Recency Frequency Monetary Analysis for Segmenting Milk Suppliers of a Dairy Organisation

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Abstract

The dairy supply chain encompasses a complex network of stakeholders, including milk producers, processors, distributors and retailers. Effective management of this supply chain is essential for ensuring the continuous supply of high-quality milk and milk products to consumers. Milk suppliers, as the primary source of milk, play a critical role in the dairy supply chain. Understanding and segmenting milk suppliers based on their milk-supplying behaviour can provide dairy organisations with valuable insights for optimising supply chain management strategies. It will also improve supplier relationships and enhance overall profitability. At present, all transactions of individual milk suppliers are digitally recorded immediately at the point of their supply on a daily basis, creating a massive database that can be used for dynamic data analysis by fast computing facilities available in information technology today. Recency frequency monetary (RFM) analysis is a powerful tool that can be used to segment milk suppliers based on their milk-supplying behaviour. Further, based upon the initial RFM analysis, machine learning-based algorithms may be utilised to give interesting insights into the supply patterns, which may be missed by normal statistical analysis. This article explores the benefits of RFM application for segmenting milk suppliers of a dairy organisation for managing the supply chain effectively with a real case example.

Keywords

Recency frequency monetary analysis

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Introduction

Milk procurement in a typical village in India is essentially a bulking operation, as an average milk supplier supplies only about 2–5 L of milk a day, and hence there is a need for a multitude of suppliers for a viable operation. However, keeping physical track of the supply behaviour of thousands of such suppliers over a period of time becomes a herculean task for the milk procurement managers, especially when the area of operations spans across more than three to five districts and the milk suppliers supply milk twice a day.

To put it in perspective with an example, an organisation procuring an average of 2 lakh litres of milk per day may have around 40,000 milk suppliers dispersed widely in 400 villages with a geographically spread across 3000 sq. km. Assuming two milk-supplying transactions per day per milk supplier, wherein the quantity and quality of milk supplied, as well as the value of milk received is recorded, we have a database of around 3 crore records or transactions in a single year. (*However, with today's fast computing facilities, we can analyse the last 5 years of data with maybe 15 crore records within seconds for all these thousands of milk suppliers along with their seasonal or sporadic variations*.)

Adding to the complexity of the milk supply chain is that not all suppliers supply milk every day. There may be suppliers who are leaving or joining depending upon the season (milk supply is strongly seasonal and also impacted by vagaries of weather conditions) or competition due to the availability of better prices and/or facilities provided by other players. Further, new animals may have been inducted or some animals may be dry in the supplier household. Given that milk suppliers in India are mostly smallholder farmers residing in the villages, the changing economic condition of the supplier households also plays an important part in their milk-supplying behaviour. For an effective supply chain management, the milk procurement managers need to be constantly aware of the reasons behind the increase or decrease in milk supplies.

Supplier Segmentation and Recency Frequency Monetary Analysis

Milk suppliers are the backbone of the dairy industry, providing the raw material for milk production. Their performance directly impacts the quality and quantity of milk produced, which in turn affects the dairy organisation's ability to meet market demand and achieve its financial goals. Thus, effective segmentation of milk suppliers can help dairy organisations in the following ways:

- *Optimise procurement strategies*: By understanding the different segments of milk suppliers, dairy organisations can tailor their procurement strategies to maximise value from each segment.
- *Improve supplier relationships*: Segmentation can help dairy organisations identify and focus on their most valuable suppliers, building stronger relationships and fostering long-term partnerships.

- *Enhance overall profitability*: By optimising procurement strategies and improving supplier relationships, dairy organisations can reduce costs and increase profitability.

In fact, supplier segmentation, which is a strategic approach to grouping suppliers based on shared characteristics, has now emerged as a valuable tool for dairy organisations to enhance supplier relationships and drive profitability.

Among the various supplier segmentation techniques, RFM analysis has gained prominence due to its simplicity and effectiveness.

