distant geographies as in the case of short sea shipping supply chain is a significant concern as currently the farmers are more accustomed to sell to known local buyers with a very small number of exceptions that engage in export supply. Nevertheless, with reference to the section 4.2.2.1 on farmer identification, it was expected that a lack of trust would be a risk that can be mitigated as the communication barrier is bridged by the farmer (AAR) who also plays the role of aggregator between the market player and other coconut farmers.

[86] *http://www.censusindia.gov.in/Census_Data_2001/Census_Data_Online/Language/gen_note.html*

Therefore, no soft elements influence the conclusion of the match analysis result: FMC 1, i.e. farmer AAR's supply of tender coconuts to market player FARMFRESH, is the most attractive product-market combination.

FMC1 will therefore be considered as a viable input for the next phase: Supply chain design.

4.3. Supply chain design

As described in the methodology, dependent on the available opportunities one or multiple supply chain designs (scenarios) can be considered. Each supply chain scenario will be described according to four levels: physical (4.3.1), logistical control (4.3.2), information (4.3.3) and organisational (4.3.4). The different scenario(s) will be evaluated afterwards (4.3.5). The observations made in this section will aid the conclusion and design of the supply chain to be put into test implementation and will be the input for Phase D: Test implementation.

As determined in 4.2.3, the FMC of the lead farmer from CEZ Malabar supplying tender coconuts to the online retailer from CEZ Suryapur is considered for the purpose of this supply chain design.

As will be observed, results of section 4.3.5 illustrate that the most important consideration refer to storage conditions during the entire supply chain: Ambient, Partial cooling, Maximum cooling. Therefore, the selected supply chain design scenarios for the FMC under consideration differ on Physical design. For the Logistical control, Information and Organization (described in 3.3, no scenarios are set in case of 'Logistical control' and 'Information' because the short sea shipping supply chain information and control design for all three storage conditions will be identical. With regard to 'Organization', no scenarios are set because only one option is considered as realistic.

This can be illustrated by the table below:

Table 79 Link between scenarios and parameters of the logistical concept

Physical design	**Logistical control**	**Information**	**Organization**
Scenario 1: ambient	Identical for all three scenarios		
Scenario 2: partly cooled			
Scenario 3: cooled ambient			

4.3.1. Physical design

Currently, most fresh produce is not transported via cold chain in India. Due to the lack of cold chain infrastructure in the country at present and to ensure that this supply chain design remains applicable for the stakeholders, it was decided to establish three scenarios using the storage and carriage temperature as the control/determining variable to draw comparisons of quality of the fresh produce. These scenarios had to mimic:

1. ambient conditions where no cold chain infrastructure was available;
2. a partial cold chain condition where cold chain warehousing infrastructure was not available at the farmer and/or buyer end but carriage through a reefer container was possible; and
3. maximum cooling conditions in which cold chain infrastructure was available throughout the supply chain from end to end.

<u>Scenario 1: Ambient</u>

Prevalent supply chains entail a lead time of approximately 18 days including consolidating the produce from different farmers, sorting and grading, packaging, loading and transport by road and sea and unloading the produce to a central collection location, processing and documentation, transport, and distribution from the central delivery location to the retail chains and then to the final consumer. All of this is done under ambient temperatures (approximately 24.5 °C).

The below Figure 15 illustrates the process flow imitated in the simulation of the ambient scenario 1. As noted in section 4.2.2.2, the lead farmer sources the produce from the individual farmers in small trucks. The produce is transported from the lead farmer's farm in a 20-ft container at ambient temperature.

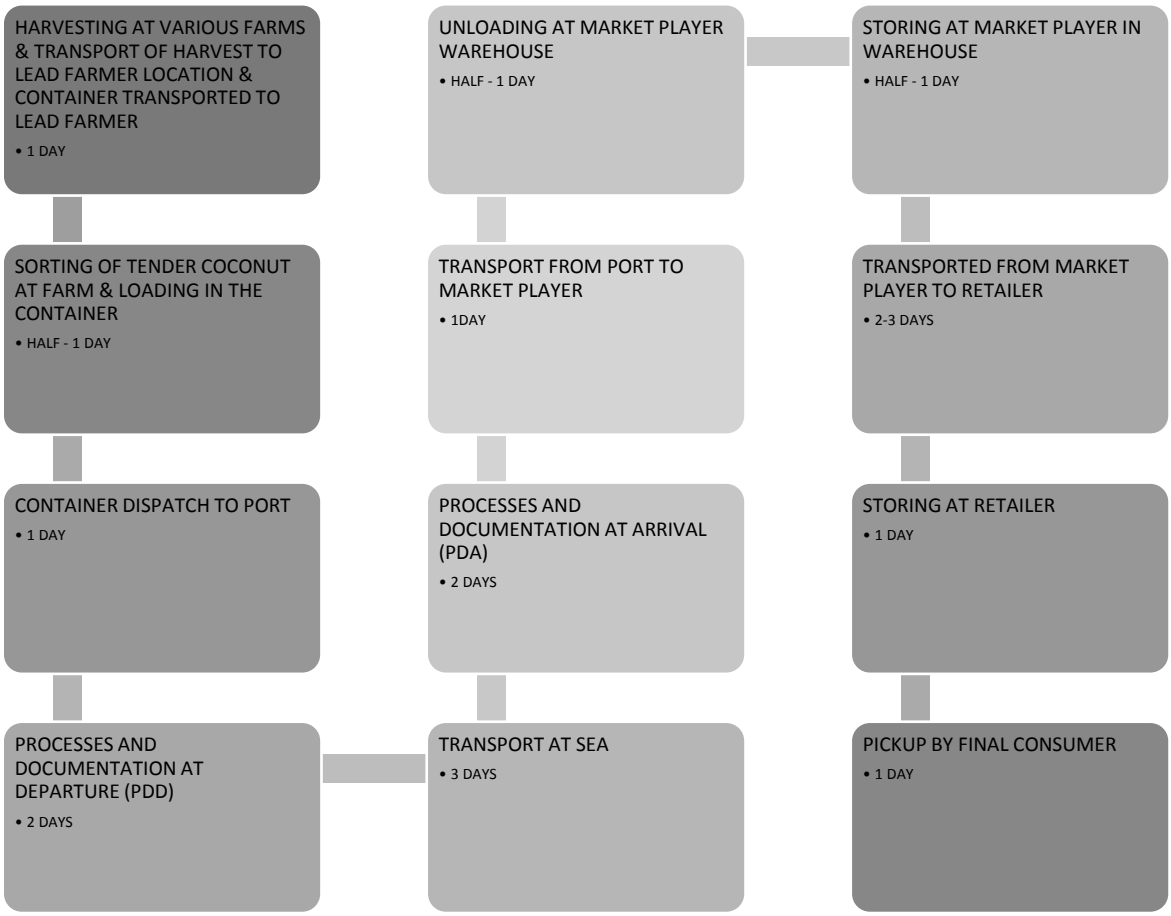


Figure 16 Process flow of supply chain for ambient scenario

Scenario 2: Partial Cooling

During the interview with FARMFRESH (the shortlisted market player in the selected FMC1), the limitation of the absence of cold storage at the market player's warehousing facility was discussed. This would have led to ambient storage of coconuts for 4 to 5 days after delivery to the market player warehouse. Additionally, given the Indian market conditions, it is not expected that even online retailers such as FARMFRESH would invest in cold storage for fresh produce in the immediate future. It is expected that ambient storage towards the latter part of the supply chain would still result in sufficient quality at the consumer end (18 days post-harvest). This scenario therefore contains a cold chain up to the movement of unloading at the market player warehouse.

The below Figure 16 illustrates the process flow imitated in the simulation of the partial cooling scenario 2. Unlike in the case of the ambient scenario, in the partial cooling temperature scenario, a reefer container was considered for the transport of the tender coconuts from the farm to the FARMFRESH warehouse. However, the absence of cold storage facilities at the market player warehousing would occur under ambient temperature.

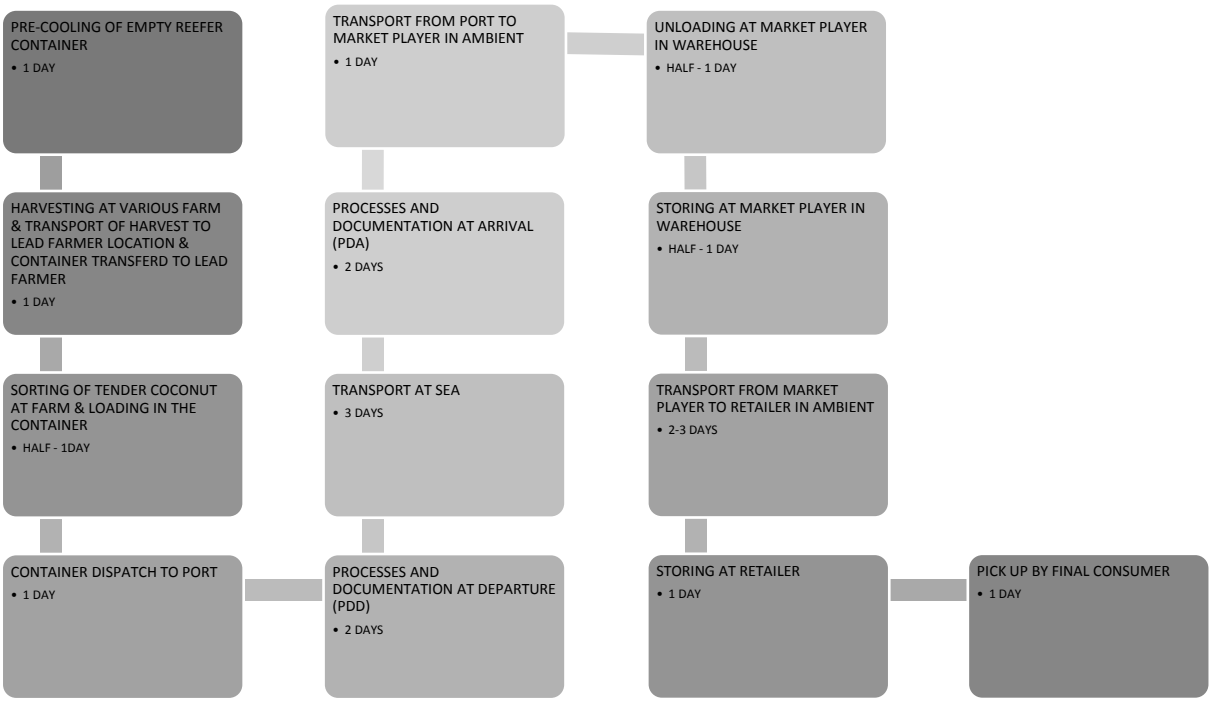


Figure 17 Process flow of supply chain for partial cooling scenario

<u>Scenario 3: Maximum Cooling</u>

Under ideal conditions, it is assumed that cold storage of the tender coconuts would take place only after the first two days post-harvest. The end to end maximum cooling period is therefore considered from this point in time to the time that the produce reaches the end consumer. This scenario would also result in superior consumable quality of the produce and farmers earning significantly higher revenue from high end market players located geographically in distant locations, who would be willing to pay a premium for this superior quality.

Additionally, it is assumed in this scenario that from the lead farmer to the port of origin, and onwards to port of destination through short sea mode and till the final delivery to the market player's premises, the produce will move in a reefer container and the market player will also have cold chain storage facility at his end.

The below Figure 17 illustrates the process flow imitated in the simulation of the maximum cooling scenario 3. In the case of maximum cooling, it was assumed that the market player would invest in a cold storage warehouse after receiving the shipment of the tender coconuts.

Figure 18 Process flow of supply chain for maximum cooling scenario

4.3.2. Logistical control

Given Indian market conditions of agricultural land holding, consumer behaviour and consumption patterns, the trend of small farms as well as small retail shops is assumed to continue even if farmer organisations and aggregator communities are established. The purchase of fresh produce such as tender coconuts by several small vendors as well as small markets is therefore expected to occur concurrently to large scale purchases.

Additionally, doorstep deliveries through e-commerce retail (such as GO2FRESH) have also witnessed significant growth in recent times and are growing as a trend.

It can therefore be assumed that small scale buyers as well as small farms will continue to exist in the Indian fresh produce supply chain.

Customer Order Decoupling Point (CODP) and Cross Docking

In current supply chains in which the market player is involved, as well as in this short sea shipping supply chain, the CODP will rest at the market player warehouse. However, with better information sharing in the future (elucidated in section 3.3.3), the final customer manifest indent can be given to the farmer so that orders may be pre-packed for end users such as retailers or hotel chains (e.g. private label packaging) at the farmer location before shipment. This will enable entities such as FARMFRESH to share individual smaller buyer packaging requirements with the farmer, and reduce the time taken to customise sorting and packaging of the fresh produce inventory at their warehouse for individual buyers. Additionally, it enables cross-docking of the tender coconut shipments as no further value-added processes need to be performed at the warehouse.

In the future, this change of the CODP from the market player warehouse to the lead farmer aggregation location will result in a reduction in lead time and fewer stocks at the market player end. It will therefore result in lower supply chain cost and better tender coconut quality at the consumer end. The availability of better quality at the consumer end might lead to the opportunity to serve markets that demand supreme quality and are willing to pay a higher price, enhancing the business prospects of the short sea shipping supply chain.

Continuous replenishment

The question of continuous replenishment exists where frequent delivery of smaller fresh produce consignment sizes is possible.

In this case, since a large quantum of produce is being moved, continuous replenishment from the lead farmer is ruled out.

The current processes after delivery at the warehouse of FARMFRESH are based on continuous replenishment only.

However, in a complete cold chain scenario the continuous replenishment from the marker player warehouse to the retails is a distinct possibility.

4.3.3. Information

Below is the information shared along the supply chain for short sea shipping:

1. Order indent prepared by the market player based on orders by retailers.
2. Order quantity, quality specification & delivery time lines are communicated to the lead farmer.
3. Lead farmer communicates order quantity, quality specification & delivery time lines to the other farmers.

4. Post confirmation of orders from other farmers, the lead farmer confirms the order quantity, quality specification & the delivery time lines to the market player.
5. Market player issues the final order with confirmed quantity, order details and delivery time lines to the lead farmer.
6. Market player contacts the logistics company with information about the shipment quantity and shipment ready date.
7. The Logistics Company confirms container availability, vessel schedule and trailer truck availability to the market player.
8. The market player communicates indicative pickup date to the lead farmer.
9. The farmer confirms the pickup date and communicates the same to the other farmers.
10. The Logistics company informs the container number & trailer license plate number to the market player.
11. The Market player shares the container number & trailer license plate number with the lead farmer.
12. The lead farmer prepares the invoice and related documents and sends them to the market player & Logistics Company.
13. The container is dispatched on the trailer to the farm on the agreed date.
14. The container reaches the farm and is loaded & sealed, and the lead farmer prepares the packing list.
15. The container is dispatched from the farm and the Seal number and the packing list are shared with the market player and logistic company.
16. The container arrives at container freight station and bill of lading is prepared based on the invoice documents.
17. Container is loaded on the vessel & bill of lading, Invoice and packing list are sent to the market player.
18. The container is tracked by all stake holders using the bill of lading number or the container number.
19. Container is offloaded at the destination port and moved to the container freight station for documentation process. The market player is informed.
20. The container is loaded onto the trailer. The trailer license plate number and the driver contact number are shared with market player.
21. The trailer reaches the market player warehouse and shipment is offloaded. Quantity and quality check is done, and order receipt is confirmed to the lead farmers & the logistics company.
22. The lead farmer is paid the remaining amount or total amount based on payment terms.
23. Market player segregates and repacks the coconuts for final shipments to the retailers and prepares the delivery order & invoice and shares the same with the retailers.

24. The retailers receive the shipment, issue order receipt to the market player and make the final payment to the market player.
25. The end consumer picks the product from the retailer. Retailer prepares the invoice and checkout upon payment.

Almost all information listed above is shared via email, fax or in printed document form. All other information such as schedules and phone numbers are shared on the telephone and emails. The tracking of bill of lading is done using the online track and trace systems available of shipping lines on their internet web pages or by calling up their customer service team.

Key information, including tracking and tracing information of the short sea shipping is currently available at the data points given in the table below. This information sharing is expected to improve in the future due to technology advancement and increased data connectivity.

Table 80 Key information in the supply chain currently accessible

Data Point	Generated By	Shared With
Order confirmation (trigger point of supply chain)	Market Player	Lead Farmer
Container & trailer availability and the vessel schedule	Logistics Company	Market Player, Lead Farmer
Invoice and packing list	Lead Farmer	Market Player, Logistics company
Seal no, **container no**, trailer licence plate number, **bill of lading number**	Logistics company	Market Player, Lead Farmer
Trailer no at the destination port	Logistics company	Market Player
Driver contact number	Logistics company	Market Player

The data points mentioned in the above Table 80 already exist to facilitate other (non-short sea shipping) supply chains. The information management utilized for short sea shipping will apply in non-short sea shipping supply chains as well. No additional information is mandated to be shared and no additional data points need to be created in order to successfully implement the short sea shipping supply chain.

The dynamic and live availability of data helps to monitor quality of fresh produce under specific temperature and humidity conditions and to control them. With increased use of mobile data in rural India, it is expected that more mobile platforms will be developed to allow information sharing of all major data points mentioned in the table above on a real-time basis.

4.3.4. Organization

As mentioned in the phase C of the methodology, supply chains involving smallholder farmers usually apply one of four organisation models:

1. Bilateral relations between individual farmer and market player
2. Contract farming
3. Linkage through lead farmer
4. Linkage through cooperatives

Linkage through lead farmer has been considered as the most effective organisational model to connect the farmer with the market player for the purpose of this study and selected FMC. Reasons for this organization choice are listed below:

It has been documented that despite wide cultivation of tender coconuts in the state of Kerala, very few large plantations exist in the region. In fact, over 95% of coconut trees in Kerala are grown in the peripheries of homes, making the cultivators traditional smallholders as described in the methodology (3.3.4).

