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A Research Paper on Inbound Logistics of Fertilizers in Nagarjuna Fertilizers and Chemicals Limited, Kakinada

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Abstract:
Agriculture, the back bone of India now is facing many problems including the shortfall in the supply of fertilizers is the result of irregular supply of inputs to the fertilizer industry. Nagarjuna Fertilizers and Chemicals Limited is the major urea producer for the farming community of Andhra Pradesh and plays a crucial role in the fertilizer industry of India and abroad. For this reason the present study focused on the inbound logistics the primary activity of Supply Chain Management of Nagarjuna Fertilizers and Chemicals Limited, Kakinada. The methodology for this study includes research design, collection of secondary data, classification and tabulation of data and diagrammatic and graphical representation of data. In conclusion the above data is analyzed and report to conclude that the company is facing inbound logistics problems which in turn results to the problems of fertilizers availability that can be solved by efficient execution of the suggestions made in this reading.

Keywords: *fertilizers, inbound logistics, supply chain management*

1. Introduction

Urea the fertilizer is very essential plant nutrient made up of natural gas or naphtha from petroleum byproduct. Inbound logistics the primary activity of the supply chain management is taken to understand and analyze the various inputs (inbound logistics) of Nagarjuna Fertilizers and Chemicals Limited and the fertilizer industry at large. The primary inputs required by the Nagarjuna Fertilizers and Chemicals Limited are Natural Gas, Naphtha, Electricity and fuel Natural Gas. Purchases of traded products, Pool Urea (imports), Specialty Fertilizers are also considered as they are inflows to the company. Catalysts Charge, Chemicals and Consumables, Packing Material, stores and spares, and others (indigenous) are considered to study how effective and efficient they are in the Supply Chain Management of Nagarjuna Fertilizers and Chemicals Limited and to the fertilizer industry itself.

2. Literature Review

The supply chain, also known as value chain is a concept from business management that was first described and popularized by Michael Porter in his book, Competitive Advantage: Creating and Sustaining Superior Performance. Porter, M. E. (1985)[1]
Gupta (1984)[2] has made a detailed study of the problems and issues relating to marketing of fertilizers According to his analysis; the cooperatives cover 97% of the six lakh villages and the membership accounts for 45% of the rural population. He contends that even though in absolute terms the quantum of fertilizers marketed by the cooperatives has increased, their share has come down from 70 to 45% partly because of internal problems and partly external. The need to step up the share of cooperatives to 55% has been emphasized. Vittal (1984)[3] has brought out the strategies of cost reduction in logistics of fertilizer distribution in a lucid way. He contends that production and distribution of fertilizers in the most efficient manner is an issue of prime national importance. While evolving strategies for cost reduction, the skewed distribution of fertilizers (which has led to skewed consumption) has to be taken in to consideration. In his study Rama Swamy (1985)[4] covers major fertilizer marketing functions. It describes the process of fertilizer marketing in India as existed prior to 80s. It has brought out the Strengths, Weakness, Opportunities and the Threats (SWOT) of the fertilizer marketing system. It also brings out the need and feasibility of containing the marketing costs in the fertilizer industry. A study conducted by H.K.LakshmanRao at Madras Fertilizers Ltd. (1986)[5] Public Distribution System in fertilizer adversely affected an orderly development of consumption. Small to Medium sized holdings farmers were unable to adopt a consistent approach with regard to usage of fertilizer products due to uncertainty of the availability of the products of their choice. According to the Sivaraman committee, appointed by Government of India (GOI) for studying the marketing aspects reported in the mid 70s that the marketing and distribution of fertilizers were not up to the expectations and the cooperatives which play a major role in the distribution lacked marketing approach.

According to Saleem Ahmed, Chowdhury and others (1992)[6] Fertilizer demand projections and also the agricultural productions based on time series data on past consumption trends of fertilizer consumption and food production estimates for south eastern countries. They contend that time series analysis is best suited for short term forecasting in fertilizers. According to them "To meet the year 2000 projected agricultural production targets would grow by 45% in case of India, and would double in respect of Bangladesh & Nepal and would grow about 77% in case of Pakistan."

