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A Study on Dairy Supply Chain Management Practices of Dairy Companies with Special Reference to Erode District

A. Lakshmi Priya[1], Dr. R. Vanathi[2]

[1]Research Scholar, Department of Business Management, Erode Arts and Science College (Autonomous), Erode-638009.
[2]Assistant Professor (SS) and Head, Department of Business Management, Erode Arts and Science College (Autonomous), Erode-638009.

Abstract
The study examines the dairy supply chain management practices of dairy companies in Erode district. In this way, the study explores the role of supply chain practices and profile dimensions of milk cooperative societies impacts its operational performance. The study identified four dimensions such as procurement and handling, packaging and storage, logistics efficiency, and record keeping as important aspects influencing supply chain management of dairy companies. The study used 74 cooperative societies to collect primary data through the presentation of structured questionnaire. Result shows that there are several aspects have strong impact on dairy supply chain management practices. The study also finds that age, membership, daily procurement, and volume of business significantly shape the performance of cooperatives. Findings demonstrate that an effective cooperative organization combined with disciplined supply chain processes improves milk procurement, member satisfaction, timely payments, profitability, and hygiene quality. It is important to combine supply chain execution and profile development for improved teamwork and long-term operations in the dairy sector.

Keywords: Dairy, Supply Chain Management, Procurement, Performance, Packaging, Logistics.

1. Introduction

The dairy industry is the important components of agricultural sector in India. The dairy industry provides essential nutritional content to millions of consumers and also provides employment and livelihood to a considerable portion of rural population. Among the different regions contributes to dairy products, Tamilnadu stands out for its organized dairy sector, Especially, Erode district render main role because of its strong network of dairy farmers, co-operative societies and private milk processing unit. The dairy farming is widely practiced alongside other farming activities in this region. The need for a well-managed supply chain has become more pronounces, with the rising demand for milk and entire dairy products. The

[1] Research Scholar, Department of Business Management, Erode Arts and Science College (Autonomous), Erode-638009.
[2] Assistant Professor (SS) and Head, Department of Business Management, Erode Arts and Science College (Autonomous), Erode-638009.

goal of supply chain management is to save costs, enhance customer satisfaction, and boost flexibility by organizing and managing the movement of goods and information between suppliers, facilities, warehouses, and customers (Jadhav et al., 2023). The supply chain of a commercial operation consists of purchasing materials from suppliers, transporting materials from suppliers to facilities, manufacturing items at facilities, transporting goods from facilities to ware houses, and transporting goods from ware houses to customers (Kotni et al., 2022). Technology is used by many dairy producers, processors, and distributors to automate manual procedures.

The supply chain management in dairy sector involves entire processes from milk production at farms, collection at cooling centers, logistics, milk process, packaging, storage, distribution to the ultimate consumers. Milk is a highly perishable nature, it requires timely handing and proper management among different kinds of stakeholders, speedy management helps to prevent losses and ensure product quality (Purohit et al., 2024). The profitability of dairy businesses and customer satisfaction are directly influenced by the effectiveness of supply chain management techniques. Fresh milk and dairy products are promised to reach consumers in a best condition and within suitable time due to a well-integrated dairy supply chain. Furthermore, it lowers operating cost, gets rid of the pointless middlemen, and promotes transparency and accountability all the way down the supply chain. Numerous dairy companies operate in the district, it includes cooperative societies, private dairies, milk merchants, they primarily use collaboration with stakeholders to market its products (Sachin et al., 2019).

