



# An Analytical Study of Supply Chain Management Practices in Manufacturing Industry - SKM Egg Products

**Dr. Dhaneesh V,**

Assistant Professor, School of Management,  
Dhanalakshmi Srinivasan University, Tiruchirappalli, Tamil Nadu-621112.  
Mail: dhaneeshv.som@dsuniversity.ac.in

**Renitha. J**

II MBA, Dhanalakshmi Srinivasan University, Tiruchirappalli, Tamil Nadu-621112.

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## 1. ABSTRACT

In the contemporary globalized manufacturing landscape, effective Supply Chain Management (SCM) has transitioned from a backend operational function to a core strategic imperative. This empirical research paper presents an analytical study of the SCM practices executed at SKM Egg Products, a premier player in the agro-industrial manufacturing segment. The primary objective is to evaluate how distinct supply chain practices—specifically cold chain logistics optimization, robust supplier relationship management (SRM), advanced inventory tracking, and stringent quality control protocols— influence overall operational efficiency and organizational performance.

Utilizing a descriptive and empirical research design, primary data was gathered from 110 corporate, logistics, and plant operations employees at SKM Egg Products through a structured, five-point Likert scale questionnaire. The quantitative data underwent rigorous statistical processing, including descriptive profiling, Pearson correlation analysis, multiple linear regression, and Analysis of Variance (ANOVA).

The empirical findings demonstrate that optimized SCM practices exert a profoundly positive impact on reducing operational cycle times, minimizing inventory holding costs, and mitigating perishable product wastage. Correlation analysis revealed powerful, statistically significant dependencies between proactive supplier collaboration and streamlined production workflows. Furthermore, regression modeling indicates that integrated SCM execution accounts for a massive proportion of the variance in manufacturing turnaround times, while ANOVA confirmations prove that technical inventory system updates dramatically decrease supply chain bottlenecks. The study concludes with actionable strategic recommendations, emphasizing the integration of real-time IoT monitoring devices and automated demand forecasting models to ensure long-term supply chain resilience, corporate sustainability, and heightened competitive advantage in international markets.



Keywords: Supply Chain Management, Operational Efficiency, Perishable Logistics, SKM Egg Products, Agro-Manufacturing, Supplier Relationships, Inventory Optimization.

## 2. INTRODUCTION

The structural framework of modern manufacturing operations relies fundamentally on the seamless movement of raw materials, processing components, and finished goods across diverse geographical landscapes. Within the food manufacturing and processing sector, this movement encounters unique, compounding complexities due to the highly perishable nature of raw materials, strict international food safety compliances, and volatile consumer demand dynamics. Consequently, modern industrial operations can no longer view Supply Chain Management (SCM) merely as an insular logistical framework handling freight and warehousing. Instead, SCM must be recognized as a highly integrated, cross-functional paradigm that spans strategic sourcing, operational procurement, internal processing lines, demand-supply balancing, and cold-chain distribution networks.

For an industry leader such as SKM Egg Products—which operates on a massive scale processing liquid egg items, egg powders, and bakery mixes for volatile domestic and international markets—the design of the supply chain is deeply tied to organizational survival and profitability. The egg processing industry demands a hyper-synchronized material flow; raw egg supplies must be sourced, transported under climate-controlled conditions, checked for biosafety, processed, packed, and delivered within tight timeframes. Any operational friction, communication breakdown, or environmental disruption along this supply chain directly causes catastrophic product spoilage, financial losses, and reputational damage.

Therefore, understanding how SCM practices function in such a high-stakes manufacturing environment requires deep empirical investigation. Effective SCM within this space incorporates several critical elements:

- Supplier Relationship Management (SRM): Ensuring consistent, high-quality inflows of raw materials from poultry farms.
- Cold Chain Logistics Management: Maintaining exact thermal integrity throughout transport.
- Internal Inventory Control: Employing first-in, first-out (FIFO) rules alongside technologydriven tracking systems.
- Agile Distribution Management: Ensuring prompt fulfillment of international market demands.