As mentioned in the results of Phase B (4.2.2.1), the state of Kerala (which lies in the CEZ Malabar region) experienced drought for two consecutive years. In addition, the coconut farms also suffered an insect attack. These two facts reduced the options for finding lead farmers and a single farmer for sourcing the minimum quantity required was identified. This minimum quantity is a large batch of tender coconuts of at least the capacity of one 20ft refer container.

Additionally, in average years in which farmers do not face the challenges of drought and insect attacks, many smallholder farmers exit – who are not able to harvest a full container at once.[87] Therefore, consolidation of tender coconuts from multiple farmers is required, a prerequisite for an effective organization model.

[87] *An Analytical Study On Agriculture In Kerala (pg 11) http://www.keralaagriculture.gov.in/pdf/a_s_06042016.pdf; see Appendix 7 for screenshot*

In addition, as observed in the sub-section Soft Elements of the Phase B results, a communication barrier due to language is also observed as a limiting aspect between individual farmers from the origin CEZ Malabar and the market player from the destination region, causing lack of trust between the market player and the farmer. However, it was expected, that the lead farmer (AAR) conversant in local language Malayalam, language of business English and national language Hindi, would bridge this issue by playing the role of aggregator between the market player and other coconut farmers.

Moreover, smaller individual farmers do not currently possess the requisite skill sets and financial capacity to absorb the uncertainties of the market, which a lead farmer could mitigate with greater ease. The small individual farmer therefore receives payment immediately in cash on delivery to the lead farmer, whereas the lead farmer accepts payment as agreed with the market player. In this organization model, the lead farmer takes a financial risk.

The above considerations led to the selection of Linkage through Lead Farmer as the organisational model for the purpose of this study.

4.3.5. Supply chain evaluation

Conclusions for the feasibility of the redesigned short sea supply chain are made on the basis of the below performance indicators:

1. *Cost* of the harvesting & aggregation process, and transport, and the cost feasibility analysis
2. *Quality loss* of Tender Coconuts during the total time between receiving the order at the farmer and product replenishment at the market player (order lead time).

4.3.5.1. Cost

As observed in the case of the three storage temperature scenarios, the first three activities in the supply chain remain identical.

Below is the logistics cost of transport for the various modes of transport from the farm in CEZ Malabar to market player in the destination CEZ Suryapur as calculated in the results of Phase A.

Since the price difference is calculated between wholesale markets at CEZ Malabar and CEZ Suryapur (1225 INR, as seen in criteria d of the results shown in section 4.1), it can be concluded that cost of transporting the harvest to the local market is included in the prices. The total cost of the current supply chain therefore also includes the post-harvest costs incurred. Basis this amount the additional earning per ton and total earnings for 19 tons of coconut were calculated in Phase A as well. Table 61 from the 4.1.3.1 is reproduced for reference below as Table 81.

Table 81 Additional earnings for the former using short sea shipping to transport 19T coconuts from CEZ Malabar to CEZ Suryapur

Cost Feasibility Analysis for Short Sea Shipping from farm in CEZ Malabar to buyer in CEZ Suryapur	**Amount (INR)**
Price difference between CEZ Malabar and CEZ Suryapur Markets for Coconut **Per Quintal**	1225
Price difference between CEZ Malabar and CEZ Suryapur **Per ton** (1 ton = 10 quintal)	12250
Total additional earning for seller for 19 tons of coconut	232750
Cost of Short Sea Shipping for 40 ft. reefer container	186860
Net additional earning for 19 ton of coconuts using short sea shipping	45890
Per ton additional earning	2415

There is a net earning of INR 2415 per ton (INR 2.66 per kg) after deducting all costs.

To conclude the supply chain evaluation on Costs: all three scenarios are feasible from a business perspective.

4.3.5.2. Quality loss

As discussed in the section on throughput times, apart from port-to-port connectivity[88], the entire supply chain process of farm to consumption is longer. The same has been documented in the storage temperature scenarios process flows in this report in section 44, factoring in various steps of farmer group activities as well as logistical processes.

The calculation of lead time for all three scenarios is listed in the table below:

Table 82 Lead time calculation for all three temperature scenarios

SL. No.	**ACTIVITIES**	**SCENARIO 1: AMBIENT**	**SCENARIO 2: PARTIAL COOLING**	**SCENARIO 3: MAXIMUM COOLING**
1	HARVESTING AT VARIOUS FARMS & TRANSPORT OF HARVEST TO LEAD FARMER LOCATION & CONTAINER TRANSFERD TO LEAD FARMER/PRE-COOLING OF EMPTY REEFER CONTAINER (**For Scenario 1 & 2)**	1 Day	1 Day	1 Day
2	SORTING OF TENDER COCONUT AT FARM & LOADING IN THE CONTAINER	Half-1 Day	Half-1 Day	Half-1 Day
3	CONTAINER DISPATCH TO PORT	1 Day	1 Day	1 Day

[88] *Appendix 11*

SL. No.	ACTIVITIES	SCENARIO 1: AMBIENT	SCENARIO 2: PARTIAL COOLING	SCENARIO 3: MAXIMUM COOLING
4	PROCESSES AND DOCUMENTATION AT DEPARTURE (PDD)	2 Days	2 Days	2 Days
5	TRANSPORT AT SEA	3 Days	3 Days	3 Days
6	PROCESSES AND DOCUMENTATION AT ARRIVAL (PDA)	2 Days	2 Days	2 Days
7	TRANSPORT FROM PORT TO MARKET PLAYER	1 Day	1 Day	1 Day
8	UNLOADING AT MARKET PLAYER WAREHOUSE	Half-1 Day	Half-1 Day	Half-1 Day
9	STORING AT MARKET PLAYER IN WAREHOUSE	Half-1 Day	Half-1 Day	Half-1 Day
10	TRANSPORTED FROM MARKET PLAYER TO RETAILER **(By Reefer vehicle for Scenario 3**)	2-3 Days	2-3 Days	2-3 Days
11	STORING AT RETAILER (**In Cold Chamber for Scenario 3**)	1 Day	1 Day	1 Day
12	PICKUP BY FINAL CONSUMER	1 Day	1 Day	1 Day
	Total Days	**17 Days**	**17 Days**	**17 Days**

Total time taken from farm to consumer is 17 days in all three scenarios. However, adverse weather conditions at sea may cause a delay. To factor in this delay, one extra day is added to the days taken for transport at sea. It can therefore be concluded that the lead time for all three scenarios is 18 days.

Comparisons are drawn between the three storage temperature scenarios for expected loss of produce. For the purpose of this study, out of the options mentioned in the methodology, the definition of losses relevant are: market acceptance of the fresh produce, and the value of the produce at the end of the supply chain in all three temperature scenarios. It should be noted here that the selected market player, FARMFRESH also demanded an extra quantity of approximately 10% above the order size, anticipating loss of produce in transit, in terms of market acceptability.

It is expected that the produce will be of at least consumable quality in all three scenarios. However, this cannot be concluded definitely without testing the supply chain.

The value of the fresh produce can only be deduced at the time of the final implementation (not under laboratory conditions), during which it is delivered to the market player. Therefore, for the purpose of this study, product loss needs to be evaluated only in terms of the market acceptance of the tender coconuts.

Considering the product quality and the end of the short sea shipping supply chain, there exists uncertainty about the quality of tender coconuts in the absence of end-to-end cold chain. More particularly, once a the refer container carrying tender coconuts reaches the market player premises, the absence of cold chain storage at FARMFRESH location posed a challenge and brought forth question on the impact of product quality in part cold chain.

To conclude the supply chain evaluation on quality loss: the effect of the supply chain design on quality loss is unclear, to be able to eliminate uncertainties a test implementation is required.

4.4. Test implementation

The primary purpose of this study is to test the potential of short sea shipping as a method for the transportation of fresh produce as commodity. Tender coconuts were chosen as the commodity.

In order to test the technical feasibility of a short sea shipping chain for tender coconuts, a test transport with fresh coconuts was planned. The expected time between harvest and cooling of the tender coconuts was to be 5-6 days due to absence of a (pre)cooling facility. Prompt post-harvest cooling is essential to prolong the shelf-life of tender coconuts. It was decided not to risk two entire containers of coconuts (to test ambient as well as cold chain scenarios) for this trial because of temperature management issues, which could result in a total loss of the cargo due to quality decay.

Instead, a controlled small-scale transport simulation with three storage temperature scenarios was performed. A cold storage facility capable of warehousing temperatures of 13 °C was used at the origin CEZ Malabar in Palakkad to provide optimal cooling conditions.

Results of this section on the chain simulation are documented in the following sections:

1. Scope
2. Define test implementation team
3. Measurement protocol

4.4.1. Scope

With reference to section 4.3 on the need for test implementation, it was concluded that a controlled small-scale laboratory simulation mimicking the lead time with the three temperature scenarios was required to be carried out to demonstrate to the members of the consortium which scenarios of the test implementation are feasible.

With reference to section 4 on Physical design, these three scenarios are as listed below:

a. Ambient (A): 6 crates of tender coconuts were tested under ambient temperature conditions for 18 days (to reflect the number of days taken to implement the entire supply chain). As mentioned in section, one extra day is added to the days taken for transport at sea (17 days). Therefore, the lead time for all three scenarios is considered to be 18 days.
b. Partial cooling (P): It was decided to observe two crates of tender coconuts shifted to ambient temperature for 4-5 days towards the end of the experiment under chain simulation.
c. Maximum cool (M): The ideal scenario of end-to-end cold chain was also simulated to demonstrate the maintenance of superior quality aspects of the tender coconuts.

4.4.2. Define test implementation team

As stated in the Phase D methodology of this study, it was not mandatory for members of the consortium to be part of the chain simulation, however, all members of the consortium had to be in agreement to its participants.

As the test implementation of the suggested supply chain method via short sea shipping is a laboratory simulation, the involvement of the logistics service provider was not relevant. The Palakkad Ice & Cold Storage at Palakkad was treated as a make-shift laboratory for the purpose of this experiment.

Participating members of the test implementation team are listed below:

1. Quality Supervisor – This role required the person to set the parameters of quality of the tender coconuts from the start of the experiment. It also required for the individual to supervise the measurements and rating of the tender coconuts on the pre-determined days of the experiment as well as direct the researcher on nuances of quality that underwent change.
2. Research Analyst – The research analyst was part of the local partner team who noted all results, documented and offered primary observations gathered from the log meters and testers.
3. Farmer – Farm aggregator AAR provided sorting and grading services apart from sourcing the coconuts from the two farms
4. Testers – A sample size of 4 to 8 local dwellers, as per availability, was requested to test the tender coconuts on the planned measurement days for quality testing of the tender coconuts. On Day 5 (December 5, 2017): 6 persons tested the quality of the tender coconuts, on Day 12 (December 26, 2017): 4 persons tested the quality of the tender coconuts, and on Day 18 (January 1, 2018): 8 persons tested the quality of the tender coconuts. Tester demographics included workers & managers from factories close to the cold storage facility in Palakkad.

4.4.3. Measurement protocol

As mentioned earlier in this section on test implementation (4.4.2), the experiment was conducted to show the potential of transporting fresh coconuts in a short sea shipping chain and the importance of prompt cold chain as a tool to reduce post-harvest food losses.

The execution of the test implementation involved 144 pieces of tender coconuts divided into 18 crates containing 8 pieces of tender coconuts each. This test simulation was conducted for a period of 18 days. 9 crates each containing 8 pieces of tender coconut were sourced from Farm A and Farm B respectively. The coconuts were sourced from two farms to eliminate the risk of external factors that might affect the test results of the measurements of the tender coconuts.

The quality of the produce was measured on the basis of:

a. Taste of the water content
b. Internal and external surface appearance
c. Colour of the water
d. Odour of the water

The temperature measurements were constantly noted and maintained with the help of log meters. The schedule of quality measurements of the tender coconuts was planned to reflect the various stages of the supply chain. The same is shown in the table below:

Table 83 Schedule of the test implementation corresponding to the actual supply chain involving short sea shipping transport method

				Storage temperature scenario 1: Ambient	**Storage temperature scenario 3: Partly cold chain**	**Storage temperature Scenario 2: Full cold chain 13°C (FCC)**
	Day	**Supply chain steps in reality**	**Actions during demonstration pilot**			
		(which we do not do during the test pilot)	**(which we do during the test pilot)**	**Ambient**	**Part cool**	**Max cool**
Day-15	1	- Post harvesting, sorting, and loading at farm		Ambient	Ambient	Ambient
	2			Ambient	Ambient/ 13°C	Ambient/ 13°C
	3	- on land / to port		Ambient	13°C	13°C
	4	- PDD		Ambient	13°C	13°C
Dec-19	5		pictures and quality measurements	Ambient	13°C	13°C
	6	- Transport at Sea		Ambient	13°C	13°C
	7			Ambient	13°C	13°C
	8			Ambient	13°C	13°C
	9	- PDA		Ambient	13°C	13°C
	10			Ambient	13°C	13°C
	11	- On land / to buyer		Ambient	13°C	13°C

				Storage temperature scenario 1: Ambient	Storage temperature scenario 3: Partly cold chain	Storage temperature Scenario 2: Full cold chain 13°C (FCC)
	Day	**Supply chain steps in reality**	**Actions during demonstration pilot**			
Dec-26	12		pictures and quality measurements	Ambient	13°C	13°C
	13	- Storage at buyer		Ambient	Ambient	13°C
	14			Ambient	Ambient	13°C
	15	- shipment to retailer/hotel/market		Ambient	Ambient	13°C
	16	- Shelf life during retailer and storage by final consumer		Ambient	Ambient	13°C
	17			Ambient	Ambient	13°C
Jan-01	18		pictures and quality measurements	Ambient	Ambient	13°C

In order to realize this measurement plan, a cold storage facility that enabled 13 °C storage at high relative humidity (optimal storage conditions for fresh coconuts) was chosen to conduct the experiment.

Coconuts from two farms, coded T and R, were used in order to see if results were consistent for all scenarios. From each plantation, 18 crates were filled with 8 coconuts each in a randomized way. The key measurement in the experiment was on the last day, which is at the end of 18 days. However, to observe the stages of deterioration of the tender coconuts, measurement milestones were set on days 1, 5, 12 and 18. Pictures were taken of all crates and quality was determined by picture, observation of internal and external surface defects, and taste.[89]

Apart from these days, a daily log was also maintained in order to observe the gradual changes in the appearance of the tender coconuts.

A range was scored in order to rate the quality of the tender coconuts measured on each of the test days, where 1 stood for VERY GOOD, 2 for GOOD, 3 for ACCEPTABLE, 4 for SUB-STANDARD, and 5 stood for BAD.

Specific Crate codes with their measurement days are mentioned in the table below. It should be noted here that two random samples from one crate each from Group T and Group R were measured on Day 1 post-harvest. The same convention of testing was maintained for Day 5. These two crates contained ten coconuts each. Since they were disposed of immediately, these two crates were not coded.

[89] *Appendix 6*

Table 84 Codes of the crates to be measured as per the test implementation schedule

Temperature Scenarios				**Measurement Days**
AMBIENT	**MAX COOL**	**PART COOL**		
T1 A1	T4 M1	T7 P1		
R1 A1	R4 M1	R7 P1		Day 5 Measurement
T2 A2	T5 M2	T8 P2		
R2 A2	R5 M2	R8 P2		Day 12 Measurement
T3 A3	T6 M3	T9 P3		
R3 A3	R6 M3	R9 P3		Day 18 Measurement

Pictures for both plantations (T and R) are shown in the following section, separately.

In order to avoid confusions, each crate, from which a random sample of tender coconut was measured, was disposed of.

On day five, tender coconuts from crates T1A1, T4M1, T7P1 from group T and R1A1, R4M1, R7P1 from group R were measured.

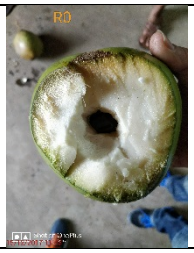
On day 12, tender coconuts from crates T2A2, T5M2, T8 P2 from group T and R2A2, R5M2 and R8 P2 from group R were tested. After this test, two crates, T9P3, and R9P3 were shifted to the ambient environment.

On day 18, tender coconuts from crates T3A3, T6M3, T9 P3 from group T and R3A3, R6M3, R9P3 from group R were subsequently measured.

Table 85 Day-wise photographic results of the test implementation for crates from group T

	Coconuts Origin T		
Day 1			
	Ambient	Part Cool	Max Cool
Day 5			
Day 12			
Day 18			

Table 86 Day-wise photographic results of the test implementation for crates from group R

	Coconuts Origin R		
Day 1			
	Ambient	Part Cool	Max Cool
Day 5			
Day 12			
Day 18			

It was observed that in Maximum Cool scenario (>13 °C, ~ 85 Humidity), condition of the tender coconuts in various quality categories such as taste, external appearance, internal appearance & milk colour is VERY GOOD for 18 to 19 days.

Under Partial Cooling temperature scenario, (12 days > (>13 °C, ~ 85 Humidity, 7 days in ambient conditions), the condition of tender coconuts in various quality categories such as taste, external appearance, internal appearance & milk colour was considered to be GOOD or ACCEPTABLE for a period of 18 Days.

In Ambient temperature scenario (~24.5 °C), the tender coconuts were observed to have a shelf life of up to 5 to 6 days at the most. After that, the tender coconuts were observed to be SUB-STANDARD or BAD. This included rotting and browning of the outer skin of the otherwise natural green colour of the tender coconut. The tender coconut also began to smell rotten and the colour of the water turned an opaque milky white, which is an indication of the water having turned rancid.

Through the results[90] of the laboratory simulation with the three temperature scenarios it was observed that of the three scenarios, partial cooling and maximum cooling are both feasible for the purpose of this study. The ambient scenario showed that the fresh produce will not remain in consumable quality till the end of the duration of the supply chain, therefore is not feasible.

