

The Procurement Perspectives of Fruits and Vegetables Supply Chain Planning

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Abstract— Supply chain planning in the fruits and vegetables (F&V) supply chains, dealing with short life cycled products in a competitive marketplace, integrates the complex network of farmers, food processing and supply to end customers to enhance operational effectiveness. This planning framework aggregates data from multiple sources, such as customers, super markets, farmer cooperatives and contract farmers, to provide visibility of demand-supply status for inter-enterprise collaboration. The supply chain analysis has considered the aspects of business planning, supply and demand management, inventory, transportation, logistics optimization from the perspective of information sharing to satisfy the need of the end customers. Further, this work assesses the sustainability of change in the management of procurement activities and ICT infrastructure supporting the e-market service mode, and builds a collaborative control framework that could provide insight to the managers of the food producing industries.

Keywords— Food industry, Supply chain planning, Information sharing, Collaborative practices

1. Introduction

The agricultural sector and food economy of India is undergoing a rapid and fundamental structural change [73]. The increasing urban populations, increasing per capita incomes, changing life styles, and maturing agribusiness markets are transforming the food production and distribution patterns. As the domestic demand is on the rise, the agricultural sector is becoming less state-controlled; the farmers and cooperatives, food processing industries and supermarkets are facing difficulties associated with their businesses [93]. Due to privatization and restructuring of fresh fruits, vegetables and foods supply chains, the members are facing a lot of coordination problems, long payment delays to farmers, problems to access

timely and quality inputs and services, high searching costs, and difficulties in meeting the improved crop production standards and related food safety requirements [9], [24]. Indian agricultural farms are increasingly interested in export-oriented fruits and vegetable processors, and supermarket and wholesale procurement cultures for domestic consumption [84]. These results in numerous coordination problems due to the cost associated with contracting farmers and collecting sufficiently large volumes of fresh farm produces from small and marginal farmers, poor infrastructure, and the geographical distance between contract farmers and supermarkets in cities [61]. The contract farmers are also facing problems due to lack of bargaining power for their farm produces, payment delays, access to high quality seeds and fertilizers, availability of energy and water, logistics, transportation and post-harvest processing infrastructure, and information on fertilizer and pesticides use and associated risks [47], [2], [96].

The search for quality fruits and vegetables from the contract farmers is the major driver for the supply chain coordination [81]. There is a need for private contracts and related emerging vertical and horizontal collaborative planning initiatives to tackle the impact of wholesale fruit and vegetable markets and distribution networks on expanding supermarkets [24], [41]. Typically, the supply chain (SC) planning and coordination environment of low to medium capital-intensive capacity of the contract farmers and farmer cooperatives, and the postharvest processing, packaging and storing and distribution processes are very complex [47], [3], [54], [87]. These supply chains have to sustain a time-based competition due to the fast changing customer demand [23], [83]. As the fresh fruits and vegetables SC is characterized by the procurement of quality fresh produces from a smaller number of farmer cooperatives and a large number of marginal or small- and medium-capacity farmers,

the major challenge in this SC is the accurate and real-time information sharing [9], [76], [74].

Literature on the supply chain planning for perishable goods emphasizes more on buyer-supplier collaboration, such as supermarket-contract farmer relationships based on multi-echelon inventory theory and supports the vegetable and food industry practices to improve collaboration among various stakeholders [52], [75], [38]. The relationship management for successful collaboration must focus on revenue sharing from the perspective of the supermarket retail supply chain by analyzing associated cost components [82], [74]. The SC managers must understand the specific characteristics of the vegetable and fruits supply chain planning and coordination. In view of this, it is imperative to assess the sustainability of change in the management of procurement activities [104], [102] and ICT infrastructure supporting the supply-demand matching mode [76], [100] and build a control framework that could provide insight to the managers of the vegetable and food industry SC.

2. Literature Review

The fruits and vegetable markets in India have evolved from short and linear supply chains controlled tightly by the state, to a highly complex, increasingly diverse and progressively coordinated supply chains. The vegetable supply chains include a very large number of farmers growing different vegetable varieties on their individual lands. Traditionally, they sell their vegetables directly to businessmen, food processing industries, wholesale markets, cooperatives, retail shops and supermarkets. The basis of negotiations in these unorganized sectors was limited to price, quality and quantity [57], [37].

The domestic demand and export opportunities have encouraged the rapid expansion of fruits and vegetable production and business in India. Increasing incomes and urban life styles have resulted in a paradigm shift in diets from staples to vegetables, fruits, livestock, dairy products, fats and oils. Fruits and vegetables exports have also increased significantly. The rapid growth of vegetable consumption, exports, production and distribution has resulted pressures in the supply chains [2]. Land resources have been reallocated in accordance to the demand for specific vegetables and fruits. The marketing channels for vegetables include direct selling to wholesale and retail markets, food processing industries, and

intermediate businessmen [63], [54]. The supermarket chains are becoming dominant in the food retail markets. The supermarkets are spreading beyond the large cities, moving to small towns and exploring opportunities in the remote areas. The supermarkets are suggesting a roadmap about vegetable varieties, crop production practices, and processing and storage requirements before reaching target customers [25].

There are a number of supply side constraints that influences how vegetable supply chains are evolving in India, including rural road conditions, food safety and small land holdings by farmers. Poor transportation infrastructure hinders the development of scale efficiency gains through centralizing vegetable processing and distribution centers [84]. However, the vegetable supply chains have benefited from recent investments in roads and transportation facilities by Indian government. The small land holdings by farmers increases the coordination costs for the cooperatives and supermarkets, and results in difficulty in obtaining the desired quantities of fresh, quality vegetables and fruits [61]. The farmer cooperatives and supermarkets are trying hard to resolve small production scale by establishing relatively large crop production base through consolidation of small lands into more practical farm production units.

Contracts are made with individual farmers taking into account the soil quality, land size, past history, interest and attitude for a specific time period [41]. The supermarkets with the help of farmer cooperatives typically hire the labour force of contract farmers, make capital investments and produce vegetables of good quality by using latest technology [87]. The supermarkets also help the contract farmers by providing seeds, inputs and extension services. The contracts are made with individual contract farmers based on the following factors:

- (a) The size of the arable land, in order to check the potential of the contract farmers to deliver a sufficiently large, consistent supply of vegetables essential for meeting the demand side obligations [100]
- (b) Supply chain coordination, such as range of crop production controls including area of farm land, hiring of labour force, types of vegetables to grow, inputs to use, quality standards and delivery date [61], [28]
- (c) Fruits and vegetables safety certification for pollution free green vegetables or organic vegetables [97], [32]
- (d) Geographical distance between the contract farmers and supermarkets to estimate the transportation costs in relation to the number

of visits for supervision of contract farmers' crop production processes, to deliver inputs, and establish close working relationships [82], [2]

The fruits and vegetable demand and supply environment is primarily driven by time-based quality crop production in desired quantity and cost for responsive and flexible supply [37], [77], [31]. The perishable nature of these products and the emergence of contract farming and farmer cooperatives has developed trends toward rapid vegetable production cycles, and volatile demands [17], [2]. The supermarkets of the future must structure their vegetable procurement process to respond to upstream demand and to absorb downstream risks (in terms of quality, timeliness and price). So, the negotiations with the farmer cooperatives and other suppliers of fresh produces may be done only at tactical and operational levels [41]. The collaboration initiatives such as investment (for direct farming, communication technology and support logistics), knowledge and information sharing, resource sharing, and crop

production, marketing and R&D for optimal methods, operational competencies and strategy development are typically done for individual fruit or vegetable [34], [52].

