Cement Industry Value Delivery Network-A Blueprint For Networking The Flow of Material, Information, and Cash.

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INTRODUCTION

Cement is a key infrastructure industry. It had been decontrolled from price and distribution on 1st March, 1989 and delicensed on 25th July, 1991. However, the performance of the industry and prices of cement are monitored regularly. Today, the Indian cement industry comprises of over 130 large cement plants with an installed capacity of 160.24 million tons and more than 365 mini cement plants with an estimated capacity of 11.10 million tons per annum as per CMA (Cement Manufacturers Association of India) report published on 31st March, 2006. Apart from meeting the entire domestic demand, the industry is also exporting cement and clinker to neighboring countries like Bangladesh and Nepal. The export of cement during 2001-02 and 2003-04 was 5.14 million tons and 6.92 million tons respectively. Export during April-May, 2003 was1.35million tonnes.

The Indian cement Industry is on a drive. Driven by a booming housing sector, global demand and increased activity in infrastructure development such as state and national highways, the cement industry has positioned itself, ramping up production capacity, attracting the top cement companies in the world, and has also witnessed a theory of mergers and acquisitions.

The recent boom in the housing and construction industry in India has worked wonders for cement manufacturing companies with capacity utilization crossing the 100 percent mark for the first time in January 2007 as per relevant source (CMA). According to Cement Manufacturers Association (CMA), the average monthly capacity utilization during fiscal 2006-07 was 94 per cent. Also, cement dispatches for the recently concluded fiscal was at an all-time high of 155 million tons, up from 142 million tons in the previous fiscal, thereby recording a growth of 10 per cent. But the ride is not smooth here. Like climax in every Indian movie, serious challenges and problems have plagued the cement industry. The problems are :shortage of wagon supply, poor road, lack of uniformity in tax in India (implementation of VAT in phase wise).However, these variables are common to all the players and require combined efforts from both the government and companies' side to overcome them. The scope of the paper is to highlight how one of the players, in spite of all these constraints (being India's largest cement producers having national presence) has redefined its value delivery network by restructuring the organization and defining Plant to Market(P2M) connectivity, taking market parameters and logistics consideration into account. This exercise carried out during 2006-2007 has shown tremendous savings which not only serves as a benchmark for other cement players in India but also for other industries having similar issues.

RESEARCH BACKGROUND

The cement industry in India was in its growth trajectory over the past seven years. Domestic cement demand growth had surpassed the economic growth rate of the country for the past couple of years. The growth rate of cement demand over the past five years at 8.37% was higher than the rate of growth of supply at 4.84% as also the rate of growth of capacity addition during the same period. Demand for cement in the country is expected to continue its buoyant ride on the back of robust economic growth and infrastructure development in the country. The key drivers for cement demand are real estate sector, infrastructure projects, and industrial expansion projects. Among these, real estate sector is the key driver and accounted for almost 55% of the cement demand in FY 07.During the period FY 03 - 07, capacity additions in the country (30.6 mn tonnes) were at a slower rate compared to demand growth leading to higher average capacity utilization rates from 81.3% to 93.8% during the same period. This has exerted pressure on average prices which have increased from Rs. 156 per bag in FY 03 to Rs. 216 per bag in FY 07. In December 2007, prices stood at Rs. 245 - Rs. 250 per bag.But the situation took a serious turn and the real estate has suffered a major set back due to economic recession which resulted in sudden decline in cement prices. A few months back, each bag of cement was sold at Rs.250 per bag, now the

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price of the same bag has come down to Rs.180, which is comparable to that of FY 02-03, but over the years, the wages have doubled and rail freight has gone extremely high. Now, a major concern for the cement manufacturers is to sustain competitive advantage and improve profit margin. The major challenges in front of these players are:

- Undefined value chain (the value chain activities such as sourcing/procurement, inbound logistics, operations, outbound logistics, sales & marketing and service after sales).
- In more than 60% (as CMA report) of the existing cement players, sales and marketing departments look after outbound logistics which are concerned with the movements as per sales requirement without looking into the equation- that from which source and by which mode of transportation finished cement should be delivered.
- The movement of finished product from plant to market is based on partially defined concept (minimum logistics cost).Sometimes, a plant situated at the farthest distance has a higher contribution than a plant located at the shortest distance.
- The options of big trucks are not fully leveraged (lower per ton per kilometers than small trucks).
- The footprints of warehouses were not redefined over long periods resulting in too many warehouses that led to increase in total delivered cost (TDC).
- The milk run model is not fully leveraged, resulting in poor freight negotiation. Thus to negotiate for lower road freight milk run, options have to be explored which utilizes large size fleets with sufficient orders.
- Lack of proper coordination between Logistics, marketing and production results in high inventory, high lead time & stock out during peak season.
- In the paper, the researcher will try to come up with a strategic framework for the cement industry so that the generic problems can be addressed, which will not only lower the logistic component, but will position the sector on a global map.

LITERATURE REVIEW

Literature review, in similar direction of several research papers reveals that more and more corporations are extensively using mathematical-programming models and algorithms to support their supply chain decisions. A survey conducted in United States by Ballou and Masters (1993) suggests that 51 percent of the companies responding used commercial software in choosing their network design. Goetsachalckx (1997) reviewed strategic models for planning global distribution and production and concluded that incorporating all the factors in global supply chain design problems was difficult.Arntzen et al (1995), for example, describes supply chain models that minimize the cost and delivery lead time for the Digital Equipment Corporation subject to meeting demand. Similarly, Bradstrom et al (2004) and Ronnqvist (2003) reported on Optimization of tactical and operational planning in the forestry industry. Larry and Michael (2007) have shown how to design large -scale supply chain using Linear Programming in spreadsheets. The objective of literature review is to test the uniqueness of the methodology employed by the company to redesign the value delivery network, and savings realized by the company through this exercise. However, these works not only provide a platform but also show how optimization exercise is a key to define competitiveness of Indian firms. Now definitely, a question arises in the mind of readers, that why one should optimize their value delivery network or its supply chain and when. To answer these questions, a firm first understands that the supply chain of their firm is as per their product requirements; thus further review of interesting work by Fisher (97) provides a framework that defines the nature of a product and the existing supply chain or value delivery network has any match with the nature of the product. Thus, further review of "What is right supply chain for your product?" provides further insight in this direction. Before we proceed ahead, let's understand what is Fisher (97) framework?

Fisher (1997) proposed a framework for selecting supply chain for a product. According to this framework, the product- whether the product is innovative or functional, and depending upon this nature, the right supply chain is selected.

Fisher (1997) recommends that the features of product demand define whether the product is functional or innovative. The aspects of demand to be considered are:

- 1)Demand predictability • 2)Life cycle • 3)Product variety and lead time • 4)Service requirements

These factors determine the availability and inventory needs to meet demand. Based on these factors, the products can be categorized as either functional or innovative. There are two types of supply chains to be selected. For

functional products, an efficient supply chain that focuses on delivering products at lowest possible cost to customers should be developed. Selection of vendors like CFA's, transporters should be selected to gain low-cost solutions. However, in case of innovative products where demand predictability is very uncertain, the supply chain that suits the innovative products is responsive and hence very flexible. Thus, focus of this supply chain is not the cost but the speed and time that determine the design of the supply chain.

COMPANY

ACC (ACC Limited) is India's foremost manufacturer of cement and concrete. ACC's operations are spread throughout the country with 14 modern cement factories, 19 ready mix concrete plants, 19 sales offices, and several zonal offices. It has a workforce of about 9000 persons and a countrywide distribution network of over 9,000 dealers. ACC's research and development facility has a unique track record of innovative research, product development and specialized consultancy services. Since its inception in 1936, the company has been a trendsetter and important benchmark for the cement industry in respect of its production, marketing and personnel management processes. Its commitment to environment-friendliness, its high ethical standards in business dealings and its on-going efforts in community welfare programmes have won it acclaim as a responsible corporate citizen. ACC has made significant contributions to the nation building process by way of quality products, services and sharing its expertise.

In the 70 years of its existence, ACC has been a pioneer in the manufacturing of cement and concrete and a trendsetter in many areas of cement and concrete technology including improvements in raw material utilizations, process improvement, energy conservation and development of high performance concretes.

ACC's brand name is synonymous with cement and enjoys a high level of equity in the Indian market. It is the only cement company that figures on the list of Consumer Super Brands of India.

