

Impact of Agri-fresh food supply chain and quality practices on Environmental sustainability

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Abstract: All farming operations benefit from the agri-fresh food business since it has the ability to increase agricultural income and create a large number of job opportunities. The agriculture sector is the backbone of the economy in developing nations. The term "Agri-fresh Food Supply Chain Quality" (AFSCQ), which will be used throughout the remainder of this work, refers to the standard of the operations and the final product from the farm through the distribution of the food items or from the farm to the customer. Due to the perishable nature of the commodity, high levels of demand and price uncertainty, rising customer concern about the safety of their food, and reliance on meteorological circumstances, the AFSCQ is extremely complex. The study developed relationships between AFSCQ and Environmental Sustainability. Specifically, on supplier management (SM), Waste management (WM), and Logistics Management (LM). The AFSCQ has a significant impact on environmental sustainability since its methods are applied throughout the whole supply chain. Organizational sustainability differs from conventional performance indicators in that it takes into account economic, social, and environmental sustainability in addition to other elements like sales, return, and market share. A thorough literature research was conducted for this study in order to identify the environmental sustainability variables and AFSCQ practices.

Key words: Agri-fresh food, sustainability, AFSCQ, Supply chain practices, WM, LM, SM.

I. INTRODUCTION

As the competition intensified beyond a single corporation into the supply chain, organizations, practitioners, consultants, and scholars began to realize that it is insufficient if their major priority is to increase performance through internal practices in their own industry.

The SCM idea is appealing to academics, researchers, and business management alike. After recognizing how crucial SCM is to preserving their products' and services' competitive advantage in the crowded market, many businesses have begun to accomplish this. The quality issues in the supply chains have gotten little attention, despite the importance of supply chains and their part in enhancing firms sustained competitive advantage.

However, quality practices, such as top management commitment to and leadership in quality, customer focus, quality of human resources, quality of information and information technology, etc., are how quality management is characterized at the organizational level. We still have a poor understanding of supply chain level quality practices.

In the field of supply chain management, quality is essential. According to Kaynak and Hartley (2008), the establishment of a quality-based culture may improve the operational efficiency, customer satisfaction, and financial performance of supply chain partners. The development of a quality-based culture improves the sustainability of the supply chain as well as the sustainability of the economy, society, and environment. Integration of the supply chain and quality has been promoted by several academics. A more focused technique is required to assess quality issues in the internal and external supply chain contexts. set of companies.

Due to the short shelf life of food products, the requirement to conform to food product safety and quality regulations, the high degree of demand and cost uncertainty, and the dependence on climatic conditions, the AFSCQ is more complex than the supply chain quality of nonperishable goods (Vorst and Beulens, 2002). (Salin, 1998). Winter and Knemeyer (2013) emphasized the connection between supply chain sustainability and quality.

In the previous ten years, the Agri-fresh product supply chain saw significant modifications. Agri-fresh food items, which are also the raw ingredients for many food processing businesses, have a considerable impact on the global economy. Within Agri-fresh food supply chains, raw food products are transformed through packaging, distribution, and related services.

Due to the product's short shelf life, the requirement to conform to food product safety and quality regulations, the degree of demand and price uncertainty, and the dependence on climatic conditions, the AFSCQ is more complex than the supply chain quality of non-perishable items (Van der Vorst and Beulens, 2002). (Salin, 1998). Cheng et al. (2014) talked about the effectiveness of supply and demand information visibility in the selling of perishable commodities.

The term "supply chain quality" refers to a set of procedures that emphasize constant process improvement among supply chain partners (firms) in order to increase performance and achieve customer satisfaction (Mellat-Parast, 2013). These definitions only apply to manufactured goods and services; perishable food products are given less consideration. According to Siddh et al. (2015), perishable food products make up a significant portion of the global economy and are a major source of raw materials for numerous food companies. The price of different food goods and perishable food products has significantly increased over the world. Since 2004, research in the area of perishable food supply chain quality has accelerated due to the strong likelihood that this topic will gain greater attention in the future. Therefore, the topic of perishable food supply chain offers a wealth of study prospects. Siddh et al. (2015) also looked at how less attention is given to research conducted in underdeveloped nations and how the majority of research publications and their concerns come from rich nations. In the future, researchers might focus specifically on difficulties with the quality of the perishable food supply chain in poor nations. It has also shown that the majority of research is focused on agri-fresh

because fruits and vegetables are perishable goods. Agri-fresh food products, according to Shukla and Jharkharia (2013), comprise fruits, vegetables, etc.