The dairy companies frequently deal with problems like lack of cold storage facilities, delay in transports, lack of infrastructure, price fluctuations, uneven milk quality. Nonetheless, few companies have started to implement contemporary supply chain techniques like automated collection facilities, digital milk testing, mobile-enabled interaction with farmers and GPS-enabled transportation. Innovation in communication and transportation systems, along with technological developments revolutionize the dairy supply chain (Mahajan et al., 2024). In dairy sector, better procedures assist in developing the cold chain, decreases spoilage, and assures constant quality standards on its products. Moreover, digital integration makes it easier for all stakeholders involved to coordinate and make business decisions more quickly (Ersoy et al., 2022). In addition to that small and marginal farmers render a main role in dairy industry. A strong supply chain relied on ensuring their suitable compensation and active engagement. A strong supply chain ecology can be formed by reinforcing farmer cooperatives, giving access to financial needs and medical care of cattle, and provision of training to maintain hygiene and quality control.

It is important to comprehend the existing supply chain procedures implemented by the dairy companies in this regard. Supply chain management direct strategies to promote stakeholder collaboration and boost the general level of efficiency of dairy sector. The active involvement of dairy companies will increase profitability. The dairy products come in different varieties, which consists of milk, curd, butter, cheese, fermented milk, yoghurts, ghee and other dairy based eateries (Ponanake and Opal, 2018). The dairy products come in the form of pouch, sachet, packet, barrel, cup, cans, bottles, and collapsible tube as per the demands of consumers. For the production of dairy products and the processing of milk, the dairy sector needs the newest, most advanced technology. To attain and preserve world-class quality, one must specify the requirements. Dairy companies need to focus on improving its efficiency, production, and ability to meet customer expectations (Kumar et al., 2022). To face the challenges, it must simultaneously improve and diversify the product mix into value-added items. The sector has always been driven by supply rather than demand, but as disposable income increases, demand should drive the industry going forward. The white revolution gave dairy farmers the chance to increase their employment and standard

of living. The capacity to find new markets for dairy products will also be important to the future of the Indian dairy industry (Yang et al., 2023).

Streamlining milk procurement required the establishment of milk collection centers at the village level to collect more quantity. As a result of acting as middlemen, these centers collected milk from farmers and made sure it was delivered to processing plants in a timely and efficient manner. They served as hubs for collecting milk from diverse sources, simplifying the process and reducing logistical challenges. Milk collection centers enhance the overall effectiveness and reliability of the dairy supply chain by providing a centralized site for milk collecting, quality assurance inspections, and storage before transportation to processing facilities (Kanna and Amudha, 2022). The step greatly simplified the process of collecting milk on a larger scale, and as the sector grew, the establishment of a dependable cold chain infrastructure became essential. In order to preserve milk's quality and freshness along the supply chain, refrigerated storage and transportation facilities were established. These expenditures improved shelf life, decreased spoiling, and raised product safety requirements. New and innovative processing facilities were required to meet the growing demand for processed dairy products. Recent facilities have included the newest machinery and technology to increase the productivity and efficiency of dairy processing processes (Mangla et al., 2019). To guarantee that dairy products fulfil legal requirements and consumer expectations, these facilities use sophisticated testing techniques and rigorous quality standards. As a result, Indian dairy products gained consumer confidence and trust, which increased their competitiveness in both home and foreign markets.

2. Need for the Study

The dairy industry has steadily been rising due to the active contribution of farmers, favourable agro-climate conditions, and constantly rising demand for milk, curd, buttermilk, butter, ghee and other dairy products. The growth in dairy industry comes the need for well-organized effective supply chain. The highly perishable condition urges the collecting agents to collect fast and send it for milk processing units. Even errors in handling or small delays can lead to spoilage, income loss and it may lead dissatisfaction to the consumers. The study is required to explore how dairy companies manage their supply chain activities and the needy areas for improvement. A better research is required to identify best practices and gaps in areas like milk procurement, storage, logistics and distribution. The study will address the role of proper supply chain collaboration in dairy marketing so as to enhance operational efficiency and minimize wastage. In this way, realization of supply chain practices will yield handsome yield to all stakeholders and ensures better coordination, cost reduction and enhanced product quality. The outcomes of the study can support decision making and formulation of strategy for dairy companies operating in the region. The study is essential to support the long-term sustainability and profitability of the dairy industry in the district.

