



Purchase Procedure and Supplier Evaluation for Food Processing Firms in Gujarat

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The food processing industry, both globally and in India, is undergoing rapid transformation driven by increasing consumer demand for safe, high-quality, and convenient products. As a major agricultural producer, India plays a pivotal role in the global food supply chain, particularly in the expanding frozen food segment, where demand for ready-to-eat and ready-to-cook products is rising steadily. This study focuses on the procurement and supplier evaluation practices of a leading frozen food manufacturer based in Gujarat. It critically examines the company's structured procurement framework, which emphasizes transparency, cost optimization, and strict compliance with food safety and regulatory standards. The procurement process involves close coordination among cross-functional departments including production, quality control, and new product development (NPD), ensuring seamless sourcing and consistent product quality. Primary data were collected from 20 procurement professionals across the sector using a structured questionnaire.

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The Henry Garrett Ranking method was applied to prioritize supplier evaluation criteria based on practical significance. The analysis revealed that product quality was considered the most crucial factor in supplier selection with a Garrett mean score of 78.40, followed by price (75.00) and accuracy of delivery (70.36). Other notable criteria included rejection handling, supplier capability, and service responsiveness. The findings provide a practical and data-driven framework that food processing firms can adopt to enhance supplier selection, streamline procurement workflows, and strengthen supply chain resilience. The study also contributes to existing literature by bridging the gap between procurement theory and its real-world application in the Indian frozen food industry.

Keywords: Henry Garrett ranking method; supply chain; procurement process; supplier evaluation; frozen food industry.

1. INTRODUCTION

The frozen food industry plays a crucial role in modern food supply chains, transforming perishable agricultural commodities into value-added, shelf-stable, and consumer-ready products (Mazz *et al.*, 2022; Sajankar *et al.*, 2025). This sector has experienced rapid growth in recent years, driven by changing consumer lifestyles, a preference for convenience, and increased focus on food safety and quality (Funde & Shrivastava, 2023; Arora *et al.*, 2022). India, with its abundant agricultural base and growing middle class, holds significant potential in frozen food manufacturing and exports (Calapre & Paspasan, 2024; Kaur *et al.*, 2024).

Procurement in this industry is a vital function that ensures the availability of raw materials and packaging components, directly impacting product quality, operational efficiency, and regulatory compliance. Due to the perishable nature of inputs and stringent food safety norms, food firms must adopt structured, transparent, and quality-oriented procurement practices (Dua & Sahu, 2024; Luzzini & Ronchi, 2011). Effective procurement depends on selecting reliable suppliers who consistently deliver safe, compliant, and cost-effective materials. Therefore, supplier evaluation is a critical step in managing risk and maintaining a resilient supply chain (Asamoah *et al.*, 2016; Saad *et al.*, 2016; Prahinski & Benton, 2004).

While several global studies have explored procurement models and vendor evaluation frameworks (Kamath *et al.*, 2018; Kaur & Singh, 2019), there is a limited amount of empirical research focused on frozen food manufacturing in the Indian context (Lou *et al.*, 2024; Chauhan *et al.*, 2025). Moreover, practical documentation of how procurement is carried out for both existing and new suppliers remains underexplored.

This study addresses this gap by examining the procurement workflow and supplier evaluation practices in Gujarat's frozen food manufacturing sector. It also identifies key criteria considered during supplier selection, using the Henry Garrett Ranking method to prioritize responses from industry professionals.

The specific objectives of the study are:

- To study the process of raw material purchasing in frozen food manufacturing firms
- To determine the important criteria used to evaluate suppliers in food processing firms
- To develop a supplier evaluation framework based on practical rankings

2. RESEARCH METHODOLOGY

This study was conducted to explore procurement practices and supplier evaluation criteria among frozen food processing firms in Gujarat. A multi-stage purposive sampling technique was employed. Initially, food manufacturing firms operating in the frozen food sector across major districts of Gujarat were identified. From this pool, 20 firms were selected based on their scale of operations (medium to large), active procurement departments, and willingness to participate. Respondents included purchase managers or procurement heads from each selected firm.