The demand-intensive capacity of the fruit and vegetable supply chain requires that the vegetable supermarkets need to have vertical collaborative relationships with the contract farmers and cooperatives to increase the responsiveness of the supply chain [31], [24]. In order to tackle the consumer demand uncertainties and time compression, the contract farmers and cooperatives need to have horizontal collaborative relationships [28], [4] by using compatible information and communication technology (ICT). If the transaction/transportation costs decrease, reverse auctions may be employed by the supermarkets, and the contract farmers and cooperatives [101], [82]. With the advent of internet in the market place, fruits and vegetables supply chains tackle the issue of changing consumer requirements [107], [29] as depicted in Figure 1.

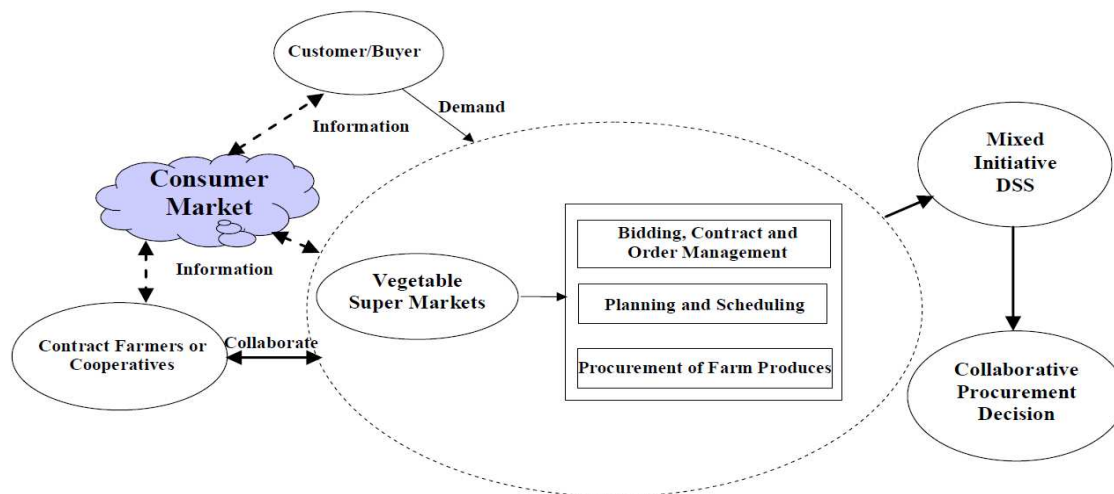


Figure 1. Dynamic fruit and vegetable supply chain

The fruits and vegetables supply chains must realize that they must have complete information in time; improved sharing of information can lead to improved coordination for faster response, increased flexibility, and lowered inventory, transportation and production costs [76], [56]. In order to leverage supply chains' knowledge for rich decision support, the fruit and vegetable supply chain may adopt e-procurement [69], with the market intermediary as the solution provider. This may support decision making and collaboration for these perishable goods, under single period uncertain demand scenario [64]. So, it is essential

to develop vegetable supply chain planning frameworks to facilitate collaborative procurement practices for maximum consumer satisfaction.

3. Supply Chain Planning

The customer demands in a vegetable supply chain typically include orders from supermarkets, wholesalers, and retailers to sell the fruits and vegetables to the end customers. Lately the emphasis of this chain is on supplier owned inventory programmes, where the supermarkets require that the contract farmers and cooperatives

manage, coordinate, and supply fresh fruits and vegetables to their stores based on a predetermined stock level [85]. Contracts may require that these cooperatives must quickly respond to original forecast and customer demand. The supply chain planning solutions must incorporate flexibility and responsiveness in an integrated information environment [4]. The other features which must be considered are as follows:

1. Reduce the planning cycle time by considering all fruits and vegetables demands in the system, total supply available, capacity constraints, and methods of production, packaging, storing and transportation [44]
2. Reduce the total inventory by analyzing all vegetable stocks in the supply chain, and trading-off supply and demand through quick planning to transmit the real needs to the contract farmers and cooperative partners [22]
3. Enhance responsiveness to customer demands by incorporating available-to-promise (ATP) functionality where supermarkets quote delivery schedules accurately and by incorporating capacity-to-promise (CTP) functionality for planning demands when sufficient supply of vegetables are not available. This would review resource availability for producing the required vegetable supply to satisfy the customer demand in real-time [31]
4. Enhance the vegetable supply chain visibility by analyzing the activities at contract farmers and cooperatives based upon the data communicated by each supermarket to contract farmers [8], [14]
5. Increase information exchange capabilities through closer ties with contract farmers and cooperatives, SC planners, logistics providers, supermarkets and end-customers by appropriate information sharing using collaboration technology [33], [88]

3.1 Perspectives of F&V Supply Chain Planning

The fruits and vegetables (F&V) supply chains must be able to design, deploy, and implement an enterprise-wide SCM environment (for individual supermarket network) through demand forecasting, master planning and demand fulfillment modules [98]. The following features are critical to supply chain planning:

- Use a centralized the supply chain planning process: Develop integrated planning solutions to match supply and demand of fruits and vegetables, and review the supply and capacity of individual contract farmers

and cooperatives [51].

- Evolve an enterprise wide solution (for a network of supermarkets): Provide accurate information about end-consumer orders, vegetable availability, and customer demand quickly [80].
- Reengineer the core vegetable supply-demand matching processes: Combine advanced information technologies with innovative SCM techniques [42]. Incorporate regular and seasonal demand forecasting, strategic capacity planning, contract farmer loading, allocation management to various contract farmers, fruit and vegetable transfers, and regional warehouse management [95].

The business planning framework of supermarkets for the fresh produce fruits and vegetables is based on the fulfillment of customer demand followed by strategic supermarket goals of revenue, margin, and market share through system-wide planning across sales, finance, and production-distribution through monitoring, intelligent analysis, and control [1]. The solutions must provide a basis to optimize business plans across different F&V demand-supply scenarios and facilitate decision making [79]. The business planning activities may include demand and forecast planning [26], contract farmer capacity and inventory planning [45], and operational and financial evaluation [11]. The business planning framework must consider the following perspectives for closed-loop analysis of the F&V supply chain: (1) Supply management, (2) Demand management, (3) Inventory management, (4) Customer order management, and (5) Transportation and logistics management.