3. Problem Statement

The dairy industry faces rising pressure to meet increasing consumer demand while preserving quality reducing losses. The region has well-established dairy companies, still few dairy firms continue to experience challenges related to ineffective logistics, insufficient cooling storage, irregular quantity of milk collection, and low adoption of modern supply chain practices. The issues lead to spoilage in milk, high operational costs, delayed deliveries and lack of need fulfilment among end users. The small dairy farmers, who form the backbone of milk production in the region, often they are lacked in better

infrastructure and support required produce and deliver milk that meets quality standards consistently. Meanwhile, dairy firms struggle to coordinate with various stakeholders spread across rural areas. There is a pressing need to assess how existing supply chain systems operate and ensure profitability among the stakeholders. The issue lies not only in outdated practices but also in the uneven adoption of technology, low level of coordination, and lack of integrated supply chain systems. The performance of the dairy supply chain remains suboptimal, without a systematic approach to managing such activities. Therefore, the study seeks to examine the current supply chain management practices of dairy companies.

4. Literature Review

Supply chain management is a tactic for enhancing processes' resilience, adaptability, and competitiveness. Enhancing a product's competitiveness is the aim of supply chain management (Shilpa, 2017). The performance of every company in the chain is referred to as supply chain performance. The connections among its enterprises have a significant impact on its overall success. A company's success may be directly impacted by some factors, but the entire chain may also be indirectly impacted (Gentian et al., 2016). The public has expressed serious concerns about safety failures in the dairy supply chain, and safety issues in the dairy industry have received increased attention (Aisha et al., 2021). Supply chain management has attracted a lot of scholarly attention lately and has grown in significance in relation to corporate performance (Vishal and Shah, 2016).

The Indian dairy industry's supply chain is extremely complicated because it depends on a number of variables, including ambient temperature, the availability of cold chains, and shorter shelf life. The intricacy is increased by the fragmented Indian dairy business (Sale et al., 2021). Through sharing real-time data with various stakeholders and identifying any variations in the quantity and quality of milk during value chain transportation phases, digitalization solutions like the Internet of Things and advanced analytics might be beneficial (Nurakhova et al., 2020). Making smarter decisions is another possible advantage of digitizing the dairy supply chain. Order tracking, inventory management, payment tracking, sales growth, and other tasks can be automated with the use of real-time data and sophisticated analytics, which also make it easier to comprehend consumer purchasing trends (Burkitbayeva et al., 2023). Private companies and dairy cooperatives are now concentrating on offering farmers digital payments. Digital payments, which offer cost reductions and transparency, will enable farmers to take advantage of financial inclusion. Building and managing data-driven farmer beneficiary programs is made simpler by allowing direct digital payments to farmer bank accounts (Ramapriya and Shobarani, 2016).

5. Research Objectives

The study is initiated with the ensuing objectives.

1. To analyze the socio-economic characteristics of cooperative societies and its milk collecting agents.
2. To investigate factors influencing dairy supply chain management practices.
3. To examine the impact of dairy cooperative society profile on performance of cooperative societies.

6. Research Methodology

The study examines the dairy supply chain management practices of dairy companies in Erode district, Tamilnadu. The study purposively selected 74 milk collecting cooperative societies as samples for collection of data. The study used structured questionnaire to collect data from the societies. The milk collecting agents of cooperative societies are approached for data collection. The primary data is collected

from milk cooperative societies. Percentage analysis is used to check the profile of cooperative societies and milk collecting agents. The study proposed a model to test the different factors influencing supply chain management practices of such milk collecting dairy units. Factor analysis and regression technique are applied to test the proposed conceptual model. One-Way ANOVA is sued to measure the influence of cooperative society dimensions of its performance.

7. Results and Discussion

7.1. Analysis of Socio-Economic Profile

The profile of cooperative societies and its milk collecting agents are analyzed in accordance with their socio-economic characteristics. These are listed below.