The first objective, studying the raw material procurement process, was addressed using a case study and observational approach within one leading frozen food firm. The researcher reviewed documentation, procurement workflows, and conducted informal interviews with procurement and quality assurance teams. To achieve the second objective, identifying

important supplier evaluation criteria, data were collected through a structured questionnaire administered to the 20 participating firms. Respondents were asked to rank a set of predefined supplier evaluation criteria (such as quality, price, delivery accuracy, etc.) based on their practical importance in decision-making. The selection of 20 firms was done using purposive sampling, focusing on medium to large-scale food manufacturers with operational procurement departments. Firms were chosen based on accessibility, willingness to participate, and geographic representation across key districts in Gujarat to ensure a representative industry snapshot.

The Henry Garrett Ranking Technique was selected for its ease of use and interpretability in industrial studies where expert judgment is crucial. Though considered traditional, this method remains widely adopted in supply chain, agribusiness, and procurement research due to its ability to convert qualitative rankings into statistically analyzable scores. This method converts ranks into scores based on percentage positions, allowing the calculation of mean scores across all respondents to determine the relative importance of each criterion. The formula used to calculate the percentage position is:
Percentage position = $100 \times (R_{ij} - 0.5) / N_j$

Where,

R_{ij} = Rank given for the i^{th} variable by j^{th} respondent

N_j = Number of variables ranked by j^{th} respondent

These percentage positions were then converted into Garrett scores using a standard table. The mean scores for each criterion were calculated to determine their final ranking.

3. RESULTS AND DISCUSSION

3.1 To Study the Process of Raw Material Purchasing in Frozen Food Manufacturing Firm

3.1.1 Key activity of the purchase department

- 1. Initiation of Purchase for Raw and Packaging Materials:** In the dynamic world of frozen food manufacturing, efficient procurement is essential for meeting production and quality demands. This process is closely linked to demand

forecasting, customer orders, and production planning, forming a critical chain that ensures a smooth and profitable operation.

- 2. Production Planning:** The production manager prepares a weekly production plan, which is shared with the purchase department to estimate raw material requirements based on defined recipes.
- 3. Material Requirement Estimation:** Using standardized product recipes, the total quantity of ingredients required is calculated.
- 4. Change Communication:** Any changes in the production plan are promptly communicated to the purchasing department for real-time adjustments to procurement.
- 5. Procurement Timing Based on Shelf Life**
 - Dry and non-perishable items (e.g., spices, oils):** Procured one week in advance.
 - Perishable items (e.g., fruits, vegetables):** Procured one day before production.

3.1.2 Procurement process of past purchase raw material

There are distinct procurement procedures for raw materials based on whether the item has been previously used or is being procured for the first time. Previously purchased raw materials refer to ingredients that have already been included in past formulations and recipes. For such items, a list of approved vendors is usually available, eliminating the need for supplier discovery, sample approval, or new vendor onboarding.

The procurement process begins when a demand is raised by the production unit (kitchen), followed by the following steps:

- 1. Demand from kitchen and prepare specification of product**

The procurement process begins with the purchasing unit identifying the need, followed by

an internal review of the technical and financial requirements.

Items, equipment, materials, and components required at the manufacturing site are recognized and a requisition is prepared for the same.

This requisition is then sent to the store department for further verification on the availability of them in the store. This requisition is a formal document with a specific document number and is called Material Requisition or Material Indent. The store department checks the availability of this material. In case the material is available in the store, the same is issued with an issue note.

However, if the said material is not available in the store, then another requisition needs to be raised. This requisition is called a Purchase Requisition. The same is raised by the store department and is sent to the purchase department for further action. The specification aims Fig. 1 Procurement process for past purchase (existing suppliers) to increase food safety and ensure the frozen food products quality high. Product specification is usually created by the Purchasing Department, together with the Quality Assurance (QA) Team in a frozen food company. The purchasing Team decides what to buy and from whom and the

quality Team makes sure the products are safe, high quality, and meet food laws.