RFM analysis classifies suppliers based on three key dimensions:

- *Recency*: Measures the time since the supplier's last supply.
- *Frequency*: Indicates the number of supply transactions made by the supplier within a specified period.
- *Monetary value or volume of milk supplied*: Represents the total volume of milk supplied and/or its monetary value over a defined timeframe.

Database and Methodology Used for the Study

Daily milk transaction data for 1,564 milk suppliers residing in 15 nearby villages for a milk chilling centre in Uttar Pradesh were collected between the period August 2007 and July 2009. The transaction data consisted of 'Supplier's Name/ ID', 'Village Code/ID', 'Date of supply', 'Volume of milk (kg)' supplied and 'Value of milk supplied (Rs)' for each of their daily transactions during this period.

Some records for understanding of the database are as shown in Table 1.

The application software for RFM analysis was developed in Python (*though it can also be done very easily in Excel and utilised if the volume of data is not very big*).

To calculate *Recency*, we subtracted the last supply date from the current date and extracted the number of days using the datetime.now().date() function of Python. It gives us the number of days since the supplier's last supply, representing their recency value.

After that, we calculated the *Frequency* for each supplier. We grouped the data by 'Supplier Name/ID' and counted the number of *unique* 'Date of Supply' values to determine the number of supplies made by each supplier. It gives us the frequency value, representing the total number of supplies made by each supplier.

Finally, we calculated the *Monetary/Volume value* for each supplier. We grouped the data by 'Supplier Name/ID' and summed the 'Volume of Milk Supplied' values to calculate the total amount of milk supplied by each supplier. This could also have been done using the monetary value of the milk supplied but in our context, when this information needs to be used by the procurement manager, it is more apt to provide it in terms of volume. It gives us the *Monetary/Volume value*, representing the total monetary/volume contribution of each supplier.

By performing these calculations, we now have the necessary RFM values (recency, frequency, monetary/volume value) for each supplier, which are important indicators for understanding supplier behaviour and segmentation in RFM analysis.

Table 1. Sample Transaction Records.

Supplier ID	Supplier Name	Village Code/ ID	Date of Supply	Volume of Milk Supplied (kg)	Value of Milk Supplied (₹)
12019	Chandra Gupta	12	22 August 2007	2	62.50
12018	Dharmendra	12	22 August 2007	2	62.50
10022	Jung Bhadur	10	23 August 2007	1	31.25
9009	Ram Milan	9	23 August 2007	3	93.75
3007	Viswanath	3	23 August 2007	1	31.25
10030	Ram Kumar	10	24 August 2007	1	31.25
7012	Awadhesh	7	25 August 2007	5	156.25
13009	Suneeta	13	29 August 2007	1	31.25
12012	Rakesh Kori	12	29 August 2007	6	187.50
7014	Ram Kumar	7	29 August 2007	4	125.00
7002	Prem Nath	7	29 August 2007	5	156.25
13011	Dashrath	13	31 August 2007	2	62.50
10026	Deepak	10	31 August 2007	9	281.25

We assigned scores from 5 to 1 to calculate the *Recency* score, where a higher score indicates a more recent supply. It means that suppliers who have supplied more recently will receive higher recency scores.

We assigned scores from 1 to 5 to calculate the *Frequency* score, where a higher score indicates a higher supply frequency. Suppliers who made more frequent supplies will receive higher frequency scores.

To calculate the *Monetary* score, we assigned scores from 1 to 5, where a higher score indicates a higher Volume supplied by the customer.

To calculate RFM scores, we used the pd.cut() function of Python to divide recency, frequency and monetary values into bins. We define five bins for each value and assign the corresponding scores to each bin.

This is illustrated with an analysis of some sample suppliers in Table 2.

For instance, a supplier with a recent supply, high supplying frequency and very significant monetary value or volume of milk supplied would receive high scores, namely 555 across all three dimensions, placing them in a segment of high-value, loyal suppliers, while the worst supplier may be scored as 111.

