

Assessing the Impact of Outlet Attributes on Supply Chain Management Effectiveness in Frozen Food FMCG Distribution in Hyderabad and Secunderabad

Manoj K.V^{1*}, Dr. Gurdip Singh²

¹Research Scholar, Department of Commerce, Mansarovar Global University, Bhopal, M.P, India

²Professor, Department of Commerce, Mansarovar Global University, Bhopal, M.P, India,

Abstract

Frozen food fast-moving consumer goods (FMCG) distribution depends on retail outlet readiness as much as on manufacturers, transporters and distributors. In urban Indian markets, the outlet is the final cold-chain link, where infrastructure, handling practices, ordering discipline and distributor coordination shape product quality, availability and delivery reliability. This paper examines the effect of outlet attributes on Supply Chain Management (SCM) effectiveness in frozen food FMCG distribution in Hyderabad and Secunderabad. The study considers five outlet dimensions: cold-storage infrastructure, handling and safety capability, ordering and inventory capability, outlet accessibility and convenience, and outlet image and service quality. SCM effectiveness is assessed through delivery reliability, responsiveness, stock availability, wastage control, coordination, information sharing and cost efficiency. Using a quantitative, explanatory, cross-sectional design based on 384 outlets, the study applies SPSS and SmartPLS. Findings show that all five dimensions positively affect SCM effectiveness, with ordering and inventory capability as the strongest predictor.

Keywords: Frozen food FMCG, outlet attributes, SCM effectiveness, cold chain, retail distribution, PLS-SEM, Hyderabad, Secunderabad.

1. INTRODUCTION

Frozen food FMCG distribution plays an increasingly important role in urban retailing, because of the convenience, variety, hygiene, extended shelf life and product availability demanded by consumers. Frozen food is different from dry grocery products because it requires an uninterrupted cold chain from production to the point of sale. Any weakness at the retail outlet, including lack of freezer space, poor handling, inconsistent ordering, insufficient power backup poor replenishment or weak product display can cause a reduction in product quality and a decrease in the overall supply chain. The retail outlet is thus not a passive selling point. It is an operational node where logistics, storage, service quality and product safety and customer-facing performance converge. It is especially true in the case of Hyderabad and Secunderabad, where the supermarkets, mini-markets, convenience stores, frozen food speciality stores and traditional kirana stores are all intermingled in dense and varied retail geographies.

The supply-chain literature has long been advocating the importance of integration between suppliers, internal operations, logistics partners, and customer-facing units (Lambert & Cooper, 2000; Mentzer et al., 2001a; Stock & Boyer, 2009). This integration is particularly critical in FMCG due to the frequent product turnover and short replenishment cycles, coupled with demand volatility, which puts pressure on forecasting, timely delivery and responsive coordination (Bala & Kumar, 2011; Christopher, 2016; Lee et al., 1997). The challenge in frozen foods is more acute as the value of the product is time and temperature dependent (Aung & Chang, 2014; James & James, 2010; Mercier et

al., 2017; Ndraha et al., 2018). Distributor capacity and transport quality are important, but the attributes of the outlet will influence the effectiveness of the supply chain at the outlet-level.

Existing research provides good starting points, but not in a fully context-specific way. The importance of the physical dimension, reliability, personal interaction and policy on retail outcomes have been measured in retail service quality studies (Cronin & Taylor, 1992; Dabholkar et al., 1996; Parasuraman et al., 1988; Siu & Cheung, 2001). Logistics service quality research has created measures of order quality, order accuracy, personnel contact, timeliness, information quality and discrepancy handling (Bienstock et al., 1997; Mentzer et al., 1999; Mentzer et al., 2001b; Rafiq & Jaafar, 2007). Supplier relationship, information sharing, customer relationships and lean practices have been measured as drivers of competitive advantage and organisational performance in SCM studies (Fawcett et al., 2008; Li et al., 2005; Li et al., 2006; Tan, 2001; Tan et al., 2002). Cold-chain studies have focused on temperature control, traceability, infrastructure, food quality and reliability of logistics (Arora et al., 2023a; Arora et al., 2023b; Aung & Chang, 2014; Bogataj et al., 2005; Montanari, 2008; Wang et al., 2024). However, few studies combine these strands and explore the impact of outlet-level attributes on SCM effectiveness in the frozen food FMCG distribution in twin-city retail scenario in the Indian context.

This paper evaluates the influence of outlet attributes on SCM effectiveness in the distribution of frozen food FMCG in Hyderabad and Secunderabad. The aim is to identify the key outlet attributes relevant to the distribution of frozen food FMCG products, measure SCM effectiveness at the outlet-level, test the effect of the outlet attributes such as cold-storage infrastructure, handling and safety capability, ordering and inventory capability, outlet accessibility and convenience and outlet image and service quality on SCM effectiveness, and provide managerial recommendations for improving the performance of frozen food distribution.

2. LITERATURE REVIEW

2.1 Frozen food FMCG distribution and cold-chain dependence

The distribution of frozen food FMCG products is different from the distribution of ordinary FMCG products because the value of frozen products relies on maintaining product integrity throughout the temperature-controlled movement, storage and display. Food cold-chain research indicates that deterioration may not only occur during the manufacturing or transport processes, but also at the transfer points, retail storage and consumer-facing locations (Aung & Chang, 2014; James & James, 2010; Mercier et al., 2017). Temperature abuse can have an impact on safety, texture, shelf life and on customer trust, and inadequate monitoring and poor traceability make corrective action difficult (Bogataj et al., 2005; Montanari, 2008; Ndraha et al., 2018). The outlet is thus a crucial link in the cold chain of frozen food FMCG, rather than the end of it.