3.1.1 Perspectives of supply management

Supply management perspectives focus on the contract farmers and cooperatives to manage their capacities to meet end consumer demand at an optimal and stable price on a continuous basis and maximize their revenues and margins [13]. These farmer cooperatives need to improve consumer satisfaction by ensuring reliable deliveries against prior commitments in terms of quantity, quality and price [98]. The supermarkets must integrate with contract farmer crop planning and scheduling to ensure that the fruits and vegetables are produced most economically by considering the complexities of the agri-supply chain [48]. Recent trends towards outsourcing of fruits and vegetables production and supply to potentially big contract farmers and cooperatives focuses more on effective contract farmer management, food supply chain

visibility, and control of the end-to-end supply chain for system-wide collaboration [27].

The F&V supply management may consider the following perspectives: (a) capacity management by contract farmers [58], (b) raw material and crop production planning (such as seeds, fertilizer, water, power, manpower and mechanization) [80], (c) sequencing of various crops and scheduling (different customer priorities and product priorities based on demographic and geographical considerations), management of contract farmers and cooperatives [16], [14], (d) implications of transaction costs, risks, responsiveness and innovative methods for supply chain visibility [8], (e) activity planning and design to allow vegetable supply to meet customer demand [49]. These perspectives, along with optimization techniques and scenario analysis, would enable an accurate modelling of vegetable supply chains and rapid configuration of agri-business decision rules.

3.1.2 *Perspectives of demand management*

The demand management perspectives of fruits and vegetable supply chain are based on the understanding and trade-off of uncertain market conditions and issues across multiple farm locations while predicting the customer demand [51]. The supermarkets must engage in evolving decisions pertaining to ration the supply of fruits and vegetables based on contingency or normal supply, develop plans from the perspectives of finance, operations, sales, and marketing, and monitor actual performance against strategic objectives of the supermarket [62], [67]. This would result in effective inbound and outbound flows of fresh farm produces, and logistics across the supply-demand networks through intelligent decision support and continuous learning [92], [98].

The F&V demand management may consider the following perspectives: (a) consensus demand planning [15], (b) price planning and management, and demand collaboration [94], (c) customer orientation and programme management [35], and (d) customer demand adjustment [50].

3.1.3 *Perspectives of inventory management*

The inventory management perspectives of fruits and vegetable supply chain focus on multi-echelon inventory optimization problem, which enables food supply chain to improve customer service as

well as to reduce lead times and costs by optimizing stocking/inventory/delivery strategies to meet consumer market demand [22]. The supply chain managers attempt to optimize strategies for what, when, and how much to produce and procure, selection of contract farmers or cooperatives, and amount of safety stock to carry [53]. This would determine the positioning of right fruits and vegetables at right place, right time, right quantity and right price to meet customer requirements at a supermarket [72]. The detailed analysis of inbound and outbound fresh produces and work flows (in terms of cropping, harvesting, post-harvesting, packaging, storing, transporting, and delivering etc.) would optimize the stock level for better performance [68].

The F&V inventory management may consider the following aspects: (a) perspectives of fruits and vegetables stratification and segmentation [44], (b) supermarket order lead time analysis [107], (c) F&V stock/inventory delivery postponement optimization [89], (d) stock/inventory target optimization [7], (e) inventory/stock status systems from the organizational perspective [21], (f) F&V replenishment policy [90], (g) analysis of point-of-sales data and consumer buying behavior, and (g) continuous learning from the customer feedback and strategies to improve the process to maintain stable price while increasing the quality of farm produces [107].

3.1.4 *Perspectives of customer order management*

Customer order management perspectives focus on allocation of supply across various delivery channels to satisfy consumer demand while maintaining the priorities of supermarket supply chain [71]. This can be realized by an effective and feasible order fulfillment strategy, characterized by quick response to customers compatible to changes in consumer market, environment, and external factors [77].

The F&V customer order management may consider the following perspectives: (a) customer allocation management [107], (b) order delivery [71], (c) customer orientation management [31], (d) price-quote optimization [37], and order management (e-ordering) [78].

3.1.5 *Perspectives of transportation and logistics management*

The transportation and logistics management perspective focuses on a transportation planning and optimization system for superior customer service and appropriate stock/inventory levels. The major objective is to reduce the transportation costs in the fresh produce F&V supply chains where transportation and logistics costs are significant percentage of the costs of goods or services provided [89].

Transportation and logistics management perspectives include designing an optimal logistics offering by evaluating alternative transportation scenarios considering the perishability and damage of fresh fruits and vegetables while in transit [19]. This also includes decisions of cross docking, cost and service level trade-offs, and other strategies, such as merge-in-transit, or drop-shipping by using a robust logistics information systems. These enable the supply chain managers to determine the lowest cost transportation strategy for customer-centric decision-making [91]. The F&V transportation and logistics management system may consider the following perspectives: (a) transport optimization [19], (b) transport and logistics planning and information management [36], [18].

In summary, the F&V supply chain must evaluate alternative strategies regarding contract farmer locations, fruits and vegetable mixes, transportation strategies, and vegetable stock deployment strategies [98], [95], [18], [34] to understand the impacts of changes [30]. The F&V supply chain system may also consider the perspectives of (a) farm production planning, control, and alignment of competitive priorities [99], (b) strategic outsourcing of farm production and the associated transaction costs [39], [59] and (c) rationalization of contract farmers and cooperatives [86].

3.2 **Insights from Literature**

A detailed review of literature has explored the various perspectives of supply chain planning for the fresh farm produce fruits and vegetables for operational and strategic effectiveness. The perspective supermarket vegetable supply chain planning opportunities, with a given set of inputs

such as consumer demand and business priorities, would result in the following:

- Improved ability to meet the objectives of the supermarket supply chain: Decrease in the response time to satisfy the consumer demand; improved strategies for producing and delivering quality fruits and vegetables in desired quantity at low cost
- Better utilization of available farm capacity: Maximize the utilization of available resources of the contract farmers and cooperatives; enhance the capital invested in resources for on-time delivery of fruits and vegetables
- Minimization of SC cost: Evaluating various cost components, such as farm production cost, procurement cost, outsourcing cost, holding cost, shortage cost, transportation and other associated logistics cost for an optimized/balanced trade-off
- Increased customer service level: Number/percentage of available opportunities during which the contract farmer and farmer cooperatives satisfy the demand of the customer
- Improved control, communications and flexibility: Optimal stock level of fruits and vegetables; minimize the time required for accurate on-time transfer of real-time data (POS data); varieties of fruits and vegetable goods to satisfy various consumer segment

4. **Collaboration in SM Vegetable Supply Chain: Case Study**

The supermarket (SM) venture considered in the case study, operating as a large-scale supermarket since 2000, has five outlets in the city and have planned for more stores in the city. Fresh vegetable supplied to the customers at the SM accounts for 15 per cent of the total food sales. Even though the fresh vegetable do not generate a very big revenue, still SM has the potential to capture the consumer market, as fresh vegetables are the most important items for the consumers of the city considered in the case study. Even though the market share of SM in terms of fresh produce is small, the turnover is growing at an approximate rate of 24 per cent per annum. So, the impact of business practices and

supply chain management would be of prime importance in future.

