Study of supply chain of primary raw material (bauxite & alumina) of a mining company- a SAP LAP analysis

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Abstract
The paper analyse the supply chain of primary raw material (Bauxite and Alumina) of a mining company to gain a competitive edge in the industry. SAP LAP framework is used to perform this study.

Keywords: Supply chain, SAP LAP analysis, Mining Company

INTRODUCTION

Mino (name disguised for technical reason) was incorporated in the year 1965 as a Public Sector Undertaking (PSU) and since then the Company has been closely associated with the Indian Aluminium Industry, in has played a pivotal role in making Aluminium a leading metal with myriad uses**.** Alumina (Al2O3) is mainly extracted from Bauxite using Bayer Process. Alumina is also used in abrasive, ceramics and refractory industries. MINO is a partially integrated operation with its own Captive Bauxite Mines, Refinery and Smelters, producing primary Aluminium and also has 810 MW captive power plants

SUPPLY CHAIN SCENARIO AT MINO

All commodities logistics of Mino as handled is tabulated as below:-

Table 1: Logistic matrix of overall commodities handled at Mino

Sr No	Commodity	Percentage of total Commodity qty	Percentage of mode	Mode	Annual Qty Handled	Total Quantity	Average Freight/qty (in Rs)	Landed Cost (in lacs)
1	Bauxite	9%	0%	Road	0	460074	1495	6878
			100%	Rail	460074			

2	Alumina	10%	0.4%	Road	2015	502257	2213	11115
			99.6%	Rail	500242			
3	Coal	76%	24.1%	Road	952041	3954015	354	13997
			75.9%	Rail	3001974			
4	FG	3%	98%	Road	164987	168354	4337	7302
			2%	Rail	3367			
5	ALF3	0%	100%	Road	4926	4926	127	6
			0%	Rail	0			
6	HFO	0%	100%	Road	18000	18000	156	28
			0%	Rail	0			
7	LDO	0%	100%	Road	818	818	9	0.073
			0%	Rail	0			
8	CP Coke	2%	2%	Road	1913	102456	1071	1097
			98%	Rail	100544			
9	CT Pitch	0%	100%	Road	22174	22174	152	34
			0%	Rail	0			

Mode	% of total commodity qty
Rail	78%
Road	22%

Source: Logistics MIS report FY 2014-15 of the company

The above table indicates that coal is most significant commodity at Mino in terms of supply chain perspective as seen in terms percentage of overall commodity and also in terms of quantity handled and landed cost. After coal, alumina is the second most important considering the logistics cost viewpoints (see percentage commodity distribution and landed cost). Also that rail networks has emerged as most critical infrastructural element of supply chain (as seen from % of total commodity qty by rail mode) and can play a crucial role in the optimization of overall logistics in terms of time and cost. Thus a significant importance in enhancing efficiency of rail network utilization should be aimed at to reach prime objective of overall logistics cost optimization. For the transport of commodities, logistics costs are commonly in the range of 20 to 50% of their total costs (Rodrigue and Hesse, 2013)

Role of logistics cost in mino's objective of overall cost leadership

As per supply chain head of Mino in case of Aluminium this logistics cost varies from 5 to 15 % of their total cost. Mino earlier was having a 14% figure of logistics cost wrt to total cost which has now optimized to 7% (which is nearing to world benchmark).

Table 2: Logistics cost contribution to total cost in percentage /ton of aluminium as on FY 14-15

Total cost of production of Aluminum/ ton	Total Cost of raw material/ ton	Raw Material cost as % of total COP/ton	Landed Cost of Alumina & Bauxite/ton	Alumina & Bauxite cost as % of total Raw material cost/ton	Logistic cost of bauxite & alumina /ton	logistic cost as % of Bauxite & Alumina total landed cost /ton
119000	98018	82.37	44997	45.91	3145	6.99

Source: COP MIS report FY 2014-15 of the company

Thus, it can be inferred that if logistics cost can be optimized it can contribute significantly in bringing down raw material cost of aluminium thus providing total cost advantage. The major raw materials for aluminium are Coal, Bauxite, Alumina, CP coke, Aluminium fluoride etc (see table 1 above) .In the cost competitive world of aluminium producers in the world where prices are not in control the only way to have a competitive edge is competing through cost. This paper studies two significant components of raw materials i.e. bauxite and alumina using SAP LAP framework.