Cold-chain literature emphasises infrastructure, temperature control, and logistics responsiveness and safety assurance (Arora et al., 2023a; Arora et al., 2023b; Joshi et al., 2012; Raab et al., 2011; Wang et al., 2024). Arora et al., (2023b) found that the cold-chain infrastructure, handling practices, safety and quality, traceability and responsiveness are important issues in frozen food in India. Wang et al. (2024) created a cold-chain logistics service quality scale for fresh product e-commerce, which emphasises aspects such as reliability, convenience, freshness and personnel contact quality. While fresh product e-commerce is different from frozen food retail distribution, both rely on the need for quick turnaround, reliable information, condition control and customer trust. In the retail outlet, they become freezer adequacy, backup power, display discipline, stock rotation, staff awareness and timely coordination with the distributors.

2.2 Outlet attributes as operational resources

Outlet attributes can be viewed as resources at the store-level that can either facilitate or hinder supply-chain performance. The resource-based view proposes that the performance of a firm will be enhanced if it effectively uses valuable, rare, hard-to-imitate and well-organised resources (Barney, 1991; Wernerfelt, 1984). Within the frozen food outlet setting, resources are physical facilities, trained staff, ordering procedures, space, information systems and local knowledge of customers. Dynamic capabilities theory also indicates that companies need to be aware of market changes, capture opportunities, and modify their operating procedures in evolving markets (Teece et al., 1997; Teece, 2007). This translates into fast order changes, seasonal demand planning, avoiding out-of-stock situations and coordinating with distributors to replenish stock.

The research on retail service quality indicates that physical elements and service procedures have an impact on service outcomes. Dabholkar et al. (1996) developed a Retail Service Quality Scale, which

comprises physical aspects, reliability, personal interaction, problem solving and policy. This scale was developed for retail service quality but there are some dimensions that are applicable for frozen food FMCG outlets. Physical aspects relate to freezer space, cleanliness and display quality. Reliability is related to product availability and product condition. Problem solving is related to complaints, returns and product damage. The same reasoning applies to SERVQUAL and performance-based measures of service (Cronin & Taylor, 1992; Parasuraman et al., 1988).

Location and access are outlet attributes as well. The ability of delivery vehicles to easily access outlets and unload products and replenish outlets without delay is critical to distribution efficiency. This is crucial in urban areas with high density, as traffic, parking limitations and small lanes and storage can impact delivery reliability. Logistics research indicates that order procedures, timeliness, information quality, personnel contact and discrepancy handling are all factors that affect service quality (Bienstock et al., 1997; Mentzer et al., 1999; Mentzer et al., 2001b). These logistics aspects are influenced, at least in part, by the outlet's capacity to accept delivery, to inform the supplier of the stock required and to ensure the quality of the product following delivery in the frozen food retail environment.

2.3 Retailing and FMCG distribution SCM effectiveness

SCM effectiveness is the degree of reliable, responsive and cost-efficient, coordinated product movement from suppliers to customers. It is wider than logistics efficiency as it involves relationship quality, information sharing, stock availability, demand response, wastage control and end-customer service. Reliability, flexibility, responsiveness, cost, asset utilisation and customer service have been used to measure the effectiveness of supply-chain performance (Beamon, 1999; Gunasekaran et al., 2001; Gunasekaran et al., 2004; Neely et al., 1995; Shepherd & Günter, 2006). The SCOR model also categorises supply-chain performance in terms of reliability, responsiveness, agility and cost and asset management (Supply Chain Council, 2012). These dimensions are appropriate for FMCG as supply chains need to be fast, accurate and responsive.

In the food and retail supply chain, effectiveness is also related to collaboration and information visibility. Lee et al. (1997) demonstrated the effects of demand distortion in the absence of accurate and timely information among supply-chain partners and Chen et al. (2000) provided an understanding of how variability can magnify along the supply chain. Li and Lin (2006) highlighted the importance of information sharing and information quality, and Simatupang and Sridharan (2005) related collaboration to joint decision-making and performance improvement. Retail distribution relies on store-level sales data, distributor responsiveness and understanding of demand patterns (Flynn et al., 2010; Gimenez & Ventura, 2005; Prajogo & Olhager, 2012). Poor outlet-distributor coordination can result in either stock-outs or over-stocking in the case of frozen food FMCG, which can negatively affect performance.

The Indian retail landscape is even more complicated as organised retail, traditional retail and hybrid retail coexist. Validated scales provided by Gawankar et al. (2013) and Gawankar et al. (2016) are helpful in the context of SCM practices and supply-chain performance in Indian retail. Kumar and Singh (2023) further elaborate on this by demonstrating the relevance of SCM practices and retail outlet attributes in the food retail performance. The significance of these studies in the present paper is that they indicate that the research on Indian retail supply chain can be empirically tested using SEM based designs with adapted multi-item scales.

2.4 Combining retail service quality, logistics service quality and cold-chain performance

The current framework is a synthesis of three streams of literature. First, retail service quality can account for the physical appearance, reliability, and discipline toward the customer at the outlet-level (Dabholkar et al., 1996; Parasuraman et al., 1988; Siu & Cheung, 2001). Second, logistics service quality helps to understand the relationship between distributors and retailers: order quality, timeliness, information quality and discrepancy handling (Bienstock et al., 1997; Mentzer et al., 1999; Mentzer et al., 2001b; Rafiq & Jaafar, 2007). Third, cold-chain performance is the explanation of temperature control, safety, traceability and condition-sensitive handling (Arora et al., 2023a; Aung & Chang, 2014; Mercier et al., 2017; Wang et al., 2024).

These bodies of literature are complementary. Retail service quality is good, but if it is the only one, it is too customer-facing. Using logistics service quality alone is useful but too distributor-focused. While cold-chain management is helpful, it can underestimate other aspects of retailing like ordering discipline, accessibility and outlet image. The current framework integrates these perspectives to view outlet attributes as a package of operational and service capabilities, which affects SCM

effectiveness. This is in line with the literature in operations strategy and logistics, which states that the better the physical assets, human skills, information flows, and process routines are aligned, the better the performance (Bowersox et al., 2013; Christopher, 2016; Chopra & Meindl, 2016; Rushton et al., 2017). It is also in line with broader research on sustainability, resilience, collaboration, digital capabilities and supply-chain risk management (Agrawal et al., 2015; Brandenburg et al., 2014; Cao & Zhang, 2011; Carter & Rogers, 2008; Christopher & Peck, 2004; Gimenez & Tachizawa, 2012; Kshetri, 2018; Manzini & Accorsi, 2013; Seuring & Müller, 2008; Wieland & Wallenburg, 2012).