Table 1: Analysis of Socio-Economic Profile

Profile	Distribution	Frequency	Percentage
Gender	Male	51	68.92%
	Female	23	31.08%
Age	Below 30 years	17	22.97%
	30 – 50 years	41	55.41%
	Above 50 years	16	21.62%
Academic Qualification	Illiterate	12	16.21%
	SSLC	28	37.84%
	HSC/Diploma	19	25.68%
	Degree	15	20.27%
Age of Society	Below 10 years	11	14.87%
	10 – 20 years	24	32.43%
	Above 20 years	39	52.70%
Membership	Below 100 members	31	41.89%
	100 – 200 members	26	35.14%
	Above 200 members	17	22.97%
Daily Procurement	Below 1000 litres	37	50.00%
	1000 – 1500 litres	25	33.79%
	Above 1500 litres	12	16.21%
Volume of Business (per day)	Below Rs.30,000	35	47.30%
	Rs.30,000 – 45,000	26	35.13%
	Above Rs.45,000	13	17.57%

Source: Primary Data

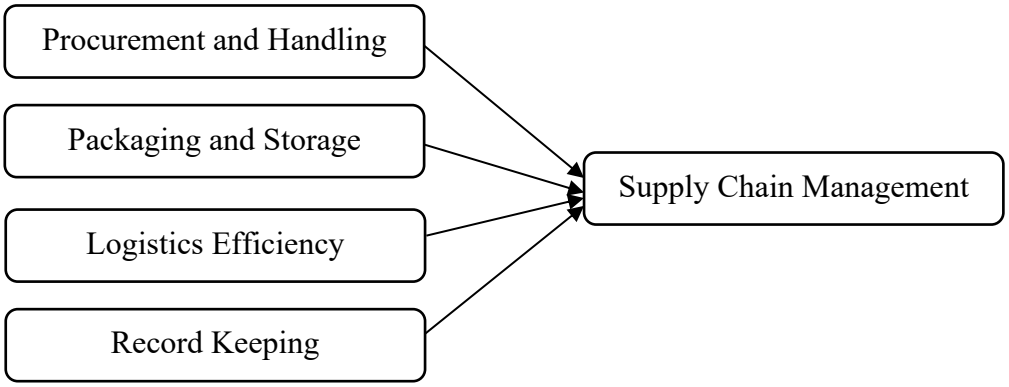
Table 1 shows that the profile of milk cooperative societies and its milk collecting agents. Gender shows that 68.92% of collecting agents are male, and 31.08% of collecting agents are female. Age level reveals that 55.41% of collecting agents fall within 30 – 50 years' age group, while younger agents that is, below 30 years' account for 22.97% and above 50 years' account for 21.62%. Academic qualification shows that 37.84% of collecting agents have completed SSLC, 25.68% hold HSC or diploma qualifications, 20.27% are graduates, and 16.21% are illiterates, it shows that a majority with basic education. Age of society

shows that 52.70% of the milk cooperative societies have been operating for more than 20 years, while 32.43% of the societies are operating between 10 – 20 years and 14.87% of the societies are operating less than 10 years. Membership size reveals that 41.89% of the societies have less than 100 members, 35.14% have 100 – 200 members, and 22.97% have more than 200 members. Dairy milk procurement is lower than 1000 litres for 50% of societies, 1000 – 1500 litres for 33.79% of societies and more than 1500 litres for 16.21% of societies. Volume of business per day shows that 47.30% of societies earn below Rs.30,000, 35.13% earn with Rs.30,000 – 45,000 range and only 17.57% exceed Rs.45,000. The profile analysis reveals that male operated, moderate education and middle age are the majority of collecting agents, and limited procurement, functioning in a small to medium scale and limited financial capabilities are the majority of cooperative societies.