According to SathyaRao & Sandhya (1994)[7] in their research paper the distribution system of fertilizers in Andhra Pradesh based on secondary data of pertaining to 30 fertilizer plants, located in different states, supplying various fertilizer products such as Urea, Ammonium Sulphate, CAN, SSP, DAP, Complex fertilizers to 22 districts of Andhra Pradesh. A distribution model based on L.P. has been adopted for identifying the districts and the plants on a least transportation cost by rail. A saving of 18% has been arrived at based on this model. Bowersox and Closs (1996)[8] states that the emphasis on cooperation represents the synergism leading to the highest level of joint achievement. A primary level channel participant is a business that is willing to participate in the inventory ownership responsibility or assume other aspects of financial risk, thus including primary level components According to Lambert and Cooper (2008)[9] operating an integrated supply chain requires a continuous information flow. However, in many companies, management has reached the conclusion that optimizing the product flows cannot be accomplished without implementing a process approach to the business.

According to Prasada Rao Bondada (2014)[10] it was found that in the fertilizer industry over 17.12 % of installed capacity is underutilized is due to irregular supply of inputs in due time. And at the same time it was found that more production of Urea is possible than its installed capacity and the company is performing well in conversion of ammonia to Urea.

3. Need for the Study

The definite need for the study of inbound logistics of fertilizers with special reference to Nagarjuna Fertilizers and Chemicals Limited, Kakinada is to study inbound logistics and other inputs like pool urea as the company produces and markets a wide range of fertilizers. Urea (widely used) nitrogenous fertilizer is manufactured at the Kakinada Plant as well as marketed. And the pool urea is imported at the Kakinada and the Vizag Ports. The farming community in Andhra depends to a large extent on the urea produced by Nagarjuna Fertilizers and Chemicals Limited (NFCL). NFCL presently markets around 0.6 million tons of imported urea and 1.2 million tons of manufactured urea. NFCL is major urea provider for the Andhra Pradesh. This is the main reason to choose this company for study.

4. Statement of the Problem

Today the agriculture; the primary sector of India is facing many problems including the scarcity in the availability of fertilizers. NFCL with a capacity of 1.5 Million Tons per annum is major urea producer for the Andhra Pradesh and plays a vital role in the fertilizer industry. Hence the present study focused on to find out and analyzes the bottlenecks in SCM of NFCL and Fertilizer industry.

5. Objectives

- To study the supply chain management of the Nagarjuna Fertilizers and Chemicals Limited
- To understand and analyze the various inputs (inbound logistics) of Nagarjuna Fertilizers and Chemicals Limited and to study how effective and efficient they are using in their Supply Chain Management.
- To make suggestions for improvement.

6. Hypotheses

- There is no significance difference between % change of both quantity and the values for inbound logistics
- There is no significance difference between supply and demand for pool urea
- There is no significance difference between values of electricity purchased and electricity by own generation

7. Research Methodology

The analysis may be possible by studying the data available in the company. The methodology includes collection of secondary data, classification and tabulation of data and diagrammatic and graphical representation of data. Finally the above data is analyzed and reported

7.1. The secondary data

The secondary data was collected from organization records, management reports, the department of fertilizers and the Fertilizer Association of India and the special project reports to understand the present state of supply chain management primary activities.

7.2. Tools for data analysis

The various tools used in processing and analysis of data were done with the help of the StatistiXL (Statistical Package for Social Sciences) and STATISTICS XL computer software. MS Excel is used to calculate mean and other and drawing of tables, charts and the figures.

7.3. Testing of Hypothesis

7.3.1 Chi – square (χ^2) test

Chi – square test is the very powerful test for testing the significance of the discrepancy between theory and experiment is used to test the 'goodness of fit' it was given by Prof. Karl Pearson. It enabled to find if the deviation of the research from theory is just by probability or is it actually due to the insufficiency of the theory to fit the observed data.

7.3.2. Formula used

χ^2 = (observed value – expected value)^2 / expected value

7.3.3. Mean

The mean (the expected frequencies) in each group or condition is calculated by addition of all the scores in a given condition (for 10years), and then dividing by the number of years (10) in that condition.