2.5 Research gap

Four gaps are evident in the literature. First, although there are many studies that investigate the practices in the supply chain and their impact on firm performance, few studies investigate outlet-level attributes as direct determinants of SCM effectiveness in the distribution of frozen food FMCG. Second, studies on the cold chain have been mainly based on logistics infrastructure, and food safety, while the readiness of retail outlets in urban markets in India has received less attention. Third, retail service quality studies are primarily concerned with customer perceptions, but the frozen food FMCG requires operational measurement of storage, handling, ordering and replenishment capacity. Fourth, while there are retail SCM scales in India, there is a potential to tailor them to a particular frozen food FMCG distribution context in Hyderabad and Secunderabad.

This paper introduces a model that allows outlet attributes to affect SCM effectiveness, to fill these gaps. PLS-SEM is used for examining the model since the constructs are latent, multi-dimensional and predictive. The methodological basis is provided by the literature on SEM and PLS-SEM with regard to reliability, validity, model assessment, prediction and common method bias (Chin, 1998; Cohen, 1988; Fornell & Larcker, 1981; Hair et al., 2011; Hair et al., 2017; Hair et al., 2019; Henseler et al., 2015; Kline, 2016; Kock, 2015; Nunnally & Bernstein, 1994; Podsakoff et al., 2003; Sarstedt et al., 2020; Shmueli et al., 2019).

3. CONCEPTUAL FRAMEWORK AND HYPOTHESES

Outlet attributes are considered an explanatory construct, and are represented by five dimensions: cold-storage infrastructure, handling and safety capability, ordering and inventory capability, outlet accessibility and convenience, and outlet image and service quality. SCM effectiveness is considered as the dependent construct that is reflected in delivery reliability, responsiveness, stock availability, wastage control, coordination and cost efficiency.

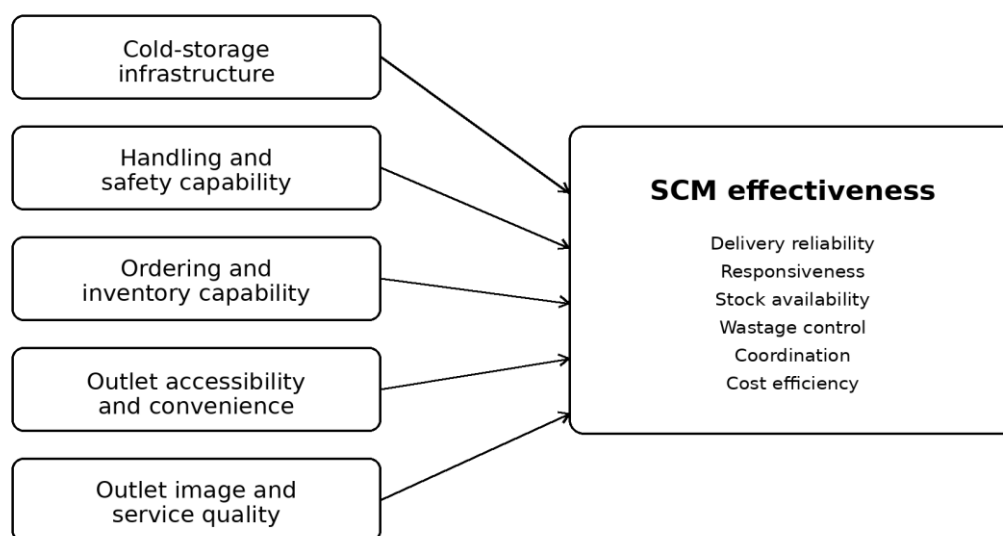


Figure 1. Conceptual model of outlet attributes and SCM effectiveness

Adapted from the literature on retail service quality, logistics service quality, SCM practices, cold-chain performance and supply-chain performance (Beamon, 1999; Dabholkar et al., 1996; Gawankar et al., 2013, 2016; Kumar & Singh, 2023; Li et al., 2005; Mentzer et al., 1999, 2001b; Wang et al., 2024).

Cold-storage infrastructure is expected to enhance SCM effectiveness because frozen food products need freezer space, continuity of temperature and safe display. SCM is undermined if the outlet does not have the capacity to keep the product in good condition after delivery, despite good upstream logistics. Studies on cold-chain focus on the importance of temperature management and

infrastructure quality (Aung & Chang, 2014; James & James, 2010; Mercier et al., 2017; Ndraha et al., 2018), supporting this argument. Hence, H1 suggests that the cold-storage infrastructure positively and significantly affects SCM effectiveness in the distribution of frozen food FMCG.

Handling and safety capability is the knowledge and practice of the outlet staff in unloading, storing, rotating, displaying and handling complaints. Thawing, product damage, spoilage and returns can be a result of poor handling. Previous studies on cold-chain performance and food quality indicate that the human practices of handling food are still relevant even in the presence of physical infrastructure (Arora et al., 2023a; Bogataj et al., 2005; Montanari, 2008; Raab et al., 2011). Thus, H2 suggests that handling and safety capability positively and significantly affects SCM effectiveness in frozen food FMCG distribution.

Ordering and inventory capability reflects how well the outlet manages to track stock and forecast demand, communicate with distributors about restocking needs, and prevent overstocking and stockouts. Information sharing and information quality and replenishment coordination have been associated with supply-chain performance in SCM literature many times (Li & Lin, 2006; Li et al., 2005; Prajogo & Olhager, 2012; Simatupang & Sridharan, 2005). Hence, H3 suggests that ordering and inventory capability positively and significantly affects SCM effectiveness in the frozen food FMCG distribution.