The term "agri-fresh food supply chain quality" (AFSCQ) refers to the process and product quality from the farm to the point at which the food products are delivered to consumers, or "from farm to folk." While the Agri-fresh Food Supply Chain Quality (AFSCQ) is unique and peculiar in some ways, managing such a supply chain is common and challenging. The term "AFSCQ" refers to a collection of formalized procedures or activities that place a focus on advancing continuous process improvement among supply chain participants in order to improve organizational sustainability or performance sustainability and safeguard the shelf life of agri-fresh food products.

Academics, researchers, and business managers are all interested in the SCM concept.

Many businesses have started doing so after realizing how important SCM is to maintaining their products' and services' competitive advantage in the crowded market. Despite the significance of supply chains and their role in boosting an organization's sustainable competitive advantage, the quality problems in the supply chains have received relatively little attention. Recent product recalls and supply chains' susceptibility to risk and disruption demonstrate that quality issues have not been fully acknowledged throughout the supply chains.

However, quality management is defined at the organizational level in terms of quality practices like top management commitment to quality, customer focus, and quality of

We still give only a limited amount of thought to quality practices at the supply chain level, considering factors like human resources, information quality, and information technology.

II. LITERATURE REVIEW

In the research paper "The effects of COVID-19 on Bangladesh's agri-food systems and people's health", the review's conclusions are broken down into two groups: (i) COVID-19's consequences on agri-food systems, and (ii) COVID-19's implications for agri-food-related health issues. The following paragraphs will clarify these two impacts. Through a variety of infrastructure-technological initiatives, such as diversifying income sources through varied cropping practices and integrating ICT (Information and Communications Technology) into various agri-food system sectors, Bangladesh's agri-food systems are adapting to and coping with the effects of climate change (Mondal et al., 2019).

Another Research on Food supply chain sustainability implementation issues: the instance of a UK artisan cheese manufacturer, this investigation highlighted a number of significant hurdles, including the initial investment cost, firm size, and ignorance of governmental regulations. When it comes to implementing sustainability practices, internal obstacles are by far more prevalent than external ones. It was discovered that one issue affecting the degree of integration in SMEs was the absence of consensus among various stakeholders on the idea of sustainability.

In the research on "Developing Economy's Sustainable Agri-Food Supply Chain Practices: A Few Empirical Evidences" to examine the most urgent problems relating to sustainable agri-supply chains and management, this study also examines the factors that influence the adoption of sustainable agribusiness practices in India. The study's constructs were determined over the course of two phases: a literature analysis and semi-structured interviews with supply chain enablers and intermediates in the Indian state of Uttarakhand (traders, officials, local mandis, and local markets). A semi-structured interview with AFSC partners revealed five constructs with twenty-seven attributes.

By combining applied mathematical optimization with SAW, a distribution center can be selected to enhance the Vietnamese fruit and vegetable supply chain. They collected a total of 439 samples from Vinh Long province and used a variety of survey methods, including in-depth interviews, focus groups, and face-to-face interviews, to analyze the sweet potato supply chain in the Mekong Delta region. They also gathered secondary data from recent articles, studies, and research articles. This study employed compromised programming based on IBM CPLEX Optimizer and mixed-integer linear programming to choose a distribution facility when cost and transport time were trade-offs. Additionally, this study employed Simple Additive Weighting (SAW) to assist in decision-making based on the findings of experts and Excel software.

Fresh Food Suppliers' Reaction to Large European Retailers' Sustainable Supply Chain Management. To close the gap between divergent sustainability requirements in the supplier-retail relationship in perishable supply chains, they advocated strategic convergence and partnership. Although the findings can be applicable to other agri-food chains with a similar structure, this article concentrates on supply networks for fresh vegetables.