It was also concluded that the maximum cooling scenario offers a distinct advantage in terms of product quality, likely to fetch a premium for the farmer owing to the superior quality of the produce.

[90] *Appendix 6*

5. Conclusion and discussion

Auke Schripsema, Han Soethoudt, Seth Tromp, Bhairavi Jani, Priyanca Vaishnav, Anjali Anit, Sibasish Pradhan

The main goal of this project is to exploit efficient new urban short sea food supply chains within emerging economies that significantly reduce urban food losses and improve business profitability. Therefore, this study covers the development and piloting of a methodology for new short sea urban supply chains in India and its local knowledge transfer by capacity building and setting up partnerships that can implement the newly designed urban food supply chain.

The methodology was built upon existing knowledge and methodologies from literature. However, none of the methodologies found in literature include a methodology that facilitates a (potential) business (consortium) in developing a concrete short sea shipping supply chain and comparing this supply chain with existing supply chains with regard to both business effectivity and the reduction of food losses. Therefore, in developing and applying the methodology, the project team involved in this study has been pioneering with the concept of short sea shipping.

The documented methodology in this report consists of four steps:

1. The selection of product-route combinations resulting in a table including all, from a cost point of view, potentially feasable short sea shipping routes between coastal economic zones(CEZs), and a selection of fruits and vegetable products which are promising and suitable in terms of quality decay to be transported on these routes.
2. With respect to these product-route combinations, the selection of farmer-market combinations is established resulting in a table with the potentially viable combinations of farmers and market players (both by name or pseudonym). This table quantitatively scores both the market player attractiveness and the match between market player requirements and farmer status showing the most feasible farmer-market combination. At this stage the product label and variety are specified.
3. With respect to these farmer-market combinations, an evaluated supply chain design, (proof-of-concepts) with physical design, logistical control, information and organisation designs determined.
4. With respect to these supply chain designs, a pilot setting is created resulting in a proof-of-principle that reduces the risk and uncertainty of the envisioned implementation of a short sea shipping supply chain.

The results of these for steps are:

1. The only product-route combination, that meets all the criteria of the methodology, is the route from CEZ Malabar to CEZ Suryapur for coconuts.
2. The most attractive farmer-market combination is the supply of Tender coconuts from farmer AAR to market player FARMFRESH.

3. Three supply chain design scenarios (ambient, partial cooling, maximum cooling), that differ on physical design only, are feasible from a business perspective. However, the effect of the supply chain design on quality loss could not be determined based on theory alone.
4. A test implementation (pilot setting) was performed to be able to eliminate uncertainties with regard to the effect on quality loss. Through the results of the laboratory simulation it was observed that of the three scenarios, partial cooling and maximum cooling are both feasible for the purpose of this study. The ambient scenario showed that the Tender coconuts will not remain in consumable quality till the end of the duration of the supply chain, and therefore is not feasible.

Additionally, successive to the results, the project teams discussed the process of designing and following the methodology itself and its usability in future applications:

One crucial aspect of this methodology turned out to be the availability of (quantitative) data. Even though India has a lot of data resources available, not all data could easily be found. In some cases, only interviews instead of literature or databases could provide the required data.
In case of emerging economies, data availability might be a significant challenge. Additional interviews are probably limited due to budget constraints. It is a time-consuming process to perform interviews as well as finding the right expert beforehand.

Secondly, the methodology describes multiple considerations and criteria that facilitate the applicant in eliminating both unfruitful options with respect to business effectivity and food loss reduction. In doing so, it focusses on the best opportunity available.
Given time and budget constraints that are present in any project, this can be a powerful tool: in a relatively short time period the energy of the team(s) involved is focussed on the best opportunity available. On the other hand, options that still can be considered as large opportunities might be ignored.

An additional remark that comes to mind with regard to the offered methodology is the broadness of it. It starts from an emerging economy, in this case the country of India (the seventh largest country in the world) and narrows down to the implementation of a short sea shipping supply chain. It involves a broad variety of expertise: market specialists, economists, experts on the reduction of food losses, fresh-product experts and different supply chain actors (each having their own crucial role during an implementation).

The question is whether this methodology adds value to project teams with a relatively smaller scope as well. Probably, two different type of projects with a smaller scope could benefit from the presented methodology as well:

- Operational projects with a specific market player and farmer (group): these projects might be initiated by the private sector that already has a source (farmer, farmer group, region) and the market player (retailer, hotel chain, etc.) in mind. As an example: how to realize an agro-logistical supply chain (probably with help or short sea shipping) of apples from Himachal farmers to Hyderabad retailers cost effectively and with a minimum amount of food losses?

  A project like this is expected to benefit from the supply chain design and test implementation part of this methodology. The PRC and FMC section are not required.
- Strategic projects to improve a country's food security, food quality or export opportunities: These kinds of projects are usually executed by government bodies. Especially the PRC analyses could be of value.
- Other modalities: Although the methodology developed is dedicated to short sea shipping, it can be applied to other modalities as well. In fact, the methodology can be used to realize a new agro-logistical supply chain in general.

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Appendices

Appendix 1: Number of shipping lines servicing the CEZs (criteria d, 4.1.1.4)

Interview no.: 001072017

Ref.: page 32, para 2 / line 3

Interviewer: Anjali Anit

Interviewee: Mr. Rajan S. (Blue Sea Shipping Agency Pvt. Ltd.) / P. Deshmukh (SCA Logistics Pvt. Ltd.) Mumbai

Date: 15th June 2017 / 17th June 2017

Time: 11:30 am

Q - Which shipping lines have services to the ports in the table below?

A - Indian Flag vessel – SCI Shipping line subject to availability of cargo, and foreign flag-bearing vessels (operated by other shipping lines) having services to the given port

Table 87 Shipping lines servicing the CEZs (criterion d)

Sr.no.	CEZ	State	Port	Does the port have shipping line services?	Connectivity
1	Kutch	Gujarat	Kandla	Yes	SCI / MSC Line
			Mundra	Yes	11 shipping line/SCI/Shreyas Shipping
2	Saurashtra	Gujarat	Pipavav	Yes	SCI / Maersk Line /Shreyas Shipping
			Sikka	No	
3	Suryapur	Gujarat	Dahej	No	
			Hazira	Yes	SCI / Shreyas Shipping
4	North Konkan	Maharashtra	JNPT	Yes	Feeder Vessel - Seimatech / OEL. SCI /Shreyas Shipping
			Mumbai	No	
5	South Konkan	Maharashtra, Goa	Dighi	No	
			Jaigarh	No	
			Mormugao	No	
6	Dakshin	Karnataka	Mangalore	Yes	SCI/Shreyas Shipping
7	Malabar	Kerala	Kochi	Yes	Feeder Vessel - BTL / Chakiat /Maersk LineSCI /Shreyas

Sr.no.	CEZ	State	Port	Does the port have shipping line services?	Connectivity
8	Mannar	Tamil Nadu	Tuticorin	Yes	Feeder Vessel - BTL / Chakiat /Maersk Line SCI /Shreyas Shipping
9	Poompuhar	Tamil Nadu	Cuddalore	No	
10	VCIC South	Tamil Nadu	Chennai	Yes	Feeder Vessel -MOL Feeder. SCI
			Ennore	No	
			Kattupalli	Yes	Feeder Vessel -TS Line SCI/Shreyas Shipping
11	VCIC Central	Andhra Pradesh	Krishnapatnam	No	
12	VCIC North	Andhra Pradesh	Visakhapatnam	Yes	SCI /Shreyas Shipping
			Kakinada	Yes	SCI /Shreyas Shipping
13	Kalinga	Odisha	Paradip	No	
			Dhamra	No	
14	Gaud	West Bengal	Kolkata	Yes	Feeder Vessel - Mexicon Shipping / Parma Shipping. SCI / Shreyas Shipping
			Haldia	Yes	Feeder Vessel - Mexicon Shipping / Parma Shipping. SCI / Shreyas Shipping

Appendix 2: Minimum Shipping Connection to Other Ports (criteria e, 4.1.2)

Interview no.: 001072017

Ref.: page 32, para 2

Interviewer: Anjali Anit

Interviewee: Rajan S. (Blue Sea Shipping Agency Pvt. Ltd.) / P. Deshmukh (SCA Logistics Pvt. Ltd.) Mumbai

Date: 15th June 2017 / 17th June 2017

Time: 11:30 am

Q Do all the ports that fall under Indian CEZs have at least one shipping line connection to other ports?

A Yes, all ports have connectivity to at least one other port. Several ports are serviced by Shipping Corporation of India vessels (Indian flag-bearing vessels) subject to availability of cargo, as well as one or more foreign flag-bearing vessels (operated by other shipping lines).

Appendix 3: Feeder Vessels Plying per week between Ports (criteria g, 4.1.3)

Interview no.: 003072017

Ref: page 40, para 2

Interviewer: Anjali Anit

Interviewees: Rajan. S (Blue Sea Shipping Agency Pvt. Ltd.) / P. Deshmukh (SCA Logistics Pvt Ltd), Mumbai

Date: 17th June 2017 | Time: 11: 30 am

Q – Which ports from the CEZs shortlisted after criteria d & e offer Feeder Vessel services?

A –

1. Kandla port is serviceable with three feeder vessels: one is Paramount Shipping and their frequency to port is weekly. The other two are Orient Liner, and Parekh Shipping and their frequency to port is twice a week each.

2. Mundra port is serviceable with four feeder vessels: Paramount Shipping and Seimatech have weekly frequency to the port, while the other two - Orient Liner, and Parekh Shipping have frequency to port is twice a week each.

3. Pipavav port is serviceable with feeder vessel services three times a week

4. Hazira port is serviceable with feeder vessels three to four times a week

5. JNPT port is serviceable with 2 feeder vessels: one is Orient Liner, and the other is Parekh Shipping. Their frequency to the port is twice a week each.

6. Kochi port is serviceable with 3 feeder vessels, one is BTL, second is Chakiat and third is Maersk Line their frequency to port is weekly each

7. Tuticorin port is serviceable with 3 feeder vessels, one is BTL, second is Chakiat and third is Maersk Line their frequency to port is weekly each

8. Chennai port is serviceable with 2 feeder vessels, one is TS Line and other is MOL there frequency to port is twice a week each

9. Kattupalli port is serviceable with 2 feeder vessels, one is TS Line and other is MOL, whose frequency to port is twice a week each

10. Visakhapatnam port is serviceable with feeder vessels twice a week

11. Kolkata port is serviceable with 2 feeder vessels are Mexicon Shipping, and Parma Shipping Each of their frequency to the port is every 15 days.

12. Haldia port is serviceable with 2 feeder vessels are Mexicon Shipping and Parma Shipping Each of their frequency to the port is every 15 days.

Table 88 Tabulated results of feeder-vessel connectivity to ports shortlisted in criteria d & e, for criteria g

Sr.no.	CEZ	Port	No of Feeder Vessels	Company	Frequency	Type
1	Kutch	Kandla	1	Paramount Shipping	Weekly	Feeder Vessel
		Kandla	2	Orient Liner / Parekh Shipping	Twice a week	Feeder Vessel
		Mundra	2	Paramount Shipping /Seimatech	Weekly	Feeder Vessel
		Mundra	2	Orient Liner / Parekh Shipping	Twice a week	Feeder Vessel
3	North Konkan	JNPT	2	Orient Liner / Parekh Shipping	Twice a week	Feeder Vessel
		Mumbai	NA	NA	NA	NA
6	Malabar	Kochi	3	BTL / Chakiat /Maersk Line	Weekly	Feeder Vessel
7	Mannar	Tuticorin	3	BTL / Chakiat /Maersk Line	Weekly	Feeder Vessel
9	VCIC South	Chennai	2	TS Line /MOL	Twice a week	Feeder Vessel
		Kattupalli	2	TS Line /MOL	Twice a week	Feeder Vessel
13	Gaud	Kolkata	2	Mexicon Shipping /Parma Shipping	Every 15 days	Feeder Vessel
		Haldia	2	Mexicon Shipping /Parma Shipping	Every 15 days	Feeder Vessel

Appendix 4: Availability of Cranes, Trailers, Side Loaders and Carriers or Ro-Ro services (criteria h, 4.1.3)

Interview no.: 004072017

Ref: page 40, para 3

Interviewer: Anjali Anit

Interviewee: Rajan S. (Blue Sea Shipping Agency Pvt. Ltd.) / P. Deshmukh (SCA Logistics Pvt. Ltd.) Mumbai

Date: 17th June 2017

Time: 11: 30 am

Q Do the Kandla, Mundra, Pipavav, Hazira, JNPT, Mangalore, Kochi, Tuticorin, Chennai, Kattupalli, Visakhapatnam, Kakinada, Kolkata, Haldia ports (ports in table 5-6) have cranes, trailers, side loaders and carriers?

A All the ports mentioned in the question make available the facility of cranes, trailers, side loaders and carriers (in the case of container transport).

Q Do the Kandla, Mundra, Pipavav, Hazira, JNPT, Mangalore, Kochi, Tuticorin, Chennai, Kattupalli, Visakhapatnam, Kakinada, Kolkata, Haldia ports (only the ones in table 5) have roro services?

A At present, none of the ports offer scheduled Ro-Ro services.

Appendix 5: Draft of Kolkata Port (criteria i, 4.1.3)

Interview no.: 005072017

Ref.: page 40, para 4

Interviewer: Anjali Anit

Interviewee: Rajan S. (Blue Sea Shipping Agency Pvt. Ltd.), Mumbai

Date: 17th June 2017

Time: 11: 30 am

Q What is the draft at Kolkata port?

A Kolkata port is the oldest operating in India, so port draft level is 5.5 meters

Appendix 6: Container Freight Stations in a 15-Km radius of Ports (criteria j, 4.1.3)

Interview no.: 006072017

Ref.: page 40, para 5

Interviewer: Anjali Anit

Interviewee: Mr. P. Deshmukh (SCA Logistics Pvt. Ltd.) Mumbai

Date: 17th June 2017 | Time: 11:30 am

Q No of CFS in radius of 15 km of given port

A All ports that fall under the CEZs listed by the Ministry of Shipping, Govt. of India, have container freight stations (CFS) in a radius of 15 km from the port.

Table 89 Tabulation of container freight stations at ports in the list, after Criteria d & e are applied, is as below:

Sr.no.	CEZ	State	Port	CFS Name	Location
1	Kutch	Gujarat	Kandla	Regal Shipping Pvt. Ltd.	Gandhidham-Kutch
				Liladhar Pasoo	KSEZ Kandla
				Desh Gujarat	Kandla Port
			Mundra	Seabird Marine Pvt. Ltd.	Mundra
				Liladhar Pasoo	Mundra
				Saurashtra CFS Pvt. Ltd.	Mundra
				Ameya Logistics	Mundra
				Adani Ports/SEZ	Mundra
2	Saurashtra	Gujarat	Pipavav	Gateway Distripark Ltd.	Pipavav
				Liladhar Pasoo	Pipavav
				Central Warehousing Corp.	Pipavav
				ACTL CFS	Pipavav
				APM Terminals Ltd.	Pipavav
3	Suryapur	Hazira	Hazira	Parekh Group	Hazira
4	North Konkan	Maharashtra	JNPT	Central Warehousing Corp.	Kalamboli
				Apollo Logisolution Pvt. Ltd.	Panvel
				Navkar Corp.	Panvel
				Continental Warehouse Corp.	Nhava Sheva
				Seabird Marine Agencies	Nhava Sheva
6	Dakshin	Karnataka	Mangalore	Sima Mulls Customs Free Bonded Warehouse	Mangalore
				Jay Narayan Shipping Co.	Mangalore
				Sulekha Mangalore	Mangalore
				Central Warehousing Corp.	Mangalore

Sr.no.	CEZ	State	Port	CFS Name	Location
7	Malabar	Kerala	Kochi	Kochi Bonded Warehouse	Ernakulam
				BLR Logistics	Kochi
				Cochin Port FTWZ	Cochin
8	Mannar	Tamil Nadu	Tuticorin	Central Warehousing Corp.	Tuticorin
				Tuticorin Warehousing	Madathur
				Kalmandapam Warehousing	Chennai
				Virugambakkam Warehousing	Chennai
10	VCIC South	Tamil Nadu	Chennai	ACME Warehousing Pvt. Ltd.	Chennai
				Continental Warehousing Pvt. Ltd.	Chennai
				Kaveri Warehousing	Chennai
				Custom Bonded Warehousing Corp.	Chennai
			Kattupalli	APM Terminal South Asia	Kattupalli
				Central Warehousing Corp.	Kattupalli
12	VCIC North	Andhra Pradesh	Visakhapatnam	SICAL Logistics	Visakhapatnam
				EULER Herms	Visakhapatnam
				Maha Murthy Logistics Pvt. Ltd.	Visakhapatnam
			Kakinada	Euler Hermes	Kakinada
				Mohasin Group of Companies	Kakinada
				Concor Logistics Park	Kakinada
14	Gaud	West Bengal	Kolkata	West Bengal State Warehousing Corporation	Kolkata
				BLR Logistics	Kolkata
				Veritas Logistics	Kolkata
			Haldia	Appejay Infralogistics Pvt. Ltd.	Haldia
				AL Logistics (Greenways) Pvt. Ltd.	Haldia
				LCL Logix Pvt. Ltd.	Haldia
				Amco Cargo System India Pvt. Ltd.	Haldia

Appendix 7: Charging points for reefers at Container Freight Stations (criteria j, 4.1.3)

Interview no.: 007072017

Ref.: page 40, para 5

Interviewer: Anjali Anit

Interviewee: Mr. Rajan S. (Blue Sea Shipping Agency Pvt. Ltd.) Mumbai

Date: 17th June 2017 | Time: 11: 30 am

Q Which container freight stations offer charging points for reefer containers?