The ease of access and convenience of outlets affects the distributor's ability to provide frozen food products in a timely and safe manner. Lack of vehicle access, poor unloading facilities and poor store layouts can cause delays in delivery and handling times. Logistics service quality research reveals that timeliness, order condition and delivery procedures influence customer and channel performance (Bienstock et al., 1997; Mentzer et al., 1999; Mentzer et al., 2001b). Hence, H4 proposes that outlet accessibility and convenience positively and significantly influence SCM effectiveness in the distribution of frozen food FMCG.

Outlet image and service quality may also impact SCM effectiveness, by supporting disciplined storage, improved customer trust, complaint management and enhanced distributor-retailer relationships. The significance of physical aspects, reliability, personal interaction and problem solving in retail service quality research supports the importance of these aspects of the retail store (Cronin & Taylor, 1992; Dabholkar et al., 1996; Parasuraman et al., 1988). Hence, H5 suggests that outlet image and service quality positively and significantly affects SCM effectiveness in the distribution of frozen food FMCG.

Table 1. Summary of hypotheses

Hypothesis	Relationship	Expected direction	Theoretical support
H1	Cold-storage infrastructure -> SCM effectiveness	Positive	Cold-chain management and resource-based view
H2	Handling and safety capability -> SCM effectiveness	Positive	Cold-chain safety and process capability
H3	Ordering and inventory capability -> SCM effectiveness	Positive	Information sharing and supply-chain coordination
H4	Outlet accessibility and convenience -> SCM effectiveness	Positive	Logistics service quality and delivery reliability
H5	Outlet image and service quality -> SCM effectiveness	Positive	Retail service quality and customer-facing reliability

Source: Developed by the author based on cold-chain management, logistics service quality, retail service quality and SCM literature (Aung & Chang, 2014; Barney, 1991; Dabholkar et al., 1996; Li et al., 2005; Mentzer et al., 1999, 2001b; Kumar & Singh, 2023).

4. RESEARCH METHODOLOGY

The study was of a quantitative, explanatory and cross-sectional survey design. A quantitative design was suitable because it measured the strength and significance of the relationships between latent variables. An explanatory design was appropriate because the purpose was to evaluate the effect of the outlet attributes on the effectiveness of the SCM, not just describe outlet attributes. The study adopted a cross-sectional approach since the responses of the retail outlets were analysed at a particular time in both Hyderabad and Secunderabad.

PLS-SEM was selected as the main analysis technique. PLS-SEM can be applied when the aim of the research is prediction, the model includes latent constructs, the research context is developing or under-researched, and the researcher wants to evaluate both the measurement and structural models (Chin, 1998; Hair et al., 2011; Hair et al., 2017; Hair et al., 2019). Outlet attributes and SCM effectiveness are multi-item constructs and simple regression would be weaker because it would fail to account for measurement error and construct validity.

The target population was retail outlets which sold frozen food FMCG products in Hyderabad and Secunderabad. These were supermarkets, mini-markets, convenience shops, shops with freezer facility and frozen food speciality outlets. The unit of analysis was the retail outlet. The respondent was the person most knowledgeable about frozen food purchasing, receiving, storage and inventory practices, outlet owners, store managers, purchase managers, distribution coordinators and inventory handlers.

A stratified sampling was applied, to include representation of outlet format and geographical zone. This had to be done because there was a difference between the freezer capacity, the ordering discipline, the capability of the staff and access to the distributor between the large supermarket and the small kirana outlet. 384 valid responses were included in the analysis. This sample size was appropriate for PLS-SEM, as it was sufficiently large for a model with multiple predictors and latent dimensions (Cohen, 1988, Hair et al., 2017, Kline, 2016).

The questionnaire was designed using published scales, but with some adaptations. Outlet attributes were measured with adapted indicators from the Retail Service Quality Scale, food-retail outlet attribute studies, logistics service quality research and cold-chain studies (Dabholkar et al., 1996; Kumar & Singh, 2023; Mentzer et al., 1999; Wang et al., 2024). Adapted indicators from the supply-chain performance scale, logistics service quality scale, SCM practices scale and Indian retail supply-chain performance scale (Beamon, 1999; Gawankar et al., 2016; Gunasekaran et al., 2004; Li et al., 2005; Shepherd & Günter, 2006) were used to measure SCM effectiveness. The five-point Likert scale (1 = strongly disagree to 5 = strongly agree) was used.

Table 2. Measurement scale and source base

Construct	No. of items	Example measurement focus	Main source base
Cold-storage infrastructure	4	Freezer capacity, temperature maintenance, backup power, safe display	Aung & Chang (2014); Arora et al. (2023a); Dabholkar et al. (1996)
Handling and safety capability	4	Staff handling knowledge, unloading speed, stock rotation, removal of damaged items	Arora et al. (2023b); Mercier et al. (2017); Ndraha et al. (2018)
Ordering and inventory capability	4	Stock monitoring, timely reordering, demand communication, inventory records	Li et al. (2005); Li & Lin (2006); Prajogo & Olhager (2012)
Outlet accessibility and convenience	4	Distributor access, unloading space, route convenience, storage layout	Kumar & Singh (2023); Mentzer et al. (1999); Mentzer et al. (2001b)
Outlet image and service quality	4	Clean frozen section, organised display, complaint handling, customer confidence	Dabholkar et al. (1996); Parasuraman et al. (1988); Siu & Cheung (2001)
SCM effectiveness	8	On-time delivery, stock availability, lower wastage, coordination, responsiveness, cost efficiency	Beamon (1999); Gawankar et al. (2016); Gunasekaran et al. (2004); Supply Chain Council (2012)

Source: Adapted from validated retail service quality, logistics service quality, SCM practices, cold-chain and supply-chain performance scales (Beamon, 1999; Dabholkar et al., 1996; Gawankar et al., 2016; Kumar & Singh, 2023; Li et al., 2005; Mentzer et al., 1999; Wang et al., 2024).