Another study on Agri-food supply chain in India: a strategic study. They identified numerous internal (strengths and weaknesses) and external (opportunities and threats) components of AFSC in this article in order to develop a strategic viewpoint. To prioritize the detected elements based on the found factors, questionnaires are produced and disseminated to experts from academia and industry. The analytical hierarchy process (AHP) and fuzzy-AHP approaches are used to rank the identified strengths, weaknesses, opportunities, and threats variables, followed by comparative analysis.

Models for Energy-aware Loss-based Inventory Optimization in Agri-Fresh Food Supply Chains. Due to the high incidence of food loss during the inventory stage and the large energy consumption by warehouse activities, this article focuses on warehousing and inventory optimization in the agricultural fresh food supply chain. There have been established three models for mathematical programming: linear programming (LP), mixed integer linear programming (MILP), and mixed-integer quadratic programming (MIQP), each of which builds on the one before it.

A model-focused analysis of recent developments and possibilities in the sustainable food supply chain. The applied OR strategies discussed in this study for dealing with SFSC problems are primarily model-oriented and vary depending on the situation. Even while a structured framework of SFSC research methods is crucial, current assessments of FSC literature are fairly general and fail to explicitly take sustainability into account from a model-oriented perspective. It looked at 83 scientific journal articles that all incorporated pertinent mathematical modelling approaches.

Supply Chain for Sustainable Agri-Food with Uncertain Demand and Lead Time. To take into account stochastic demand and lead time, CO₂ emissions across the supply chain, service levels, and product lifespan effects, they created a discrete-event simulation model. Reducing order amounts can reduce costs and emissions by 27.42 percent and 18.21 percent, respectively, without lowering service standards, according to simulation data.

State-of-the-art for managing uncertainty in the agricultural supply chain. The goal of this work is to give a summary of the most current advancements and innovations in the use of operations research approaches to address challenges with agricultural supply chain management that involve uncertainty. It seeks to: (i) give a thorough review of the main research areas; (ii) point out the most significant and popular frameworks; and (iii) talk about the emergence of new operations research advancements in the agriculture sector.

Major concerns and obstacles in the fruits and vegetable agribusiness supply chain in Uttarakhand, India. Post-harvest losses and wastages plague the entire F&V supply chain in Uttarakhand as a result of the chain's length and fragmentation, reliance on intermediaries, poor road infrastructure, ineffective mandi system, lack of cold chain infrastructure, high packaging costs, subpar distribution quality, and a weak link in the chain.

Pricing for agricultural products using an agent-based simulation of client preference. This essay focuses on retail pricing strategies for agricultural products that take into consideration consumer preferences. We demonstrate how pricing strategies can be influenced by agent-based modelling. Over a predetermined time period, the model replicates the exchange of goods and services between merchants and clients.

Perishable product production and distribution strategy with several objectives. Through a multi-objective framework, this essay investigates. They created models for perishable items with both fixed and variable shelf lives in order to operationally integrate these two linked planning concerns (economic considerations and intangible value of freshness).

An evaluation of the use of planning models in the agri-food supply chain. The main advancements in the area of production and distribution planning for agricultural crops-based agri-foods are reviewed in this study. We pay particular attention to models that have been implemented successfully. The models are categorized according to pertinent attributes including the optimization techniques applied, the varieties of crops modelled, and the size of the plans, among others.

Management of the Agri-Food Supply Chain: Literature Review. Researchers can use the gaps identified in this paper's analysis of agricultural supply chain management (SCM) techniques to supplement their idea generation, and practitioners can organize the scope and boundaries of Agri-meals SCM. This study represents the first attempt to conduct an important literature review of the material that is currently available on Agri-meals SCM techniques for developing countries like India.

