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SWOT Analysis of Dairy Processing Supply Chain of JMF using Analytical Hierarchy Process

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ABSTRACT

Background: Jharkhand State Cooperative Milk Producers' Federation (JMF) plays crucial role in processing of raw milk procured from the member-producers across the Jharkhand State and contributes to dairy development. The current study investigates the critical factors in JMF's dairy supply chain, specifically the processing unit and offers an initial decision framework for its implications.

Methods: To summarise the strengths, weaknesses, opportunities and threats (SWOT) of the milk processing system in JMF, the necessary data were collected from dairy producer members, including dairy farmers, executives and key informants of processing units. This includes identifying the dairy industry's objectives as well as the internal and external critical factors (CFs). Because SWOT analysis provides no investigative basis for evaluating the priorities of CFs, the analytic hierarchy process is used to define the priorities of identified CFs. The CFs have also been sorted in the order of importance.

Result: The findings of this study show that fully computerised system with self-automation facilities; high operational cost for processing liquid milk; development of new product and value addition; high labour cost or shortage of labour are the major strength, weakness, opportunity and threat of JMF, respectively. Further, the SWOT-based methodology provides critical sensitivity in assessing supply chain strategies for the dairy cooperative like JMF.

Key words: Critical factors, Dairy, JMF, Processing, SWOT.

INTRODUCTION

India is the world's largest producer of milk, with 22 per cent of global production (FAO, 2019). According to NDDB Report 2018-19, India produced 187.7 MT of milk with per capita availability of 394 g/day (NDDB, 2019). The dairy sector contributes 27 per cent of agriculture GDP and 67 per cent of the total output of the Livestock Sector, thus providing livelihood opportunity to 70 million households (GoI, 2018). Much of the success of the 'White Revolution' in India is attributed to the co-operative framework of dairy development strategies. After operation flood programme, even though India has stood self-sufficient in milk production, but milk production throughout the states in India is not uniformly distributed and therefore, there are huge demand and supply gap of milk and milk products in few states of Eastern India. Jharkhand is backward state in terms of number of cooperatives. At present, the Jharkhand State is ranked 17th in the position both in terms of milk production as well as milk productivity (GoI, 2019). Due to lack of proper infrastructure for dairy processing and manufacturing of milk and milk products have posed challenged for dairy development in the State. With an aim to promote dairying as a source of livelihood in the rural parts of the state and propel Jharkhand towards self-reliance in milk and milk products, Jharkhand State Cooperative Milk Producers' Federation was formed in August 2014 by the joint initiative of Government of Jharkhand and National Dairy Development Board. Several studies have shown that integration with co-operatives have benefited the farmers and indeed have served as a catalyst for linking Indian dairy smallholders to domestic as well as global markets (Birthal *et al.*, 2007, 2009; Candler and Kumar, 1998; Cunningham, 2009; Kumar, 2010). Quality management is the significant factor in dairy supply chain (DSC) subsequently the inventory management, supplier management and technological innovations (Mor *et al.*, 2018a,b,c). The optimal effectiveness is required in the dairy sector to achieve better product quality and food safety (Bhardwaj *et al.*, 2016 and Mor *et al.*, 2018d). Food producers, as well as processors, need to focus on the effective marketing strategies to target

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the rural market (Mor *et al.*, 2016; Mor *et al.*, 2017; Mor *et al.*, 2018e).

An analytic hierarchy process (AHP) approach allows the top management to measure the level of uniformity in finding the decision problems (Saaty, 1980). Madaan and Mangla (2015) suggested focusing on CFs in food sector using AHP. Dweiri *et al.* (2016) found that usage of AHP for supplier selection improves the consistency and robustness throughout the process. Mor *et al.* (2015, 2018f) addressed a review of the principles, bottlenecks and strategies of supply chain practices of Indian agri-food sector and recomm ended to nurture the system effectiveness over policy direction. Ayodele *et al.* (2014) recognized the challenges existing in unloading and knowledge optimization schemes into the food chain. Ansari *et al.* (2019) recognized the key performance outcomes for the adoption of supply chain remanufacturing and prioritized the factors through hybrid fuzzy AHP and fuzzy TOPSIS approach.