Gradually, the SM has adopted the practice of collaborative business to promote selling of fresh fruits and vegetables by developing collaborative relationships with a two farmers' cooperatives (FC). The vegetables within the SM are priced competitively in comparison to traditional local and national market. However, the consumers have a perception that the SM prices are typically higher than the traditional retail market. The SM has adopted promotional strategies for fresh vegetables to gain and improve market share. They have identified fresh fruits and vegetables to be considered under the purview of promotion, at least a couple of weeks prior to the start of the promotion. They have explained and discussed the impact of such a strategy with the farmers' cooperatives, in order to ensure that these cooperatives would be able to satisfy the enhanced demand during this period. The SM also ensures that the price of the identified fresh fruits and vegetables remain stable during the entire season, and accordingly the SM and FC mutually agreed to develop a special price. This special price has benefited the contract farmers and cooperatives as the returns from the supermarkets were significantly more than that of the traditional supply.

A big contract farmer cooperative of fresh vegetables with a very high quantity supply of 5 tonnes of vegetable supply per week regularly replenishes the shelves of the supermarket. The cooperative supplies a number of vegetables by collecting from a number of contract farmers by properly coordinating all the supply and logistics, as prices and demand of the fresh vegetables are very volatile in the rural area and the cities. Further, these vegetables are characterized by very short life cycle and shelf life. The supply is also affected by the climatic and weathering conditions of the contract farmers. The SM shares information (on a daily basis) with the farmer cooperatives and contract farmers, which supports joint planning and implementation. They also consider the weather forecast to decide about the forward ordering, given the information about the customer demand. Typically, the SM places the forward ordering at least 5-7 days before the expected delivery date. This helps the farmer cooperative to coordinate the supply of fresh vegetables from contract farmers to

satisfy the high quality order of the SM. This ordering system helps the farmer cooperatives to meet the contingency weather/climatic conditions that may arise during cropping and harvesting season.

4.1 Contract Farmer/Cooperatives Development

The essence of a collaborative relationship for the supermarket in the retail fruits and vegetable supply chain is based on the premise of developing suitable contract farmers and cooperatives for strategic competitive advantage. The supermarket (SM) has developed the relationships which are characterized by the following factors:

- Standardization and Quality Certification:** The supermarkets use a procedure for standardization and quality certification of fresh farm produced fruits and vegetables from each contract farmer, which is built into the system. So, goods from these contract manufacturers requires minimal inspection during delivery before placed on the shelf. Most of the vegetables and fruits received from the contract farmers are in conformance to the desired specifications, such as size and quality of the fruits [9], [97]. The contract farmers are recognized and rewarded for their fruits' and vegetables' quality improvement. These contract farmers are quality certified, preferably ISO 9000. The supermarket invests on these contract farmers to enhance quality and quantity production on a continuous basis. These farmers adopt cutting edge technology to increase productivity and beat competitors [52]. As there is an intense price competition for these commodities, they also adopt creative strategy to differentiate itself from other farmers.
- Performance Measurement:** The supply chain managers visit the contract farmers to assess the development at their farms, so that the fruits and vegetable from these contract farmers has a very low wastage and return rate. They help these contract farmers to improve performance. So, the delivery performance of these contract farmers or cooperatives is good. The supermarkets provide these farmers with feedback about its performance. The contract farmers are regularly informed of their performance in terms of quality, delivery, cost etc. The quantity of fresh farm produces delivered by the contract farmers or

cooperatives on a regular basis meets the supermarkets' quantity performance objectives. The customer departments of the supermarkets are satisfied with the attention and dedication of procurement departments, farmer cooperatives and contract farmers [107].

- **Collaborative Relationship Management:** The SM collaborates with the contract farmers while improving and developing activities for new and improved seeds, fertilizers, maintenance of vegetation and cropping, mechanization, handling and other post-harvest processing. The cooperatives customize the packing of certain goods as requested by the supermarkets. The supermarkets and farmer cooperatives always maintain relationships with a limited number of contract farmers (maximum 2-3 for each fruit and vegetables). The relationship between the contract farmers, cooperatives and the supermarket is considered as a partnership. There is a mutual trust between these members and a mutual awareness of other member's needs [12]. There is goal congruence between these SC members.

- **Lead Time Management:** The contract farmers are flexible to certain extent to adjust production schedules without affecting the delivery schedule of farm produces [55]. The supermarkets limit allocation to the contract farmers to avoid these farmers become dominant. The contract farmers and cooperatives have typically short lead-time from order to delivery. The logistics administration from these cooperatives is efficient. Most of the deliveries from the contract farmers are on the delivery dates, which minimize the probability of lost sales and consumer goodwill.

- **Information Sharing:** The supermarkets and farmer cooperatives have an access to the contract farmers' internal information regarding cost of vegetable production and level of quality. The response to enquiry from these members is prompt. The supermarkets have access to contract farmers' and cooperatives' external information, such as accounting information. The contract farmers are aware of the fact that failure to comply with price and quality requirements of fruits and vegetables would result in reduced business. So, there is frequent formal and

informal information exchange between the SC members [76].

- **Price Management:** Typically, the procurement of fruits and vegetables by supermarkets meets the target cost or standard cost, so that the consumer price remains stable for a very long period of time [82]. Most of the time, the price is equal to or lower than the market average. The supermarket undertakes quality-based price negotiation with these farmers or cooperatives [37]. There are contractual agreements when negotiating with these farmers or cooperatives. This enables the supermarket, contract farmers and cooperatives perform very well together while carrying out their respective tasks. The farmer cooperatives and the supermarkets provide training to the contract farmers for special post-harvest care (including better cleaning, packaging, hygienic conditions in conformance to the customer requirement and long shelf-life) of the farm produces to add value to the product on the shelf. This enhances the scope of regular cost reduction of the farm vegetables.

- **Alignment with Strategic Business Objectives:** The supermarket relies heavily on these contract farmers to achieve its business objectives. These farmers commit on strategic, long-term issues, rather than just short-term actions. There is a stimulation of empowerment, creativity, innovation and collaboration within the SC. There is mutual encouragement in improvement activity. The contract farmers and supermarket organize joint quality planning, joint crop and production planning, joint workgroups. They held meetings on a regular basis to solve problems. They also use conflict resolution and revenue sharing techniques. The policy and strategy of supermarket retail supply chain are based on understanding and anticipating the needs and expectations of stakeholders; this is aligned with the partners' policy and strategy through value chain analysis [43]. Policy and strategy are based on internal performance indicators, with the ultimate goal is to satisfy end-customers [10], [103].