Four-tiered agri-food supply chain quality control using a variety of methods. Current studies on the supply chain coordination difficulty of product quality focus on the two-echelon supply chain. This diagram shows a four-echelon agri-food supply chain with one agricultural producer, one processing business, one distributor, and plenty of consumers. The results indicate that both approaches have an effect on quality assurance at the processing level, but only the profit-sharing strategy and a consumer-focused quality guarantee have an effect on the quality of agricultural producer products. As a result, a processing company's commitment to good quality is its only means of controlling the price of food on the market.

Study on supply chain coordination for fresh agricultural products under supply disruptions. In this study, a supply chain for fresh agricultural products with a single supplier and retailer encounters supply disruptions over the planning horizon. Both centralized and decentralized supply chains' ideal solutions are investigated. It has been determined that the very last output's lowering piecewise feature must be the highest wholesale price. A lump-sum fee is proposed in order to ensure that the provider and the shop have incentives to simply accept the coordinating contract. With the two-component tariff contract, the lump-sum charge is given, benefiting both the provider and the retailer.

Designing a sustainable Indian Agri-fresh food supply chain using innovative methods. The traditional Indian agri-clean food supply chain (AFSC) is disorganized and run through a large number of middlemen, making it unsustainable from the farmer (poor profitability) to the consumer (not getting excellent product even after paying an excessive price). The goal of this essay is to support creative ideas for creating a long-lasting Indian AFSC. Authors have developed 80 approaches to enhance this chain's overall performance by integrating SWOT into the TOWS (threat, opportunity, weak spot, and strength) matrix.

Coordination of the agri-food supply chain: state-of-the-art and recent advancements. This study was designed to review a comprehensive understanding of the agri-food supply chain, with a focus on coordination issues. The publications are categorized based on interdependencies, coordination mechanisms, and methodology, which are three key categories for studies on agri-food supply chain coordination.

Review of the Literature on Investigating Supply Chain Quality Problems and Structures in the Agri-Fresh Supply Chain. In today's global market, the food delivery chain (FSC), an agri-clean delivery chain, is experiencing a particular problem with accurately timed order commitment. The issue is mostly related to the lack of coordinated order quantity decision-making. Researchers who follow the conventional quality framework of the food supply chain are conducting the investigation.

III. RESEARCH GAP & HYPOTHESIS

Focusing on environmental sustainability and constructs affecting it. Constructs we identified are:

- WM – Waste Management
- SM – Supplier Management
- LM – Logistics Management

The following are hypothesis –

- H1a: Waste Management has a significant impact on Environmental sustainability
- H1b: Waste Management does not have a significant impact on Environmental sustainability
- H2a: Supplier Management practices have significant impact on Environmental sustainability
- H2b: Supplier Management practices do not have an impact on Environmental sustainability

- H3a: Choice of logistics do have impact on environmental sustainability
- H3b: Choice of logistics do not have impact on environmental sustainability

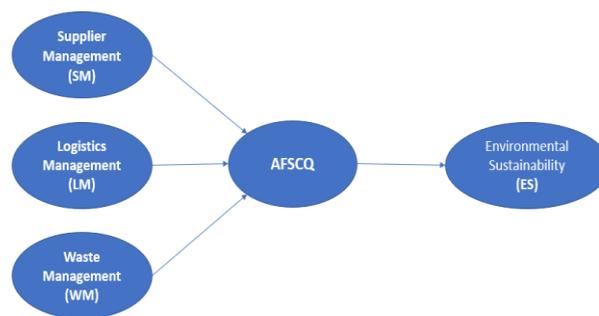


Figure 1: Conceptual model of AFSCQ practices and Environmental sustainability

Here, we have mainly focused on the primary data is on the process of being collection. We have prepared our questionnaire.

The below link is the questionnaire we have prepared for data collection.

https://docs.google.com/forms/d/1bZqFCWHM4f-8OHK8IQ_Jo_q3e-sTgeSF-x07P9gUs-0/edit?ts=622f8249

IV. RESEARCH METHODOLOGY

This section explains the methodology used to measure the hypothesis chosen for the study. The study was made in an attempt to understand the factors that are impacting the environmental sustainability.