The company's various businesses are supported by a powerful, in-house research and technology backup facility - the only one of its kind in the Indian cement industry. This ensures not just consistency in product quality but also continuous improvements in products, processes, and application areas.

ACC has a rich experience in mining, being the largest user of limestone, and it is also one of the principal users of coal. As the largest cement producer in India, it is one of the biggest customers of the Indian Railways, and the foremost user of the road transport network services for inward and outward movement of materials and products. ACC has also extended its services overseas to the Middle East, Africa, and South America, where it has provided technical and managerial consultancy to a variety of consumers, and also helps in the operation and maintenance of cement plants abroad.

ACC is among the first companies in India to include commitment to environmental protection as one of its corporate objectives, long before pollution control laws came into existence. The company installed pollution control equipment and high efficiency sophisticated electrostatic precipitators for cement kilns, raw mills, coal mills, power plants and coolers as far back as 1966. Every factory has state-of-the art pollution control equipment and devices.

ACC demonstrates the practices of being a good corporate citizen undertaking a wide range of activities to improve the living conditions of the under-privileged classes living near its factories. After Holcim became its strategic partner, they took several measures to shape the company into a truly global company and the most important of such measures; they took optimization exercise across India to redefine the existing value delivery network. Here in this case, the researcher will focus on one such exercise carried out in Eastern part of the company.

SCENARIO OF ACC LIMITED BEFORE OPTIMIZATION

- Historically evolved warehouses footprint to meet the needs of the immediate geography-mushrooming of warehouses in the state with widely varying volumes and sizes.
- Direct firing option from the plant not leveraged to the fullest to optimize primary and secondary freight.
- Large buffers set up by way of warehouse stocks/option to serve the market requirements in case of slippages in deliveries by the plant.
- No institutionalized mechanism for identifying and adherence to the optimal routes (L1 and L2) for each destination/block.
- Lack of a system to identify the most optimum plant to source the requirements of each district-Instances of sub-optimal plants supplying to long-haul districts.

APPROACH TO OPTIMIZATION (METHODOLOGY USED)

- Developed destination-wise route optimization model based on latest Total Distribution Cost (TDC).
- Identified district clusters with common logistics/market characteristics and developed specific hypotheses to reduce TDC.
- Held brainstorming sessions with sales and logistics team to validate hypotheses and identify potential new routes to market.
- Determined optimal routes to market for each district-two routes identified for each destination.
- -L1 (most preferred route).
- -L2 (Next best alternative).
- Designed revised outbound footprint, taking into account feasibility/transportation limitations.

INTRODUCTION TO OPTIMIZATION

A network optimization model is developed for all destinations from existing sources which is simple LP model popularly known as transportation model assuming that entire cement will be sold as per production capacity and demand of each destination should be met fully. For example, here, a network model has been developed showing supply region (source) and destinations. For example:

TABLE 1: TRANSPORTATION MODEL

Sources	D1	D2	D3	D4	Capacity
S1	C11	C12	C13	C14	X1
S2	C21	C22	C33	C34	X2
S3	C31	C32	C33	C34	X3
S4	C41	C42	C43	C44	X4
Demand	D1	D2	D3	D4	

Here S1, S2, S3 & S4 represent different sources where as D1, D2; D3& D4 represent various destinations. The basic assumption has been taken, $\sum$ (S1+S2+S3+S4) = $\sum$ (D1+D2+D3+D4). Here Table 1 refers to balanced transportation problem and the cell of matrix shows cost of transportation represented as C11, C12, C13...

In this case, the objective of the problem is Total cost of transportation, with given constraints that decision variables (the quantity to be transported from a given source to a given destination) should be greater or equal to zero and the capacity of each plant should be satisfied at the same time and the capacity should be met fully. Here, the concerned company, instead of minimizing Total Delivered Cost (TDC), employed broader view that takes entire component into account, i.e. maximizing contribution.

Here contribution is defined as:

Contribution=Price-Cost to serve….. (1)

Where Cost to Serve= (Total delivered Cost+Excise+Tax+Packagingcharge+ VCOGS[1]).