MATERIALS AND METHODS

A pre-tested schedule has been employed to accumulate the data from dairy producer members including dairy farmers and key informants of milk processing units to summarize the factors and sub-factors related to strengths, weaknesses, opportunities, threats (SWOT) of the milk processing system in JMF. A total of 35 issues, called as SWOT factors here, have been derived on the basis of comprehensive literature assessment, focussed group discussion and a pilot study, conducted in the study area. These 35 factors comprised of ten (10) strength factors, eight (8) weakness factors, seven (7) opportunity factors and ten (10) threat factors. Further, these factors were considered for AHP analysis in consultation with the professionals of the dairy industry, JMF staffs, workers and academicians. The factors are selected based on their applicability and importance to the processing unit of dairy cooperative (JMF). Following critical factors as shown in the hierarchy model for SWOT factors (Table 3) have been carried forward for AHP analysis. The model represents various SWOT factors as criteria along with their sub-criteria. During the application of AHP, various pairwise assessment matrix has been finalized in the below Table 4 to 7 for SWOT factors (s) analysis. The nine-point scale developed by Saaty (1980) has been adopted for assessing the interaction among the SWOT factors identified for the study. Five experts from processing unit of JMF during FGD added their understanding to construct the SWOT factors. Then, the pairwise comparisons of SWOT groups using a Saaty's nine-point comparison scale were carried out in consultation with the expert's group. And finally, the SWOT factors were compared in view of every SWOT group.

The AHP steps are described below:

1. Preparation of the goal

Assessing the CFs to find their related priority.

2. Forming a pairwise assessment matrix

Pairwise assessment matrixes are formed from expert's feedback. The pairwise assessment matrix between the factors is accomplished by Saaty's scale (Table 1).

3. Determination of the Eigenvalues and Eigenvectors and comparative weights

The outlined pairwise comparison matrices are worked to establish the Eigenvalues and Eigenvectors and to compute the relative position of CFs.

4. Assessment of the consistency ratio (CR)

It is calculated to confirm the reliability of pairwise comparisons, as follows:

$$CR = CI/RI \quad .....(1)$$

Where,

Consistency index (CI) = $(\lambda_{max} - n) / (n - 1)$, ($\lambda_{max}$ is the max. average value) and random consistency index (RI) relies upon value of (n). CR must be ≤ 0.10 to have an improved level of consistency (Kumar *et al.*, 2011). Table 2 presents the corresponding values of a random index (Saaty, 1980).

Table 1: Scales in pairwise comparisons.

Score	Definition
1	Equal importance of both factors.
3	Limited importance of one factor over another.
5	Strong importance of one factor over another.
7	Very strong importance of one factor over another.
9	Extreme importance of one factor over another.
2,4,6,8	Intermediate value between two close judgements.

RESULTS AND DISCUSSION

The current study summarized and proposed a framework for the identification and assessment of the critical SWOT factors in the dairy processing supply chain of JMF, using the analytical hierarchy process (AHP) approach. The processing unit is the heart and soul of JMF where the milk after procurement from bulk milk coolers (BMCs) and milk pooling points (MPPs) are brought to the state of art dairy processing plants located at four places *viz.* Ranchi, Latehar, Koderma and Deoghar by milk tankers where milk after quality testing is further processed into fluid milk and milk products.

Strength analysis

The strength factors have been analysed for priority matrix, weight matrix and the calculations of strength as shown in Table 4. As JMF processing unit is fully computerised with self-automated infrastructure facilities; thus enabling JMF

Table 2: Random index (R.I.).

N	1	2	3	4	5	6	7	8	9	10
R.I.	0	0	0.58	0.98	1.12	1.24	1.32	1.41	1.45	1.49

to monitor and process bulk quantity of milk without much involvement of manpower. Also, due provision of adequate milk handling capacity; JMF was able to process large quantity of milk on a daily basis. The presence of large silos and tanks with large storage capacity handled surplus milk available during flush season, besides this JMF also had highest milk powder production capacity which was major strength factor as it converted excess fluid milk into milk powder during the flush season. Based on the outcome of AHP for strength factors, all the CI, RI and CR scores are valid for AHP criteria as depicted in Table 4. Also, consistency among the strength factors was confirmed since CR value (0.08) was less than (0.10).

Weakness analysis

The weakness factors have been analysed for priority matrix, weight matrix and the calculations of weaknesses as shown in Table 5. The major weakness factor was 'high cost of operation'. It was observed that cost incurred for processing liquid milk was more in comparison to milk based product. Another important weakness was 'more energy consumption'. Therefore, JMF should efficiently utilize and resort to renewable source of energy for reducing the operational cost. It was opined by majority that storage capacity for butter and cream products was not sufficient and therefore JMF should focus on increasing the storage capacity for sufficient production. All of the CI, RI and CR scores are valid for the AHP criteria as shown in Table 4 based on the results of the AHP for weakness components. Since CR value (0.08) was less than (0.10), it was also proven that the weakness variables were consistent.