Our review consists of 5 steps basically:

Step 1: Timeframe (1994 to mid-2016) - Due to the fact that the term "Food supply chain" first appeared in publications in 1994, the evaluation period for research publications is between 1994 and mid-2016. Mid-2016 is used as the collection's end date for research papers.

Step 2: Gathering research articles - We chose a few research articles from the top management science publishers. These include Science Direct, Wiley Interscience, Taylor & Francis, and Emerald Online. The vast majority of highly regarded journals are in these databases. These management science publishers were also used by Soni and Kodali (2012) for a thorough literature review of the supply chain management empirical study approach.

Step 3: Find research publications using keywords Supply chain quality, agri-food, agri-fresh, agrifood supply chain, food supply chain, fruit supply chain, vegetable supply chain, agri-fresh food supply chain, and perishable food supply chain are the search terms for research articles that were chosen from four databases. Using the aforementioned keywords, 1,562 articles were located in total.

Step 4: Sorting research publications. The following criteria were used to shortlist research publications:

Eliminating redundant publications - In this case, all of the downloaded publications were separated from the redundant publications.

Simplifying the selection process to include only pertinent publications - In this step, the sample size was decreased to create a representative sample set, for which the following policy was employed. The research article should at the very least address one of the following topics: supply chain quality, agri-fresh food, food product quality, or supply chain quality. We looked at research articles on agri-fresh produce as well as articles on difficulties with food product and supply chain quality.

Finally, the aforementioned downloaded publications were filtered down to 142 publications.

Step 5: Categorization of research publications - Here, papers are categorized into the following classes:

The quantity of yearly research articles This one displays the 23-year trend in the annual rate of AFSCQ literature publications.

Utilized tools or data analysis techniques: It provides information on the specific tools or techniques used to evaluate or analyze data. The research objective or problem at hand, as well as the type of data at hand, will determine the tool that is used.

Problems with supply chain quality One of the key classifications in the AFSCQ literature is supply chain quality issues. Reviewing these issues will result in general principles governing AFSCQ and aid researchers in developing a deeper comprehension of the topic.

The data is collected through the self-administered questionnaire which was given to various food businesses across Bangalore. The questionnaire was circulated to the selected food businesses by following cluster sampling. The self-administered questionnaire was given to them through mail. This study is focused mostly in Bangalore based food businesses and the sample is selected from these businesses through random sampling.

V. LIMITATIONS OF THE STUDY

The study is focused on the Indian market only

- The data gathered from limited locations
- The study period is short.

VI. DATA ANALYSIS & INTERPRETATION

Data Analysis - The primary research concentrated on a few variables that were determined following a thorough literature review and discussion with our research guide. The goal of the factor analysis was to reduce the number of variables by clubbing them together into identifiable factors and provide us an improved comprehension of the key elements of the research.

Reliability - The Cronchbach's Alpha value was used to determine the reliability of the questionnaire. A pilot study of 10 responses were taken for the study. The alpha value came out to be 0.889, relatively on the higher side. The ideal range for Cronchbach's Alpha

is from 0.7 to 0.95, any value above .7 is considered reliable. Hence, the value 0.811 signifies that the data collected by the questionnaire is reliable i.e., consistent, and trustworthy. Hence, the research can be carried out in this data.

	Sum of Squares	df	Mean Square	F
Between People	589.316	139	4.240	26.534
Between Items	276.952	13	21.304	
Within People	1450.834	1807	.803	
Residual	1450.834	1807	.803	
Total	2317.102	1959	1.183	

Figure 2: Cronbach's alpha

Sample Adequacy - The suitability of factor analysis is assessed using the Kaiser-Meyer-Olkin (KMO) a metric of sampling adequacy. High values (in the range of 0.5 and 1.0) suggest that factor analysis can be conducted. If the value is less than 0.5, factor analysis might not be acceptable. The KMO measure of sampling adequacy showed a score of 0.777 with a significance of 0.00 which is a desirable score. Any value above 0.74 represents an adequate value for factor analysis.