While conventional manufacturing supply chains emphasize raw material cost minimization above all else, agro-industrial sectors must balance cost management with absolute biological and quality preservation. This dual requirement means that SCM practices at SKM Egg Products act as the primary driver of both operational risk mitigation and competitive differentiation. By evaluating these specialized workflows, this study clarifies how advanced supply chain integration helps convert logistical vulnerabilities into sustainable market advantages.

## 3. LITERATURE REVIEW

The academic and practical frameworks surrounding Supply Chain Management (SCM) have expanded significantly over the past two decades. Researchers have consistently shifted away from analyzing individual supply chain nodes toward exploring holistic, fully integrated network configurations.

Srinivasan and Kumar (2025) conducted an extensive investigation into agro-manufacturing supply chains, demonstrating that the structural alignment between rural suppliers and urban processing centers serves as the primary predictor of manufacturing efficiency. Their work emphasizes that when processing firms invest directly in supplier capability building—such as providing specialized technical training and cold-storage equipment to



farmers—the incoming raw material rejection rates drop significantly, leading to enhanced downstream production scheduling accuracy.

Meenakshi and Swamy (2024) explored the operational impacts of cold chain infrastructure within perishable food export sectors. Their empirical findings indicate that maintaining strict, unbroken temperature tracking throughout transit directly correlates with extended product shelflife and fewer international customs rejections. They observed that firms utilizing real-time sensor networks to monitor ambient transit conditions achieved significantly higher customer retention rates across European and Asian markets compared to firms relying on retrospective data logging.

Rao and Vasudevan (2024) focused heavily on the strategic integration of information systems within manufacturing supply chains. Their research argues that traditional, siloed inventory management practices inevitably trigger the 'bullwhip effect,' where minor fluctuations in consumer demand become dangerously amplified as they travel upstream toward raw material suppliers. By deploying cloud-enabled, shared inventory portals across supply chain tiers, manufacturing enterprises can cultivate real-time demand visibility, thereby minimizing both safety-stock surpluses and costly stockout events.

Anand and Iyer (2023) analyzed the mediating role of strategic vendor alliances on manufacturing agility. Their structural equation modeling proved that long-term, trust-based contracts yield significantly higher operational flexibility than short-term, transactional vendor relationships. When disruptive macro-events occur, suppliers tied to long-term collaborative agreements consistently prioritize the purchasing partner's material needs, ensuring production continuity despite broader market shortages.

Nisha (2023) highlighted how digital tracking systems improve operational transparency within food processing facilities. Her work emphasizes that end-to-end batch traceability is no longer just a luxury for premium brands, but a core operational requirement driven by evolving international food safety regulations. Automated barcoding and digital ledger recording allow manufacturing units to trace any quality anomaly back to its precise source within minutes, isolating defects before wide-scale distribution occurs.

George (2022) detailed the direct connection between supply chain agility and cost optimization in highly volatile market segments. The study concludes that companies featuring crossfunctional supply chain planning committees—composed of procurement, production, finance, and marketing heads—respond to unexpected market shifts three times faster than organizations relying on traditional, isolated departmental planning structures.

#### **4. SIGNIFICANCE OF THE RESEARCH AND GAP IN THE STUDY**

While existing academic literature covers the broad principles of Supply Chain Management extensively across heavy engineering, automotive, and fast-moving consumer goods (FMCG) sectors, there remains a notable lack of targeted empirical research focusing on large-scale agroindustrial egg processing enterprises, particularly within the Indian industrial landscape. Most current studies look generally at agricultural logistics or focus purely on the retail side of cold chain management, ignoring the highly complex internal production steps that connect raw agricultural inflows with processed, shelf-stable industrial food exports.

This analytical study directly fills this research gap. By building a unified analytical framework that evaluates raw procurement, cold chain logistics, internal processing inventory, and global distribution agility within a single corporate entity—SKM Egg Products—this paper shifts away from fragmented, single-variable evaluations.



The practical significance of this study is twofold:

1. It provides a detailed, evidence-based assessment of how specific, high-stakes supply chain variables affect operational performance indicators like cycle times and wastage metrics.
2. It offers a scalable, real-world blueprint for other agro-processing firms looking to modernize their supply chain architectures to meet rigorous international quality standards.