Before the main analysis, the instrument was reviewed for content validity and clarity. Reliability was assessed through Cronbach's alpha and composite reliability, while convergent validity was assessed through factor loadings and average variance extracted (Fornell & Larcker, 1981; Hair et al., 2017; Nunnally & Bernstein, 1994). Discriminant validity was tested using the Heterotrait-Monotrait ratio (Henseler et al., 2015). Data screening included missing values, outliers, straight-lining and response consistency. Common method bias was addressed through clear item wording, anonymity and separation of predictor and outcome items in the questionnaire, with Harman's single-factor test and full collinearity VIF used as statistical checks (Kock, 2015; Podsakoff et al., 2003).

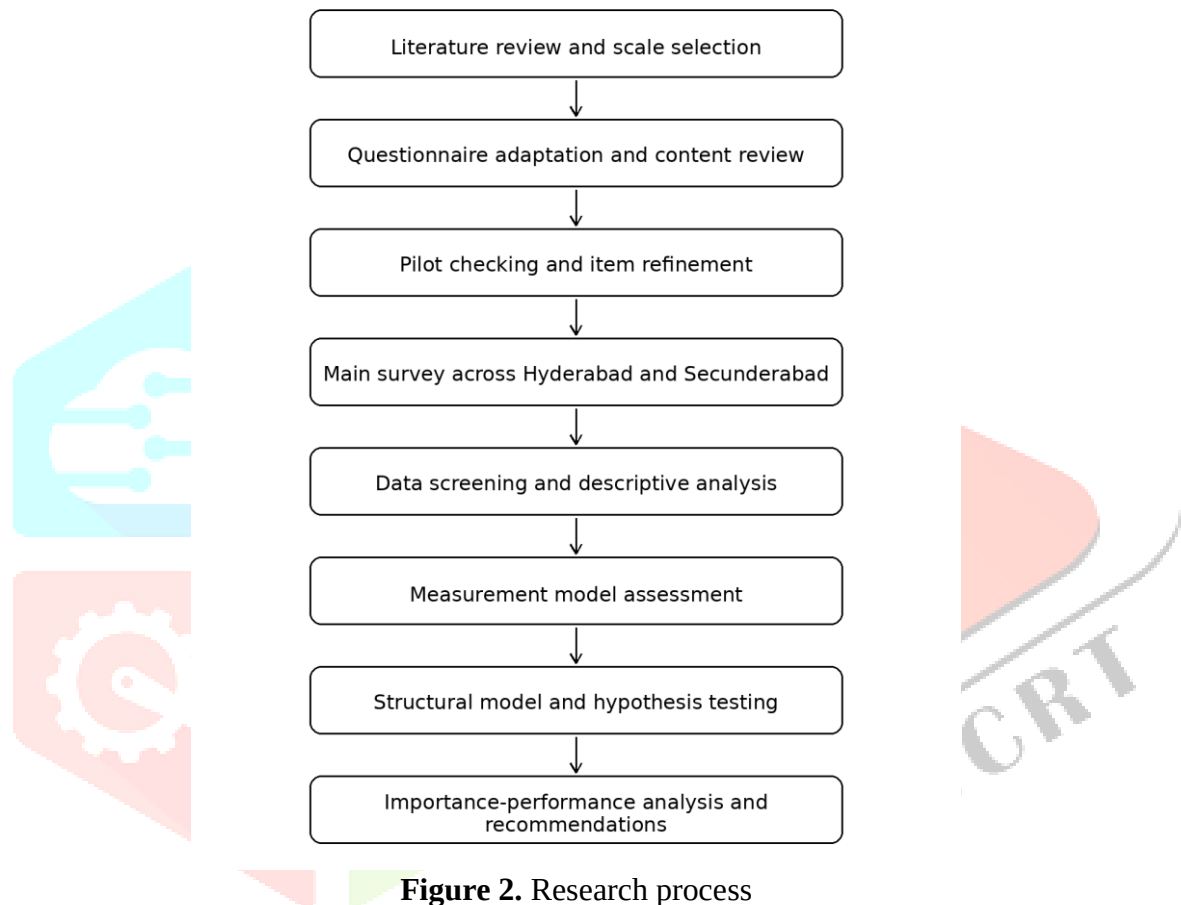


Figure 2. Research process

Source: Developed by the author based on SEM reporting and supply-chain measurement guidance (Fornell & Larcker, 1981; Hair et al., 2017, 2019; Henseler et al., 2015; Shmueli et al., 2019).

5. DATA ANALYSIS AND RESULTS

The final dataset consisted of 384 valid retail outlet responses. The outlet profile showed adequate representation of different frozen food FMCG retail formats in Hyderabad and Secunderabad. Supermarkets accounted for the largest share, followed by kirana outlets with freezer facilities, convenience stores, mini-markets and frozen food speciality outlets. This diversity was useful because frozen food distribution effectiveness can vary depending on outlet size, infrastructure and delivery access.

Table 3. Outlet profile of respondents

Category	Frequency	Percentage
Supermarkets	104	27.1
Mini-markets	72	18.8
Convenience stores	68	17.7
Kirana outlets with freezer facilities	96	25.0
Frozen food speciality outlets	44	11.5
Total	384	100.0

Source: Author's analysis based on the study dataset.

The descriptive statistics showed that respondents rated ordering and inventory capability highest among the outlet attributes, followed by outlet image and service quality. Outlet accessibility and convenience received the lowest mean score, suggesting that delivery access and unloading conditions remain practical challenges in dense urban retail areas. SCM effectiveness recorded a mean of 3.79, indicating a generally positive but improvable level of frozen food supply-chain performance.

Table 4. Descriptive statistics of constructs

Construct	Mean	Standard deviation
Cold-storage infrastructure	3.76	0.71
Handling and safety capability	3.69	0.74
Ordering and inventory capability	3.88	0.68
Outlet accessibility and convenience	3.51	0.77
Outlet image and service quality	3.82	0.70
SCM effectiveness	3.79	0.66

Source: Author's analysis based on the study dataset.