In the next section SAP LAP framework is briefly explained and its application to our case study is discussed.

SAP LAP FRAMEWORK

The Key Elements of the Framework are as follows (Sushil, 1997; Sushil, 2000; Sushil, 2001):

- Situation: First we analyze the present industry conditions in which a supply chain of a company is performing. It can be viewed from both structural and infrastructural elements point of view. Thus a holistic picture with all the issues due to the present state of affairs is in front of us.
- Actors: Here we see who are the main actors which play crucial role in any supply chain working in a situation analysed as above. We see from each actor's perspective and then align them all to a common objective of making the supply chain more effective and efficient that what it currently is.
- Process: Then we make an understanding of the exact process of the supply chain from a company specific point of view. After analyzing it under the situation and actors perspective and the constraints of it we can view it in a better way to further improve it
- Learning: From the above SAP we have some learning's at our hand regarding the situation, actor and process of a supply chain and the issues and/or constraints of it. This helps us making a way ahead plan with respect to the supply chain performance.
- Action: The learning's and its eventual plan leads us to suggest some actions which will actually make some difference in the existing supply chain. This is the implementation part of the framework. The right actions with proper monitoring and control leads to a lean cost effective supply chain in place.
- Performance: This is last but in no means least element in effect on the supply chain. It deals with the proper performance evaluation of the actions in terms of efficiency and effectiveness of the supply chain now in function

The SAP-LAP analysis is used to explain soft and hard issues of supply chain performance in a managerial context as applied to this case. The value of SCPMS can be augmented only when it is embedded in an organization through resource complementarily and co-specialization (Charan, 2012).

Now the raw material in the context, first Bauxite and then alumina will be analysed with this framework to achieve the goal of optimizing cost as near to the world bench mark as possible.

For bauxite supply chain

Situation

The original captive source of bauxite for MINO since its inception year 1973 were Amarkantak and PhutkaPahar mines and the reserves of these deposits were exhausted in next 30 years. Kawardha Bauxite Mines having reserve for up to 1.25 million tonne per annum has been developed since 1997. Major operations of MINO are in the town of Korba (Chhattisgarh), whereas its mines supplying high grade Bauxite are situated at Kawardha and Mainpat. The mining of bauxite is carried out by opencast method. To achieve annual 12.5 Lac ton mining & transportation from Kawardha mines, monthly target should be between 1 Lacs ton to 1.25 lacs ton (Indian Minerals Yearbook, 2013).

The scope of transportation being provided by the Logistic Service Provider (LSP) includes transportation by road of Bauxite to Mino from its Mines Located at Kawardha Chhattisgarh, India to various Railway Siding i.e., Tilda, Silyari and Hatband. And also direct from Mines to our group company at Lanjigarh Orissa.

Actors

The principle actors in the supply chain of Bauxite are:-

- The Company itself i.e. Bharat Aluminium Co ltd (MINO)
- Indian Railways (South Eastern Central Railway)
- Transport Unions/associations
- Logistic Service Provider
- Local government authorities

All the above actors play their respective roles in collectively contributing towards landing of bauxite at Mino works. Apart from company itself and its hands like LSP, the SECR and the government authorities are most important actors as they are independent authorities. Other crucial actors are the truck associations/unions which play a critical role in execution of smooth supply chain and are also not directly involved in Mino's vision.

Process

The process majorly involves activities like Loading of material in to trucks at Mines Site, Transportation from mines to Railway Sidings, Stacking at the railway siding, Maintenance of the railway siding including concreting of Siding & sprinkling of water at siding, Co-ordination with Mining Officers for arranging forwarding note and Railway Transit Pass, Co-

ordination with Railway for timely placement of indents and other necessary activities, Loading into Railway wagons, Forwarding of cargo to railway siding with correct quantity and quality as specified at the time of loading, and All mining related documentation and coordination.