Results

It may be noted that not all suppliers supplied milk every day in this period. Further, along with the fluctuation of the quantity of milk supplied by the suppliers in this period, there were many incidents of old suppliers leaving and/

Table 2. Recency Frequency Monetary (RFM) Score of Sample Suppliers.

| Supplier_Code	Name of Supplier	Last date of Supply	Frequency	Quantity Supplied	Recency	Frequency	Monetary	RFM Score
10002	Dharmendra	21 June 2009	516	16.62	5	5	5	555
15001	Ranjeet	31 July 2009	707	13.49	5	5	5	555
8001	Ram Milan	28 July 2009	464	13.01	5	5	5	555
10079	Ram Samujh	13 November 2008	179	5.56	4	4	5	445
22033	Shubham S.	17 September 2008	154	5.13	4	4	5	445
8015	Harish Chandra	29 December 2008	139	5.70	4	4	5	445
24055	Surendra Kumar	20 September 2008	184	3.37	4	4	4	444
20003	Ram Kumar	8 April 2008	87	4.13	3	3	5	335
10031	Daya Ram	30 April 2008	79	4.65	3	3	5	335
3078	Mahesh	23 July 2008	83	3.14	3	3	4	334
24057	Rajbahadur	7 April 2008	76	3.35	3	3	4	334
14046	Rambaran Singh	12 March 2008	72	3.46	3	3	4	334
8145	Ramsumer	10 June 2008	70	3.17	3	3	4	334
9017	Shanjay	19 December 2007	30	1.51	2	3	2	232
9025	Suneel	19 December 2007	30	1.47	2	3	2	232
9032	Raghubeer	19 December 2007	30	1.40	2	3	2	232
6031	Babu Yadav	18 December 2007	30	0.44	2	3	2	232
24016	Ramsagivan	6 December 2007	4	5.00	1	2	5	125
4036	Ramrajsingh	2 December 2007	10	4.45	1	2	5	125
13051	Shiv Karan	20 November 2007	9	4.06	1	2	5	125
22018	Shohan Lal	4 October 2007	1	0.60	1	1	2	112
13033	Mahesh	3 October 2007	1	1.00	1	1	1	111
18029	U. K. Sukla	2 October 2007	1	0.80	1	1	1	111
21019	Shyamu	24 September 2007	1	1.00	1	1	1	111
1008	Ram Sajivan	21 September 2007	1	1.00	1	1	1	111
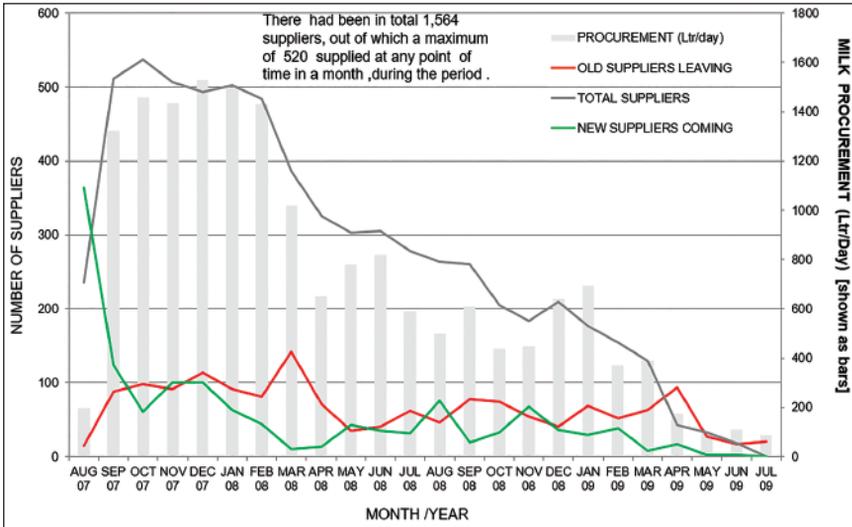
Figure 1. Dynamic Changes in Milk Procurement Volume and Milk Suppliers Over Time.

or new suppliers joining for some reason during this period. This dynamic characteristic of the milk supply chain is quite expected and is inherent in the milk supply chain, which makes the milk procurement activity very challenging. In fact, this is true of most of the rural produce in our country in bulking small holder production.