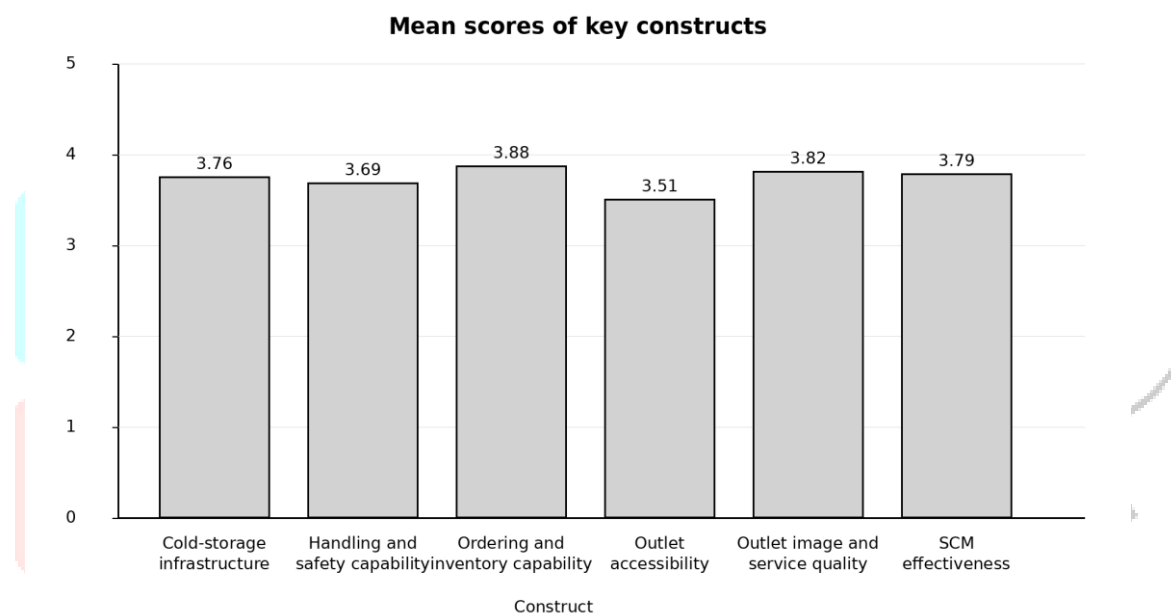


Figure 3. Mean scores of key constructs

Source: Author's analysis based on descriptive statistics from SPSS output.

The measurement model was assessed through outer loadings, Cronbach's alpha, composite reliability and AVE. All retained factor loadings were above the recommended threshold of 0.70, indicating adequate indicator reliability (Hair et al., 2017; Hair et al., 2019). Cronbach's alpha and composite reliability values were above 0.70 for all constructs, indicating internal consistency. AVE values were above 0.50, confirming convergent validity (Fornell & Larcker, 1981).

Table 5. Reliability and convergent validity

Construct	Loading range	Cronbach's alpha	Composite reliability	AVE
Cold-storage infrastructure	0.742-0.861	0.842	0.894	0.679
Handling and safety capability	0.731-0.849	0.829	0.881	0.650
Ordering and inventory capability	0.756-0.872	0.861	0.907	0.710
Outlet accessibility and convenience	0.718-0.836	0.813	0.872	0.631
Outlet image and service quality	0.746-0.858	0.846	0.895	0.681
SCM effectiveness	0.721-0.866	0.908	0.926	0.612

Source: Author's analysis based on SmartPLS output; validity criteria based on Fornell and Larcker (1981), Hair et al. (2017, 2019), and Nunnally and Bernstein (1994).

Discriminant validity was assessed using the HTMT ratio. All HTMT values were below the conservative cut-off of 0.85, confirming that the constructs were empirically distinct (Henseler et al., 2015). Harman's single-factor test showed that the first factor accounted for 34.8% of total variance,

which was below the 50% level commonly used as an initial diagnostic. Full collinearity VIF values ranged from 1.74 to 2.63, indicating that common method bias and multicollinearity were not serious concerns (Kock, 2015; Podsakoff et al., 2003).

Table 6. HTMT discriminant validity matrix

Construct	CSI	HSC	OIC	OAC	OISQ	SCME
CSI	—					
HSC	0.641	—				
OIC	0.603	0.662	—			
OAC	0.574	0.548	0.591	—		
OISQ	0.629	0.616	0.638	0.552	—	
SCME	0.741	0.718	0.763	0.654	0.706	—

Notes: CSI = cold-storage infrastructure; HSC = handling and safety capability; OIC = ordering and inventory capability; OAC = outlet accessibility and convenience; OISQ = outlet image and service quality; SCME = SCM effectiveness.

Source: Author's analysis based on SmartPLS HTMT output; discriminant validity criterion based on Henseler et al. (2015).

Table 7. Collinearity assessment

Predictor construct	VIF
Cold-storage infrastructure	2.28
Handling and safety capability	2.41
Ordering and inventory capability	2.63
Outlet accessibility and convenience	1.74
Outlet image and service quality	2.19

Source: Author's analysis based on SmartPLS collinearity output; common method bias guidance based on Kock (2015) and Podsakoff et al. (2003).

The structural model showed that all five outlet attribute dimensions had a positive and significant effect on SCM effectiveness. Ordering and inventory capability was the strongest predictor, followed by cold-storage infrastructure, handling and safety capability, outlet image and service quality, and outlet accessibility and convenience. The model explained 68.4% of the variance in SCM effectiveness, indicating strong explanatory power in the context of frozen food FMCG distribution.