7.2. Dairy Supply Chain Management Practices

The milk cooperative societies have to follow many routine activities so as to preserve its supply chain management practices. The supply chain management practices often connected with its milk procurement and handling, packaging and storage, logistics efficiency, and record keeping of cooperative societies. Therefore, the subsequent conceptual framework, as disclosed in Figure 1, is recommended to test.

Figure 1: Conceptual Model



The following hypothesis is suggested to test the factors contributing to supply chain management practices of milk cooperative societies.

H_0: Procurement and handling, packaging and storage, logistics efficiency and record keeping doesn't have significant impact on supply chain management practices.

The hypothesis is tested using factor analysis and regression co-efficient, in this way, the outcomes of KMO and Bartlett's tests are disclosed in table 2.

Table 2: KMO and Bartlett's Test

KMO Measure of Sampling Adequacy		0.842
Bartlett's Test of Sphericity	Approx. Chi-Square	667.356
	Df	105
	Sig.	.000

Source: Primary Data

Table 2 presents the KMO and Bartlett's test results to assess data suitability for factor analysis. The KMO value of 0.842 shows a higher sampling adequacy. It confirms that strong inter-correlation amongst such variables. Bartlett's Test of Sphericity is highly significant ($p < 0.000$), it confirms the correlation matrix is not an identity matrix. The results support the suitability of applying factor analysis, it confirms sufficient common variance to extract reliable and meaningful factors for further interpretation and analysis.

Table 3: Rotated Component Matrix

Factors	Variables	Component			
		1	2	3	4
Procurement and Handling	Frequency of milk collection from farmers	**0.832**	0.163	0.204	0.142
	Use of standardized milk collection equipment	**0.817**	0.154	0.198	0.133
	Accuracy in weighing in collection	**0.805**	0.182	0.213	0.151
	Testing of milk for quality and purity	**0.763**	0.145	0.166	0.127
	Hygienic handling of milk at collection points	**0.701**	0.132	0.174	0.143
Packaging and Storage	Use of big drums for milk storage	0.142	**0.822**	0.151	0.128
	Timely transfer from cans to drums	0.135	**0.781**	0.162	0.142
	Regular cleaning of containers and utensils	0.183	**0.738**	0.148	0.136
	Maintenance of cool storage	0.146	**0.711**	0.165	0.123
Logistics Efficiency	Timely dispatch of milk to processing units	0.198	0.134	**0.802**	0.143
	Condition and cleanliness of transport vehicles	0.173	0.153	**0.768**	0.154
	Cold chain maintenance during transit	0.192	0.164	**0.743**	0.125
Record Keeping	Frequency of payment to milk suppliers	0.145	0.144	0.162	**0.781**
	Maintenance of procurement and payment records	0.172	0.135	0.174	**0.762**
	Transparency in price calculation	0.162	0.158	0.159	**0.728**

Source: Primary Data

Table 3 shows that the rotated component matrix identify four key aspects influencing dairy supply chain management amongst milk cooperative societies. It consists of procurement and handling, packaging and storage, logistics efficiency and record keeping. The first factor, procurement and handling includes frequency of milk collection, using standardized equipment for collection, accuracy in weighing, quality and purity testing, and hygiene handling practices. These aspects confirm strong loading, it indicates the significant role in milk procurement and handling. The second factor, packaging and storage accounts for use of big drums for milk collection, timely transfer from cans to drums, regular cleaning of containers and cool storage maintenance. The aspects have high component values; it stresses its impact on milk preservation before transportation. Logistics efficient is the third factor, which consists of timely dispatch of milk, cleanliness of transport vehicles, maintain the cold chain during transportation. Therefore, the logistics related elements reflect operational efficiency and quality preservation in milk delivery. Record keeping is the fourth factor, it consists of frequency of payment to milk suppliers, proper maintenance of records and pricing transparency. These aspects support accountability and trust within the supply chain. It proves that all variables show significant factor loading, which is more than 0.70, it confirms strong association with respective factors. The analysis proves the internal links between variables, in which the

strength of one attribute may influence the evaluation of others. It is statistically valid, supports the model reliability in confirming the supply chain practices of cooperative society.

