

## Abstract

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The thesis is concerned with some logistics planning problems in three Steel Plants. Steel Plants are capital, energy and logistics resources intensive. Efficient and effective management of logistics (inbound, internal and outbound) holds key to the success and competitiveness of steel plants. Global sourcing of raw material, selection of carrier, choice of loading and unloading facilities, scheduling of raw materials procurements and deployment of logistics resources for minimum landed cost of raw materials at plant site significantly contribute to the manufacturing cost reduction as, besides raw materials cost, inbound logistics cost alone accounts for 8 to 15 percent of cost of goods sold. For distribution of fixed capital cost over larger volume, it is essential to maximize the throughput with minimum investment in internal logistics support facilities. Maximization of throughput for a given technology and investment in plants and machinery, requires (i) identification of bottlenecks, (ii) reduction in avoidable delays, (iii) operating parameters, logic and practices optimization, and (iv) provision of adequate logistics support facilities. Choice of right technology holds key to the success of a new plant as technology governs the investment in plant, and matching logistics facilities. As the investment in plants and machinery is much higher compared to the investment in supporting logistics facilities in a steel plant, maximization of throughput is more important than minimization of logistics support facilities in such plants. For reduction in outbound logistics cost, one has to minimize distribution cost. Besides others, this may call for back-to-back integration of raw materials procurements and finished goods supply. Logistics in steel plants has both temporal (strategic, tactical and operational) and spatial dimensions. Effective and efficient logistics planning for such plants require their seamless integration.

Considering the logistics issues peculiar to capital intensive industries like steel plants and the limitations of the available literature, this thesis develops approaches and successfully apply them to solving logistics planning problems specific to three steel plants. While the first plant is an old integrated steel plant in Eastern India that wishes to augment its capacity through addition of few key facilities, the second one is a West Coast based integrated steel plant being setup on the bank of a creek. The third one is a new plant proposed to be setup in East Coast of India. More specifically, the thesis focuses on the following logistics planning problems.

- ❶ For optimization of internal logistics system of an existing plant and the configuration after its capacity expansion, we have used a Composite Modeling approach. It uses a combination of discrete event simulation, conventional output improvement tools of Industrial Engineering and debottlenecking methods to ensure maximum throughput with minimum logistics support. The simulation model is used to predict the average daily output from the plant with known (i) plant and machinery configuration, (ii) logistics support, and (iii) operating parameters, logic and practices. The model has been also used for bottlenecks identification, evaluation of the effectiveness of a debottlenecking strategy, operating parameters/practices optimization, and for finding minimum logistics facilities necessary to support maximum throughput. The model also provides an experimental platform for Design of Experiment and

throughput maximization. Composite Modeling approach has been successfully used to increase the throughputs of an existing plant (G Blast Furnace – LD Vessel – Slab Caster System) and the same system after addition of few key facilities with minimum logistics support facilities. The recommendations, developed with active participation of the plant personnel, have been accepted for implementation to increase the throughput to (i) an average of 35.45 heats per day from a level of 30 heats from the existing plant and (ii) to a level of 70 heats after addition of a few key facilities.

- ② For the new steel plant that is proposed to be setup in East Coast, we have again developed a Composite Modeling approach that evaluates tactical and operational level performance of a strategic technological alternative and its consequential key facilities configuration if the alternative is stretched to give maximum throughput with minimum logistics support. For obtaining the maximum throughput, we have used the same composite modeling approach that has been developed and used in the existing integrated steel plant. The approach has been successfully applied to choose between two Thin Slab Casting technologies, the key facility sizes and optimum internal logistics support facilities to produce at least 2.6 million tons of Hot Rolled Coil. Operational flexibility was given due consideration in selecting the technology option with optimum internal logistics support.
- ③ For optimizing the inbound logistics for procurement of about 3.6 million tons of raw materials and back-to-back integration of 0.9 million tons of Hot Rolled Coils for export through sea route in the integrated steel plant in West Coast, the thesis has developed and used a Composite Modeling approach. This approach exploits the hierarchical problem structure to seamlessly integrate the strategic, tactical and operational level logistics planning issues and helps in generating an acceptable minimum cost solution to the complex problem. The model uses a combination of spreadsheet, linear programming and discrete event simulation models for raw material wise (i) identification of sources, (ii) selection of optimal ship size, (iii) monthly procurement planning, and (iv) monthly ship scheduling. The model is used for hiring optimum barge mix and daily deployment of barges for raw materials lightering and HRC export with or without back-to-back integration. The model has also been used to evaluate such strategic logistics alternatives as location of plant jetty, dredging of creek, exclusive use of an anchorage in a port for ship lightering/loading etc. The decision support system has been successfully developed and is being used for inbound logistics planning and HRC export by the plant.
- ④ The thesis has used a strategy of involving plant personnel at every stage of solving complex logistics problems in these three plants. Particularly, their involvement in data collection, data analysis, modeling, model validation, suggesting alternatives for debottlenecking, processing time control and improvement in the availability of critical subsystems have helped the acceptance of recommendations and their subsequent implementation.

The recommendations of the four specific logistics planning studies in three steel plants have been accepted by the management of these plants for implementation.

Key words: Logistics, Logistics Planning, Modeling, Simulation, Steel Plants