A

1. CEZ Kutch: At Kandla port, there is 1 CFS service with 48 plug-points for reefer containers. At Mundra port there is 1 CFS service that has 24 refer plug points for reefer containers

2. Hazira port has 1 CFS service available with 6 reefer plugs

3. JNPT port has 3 CFS services with 3 plug points for reefer containers

4. Kochi port is having 1 CFS service available 11 plug points for reefer containers and also cold storage facility

5.Tuticorin port has 1 CFS service with 48 reefer charging points

6. Chennai port has 3 CFS services available. 1 CFS has 11 plug points and also cold storage facility, second CFS has 55 plug points for reefer and also cold storage facility, third CFS has 36 plug points for reefer containers

7. Kattupalli port has 1 CFS service available for plug point for reefer

8. Visakhapatnam port has 1 CFS service available 75 plug point for reefer, and also has cold storage facility

9. Kakinada port has 1 CFS service available 151 plug point for reefer, and also has cold storage facility

10. Kolkata port has 2 CFS services, 1 CFS has 22 plug point for reefer and also cold storage facility and other CFS is having 29 plug point for reefer

Table 90 Table for criteria j

Sr. no.	CEZ	Port	Plug Point (s) Available at CFS	CFS Name	Type
1	Kutch	Kandla	1	Kandla Port Trust	48 Reefer Points
		Mundra	1	Hind Terminals	24 Reefer Plug Points for Storage of Reefer Containers along aith Dg Power
3	Suryapur	Hazira	1	Parekh Group	6 Reefer Points
4	North Konkan	JNPT	3	Navkar Corp Ltd, New Mumbai,	92 Reefer Plugs and Cold Storage Facility
				EFC – Container Freight Station, MIDC road	52 Reefer Plugs and Reefer Gantry at CFS
				SBW Logistics Pvt. Ltd., CFS at Taloja	32 Reefer Plugs
7	Malabar	Kochi	1	Triway Container Freight Station	11 Plug Points and Cold Storage Facility
8	Mannar	Tuticorin	1	Concor Corp of India Ltd, near Madurai by-pass road, Tuticorin	48 Reefer Plugs
10	VCIC South	Chennai	3	Triway Container Freight Station	11 Plug Points and Cold Storage Facility
				Sanco Container Freight Station	55 Plug Points and Cold Storage Facility
				Concor Freight Station at Chennai	36 Plug Points
		Kattupalli	1	T G Terminals	Reefer Plug Points
12	VCIC North	Visakhapatnam	1	Alliance Shipping and Logistics /Gateway East India CFS	75 Reefer Plugs with Cold Storage Facility

Sr. no.	CEZ	Port	Plug Point (s) Available at CFS	CFS Name	Type
		Kakinada	1	Cochin Port CFS at Willington Island	151 Plug Points and Cold Storage Facility
14	Gaud	Kolkata	2	Century Container Freight Station JJP	22 Plug Points and Cold Storage Facility
				Century Container Freight Station Sonai	29 Plug Points

Appendix 8: Port-to-Port connectivity (4.1.4, Sc. 1)

Interview no.: 008072017

Ref.: page 44

Interviewer: Anjali Anit

Interviewee: Rajan S. (Blue Sea Shipping Agency Pvt. Ltd.) / P. Deshmukh (SCA Logistics Pvt. Ltd.), Mumbai

Date: 17th June 2017 | Time: 11:30 am

Q What is the connectivity from origin to destination ports in the potentially viable short sea shipping routes between the Indian CEZ pairs that have been shortlisted in section 4.1.4, Scenario 1?

A

1. Kandla Port is having connectivity with Mundra port thru feeder vessel & Barge service, Kandla port to JNPT port has connectivity through shipping line MSC Line

2. Mundra port is having connectivity with Kandla port thru Feeder vessel, Barge service and shipping line (SCI / Shreyas Shipping)

2.1 Mundra port is having connectivity with JNPT port thru Feeder vessel and shipping line

2.2 Mundra port is having connectivity with Kochi port thru shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

2.3 Mundra port is having connectivity with Tuticorin port thru shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

2.4 Mundra port is having connectivity with Kattupalli thru feeder vessel and shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

3. JNPT port is having connectivity with Mundra port thru feeder vessel and shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

4. Kochi port is having connectivity with Mundra port thru shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

4.1 Kochi port is having connectivity with Tuticorin port thru feeder vessel and shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

5. Tuticorin port is having connectivity with Mundra port thru shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

5.1 Tuticorin port is having connectivity with Kochi port thru shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

5.2 Tuticorin port is having connectivity with Kattupalli port thru shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

6. Chennai port is having connectivity with Kattupalli port thru Feeder vessel and shipping line bearing Indian flag vessel (SCI)

7. Kattupalli port is having connectivity with Mundra port thru shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

7.1 Kattupalli port is having connectivity with Kochi port thru shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

7.2 Kattupalli port is having connectivity with Tuticorin port thru shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

7.3 Kattupalli port is having connectivity with port Chennai thru Feeder vessel and shipping line bearing Indian flag vessel (SCI / Shreyas Shipping)

Table 91 Tabulation of above interview:

Name of the company	**Cargo Moved**	**Route**	**No. of Services**	**Frequency**	**Type**	**Ref**
Paramount Shipping	Empty Container	Kandla -Mundra - Jabeleli - Kandla	1	Weekly	Feeder Vessel	point 1 Kandla port
Arcadia Shipping & Trading Company	Import Container	Kandla -Mundra - Pipavav - Kandla	1	Weekly	Barge Service	point 1 Kandla port
MSC Line	Import / Export Container /Empty Container	Kandla - JNPT	1	Weekly	Shipping Line	
Orient Liner / Parekh Shipping	Import / Export Container /Empty Container	Kandla - Mundra - JNPT -Jabeleli	2	Twice a week	Feeder Vessel	point 1 Kandla port
MSC Line /CMA CGM / Hapag-Lloyd /Hamburg Sud/OOCL/APL/ NYK/YML/Emirat	Import / Export Container /Empty	Mundra - JNPT - Jabeleli	11	Weekly	Shipping Line	point 2 Mundra port

Name of the company	Cargo Moved	Route	No. of Services	Frequency	Type	Ref
es Shipping /KMTC/MOL	Container					
Seimatech	Import / Export Container /Empty Container	Mundra- JNPT	1	Weekly	Feeder Vessel	point 2 Mundra port
Seimatech / OEL	Import / Export Container /Empty Container	JNPT- Mundra	2	Weekly	Feeder Vessel	Point 3
BTL / Chakiat /Maersk Line	Import / Export Container /Empty Container	Colombo - Kochi - Colombo - Tuticorin - Colombo	3	Weekly	Feeder Vessel	point 4.3
TS Line	Import / Export Container /Empty Container	Kattupali - Chennai - Colombo	1	Twice a week	Feeder Vessel	point 7.3
MOL Feeder	Import / Export Container /Empty Container	Chennai - Kattupalli - Singapore -Port-Klang	1	Twice a week	Feeder Vessel	point 6 Chennai port

Source: Ministry of shipping Government on India, Vision for Coastal Shipping.

Link - shipping.nic.in

Table 92 Connectivity to port

Name of the company	Cargo Moved	Route	No.of Services	Frequency
Shreyas Shipping	Containers	Mundra - Cochin - Tuticorin - Mangalore - Hazira -Mundra	2	Weekly
Shreyas Shipping	Containers	Mundra -Hazira - Nhavasheva - Mundra - Karachi - Mundra	1	Every 10 days
Shreyas Shipping	Containers	Nhavasheva-Goa-Nhava Sheva-Pipavav-Nhava Sheva	1	Weekly
Shreyas Shipping	Containers	Mundra - Tuticorin - Visakhapatnam - Kattupalli - Tuticorin-Cochin -Jebel Ali - Mundra	2	Fortnightly
Shreyas Shipping	Containers	Visakhapatnam - Kolkata -Haldia - Visakhapatnam - Kakinada - Visakhapatnam	1	Weekly
SCI	Container	Mundra - Pipavav - Cochin - Tuticorin	3	Weekly

Appendix 9: Port-to-Port Connectivity (4.1.4, Sc. 2)

Interview no.: 009072017

Ref.: page 44

Interviewer: Anjali Anit

Interviewee: Rajan S. (Blue Sea Shipping Agency Pvt. Ltd.) / P. Deshmukh (SCA Logistics Pvt Ltd), Mumbai

Date: 17th June 2017 | Time: 11:30 am

Q What is the connectivity from origin to destination ports in the potentially viable short sea shipping routes between the Indian CEZ pairs that have been shortlisted in section 4.1.4, Scenario 2?

A

1. Mundra port has connectivity with Hazira port, JNPT port, Kochi port, Tuticorin port, Kattupalli port, Visakhapatnam port, Kakinada port through Indian flag-bearing vessel (SCI / Shreyas Shipping)

2. Hazira port is having connectivity with Mundra port and JNPT port through Indian flag-bearing vessel (SCI / Shreyas Shipping)

3. JNPT port is having connectivity with Mundra port through feeder vessel and through Indian flag-bearing vessel (SCI / Shreyas Shipping)

4. Kochi port is having connectivity with Mundra port, Hazira port, Tuticorin port through Indian flag-bearing vessel (SCI / Shreyas Shipping)

5. Tuticorin port is having connectivity with Mundra port, Hazira port, Kochi port, Kattupalli port, Visakhapatnam through Indian flag-bearing vessel (SCI / Shreyas Shipping)

6. Visakhapatnam port is having connectivity with Mundra port, Kochi, Tuticorin port, Kattupalli port through Indian flag-bearing vessel (SCI / Shreyas Shipping)

Source: Ministry of shipping Government of India under section Vision for Coastal Shipping.

Link - shipping.nic.in

Table 93 Connectivity to port

Name of the company	Cargo Moved	Route	No. of Services	Frequency
Shreyas Shipping	Containers	Mundra - Cochin - Tuticorin - Mangalore - Hazira -Mundra	2	Weekly
Shreyas Shipping	Containers	Mundra -Hazira - Nhavasheva - Mundra - Karachi - Mundra	1	Every 10 days
Shreyas Shipping	Containers	Mundra - Tuticorin - Visakhapatnam -Kattupalli - Tuticorin- Cochin -Jebel Ali - Mundra	2	Fortnightly
Shreyas Shipping	Containers	Visakhapatnam -Kolkata - Haldia - Visakhapatnam - Kakinada - Visakhapatnam	1	Weekly
SCI	Container	Mundra - Pipavav - Cochin - Tuticorin	3	Weekly

Appendix 10: Distance between all ports from selected CEZs and Hazira port

Interview no.: 010072017

Ref.: page 44

Interviewer: Anjali Anit

Interviewee: Mr. Gourab Nandi , Adani Hazira Port Pvt Ltd (AHPPL)

Date: 7th July 2017 | Time: 12:07 pm

Q What is the distance from Hazira port to Kandla port, Mundra port, JNPT port, Kochi port, Tuticorin port, Chennai port, Kattupalli port, Kakinada port, and Visakhapatnam port?

A A Nautical Mile from Hazira port to Kandla port – 420 nm, Hazira port to Mundra port – 396 nm , Hazira port to JNPT port – 257 nm, Hazira port to Kochi port – 866 nm ,Hazira port to Tuticorin port – 1113 nm , Hazira port to Chennai port – 1462 nm , Hazira port to Kattupalli port – 1472.8 , Hazira port to Kakinada port – 1812 , Hazira port to Visakhapatnam – 1881 nm.

Table 94 Distance between all ports from CEZ Suryapur and Hazira port

CEZ	ORIGIN		DESTINATION							
	Port	Kandla - Kutch	Mundra - Kutch	JNPT - North Konkan	Kochi - Malabar	Tuticorin - Mannar	Chennai - VCIC South	Kattupalli - VCIC South	Kakinada - VCIC North	Visakhapatnam - VCIC North
Suryapur	Hazira	420	396	257	866	1113	1462	1472.8	1812	1881

Appendix 11: PORT - PORT CALCULATION

Table 95 PORT - PORT CALCULATION (NAUTICAL MILES)

Sr.no.	CEZ	ORIGIN		DESTINATION								
		Port	Kandla - Kutch	Mundra - Kutch	Hazira - Suryapur	JNPT - North Konkan	Kochi - Malabar	Tuticorin - Mannar	Chennai - VCIC South	Kattupalli - VCIC South	Kakinada - VCIC North	Visakhapatnam - VCIC North
1	Kutch	Kandla		24	420	453	1063	1309	1658	1668.8	2008	2077
		Mundra	24		396	429	1039	1285	1634	1644.8	1984	2052
3	Suryapur	Hazira	420	396		257	866	1113	1462	1472.8	1812	1881
4	North Konkan	JNPT	453	429	257		611	857	1206	1216.8	1556	1625
7	Malabar	Kochi	1063	1039	866	611		267	616	626.8	966	1035
8	Mannar	Tuticorin	1309	1285	1113	857	267		349	359.8	699	767
10	VCIC South	Chennai	1658	1634	1462	1206	616	349		10.8	350	419
		Kattupalli	1668.8	1644.8	1472.8	1216.8	626.8	359.8	10.8		339.2	408.2
12	VCIC NORTH	Kakinada	2008	1984	1812	1556	966	699	350	339.2		68
		Visakhapatnam	2077	2052	1881	1625	1035	767	419	408.2	68	

Vessel Speed: 20 NM/ Hour

Note: The knot (/nɒt/) is a unit of speed equal to 1 nautical mile (1.852 km) per hour, approximately 1.151 mph. The ISO Standard symbol for the knot is kn.

Table 96 PORT - PORT CALCULATION (HOURS)

Sr.no.	CEZ	ORIGIN		DESTINATION								
		Port	Kandla - Kutch	Mundra - Kutch	Hazira - Suryapur	JNPT - North Konkan	Kochi - Malabar	Tuticorin - Mannar	Chennai - VCIC South	Kattupalli - VCIC South	Kakinada - VCIC North	Visakhapatnam - VCIC North
1	Kutch	Kandla		1.2	21	22.65	53.15	65.45	82.9	83.44	100.4	103.85
		Mundra	1.2		19.8	21.45	51.95	64.25	81.7	82.24	99.2	102.6
3	Suryapur	Hazira	21	19.8		12.85	43.3	55.65	73.1	73.64	90.6	94.05
4	North Konkan	JNPT	22.65	21.45	12.85		30.55	42.85	60.30	60.84	77.8	81.25
7	Malabar	Kochi	53.15	51.95	43.3	30.55		13.35	30.8	31.34	48.3	51.75
8	Mannar	Tuticorin	65.45	64.25	55.65	42.85	13.35		17.45	17.99	34.95	38.35
10	VCIC South	Chennai	82.9	81.7	73.1	60.30	30.8	17.45		0.54	17.5	20.95
		Kattupalli	83.44	82.24	73.64	60.84	31.34	17.99	0.54		16.96	20.41
12	VCIC NORTH	Kakinada	100.4	99.2	90.6	77.8	48.3	34.95	17.5	16.96		3.4
		Visakhapatnam	103.85	102.6	94.05	81.25	51.75	38.445	20.95	20.41	3.4	

Note: If the TAT is less than 24 hours we have taken it as 1 day and if the TAT is more than 24 hours, then, 2 days, and so on so forth - in the below table.

Table 97 PORT - PORT CALCULATION (DAYS)

Sr.no.	CEZ	ORIGIN	DESTINATION									
		Port	Kandla - Kutch	Mundra - Kutch	Hazira - Suryapur	JNPT - North Konkan	Kochi - Malabar	Tuticorin - Mannar	Chennai - VCIC South	Kattupalli - VCIC South	Kakinada - VCIC North	Visakhapatnam - VCIC North
1	Kutch	Kandla		1	1	1	3	3	4	4	5	5
		Mundra	1		1	1	3	3	4	4	5	5
3	Suryapur	Hazira	1	1		1	2	3	4	4	4	4
4	North Konkan	JNPT	1	1	1		2	2	3	3	4	4
7	Malabar	Kochi	3	3	2	2		1	2	2	3	3
8	Mannar	Tuticorin	3	3	3	2	1		1	1	2	2
10	VCIC South	Chennai	4	4	4	3	2	1		1	1	1
		Kattupalli	4	4	4	3	2	1	1		1	1
12	VCIC NORTH	Kakinada	5	5	4	4	3	2	1	1		1
		Visakhapatnam	5	5	4	4	3	2	1	1	1	

Appendix 12: Port-to-port turnaround time from origin to each destination port in each selected CEZ.