2. Get quotation, supplier selection, negotiation and perform invoice

The company solicits quotations from pre-approved suppliers. Quotations are evaluated based on price, product quality, and supplier reliability. After selection, commercial terms such as pricing, delivery schedule, and payment terms are negotiated. A Proforma Invoice is then obtained from the selected supplier, summarizing the agreed-upon terms before issuing the final purchase order.

Quotation → helps in choosing the best supplier → then negotiate terms → finalized with a proforma invoice before the actual purchase.

3. Purchase order, expedite order and follow up

A formal document sent to the supplier confirming the order details (product, quantity, price, delivery date) is called a purchase order. The buyer checks in with the supplier to ensure the order is being processed and will be delivered on time. Continuous communication is maintained until the goods are received, checking for delays or issues.

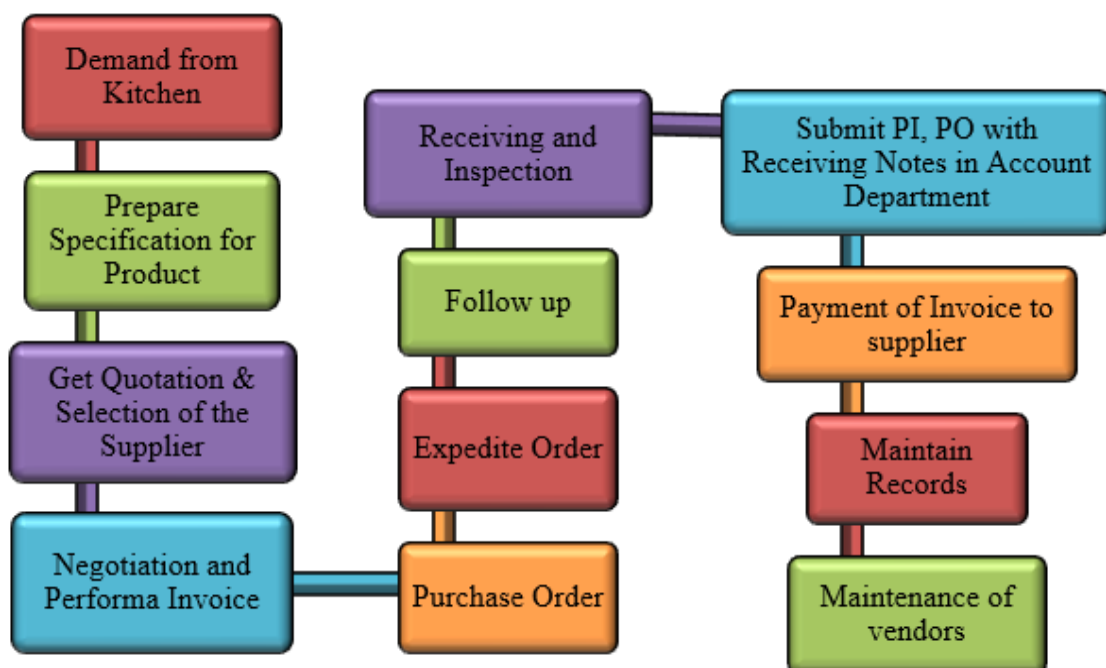


Fig. 1. Procurement process for past purchase (existing suppliers)

The purchase order confirms the deal → the buyer expedites the order to track progress → regular follow-up ensures on-time and correct delivery.

4. Receiving and Inspection

The quality team checks the received materials for defects, quantity, and compliance with specifications. Then, a receipt note is prepared by the stores/warehouse team to confirm the receipt of materials as per the purchase order and physical verification. Gate entry is where details of incoming materials (vehicle number, supplier name, invoice details) are recorded at the security gate.