Opportunity analysis

The opportunity factors have been analysed for priority matrix, weight matrix and the calculations of opportunities as shown in Table 6. The processing unit of JMF had many

Table 3: AHP model for SWOT in dairy processing supply chain of JMF.

Criteria	Sub-criteria	Critical factors (CFs)
Strength	S1	Fully computerised system with self-automation facilities.
	S2	Surplus milk handling capacity.
	S3	Adequate milk powder production capacity.
	S4	Modern equipment and machinery for processing different milk products.
	S5	Well-equipped quality control laboratory.
	S6	Space and plant hygiene are quite good due to proper design.
	S7	Maintaining quality and purity of the products.
	S8	Good supply of steam and refrigeration.
	S9	Attractive and quality packaging.
	S10	ISO:9000 and HACCP certification.
Weakness	W1	High operational cost for processing liquid milk.
	W2	More energy consumption.
	W3	Insufficient storage capacity for butter and cream products.
	W4	Low processing capacity for other milk based products.
	W5	Underutilized equipment.
	W6	Less product range.
	W7	Lack of technically experienced workers.
	W8	Overstaffing.
Opportunity	O1	Development of new product and value addition.
	O2	In-plant training for the interns, dairy entrepreneurs *etc*.
	O3	Installation of processing units in other parts of the State.
	O4	Installation of energy efficient equipment.
	O5	Expansion of milk processing capacity.
	O6	Collaboration for RandD with other institutes, dairy firms *etc*.
	O7	Upgradation of plant and products.
Threat	T1	High labour cost or shortage of labour.
	T2	Challenge to waste disposal and cleanness.
	T3	Frequent interruption due to technical or management problems.
	T4	Milk adulteration.
	T5	Mishandling or careless operation leading to accidents or hazards.
	T6	Problem of contamination.
	T7	Unhygienic practices during handling raw milk.
	T8	No food safety control measures.
	T9	Poor microbiological quality of milk.
	T10	Careless monitoring and supervision.

Table 4: Priority calculations for strength factors.

	Priority matrix (a)										Weight matrix (W)										Criteria Wt. (CW)	Wt.Sum (WS) a*W	Rank	C= WS/CW
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10				
S1	1	2.42	2.15	2.4	2.25	3.08	2.01	3.2	2.14	2.5	0.22	0.40	0.24	0.21	0.17	0.18	0.13	0.15	0.10	0.10	0.19	2.33	1	11.49
S2	0.41	1	3.3	3.04	3.42	4.3	2.24	2.41	5.12	2.1	0.09	0.17	0.37	0.27	0.26	0.25	0.14	0.11	0.24	0.09	0.20	2.19	2	11.75
S3	0.47	0.30	1	2.6	2.12	2.21	3.12	4.05	2.03	2.05	0.10	0.05	0.11	0.23	0.16	0.13	0.20	0.19	0.09	0.09	0.14	1.56	3	11.50
S4	0.42	0.33	0.38	1	2.15	3.11	2.18	2.05	2.31	2.14	0.09	0.06	0.04	0.09	0.16	0.18	0.14	0.10	0.11	0.09	0.11	1.21	4	11.48
S5	0.31	0.29	0.32	0.32	1	2.2	2.08	2.24	2.12	2.44	0.07	0.05	0.04	0.03	0.08	0.13	0.13	0.11	0.10	0.10	0.08	0.93	5	11.39
S6	0.32	0.23	0.45	0.32	0.45	1	2.22	2.7	2.15	3.02	0.07	0.04	0.05	0.03	0.03	0.06	0.14	0.13	0.10	0.13	0.08	0.86	6	11.14
S7	0.50	0.45	0.32	0.46	0.48	0.45	1	2.54	2.08	4.04	0.11	0.07	0.04	0.04	0.04	0.03	0.06	0.12	0.10	0.17	0.08	0.83	7	10.70
S8	0.24	0.28	0.25	0.33	0.45	0.37	0.28	1	2.04	2.16	0.05	0.05	0.03	0.03	0.03	0.02	0.02	0.05	0.10	0.09	0.05	0.50	9	10.79
S9	0.47	0.20	0.32	0.43	0.47	0.47	0.48	0.49	1	2.66	0.10	0.03	0.04	0.04	0.04	0.03	0.03	0.02	0.05	0.11	0.05	0.51	8	10.65
S10	0.40	0.48	0.49	0.32	0.41	0.33	0.20	0.32	0.38	1	0.09	0.08	0.05	0.03	0.03	0.02	0.01	0.02	0.02	0.04	0.04	0.42	10	10.96
Σ	4.53	5.98	8.98	11.22	13.20	17.52	15.81	21.00	21.37	24.11														
																							λ_{max}	11.19
																							CI	0.13
																							RI	1.49
																							CR=CI/R I	0.08

Table 5: Priority calculations for weakness factors.