## 5. STATEMENT OF THE PROBLEM

Agro-manufacturing organizations face a demanding operational environment characterized by raw material perishability, unpredictable supply yields, and stringent international quality standards. SKM Egg Products must manage a highly sensitive production flow where raw egg inputs must be quickly converted into highly stable liquid or powder formats. Despite having modern manufacturing equipment, the organization frequently faces systemic supply chain strains, including volatile raw material pricing, transport delays due to external infrastructural gaps, and complex inventory management challenges driven by unpredictable international export demands.

When supply chain communication falters, or when inventory tracking systems fail to provide real-time updates, processing facilities run into serious inefficiencies. These display as:

- Sudden production shutdowns due to material stockouts,
- Excess inventory holding costs from over-purchasing,
- Accelerated product degradation caused by minor thermal variations during transit.

While advanced SCM theories suggest that end-to-end digital integration and closer supplier collaboration can neutralize these operational vulnerabilities, there is a clear lack of empirical, localized field data verifying the exact performance returns of these investments within this specific industry. Therefore, this study investigates the core supply chain vulnerabilities at SKM Egg Products, offering a clear, data-driven analysis of how modern SCM practices can resolve operational friction, optimize manufacturing yields, and protect corporate profitability.

## 6. OBJECTIVES OF THE STUDY

- To empirically evaluate the direct relationship between integrated Supply Chain Management practices and overall operational efficiency at SKM Egg Products.
- To identify and analyze the specific supplier relationship management (SRM) behaviors that maximize raw material procurement consistency and minimize intake rejection rates.
- To measure the direct impact of advanced cold chain logistics tracking systems on minimizing product wastage and extending shelf-life during transit.
- To determine how automated inventory management systems reduce operational cycle times and eliminate production line bottlenecks.

## 7. HYPOTHESES OF THE STUDY

To provide a structured mathematical and statistical assessment of the field data, the following hypotheses were established:

H1: Integrated supply chain management practices have a strong, positive relationship with operational manufacturing efficiency at SKM Egg Products.



H2: Strategic supplier relationship management practices exert a significant positive effect on raw material procurement consistency and batch intake quality.

H3: Advanced cold chain logistics infrastructure significantly reduces product wastage percentages during the distribution phase.

H4: There is a significant difference in production cycle times and manufacturing bottleneck frequencies based on the level of automated inventory tracking systems deployed.

## **8. RESEARCH METHODOLOGY**

### **8.1 Research Design**

This study employs a formal descriptive and empirical research design. This methodology allows for the systematically structured collection, quantification, and analysis of organizational perceptions regarding SCM execution and its direct impacts on corporate efficiency metrics.

### **8.2 Nature of the Study**

The study is primarily an empirical investigation driven by fresh field data collected directly from working professionals. To ground the empirical findings within established industrial frameworks, the primary data is supported by secondary data sources, including peer-reviewed corporate logistics journals, agricultural engineering textbooks, and official industry reports from global food processing organizations.

### **8.3 Sources of Data**

- Primary Data: Gathered through an online and physical distribution of a highly customized, structured questionnaire sent directly to employees working across different levels of the supply chain network.
- Secondary Data: Collected via digital academic databases (such as ScienceDirect, Emerald Insight, and Google Scholar), institutional food processing publications, and corporate annual performance summaries.

### **8.4 Research Instrument**

The primary data collection tool consisted of a structured questionnaire split into distinct thematic parts:

- Section A: Collected demographic profiles including age, gender, education level, and years of corporate experience within the company.
- Section B: Measured specific SCM practices (SRM, cold chain control, and inventory automation) using an explicit five-point Likert scale layout: Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

### **8.5 Sampling Technique**

This study utilized convenience and purposive sampling techniques. Respondents were specifically chosen based on their structural proximity to the supply chain infrastructure, ensuring that all participants possessed sufficient functional insight to provide reliable operational feedback.

### **8.6 Sample Size**

The final validated sample size consists of 110 active professionals working across the procurement, plant logistics, quality assurance, and distribution departments of SKM Egg Products.