5. Submit PI, PO with Receiving Notes in Account Department & Payment of Invoice to supplier

After materials are received and inspected, the PI, PO and Receiving Notes are submitted to the Accounts Department for verification. Once matched and approved, the Invoice Payment is processed to the supplier.

6. Maintain records and maintain vendors

Maintaining records is a process of systematically storing and organizing all transaction-related documents, such as purchase orders, invoices, and receiving notes, for future reference and auditing.

Maintaining Vendors involves managing and updating vendor information, including contact details, payment terms, and performance records, to ensure smooth and efficient procurement operations (Kamath & Naik, 2018).

3.1.3 Procurement process for first time buy raw material

This process is time-consuming and involves coordination with the New Product Development (NPD) Department. The Purchase Department reaches out to multiple suppliers, collects samples from them and gives them to NPD for approval.

Potential sources for the raw material are then explored, and samples are obtained for NPD evaluation. These samples undergo further QC testing to verify compliance with specifications. Upon approval, a raw material risk assessment is conducted to evaluate quality, safety, and regulatory concerns.

Suitable suppliers are identified and asked to fill out a Supplier Information Form, after which they undergo an audit or submit a self-assessment to validate their compliance and capabilities.

If found satisfactory, the specifications are finalized and trial samples are ordered. These trial samples undergo another QC check, and if cleared, are used in commercial trial production by the NPD team. Successful batch trials lead to supplier evaluation and final selection, after which the supplier is approved and added to the vendor list.

A proforma invoice is then collected, and a purchase order (PO) is issued. Upon receipt of the material, payment is processed, and the supplier is continuously evaluated as per the scheduled audit plan to ensure ongoing compliance and performance. This interlinked process ensures quality, traceability, and reliability of new raw materials before full-scale procurement.

3.1.4 Establish contract with raw material supplier

The company establishes a structured and reliable yearly contract for raw materials that experience frequent price fluctuations, to ensure cost stability and secure uninterrupted supply. This type of contract ensures consistent supply, cost efficiency, and quality compliance, while minimizing procurement risks and enhancing supplier collaboration.

3.1.5 Comparison between food processing procurement and standard procurement process

There are mainly two types of purchase processes in food processing firms: first time purchase & listed raw material purchase. There are slight differences between these processes and standard purchasing process.

Table 1 highlights that the procurement process in food processing firms involves more steps, follows food safety standards, strict rules and a strong focus on quality to handle perishable goods and keep production running smoothly. In comparison, standard procurement processes are simpler, mainly focusing on price, on-time delivery, and basic quality checks, while the procurement process of food processing firms includes holistic consideration of multiple criteria (Maaz et al., 2022).

Steps to establish contract with raw material supplier

1. Identify Key Raw Materials (with price volatility)
2. Forecast Annual Requirement (based on production plan)
3. Review Approved Vendor List (AVL)
4. Request Quotations from Qualified Suppliers
5. Evaluate and Negotiate Commercial Terms → Price, MOQ, Delivery Terms, Credit Period
6. Define Quality Specs and Sampling Procedures
7. Draft Annual Contract (including all terms)
8. Internal Review & Approval (Purchase, QC, Finance)
9. Sign Contract with Supplier
10. Share Tentative Delivery Schedule / Forecast
11. Monitor Supplier Performance (Monthly/Quarterly)
12. Mid-Year Review (adjust terms if needed)
13. Year-End Evaluation and Renewal Decision