Table 98 Kandla port (CEZ Kutch)

CEZ	PORT		Post harvesting, sorting and loading at farm	On land to port	PDD	Transport at sea	PDA	On land to buyer	Total
	ORIGIN	**DESTINATION**							
	Kandla	Mundra	2	1	2	1	2	1	9
Kutch	Kandla	Hazira	2	1	2	1	2	1	9
	Kandla	JNPT	2	1	2	1	2	1	9
	Kandla	Kochi	2	1	2	3	2	1	11
	Kandla	Tuticorin	2	1	2	3	2	1	11
	Kandla	Chennai	2	1	2	4	2	1	12
	Kandla	Kattupalli	2	1	2	4	2	1	12
	Kandla	Kakinada	2	1	2	5	2	1	13
	Kandla	Visakhapatnam	2	1	2	5	2	1	13

Table 99 Mundra port (CEZ Kutch)

CEZ	PORT		Post harvesting, sorting and loading at farm	On land to port	PDD	Transport at sea	PDA	On land to buyer	Total
	ORIGIN	**DESTINATION**							
	Mundra	Kandla	2	1	2	1	2	1	9
Kutch	Mundra	Hazira	2	1	2	1	2	1	9
	Mundra	JNPT	2	1	2	1	2	1	9
	Mundra	Kochi	2	1	2	3	2	1	11
	Mundra	Tuticorin	2	1	2	3	2	1	11
	Mundra	Chennai	2	1	2	4	2	1	12
	Mundra	Kattupalli	2	1	2	4	2	1	12
	Mundra	Kakinada	2	1	2	5	2	1	13
	Mundra	Visakhapatnam	2	1	2	5	2	1	13

Table 100 Hazira port (CEZ Suryapur)

CEZ	PORT		Post harvesting, sorting and loading at farm	On land to port	PDD	Transport at sea	PDA	On land to buyer	Total
	ORIGIN	**DESTINATION**							
Suryapur	Hazira	Kandla	2	1	2	1	2	1	9
	Hazira	Mundra	2	1	2	1	2	1	9
	Hazira	JNPT	2	1	2	1	2	1	9
	Hazira	Kochi	2	1	2	2	2	1	10
	Hazira	Tuticorin	2	1	2	3	2	1	11
	Hazira	Chennai	2	1	2	4	2	1	12
	Hazira	Kattupalli	2	1	2	4	2	1	12
	Hazira	Kakinada	2	1	2	4	2	1	12
	Hazira	Visakhapatnam	2	1	2	4	2	1	12

Table 101 JNPT port (CEZ North Konkan)

CEZ	PORT		Post harvesting, sorting and loading at farm	On land to port	PDD	Transport at sea	PDA	On land to buyer	Total
	ORIGIN	**DESTINATION**							
North Konkan	JNPT	Kandla	2	1	2	1	2	1	9
	JNPT	Mundra	2	1	2	1	2	1	9
	JNPT	Hazira	2	1	2	1	2	1	9
	JNPT	Kochi	2	1	2	2	2	1	10
	JNPT	Tuticorin	2	1	2	2	2	1	10
	JNPT	Chennai	2	1	2	3	2	1	11
	JNPT	Kattupalli	2	1	2	3	2	1	11
	JNPT	Kakinada	2	1	2	4	2	1	12
	JNPT	Visakhapatnam	2	1	2	4	2	1	12

Table 102 Kochi port (CEZ Malabar)

CEZ	PORT		Post harvesting, sorting and loading at farm	On land to port	PDD	Transport at sea	PDA	On land to buyer	Total
	ORIGIN	**DESTINATION**							
Malabar	Kochi	Kandla	2	1	2	3	2	1	11
	Kochi	Mundra	2	1	2	3	2	1	11
	Kochi	Hazira	2	1	2	2	2	1	10
	Kochi	JNPT	2	1	2	2	2	1	10
	Kochi	Tuticorin	2	1	2	1	2	1	9
	Kochi	Chennai	2	1	2	2	2	1	10
	Kochi	Kattupalli	2	1	2	2	2	1	10
	Kochi	Kakinada	2	1	2	3	2	1	11
	Kochi	Visakhapatnam	2	1	2	3	2	1	11

Table 103 Tuticorin port (CEZ Mannar)

CEZ	PORT		Post harvesting, sorting and loading at farm	On land to port	PDD	Transport at sea	PDA	On land to buyer	Total
	ORIGIN	**DESTINATION**							
Mannar	Tuticorin	Kandla	2	1	2	3	2	1	11
	Tuticorin	Mundra	2	1	2	3	2	1	11
	Tuticorin	Hazira	2	1	2	3	2	1	11
	Tuticorin	JNPT	2	1	2	2	2	1	10
	Tuticorin	Kochi	2	1	2	1	2	1	9
	Tuticorin	Chennai	2	1	2	1	2	1	9
	Tuticorin	Kattupalli	2	1	2	1	2	1	9
	Tuticorin	Kakinada	2	1	2	2	2	1	10
	Tuticorin	Visakhapatnam	2	1	2	2	2	1	10

Table 104 Chennai port (CEZ VCIC South)

CEZ	PORT		Post harvesting, sorting and loading at farm	On land to port	PDD	Transport at sea	PDA	On land to buyer	Total
	ORIGIN	**DESTINATION**							
VCIC South	Chennai	Kandla	2	1	2	4	2	1	12
	Chennai	Mundra	2	1	2	4	2	1	12
	Chennai	Hazira	2	1	2	4	2	1	12
	Chennai	JNPT	2	1	2	3	2	1	11
	Chennai	Kochi	2	1	2	2	2	1	10
	Chennai	Tuticorin	2	1	2	1	2	1	9
	Chennai	Kattupalli	2	1	2	1	2	1	9
	Chennai	Kakinada	2	1	2	1	2	1	9
	Chennai	Visakhapatnam	2	1	2	1	2	1	9

Table 105 Kattupalli port (CEZ VCIC South)

CEZ	PORT		Post harvesting, sorting and loading at farm	On land to port	PDD	Transport at sea	PDA	On land to buyer	Total
	ORIGIN	**DESTINATION**							
VCIC South	Kattupalli	Kandla	2	1	2	4	2	1	12
	Kattupalli	Mundra	2	1	2	4	2	1	12
	Kattupalli	Hazira	2	1	2	4	2	1	12
	Kattupalli	JNPT	2	1	2	3	2	1	11
	Kattupalli	Kochi	2	1	2	2	2	1	10
	Kattupalli	Tuticorin	2	1	2	1	2	1	9
	Kattupalli	Chennai	2	1	2	1	2	1	9
	Kattupalli	Kakinada	2	1	2	1	2	1	9
	Kattupalli	Visakhapatnam	2	1	2	1	2	1	9

Table 106 Visakhapatnam port (CEZ VCIC North)

CEZ	PORT		Post harvesting, sorting and loading at farm	On land	PDD	Transport at sea	PDA	On land	Total
				to port				to buyer	
	ORIGIN	**DESTINATION**							
VCIC North	Visakhapatnam	Kandla	2	1	2	5	2	1	13
	Visakhapatnam	Mundra	2	1	2	5	2	1	13
	Visakhapatnam	Hazira	2	1	2	4	2	1	12
	Visakhapatnam	JNPT	2	1	2	4	2	1	12
	Visakhapatnam	Kochi	2	1	2	3	2	1	11
	Visakhapatnam	Tuticorin	2	1	2	2	2	1	10
	Visakhapatnam	Chennai	2	1	2	1	2	1	9
	Visakhapatnam	Kattupalli	2	1	2	1	2	1	9
	Visakhapatnam	Kakinada	2	1	2	1	2	1	9

Table 107 Kakinada port (CEZ VCIC North)

CEZ	PORT		Post harvesting, sorting and loading at farm	On land	PDD	Transport at sea	PDA	On land	Total
				to port				to buyer	
	ORIGIN	**DESTINATION**							
VCIC North	Kakinada	Kandla	2	1	2	5	2	1	13
	Kakinada	Mundra	2	1	2	5	2	1	13
	Kakinada	Hazira	2	1	2	4	2	1	12
	Kakinada	JNPT	2	1	2	4	2	1	12
	Kakinada	Kochi	2	1	2	3	2	1	11
	Kakinada	Tuticorin	2	1	2	2	2	1	10
	Kakinada	Chennai	2	1	2	1	2	1	9
	Kakinada	Kattupalli	2	1	2	1	2	1	9
	Kakinada	Visakhapatnam	2	1	2	1	2	1	9

Appendix 13: Selected products with their average production quantities (in MT) and total quantities per CEZ for each of the seven CEZs

Table 108 CEZ Kutch

Districts	Fruits					Vegetables				
	Banana	Pomegranate	Papaya	Date	Mango	Cabbage	Onion	Eggplant	Okra	Tomato
Kutch	70767	24059	174601	102778	50998	8715	61233	26275	5443	25692
Total	70767	24059	174601	102778	50998	8715	61233	26275	5443	25692
Rank	3	5	1	2	4	4	1	3	5	2

Table 109 CEZ Suryapur

Districts	Fruits							Vegetables					
	Banana	Papaya	Mango	Indian Jujube	Guava	Sapota	Coconut	Cucurbits	Tomato	Okra	Eggplant	Cowpea	Cauliflower
Baruch	1078330	56333	23363	6923	6141			51483	11227	24060	26186	6783	
Surat	527789	28247	67838			42773	1794	40005	28892	121810	81673		22917
Navsari	104000	16660	208367			75632	4259	120894	21510	59276	43743	6310	
Total	1710119	101240	299568	6923	6141	118405	6053	212382	61629	205146	151602	13093	22917
Rank	2	4	1	5	6	3	7	1	4	2	3	6	5

Table 110 CEZ North Konkan

Districts	Fruits			Vegetables	
	Banana	Grapes	Mango	Onion	Tomato
Nasik		373306	14413	1513359	152371
Thane	6648		13225		7895
Pune	67585	75755		598190	56606
Raigad	990		19415		2846
Total	75223	449061	47053	2111549	219718
Rank	2	1	3	1	2

Table 111 CEZ Malabar

Districts	Fruits					Vegetables			
	Banana	Coconut	Mango	Papaya	Pineapple	Drumstick	Ginger	Sweet Potato	Tapioca
Ernakulam	499918	216000000	27837	7585	54951	610	319	51	215452
Alappuzha	4405	222666667	18409	7587	547	301	271	43	74322
Kolam	17402	410666667	49480	3318	3241	2124	788	29	587113
Thiruvananthapuram	19681	589333333	26154	9426	1839	3018	165	97	489392
Total	541406	1438666667	121880	27916	60578	6053	1543	220	1366279
Rank	2	1	3	5	4	2	3	4	1

Table 112 CEZ Mannar

Districts	Fruits							Vegetables						
	Banana	Coconut	Jackfruit	Mango	Pineapple	Grapes	Pomefruit	Okra	Eggplant	Ginger	Sweet Potato	Tapioca	Onion	Tomato
Kanyakumari	193729	148629966.7	8144	2144	1061			209	738	123	426	113761		
Tirunelveli	219766	95168600		21006		554	2287	2356	2533			5748	20155	6931
Total	413495	243798566.7	8144	23150	1061	554	2287	2565	3271	123	426	119509	20155	6931
Rank	2	1	4	3	6	7	5	5	4	7	6	1	2	3

Table 113 CEZ VCIC South

Districts	Fruits					Vegetables				
	Coconut	Banana	Mango	Guava	Watermelon	Tapioca	Sweet Potato	Okra	Eggplant	Tomato*
Tiruvallur	5904833	50794	77005	800		2718	131	1369	6778	76
Kancheepuram	19944567	13322	16314			2665	262	3536	6189	437
Total	25849400	64116	93319	800		5383	393	4905	12967	513
Rank	1	3	2	4		2	5	3	1	4

Table 114 CEZ VCIC North

Districts	Fruits							Vegetables						
	Banana	Coconut	Lemon	Papaya	Sapota	Mango	Orange	Beans & mutter	Okra	Onion	Tomato	Cabbage	Tapioca	Eggplant
Guntur	193213	2094667	36441	26100	11864			2927	12210	1159	24985			13779
Krishna	38507	35997000		8365	5170	528158		1454	5383		16845	2197		9625
West Godavari	255541	524369333	28951	27829		89485		19135	1589		5940		1250	13892
East Godavari	282892	743674000		25235		170446	16358		12717	10946	15181		174763	20293
Visakhapatnam	22984	112446000		9036	591	106017		10649		3827	16867		2064	10395
Vizianagaram	126096	337780000		43369	1330	117548			3571	5321	12329	3319		7208
Srikakulam	41204	294986333		4441	313	766608			1906	16969	8479	4041		7562
Total	960437	2051347333	65392	144375	19268	1778262	16358	34165	37376	38222	100626	9557	178077	82754
Rank	3	1	5	4	6	2	7	6	5	4	2	7	1	3

Appendix 14: District-wise three-year as well as average production data in each of the selected CEZs.

Table 115 CEZ Kutch

Sr No.	Product	Production across most recent three years (MT)			Average Production (MT)	Harvest Seasons	Data years considered
District: Kutch							
	FRUITS						
1	Banana	16160	97450	98690	70767	Whole Year	2000, 2012, 2014
2	Pomegranate	3437	44681		24059	February, March, April	2000, 2014
3	Papaya	9500	212017	302286	174601	Whole Year	2000, 2012, 2014
4	Date	53838		151718	102778	March , April, May, June	2000, 2014
5	Mango	12730	62415	77850	50998	April, May , June	2000, 2012, 2014
	VEGETABLES						
1	Cabbage	2025	9428	14693	8715	February, March	2000, 2012, 2015
2	Onion	23100	22700	46300	61233	September, November, December, January, Febuary,March,April, May	2005, 2006, 2007
3	Eggplant	6715	22590	49521	26275	July , August, September	2000, 2012, 2015
4	Okra	2465	7147	6716	5443	April, May, June	2000, 2012, 2015
5	Tomato	2490	29760	44827	25692	January, February, March, April	2000, 2012, 2015

Table 116 CEZ Suryapur

Sr No.	Product	Production across most recent three years (MT)			Average Production (MT)	Harvest Seasons	Data years considered
District: Bharuch							
	FRUITS						
1	Banana	1092634	1059100	1083255	1078330	Whole Year	2012, 2013, 2014
2	Papaya	65840	57399	45759	56333	Whole Year	2012, 2013, 2014
3	Mango	24528	22348	23214	23363	April, May , June	2012, 2013, 2014
4	Indian Jujube	6875	6863	7031	6923	October, November	2011, 2013, 2014
5	Guava	6080	6131	6211	6141	Whole Year	2012, 2013, 2014
	VEGETABLES						
1	Cucurbits	31588	60085	62776	51483	August, September, October	2011, 2013, 2014
2	2. Tomato	8910	11993	12778	11227	January, February, March, April	2012, 2013, 2014
3	3.Okra	22662	22990	26528	24060	April, May June	2012, 2013, 2014
4	4.Brinjal	22321	26892	29346	26186	July , August, September	2012, 2013, 2014
5	5.Cowpea	6751	6460	7138	6783	June, July August	2011, 2013, 2014
District: Surat							
	FRUITS						
1	1. Banana	520093	589450	473824	527789	Whole Year	2011, 2012, 2013
2	2. Mango	63200	64400	75914	67838	April, May , June	2011, 2012, 2013
3	3. Sapota	63200		22345	42773	January, February, May, June	2011, 2013
4	4. Papaya	31960	31920	20862	28247	Whole Year	2011, 2012, 2013
5	5. Coconut	1747		1840	1794	Whole Year	2011, 2013
	VEGETABLES						
1	1. Okra	122271	118035	125125	121810	April, May June	2011, 2012, 2013

Sr No.	Product	Production across most recent three years (MT)			Average Production (MT)	Harvest Seasons	Data years considered
2	2.Brinjal	82215	70540	92264	81673	July , August, September	2011, 2012, 2013
3	3.Cucurbits	23985		56025	40005	July , August, September	2011, 2013
4	4.Tomato	22412	28200	36064	28892	January, February, March, April	2011, 2012, 2013
5	5. Cauliflower	19100	25250	24400	22917	February, March	2011, 2012, 2013
District: Navsari							
	FRUITS						
1	1. Mango	201600	213066	210436	208367	April, May, June	2011, 2012, 2013
2	2.Banana	75000	120850	116150	104000	Whole Year	2011, 2012, 2013
3	3. Chiku	74400		76863	75632	January, February, may, June	2011, 2013
4	4.Papaya	16120		17199	16660	Whole Year	2011, 2013
5	5.Coconut	4500		3818	4159	Whole Year	2011, 2013
	VEGETABLES						
1	1. Cucurbits	132250		109538	120894	August, September, October	2011, 2013
2	2.Okra	56400	62140	59287	59276	April, May June	2011, 2012, 2013
3	3.Brinjal	43365	43617	44247	43743	July , August, September	2011, 2012, 2013
4	4. Tomato	19740	20640	24150	21510	January, February, March, April	2011, 2012, 2013
5	5. Cowpea	6160		6459	6310	June, July August	2011, 2013

Table 117 CEZ North Konkan

Sr No.	Product	Production across most recent three years (MT)		Average Production (MT)		Harvest Seasons	Data years considered
District: Nasik							
	FRUITS						
1	1.Grapes	733515		13096	373306	February, March, April	2002, 2012
2	2.Mango	10310		18515	14413	May, June, July	2002, 2012
	VEGETABLES						
1	1.Onion	793741		2232976	1513359	August ,September, October	2002, 2012
2	2.Tomato	8431		296311	152371	March, April, May	2002, 2012
District: Thane							
	FRUITS						
1	1.Banana	11670		1625	6648	Whole Year	2002, 2012
2	2. Mango	14000		12450	13225	May, June, July	2002, 2012
	VEGETABLES						
1	1.Tomato	1149		14640	7895	March, April, May	2002, 2012
District: Pune							
	FRUITS						
1	1. Banana	76350		58819	67585	Whole Year	2002, 2012
2	2. Grapes	17202		14307	15755	February, March, April	2002, 2012
	VEGETABLES						
1	1.Onion	325210		871169	598190	August ,September, October	2002, 2012
2	2.Tomato	25412		87799	56606	March, April, May	2002, 2012

District: Raigadh							
	FRUITS						
1	1.Banana	1730		250	990	Whole Year	2002, 2012
2	2. Mango	18670		20160	19415	May, June, July	2002, 2012
	VEGETABLES						
1	1. Tomato	1011		4680	2846	March, April, May	2002, 2012

Table 118 CEZ Malabar

Sr No.	Product	Production across most recent three years (MT)			Average Production (MT)	Harvest Seasons	Data years considered
District: Ernakulam							
	FRUITS						
1	1.Banana	50746	54056	44953	49918	Whole Year	2012, 2013, 2014
2	2.Coconut	209000000	227000000	212000000	216000000	Whole Year	2012, 2013, 2014
3	3. Mango	17262	32276	33978	27839	March, April	2003, 2012, 2013
4	4. Papaya	7248	7115	8391	7585	Whole Year	2002, 2003, 2012
5	5. Pineapple	56478	57669	50706	54951	May, June, July, August	2002, 2003, 2012
	VEGETABLES						
1	1.Drumstick	675	563	593	611	March,April,July, August,September	2003, 2012, 2013
2	2.Ginger	388	304	265	319	December , January, February	2012, 2013, 2014
3	3.SweetPotato	46	72	36	51	May, June, September, October	2012, 2013, 2014
4	4. Tapioca	211550	205464	229341	215452	July, August, September, October	2012, 2013, 2014
District: Alappuzha							