KMO & Bartlett's Test –

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.740
Bartlett's Test of Sphericity	Approx. Chi-Square	493.682
	df	55
	Sig.	.000

Figure 3: Kaiser-Meyer-Olkin test

These two tests assess the relevance of pertaining factor analysis (Field, 2009). The lowest possible value is 0.5 for KMO measure which is acceptable (Malhotra and Dash, 2011). Figure 3 shows As well for Bartlett's test of sphericity the significant value is 0.000. In this study the value of KMO measure is (.555) and value of Bartlett's test is (Sig. 0.000) shows suitability of data for factor analysis.

Inferences from the tables –

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.526	32.057	32.057	3.526	32.057	32.057	2.493	22.663	22.663
2	1.747	15.881	47.938	1.747	15.881	47.938	2.015	18.317	40.981
3	1.320	11.996	59.934	1.320	11.996	59.934	1.741	15.823	56.804
4	1.080	9.819	69.753	1.080	9.819	69.753	1.424	12.949	69.753

Figure 4: Total variance

Figure 4 explains the total variance explained by these 4 factors namely supplier management, waste management, logistic management, and environmental sustainability is approximately 70%. Now let's see the component matrix or factor analysis result. Figure 5 shows the rotated component matrix items are strongly loading on each of the extracted constructs. The rotated component matrix for Agri-fresh Food Supply Chain Quality (AFSCQ) practices and dimension of environmental sustainability are measured with considerable factor loading on their unique constructs. The factor loadings are ranging from 0.639 to 0.916 and there are no cross loadings between constructs

		Rotated Component Matrix			
		Component			
		1	2	3	4
Waste Management	What percent of products remains unsold before expiration?			.818	
	What waste management practices are followed in your organization?			.639	
	On a scale of 1 to 5, How difficult is waste disposal method for you?			.702	
Supplier Management	Rate your supplier's fertilizers use		.789		
	Your willingness to pay more for organic raw materials		.812		
	Your willingness to reject environmental harming raw materials from supplier?		.739		
Logistics Management	On a scale of 1 to 5, How sustainably do you procure your raw materials?				.814
	What percent of raw materials get damaged while procuring from supplier?				.826
Environmental Sustainability	On a scale from 1 to 5, How would you rate the help from government related to environment sustainability	.916			
	How Important is Environmental Sustainability in your business operations?	.823			

Figure 5: Rotated Component Matrix

VII. CONCLUSION & LIMITATIONS

Finding out the gap as mentioned above we are on the way to say that it does sustainability does impact the agri-fresh food supply chain and what can be the remedies and how the environmental impacts can be reduced from supply chain of agri-fresh foods. The integration of quality and agri-fresh food supply chain, which is lacking in the relevant literature, is covered in our research. The comprehensive structure for advising AFSCQ is stated there. According to the managerial implications raised in the chapter, a conceptual framework that provides a comprehensive depiction of key practices or dimensions of AFSCQ and unique facts of organizational sustainability is suggested after reviewing the quality issues raised by the agri-fresh food supply chain.

Since AFSCQ practices are applied throughout the entire supply chain, they have a significant impact on environmental sustainability.

Aggarwal and Srivastava (2016) discovered that waste reduction is a result of collaborative supply chain activities, which differs from traditional performance measures such as sales, return, and market share, among others. This finding has significant social implications. In the context of the development of the most modern way of conducting business, Bisogno (2016) claimed that short chains can contribute to increasing the sustainability of interests by being responsible for sustainability issues while also taking into account environmental factors. In order to propose new performance measures, researchers may need to incorporate sustainability components into various AFSCQ aspects.

Material, logistics, supplier, distribution, demand, purchasing, marketing, and information management all have an impact on AFSCQ. As a result, it is dependent on a wide range of factors, some of which are frequently studied by researchers. However, others are specifically addressed, such as supply chain effectiveness, risk management, industrial supply chain quality, supply chain security, supply chain quality, relationship quality, strategic alignment, visibility, end deliverable quality, etc.

VIII. REFERENCES

**** All figures are screenshoted from SPSS and Excel result sheet****

****Conceptual model is drawn on our own after understanding from the literature review****

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