The dynamic changes in milk procurement volume and the number of milk suppliers supplying milk in each month during the period can be illustrated by a graphical analysis of the data as shown in Figure 1.

It can be seen that the total milk procurement volume was growing and reached a high of around 1,500 L/day (converted from kg to L) in December 2007. However, after that, the volume started shrinking as more suppliers started leaving as compared to new suppliers joining the organisation. It was also observed that out of the total of 1,564 suppliers who got enrolled, there was a maximum of 520 suppliers who had supplied milk at any point in time (October 2007).

To get more useful insights in supply patterns, we segmented the suppliers by creating a two-dimensional table as shown in Figure 2, wherein their recency (time since last supplied in months/year) was mapped with their total period of supply (in months/years) during this duration, as shown in Figure 2.

It can be seen that at the end of the duration, we had only 20 suppliers left in the last month. Further, 236 suppliers had left in the last 6 months prior to it, out of which 65 suppliers had been supplying regularly for one year before leaving. Many of them were supplying around 3–6 L/day. These suppliers could have been incentivised to stay with the organisation.
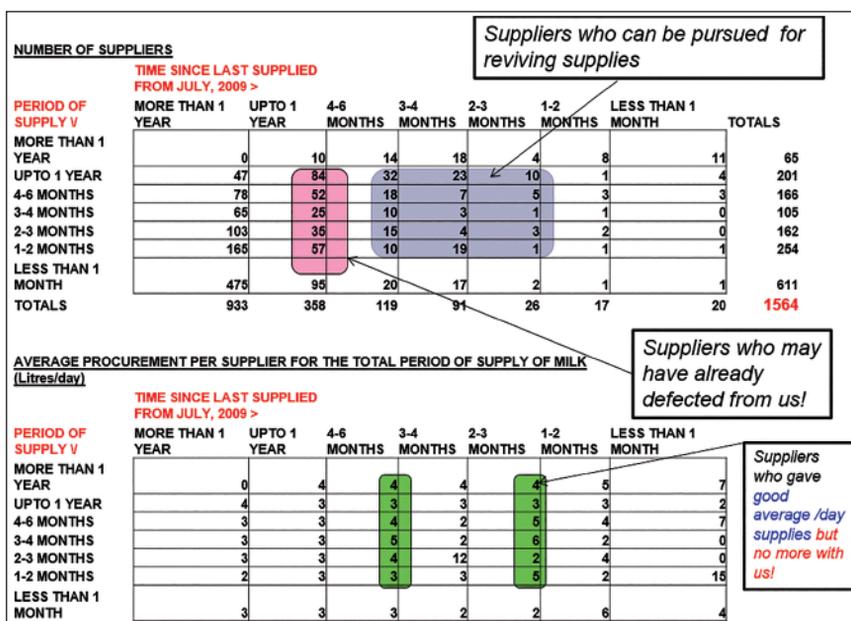
NUMBER OF SUPPLIERS

Suppliers who can be pursued for reviving supplies

PERIOD OF SUPPLY V	TIME SINCE LAST SUPPLIED FROM JULY, 2009 >							
	MORE THAN 1 YEAR	UPTO 1 YEAR	4-6 MONTHS	3-4 MONTHS	2-3 MONTHS	1-2 MONTHS	LESS THAN 1 MONTH	TOTALS
MORE THAN 1 YEAR	0	10	14	18	4	8	11	65
UPTO 1 YEAR	47	84	32	23	10	1	4	201
4-6 MONTHS	78	52	18	7	5	3	3	166
3-4 MONTHS	65	25	10	3	1	1	0	105
2-3 MONTHS	103	35	15	4	3	2	0	162
1-2 MONTHS	165	57	10	19	1	1	1	254
LESS THAN 1 MONTH	475	95	20	17	2	1	1	611
TOTALS	933	358	119	91	26	17	20	1564

Suppliers who may have already defected from us!