7.4. Decision rule

Accept Null hypothesis if calculated value of χ^2 is less than the tabulated value or reject Null hypothesis if calculated value of χ^2 is greater than the tabulated value at 5% level of significance and at 9 degrees of freedom.

7.5. The correlation coefficient

It is to determine the relationship between two properties

The equation for the correlation coefficient is:

$$Correl(X,Y) = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{\sum (x-\bar{x})^2 \sum (y-\bar{y})^2}}$$

Where x and y are the sample means average (array1) and average (array2).

8. Results & Discussion

Financial Year	Natural Gas						Naphtha (Ind)					
	Quantity (1000 SM^3)	% Change	Value (Rs. Lochs)	% Change	Average cost per 1000 SM3 (Rs.)	% Change	Quantity (MT)	% Change	Value (Rs. Lakhs)	% Change	Average cost per (MT)	% Change
2001 - 02	386342.000	-	14348.51	-	3713.940	-	78903.000	-	8625.18	-	0.10931	-
2002 - 03	406008.000	5.09	14973.96	4.35	3688.095	-0.70	87390.000	10.76	9836.54	14.04	0.11256	2.973
2003 - 04	409849.000	0.95	17118.92	14.32	4176.885	13.25	42572.000	-51.3	5761.21	-41.4	0.13533	20.23

Total	2010 - 11	2009 - 10	2008 - 09	2007 - 08	2006 - 07	2005 - 06	2004 - 05					
4201428	639932.220	565485.660	325852.910	356998.150	347201.976	366246.366	397512.000					
	13.2	73.5	-8.72	2.82	-5.20	-7.87	-3.01					
215769.7	50985.64	35287.96	15561.59	16423.53	17154.93	16875.70	17038.92					
	44.48	126.8	-5.25	-4.26	1.65	-0.96	-0.47					
48997.71	7967.350	6240.293	4775.649	4600.452	4940.908	4607.745	4286.391					
	27.68	30.67	3.80	-6.89	7.23	7.49	2.62					
809704.6	nil	6572.000	147035.050	115303.280	113012.062	116750.159	102167.000					
	-100	-95.5	27.52	2.027	-3.2	14.27	140					
209236.1	nil	1903.99	55315.86	41852.98	35517.51	30368.86	20053.95					
	-100	-96.6	32.17	17.84	16.95	51.44	248.1					
	nil	0.28971	0.37621	0.36298	0.31428	0.26012	0.19629					
	-100	-23	3.645	15.5	20.82	32.52	45.05					

Table1: Quantity and value of Natural Gas and Naphtha (Ind) Purchased for 10 Years (2001 – 2011)
Source1: NFCL Annual Reports 2002 to 2011

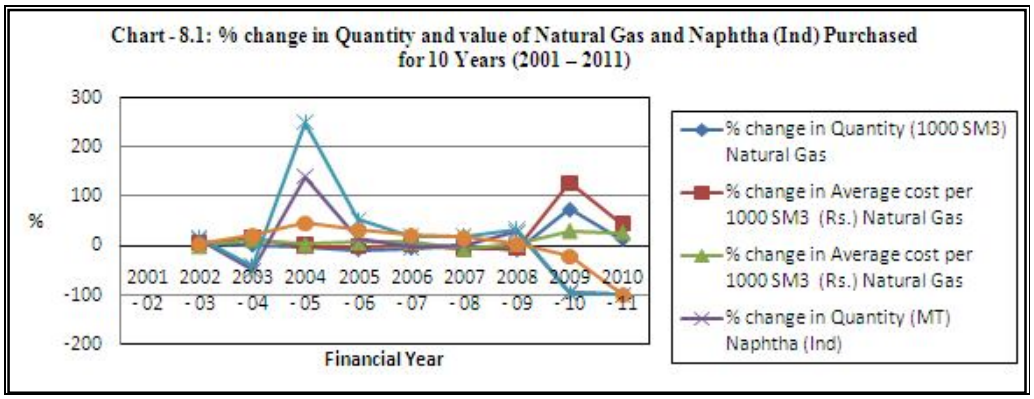

Figure 1: Quantity and value of Natural Gas and Naphtha (Ind) Purchased for 10 Years (2001 – 2011)