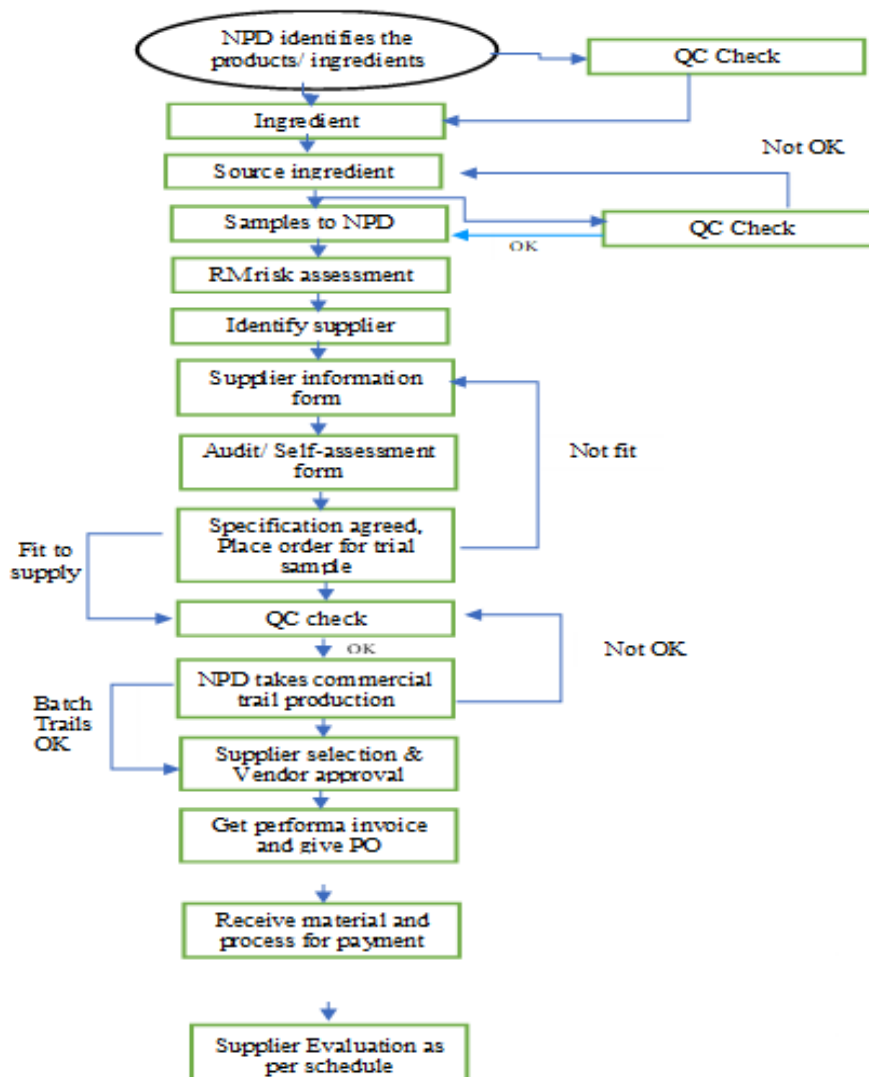


Fig. 2. Procurement process for first-time raw material

Table 1. Difference between the procurement process of food processing firms and the standard procurement process for general manufacturing or service industries

Stage	Standard Procurement Process	Food Processing Procurement
Quality Control Check (QC)	Generally, one QC check after receiving materials.	Multiple QC checks: on ingredients, on trial samples, and after delivery.
Sample/Trial Assessment	Usually a one-time technical or commercial bid evaluation — trial only for critical items.	Samples sent to NPD → Specification agreed → Place trial sample order → NPD takes commercial trial production.
Supplier Evaluation/Audit	Supplier registration, financial/technical assessment before approval.	Audit/Self-assessment form before trial supply acceptance.
Batch Production/Trial	Not common — usually direct to production after Quality Check, unless it's a new/critical item.	NPD takes commercial trial production after QC clearance on trial sample.
Invoice & Payment Process	Receive material → QC → Invoice verification → Payment processing.	Receive material → Process for payment after final QC check and supplier performance tracking.
Supplier Evaluation & Review	Annual or biannual vendor evaluation — focused on delivery, quality, and price.	Periodic supplier evaluation as per schedule.

