

Supply chain logistics challenges

Integrating the complexities of multi-site refinery supply chain logistics using advanced forecasting, planning and scheduling tools gave one refining company the ability to monitor its supply chain in real-time or near real-time

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The supply chain logistics problems facing multi-site refining companies can be complex, involving multiple stakeholders and constraints across the entire enterprise. The more complex the supply chain, the more difficult it becomes for companies to answer basic questions, such as which crude should they purchase and how should they transport it? Which facilities should process it? What will the best product slate be? Which components should they buy and which should they make?

In many cases, different departments or divisions within a company — trading, supply chain planning, refinery planning, operations and blending to name a few — have a hand in these decisions, but communication among these entities is not always clear or consistent, and each may optimise to their own objectives without regard for others. The results can drastically affect profitability.

A true solution recognises the broad range of entities making up the refining supply chain and views it as a whole, rather than as individual links. The result should be a carefully choreographed plan that enables effective, efficient and profitable operations across the entire business.

Indian refining infrastructure

Indian Oil Corporation (IOCL) is India's flagship national oil company. Ranked 189th on the Fortune 500 list, IOCL is the world's 19th-largest petroleum company and has also been recognised as the top petroleum trading company among national oil companies in the Asia-Pacific region.

Its size alone is impressive: IOCL accounts for 56% of the petroleum products market share among public companies, 42% of the national refining capacity and 69% of downstream

pipeline throughput capacity. The company has a countrywide sales network of more than 23 000 retail outlets, including more than 10 000 petrol/diesel stations, backed by 165 bulk storage facilities, 95 aviation fuel stations and 85 LPG bottling plants. Its subsidiary, IBP Co Ltd, has another 3000 retail sales outlets.

IOCL operates ten of India's 18 refineries, with a combined rated capacity of one million barrels per day. The company also owns and operates the country's largest network of cross-country crude oil and product pipelines of 7730km, with a combined capacity of 58.62 million tpy.

During 2004–05, IOCL sold 50.1 million tons of petroleum products, including exports of 1.96 million tons. Seven of its refineries achieved a throughput of 36.63 million tons, and the pipeline network transported 43.03 million tons of crude oil and petroleum products.

Challenges

As a leading oil supplier, IOCL has many roles to fill. It must maintain its leadership position and meet its vision of being a diversified, integrated energy company with a strong environmental conscience and a national role in oil security and public distribution.

As the company looked for ways to maximise profits, one thing was clear: it needed more visibility into the supply chain and also needed to find ways to optimise it as a whole.

Like many large companies, IOCL managed its disparate projects within different departments or divisions across the organisation, and ran into communication issues between those divisions. As a result, decisions were sometimes based on incomplete data, or they couldn't be applied across the entire corporation.

“Our challenge was how to plan for the various possible breaks that could occur in the supply chain and how to best optimize each specific point to increase our profitability and link activities of five separate refineries,” said Uttam Kumar Basu, general manager, optimisation, IOCL.

To put the project's size in perspective, IOCL needed to integrate, view and make decisions based on 80 crudes sourced from South America to South East Asia, ten refineries and five detailed models, along with a large network of 200 depots, 40 terminals, 17 pipelines and six transportation modes. With the complexity of the problem well beyond the realm of a spreadsheet, IOCL realised that it needed an integrated, multi-plant supply chain management solution.

After extensive study of the problem, the company evaluated different supply-chain management solutions to address the issues it had identified, and then researched how best to implement a solution that would be required to integrate the refineries' supply chains.

Solution implementation

IOCL selected Honeywell to provide and implement the solution. The supply chain management solution consists of an integrated suite of advanced forecasting, planning and scheduling tools to more effectively manage the broader supply chain. An integrated framework throughout the solution supports various modules and state-of-the-art tools for a broad range of business decisions. These enable the company to monitor the condition of the supply chain in real-time or near real-time and provide immediate feedback and exception notices.

Building on and extending several of the system's core features, the solution finally allowed IOCL to “get its arms

around” a very complex business. The models developed with the supply chain management solution covered IOCL’s entire supply chain, from crude purchase to finished product distribution, including demand, refinery process models, blending models and distribution system models.

Web-based supply chain applications dynamically model the supply chain, enabling immediate knowledge collaboration and extending visibility across and down into the enterprise. The solution combines the new visibility with advanced execution solutions, allowing the right decisions to be made more quickly and more often while minimising disruptions. The result is substantial improvement in profitability through measurable inventory and product cost reductions, faster reaction to market opportunities, improved customer relations and stronger collaboration with suppliers and customers. The solution consists of the following modules:

- Demand planning to accurately forecast demand and aggregate demand numbers
- Integrated planning (multi-plant) covering the refining supply chain
- Distribution planning to generate optimal feedstock allocation and product distribution plans
- Refinery production planning to generate individual optimised refinery operations plans.

Demand planning

To make IOCL’s supply chain more responsive to demand, the solution is demand-driven. The demand-planning module takes into account such things as forecast sales of finished product, contractual production obligations and real-time market pricing and trends, allowing IOCL to take advantage of profitable opportunities in real-time. Aggregated demand numbers from the demand-planning module are then uploaded to the supply chain database, which is the repository for all logistics-related data. From there, the data is incorporated into the integrated planning model.