AVERAGE PROCUREMENT PER SUPPLIER FOR THE TOTAL PERIOD OF SUPPLY OF MILK (Litres/day)

Suppliers who gave *good* average /day supplies *but* no more with us!

PERIOD OF SUPPLY V	TIME SINCE LAST SUPPLIED FROM JULY, 2009 >						
	MORE THAN 1 YEAR	UPTO 1 YEAR	4-6 MONTHS	3-4 MONTHS	2-3 MONTHS	1-2 MONTHS	LESS THAN 1 MONTH
MORE THAN 1 YEAR	0	4	4	4	4	5	7
UPTO 1 YEAR	4	3	3	3	3	3	2
4-6 MONTHS	3	3	4	2	5	4	7
3-4 MONTHS	3	3	5	2	6	2	0
2-3 MONTHS	3	3	4	12	2	4	0
1-2 MONTHS	2	3	3	3	5	2	15
LESS THAN 1 MONTH	3	3	3	2	2	6	4

Figure 2. Mapping Recency with Duration of Supplies.

Using the RFM Scores for Segmentation

RFM scores obtained after analysing the data (as shown earlier) for each supplier can be used to categorise suppliers into different segments. It can be seen that this score may vary from 555 for the best suppliers to 111 for the worst suppliers. We can also create further groups by combining these segments as per our strategic requirements for enhancing milk supply, as shown in Figure 3.

For instance, if our strategy is to focus on highly regular milk suppliers who stay with us, having high to average supply volumes, then we may combine RFM scores with $R = 5,4,3$ and $F = 5,4,3$ and $M = 5,4,3$ and make Category 'A' suppliers. Further, we may combine to get another Category 'B' suppliers having very low volume of milk supply but otherwise regular and staying with us with $R = 5,4$ and $F = 5,4$ and $M = 2,1$. The remaining suppliers may be categorised as Category 'C', who are mainly irregular, floating suppliers looking for arbitrage opportunities and unlikely to be dependable in future. As a strategy, we may need to develop Category 'A' with 351 suppliers and Category 'B' with 96 suppliers with proper incentives and maintain live relations for our steady milk supply instead of spreading our effort thinly over a large number of suppliers. Category 'C' has 1,117 suppliers who may not be dependable for a steady milk supply.

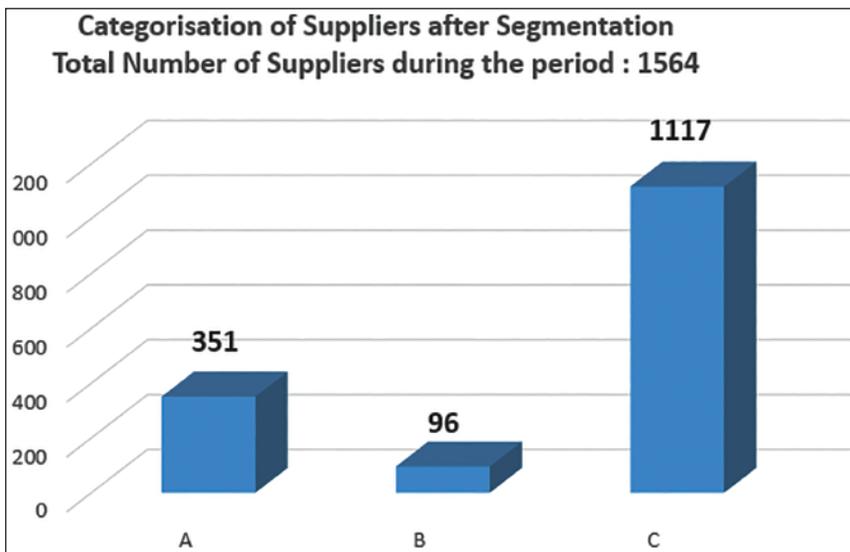This is illustrated with analysis of some sample suppliers, as shown in Table 3.