TDC (Total delivered cost) =

PFT[2]+CFA[3]+Secondary freight..…… (2)

If one looks into the equation then, it is quite evident that maximizing contribution makes more sense than minimizing only total delivered cost(TDC) because price is an external factor, hence the company cannot change. However, contribution will get maximized if the TDC and VCOGS both gets minimized; thus, the optimization exercise has taken care of optimizing not only the outbound movement but also the concerned operation and outbound movement, thus justifying the integration of production and distribution(Chandra and Fisher, 1994) to improve efficiency and effectiveness.

THE PREMIUM SOLVER TOOL GIVES THE RESULT, WHICH ANSWERS THE FOLLOWING CONCERNED QUESTIONS

- What transportation options are available?
- Which is the most cost effective option at the required time period?
- What option ensures safety and quality of goods?
- And to some extent, what route would it follow?

[1]VCOGS=Variable Cost of Good Solds.
[2]PFT=Primary Freight
[3]CFA=Carrying & Forwarding Agent.

TABLE 2 : KEY SUPPLY CHAIN LEVERS HAVE BEEN IDENTIFIED FOR THIS EXERCISE

Source of supply	Warehouse footprint	Transportation mode	Shipment size	Transportation rates	Location of Packaging
Works	Close warehouses	Rail	6 wheeler trucks	Rationalize transporter base	Current ACC plant
5 plants	Combine/Relocate existing warehouses	Road	10 wheeler trucks	Renegotiate freight costs	New grinding packaging plant
Warehouse			Trailers/larger trucks	Exploit backhaul opportunities	

The table 2 shows the key supply chain levers that have been identified for Optimization.
In simple words, key decisions that have to be taken are:

- Which mode of transportation has to be used - rail or road? A clear demarcation has to be established that which road based markets or which rail based markets are fed using combination of rail and road?
- Is it important to have warehouses in road based market? Which warehouses are to be closed?
- In case the mode of transportation used is road, whether a truck of large size/small size has to be used; why not a trailer/Volvo is used instead?

What about packaging unit? If then, what are the locations that can be identified?

OPTIMIZATION RESULTS OBTAINED

FOR CEMENT (FINISHED GOODS)

Results of pan-region optimization with marketing and logistics constraints are given below:

PRE-PAN REGION OPTIMIZATION

TABLE 3 : PLANT- STATE PSC (PORTLAND SLAG CEMENT) VOLUMES ('000 TONS) AS PER 2007 BUDGET

State	Bargarh	Chaibasa	Damodar	Jamul	Sindri	Total
Bihar	-	119	-	155	572	846
Chhattisgarh	-	-	-	420	-	420
Jharkhand	-	352	-	15	295	662
Orissa	810	37	-	41	-	888
West Bengal	82	21	505	681	-	1289
North East	-	-	-	13	2	15
Total	**892**	**529**	**505**	**1325**	**869**	**4120**

Table.3 shows that how allocation has been made from plants to the given market as per given budget of year 2007 by simply allocating budget on the basis of expert judgment.

TABLE 4 : POST-PAN REGION OPTIMIZATION

State	Bargarh	Chaibasa	Damodar	Jamul	Sindri	Total
Bihar	-	182	-	159	505	846
Chhattisgarh	-	-	-	420	-	420
Jharkhand		267	-	-	395	662
Orissa	647	99	-	141	-	887
West Bengal	-	44	505	740	-	1289
North East	-	-	-	15	-	15
Total	**647**	**592**	**505**	**1475**	**900**	**4119**

Table. 4 shows that how optimization yields different results.

TABLE 5 : VARIATION IN VOLUME ALLOCATED FOR EACH PLANT BASED ON OPTIMIZATION

PSC capacity	Bargarh	Chaibasa	Damodar	Jamul	Sindri
Pre-optimization	892	602	505	1584	900
Post-optimization	892	602	505	1584	900

TABLE 6 : CHANGE IN VARIABLES AFTER OPTIMIZATION

	Pre-Optimization	Post-Optimization
Unit VCOGS	1113(Rs/mt)	1104(Rs/mt)
Unit TDC	645(Rs/mt)	615(Rs/mt)
Unit Sales Tax	387(Rs/mt)	387(Rs/mt)

Source: Derived from ACC Financial Report, the figure is likely to change depending upon external and internal factors.