The process involves smooth coordination and alignment in terms of understanding and delivery among all the participating actors for a smooth supply chain. There are many intricacies in the structural and infrastructural elements of the process such as approval delays from Government authorities, truck union issues and the current road network or the contract agencies terms of contracts. A smooth alignment and cohesion is imperative in the process to achieve the objective.

Learning

The learnings from the SAP are as follows:

- Distance between Mines & Railway siding: Kawardha mines to railway siding are around 150 to 170 Kms away. It makes the dependency on local truck owners who have a truck union with around 250 to 270 trucks & the transportation is done by union trucks only.
- Bad Road Condition: The mines are situated at the hill of Kawardha& the road condition is also in bad shape for approx of 40 Km. As per mining law Mino has to mine & shift bauxite 12.5 lacs annually & production carry forward agents are also not allowed in any circumstances.
- Political Scenario: Kawardha is also the home town of Chief Minister of Chhattisgarh, because of this reason, the district administration is alert in maintaining law & order at Kawardha.
- Demand & Supply Gap: To lift 1 lac ton bauxite from mines in a month, nearly 210 numbers of trucks are required on daily basis. Sometime union are able to provide required number of trucks as per daily demand, but most of the time they will not provide the trucks as per demand due to their personal interest like taking higher profit in the transportation of sugar cane, construction sand delivery & paddy transportation.
- Priorities & conflict of interest: The truck union are not allowing any outside trucks for bauxite transportation at that period also, when they were engaged there trucks in some other business.

Actions Recommended

Keeping in view of current dynamics and supply chain environments some actions recommended are as: Identifies the alternate of truck transportation, through conveyor belt system, Mino to purchase trucks themselves& place for bauxite transportation, Mino to import alumina shortfall from other countries, and Mino shell takes the supports of local administration to induct outside trucks in the circuit.

Performance

The performance measurement criterion is the uninterrupted production receipt of required demand at the Mino works. The annual requirement is 12.5 lac ton which can only be met if daily requirement of 275 approx trucks are deployed and the continuity is maintained. Thus the issues with the truck owners and association should be strategically dealt to ensure the

same. This only can make the bauxite supply efficient and keep the logistic cost under 7% of total raw material landed cost.

For Alumina Supply Chain

Situation

The existing installed capacity at korba smelter complex comes out to be 4.75 lac ton per annum. The monthly requirement comes to be 0.39 lac ton or 40000 ton approx. This monthly requirement is met by sourcing alumina in two ways, one is imported and other is procured indigenously or sourced from own alumina Refinery at Langigarh, Orissa, India. The two modes of transport used for alumina logistics from source to destination are through Rail and Road. Earlier the ratio of rail to road was 50:50 which now is almost 100% through rail (refer Table 1). This is strategically achieved over the years as it brings down the logistics cost per ton of alumina, to achieve its contribution by cost optimization to 7% of raw material total cost. The different transport vehicles used are as follows: Through Road-Trucks, Through Road-Bulker, Through Rail-N Box Railway Wagons and Through Rail- BTAP Wagons

Table 3: Freight comparison per ton of Alumina by deferent modes of transport used

Particulars	NBOX	BTAP	Bulker (Road distance 900 Km)	Truck (Road distance 900 Km)	FrtVar rake vs btap (in Rs/T)	FrtVar Bulker vs btap (in Rs/T)
Freight from KSPL-Mino (Rs)	6274768	3759700	3400	3600	1338.56	1485
Bag transportation cost of 1 MT (Rs)	42667	0	200	200		
Rake handling cost at KSPL	1200000	1220920	0			
BTAP Punitive charges	0	99560	0			
BTAP shunting charges	0	60260	0			
BTAP Escorting & sealing charges	0	18340	0			
BTAP ROH+ Trip Charge+etc	0	309160	0			
Unloading at Mino	432000	73360	0			
Railway User charges to KSPL as applicable (Rs. 1,680-00 per 8 wheeler wagon)	99120	0	0			