Figure 3. Categorisation of Suppliers After Segmentation.

Note: Total number of suppliers during the period: 1,564.

You may observe that if timely action was taken in segmenting and categorising milk suppliers by observing the data (which was always available), it could have averted the milk procurement crisis happening within a mere 2 years (August 2007 to July 2009) start of this newly opened milk chilling centre.

The findings of RFM analysis may be disseminated to the village supervisors and field officers engaged in milk procurement operations, as below:

- *Village supervisors*: They can be provided with a list of suppliers who have been consistently supplying milk. These producers may be encouraged with recognition and further incentivisation.
- *Field officers*: During monthly/fortnightly review with supervisors, this may be actively pursued. The matrix would assist in segmenting producers who have left recently and may be pursued for reviving supplies.

At present, all milk supply points have the necessary computer facilities that capture *everyday milk transactions from each supplier*, which can be profitably utilised for creating this RFM on a regular basis for discussion among the field officers and village supervisors.

Benefits of RFM Segmentation for Milk Suppliers

RFM segmentation offers several benefits for dairy organisations in the context of milk procurement:

Table 3. Profile of Sample Suppliers After Categorisation and Building Recency Frequency Monetary (RFM) Scores.

Supplier Code	Name of Supplier	Village Code	Last Date of Supply	Recency	Frequency	Monetary	RFM Segment	Category
3004	Ram Phal	3	31 July 2009	5	5	5	555	A
8017	Babulal	8	1 March 2009	5	5	5	555	A
10009	Shri Ram	10	10 April 2009	5	5	4	554	A
10017	Hari Dwar	10	31 May 2009	5	5	4	554	A
8061	Ram Harsh	8	1 June 2009	5	5	2	552	B
15062	Pramod Kumar	15	2 June 2009	5	5	2	552	B
22001	Janardan Singh	22	3 June 2009	5	5	2	552	B
8011	Jang Bhadur	8	4 June 2009	5	5	2	552	B
10065	Santosh	10	5 June 2009	4	4	2	442	B
1048	Dhrma	1	6 June 2009	4	4	2	442	B
8054	Suraj Pal	8	7 June 2009	4	4	2	442	B
22029	Sataynarayan	22	8 June 2009	4	4	1	441	B
1041	Mithlrsh	1	9 June 2009	4	4	1	441	B
10080	Chunnu	10	10 June 2009	3	2	1	321	C
7040	Sumitra	7	11 June 2009	3	2	1	321	C
1049	Lendra Bhadur	1	12 June 2009	3	2	1	321	C

- *Improved supplier targeting*: RFM segmentation allows dairy organisations to identify and prioritise their most valuable suppliers, focusing their resources on those who contribute the most to their bottom line.
- *Enhanced supplier engagement*: By understanding the needs and behaviours of each supplier segment, dairy organisations can tailor their communication and engagement strategies to foster stronger relationships and improve supplier satisfaction.
- *Optimised pricing strategies*: RFM segmentation can help dairy organisations develop differential pricing strategies based on supplier value, ensuring that they are paying the right price for the quality and quantity of milk they receive.
- *Reduced churn risk*: By identifying and addressing the needs of at-risk suppliers, dairy organisations can reduce the risk of supplier churn and maintain a stable supply chain.
- *Increased profitability*: Through optimised procurement strategies, improved supplier relationships and reduced churn, dairy organisations can achieve significant cost savings and profitability gains.

Conclusion

RFM analysis is a valuable tool for segmenting milk suppliers and optimising procurement strategies in the dairy industry. By understanding the supply behaviours of their milk suppliers, dairy organisations can make informed decisions about resource allocation, supplier engagement, pricing and risk management. Effective segmentation can lead to improved supplier relationships, reduced costs and increased profitability for dairy organisations.

Declaration of Conflicting Interests

Funding

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