Table.6 shows how the variables have changed after optimization.

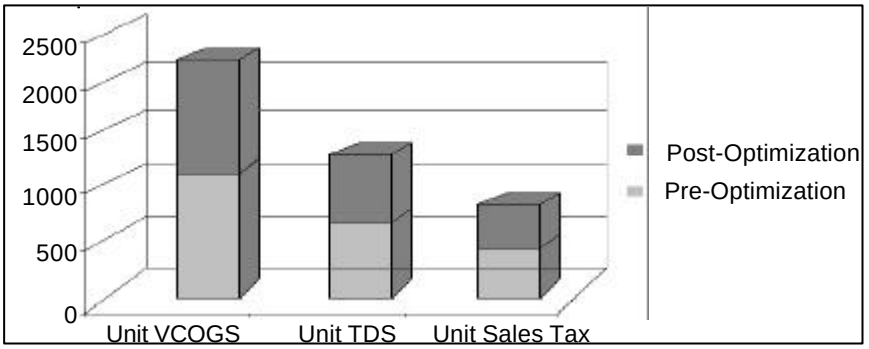

FIG. 1: SHOWS GRAPHICAL ANALYSIS OF VCOGS, TDC, UNIT SALES TAX OF PRE AND POST OPTIMIZATION STAGE.

Target increase in contribution by ~Rs.16 crore based on Budget if 100% implementation is achieved.

Plant-wise PSC recommended movement-2007 Budget (Form 15A) volume:

Parameters\Plant	Bargarh	Chaibasa	Damodar	Jamul	Sindri

TABLE 7 : PRE -OPTIMIZATION VOLUME BY TRANSPORT MODE (2007, '000 TONS)

Road	408(46%)	170(32%)	428(85%)	388(29%)	235(27%)
Rail	484(54%)	358(68%)	77(15%)	937(71%)	634(73%)

Table.5

TABLE 8 : POST OPTIMIZATION VOLUME BY TRANSPORT MODE (2007,'000 TONS)

Road	239(37%)	259(44%)	325(64%)	369(25%)	281(31%)
Rail	408(63%)	333(56%)	180(36%)	1106(75%)	619(69%)

Table.6

PRE OPTIMIZATION VOLUME

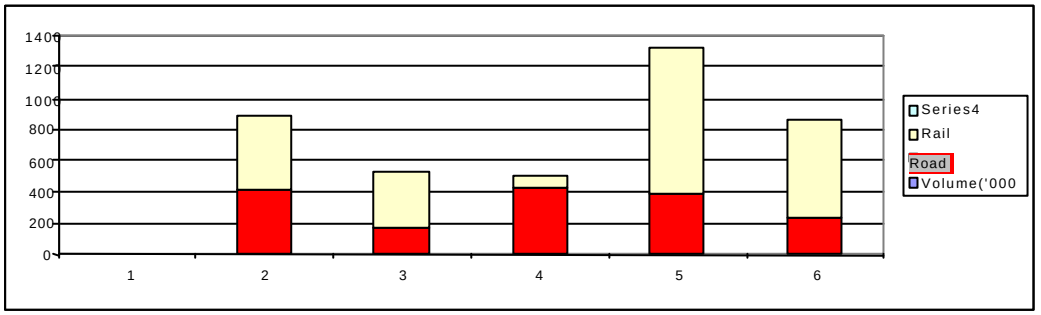

FIG. 2 : SHOWS GRAPHICAL ANALYSIS SHOWING RAIL VS. ROAD (REFER TABLE. 5)