Table 8. Structural model results

Hypothesis	Path	Beta	t-value	p-value	f ²	Decision
H1	Cold-storage infrastructure -> SCM effectiveness	0.284	5.912	<0.001	0.102	Supported
H2	Handling and safety capability -> SCM effectiveness	0.219	4.768	<0.001	0.074	Supported
H3	Ordering and inventory capability -> SCM effectiveness	0.312	6.447	<0.001	0.128	Supported
H4	Outlet accessibility and convenience -> SCM effectiveness	0.157	3.214	0.001	0.041	Supported
H5	Outlet image and service quality -> SCM effectiveness	0.193	3.987	<0.001	0.058	Supported

Source: Author's analysis based on SmartPLS bootstrapping output; PLS-SEM reporting criteria based on Chin (1998) and Hair et al. (2017, 2019).

Table 9. Model explanatory and predictive power

Endogenous construct	R ²	Adjusted R ²	Q ²	SRMR
SCM effectiveness	0.684	0.679	0.472	0.056

Source: Author's analysis based on SmartPLS output; predictive assessment criteria based on Hair et al. (2019), Sarstedt et al. (2020), and Shmueli et al. (2019).

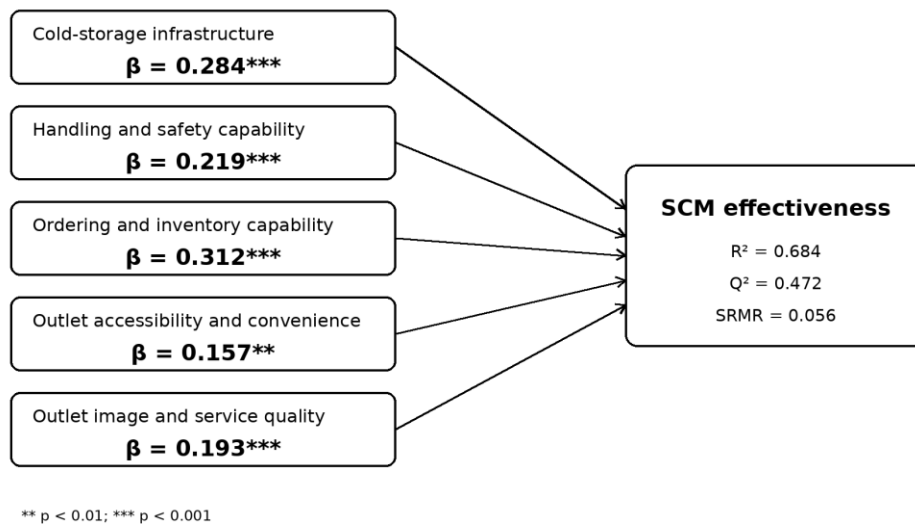


Figure 4. Structural model results

Source: Author's analysis based on SmartPLS structural model output.

The importance-performance map showed that ordering and inventory capability had the highest importance and strong performance, making it the most decisive operational capability for improving SCM effectiveness. Cold-storage infrastructure also showed high importance, but its performance score was slightly lower than ordering and inventory capability. Outlet accessibility had lower performance and moderate importance, suggesting that delivery access and unloading convenience require targeted improvement, especially in congested retail locations.

Table 10. Importance-performance map analysis

Construct	Importance	Performance	Managerial priority
Ordering and inventory capability	0.312	77.6	Maintain and strengthen
Cold-storage infrastructure	0.284	75.2	High priority improvement
Handling and safety capability	0.219	73.8	Training and process improvement
Outlet image and service quality	0.193	76.4	Service and display improvement
Outlet accessibility and convenience	0.157	70.2	Location-specific operational improvement

Source: Author's analysis based on SmartPLS importance-performance map analysis; IPMA interpretation guided by Hair et al. (2017, 2019).

6. DISCUSSION

The results show that outlet attributes play an important role in SCM effectiveness in the distribution of frozen food FMCG. The finding adds to the broader research that supply-chain performance is not only a result of the efficiency of the upstream manufacturing and distribution processes, but also of the readiness of the downstream retail nodes (Lambert & Cooper, 2000; Mentzer et al., 2001a; Stock & Boyer, 2009). This is even more critical for frozen foods distribution, where the retail outlet is the last link in the frozen chain, and must ensure the product is in good condition, available for sale and that the customer is confident.

Ordering and inventory capability turned out to be the strongest predictor of SCM effectiveness. This is in line with a previous study on SCM that revealed that information sharing, inventory visibility and replenishment coordination are related to good supply-chain performance (Li & Lin, 2006; Li et al., 2005; Prajogo & Olhager, 2012; Simatupang & Sridharan, 2005). From a practical point of view, frozen food outlets which keep a check on their stock, communicate the change in demand and maintain proper records are in a better position to avoid stock-out, overstock and wastage of products. This is especially true in Hyderabad and Secunderabad where the demand can differ from neighbourhood to neighbourhood, outlet to outlet and season to season.

Cold-storage infrastructure was the second strongest predictor. This finding aligns with the literature that emphasises the importance of temperature continuity, the quality of storage facilities and infrastructure in product safety and quality (Aung & Chang, 2014; James & James, 2010; Mercier et al., 2017; Ndraha et al., 2018). If distributors are on time with delivery, but freezer space is limited or

the outlet freezer isn't kept at the correct temperature, the whole chain is compromised. This is a testament to the fact that the installation and maintenance of freezers should not be considered as a small retail support activity for frozen food companies. They are key to SCM effectiveness.

Handling and safety capability also had a significant positive effect. This finding confirms cold-chain research, which emphasises the need for human handling practices, product rotation, and safety awareness and operational discipline (Arora et al., 2023a; Bogataj et al., 2005; Montanari, 2008; Raab et al., 2011). Frozen food products are at risk during unloading, loading into freezer units, stock rotation and customer handling. Hence, staff training and simple operating procedures can directly enhance the delivery reliability, stock condition and wastage control.