8.1. Interpretation

Figure 1 shows the Quantity and value of Natural Gas and Naphtha (Ind) Purchased for 10 Years (2001 – 2011). It shows in the years 2002 - 03, 2003 - 04, 2004 - 05, 2005 - 06, 2006 - 07, 2007 - 08, 2008 - 09, 2009 - 10 and 2010 – 11 the % change in the quantity of Natural gas is 5.09, 0.95, -3.01, -7.87, -5.20, 2.82, -8.72, 73.5 and 13.2 respectively. Whereas the % changes in the value of Natural gas is 4.35, 14.32, -0.47, -0.96, 1.65, -4.26, -5.25, 126.8 and 44.48 respectively. The reason for this unequal and irregular % changes are fluctuations in the output and flexible supply of inputs by the vendors. The % change in the quantity of Naphtha in the years 2002 - 03, 2003 - 04, 2004 - 05, 2005 - 06, 2006 - 07, 2007 - 08, 2008 - 09, 2009 - 10 and 2010 – 11 is 10.76, -51.3, 140, 14.27, -3.2, 2.027, 27.52, -95.5 and -100 respectively. And the % change in the value of Naphtha is 14.04, -41.4, 248.1, 51.44, 16.95, 17.84, 32.17, -96.6 and -100 respectively. The % change in the quantity and value of Naphtha from the year 2009 – 10 is 100% less because With the commencement of supply of natural gas to both the plants, the Company has phased out usage of Naphtha in a phased manner and has completely changed over to Natural Gas feed Stock from August '09 onwards. From this study it is clear that there is no equal and regular or gradual increase in % change of both quantity and the values. So it is suggested that the company should see that the % change in the value is always less than the % change of quantity.

Hypothesis - 1

Null hypothesis (H_0): There is no significance difference between % change of both quantity and the values for inbound logistics

Alternative hypothesis (H_a): There is no equal and regular or gradual increase in % change of both quantity and the values of inputs

Level of significance: 5%

Degrees of freedom (DF): 9

Calculated value: 220152.2

Table value: 16.92

Decision: Reject null hypothesis

Conclusion: It's very significant that there is no equal and regular or gradual increase in % change of both quantity and the values of inputs

The correlation coefficient result: Between the quantity and value of natural gas is 0.951805 shows positive correlation.

Financial Year	Quantity (MT)	% Change	Value (Rs. Lakhs)	% Change	average cost per MT	% Change
2001 – 02	20100		793.548		0.03948	
2002 – 03	21354	6.24	843.0559	6.24	0.03948	0
2003 – 04	22354	4.68	905.9629	7.46	0.040528	2.65
2004 – 05	20144	-9.89	805.24	-11.1	0.039963	-1.39
2005 – 06	38418.45	90.7	1516.76	88.4	0.03948	-1.21
2006 – 07	711591.64	1752	28839.69	1801	0.040528	2.65
2007 – 08	1460879.09	105	58307.23	102	0.039912	-1.52
2008 – 09	706572.15	-51.6	27914.55	-52.1	0.039507	-1.01
2009 – 10	606947.05	-14.1	28223.03	1.11	0.0465	17.7
2010 – 11	558435.78	-7.99	28647.86	1.51	0.0513	10.3
Total	4166796		184041.9		0.416678	

Table 2: Quantity and value of Pool Urea Purchased for 10 Years
Source2: NFCL Annual Reports 2002 to 2011