POST OPTIMIZATION VOLUME

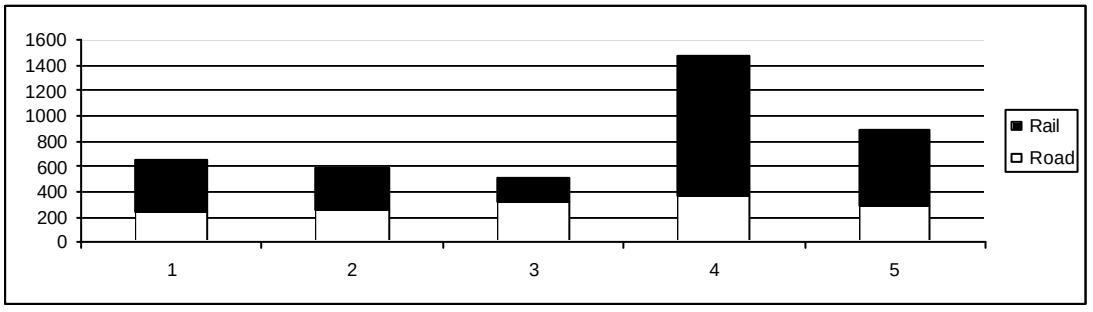

FIG. 3 : SHOWS GRAPHICAL ANALYSIS SHOWING RAIL VS. ROAD (REFER TABLE.6)

WAREHOUSE SERVING EACH STATE

	Bihar	Chattisgarh	Jharkhand	Orissa	WB
Current footprint	18	1	6	17	12
Recommended footprint	19	1	6	16	8

TABLE.9 : ON THE BASIS OF THE RESULT OBTAINED THROUGH OPTIMIZATION EXERCISE, THE EXISTING WAREHOUSE FOOTPRINTS WERE REDESIGNED.

TABLE 10 : POTENTIAL SAVINGS REALIZED

	Invisible	Total
Savings with logistics / marketing constraints	0	16.1
Potential additional savings from WB	16.1	3
Potential additional savings from Orissa	19.1	1.3
Potential additional savings from Jharkhand	20.4	0.6
Total potential savings	0	21

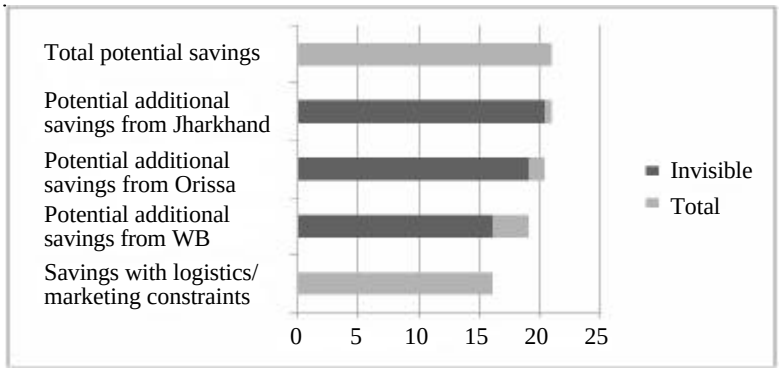

FIG. 4 : BENEFIT FIGURE HAS BEEN ARRIVED AFTER TAKING SEVERAL MARKETING AND LOGISTICS CONSTRAINTS.

KEY CONSIDERATIONS TAKEN

Benefits figures derived taking logistics/marketing constraints in W.B, Orissa &Jharkhand.

Key issues to be addressed (invisible benefits):

- Availability of trucks at Damodar is a major constraint. • Maximum % of road dispatches from Damodar (W.B plant) is 65-70%. • Non trade government volumes can only be supplied by Bargarh, state based plant.
- Close down some warehouses in Orissa and W.B.

The finalized clinker movement plan reduces the net freight costs by Rs. 26/ ton for the total clinker movement of 1,790,000 tons:

'000 tons	Bargarh	Chaibasa	Jamul	Bhatapara	Clinker Ground	Storage space	Opening Stock		Closing Stock	
Clinker Production	788	1,201	805	1,225						
Self consumption	5951	502	728	530	kTons	kTons	kTons	Days	kTons	Days
Damodar	-	-	89	194	276	33	20	12	26	17
Sindri	-	428	-	-	416	100	29	13	42	17
Sankrail	158	305	-	232	691	25	20	6	24	8

ACC to Ambuja movement	565,000 tons	Total movement : 1,790,000 tons Net ACC to Ambuja movement: 371,000 tons
Ambuja to ACC movement	194,000 tons	
Freight per ton - ACC	Rs. 372/ ton	Total freight spends: Rs. 88.1 cr. (ACC- Rs. 26.5 cr., Ambuja -Rs. 61.6 cr.)
Freight per ton - Ambuja	Rs. 571/ ton	

TAB. 11 : SHOWING THE CLINKER (CHIEF RAW MATERIAL OBTAINED THROUGH HEATING A MIXTURE OF LIME STONE AND GYPSUM AT HIGH TEMPERATURE) AFTER OPTIMIZATION.