	Priority matrix (a)								Weight matrix (W)								Criteria Wt. (CW)	Wt.Sum (WS) a*W	Rank	C= WS/CW
	S1	S2	S3	S4	S5	S6	S7	S8	S1	S2	S3	S4	S5	S6	S7	S8				
S1	1	2.33	2.09	2.04	2.05	3.5	2.04	3.12	0.25	0.43	0.24	0.20	0.18	0.20	0.14	0.17	0.18	1.65	1	9.07
S2	0.43	1	3.51	3.02	3.24	4.2	2.31	2.04	0.11	0.18	0.40	0.30	0.28	0.24	0.16	0.11	0.18	1.63	2	9.30
S3	0.48	0.28	1	2.3	2.12	2.12	2.51	2.05	0.12	0.05	0.11	0.23	0.18	0.12	0.17	0.11	0.11	0.98	3	8.96
S4	0.49	0.33	0.43	1	2.06	3.05	2.08	2.16	0.12	0.06	0.05	0.10	0.18	0.17	0.14	0.12	0.09	0.84	4	8.98
S5	0.49	0.31	0.47	0.49	1	3.14	2.14	2.24	0.12	0.06	0.05	0.05	0.09	0.18	0.15	0.12	0.08	0.73	5	8.93
S6	0.29	0.24	0.47	0.33	0.32	1	2.01	3.2	0.07	0.04	0.05	0.03	0.03	0.06	0.14	0.18	0.06	0.51	6	8.52
S7	0.49	0.43	0.40	0.48	0.47	0.50	1	2.45	0.12	0.08	0.04	0.05	0.04	0.03	0.07	0.13	0.06	0.48	7	8.45
S8	0.32	0.49	0.49	0.46	0.45	0.31	0.41	1	0.08	0.09	0.06	0.05	0.04	0.02	0.03	0.05	0.04	0.36	8	8.78
Σ	3.98	5.42	8.86	10.12	11.70	17.82	14.50	18.26												
																			λ_{max}	8.87
																			CI	0.12
																			RI	1.41
																			CR = CI/RI	0.08

Table 6: Priority calculations for opportunity factors.

	Priority matrix (a)							Weight matrix (W)							Criteria Wt. (CW)	Wt.Sum (WS) a*W	Rank	C= WS/CW
	S1	S2	S3	S4	S5	S6	S7	S1	S2	S3	S4	S5	S6	S7				
S1	1	2.5	2.08	3.1	2.55	3.1	2.6	0.30	0.48	0.25	0.33	0.21	0.19	0.17	0.21	1.68	1	7.87
S2	0.40	1	3.5	2.04	3.21	4.3	2.3	0.12	0.19	0.42	0.22	0.26	0.27	0.15	0.18	1.44	2	8.00
S3	0.48	0.29	1	2.11	2.12	2.18	3.2	0.15	0.05	0.12	0.22	0.17	0.13	0.21	0.12	0.90	3	7.67
S4	0.32	0.49	0.47	1	2.51	3.03	2.13	0.10	0.09	0.06	0.11	0.20	0.19	0.14	0.10	0.75	4	7.61
S5	0.39	0.31	0.47	0.40	1	2.11	2.04	0.12	0.06	0.06	0.04	0.08	0.13	0.13	0.07	0.51	5	7.43
S6	0.32	0.23	0.46	0.33	0.47	1	2.2	0.10	0.04	0.06	0.03	0.04	0.06	0.14	0.05	0.39	6	7.41
S7	0.38	0.43	0.31	0.47	0.49	0.45	1	0.12	0.08	0.04	0.05	0.04	0.03	0.06	0.05	0.35	7	7.53
Σ	3.30	5.25	8.30	9.45	12.35	16.17	15.47											
																	λ_{max}	7.64
																	CI	0.12
																	RI	1.32
																	CR = CI/RI	0.08

Table 7: Priority calculations for threat factors.