As the system is characterized by a high level of collaboration between the stakeholders of the supply chains, there are certain relation-specific investments to improve the quality of delivery on a continuous basis. The SM is also investing on the

contract farmers for high quality fruits and vegetables to satisfy the premium customer segments. The SM has invested on the cooperatives to develop a small warehouse/store house for post-harvest treatments and temporary storing, and coordinated logistics system for cross docking of fresh vegetables to the SM. These initiatives have been taken to develop strong collaborative relationships, and profit maximization and sharing. The SM has taken initiatives by investing in the training of the contract farmers and cooperatives in harvesting, processing, packaging, storing, transportation and delivery of fresh fruits and vegetables to minimize the transit damage and enhance the shelf life. This approach has reduced the wastages by approximately 10 per cent.

4.2 Collaborative Supply Chain Business Planning Strategies for Information Exchange

The unique characteristics of the fresh produce fruits and vegetables supply chain include [60]:

- Volatile, and uncertain demands with pressure on managers of retail supply chains for market share and financial performance
- Multiple planning dimensions, including adoption of new technology for cropping, harvesting, post-harvesting, packaging and storing, fruits and vegetables quality, delivery chain, alliances with contract farmers, cooperatives, channels, and support services
- Little historical data availability from the perspective of technology upgradation, and adoption by contract farmers, collaboration among contract farmers and cooperatives, and globalization of fruits and vegetable supply.
- Isolated groups of expert knowledge in agri-technology and business management
- Lack of a single view of the possible impact of an investment beyond the scope of any single enterprise planning system in the fruits and vegetables retail supply chain

In view of the above, the business planning model of an agri-supply chain depends on the way the business grows when it offers a variety of fruits and vegetables to an existing market. When markets are segmented by customer value and

buying behaviour, decision-makers of F&V retail supply chains may use the modeling approach to compare expected financial returns on alternative investments that works very well for some market segments than others. Investments on contract farmers and cooperatives that affect a specific attribute have different implications for each market segment. It results in market share, revenue, and profit that take into account the changes in size of that targeted segment and the overall market demand [66]. Specific investments on the contract farmers, cooperatives, technology and logistics service providers that can be considered during the analysis include price discounts and pricing strategy [106], relationship marketing programmes [65], [105], advertising to improve target customer awareness [77], new supply chain development and introduction of new technology [44], forward contracts for quality fruits and vegetables supply [70], and collaborative communication for demand chains [94].

The initiative to improve business performance of the SM retail supply chains calls for an assessment of both quality and price attributes of fruits and vegetables [37]. Quality attributes can be improved by investments to improve the size, colour and nutritional value, taste-related internal quality like sweetness (high total soluble solids and low soluble tannins). Price attributes can be improved by investments in technology for post-harvest processing, packaging, storing, sourcing, logistics, risk management, order and forecast management, supply chain incentives, discounts, advertising, and collaborative infrastructure [33]. It may be inferred that planned investment will influence customer perception and improved sales. In order to incorporate the above features in collaborative SC business and operational planning models, and to assess the sustainability of the changes in the management of procurement activities, it is imperative to develop a collaborative and compatible information exchange system and infrastructure. Further, it is essential to build control frameworks supporting the vertical collaborative relationships for SC effectiveness.

4.3 Information Sharing Considerations in Collaborative Supply Chain Planning

The information systems is used by the SM as a collaboration tool for the supply chain planners to integrate the contract farmers, cooperatives,

supermarkets and target customers by facilitating the flow of information among each other. In order to cope with the increasing need for information exchange, new technologies enabled by internet-based communication platforms and retail exchanges have been evolved, and implemented in the retail supply chain [6]. Such exchanges are characterized by supermarkets' direct access to contract farmers and cooperatives; this enables business to interact through a neutral intermediary (the exchange) to conduct one-to-one or multiple transactions. So, SM gains direct access to more contract farmers and vice-versa. This results in a more efficient supply system, through better and more rapid communications facilitating improvements in planning and procurement procedures. So, this decentralized application architecture copes well with the increased transaction volumes of fruits and vegetables, and high frequency of interactions between SC members. The information shared between these members is stock, capacity, supply, POS demand data, order status, crop production and harvest planning and scheduling, logistics, and so on. Although ICT facilitates information sharing, it does not verify data accuracy. This necessitated the continuous information audit to ensure accurate information exchange between the demand and supply nodes. This data is directly used for demand forecasting, crop production planning and scheduling, supply and transportation planning [33]. These data are transferred to all SC members to determine replenishment policies for the fresh fruits and vegetables [44]. The collaborative forecasting and replenishment (CFAR) system enabled the supermarket and contract farmers to forecast demand and to determine crop production schedule. The demand uncertainty of these perishable goods depends on the unknown market reception. With a prior knowledge about the market, the contract farmers determined how much capacity to reserve. The stocking decisions have been made by learning about the demand and other relevant variables by observing some market signals. This stocking status and policies determine the ordering policies as well as the expected cost of the members of the collaborative supply chain [68].

The supermarket-contract farmers supply chain resort to either continuous replenishment programme (CRP) or Cooperative-owned stock (COS) programme to share the actual information [85]. In CRP, the SM shares its daily demand, sales

and stock data with the contract farmers and cooperatives, and instructs them to maintain the SM's stock level within prespecified limits. In COS, the contract farmers has access to supermarket stock data and maintains the fruits and vegetables stock level by generating purchase orders as and when required [85].

The cooperative-owned stock (COS) is considered as a very effective collaboration strategy. Under the arrangement of COS strategy, the contract farmer cooperative has the responsibility to maintain and manage the stock of fruits and vegetables near the supermarket premises. The framework for information flow depicting the COS implementation between the supermarket and contract farmers/cooperatives is depicted in the Figure 2. In COS implementation, the stock is kept in a store near the SM premises for a small period of time (depending on the perishability of the fruits and vegetables).

The farmer cooperative replenishes the fruits and vegetables based on their criticality governed by either continuous review system or periodic review system and transfers bills to the downstream partners (supermarket). Continuous review system is selected for high-priced vegetables with very short shelf-life and periodic review system is selected for relatively low-priced vegetables with a relatively higher shelf-life. The supermarket chooses the most appropriate replenishment strategy for each fruits and vegetables (based on price, shelf-life and consumption volume) with lower total relevant cost (TRC). This results in high responsiveness to the customer through appropriate information sharing as the stock visibility is very high. The supermarket has devised a contract with the contract farmers and cooperatives to regulate the rights, responsibilities and obligations of the SC members, including the procedures for information and risk sharing. The reorder point, delivery time, lowest stock parameter, and information transfer mode has been determined by negotiation in this collaborative SC. So, COS is a strategy by which the supermarkets (SM) can adopt the practice of just-in-time collaborative partnership (JITCP) without incurring high replenishment costs. After the implementation of JITCP, the contract farmers and cooperatives have maintained the stock of fruits and vegetables in a store near the supermarket premises as well as at its central warehouse to satisfy the demand from all other

wholesalers and supermarkets in the retail supply chain.