Source: Author's original work based on survey conducted in ACC and derivation based on his observation.

This plan leads to optimum clinker movement to minimize the per ton cost of clinker freight for 2007 - after considering the quality and tax constraints, the storage norms and the clinker stock requirements.
The specific objective of outbound integration is to reduce total cost-to-serve by leveraging production capacities across ACC and Ambuja for key markets:

FIG. 5 : EASTERN REGION MAP SHOWING ACC AND AMBUJA CEMENT MANUFACTURING UNITS FOOTPRINTS.
Source: Author's original work.
Here, Sankrail and Bhattapara are Ambuja Cement manufacturing units and rest are ACC manufacturing plants.

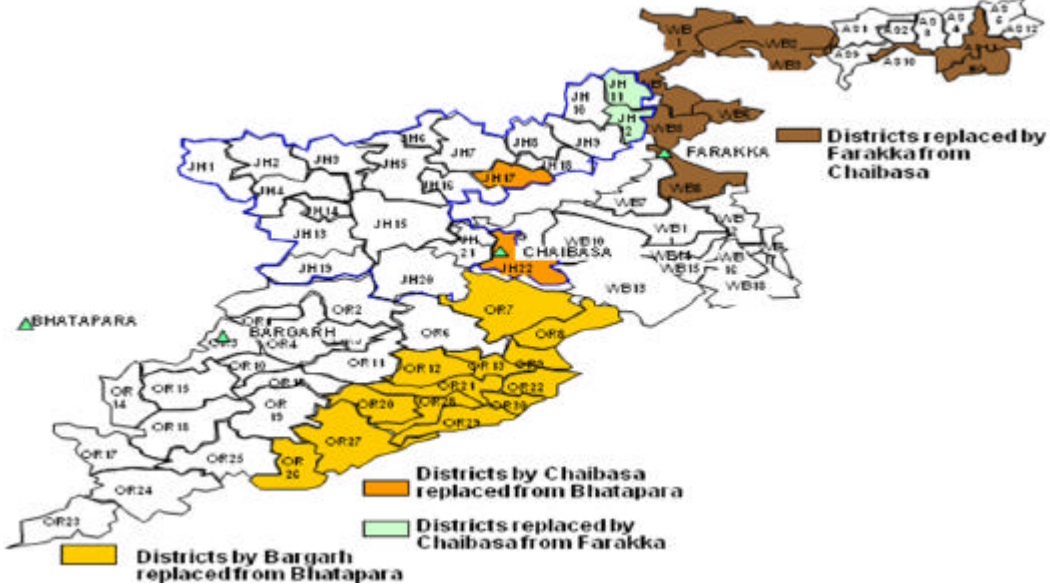

FIG. 6 : SHOWS HOW ORISSA MARKET IS NOW AFTER OPTIMIZATION. THE MARKET IS SHARED BETWEEN AMBUJA AND ACC, WHICH IS A CLASSIC EXAMPLE OF COLLABORATION TO ACHIEVE LOGISTICAL EXCELLENCE.

PROPOSED STRATEGIC FRAMEWORK

For the analysis of the given case, the authors propose a strategic framework that will guide the entire industry to redefine their value chain so as to revolutionize the practice of cement producing:

FIGURE : PROPOSED SALES AND OPERATIONAL PLANNING FRAMEWORK

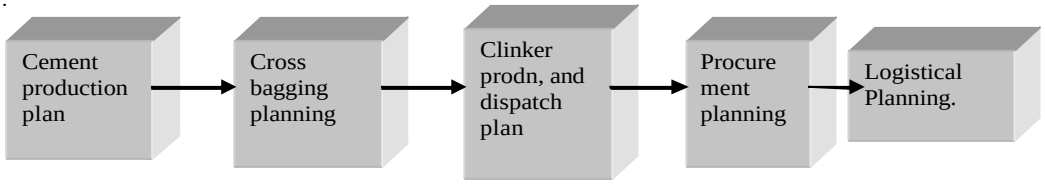

FIG. 7 : THIS FRAMEWORK WILL HELP CEMENT INDUSTRY TO FOCUS ON EACH ACTIVITY THAT MAY SOLVE THE PUZZLE BETWEEN SALES AND OPERATION.