3.1.6 Inventory forecast for raw material in a frozen food firm

1. Analyze Sales Forecast & Production Plan

Estimate finished goods demand based on historical sales, seasonal trends, and marketing plans.

Convert this into raw material requirements using Bill of Materials (BOM) for each product.

2. Classify Raw Materials

Group items into categories:

High usage (A) – e.g., vegetables, dairy ingredients.

Moderate usage (B) – spices, flavors.

Low usage (C) – specialty or imported ingredients

3. Calculate Lead Time & Safety Stock

Determine average supplier lead time for each raw material.

Calculate safety stock to avoid shortages due to delays or demand fluctuations.

4. Apply Inventory Forecasting Methods

Choose the best-fit method:

Time Series Analysis – Based on past consumption trends.

Moving Average or Exponential Smoothing – For stable demand items.

Demand-Driven Forecasting – For promotional/seasonal products.

5. Monthly/Quarterly Consumption Planning

Forecast monthly or quarterly raw material needs.

Adjust for promotions, holidays, and seasonal spikes (e.g., summer demand for frozen fruits).

6. Generate Procurement Plan

Align forecast with procurement cycles.

Plan bulk buying for high-usage items to optimize cost and logistics.

7. Monitor & Update Forecast Regularly

Compare forecasted vs. actual consumption. Adjust forecasts monthly based on deviations and changes in market demand.

3.2 To Determine the Important Criteria to Evaluate Suppliers in Food Processing Firms

Supplier evaluation plays a critical role in ensuring quality and consistency in the food processing industry. Based on literature, industry consultations, and internal procurement documentation, 22 evaluation criteria were shortlisted for this study. These factors reflect commonly used metrics in vendor assessment within the food manufacturing sector and were chosen for their relevance to quality assurance, cost efficiency, reliability, and compliance. Procurement heads from 20 frozen food firms ranked these criteria according to their importance in real-world supplier selection. The rankings were analyzed using the Henry Garrett Ranking Method, allowing calculation of mean scores and prioritization of each factor.

The Garrett scores in Table 2 are the result of aggregating individual rankings assigned by procurement professionals across the 20 firms. Each participant ranked all 22 criteria, which were then converted to scores using the Garrett Table. Mean scores were calculated across respondents to derive a weighted ranking. This method ensures a consolidated industry view of supplier evaluation priorities grounded in operational practice. Table 2 indicates that quality of product is the most significant criterion in supplier evaluation within food processing firms, with a Garrett mean score of 78.40, earning it the top rank. The prioritization of "Quality of Product" as the most important criterion reflects the frozen food industry's strict adherence to food safety regulations, consumer expectations for consistent taste and safety, and potential financial and reputational risks of substandard inputs. Since frozen products undergo limited post-processing by consumers, the quality of raw materials directly influences final product perception and regulatory compliance. This is followed by price, which secured the second rank with a mean score of 75.00, and accuracy of delivery, ranked third with a mean score of 70.36. Other notable factors include rejection and repair service, production facility and capability, and performance history, which were ranked fourth, fifth, and sixth, respectively.

Table 2. Criteria for the evaluation of suppliers in food processing firms

Criteria	Total Score	Garrett Ranking Mean	Rank	Category
Quality of Product	1650	78.40	I	Extreme Importance
Price	1548	75	II	
Accuracy of Delivery	1494	70.36	III	
Rejection & Repair Service	1725	67.90	IV	
Production Facility & Capability	1395	63.40	V	
Warranties & Claim Policies	1362	61.90	VI	Considerable Importance
Performance History	1287	58.5	VII	
Communication System	1248	56.72	VIII	
Technical Capability	1206	54.81	IX	
Financial Positions	1113	50.59	X	
Procedural Compliance	1050	47.72	XI	Average Importance
Reputation and Position in the Industry	1029	46.77	XII	
Desire for Business	1005	45.68	XIII	
Management and Organization	942	42.81	XIV	
Operation Controls	774	35.18	XV	
Attitude	774	35.18	XVI	Slight Importance
Impression	765	34.77	XVII	
Packing Ability	720	32.72	XVIII	
Labor Relation Record	654	29.72	XIX	
Geographical location	591	26.86	XX	
Amount of Past Business	483	21.95	XXI	
Training Aids	396	18.00	XXII	