	Priority matrix (a)										Weight matrix (W)										Criteria Wt. (CW)	Wt.Sum (WS) a*W	Rank	C= WS/CW
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10				
S1	1	3.12	2.07	2.04	2.06	3.56	2.3	3.12	2.41	2.31	0.21	0.44	0.23	0.18	0.16	0.20	0.14	0.15	0.11	0.10	0.19	2.24	1	11.65
S2	0.32	1	3.16	3.08	3.24	4.32	2.24	2.51	2.14	2.11	0.07	0.14	0.35	0.27	0.25	0.24	0.14	0.12	0.10	0.09	0.18	2.08	2	11.76
S3	0.48	0.32	1	2.54	2.31	2.24	3.21	4.1	2.16	2.45	0.10	0.04	0.11	0.22	0.18	0.13	0.20	0.20	0.10	0.10	0.14	1.58	3	11.44
S4	0.49	0.32	0.39	1	2.16	3.11	2.16	2.03	2.33	2.05	0.11	0.05	0.04	0.09	0.17	0.17	0.13	0.10	0.10	0.09	0.10	1.19	4	11.38
S5	0.49	0.31	0.43	0.46	1	2.03	2.04	2.42	2.21	4.21	0.10	0.04	0.05	0.04	0.08	0.11	0.12	0.12	0.10	0.18	0.09	1.05	5	11.13
S6	0.28	0.23	0.45	0.32	0.49	1	2.11	2.15	2.51	3.2	0.06	0.03	0.05	0.03	0.04	0.06	0.13	0.11	0.11	0.13	0.07	0.83	6	11.18
S7	0.43	0.45	0.31	0.46	0.49	0.47	1	2.45	2.06	2.1	0.09	0.06	0.03	0.04	0.04	0.03	0.06	0.12	0.09	0.09	0.07	0.73	7	11.16
S8	0.32	0.40	0.24	0.49	0.41	0.47	0.41	1	5.06	2.25	0.07	0.06	0.03	0.04	0.03	0.03	0.02	0.05	0.23	0.09	0.06	0.72	8	11.06
S9	0.41	0.47	0.46	0.43	0.45	0.40	0.49	0.20	1	2.08	0.09	0.07	0.05	0.04	0.04	0.02	0.03	0.01	0.04	0.09	0.05	0.52	9	10.94
S10	0.43	0.47	0.41	0.49	0.24	0.31	0.48	0.44	0.48	1	0.09	0.07	0.05	0.04	0.02	0.02	0.03	0.02	0.02	0.04	0.04	0.44	10	11.05
Σ	4.66	7.09	8.93	11.32	12.86	17.91	16.43	20.42	22.36	23.76														
																							λ_{max}	11.27
																							CI	0.14
																							RI	1.49
																							CR = CI/RI	0.09

opportunities, the most important ones prioritized by majority was value-addition of milk products. The JMF has better scope of developing wide range of new products apart from packaged milk like flavoured lassi, cheese, butter, kalakand etc. which would enhance the cooperative business. Besides this, JMF has planned for installation of processing units in other parts of the State in future, which would further enhance production and give employment opportunities to the local people. The in-plant training often conducted by JMF gave better exposure to interns, budding entrepreneurs and new employees regarding dairy processing and value addition of milk products. Table 4 shows that all the CI, RI and CR scores satisfy the AHP criteria. Furthermore, the CR value (0.08) was lower than (0.10), indicating consistency among the opportunity components.

Threat analysis

The threat factors have been analysed for priority matrix, weight matrix and the calculations of threats as shown in Table 7. The major threat expressed was high cost of labour. In JMF, there was acute shortage of labour due to which they had to hire labour at high cost which in turn increased the operational cost. Another important threat ranked in order of priority was 'challenge to waste disposal and cleanliness'. Therefore, JMF should adopt proper waste management practices and keep the environment clean and hygienic. Further, it was noticed that frequent interruption in the production process due to technical or mechanical problems incurred huge losses in the processing unit. According to the results of AHP for threat components, all of the CI, RI and CR scores are valid for AHP criteria, as shown in Table 4. Furthermore, the consistency of the threat components was established because the CR value (0.08) was less than (0.10).

CONCLUSION

The identification and assessment of the CFs in the dairy processing supply chain of JMF, using the AHP approach revealed some of the important strengths, weaknesses, opportunities and threats. The major findings of the study based on expert views highlighted that, fully computerised system with self-automation facilities, surplus milk handling capacity, adequate milk production capacity of JMF were the major strengths identified. Whereas, high operational cost for processing liquid milk, more energy consumption, insufficient storage for butter and cream products were the major weaknesses. Further, development of new products and value addition, In-plant training for the interns, dairy entrepreneurs *etc*., installation of processing unit in other parts of the State were the major opportunities identified. However, high labour cost or shortage of labour, challenge to waste disposal and cleanliness, frequent interruption due to technical or management problems were some of the potential threats linked with dairy processing supply chain of JMF. Therefore, JMF should embark upon product diversification, quality assurance and usage of energy-efficient technology to enhance the productivity of the dairy processing unit. The SWOT analysis will further guide policy makers/top level management to reduce the weaknesses and threats and exploit its strengths and opportunities for better performance of JMF.

Conflict of interest: None.

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