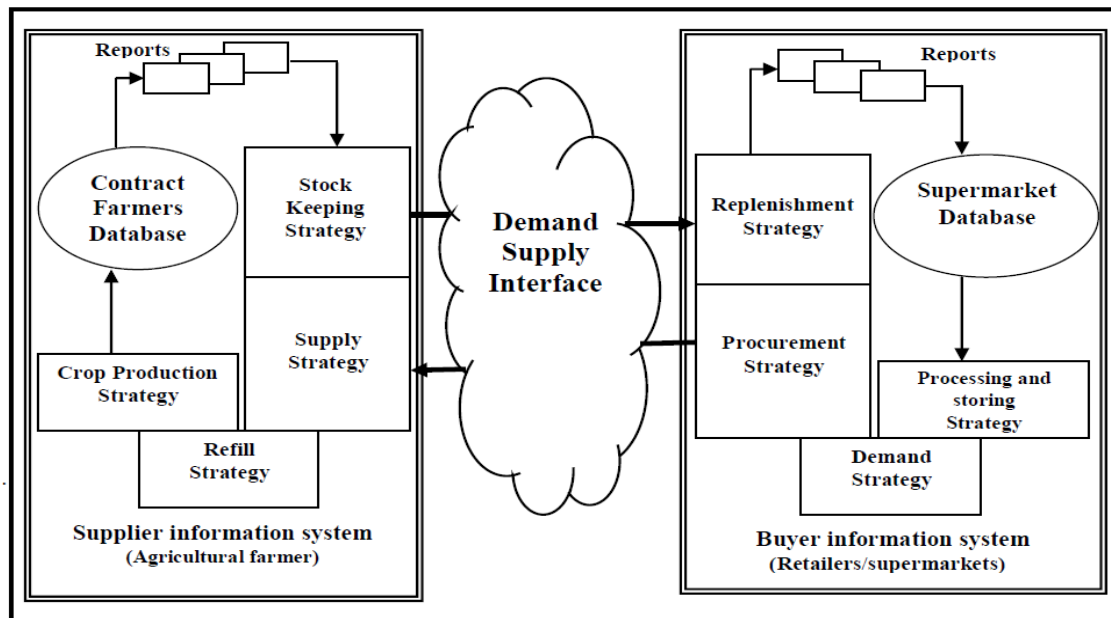


Figure 2: Integrated information flow structure for COS implementation

The COS strategy for the fresh produce fruits and vegetable SC provides purchasing enquiry, including long-term purchasing and forecasting, short-term delivery schedule, purchasing order, and stock inquiry, including balance stock status and a record of consumed stock. The COS strategy results in faster stock turn-over and more accurate demand forecasting and higher responsiveness in supply chain planning. The immediate implication of implementing COS is that the contract farmers and cooperatives would avoid gaming-behaviour of the supermarket retailers, as a substantial part of the total stock is related to the final market uncertainty rather than contract farmer cycle times. So, COS strategy acts as an enabler for the collaborated relationship between supermarket and contract farmers.

4.4 Collaborative Process Management in F&V Supply Chain

The collaborative process management (CPM) in fruits and vegetable supply chain of retail supermarkets have focused collaborative practices in both supply and demand processes to ensure vertical and cross-functional relationships. This is based on the fact that both the sales forecast and the order forecast are considered in the joint planning

and decision-making process. Collaboration in demand processes (customer demand forecast) has occurred to create and enhance the supply chain effectiveness. Collaboration in supply processes (crop production scheduling, carrier utilization, warehouse management, order forecasts and replenishments) has also occurred to create and enhance supply chain efficiencies. In order to optimize the supply chain decisions by matching supply and demand, the supermarkets and the contract farmers have conducted a number of scenario analyses.

The collaborative process management (CPM) is characterized by joint business planning processes, creation of order forecasts and the execution of replenishment orders by COS strategy for matching supply and demand. The contract farmers, cooperatives and supermarket have agreed and operated to procurement commitments and developed a very high level of trust. This has resulted in the development of effective and efficient two-way communication channels for simultaneous exchange of information; the members updated the relevant information in real-time and the relationships became stronger.

The supply chain planning process was done for a long time horizon (2-3 years) and focused on future business for maximum customer satisfaction and profit generation. The process management resulted in improved fill rate, reduced lost sales and optimized supply process through maximum transport utilization. The collaborative forecast planning was done on an annual basis with review of plans and collaboration in every fortnight. This has led to the characterization of CPM activities from the perspectives of CPFR [20]. The supermarket has observed that there is a trend of increase in the volume of sales of fresh fruits and vegetables at all the outlets in the city over the last two years. The supermarket has at least 50 distinct contract farmers under the aegis of two farmer cooperatives who are working on some form of CPFR to develop CPM culture in the supply chains. All the SKUs of the contract farmers were included in the CPM relationship and special attention was given to promotional items, and the items with premium price and quality.

Earlier, the order forecast for the fresh fruits and vegetables were not considered seriously by the supermarket. However, accurate item-level sales forecast to the contract farmers is essential to drive the supply chain efficiency. This forecast was translated to the purchase order by the supermarket. In the process, the supermarket and farmer cooperatives have engaged in joint planning of economic cropping quantity (due to perishable nature of fruits and vegetables), capacity management, efficient shipping methods and cross-docking, timing and quantity of deliveries, optimized utilization of carrier load, and other relevant ordering strategies to enhance supply chain efficiency. The supermarkets have invested in the design of supply chain information systems for item-level input provided by the sales forecast to generate item-level purchase order forecast. This is the essence of a successful CPM system, which translates the item-level customer demand to purchase order decisions that enable the supermarket retail supply chain to maximize efficiency, optimize total relevant cost and ultimately lower prices of good quality fruits and vegetables for end customers.

The collaborative process management (CPM) of the supermarket retail supply chain of fresh farm produces fruits and vegetables resulted in the following: (a) increased sales growth (67%) due to

improved customer service through collaborative practices, (b) improved shipping performance such as fill rate (96%) through cross-docking and removing intermediaries, (c) greater promotional planning and ensuring the promotions are serviced with the fruits and vegetables offerings on the shelves of the supermarket (with promised price and quality) resulting in increased customer base (56%), (d) improved inventory turns (24 turns per year) as the average 12 month cost of sales is very high in comparison to average current stock on shelves, and (e) significantly decreased freight rates (24%) due to joint order forecasts and logistics coordination. Further, there were significant improvements at the supermarket, such as reduced stock-out (less than 1% time) due to greater visibility and enhanced communication capabilities. So, the ownership for CPM success is attributed to strategic decision-making, longer planning horizon, and more committed order purchasing.

The supermarket, contract farmers and cooperatives have implemented the CPM practices through extensive training programmes for the collaborating contract farmers. The training programmes have focused on (a) grinding the forecast theories and practice to generate item-level purchase order forecast, (b) examining, understanding and utilizing the information and communication technologies for competitive advantage, (c) simulating the activities of the customers and their buying behavior for effective promotional activities, and (d) examining the supply chain tradeoffs from the perspective of reduced cycle time, customer satisfaction and maximum revenue. This encouraged the contract farmers and cooperatives to apply the knowledge and organizational learning to develop collaborative relationships with the supply chain members, which enhanced the scalability of CPM.