Table 4: R-Square and Durbin-Watson Test

Model	R Square	Durbin-Watson
1	0.712	1.829

Source: Primary Data

Table 4 shows the results of the R-Square and Durbin-Watson test. The estimated R-Square rest value of 0.712 is found acceptable range for regression analysis. Moreover, the Durbin-Watson test yields a value of 1.829, it strongly confirms the autocorrelation is approaching zero or considerable variance occurs between the two variables.

Table 5: Results of ANOVA Test

Model	F	Sig.
1	78.583	0.000

Source: Primary Data

Table 5 reveals the ANOVA results, it shows that the influence of procurement and handling, packaging and storage, logistics efficiency and record keeping show significant variation and can effectively serve as predictors of supply chain management. The outcome is supported by a high F-value of 78.583 with a significance value of $p<0.000$, proves statistical relevance at the 1% level.

Table 6: Results of Regression Coefficient

Variables	Standardized Beta	t	Sig.	Collinearity Statistics	
				Tolerance	VIF
Constant	.411	.739	.642	.434	1.162
Procurement and Handling	.381	5.896	.000	.624	1.458
Packaging and Storage	.295	5.971	.000	.615	1.324
Logistics Efficiency	.367	4.652	.000	.709	1.241
Record Keeping	.259	4.857	.000	.562	1.235

Source: Primary Data

Table 6 provides the results of regression analysis; it shows the influence of dairy supply chain practices in milk collecting cooperative societies. The variables such as procurement and handling, packaging and storage, logistics efficiency, and record keeping proves strong statistical significance ($p<0.000$) in forecasting supply chain management. It is supported by high standardized beta coefficients (0.381, 0.295, 0.367 and 0.259 respectively) with t-values of (5.896, 5.971, 4.652 and 4.857) respectively. The results support that each dimension equally contributes to make supply chain effectiveness. The variance inflation factor values, are found between 1.235 to 1.458, which is below the threshold of 10, it indicates the absence of multicollinearity and validates the independence of each predictor variables. The tolerance values, which above 0.5, further validates such phenomenon. The results lead to the rejection of null hypothesis,

which proves that dairy supply chain dimensions significantly impact performance outcomes. Particularly, procurement and handling, and logistics efficiency emerge as specifically influential. It can be inferred that procurement and handling, packaging and storage, logistics efficiency, and record keeping can enhance the supply chain management practices of milk collecting cooperative societies.

7.3. Impact of Milk Cooperative Profile on its Performance

The impact of milk cooperative profile on its performance is tested using One-Way ANOVA. The hypothesis (H_0) shows that profile of cooperative society doesn't have significant difference in its performance. The performance of milk cooperative society includes, increase in quantity of milk procurement, member satisfaction and support, prompt payment for suppliers, profitability, and stabilization of hygiene milk quality, the results are depicted in table 7.

Table 7: One-Way ANOVA

Performance	Age of Society		Membership		Daily Procurement		Volume of Business	
	Value	Sig.	Value	Sig.	Value	Sig.	Value	Sig.
Increase in quantity of milk procurement	16.254	.000***	18.571	.000***	3.375	.024**	17.875	.000***
Member satisfaction and support	14.639	.000***	3.842	.021**	17.524	.000***	16.996	.000***
Prompt payment for suppliers	15.367	.000***	13.674	.000***	15.248	.000***	13.814	.000***
Profitability	14.345	.000***	14.719	.000***	13.627	.000***	2.474	.036**
Stabilization of hygiene milk quality	16.414	.000***	17.824	.000***	15.546	.000***	15.752	.000***