Table 3. Criteria used most often for supplier evaluation

Criterion	Key terms used for measurement
Quality	Quality consistency, proactive quality management
Price	Price competitiveness, Price stability
Accuracy of Delivery	On-time delivery, Delivery flexibility
Rejection & Repair Service	Rejection rate handling, Complaint resolution time
Production Facility & Capability	Capacity adequacy, scalability & expansion potential

Table 4. Framework for supplier evaluation in food processing firms (Based on six criteria)

Criteria	Scale					Total (50)
	1	2	3	4	5	
1 Quality						
Quality consistency	Never Consistent (0-20%)	Rarely Consistent (21-40%)	Sometimes Consistent (41-60%)	Often Consistent (61-80%)	Always Consistent (81-100%)	
Proactive quality management	Not at all Proactive	Slightly Proactive	Moderately Proactive	Very Proactive	Extremely Proactive	
2 Price						
Price competitiveness	Not at all Competitive	Slightly Competitive	Somewhat Competitive	Very Competitive	Extremely Competitive	
Price stability	Very Unstable (>12)	Very Unstable (>12)	Neutral (6.1-9%)	Stable (3.1-6%)	Extremely Stable (0-3%)	
3 Accuracy of Delivery						
On-Time Delivery	Never (Delay more than 15 days)	Rarely (Delay 8-15 days)	Sometimes (Delay 4-7 days)	Often (Within 3 days)	Always (On or before agreed time)	
Delivery Flexibility	Not at all flexible	Slightly flexible	Moderately flexible	Very flexible	Extremely flexible	
4 Rejection & Repair service						
Rejection Rate Handling	Very Frequently (> 41%)	Frequently (31-40%)	Occasionally (21-30%)	Rarely (11-20%)	Very Rarely (0-10%)	
Complaint Resolution Time	Very Dissatisfied (>21 days)	Dissatisfied (15-21 days)	Neutral (7-14 days)	Satisfied (4-7 days)	Very Satisfied (Within 4 days)	
5 Production Capacity & Facility						
Capacity Adequacy	Very Dissatisfied (20% Met)	Dissatisfied (21-40% Met)	Neutral (41-60% Met)	Satisfied (61-80% Met)	Very Satisfied (81- as per required PO quantity)	
Scalability and Expansion Potential	Not at all Scalable	Slightly Scalable	Moderately Scalable	Very Scalable	Extremely Scalable	



Fig. 3. Data collection

3.3 To Develop a Supplier Evaluation Framework Based on Practical Rankings

In order to enhance the effectiveness of supplier selection and performance assessment in food processing firms, it is essential to establish a structured and practical evaluation system. Utilizing the data obtained from the second objective, which identifies and ranks key supplier evaluation criteria through empirical analysis, a comprehensive framework for supplier evaluation

can be developed. The most important six criteria such as quality, price, delivery time, rejection & repair and production facility will be used to evaluate the supplier. This framework will assist firms in making informed procurement decisions by systematically assessing suppliers against multiple, relevant performance parameters.

Table 4 is designed to systematically assess and rank suppliers in food processing firms based on multiple critical performance dimensions. Each criterion within the framework is measured using

a 5-point scale, where 1 represents the lowest level of performance and 5 represents the highest. This structured approach enables organizations to objectively evaluate their suppliers across key operational and service parameters. Additionally, the specific criteria and scaling descriptions can be customized by individual organizations according to their operational needs, priorities, and industry requirements. Quality is assessed based on the consistency of the goods or services delivered and the supplier's proactive approach to quality management. This reflects a preference for preventing issues through continuous monitoring and compliance, rather than merely reacting to problems. Maintaining high-quality raw materials in production is essential for ensuring food standards as per FSSAI regulations, and as reflected in the responses from food processing firms, quality remains the top priority in their procurement decisions.