The major limitation of collaborative process management is the exploration of most appropriate technology that would be compatible and economic with evolving collaborative relationships; so, some contract farmers and cooperatives resort to the generation of order forecasts manually keeping in view the return on investment for outsourced technology, which may not prove economical. The information systems software must have a built-in statistical tool for data extrapolation and spreadsheet analysis. Another aspect of fruits and

vegetable supply chains consisting of supermarkets is the demand planning, which is typically done on a local or regional basis, but should be done on a national basis. The major challenge of the CPM strategy is performance measurement for vertical and horizontal collaboration based on forecast accuracy for a successful and stable relationship.

The success of the collaborative process management (CPM) strategy depends on three aspects: (a) building of trust, (b) working for joint business goals, and (c) designing, developing and implementing various member-specific processes/activities to achieve the goal of demand-supply matching. For collaborative transaction management practices, the supermarket has implemented COS strategy for improved stock performance. A mixed-mode strategy is typically employed in the supermarket retail supply chain, i.e., for standard fruits and vegetables the COS strategy of collaborative transaction proved to be effective, and for high quality and premium priced fruits and vegetables with high demand uncertainty, the CPM strategy proved to be effective.

In summary, the CPM strategy is based on the following tenets for a successful and stable collaborative relationship in the supermarket retail supply chain:

- a. There is one-to-one interaction among SC members, which focuses on joint problem solving, strategic business planning and developing member-specific processes.
- b. All the processes are fully integrated for a strong relationship.
- c. There is a simultaneous exchange of information and knowledge among members regarding supply chain management activities.
- d. The collaborative relationships support supply chain effectiveness and strategic effectiveness.
- e. The relationship focuses on long-term future planning supported by regular information and knowledge exchange.
- f. Result-oriented rationing activities are focused to prioritize the supply of fresh produced fruits and vegetables in relation to actual day-to-day operational demand.

4.5 Information Collaboration in F&V Supply Chain

Collaborative forecasting enhances the F&V demand information transaction in the supply chain by developing a forecast based on consensus among members [20]. This ensures the orders (based on POS data) to be visible in real-time. This strategy consolidates forecasts for various fruits and vegetables which are seasonal or time dependent. Further, the supply chain members can view each other's forecast by using a web-based system. So, in the supermarket retail supply chain network with collaborative forecasting, the members share POS data to reach a consensus and use the same data to place orders for meeting end-customer demand. This allows the contract farmers and cooperatives to attain higher efficiency than COS, due to a stable and continuous demand of the fruits and vegetables stock along the supply chain and consequently small investment or capital requirements [22].

Collaborative planning ensures that the supply chain member can access the information of any other member over which it has no control, but can use it solely for the purpose of supply chain planning [20]. Such information includes the processed, harvested and on-farm fruits and vegetables and in-process fruits and vegetables of the members. This implies that collaborative planning can be viewed as an integration of collaborative forecasting and COS. So, in a supply chain network with collaborative planning, the partnership extends to collaborative stocks and ordering decisions. This approach would ensure that by using a web-based system, all the supply chain members will have access to real-time forecast and demand information. Due to complete visibility of material flow along the chain, it is possible to adjust new customer requirements in less time. This results in less inventory investment and cost to achieve the target service level along the supply chain [40].

4.5.1 Vertical Collaborations Steps

These are the processes that the members follow to collaborate with their SC partners (buyers and suppliers). Non-collaborative SC (NC) means that the business partners do not share critical information, i.e., they only transfer information about perishable products, orders and order status,

and exclusively between each supermarket-contract farmer relationships. Time delays exist in receiving and processing orders, as well as knowing the real stock status. The following improvement steps are proposed during the implementation of collaborative relationships (CoR) in the fruits and vegetables supply chains.

STEP-1: F-CEP (Forecasting for collaborative e-procurement) offers the possibility to speed up the information about customer demand along the supply chain. It enables the members to make consensus forecasting and allows the orders in the SC to be visible real-time, and processed these orders accordingly. The objective of consensus forecasting is to consolidate the various forecasts into a common time-series to be used for further business planning. Supermarkets, contract farmers and cooperatives can know each other's forecasts, make changes and agree on consensus-forecast using Internet.

STEP 2: P-CEP (Planning for collaborative e-procurement) allows the SC members to access additional information over which they do not have any control, and use it in their planning process. This additional information is about finished goods inventories (FGI) in stock and work-in-process inventory (WIP) of the downstream SC members. So, P-CEP is an aggregation of F-CEP and collaborative stock (COS). However, inaccurate forecasts and transshipments may result in lower fruits and vegetables SC performance.

4.5.2 Proposed Scheme

The sequence of steps to improve the performance of the SC through a gradual increment in the collaboration is proposed (Figure 3). Further analysis could be made to explore and check the outcomes of the implementation of F-CEP and P-CEP.

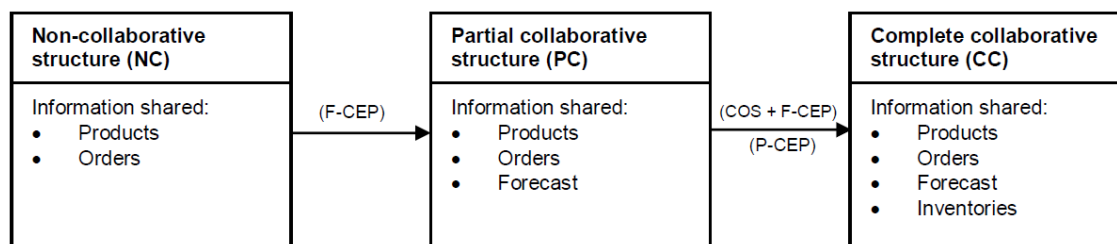


Figure 3. Steps to achieve full collaborative SC structure from non-collaborative structure

4.5.3 Implementation

When no collaboration exists in the SC, the inventory managers have only operative information about the order placed by their immediate downstream partners. The desired order rate depends on the local firm forecast and local inventories.

1. In order to model a F-CEP structure, the business partners must share the end- customers information to establish a consensus-forecast and to use the same forecast to place their orders. Then the supply chain collaborates on meeting end-customer demand, discusses and solves issues and sales expectations on a timely basis.
2. In order to model a P-CEP structure, it is essential to consider that the collaborative partnership extend to collaborative inventories and ordering system in the entire SC network. There is no need for local forecasts, as all SC

members will be provided with real-time forecast and demand information through internet. So, all the SC partners will have visibility to inventory and capacity utilization all through the chain. For this complete collaborative structure, a common shared-information system has to be developed in the SC. This is where FP-CEP (Forecasting and Planning for collaborative e-procurement) fits in.

4.5.4 Insights from the proposed scheme

The proposed scheme leads to a number of managerial insights, which are as follows:

1. Gradual increments of information sharing will produce positive changes in the local and global performance of the supermarket retail SC, as it would be easy for the personnel of the partners to adapt to the changing scenario.
2. F-CEP will allow supermarket SC to attain a higher efficiency increment than the COS

practice. This is due to the fact that F-CEP possesses more uniform behavior of the inventories along the SC and smaller average cash requirements with similar service level as that of COS.