***Significant at 1%, **Significant at 5%.

Table 7 shows that the results of One-Way ANOVA, it checks the statistically significant association between profile of milk cooperative societies and its performance. The age of milk cooperative society reveals that it has statistically significant impact on all performance indicators at 1% level. Therefore, the results show that high quantities of milk procurement (16.254, p<0.000), member satisfaction and support (14.639, p<0.000), better prompt payment systems (15.367, p<0.000), profitability (14.345, p<0.000), and stabilization of hygiene milk quality (16.414, p<0.000). It confirms that age of society enables better supply chain management. The membership of milk cooperative society reveals that it has statistically significant impact on all performance indicators at 1% level, except member satisfaction and support, which is significant at 5% level. Therefore, the results show that increase in quantity of milk procurement (18.571, p<0.000), member satisfaction and support (3.842, p<0.021), better prompt payment systems (13.674, p<0.000), profitability (14.719, p<0.000), and stabilization of hygiene milk quality (17.824, p<0.000). It confirms that membership of milk cooperative society enables better supply chain management. The daily milk procurement of milk cooperative society reveals that it has statistically

significant impact on all performance indicators at 1% level, except increase in quantity of milk procurement, which is significant at 5% level. Therefore, the results show that increase in quantity of milk procurement (3.375, p<0.024), member satisfaction and support (17.524, p<0.000), better prompt payment systems (15.248, p<0.000), profitability (13.627, p<0.000), and stabilization of hygiene milk quality (15.546, p<0.000). It confirms that daily milk procurement of milk cooperative society enables better supply chain management. The volume of business of milk cooperative society reveals that it has statistically significant impact on all performance indicators at 1% level, except profitability, which is significant at 5% level. Therefore, the results show that increase in quantity of milk procurement (17.875, p<0.024), member satisfaction and support (16.996, p<0.000), better prompt payment systems (13.814, p<0.000), profitability (2.474, p<0.036), and stabilization of hygiene milk quality (15.752, p<0.000). It confirms that volume of business of milk cooperative society enables better supply chain management. The result proves that age, membership, dairy procurement and volume of business have strong effect in determining cooperative performance.

8. Conclusion

The study investigated the significance of supply chain management techniques in improving operational outcomes and methodically looked at how the milk cooperative profile affected its performance. It demonstrates that key performance metrics are greatly impacted by profile traits of milk cooperative societies, including age, membership strength, daily procurement volume, and business volume. Prompt payments, profitability, member happiness and support, amount of purchases, and hygienic criteria for milk quality are all included. As the cooperative society matures, maintains a sizable and engaged membership, handles larger volumes of milk each day, and expands its business operations, these performance metrics demonstrate quantifiable improvement. The results confirm that cooperatives' organisational characteristics have a direct impact on their effectiveness and competitive position. The study also evaluated a conceptual framework that outlines four important factors, that is, procurement and handling, packaging and storage, logistics efficiency, and record keeping that influence supply chain management practices. These components were verified by thorough factor analysis, demonstrating high internal consistency and pertinence. The idea that structured operational activities improve cooperative functioning is supported by regression analysis, which verifies that each factor significantly adds to the effectiveness of supply chain procedures. Among the most important factors were procurement and handling, while logistics efficiency came in second. Cooperative outcomes are influenced by a number of factors, it consists of maintaining hygienic conditions, monitoring quality from the moment of collection to delivery, making sure milk is moved on time, and keeping open and honest records. The findings collectively highlight the need for cooperative societies to give organisational development and process management methods top priority in order to enhance performance. Long-term sustainability, improved quality control, and increased trust can result from concentrating on member involvement, capacity building, and operational openness.

9. Research Implications

The study proves that a well-structured profile and disciplined execution of supply chain practices serve as the backbone of successful dairy cooperatives. The study strengthens the importance of integrated planning that aligns cooperative structure with operational activities. It is evident that performance in the dairy sector is not only a matter of volume but also of how systematically each stage is handled. Thus,

cooperative societies must invest in process optimization, staff training, and infrastructure improvements to remain competitive. The results of the study guide cooperative leaders, policymakers, and stakeholders in designing support systems and development policies tailored to the growth of milk cooperative societies.

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