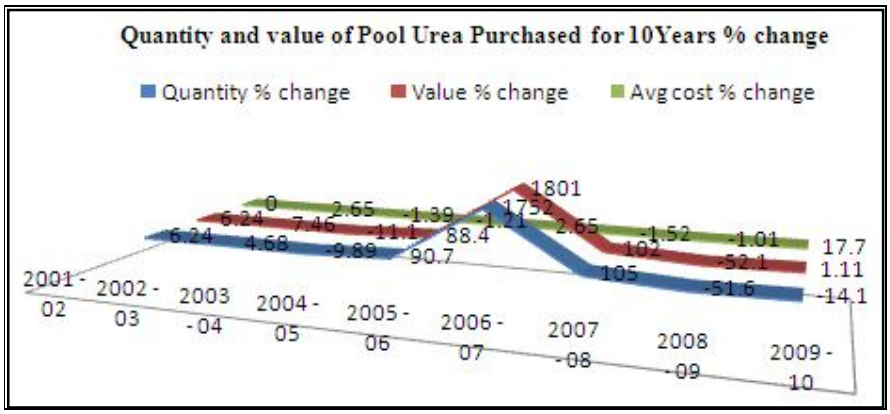

Figure 2: Quantity and value of Pool Urea Purchased for 10 Years

8.2. Interpretation

Figure 2 Presents the Quantity and value of Pool Urea Purchased for 10 Years (2001 – 2011). It shows in the years 2002 - 03, 2003 - 04, 2004 - 05, 2005 - 06, 2006 - 07, 2007 - 08, 2008 - 09, 2009 - 10 and 2010 – 11 the % change in the quantity of Pool Urea Purchased is 6.24, 4.68, -9.89, 90.7, 1752, 105, -51.6, -14.1, and -7.99 respectively. Whereas the % changes in the values of Pool Urea Purchased is 6.24, 7.46, -11.1, 88.4, 1801, 102, -52.1, 1.11, and 1.51 respectively. The reason for this unequal and irregular % changes are fluctuations in the govt. import orders. The % change in the quantity of Pool Urea Purchased in the year 2005 – 06 is 90.7, in the year 2006 – 07 it is1752, and in the year 2007 – 08 it is 105 is due to govt. estimations about the demand for urea and again in the year 2008 – 09 it is only -51.6 is due to lack of imports. The % change in the value of Pool Urea Purchased is always more or less equals to the % change in the quantity it indicates the stable value of imports.

From this study it is clear that the demand for pool urea has increased tremendously and the quantity purchased has shown down fall it indicates supply gap to meet the demand. So it is suggested that the govt. should pursue the demand and supply very keenly so that it can fill the gap between them.

Hypothesis - 2

Null hypothesis (H_0): There is no significance difference between supply and demand for pool urea
Alternative hypothesis (H_a): There is supply and demand gap for pool urea
Level of significance: 5%
Degrees of freedom (DF): 9
Calculated value: 5008722
Table value: 16.92
Decision: Reject null hypothesis
Conclusion: It's very significant that the demand for pool urea has been raised tremendously and the quantity purchases have shown down fall it indicate supply gap to meet the demand

The correlation coefficient result: Between the quantity and value of pool urea is 0.993666 shows positive correlation.

Financial Year	Electricity Purchased			Electricity own generation		
	Quantity (1000 KWH)	Value (Rs. Lakhs)	Average Cost per unit (Rs./KWH)	Quantity (1000 KWH)	Cost of gas per Unit of Power generated (Rs./KWH)	Total value (Rs.)
2001 - 02	3146.266	236.46	7.52	177032.150	0.69	123391.4
2002 - 03	2959.508	659.06	22.27	176949.356	0.77	136781.9
2003 - 04	3030.224	541.98	17.89	178917.173	0.89	159594.1
2004 - 05	2836.406	217.61	7.67	210771.800	0.81	172200.6
2005 - 06	2897.981	214.03	7.39	205476.000	0.84	172599.8
2006 - 07	3109.605	250.08	8.04	204165.000	0.87	179052.7
2007 - 08	3359.292	250.47	7.46	212111.200	0.82	173931.2
2008 - 09	3146.266	231.63	8.03	220976.000	0.82	181200.3
2009 - 10	2398.440	253.20	8.07	227647.200	1.17	266347.2
2010 - 11	2805.200	243.78	8.09	247670.000	1.51	373981.7
Total	29689.19	3098.3		2061716		1939081

Table 3: Quantity and value of Electricity Purchased an own generation for 10Years (2001 – 11)
Source3: NFCL Annual Reports 2002 to 2011