P-CEP will allow complete visibility of the total material flow along the SC. This will result in optimized movements, and handling and storage of materials along the supply chain, enabling the ordering policies to adjust to the new customer requirement. This is achieved through less inventory investment and cost along the chain. So, P-CEP will stabilize the critical variables to enable highest throughput, even when the information has to pass through multiple intermediaries between the end customers and the contract farmers.

4.6 Major Observations from the Case Study

The supply chain collaboration initiatives have resulted in paradigm shifts in business processes. The critical collaboration enablers to this effect (based on proposed planning frameworks) in the supermarket supply-demand network are presented in the following Table 1. The employees of the supermarket outlet, cooperatives, and contract farmers evaluated the extent to which each item in the table below has facilitated collaboration for strategic mutual advantage (on a five point Likert scale). These respondents determined the relative implementation of collaborative initiatives in the supermarket supply chain for fruits and vegetables to determine the scope for future improvement.

Table 1. Critical collaboration enablers

Sl. no	Critical Enablers	Mean Score	Rank
1	Willingness to share information	4.58	1
2	Supply base reduction	4.50	2
3	Frequent communication	4.49	3
4	Sharing technical expertise with contract farmers	4.46	4
5	Common goals and objectives of the stakeholders	4.42	5
6	Using cross-functional teams and processes	4.34	6
7	Sharing expertise with end-customers in relation to food quality and safety	4.31	7
8	Use of total cost analysis before delivering goods to end customers	4.14	8
9	Implementing farmer cooperative owned inventory (COI)	4.13	9
10	Interaction of senior management with the cooperatives, contract farmers and end-customers	4.10	10
11	Use of consistent supply chain measures	4.06	11
12	Revenue sharing and risk sharing measures	3.99	12
13	Increased supply chain training to contract farmers in relation to food safety and hygiene	3.87	13
14	Clearly defined collaboration guidelines for all the cooperatives and contract farmers	3.81	14
15	Clearly defined common operating procedures	3.70	15
16	EDI linkages between the farmer cooperatives and supermarket	3.53	16
17	Use of activity based costing to determine the prices of the perishable commodities	3.17	17

It is clear from the above analysis that some of these enablers have a very significant impact on the supply chain collaboration (say mean score above 4.40). Other enablers don't have a very positive impact on the supply chain collaboration. The reason for the low mean scores may be due to the fact that the supply chain members in the supermarket supply chain are not sufficiently advanced in adopting these practices to make supply chain collaboration a success. The supply chain members felt that the aspect of collaboration is a complex process and these practices may not

be easy or sufficient to reduce the gaps of collaboration in the supermarket supply chain. The greatest agreement among the members lies in the factors, such as willing to share pertinent information and its frequency, and reduction of supply base as vital to effective SCM. As the mean scores are evaluated, a pattern emerges where the SC managers rank various practices that they implement on a regular basis. It has been observed that the managers who are more experienced in a particular practice tend to assign more weights on that particular practice in terms of perceived

importance. It requires a more effective training regarding the applicability and impact of different collaborative practices, more extensive communication between the SC managers and employment of cross-functional teams.

Implementation of effective training of the enterprise members for the supply chain orientation helped the managers to communicate effectively with diverse functional members. This strategy generated a situation in which the top management established priorities and allocated resources. This success story justified further investment in collaborative efforts. The inputs were received from the advisory council, customer council, farmer cooperatives and contract farmers, which were duly customised and implemented for effective collaborative practices for supply chain effectiveness. The managerial implication of this success story lies in effective people management through effective communication, interdisciplinary-team collaboration to bridge the gap encountered in supermarket supply chain. It was inferred that while SC collaboration is enabled by information technology, the effectiveness of SC practices is due to people orientation.

The analysis leads to following managerial insights:

1. Although cost reduction of fresh farm produced fruits and vegetables is the important motivation for strategic SC collaboration, customer satisfaction and service is more important for the SC managers.
2. While technology and information exchange are critical for successful SC collaboration, people issues, such as culture, trust, supporting change, and willingness to collaborate are more critical. This can be attained through suitable organisational culture and structure, management styles.
3. The SC managers must focus on people training, education, and selecting right people to be a part of the teams and interacting with each other, which would foster commitment to SC collaboration.

5. Conclusion

Due to the emergence of e-market and the competition for the supply of perishable fruits and vegetables, the issue for the supermarkets lies in tackling the time-based competition and volatile

customer demand and developing a responsive and flexible supply chain. So, the supermarkets dealing with the supply of fresh farm produce fruits and vegetables are focusing more on tactical and operational issues instead in alignment of the strategic business issues. The perspectives of supply chain planning proposes guidelines, with the use of proposed ICT framework, may form the basis for enhanced business capabilities of supermarket retail industries by taking into consideration the real-time end-customer behaviour in marketplaces.

The supermarket-contract farmer supply network uses the concept of preferred supplier (contract farmers), which requires a reduced governance costs related to handling practices and transport through a small dedicated base of contract farmers or cooperatives. This requires lead time reduction for the centralized coordinated ordering and deliveries while maintaining good relations with these contract farmer and cooperatives. This process requires increased investments for quality assurance and safety through contract farmers. The case study reveals that the implementation of good standards and practices has reduced the chance of unsatisfied customers, which contributes to a good image of the supermarket. The proposed ICT framework would control the information costs through collaborative supplier-buyer networks. The contract farmers may be encouraged to pursue quality controls at the farm level through relation-specific investments. The supermarkets focus on the introduction of new varieties of fresh farm produced fruits and vegetable, new farm machineries and technologies, including the development of organic farm produces, oriented towards specific consumer demands. This would enable the branding of fresh produce fruits and vegetables of the supermarket through close partnership of the contract farmers, cooperatives and the supermarket [46]. This partnership would have some direct implications for the time-horizon of contractual agreements and the trust in delivery relationships [12]. Further, pooling of the contract farmers and cooperatives would represent a business model to allow small and marginal farmers to have direct linkages with the supermarket.

In summary, this paper has focused on a better understanding of the degree of interdependence within the supply chain collaboration, and the type

of ICT needed to facilitate such a relationship in a gradual manner. As the supply chain members become more interdependent, there would be a need for how these networks can be organized in a vertical manner (a supply chain) or a horizontal manner (supermarket marketing group). This would enhance the interchange of information and acquisition of knowledge among all the stakeholders.

The use of case study to examine driving forces and its imperatives for vertical collaboration has some limitations. Although the supply chain literature assumes that the collaborative relationship results in enhanced operational and business performance, analytical, quantitative and empirical studies may be conducted to evaluate the relationship between collaboration and performance in the supermarket supply chains. Further, the present study is based on the perspectives of single supermarket, and thus a single supply chain. So, future study should focus on several supply chains and/or networks to provide insights about the patterns of vertical and horizontal collaboration.

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