	FRUITS						
1	1.Banana	5002	4481	3733	4405	Whole Year	2012, 2013, 2014
2	2. Coconut	233000000	217000000	218000000	222666667	Whole Year	2012, 2013, 2014
3	3.Mango	16221	18300	20707	18409	March, April	2012, 2013, 2014
4	4. Pineapple	392	569	681	547	Whole Year	2003, 2012, 2014
5	5.Papaya	5581	9255	7925	7587	May, June, July, August	2003, 2012, 2014
	VEGETABLES						
1	1.Drumstick	277	292	334	301	March,April,July, August,September	2012, 2013, 2014
2	2.Ginger	261	292	261	271	December , January, February	2012, 2013, 2014
3	3.SweetPotato	21	33	75	43	May, June, September, October	2012, 2013, 2014
4	4. Tapioca	72919	62212	87834	74322	July, August, September, October	2012, 2013, 2014
District: Kolam							
	FRUITS						
1	1.Banana	16022	19151	17032	17402	Whole Year	2012, 2013, 2014
2	2.Coconut	372000000	473000000	387000000	410666667	Whole Year	2012, 2013, 2014
3	3.Mango	27296	62540	58605	49480	March, April	2003, 2012, 2013
4	4.Papaya	1021	1042	7891	3318	Whole Year	2002, 2003, 2012
5	5. Pineapple	4497	4206	1019	3241	May, June, July, August	2002, 2003, 2012
	VEGETABLES						
1	1.Drumstick	3224	1648	1501	2124	March,April,July, August,September	2012, 2013, 2014
2	2.Ginger	819	716	828	788	December , January, Febuary	2012, 2013, 2014

3	3.SweetPotato	22	22	44	29	May, June, September, October	2012, 2013, 2014
4	4.Tapioca	531482	568257	661600	587113	July, August, September, October	2012, 2013, 2014
District: Thiruvananthapuram							
	FRUITS						
1	1.Banana	24290	18753	15999	19681	Whole Year	2012, 2013, 2014
2	2.Coconut	552000000	551000000	665000000	589333333	Whole Year	2012, 2013, 2014
3	3.Mango	24264	25617	28582	26154	March, April	2003, 2012, 2013
4	4.Papaya	6855	6979	14443	9426	Whole Year	2002, 2003, 2012
5	5.Pineapple	2207	2005	1306	1839	May, June, July, August	2002, 2003, 2012
	VEGETABLES						
1	1. Drumstick	3585	2661	2807	3018	March,April,July, August,September	2003, 2012, 2013
2	2.Ginger	154	138	203	165	December , January, Febuary	2012, 2013, 2014
3	3.SweetPotato	147	77	66	97	May, June, September, October	2012, 2013, 2014
4	4.Tapioca	414271	467512	586394	489392	July, August, September, October	2012, 2013, 2014

CEZ Mannar

Sr No.	Product	Production across most recent three years (MT)			Average Production (MT)	Harvest Seasons	Data years considered
District: Kanyakumari							
	FRUITS						
1	1.Banana	219970	163039	198178	193729	Whole year	2009, 2011, 2013
2	2.Coconut	389900	158400000	287100000	148629967	June,July,August,September	2009, 2011, 2013
3	3.Jackfruit	8819	7469		8144	Whole year	2009, 2011, 2013
4	4.Mango	2955	1333		2144	March, April, May, June	2002, 2003
5	5.Pineapple	1578	543		1061	Whole year	2002, 2003
	VEGETABLES						
1	1.Okra	194	224		209	March,July,August, September	2002, 2003
2	2.Eggplant	335	1141		738	February,March,July, August	2002, 2003
3	3.Ginger	225	110	35	123	Whole year	2009, 2011, 2013
4	4.SweetPotato	230	1035	13	426	January, Febuary	1997, 1998, 2008
5	5.Tapioca	189581	115400	36303	113761	July, August, September	2009, 2011, 2013
District: Tirunelveli							
	FRUITS						
1	1.Banana	235570	211954	211773	219766	Whole year	2009, 2011, 2013
2	2.Coconut	205800	128000000	157300000	95168600	June,July,August,September	2009, 2011, 2013
3	3.Grapes	566	541		554	April,May,August,September	2002, 2003
4	4.Mango	28716	13296		21006	March, April, May, June	2002, 2003
5	5.Pome Fruit(Apple, Pears)	1836	2738		2287	July,August,September	2002, 2003
	VEGETABLES						
1	1. Okra	2644	2067		2356	March,July,August, September	2002, 2003
2	2.Eggplant	3062	2003		2533	February,March,July, August	2002, 2003

3	3.Onion	26371	24035	10059	20155	September, October	2009, 2011, 2013
4	4.Tapioca	5894	7908	3441	5748	July, August, September	2009, 2011, 2013
5	5.Tomato	7255	6607		6931	September,October	2002, 2003

Table 119 CEZ VCIC South

Sr No.	Product	Production across most recent three years (MT)			Average Production (MT)	Harvest Seasons	Data years considered
District: Thiruvallur							
	FRUITS						
1	1. Banana	75048	47846	29489	50794	Whole Year	2009, 2010, 2013
2	2. Coconut	14500	10200000	7500000	5904833	June, July, August, September	2009, 2010, 2013
3	3.Mango	71255	33114	126646	77005	March, April, May, June	2002, 2003, 2013
4	4.Guava	800 (average of 3 years)			800	6 months	2006, 2007, 2008
	VEGETABLES						
1	1. Sweet Potato	27	292	73	131	January, Febuary	2007, 2008, 2009
2	2. Tapioca	3516	3201	1436	2718	July, August, September	2009, 2011, 2013
3	3. Eggplant	3086	2790	14457	6778	Febuary, March, July, August	2003, 2006, 2013
4	4. Okra	1401	1337		1369	March, July, August, September	2002, 2003
5	5.Tomato *	76			76		2006
District: Kancheepuram							
	FRUITS						
1	1. Coconut	33700	25900000	33900000	19944567	June, July, August, September	2009, 2011, 2013

2	2. Banana	16352	12340	11273	13322	Whole Year	2006, 2009, 2011
3	3. Mango	5902	18917	24122	16314	March, April, May, June	2003, 2006, 2013
4	4.Guava	3696		1356 (estd.)	2526		2006, 2013
5	5.Watermelon	n/a					
	VEGETABLES						
1	1. Tapioca	551	3465	3980	2665	July, August, September	2009, 2011, 2013
2	2. Sweet Potato	480	199	106	262	January, Febuary	2006, 2008, 2013
3	3. okra	1851	5175	3582	3536	March, July, August, September	2002, 2003, 2006
4	4. Eggplant	2388	9185	6994	6189	Febuary, March, July, August	2002, 2003, 2006
	5. Tomato	296	599	417	437	September, October	2002, 2003, 2006

Table 120 CEZ VCIC North

Sr No.	**Product**	**Production across most recent three years (MT)**			**Average Production (MT)**	**Harvest Seasons**	**Data years considered**
District: Guntur							
	FRUITS						
1	1.Banana	151597	216308	211734	193213	Whole year	2010, 2011, 2013
2	2.Coconut	2016000	1840000	2428000	2094667	Whole year	2012, 2013, 2014
3	3.Lemon	35068	36743	37512	36441	October, November	2012, 2013, 2014
4	4.Papaya	35076	29369	13856	26100	Whole year	2012, 2013, 2014
5	5.Sapota	12933	11833	10826	11864	October, November	2012, 2013, 2014
	VEGETABLES						
1	1. Beans & Mutter	2348	3505		2927	July, August September	2002, 2003

2	2.Okra	10018	14402		12210	April , May, September, October	2002, 2003
3	3.Brinjal	11265	7076	22995	13779	September, October, Febuary, March	2012, 2013, 2014
4	5.Tomato	35211	26002	13742	24985	October , November, March, April	2012, 2013, 2014
5	5.Tomato	35211	26002	13742	24985	October , November, March, April	2012, 2013, 2014
District: Krishna							
	FRUITS						
1	1.Banana	33847	35937	45738	38507	Whole year	2010, 2011, 2013
2	2.Coconut	34309000	34029000	39653000	35997000	Whole year	2012, 2013, 2014
3	3.Mango	436226	484781	663468	528158	October , November, March, April	2012, 2013, 2014
4	4.Papaya	8715	6853	9526	8365	Whole year	2012, 2013, 2014
5	5. Sapota	6112	4873	4526	5170	October, November	2012, 2013, 2014
	VEGETABLES						
1	1. Beans & Mutter	922	1985		1454	July, August September	2002, 2003
2	2. Okra	5093	5673		5383	April , May, September, October	2002, 2003
3	3. Brinjal	10945	7392	10537	9625	September, October, Febuary, March	2012, 2013, 2014
4	4.Cabbage	3317	2891	382	2197	October, November,March, April	2012, 2013, 2014
5	5.Tomato	20554	16380	13601	16845	October , November, March, April	2012, 2013, 2014
District: West Godavari							
	FRUITS						
1	1.Banana	212967	348290	205367	255541	Whole year	2010, 2011, 2013
2	2.Coconut	405213000	448904000	718991000	524369333	Whole year	2012, 2013, 2014

3	3.Lemon	30138	26829	29885	28951	October, November	2012, 2013, 2014
4	4.Mango	101832	62600	104022	89485	October , November, March, April	2012, 2013, 2014
5	5.Papaya	33442	32012	18034	27829	Whole year	2012, 2013, 2014
	VEGETABLES						
1	1. Beans & Mutter	2212	1615		1914	July, August September	2002, 2003
2	2.Okra	1511	1667		1589	April , May, September, October	2002, 2003,
3	3.Brinjal	16736	7663	17276	13892	September, October, Febuary, March	2012, 2013, 2014
4	4.Tapioca	840	1528	1381	1250	Whole year	2011, 2012, 2013
5	5.Tomato	5388	6349	6083	5940	October , November, March, April	2012, 2013, 2014
District: East Godavari							
	FRUITS						
1	1.Banana	392291	302514	153871	282892	Whole year	2010, 2011, 2013
2	2.Coconut	729965000	720895000	780162000	743674000	Whole year	2012, 2013, 2014
3	3.Mango	157496	162814	191027	170446	October , November, March, April	2012, 2013, 2014
4	4.Orange	17315	15401		16358	Whole year	2002, 2003
5	5.Papaya	25164	26530	24011	25235	Whole year	2012, 2013, 2014
	VEGETABLES						
1	1.Okra	13947	11486		12717	April , May, September, October	2002, 2002
2	2.Brinjal	29399	16447	15032	20293	September, October, Febuary, March	2012, 2013, 2014
3	3.Onion	10773	11463	10602	10946	October , November, March, April	2012, 2013, 2014
4	4.Tapioca	124228	208870	191193	174764	Whole year	2011, 2012, 2013

5	5.Tomato	15939	15245	14360	15181	October , November, March, April	2012, 2013, 2014
District: Visakhapatnam							
	FRUITS						
1	1.Banana	18459	22833	27661	22984	Whole year	2010, 2011, 2013
2	2.Coconut	99838000	76721000	160779000	112446000	Whole year	2012, 2013, 2014
3	3.Mango	127051	153771	37229	106017	October , November, March, April	2012, 2013, 2014
4	4.Papaya	10349	9594	7164	9036	Whole year	2012, 2013, 2014
5	5.Sapota	713	348	711	591	October, November	2012, 2013, 2014
	VEGETABLES						
1	1.Beans & Peas	8162	13135		10648.5	July, August September	2002, 2003
2	2.Brinjal	13638	9397	8150	10395	September, October, Febuary, March	2012, 2013, 2014
3	3.Onion	3757	4167	3558	3827	October , November, March, April	2012, 2013, 2014
4	4.Tapioca	2251	2302	1639	2064	Whole year	2011, 2012, 2013
5	5.Tomato	17949	19441	13210	16867	October , November, March, April	2012, 2013, 2014
District: Vizianagaram							
	FRUITS						
1	1.Banana	167277	133645	77367	126096	Whole year	2010, 2011, 2013
2	2.Coconut	43552000	43592000	14190000	33778000	Whole year	2012, 2013, 2014
3	3.Mango	100555	120554	131536	117548	October , November, March, April	2012, 2013, 2014
4	4.Papaya	41606	28540	59961	43369	Whole year	2012, 2013, 2014
5	5.Sapota	1690	1204	1096	1330	October, November	2012, 2013, 2014
	VEGETABLES						

1	1.Okra	3243	3898		3571	April , May, September, October	2002, 2003
2	2.Brinjal	7460	6076	8087	7208	September, October, Febuary, March	2012, 2013, 2014
3	3.Cabbage	4950	3097	1910	3319	October , November, March, April	2012, 2013, 2014
4	4.Onion	6300	4695	4967	5321	October , November, March, April	2012, 2013, 2014
5	5.Tomato	12624	12007	12355	12329	October , November, March, April	2012, 2013, 2014
District: Srikakulam							
	FRUITS						
1	1.Banana	21745	54319	47549	41204	Whole year	2010, 2011, 2012
2	2.Coconut	306951 000	249859 000	328149 000	294986333	Whole year	2012, 2013, 2014
3	3.Mango	115045	57047	57731	76608	October , November, March, April	2012, 2013, 2014
4	4.Papaya	4902	4405	4015	4441	Whole year	2012, 2013, 2014
5	5.Sapota	436	310	192	313	October, November	2012, 2013, 2014
	VEGETABLES						
1	1.Okra	1911	1901		1906	April , May, September, October	2010, 2011, 2012
2	2.Brinjal	8313	5805	8568	7562	September, October, Febuary, March	2012, 2013, 2014
3	3.Cabbage	5713	4073	2337	4041	October , November, March, April	2012, 2013, 2014
4	4.Onion	21064	18446	11398	16969	October , November, March, April	2012, 2013, 2014
5	5.Tomato	6861	8445	10131	8479	October , November, March, April	2012, 2013, 2014

Appendix 15: Perishability of Fruits and Vegetables

Table 121 Perishability of Fruits

		*Source: UCDAVIS**			
S.NO.	**FRUITS**	**Reefer/Cold Chain**			
		Minimum (in days)	**Maximum (in days)**	**Average no of days(a)**	**Available no. of days for logistics (a-5)**
1	Papaya	7	21	14	9
2	Date	180	360	270	265
3	Mango	14	21	17	12
4	Pomegranate	60	90	75	70
5	Banana	7	28	17	12
6	Sapota	14	14	14	9
7	Indian Jujube		28	14	9
8	Grapes	30	180	105	100
9	Coconut	30	60	45	40
10	Pineapple	14	28	21	16
11	Jackfruit	14	28	21	16
12	Pomefruit (apple/pear)	30	60	45	40
13	Guava	14	21	17	12
14	Watermelon	14	21	17	12
15	Lemon	14	14	14	9

Table 122 Perishability of Vegetables

		Source: UCDAVIS			
S.No.	**VEGETABLES**	**Reefer/Cold Chain**			
	(in days)	**Minimum**	**Maximum**	**Average no of days(a)**	**Available no. of days for logistics (a-5)**
1	Onion	30	240	135	130
2	Tomato	14	35	24	19
3	Brinjal/eggplant	7	14	10	5
4	Cabbage	21	42	31	26
5	Ladyfinger/okra	7	10	8	3
6	Cucurbits	10	14	12	7
7	Cauliflower	21	28	24	19
8	Tapioca	Data not available			
9	Drumstick	Data not available			
10	Ginger	180	180	180	175
11	Sweet potato	120	210	165	160

Appendix 16: Oversupply calculations for each of the selected CEZs.