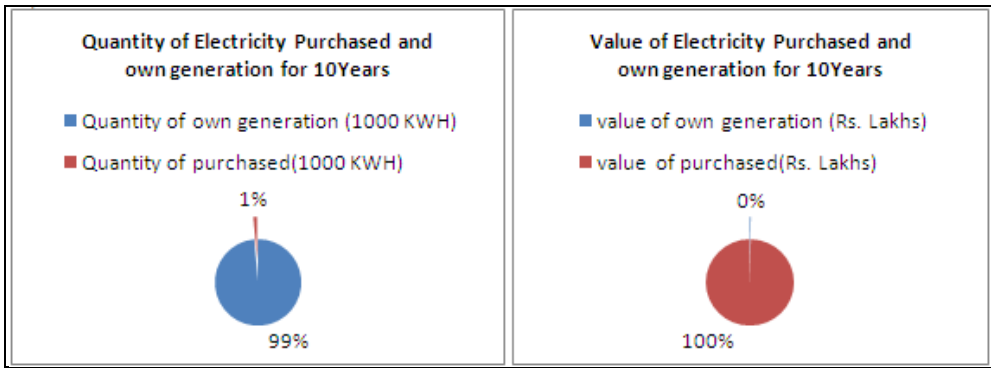

Figure 3: Quantity and value comparison of Electricity Purchased and own generation for 10Years (2001 – 11)

8.3. Interpretation

Figure3 Shows the quantity and the value comparison of electricity purchased and own generation over ten years. It shows in the quantity of total electricity 99% is in the form of own generation and only 1% is in the quantity of purchased electricity. Where as in the total value nearly 100% is the value of purchased electricity and only very negligible portion is the value of own generation. From this study it can be said that the company is paying maximum value to the less quantity of electricity purchased. So it is suggested that the investments in purchasing electricity is harvested and the same is invested to produce more by own generation.

Hypothesis - 3

Null hypothesis (H_0): There is no significance difference between values of electricity purchased and electricity by own generation
Alternative hypothesis (H_a): The company is paying maximum value to the less quantity of electricity purchased
Level of significance: 5%
Degrees of freedom (DF): 9
Calculated value: 206.734
Table value: 16.92
Decision: Reject null hypothesis
Conclusion: It's very significant that the company is paying maximum value to the less quantity of electricity purchased
The correlation coefficient result: Between the quantities of electricity purchased and own generation is -0.39181 shows negative correlation.
Between the total value of electricity purchased and own generation is -0.30548 shows negative correlation

9. Findings and Suggestions

- There is no equal, regular or gradual increase in % change of both quantity and the values of inputs.
- The demand for pool urea has increased tremendously and the quantity purchased has shown down fall. It indicates supply gap to meet the demand.
- The company is paying maximum value to the less quantity of electricity purchased.
- The average Rate per Unit of Natural Gas (Rs/1000 SM^3) is 50% more in the year 2001 to 2011.
- The inputs to the company are not in regular it plays a bottleneck in the output.

9.1. Suggestions

- It is suggested that the company should see that the % change in the value is always less than the % change of quantity of basic inputs.
- The investments in purchasing electricity is harvested and the same is invested to produce more by own generation.
- If the company can use alternative resources like solar energy and the wind energy as the company is located in the coastal region which can help the company to meet its objective of reducing the cost of power and fuel.
- If the company can source its inputs from multi suppliers it can gain cost affective supplies which results the lower costs.
- The govt. should make more Natural gas allocations to fertilizer industry so that the industry can increase its production.
- The govt. should pursue the demand and supply very keenly so that it can fill the gap.

10. Conclusion

The whole study was based on the secondary data available with the company as there is less scope of primary data and it is the limiting factor. Hence the chi square test has been used to test its significance and it was concluded that the company and the government should see that these inputs should flow consistently to meet the demand from the end user (the farmer) so that problems in inbound logistics of Supply chain management in NFCL will be solved.

10.1. Scope for Further Research

The recommended future study may be on the use of other alternatives inputs for manufacturing of urea and other fertilizers.

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