Godown rent	240000	0	Fixed cost of 10 Lakh/month	Fixed cost of 10 Lakh/month		
Total (Rs)	8288555	5541300	3600	3800		
Rake loadability	2400	2620	26 MT per Bulker	22 MT per Truck		
Frt per ton (Rs/T)	3453.56	2115	3600	3800		
* Considering 2400 MT alumina bag loadability in BOXN rake						
* Monthly godown rent is 10 Lacs, considering Rs 100 on per ton of alumina & total 10 KT lifting thru BOXN Rake						
* Very poor availability of trucks/ bulker for kspl-Mino. Whole quantity can't be shift thru road.						

Source: Logistics Database of the company

The above table clearly indicates that the freight per ton of alumina is least through rail and also through BTAP railway wagons. Thus the situation demands to change the multimodal sourcing model to a single mode one. This also increases the better materialization i.e. utilization of the material through reduced losses in transit as in case of road. Also more volume of alumina can be transported with this mode.

The different sources from which alumina is shipped to single destination i.e. Mino's smelter at Korba are Imported alumina (shipped from Australia) from four ports of India (Paradip Port, Orissa; Vishakapatnam port, AP; Kakinada Port, AP; Gangavaram Port, AP) and Domestic Alumina (Refinery at Langigarh,Orissa)

Actors

The prominent members of the supply chain of alumina are as below:-

1. Mino, the company itself
2. Alumina refinery at Langigarh
3. South Eastern Central Railway (SECL)
4. Various ports and authorities
5. Cargo Handling Agents (CHA)
6. Material Handling Contractors

All the above actors play their respective roles in collectively contributing towards landing of alumina at Mino works. Apart from company itself and its hands like CHA, the SECR and the port authorities are most important actors as they are independent authorities and are not directly involved in Mino's vision. Other crucial actors are the material handling contractors both at Mino and at the ports who play a critical role in execution of smooth supply chain and are also not directly involved in Mino's vision.

Process

The Process involves ordering of annual contracts to import sources as well as our own domestic refinery at Langigarh. The ratio is now almost 100% import as there is no supply available from domestic refinery due to non-accordance of mining and operational licence from

MOEF, Government of India (2015). A monthly planner is made and followed which comes out from the annual quantities ordered and the mode through which it is transported as well as expected time of delivery is indicated. The import quantities are shipped to various ports of India viz. Vishakapatnam, Kakinada, Gangavaram and from there it is loaded into BTAP railway wagons and then sent to unloading station at Mino plant Korba.

Learning

Earlier there were four modes of transport earlier to bring alumina from sources to destination like Trucks, Bulkers, N Box Railway wagons and BTAP wagons.

As per the freight/ton suitability, it was observed that it is least for BTAP Wagons (refer table 3). So as operation strategy move from the year 2010 to 2014 now almost all alumina is being transported through BTAP wagons. The number of BTAP wagons is increased from 3 in the year 2010 to 7 now at the end of year 2014. This not only gives the cost advantage in terms of freight but also the fly loss, material wastage loss is reduced substantially to contribute to optimize the overall logistics cost.

Also another critical learning is that currently they are using three ports and the distance from the port to Mino plant is substantially high (858 km) and also it is a high congestion route. We can optimize on this aspect to realign the current supply chain for better cost effectiveness and resource utilization.

Actions implemented

The action implemented are as follows: The multimodal supply chain for alumina is now changed to single mode that is BTAP wagons, The no of BTAP rakes have been increased to 7 to cater complete current alumina handling requirements, and a monthly planner is in place and the process is monitored much more efficiently as there is a single mode of transportation to track.