Table 123

OVERSUPPLY TABLE- (VEGETABLES & FRUITS) IN CEZ - KUTCH									
S.No.	**Vegetable/Fruit**	**Harvest Months**	**Production (in kgs.)**	**Population (2011)**	**Production kg/month/person (a)**	**Consumption (kgs)/month/person (b) (2011-12)**	**formula for over supply**	**result (2b)**	**Oversupply**
1	Banana	12	21300000		0.85	1.07	a>=2b	2.14	***No***
2	Onion	8	61233330	2,092,371	3.66	0.95		1.90	***Yes***
3	Potato	3	4766670	2,092,371	0.76	1.61		3.22	***No***
4	Tomato	4	25692000	2,092,371	3.07	0.81		1.61	***Yes***
5	Date	4	102778000	2,092,371	12.28	0.02		0.03	***Yes***
6	Papaya	12	174601000	2,092,371	6.95	0.08		0.16	***yes***
7	Mango	3	50998000	2,092,371	8.12	0.20		0.40	***yes***
8	Cabbage	2	8715000	2,092,371	2.08	0.271		0.542	Yes

Table 124

OVERSUPPLY TABLE- (VEGETABLES & FRUITS) IN CEZ - SURYAPUR									
S.No.	**Vegetable/Fruit**	**Harvest Months**	**Production (in kgs)**	**Population (2011)**	**Production kg/month/person (a)**	**Consumption (kgs)/month/person (b) (2011-12)**	**formula for over supply**	**result (2b)**	**Oversupply**
1	Mango	3	299568000	30,219	3304.41	0.20	a>=2b	0.40	**Yes**
2	Banana	12	1710119000	30,219	4715.90	1.07		2.14	**Yes**
3	Papaya	12	101240000	30,219	279.18	0.08		0.16	**Yes**
4	Tomato	4	61629000	30,219	509.85	0.81		1.61	**Yes**
5	Cauliflower	2	22917000	30,219	379.18	0.33		0.65	**Yes**

Table 125

OVERSUPPLY TABLE- (VEGETABLES & FRUITS) IN CEZ - NORTH KONKAN									
S.No.	**Vegetable/Fruit**	**Harvest Months**	**Production (in kgs)**	**Population (2011)**	**Production kg/month/person (a)**	**Consumption (kgs)/month/person (b) (2011-12)**	**formula for over supply**	**result (2b)**	**Oversupply**
1	Grapes	3	449061000	32,316,354	4.63	0.08	a>=2b	0.17	**Yes**
2	Banana	12	75223000	32,316,354	0.19	1.07		2.14	**No**

3	Mango	3	47053000	32,316,354	0.49	0.20		0.40	**Yes**
4	Onion	3	2111549000	32,316,354	21.78	0.95		1.90	**Yes**
5	Tomato	3	219718000	32,316,354	2.27	0.81		1.61	**Yes**

Table 126

OVERSUPPLY TABLE- (VEGETABLES & FRUITS) IN CEZ - MALABAR									
S.No.	**Vegetable/Fruit**	**Harvest Months**	**Production (in kgs)**	**Population (2011)**	**Production kg/month/ person (a)**	**Consumption (kgs)/month/person (b) (2011-12)**	**formula for over supply**	**result (2b)**	**Oversupply**
1	Banana	12	541406000	11,346,979	3.98	1.07		2.14	**Yes**
2	Coconut	12	1438666667000.00	11,346,979	10565.71	0.76		1.51	**Yes**
3	Mango	2	121886000	11,346,979	5.37	0.20		0.40	**Yes**
4	Papaya	4	27916000	11,346,979	0.62	0.08	**a>=2b**	0.16	**Yes**
5	Pineapple	4	60578000	11,346,979	1.33	0.03		0.05	**Yes**
6	Ginger	3	1543000	11,346,979	0.05	0.07		0.15	**No**
7	Sweet Potato	4	220000	11,346,979	0.00	0.01		0.02	**No**

Table 127

OVERSUPPLY TABLE- (VEGETABLES & FRUITS) IN CEZ - MANNAR									
S.No.	**Vegetable/Fruit**	**Harvest Months**	**Production (in kgs)**	**Population (2011)**	**Production kg/month/person (a)**	**Consumption (kgs)/month/person (b) (2011-12)**	**formula for over supply**	**result (2b)**	**Oversupply**
1	Coconut	4	243798567000.00	6,697,783	9099.97	0.76		1.51	**Yes**
2	Banana	12	413495000	6,697,783	5.14	1.07		2.14	**Yes**
3	Mango	4	23150000	6,697,783	0.86	0.20		0.40	**Yes**
4	Jackfruit	12	8144000	6,697,783	0.10	0.01	a>=2b	0.02	**Yes**
5	Pomefruits	3	2287000	6,697,783	0.11	0.20		0.39	**No**
6	Onion	2	20155000	6,697,783	1.50	0.95		1.90	**No**
7	Tomato	2	6931000	6,697,783	0.52	0.81		1.61	**No**

Table 128

OVERSUPPLY TABLE- (VEGETABLES & FRUITS) IN CEZ - VCIC SOUTH									
S.No.	**Vegetable/ Fruit**	**Harvest Months**	**Production (in kgs)**	**Population (2011)**	**Production kg/month/ person (a)**	**Consumption (kgs)/month/ person (b) (2011-12)**	**formula for over supply**	**result (2b)**	**Oversupply**

1	Coconut	4	25849401000	12373088	522.29	0.76	a>=2b	1.51	**Yes**
2	Banana	12	143682000	12373088	0.97	1.07		2.14	**No**
3	Mango	4	597601000	12373088	12.07	0.20		0.40	**Yes**
4	Guava	6	3326000	12373088	0.04	0.09		0.18	**No**
5	Sweet Potato	2	260000	12373088	0.01	0.01		0.02	**No**
6	Tomato	2	513000	12373088	0.02	0.81		1.61	**No**

Table 129

OVERSUPPLY TABLE- (VEGETABLES & FRUITS) IN CEZ - VCIC NORTH									
S.No.	**Vegetable/ Fruit**	**Harvest Months**	**Production (in kgs)**	**Population (2011)**	**Production kg/month/ person (a)**	**Consumption (kgs)/month/ person (b) (2011-12)**	**formula for over supply**	**result (2b)**	**Oversupply**
1	Coconut	4	2051347333000.00	27,834,650	18424.40	0.76	a>=2b	1.51	**Yes**
2	Banana	12	960437000	27,834,650	2.88	1.07		2.14	**Yes**
3	Mango	4	1778262000	27,834,650	15.97	0.20		0.40	**Yes**
4	Papaya	12	144375000	27,834,650	0.43	0.08		0.16	**Yes**
5	Lemon	3	65392000	27,834,650	0.78	0.12		0.25	**Yes**
6	Onion	2	38222000	27,834,650	0.69	0.95		1.90	**No**
7	Tomato	2	100626000	27,834,650	1.81	0.81		1.61	**Yes**

Appendix 17: Average monthly prices derived across 12 months from three most recent years for viable CEZs.

Table 130 CEZ VCIC North (Visakhapatnam) – CEZ Suryapur (Vadodara): Banana

CEZ VCIC North				
Visakhapatnam	**Banana**			
				In Rs/Quintal
Month	**2014**	**2015**	**2016**	**AVG**
JAN			123.95	123.95
FEB			113.69	113.69
MAR	162.78		110	136.39
APR			118.76	118.76
MAY			128.76	128.76
JUN			1060	1060
JUL		220	930	575
AUG			190.57	190.57
SEP	190		170	180
OCT	180	150.51	153.09	161.2
NOV		113.87	157.55	135.71
DEC			144.89	144.89
				2878.35
			Avg price	**239.86**

Table 131

CEZ Suryapur					
Vadodara	Banana				
				In Rs/Quintal	**In Rs/Quintal**
Month	**2014**	**2015**	**2016**	**AVG**	**Difference in Price**
JAN	850	1876.08	1300	1342.03	1218.08
FEB	850	1250.17	1261.69	1120.62	1006.93
MAR	823.77		1317.34	1070.56	934.17
APR	863.14		1436.16	1149.65	1030.89
MAY	825.39	1405.55	1151.69	1127.54	998.78
JUN	841.87	906.06	1096.74	948.22	111.78
JUL	939.1	1404.68	1166.92	1170.23	595.23
AUG	920.01	1198.54	1196.02	1104.86	914.29
SEP	790.61	991.09	1185.59	989.1	809.1
OCT	808.51	1176.55	1192.59	1059.22	898.02
NOV	1066.24	1366.72	1427.96	1286.97	1151.26
DEC	1336.43	1346.43	1404.74	1362.53	1217.64
					10886.17

				Avg Price	**907.18**

Table 132 CEZ VCIC North (Visakhapatnam) – CEZ Suryapur (Vadodara): Tomato

CEZ VCIC North				
Visakhapatnam	Tomato			
				In Rs/Quintal
Month	**2014**	**2015**	**2016**	**AVG**
JAN			820.96	820.96
FEB				
MAR			850	850
APR			850	850
MAY			1088.71	1088.71
JUN			1419.55	1419.55
JUL			1056.81	1056.81
AUG			678.84	678.84
SEP			802.3	802.3
OCT			806	806
NOV			666	666
DEC		958.91	800	879.46
				9918.63
			Avg Price	**901.69**

Table 133

CEZ Suryapur					
Vadodara	Tomato				
				In Rs/Quintal	**In Rs/Quintal**
Month	**2014**	**2015**	**2016**	**AVG**	**Difference in Price**
JAN	744.74	1337.8	726.61	936.38	115.42
FEB	426.24	1157.4	741.49	775.04	775.04
MAR	366.23	1120.64	531.62	672.83	177.17
APR	491.7	1135.49	722.47	783.22	66.78
MAY	825.39	1390.08	1744	1319.82	231.11
JUN	841.87	1520.97	3337.7	1900.18	480.63
JUL	939.1	1840.86	3160.7	1980.22	923.41
AUG	920.01	1119.79	1264.45	1101.42	422.58
SEP	790.61	1113.13	817.7	907.15	104.85
OCT	808.51	1232.28	657.73	899.51	93.51
NOV	1066.24	2355.85	810.27	1410.79	744.79
DEC	1336.43	1079.94	456.3	957.56	78.1
					4213.39
				Avg Price	**351.12**

CEZ Malabar (Coimbatore) - CEZ Suryapur (Surat): Coconut

Table 134

CEZ Malabar				
Coimbatore	Coconut			
				In Rs/Quintal
Month	2014	2015	2016	AVG
JAN	686.68	1342.01	1021.31	1016.67
FEB	934.08	1374.3	1018.64	1109.01
MAR	878.98	1350.33	1024.82	1084.71
APR	923.28	1393.43	1012.27	1109.66
MAY	899.55	1392.93	1317.51	1203.33
JUN	864.02	1408.38	1250.61	1174.34
JUL	851.39	1319.36	1414.71	1195.15
AUG	852.22	1400	1400	1217.41
SEP	869.33	1400	1405.12	1224.82
OCT	1241.6		1404.03	1322.82
NOV	655.83		1689.6	1172.72
DEC	989.5	1093.72	1737.47	1273.56
				14104.2
			Avg Price	**1175.35**

Table 135

CEZ Suryapur					
Surat	Coconut				
				In Rs/Quintal	In Rs/Quintal
Month	**2007**	**2008**	**2010**	**AVG**	**Difference in Price**
JAN		17500		17500	16483.33
FEB					
MAR		15000		15000	13915.29
APR		15998.55		15998.55	14888.89
MAY			4380.24	4380.24	3176.91
JUN					
JUL		21749.21		21749.21	20554.06
AUG		22500		22500	21282.59
SEP					
OCT	20892.57			20892.57	19569.75
NOV	19276.93			19276.93	18104.21
DEC					
					127975.03
				Avg Price	**15996.88**

CEZ Mannar (Madurai) – CEZ Suryapur (Surat): Coconut

Table 136

CEZ Mannar				
Madurai	Coconut			
				In Rs/Quintal
Month	2002	2004	2005	AVG
JAN				
FEB				
MAR		5601.89	7000	6300.95
APR		6283.33	6250	6266.67
MAY		5487.5	5700	5593.75
JUN		6058.33	5619.05	5838.69
JUL		6025	5250	5637.5
AUG		6250	5290	5770
SEP		6333.52	5000	5666.76
OCT		6375.03		6375.03
NOV	415	6874.91		3644.96
DEC	2007.5	6687.5		4347.5
				55441.81
			Avg Price	**5544.18**

Table 137

CEZ Suryapur					
Surat	Coconut				
				In Rs/Quintal	In Rs/Quintal
Month	**2007**	**2008**	**2010**	**AVG**	**Difference in Price**
JAN		17500		17500	
FEB					
MAR		15000		15000	8699.05
APR		15998.55		15998.55	9731.88
MAY			4380.24	4380.24	-1213.51
JUN					
JUL		21749.21		21749.21	16111.71
AUG		22500		22500	16730
SEP					

OCT	20892.57			20892.57	14517.54
NOV	19276.93			19276.93	15631.97
DEC					
					80208.64
				Avg Price	**11458.38**

Appendix 18: Wholesale market rates for Coconut in CEZ Suryapur

Interview no.: 017072017

Ref.: page 79

Interviewer: Anjali Anit

Interviewee: Mr Parekh, Agricultural Produce Market Committee-Ahmedabad

Date: 12th July 2017 | Time: 12:45 pm

Q What is the current wholesale price of coconut in the APMC market?

A The current rate for coconuts is 24 INR per piece.

Appendix 19: Total cost of transport from Farm in Malabar to Buyer in Suryapur via short sea shipping

Table 138

	Amount
A. First Mile cost	
Pre-cooling cost (Plug-in charges)	3500
Transportation cost (Empty container to farm and loaded container)	30000
Sorting and loading at farm	
Port THC, Port Custom and other documentation at Kochi port	12980
Shipping Freight Cost	81900
Lift on – Lift off charges (Shipping charges)	2000
B. Last Mile Cost	
Plug-in charges at Mundra port	3500
Port THC, Port Customs and other documentation at Mundra port	12980
Transportation cost for container delivery to Rajkot	40000
Total	**186860**

Appendix 20: Capacity 40-ft Cargo Container for Coconut

Interview no.: 012072017
Ref.: page 32, para 2 / line 3

Interviewer: Anjali Anit
Interviewee: P. Deshmukh (SCA Logistics Pvt. Ltd.) Mumbai

Date: 12th July 2017
Time: 2:30 pm

Q – How many tons of coconut can be carried in a 40-ft cargo container?

A – The maximum payload (capacity) of a 40-ft REF container is 26,240 kg, but Coconuts don't cube out and so the most quantity that can fit is about 19 MT cargo in the 40-ft REF due to the shape as well as packaging.

In the 40-ft container category, there are two types of trailers available in the market in which cargo may be carried.

Table 139

Trailer Type	3519	4019
Carrying Capacity MT	19	25

Appendix 21: Pilot design

The pilot design as described in section 4.4 is illustrated by using coconut as an example product.

Product preparation
For example, coconuts are de-husked at farm level to reduce the transport weight and volume. The outer coloured skin (exocarp) plus the fibrous inner husk (mesocarp) is stripped away by striking the coconut against a sharp-pointed metal stake mounted on a platform. A few impaling strokes loosen the husk, making it easier to be removed. Machete can also be used to start the de-husking process. De-husked coconuts are oval to round in shape with the eyes showing. The discarded husks can be placed several layers deep over the de-husked coconuts to help reduce desiccation. Moreover, they can be reused as raw material for making pallets.

Grading
Select products that are of sufficient and uniform quality. This is also done at farm level. Take into account that there will be some quality decay during transport, implying 'sufficient' to be higher than the market player requirements. For example, fresh de-husked coconut is expected to be brown, free from damage, cracking, and sunken eyes and attain the required size specifications. There should not be noticeable blemishes or skin damage from insects, diseases, or physical injury. Coconuts should be free of stress cracks and not have any protruding germination tubes, leakage of water around the eyes, or surface mould. When shaken, the fruit should have a sloshing sound, indicating the presence of water in the coconut. Any fruit that does not have a sloshing sound when shaken should not be packed for market. Losses in coconut are mainly as a result of cracking due to poor handling and inappropriate storage and transport condition. Spoilage can occur from softening and disease infection of the eyes.
Eventually different classes are transported if there is a market for them.

After grading the coconuts are transferred to a nearby collection point. The planning of the converging flows of coconuts to this collection point is adapted to the logistic scheme of the shipping route and the port handling and throughput time. In case the coconuts arrive in significantly different time-intervals, storage or even cold storage might be necessary. The required volume is one or two 40 ft. containers (or TEU?). One 40 ft. container can carry around 22.5 MT of fresh coconuts.

Pre-cooling
Temperature control for long term shipment is essential. For some agricultural products field heat must be removed (precooling) before they are loaded into the container. This will be researched before the preparation of the pilot.

Packaging
For example, coconuts are transported in containers, first on land, then at sea and then again on land. Coconuts may be sold in bulk or packed in large synthetic or mesh sacks of known fruit count per sack. Stackable cartons boxes are also used albeit for export mainly.

Figure 19: some examples of coconut packaging (carton boxes, bags with fixed number of coconuts)
Ventilation is important for coconuts; hence the packaging should allow for air flow to pass through. Two scenarios are the most likely in India. Either products are packed in bags with about 25 fresh coconuts or they are high end, and stackable carton boxes are used, causing less physical damage. In the first case the bags are carried into the container piece by piece by workers, and most likely the coconuts are sold loose in some outlet (or no consumer nor sales packaging is required, e.g. in case of the out of home sector). In the second case boxes can be stacked and put on pallets. Using a forklift reduces the loading time tremendously.
Note that either way a lot of material is required to load the coconuts in the container in such a way that the product stays in place (e.g. tie wraps), the packaging carries the correct information and market player requirements are satisfied.

Loading
It should be decided which type of load carrier is used. In case pallets are used:

a) Put all cartons on a pallet after packing

b) Make vertical stacks and make sure that ventilation holes inside the cartons match with the cartons placed above and under

c) Reinforce the cartons at the base of the pallet. Strap the whole pallet to make stable stacks

d) Strap cartons on pallet

e) Maintain low temperature once the pallet is pre-cooled

Coconuts can be shipped successfully by sea in reefer or dry containers for up to three weeks. A refrigerated container is recommended for the transport of fresh coconut. A storage temperature of 12ºC (*to be checked*) will assist in quality maintenance.

Cargo Handling of cargo is another important factor in the chain. Coconut requires cool, dry and good ventilation. In damp weather (rain, snow), the cargo must be protected from moisture, since it may lead to mould, spoilage and self-heating as result of increased respiratory activity.

No hooks should be used with bagged cargo, so as to prevent damage to the bags and loss of volume. In order to guarantee safe transport, the bags must be sowed and secured in a way that they cannot slip or shift during transport. Coconut packs can be segregated with fibre rope or/and thin fibre nets. Attention must also be paid to storage patterns which may be required as a result of special considerations, such as ventilation measures.
Depending on the scenario the container will be loaded. Ventilation in reefer containers is possible only in case where big holes are available in below and/or above the packaging of the product. This is not the case if bags are stacked loose in the container.

In case of pallets, the cold air enters from beneath the load. This airflow is directed through or alongside the cartons to the upper part of the container where it is directed back to the cooling equipment. In order to ensure proper temperature control in the whole load, appropriate stacking of the pallets is essential:

a) Prior loading, inspect the empty container in order to remove any foreign objects

b) Check if the 4 drain holes are open

c) IF the container is loaded on a dock where temperature is controlled:
   i. YES: the empty container can be pre-cooled prior to loading. Run the container empty at temperature set-point for at least 3 hours with doors closed
   ii. NO: the empty container must NOT be pre-cooled

d) Load of the container (cooling unit OFF)

e) Loading of the container should be done within one hour

f) Place the pallets inside the container in such a way to avoid any chimneys between the pallets

g) Fill up the complete container with pallets, do not leave any open spaces on the t-bar floor as it will create "false air", i.e. short-cuts air circulation between supply and return airflow

h) Do not load above the red load line (to allow air flow; check of such a line is available)

i) Cover the T-bar and pallet end conform pictures

Figure 20: examples of covering the T-floor at the doors to avoid air return through open area

j) After closing the doors, the cooling unit can be switched ON

k) The power supply of the reefer container should be assured by a Genset (Generator for power) or other power supply until loading onto the vessel in the port of Kochi.