PROPOSED LOGISTICS PROCESS FRAMEWORK

If we refer to Fisher's (1997) framework, he proposes the right supply chain for right product as given below:

FIGURE 8

	Functional products	**Innovative Products**
Efficient Supply Chain	**Match**	**Mismatch**
Responsive Supply Chain.	**Mismatch**	**Match**

Source: Fisher (1997).

From the case study, it is quite evident that cement is the functional product, but if we map the given product with the existing supply chain,then in almost 70% of the total respondents, their supply chain fits into lower left Quadrant, i.e. there is a mismatch between product and kind of supply chain, hence to shift into the upper left Quadrant, the focus should be on low distribution cost .Thus, in the given case study, pan region Optimization exercise rolled out by one of the major cement producer shows that it was a major step taken towards the right direction and thus to achieve this strong vendor relationship in terms of strong CFA's, the transporters' capability needed to be build up. In order to achieve the Optimization result, an institutionalized mechanism of monitoring L1&L2 needed to be established. For this purpose, the researcher has proposed a Logistics Framework which is derived from Fishers (1997) framework. Here, this proposed framework is an extension of Upper Left Quadrant of the Fisher (1997) framework.

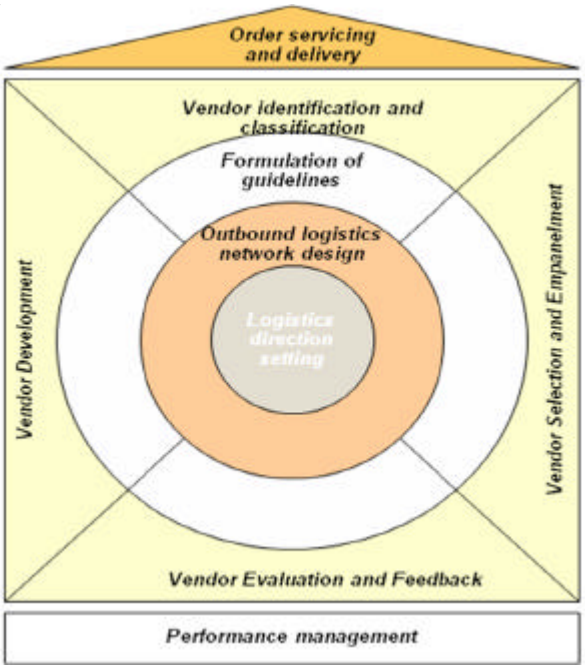

FIGURE 9 : LOGISTICS FRAMEWORK

Source : Result of Interaction with Sr. VP Logistics and Sr. VP Marketing.

In this framework, the authors want to propose that the logistics department should have a fixed and definite focus which will be the guiding mechanism for the Logistics department. The result obtained through optimization has to be strictly implemented in a phased manner, so that sales should not suffer. Outbound Logistics movement has to be tracked as per developed institutionalized mechanism (L1 & L2) for each destination.
Vendor identification, selection, development, & management are critical issues because here Vendors include Suppliers, Transporters, Carrying & Forwarding Agents. Thus, this framework is an Integration of Logistic and Vendor Management which shows how the industry can truly adopt this framework to achieve sustainable advantage in this fiercely competitive world.

CONCLUSION

In our research, we took ACC Limited to study how problems of major cement producing companies can be addressed. The research findings indicate clearly that the methodology used in this research is already known to the research community and literature survey of various scholars indicates that how by using simple LP technique, supply chain can be redesigned to reduce the total logistics cost but the ultimate problem lies in lack of awareness among the end users or one who is responsible for implementation. Before this research hypothesis was formulated, the major challenges that were encountered by the researchers were the availability of data and it is one of the limitations of this research paper. However, it is clear from the findings that there are many companies in India where there is immense scope for theoretical and industrial researchers to test the hypothesis and redesign the existing supply chain and thus, the term supply architecture was purposely chosen to indicate that there is an immense opportunity in this direction for Industrial Engineers, Operations researchers and other related managers and engineers.

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