Price is evaluated not only in terms of market competitiveness but also in terms of long-term price stability. This highlights the importance of predictable and reliable pricing for effective budget planning and procurement efficiency. Results indicate that price is the second most important factor in supplier evaluation, as managing the cost of individual materials is essential for controlling total production expenses.

Accuracy of Delivery includes both on-time delivery performance and flexibility in adjusting delivery schedules. This criterion emphasizes the supplier's ability to respond to changing operational needs and maintain continuity in supply. According to the analysis, delivery is third key factor, as consistent raw material availability is vital for maintaining a seamless supply chain flow.

Rejection and Repair Service is measured by the rate at which defective goods are handled and the speed of complaint resolution. A supplier's responsiveness in these areas indicates their commitment to post-purchase service and customer satisfaction. Material rejections, driven by perishability and stringent food standards, are a common issue for food processing firms. In this context, suppliers who swiftly replace rejected materials and maintain high quality are highly valued by organizations.

Finally, Production Facility and Capability refers to the supplier's installed production capacity,

readiness to meet demand, and scalability for future growth. It reflects the firm's ability to maintain supply even during high-demand periods or when product expansion is required. In addition to quality, price, delivery, and repair service, the supplier's production capacity and facility standards also hold significant importance.

4. CONCLUSION

The study reveals that frozen food manufacturing firms in Gujarat follow a well-structured, quality-driven procurement system that prioritizes operational efficiency, compliance with food safety norms, and supplier accountability. Observations from a leading firm demonstrated detailed workflows for both routine and first-time raw material purchases, involving collaboration between procurement, quality assurance (QA), and new product development (NPD) teams. Analysis of data from 20 firms using the Henry Garrett Ranking method highlighted that product quality was the most important supplier evaluation criterion, with a mean score of 78.40, followed by price (75.00) and accuracy of delivery (70.36). Other factors such as rejection handling, production capability, and performance history were also identified as relevant but secondary considerations. These findings reflect the critical need for reliable, safe, and cost-effective procurement in the highly sensitive frozen food sector. The insights from this study offer a valuable framework for procurement officers, supply chain managers, and policymakers aiming to strengthen vendor evaluation systems, enhance sourcing efficiency, and ensure continuous quality assurance in the Indian food processing industry. The supplier ranking model and mapped procurement procedures may also serve as a benchmark for other agro-processing units seeking to professionalize their sourcing functions.

5. SCOPE OF FUTURE RESEARCH

Future research can be extended across multiple strategic areas to further strengthen procurement systems in the frozen food industry:

1. Technological Advancements

Investigate how emerging technologies such as blockchain, artificial intelligence (AI), and the Internet of Things (IoT) can enhance traceability, automate quality

control, and improve transparency across procurement and supply chains.

2. Sustainable and Ethical Procurement

Explore the integration of sustainability criteria into supplier selection focusing on environmental impact, ethical sourcing, and corporate social responsibility (CSR) in line with global food industry trends.

3. Risk Mitigation and Supply Chain Resilience

Analyze strategies to reduce vulnerabilities in the raw material supply chain related to climate change, geopolitical disruptions, and pandemics, which may affect sourcing and lead times.

4. Supplier Collaboration and Innovation

Examine how long-term partnerships and collaborative frameworks with suppliers contribute to improved product quality, delivery reliability, and innovation in ingredient sourcing and logistics.

5. Consumer-Driven Procurement

Study the influence of evolving consumer preferences such as growing demand for organic, non-GMO, or locally sourced ingredients on supplier selection and procurement decision-making.

6. Building Resilient Procurement Systems

Develop frameworks that help frozen food companies withstand disruptions while maintaining consistent raw material flow through agile procurement practices and data-driven forecasting.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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