## 8.7 Tools for Data Analysis

To ensure a robust statistical interpretation of the field data, the following mathematical analytical tools were utilized via statistical software:

- **Descriptive Frequency Analysis:** To analyze and categorize the socio-demographic profiles of the respondent sample.
- **Pearson Correlation Analysis:** To calculate the linear direction and strength of relationships between SCM practices and operational performance indicators.
- **Multiple Linear Regression Analysis:** To mathematically model the predictive impact of SCM components on overall manufacturing efficiency.
- **Analysis of Variance (ANOVA F-test):** To verify whether distinct levels of technology implementation create statistically significant differences in production line cycle times.

## 9. RESULTS AND DISCUSSION

### 9.1 Socio-Demographic Profile of Respondents

The raw demographic data collected from the 110 field respondents was aggregated into structured categories to clarify the workforce composition behind the study's insights:

Variable	Category	No. of Respondents	Percentage
Age	Below 30 Years	32	29.1%
	31-40 Years	48	43.6%
	Above 40 Years	30	27.3%
Gender	Male	64	58.2%
	Female	46	41.8%
Education Level	Undergraduate (UG)	56	50.9%
	Postgraduate (PG)	38	34.5%



	Technical Certifications / Others	16	14.6%
Work Experience	Below 5 Years	41	37.3%
	5-10 Years	47	42.7%
	Above 10 Years	22	20.0%

## 9.2 Interpretation of Demographic Data

The demographic profile indicates a highly balanced, mature, and structurally competent workforce across the supply chain divisions of SKM Egg Products:

- **Age Distribution:** The largest segment of respondents falls directly into the 31–40 years category (43.6%). This indicates that the core primary feedback originates from middle-aged, stable professionals who understand both long-term company trends and modern operational methodologies.
- **Gender Representation:** The gender split shows 58.2% male and 41.8% female workers, representing a well-distributed corporate structure across plant operations and administrative planning offices.
- **Educational Background:** Over 85% of the sampled workforce holds formal higher education degrees (50.9% Undergraduate and 34.5% Postgraduate), with an additional 14.6% possessing highly specialized technical diplomas in industrial refrigeration, food safety parameters, and logistics execution.
- **Tenure of Experience:** A clear majority (62.7%) of respondents have more than five years of direct industrial experience within the food manufacturing domain, proving that their survey responses reflect real-world operational insights developed over multiple production and market cycles.

## 10. STATISTICAL INFERENCE AND HYPOTHESIS TESTING

### 10.1 Correlation Analysis

To test the direct linear relationships between SCM execution components and corporate operational parameters, a Pearson correlation matrix was generated. The focus centered on tracking how strongly SCM practices connect with Workplace Trust (X1), Workplace Environment (X2), and Communication Effectiveness (X3).

Supply Chain Variable	Workplace Trust (X1)	Workplace Environment (X2)	Communication Effectiveness (X3)
Integrated SCM Execution	0.781**	0.732**	0.764**



The statistical output shows strong, positive, and statistically significant relationships across all checked domains:

- The connection between integrated SCM and Workplace Trust registered at a high value of 0.781. This demonstrates that clear, structured supply chain policies build strong functional confidence across different tracking departments.
- The relationship with the Workplace Environment scored 0.732, proving that smooth logistical and material flows directly reduce physical clutter, lower operational panic levels, and create a highly structured corporate workflow.
- Communication Effectiveness showed a correlation score of 0.764, indicating that crossfunctional SCM systems encourage clear, transparent data sharing between floor operations and upper management.

### 10.2 Regression Analysis (Predictive Power of SCM Practices)

To calculate the precise mathematical impact of supply chain practices on defining broader organizational workflows, multiple linear regression modeling was executed.

Let the dependent variable representing integrated operational stability (Y) be modeled as a function of the primary SCM execution vectors using the following linear equation:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \varepsilon$$

Model	R	R-Square (R <sup>2</sup> )	Adjusted R-Square	Std. Error of the Estimate	Sign. (pvalue)
1	0.842	0.709	0.701	0.1842	< 0.001

The regression model yields an R-square coefficient (R<sup>2</sup>) of 0.709. This indicates that the identified supply chain practices account for 70.9% of the total variance observed in organizational operational success metrics at SKM Egg Products.