Outlet image and service quality positively and significantly influenced SCM effectiveness. This finding is in line with the literature of retail service quality which associates physical attributes, reliability and problem solving with store-level outcomes (Cronin & Taylor, 1992; Dabholkar et al., 1996; Parasuraman et al., 1988; Siu & Cheung, 2001). Outlet image is not just a marketing issue in the frozen food distribution business. A clean and organised frozen section represents good product handling, increased customer confidence and increased discipline in storage and display. Complaint handling can also be used by distributors to find out if there are any recurring issues with product quality, delivery time or packaging.

Outlet accessibility and convenience were the least but still important factor. This finding indicates that access conditions are important, however there may be a geographical element involved. When roads are narrow and parking space and unloading areas are scarce, delivery can be delayed and handling time increased in congested urban areas. The significance of delivery timeliness, order condition and delivery procedures are supported by logistics service quality studies (Bienstock et al., 1997; Mentzer et al., 1999; Mentzer et al., 2001b; Rafiq & Jaafar, 2007). In the case of distributors, route planning and delivery scheduling should consider outlet accessibility, rather than just order volume.

Overall, the results confirm the resource-based view as outlet-level infrastructure, routines, staff skills and service processes are all resources that enhance the performance of the supply chain (Barney, 1991; Wernerfelt, 1984). The results also provide support for dynamic capabilities theory, as the effective frozen food outlets must be able to quickly sense the changes in demand and adapt orders and coordinate replenishment (Teece et al., 1997; Teece, 2007). The study thus contributes to the literature on cold-chain and SCM by demonstrating that retail outlets can be considered as active centres of supply-chain capabilities, instead of passive sales points.

7. MANAGERIAL IMPLICATIONS

The study offers several practical implications. Frozen food manufacturers and distributors should evaluate outlet readiness prior to increasing product placement. Outlets should be selected and evaluated based on freezer capacity, power backup, and temperature maintenance and staff handling knowledge. This would mean less product damage, wastage and customer complaints.

Second, ordering and inventory functions should be enhanced by the use of simple digital stock records, reorder alerts and distributor-retailer communication routines. Many small outlets do not necessarily need enterprise systems but they do need good records, reorder discipline and timely demand communication. This can help minimise stock-outs and overstocks.

Third, staff training should be regarded as an integral part of the cold chain intervention. Retail employees need to know how to unload quickly, how to load the freezers, how to follow the "first in first out" rule, how to handle thawed products and how to report complaints. Daily discipline can be aided with short visual checklists that can be posted adjacent to freezer areas.

Fourth, distributors need to enhance the route planning with regard to outlet accessibility. Outlets with access challenges may require delivery time windows, smaller delivery vehicles, quicker unloading procedures or more frequent, but smaller delivery cycles. This would help minimise handling delay and enhance the quality of products.

Fifth, there is a need to integrate outlet image and service quality with SCM monitoring. An attractive and well organized frozen food section is not only appealing to the customer, but it is a sign of good storage discipline and control. Frozen food manufacturers can provide retailers with display information, freezer maintenance audit and customer complaint monitoring.

8. THEORETICAL CONTRIBUTIONS

The study has four theoretical contributions. First, it incorporates retail service quality, logistics service quality and cold-chain performance into a single outlet-level SCM model. Second, it extends Indian retail SCM research by being specific to the frozen food FMCG distribution in Hyderabad and Secunderabad. Third, it demonstrates that outlet attributes can be considered as measurable operational capabilities that have a direct impact on SCM effectiveness. Fourth, it supports the use of PLS-SEM to analyse multi-dimensional supply-chain constructs in retail distribution contexts.

The study also adds to the literature on supply-chain performance measurement, by adapting traditional performance dimensions (e.g., reliability, responsiveness, cost and asset efficiency) to a frozen food outlet setting (Beamon, 1999; Gunasekaran et al., 2004; Shepherd & Günter, 2006; Supply Chain Council, 2012). In doing so, it moves closer to the reality of cold-chain execution at the retail level.

9. LIMITATIONS AND FUTURE RESEARCH

The study is limited to the outlets of frozen food FMCG in Hyderabad and Secunderabad; the results may not be fully applicable to the rural markets or other metropolitan regions in India. Further research can be done to compare the findings with the cities of Bengaluru, Chennai, Mumbai, Delhi and Kolkata. A second limitation is that the responses are at the outlet-level, and may be based on outlet managers' or owner's perceptions. Future studies can integrate outlet survey data with distributor delivery data, stockouts data and product return data and temperature logs.

Other factors that can be explored in future studies include outlet type, outlet size, freezer ownership, distributor relationship length and digital ordering adoption. Longitudinal studies could also demonstrate the impact of outlet attributes on SCM effectiveness over time. Finally, future studies could be conducted to compare the frozen food FMCG with other fresh food, dairy, meat and pharmaceutical cold-chain categories to determine if there are outlet-level drivers that are different across temperature-sensitive categories.

10. CONCLUSION

This paper assessed the impact of outlet attributes on SCM effectiveness in the frozen food FMCG distribution in Hyderabad and Secunderabad. The results reveal that cold-storage infrastructure, handling and safety capability, ordering and inventory capability, outlet accessibility and convenience, outlet image and service quality all positively and significantly affect SCM effectiveness. Ordering and inventory capability was the strongest predictor followed by cold storage infrastructure and handling capability. The model accounted for 68.4% of the variance in SCM effectiveness, indicating strong explanatory power.

The study confirms that frozen food outlets are more than just sales outlets. They represent key points in the cold chain where infrastructure, staff capacity, ordering behaviour, accessibility and service quality all have an impact on the performance of the supply chain. The results indicate that managers need to improve outlet readiness, have support for freezer infrastructure, train their staff, and improve replenishment communication and location-sensitive delivery planning. For researchers, the study provides an outlet-level framework that has been tested and links the attributes of the retail outlet to SCM effectiveness in a frozen food FMCG context.

Conflicts of Interest Declaration

All authors declare that they have no conflicts of interest.

Informed Consent Declaration

Participation was voluntary, and informed consent was obtained from respondents before data collection.

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