The recommended set points for container transport of coconuts on the road or at sea are:

a) Temperature set-point: 12°C (54°F)

b) Ventilation set-point: to be researched

c) Drain holes open

d) Humidity control: between 80-90% (if available)

e) Defrost cycle: to be researched

Transportation

Transportation consists of

1. Inland transport 1: Transport from collection point to port is done at agreed set point conditions in either scenario.

2. Port 1: At the port the container is stacked and connected to power to maintain the conditions. Port procedures take place, like paper work, eventually some control. All this needs to be prepared with the stakeholders in the port. These could be logistic service providers at the port to load and unload, state government and the shipping company. Arrival at the port is planned in such a way that procedures are finished when the boat is leaving

3. Short sea shipping
4. Port 2: Similar to port 1. Planning of truck transport is optimized in relation to throughput time in port.
5. Inland transport 2: Transport at set point conditions from the port of Mundra to the drop off location(s) of the market players.

Unloading at drop off point(s) market players
A check is done by the market player on the load, according to the predefined requirements.

Appendix 22: Completed Market Player Questionnaire - 1

1. Buyer name- **Sameer**
2. Location(s) (city name)- **Surat**
3.Designation of interviewee- **Owner**
4. What kind of produce do you sell (or process)?
a. Tender coconut
b. Brown coconut with hard shell
Ans. A. Tender coconut
quantity

5. What is the size of produce do you sell (or process)?
a. Small Coconut
b. Medium Coconut
c. Large Coconut
Ans. B. Medium Coconut

6. what period of the year are you sourcing this produce?
a. Year around
b. June-July
c. December-January
Ans. 4 months (Aug-Nov – festival season in Gujarat)

7.From what type of stakeholder and where are you buying this produce?
a. Farmer (region)
b. Wholesaler (region)
c. Trader (region)
Ans. Bought from trader (this is an agent who sorts quality at preliminary level).

8. Do you have some kind of agreement with the supplier?
a. yes
b. no
Ans. No

9. Does the agreement contain product requirements?
a. yes (please specify like Green coconut, brown ripe coconut, no damage, Size)
b.no
Ans. Yes. Green coconut

10. What is the kind of price agreement with the supplier?
Ans. No agreement.

11. Is there an agreement on the amount per week?
a. yes
b.no
Ans. No such agreement.

12.What is the period of the agreement?
a.1 year
b. Monthly
c. Weekly
Ans. Not applicable.

13. Is it a written or oral agreement?
a. written
b. oral
Ans. Not applicable.

14. On average how often in a week is there a delivery of produce?
a. Once a week
b.3 days a week
c. 6-7 days a week (Daily)
Ans. A. Once a week.

15. what is the way of transport used?
a. Open truck
b. Covered truck
c. Tempo
d. Part load truck
Ans. C. Tempo

16.Transportation cost bared by?
a. supplier
b. buyer
Ans. Buyer

17. How produce is packed?
a. particular packaging
b. Gunny bag
c. loose?
Ans. B. Gunny bags.

18. What happens if the produce is not accepted?
a. Return back to supplier
b. Sale it by supplier in local market
Ans. Sold at discount.

19.what do you consider as the most criterion important points with respect to the supplier and in what order?
a. constant satisfactory quality
b. niche product
c. Price /Quality
d. delivery reliability
e. high quality
Ans. E. High Quality

20. what is agreed about the payment/how is the payment organized?
a. Immediate cash
b. Cash within 7 days
c. Cash after 15 days
d. Online within 7 days
e. Online payment after 15 days
f. Advance Payment
Ans. Depends on the payment terms of supplier.

21.What is the current price in your shop for coconuts and how do you determine the price?
Ans. Approximately 14 INR per pc, margin is of 0.30 paisa.

Appendix 23: Completed Market Player Questionnaire – 2

Table 140

Company name	FarmFresh	
Function interviewee	AGM Sales ad manager	
Question	Answer	Comment
what kind of coconuts do you sell?	Tender coconut / Brown coconut	specify as used in market
what period of the year are you sourcing these coconuts?		
variety 1: …	year round - winter tender goes down a bit	e.g. year-round or September-December
variety 2: …		
what kind of stakeholders you source from?	Farmer directly	e.g. middlemen or farmers directly
from which region and what period of the year are you sourcing coconuts?	South region / year around	
variety 1: …		e.g. Tamil Nadu (Sept-Jan)
variety 2: …		
…		
Do you have some kind of agreement with the stakeholders you source the coconuts from?	no	
Do you use product requirements when you buy?	Tender coconut - Category. Grade A - water content - 300-400 ml, Quality Spec - 0% to 10%scar & rest green, Un-bunched pieces - max 20%	e.g. are there some kind of quality aspects involved
	Tender coconut - Category. Grade B - water content - 300-400 ml, Quality Spec - 10% to 20% scar & rest green, Un-bunched pieces - max 25%	
What is your sales volume per week or per month? Different per season?	5000 pcs * (8-10 loads) per month	Is there an order on volume or an agreed standard amount?
From here the question are per sourcing area/supplier. If he has more than one supplier some answers might differ and should be registered		
How is the price agreement process with the supplier? Do you or the supplier use reference prices?	Market price	Is it a fixed price for some time, or relative to wholesale market price of the day before for every deal, ...
What is the price range for coconuts when you buy? Are there seasonal variations?	Mumbai price Category A - Rs.16-18 /pcs	yes, at winter season price goes down
	Mumbai price Category B - Rs. 14 -16/pcs	
what does the supply chain look like? Describe the stakeholders and what activity takes place where?	At farm - Sorting /grading /quality check / loading	e.g. farmer (de-husking, sorting, pack in plastic bags) - middleman (loading, transport in small van collected from farmers to LSP, unloading) - logistic service provider (loading container for uncooled long distance transport, transport to market) - ...
Logistics		
a. On average how often in a month is there a delivery of coconuts?	weekly shipment for tender and bi-weekly for semi husked	if there are more varieties involved this might vary per variety
b. Is there temperature control?	open truck -	cooled truck, open truck, covered truck (will vary over the different parts of the supply chain)
c. what happens if the order is not accepted or part of it is bad? Who is responsible and pays for it?	farmer	lower payment, only good part is accepted, totally rejected?
d. what is the lead time from ordering to really getting it?	10 - 15 days	

e. are the coconuts transported in crates, a particular kind of packaging or lose? This might differ per part in the supply chain.	pp bags/jute	
what share (estimate as % of supply) of the coconuts that arrive are not meeting the market requirements and can only be sold at a much lower price or become waste?		
what is the main cause for these losses you think?	quality at source itself. No so much in transit	
what do you consider as the two most important points with respect to the supplier and in what order?	better sorting and grading at source	e.g. price, supply reliability
what is agreed about the payment/how is the payment organised?	7 to 10 days	e.g. is payment cash or after 8 days by bank
If there is one improvement in the supply chain you can apply, what would it be?	quality and Faster transit time	e.g. better packaging to decrease mechanical damage
Anything you would like to add?	Complimentary -350 pcs	

Appendix 24: Completed Market Player Questionnaire - 3

1. Buyer name- **GO2FRESH**
2. Location(s) (city name)- **New Mumbai**
3. What kind of produce do you sell (or process)?
a. Tender coconut
b. Brown coconut with hard shell
Ans. A. Tender coconut and B. Brown coconut

4. Do you use product requirements when you buy?
a. 300-400 ml water content
b. Green natural in colour & Tender
c. No empty /dry nuts
Ans.A. 300-400 ml water content

5. what period of the year are you sourcing this produce?
a. Year around
b. June-July

c. December-January

Ans. A .year round - winter tender goes down a bit
6. From what type of stakeholder and where are you buying this produce?
a. Farmer (region)
b. Wholesaler (region)
c. Trader (region)
Ans. Aggregator(South region)
7. Do you have some kind of agreement with the supplier?
a. yes
b. no
Ans. N.A

8. Does the agreement contain product requirements?
a. yes (please specify like Green coconut, brown ripe coconut, no damage, Size)
b.no
Ans. N.A

9. What is the kind of price agreement with the supplier?
Ans. N.A

10. Is there an agreement on the amount per week?
a. yes
b.no
Ans. N.A

11. What is the period of the agreement?
a.1 year
b. Monthly
c. Weekly
Ans. N.A

12. Is it a written or oral agreement?
a. written
b. oral
Ans. N.A

13. On average how often in a week is there a delivery of produce?
a.Once a week
b.3 days a week
c. 6-7 days a week (Daily)
Ans. A. Once a week.
14. what is the way of transport used?
a.Open truck
b.Covered truck
c.Tempo
d. Part load truck
Ans. Open truck

15. Transportation cost bared by?
a. supplier
b. buyer
Ans. N.A
16. How produce is packed?
a. particular packaging
b.Gunny bag
c. loose?
Ans. N.A
17. What happens if the produce is not accepted?
a. Return back to supplier
b. Sale it by supplier in local market

Ans. N.A

18. what do you consider as the most criterion important points with respect to the supplier and in what order?
a. constant satisfactory quality
b. niche product
c. Price /Quality
d. delivery reliability
e. high quality
Ans. N.A

19. what is agreed about the payment/how is the payment organized?
a. Immediate cash
b. Cash within 7 days
c. Cash after 15 days
d.Online within 7 days
e. Online payment after 15 days
f. Advance Payment
Ans. Online payment after 15 days

Appendix 25: Farm Aggregator Questionnaire

1. **Name –** AAR

2. **What way can he be reached if client wants to order something?**

   Ans. Clients call me directly for any requirements.

3. **Total land holding (Acre) – under farming?**

   Ans. I have 8 acres of land holding.

4. **Area under farming (Acre) for coconut produce?**

   Ans. About 5 acres of my farm land is dedicated to coconut farming.

5. **How many variety of coconut produce does the farmer grow?**
   - **A. Fresh Green Coconut**
   - **B. Brown Ripe Coconut**

Ans. I grow the brown ripe coconut.

6. **What kind of Coconut do they produce?**
   - **A. Tender Coconut (Only Water)**
   - **B. Tender Coconut (Thin Layer of malai with water)**
   - **C. Tender Coconut (Thick Layer of malai with water)**
   - **D. Brown Ripe Coconut**

Ans. I produce the brown ripe coconut.

7. **Who is buying from them?**
   - **A. Wholesaler**
   - **B. APMC**
   - **C. Retailer**
   - **D. Local trader**
   - **E. Online Retailer**
   - **F. Supermarket**
   - **G. Food processing Unit**
   - **H. Middle Man**

Ans. A local trader comes to buy from my farm.

8. **Is there any buyer who has an agreement with him and what is the agreement about? Is there some kind of preference (quality, size, variety, ...) or requirement for some buyer?**

Ans. There are no requirements defined or agreements made orally or in writing.

9. **Where does the transaction take place?**
   - **A. On farm**

B. APMC
C. Collection center
D. Local Wholesale market
E. local Retailer

Ans. The transaction happens on the farm itself.

10. How is the payment arranged?

A. Immediate cash
B. Cash within 7 days
C. Cash after 15 days
D. Online within 7 days
E. Online payment after 15 days.
F. Advance payment

Ans. Payment is made immediately in cash.

11. Is the farmer capable/willing to wait for the payment for one week, since the produce arrives at the buyer about one week later?

Ans. No, I can get cash immediately, why must I wait whole week?

12. Farmer is having written agreement with current buyer(s)?

Ans. I have no agreements with my current buyer

13. How do they determine the price for sale?

A. By prevalent market price
B. Recover cost
C. Earn some profit
D. Market demand at the time of harvest – 1. Stable 2. Fluctuating 3. Increasing 4. Decreasing

Ans. Sale price depends on the market price, which is recorded in the newspapers every day; I also cross check it with buyers and farm owner friends.

14. What is the produce quality at the time of harvest?

A. No damaged spots
B. Size
C. Semi ripen
D. Close to ripening
E. Ripened

Ans. Since coconuts are largely produced for production of coconut oil, coconut milk, as food ingredient, I sell only the ripened brown variety.

15. Does the farmer know where the produce is going to?

A. If Yes, then where?

B. No

Ans. Yes usually it goes to the nearest market within my state; sometimes it also goes to Tamil Nadu.

16. Does the farmer send a produce out of state?

Ans. Yes some of my produce also goes to Tamil Nadu.

17. How are the produce transported from the farm to point of delivery?

A. Open truck

B. Covered truck

C. Tempo

D. Tractor

E. Part truck/ tempo

F. own transport (Please specify)

g. If not by road? Please specify the mode.

Ans. The produce is generally transported in open trucks.

18. What is the transport costs in INR per kg.? (if the farmer can't specify then ask how they transport, how much do they transport in kg terms and then ask how much they paid for it in total and arrive at the result)

A.Cost per km

B.Cost as per vehicle

C. Cost per bag of ... kg

Ans. I don't pay for transport.

19. Who is arranging for transport?

A. Farmer

B. Buyer

C. Middleman

Ans. Buyer arranges transport.

20. Who is paying for the transport cost?

A. Farmer

B. Buyer

C. Middleman

Ans. Buyer bears cost of transport.

21. What months of the year is the farmer harvesting?

Ans. The trees bear fruit all year round, which takes 60 days to ripen. I therefore harvest every 60 days.

22. How much was the average yield (kg/acre) in the last 3 years for coconut crop produced?

Ans. 2014-15-16 were drought years, so the yield has been quite poor – about 20-30 kg per acre. However, we expect better results this year as the region has received ample rain.

23. Farmer provides[91]/delivers produce to the buyer/market at what frequency?

A. Once in 15 days
B. Once a month
C. One time only
D. Once a week
E. Twice a week
F. Everyday

Ans. I am able to deliver produce only every 60 days. However, bigger farmers end up harvesting and sending produce everyday as by the time they are done from one end to the other, fruits from the first belt of trees are ready for harvest.

24. Distance from farm to nearest market?

A. less than 5 km
B. 5-10 km
C. 10-50 km
D. More than 50 km

Ans. My farm is about 1.5 km from the market, so less than 5 km.

25. How does the farmer sort / grad of produce?

Ans. No sorting/ grading is done at the farm level. The trader opens and husks the full stock at the farm and discards any produce that is too small or rotten. This is generally no more than 0.05% of the total quantity.

26. Is there packaging for transport from farm to next link in the supply chain?

Ans. No, the coconut is either put in gunny bags or sent lose in open trucks.

[91] *In case it is collected*

27. What kind of packaging: is it packed in

- **A. Jute Bag**
- **B. Box**
- **C. Plastics bag**
- **D. Loose**

Ans. The coconut is at best packed in gunny bags, but usually sent lose in open trucks.

30. Who is arranging the packaging and doing the work? (farmer or buyer?)

Ans. The buyer arranges for all the packaging and he is the one who packs and loads the produce as well.

Appendix 26: Measurements of the tender coconuts under test implementation

Table 141

			Coconuts -T(Farm A)						
Data sheet	**Days**		**External appearance**		**Internal colour etc**	**Milk colour**	**Taste**		**Time**
Dec-15	**Day 1**		1		1	1	2		11:36 A.M.
Dec-19	**Day 5**								
		T1A1	1		1	1	1		10:57
		T7P1	1		1	1	2		10:56
		T4M1	1		1	1	1		10:55
Dec-26	**Day 12**								
		T2A2	4		4	3	3		11:11
		T5M2	1		1	1	1		11:10
		T8P2	1		1	1	1		11:07
Jan-01	**Day 18**								
		T3A3	4		4	3	4		11:39
		T6M3	1		1	1	1		11:39
		T9P3	2		2	1	2		11:40

Table 142

			Coconuts -R(Farm B)					
Data sheet	**Days**		**External appearance**		**Internal colour etc**	**Milk colour**	**Taste**	**Time**
Dec-15	**Day 1**		2		1	1	2	11:43 A.M.
Dec-19	**Day 5**							
		R1A1	2		2	1	2	11:15
		R7P1	2		2	1	1	11:14
		R4M1	2		2	1	1	11:13
Dec-26	**Day 12**							
		R2A2	3		3	3	3	11:24
		R5M2	1		1	2	2	11:22
		R8P2	1		1	2	2	11:19
Jan-01	**Day 18**							
		R3A3	3		3	3	3	11:45
		R6M3	1		1	1	1	11:46
		R9P3	2		1	1	2	11:47

Appendix 27: An Analytical Study on Agriculture in Kerala

http://www.keralaagriculture.gov.in/pdf/a_s_06042016.pdf

Kerala or Keralam got its name from 'kera' (coconut). For centuries, coconut trees and coconuts played a vital role in the everyday life and economy of Kerala. Although coconuts are cultivated in nearly 8.08 lakh hectares of land, constituting almost 39.4 percent of the state's net cropped area, there are very few large coconut plantations in the state. More than 95 percent of coconut trees in Kerala are grown in the front and back yards of homesteads.

Coconut palms grow almost everywhere in Kerala. In the low lands, coconut forms one of the main crops. The midlands and the slope of the high lands are also best suited for its cultivation. The seaboard, the shores of lagoons, backwaters and the banks of rivers are studded with coconut trees. Coconut cultivation is now extended to higher elevations such as in Idukki district. Coconut farming in Kerala is facing severe setback in recent years owing to fall in market price and low productivity due to pest and disease attacks. The rise in cost of cultivation and competition from other oils such as palm oil etc are other reasons affecting the production of coconut. Kerala's share in area of coconut farming in the country had declined from 69% in 1955-56 to 38% in 2013-14.