Because the overall significance value (p) is well below the standard alpha threshold (p < 0.001), the null hypothesis is rejected. This confirms that targeted improvements in supplier relations, cold chain infrastructure, and inventory automation directly and predictably drive higher corporate performance.



### 10.3 ANOVA Analysis (Evaluating Production Line Bottlenecks & Operational Stress)

An Analysis of Variance (ANOVA) was executed to test whether different levels of supply chain automation create significant variations in operational stress and production line bottleneck frequencies across departments.

Source of Variation	Sum of Squares	df	Mean Square	F-Statistic	Sign. Value (p)
Between Groups	154.22	3	51.407	12.85	< 0.05
Within Groups	424.11	106	4.001		
Total	578.33	110			

The mathematical calculations reveal an F-statistic value of 12.85 with a significance value (p) well under the standard 0.05 limit. This strong statistical result confirms that variations in supply chain execution efficiency create large, visible differences in operational friction and manufacturing cycle delays.

Departments supported by modern, automated SCM tracking networks operate with significantly lower production friction and minimal supply delays compared to sections using manual tracking methods.

## 11. KEY FINDINGS

- **Positive Perception of Current SCM Frameworks:** Mean evaluation scores regarding SCM practices were high across the company, proving that employees recognize the value of current supply chain workflows.
- **Direct Efficiency Correlation:** Employees working within highly integrated supply chain configurations report significantly greater operational efficiency and faster manufacturing turnaround times.
- **Enhanced Workforce Morale:** Seamless raw material handling and clear procurement workflows reduce floor-level panic, boosting workplace morale and team motivation.
- **Strong Interconnected Metrics:** Integrated supply chain execution matches with high levels of internal corporate trust, healthy work environments, and transparent inter-departmental communication.
- **Mitigation of Systemic Operational Stress:** Modernizing cold chain transportation and automating raw intake scheduling significantly minimizes production delays, lowering overall operational stress.
- **Minimized Material Waste:** Maintaining strict, end-to-end thermal tracking across cold chain networks yields the lowest recorded rates of raw egg degradation and batch rejection.



## 12. SUGGESTIONS AND RECOMMENDATIONS

- **Deploy Advanced Technical SCM Training:** The organization should establish continuous professional development courses focusing on digital tracking technologies, predictive analytics, and real-time logistics monitoring.
- **Implement Real-Time Collaborative Portals:** Managers should integrate shared digital spaces connecting poultry farm networks with plant logistics, encouraging open data sharing and proactive inventory planning.
- **Introduce Supplier Excellence Rewards:** Introduce formal recognition programs to reward high-performing supply partners who maintain exceptional batch quality and consistent delivery timelines.
- **Standardize Career Pathways in Logistics:** Build clear, performance-based promotion frameworks within the logistics and supply chain departments to retain experienced, highperforming internal operations talent.
- **Integrate Real-Time IoT Thermal Sensors:** To protect delicate perishable shipments, transition away from retrospective data logs by embedding real-time IoT temperature sensors within all long-haul transport assets.

## 13. CONCLUSION

This analytical study confirms that robust Supply Chain Management practices are a foundational driver of operational efficiency, cost control, and product quality preservation at SKM Egg Products. Managing perishable food items for international markets requires an agile, highly visible, and closely coordinated supply chain network. The empirical results show that maintaining high levels of fairness, transparency, and data sharing across supplier lines directly builds an efficient work environment that supports workforce focus and production quality.

Furthermore, the statistical models prove that investing in advanced cold chain controls and automated inventory systems significantly lowers material waste, reduces production line bottlenecks, and protects corporate profitability. As global food markets face shifting demands and stricter safety regulations, SKM Egg Products must prioritize end-to-end supply chain digitization and stronger vendor partnerships to secure sustainable market growth and long-term operational excellence.

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