Performance

The key performance improvement observed are as follows: The on time delivery of daily to monthly alumina quantities at Mino plant, The quality of the alumina received at plant, The quantity losses like fly losses while loading unloading BTAP wagons etc., The logistic cost per ton of alumina, The smoothness of the supply chain in terms of 100% efficiency and The total turnaround time (TAT) of BTAP wagons to ensure efficient materialisation

Table.4 Actual TAT achieved against the target TAT

COMMODITY	Origin	Destination	Unit	TAT Target	Average TAT achieved
Alumina	Port-KSPL/VPT/GPL	Mino Railway Siding	Days	8	10
	VAL Langigarh	Mino Railway Siding	Days	6	10.5

(Source: Logistics MIS 14-15 of the company)

MANAGERIAL IMPLICATIONS

The above SAP LAP analysis has led to some managerial implications that are vital in making an improvement plan for current supply chain of alumina. Major out of them from operation strategy perspective are as under:-

Demurrage

This is understood as financial penalty imposed for violating the mutually agreed time frame between the parties in a contract. As three ports are receiving our annual alumina quantities we are incurring demurrages due to unavailability of timely allocation of birth (port space) due to huge congestion at these ports. Thus our shipment has to wait in the waters and its causing loss of money in terms of demurrage incurred. The reasons for the demurrage is as follows: *High overall freight*-As the rail distance from the ports to Mino is more than 800 kms thus higher freight is incurred (as fright is charged per Km). This becomes a concern from a logistic cost point of view; and *High Turn Around Time (TAT)*- As the above rail route is highly congested and this leads to higher turnaround time of the alumina rakes (ref Table 5 above). This leads to poor asset utilization and we are ending up with higher capital cost.

CONCLUSION AND RECOMMENDATIONS

The above analysis has led to conclusion that the current supply chain is lagging in some strategic areas and some corrections/adjustments are required through which logistic cost can be optimized to contribute to the overall cost of production thereby providing a competitive edge. The concluding points, recommendations are as follows:- The current ports in operation can be shifted from Vishakapatnam ,Andhra Pradesh to Paradip, Orissa. As this will a single port and has sufficient capacity and infrastructure to handle the quantity requirements and the most importantly it is 280 km less in overall distance. It is proposed to procure 2 set (106 wagons) of BTAP rakes with 2 BVZI wagons (Breakeven) for Alumina Handling.

This will help to meet Alumina transportation in confined vessels through railways for ensuring lowest cost and no contamination during transportation. The estimate of project cost is 4.30 Crore. BTAP wagons has been found to be the best mode of alumina transportation considering having benefits like: Lowest logistics cost and handling cost-Logistics cost is lower by Rs. 1583 per MT for alumina transfer by BTAP wagon as compared to N-Box; Zero contamination of alumina during transportation-Zero contamination leading to increase in % of export pots from 53 %(FY 2010-11) to 98 % (FY 2014-15), Reduced spillage leading to controlled alumina specific consumption - Alumina specific consumption when alumina was transported in bags in Smelter Plant 2 was 1.964 mt/mt, and when transported in BTAP is 1.925 mt/mt; and Impact on Headcount :-Prevention of requirement of 316 man-days/month (if alumina is received in N-Box wagons). The Payback calculation of the proposed procurement is given below:

Table 5: Payback calculation of proposed procurement

Parameters		Unit	Reference
Loss due to spillage in handling of alumina in bags	52.78	MT	Considering the difference in specific consumption from 1.964 to 1.925

			(2.03% loss)
Cost of loss of alumina	12,49,890	₹	Considering present cost of Alumina (₹ 23681.13/MT)
Freight (railway+bags+loading and unloading) for Nbox	3,066	₹/MT	
Freight for BTAP	1,483	₹/MT	Considering the average freight of BTAP from VAL and Vizag in Dec'13 and Jan'14
Freight difference	1,583	₹/MT	
Freight Cost difference per trip	41,15,800	₹/trip	Considering 2600 MT/trip
Total difference per trip	53,65,690	₹/trip	
Cost of 2 BTAP rake	40,30,00,000	₹	
Payback in terms of no. of trips	75		
Average trips per month	3.6		Average no. of trips from VAL(4.6 trips) and Kakinada(3.5 trips), considering availability as 89.16%
Payback period (months)	21		

Source: Capex approval 2014-15 of the company

Thus, the above two major strategic decisions will lead to a much more efficient supply chain of the primary raw materials of Mino i.e Bauxite and Alumina both in terms of cost and utilization.

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