The integrated planning model is actually an aggregation of refinery, distribution and demand sub-models, each requiring large amounts of data. The model also contains the details of each refinery configuration, so that the refinery and overall supply-and-demand infrastructures form the basis on which the optimised plan for the entire supply chain is generated. This “corporate” plan

is communicated to the distribution and refinery models, which then generate operational plans that adhere to the corporate objectives. The corporate plan also forms the basis for crude selection, including consideration of distance and freight costs between locations.

Refinery planning model

The proprietary Honeywell Refinery and Petrochemical Modeling System (RPMS) contains integrated planning features, cost-effective implementation and investment modelling capabilities. It also incorporates data from the crude assay database and Honeywell’s ASSAY2000 software into the overall solution.

A third-party crude assay database supplies crude properties (yield and quality of standard cuts) and provides crude assay updates every quarter in text format. Using an interface utility, this quality data is converted to an XML format file that is used by ASSAY2000 to recut the assay into tower-specific cuts, which can then be used by the RPMS model. The result is yield quality information for each crude type that is specific to the physical configuration of the IOCL refineries. The refinery LP models then use the output (crude and vacuum unit yield vectors and properties) to generate the operating plans for each plant.

Each of the refinery models includes the major process units, blends, inventories and stream routings that have a significant impact on refinery economics during optimisation. The optimisation is also subject to various economically significant refinery constraints, such as capacity constraints on major units, quality constraints on products and unit feeds, environmental constraints and evacuation constraints.

These refinery models, along with the crude assay data, are directly embedded into the integrated planning model, with supply and distribution structure obtained from the supply chain database. This design allows the flexibility to model greater detail in the distribution models than is required merely from the perspective of corporate-wide optimisation.

Supply chain database

As mentioned before, the supply chain database is the repository for all logistics-related data. This includes static data such as operating modes, terminal/depot configuration and linkages, as well as dynamic data such as demand, market prices, linkage costs

based on freight, duties and taxes, crude availability and crude costs. The database has the following functions:

- **Temporal integration** Data for yearly and quarterly models are available in one place and can be rolled up or down as needed

- **Hierarchical integration** Aggregation for the integrated model is based on detailed data available for operational distribution models

- **Calculations** Final linkage costs are calculated using tax logic, current prices, distances and freight rates

- The supply chain database also provides distribution-related inputs to both the integrated planning and distribution planning models.

IOCL and Honeywell used cross-functional teams staffed from both organisations through each stage of the project: consultation, implementation and support. By using the appropriate experts for each specific phase, IOCL was able to expedite the implementation process — the project’s effectiveness was evident as early as a few weeks into the project. Ultimately, using a three-phased approach to implementation consisting of consulting, model prototyping and development and support, the five refineries were fully integrated in only ten months.

The consulting phase of the implementation began by mapping IOCL work practices around planning and supply chain management. The main task in this phase consisted of interviewing the extensive groups of people across the company’s numerous locations, whose job functions in some way touched or were touched by the supply chain management function. The primary deliverable of this phase was the functional design of the overall solution, which consisted of two parts:

- Specifications for the models and software previously described

- “To-be” processes described in use-case narratives. These were based on best practices and technology available.

Model prototyping and development

The project includes some of the largest models of this type in use anywhere in the world today. To achieve success, the implementation required that prototypes for each model be developed. As the prototyping occurred, user evaluation and feedback was collected at each stage and incorporated back into the models. This real-time, ongoing collaboration with the users resulted in

fine-tuned models that accurately reflected the IOCL environment. In the final steps of this phase, each of the various models and software underwent rigorous performance testing, first individually then finally in the integrated planning model environment.

Supply chains are dynamic, ever-changing entities, as market conditions, physical configurations and business objectives evolve. Understanding this, IOCL and Honeywell made a commitment to work together to maintain and grow the solution over the long term to meet future needs and challenges. In keeping with this objective, Honeywell worked closely with IOCL throughout the project to benchmark the complete planning process. Under the long-term support agreement, Honeywell consultants pay regular visits to IOCL sites to ensure the new system is performing to the expectations of IOCL and that the benefits are being realised and sustained. The result is a dynamic, flexible solution that grows and changes with IOCL's business.

Benefits

The investment modelling capabilities of the solution also provide a unique opportunity for IOCL to look at every investment as a capital expenditure and make decisions based on sophisticated investment analysis. After just four months of using the integrated planning model, the company experienced a paradigm shift in how it evaluates and approves these expenditures. Any such expenditure is now validated using the integrated planning model as a required step in the evaluation, prior to any approvals being considered.

This evaluation capability extends to other areas as well. The marketing division, for example, uses the model to determine whether to buy production from other refineries in order to meet demand numbers or to change production within the IOCL supply chain instead. Likewise, as the refineries attempt to maximise throughput and margin, the crude trading group may be making their purchases based mainly on which crude seems to be the best deal from a trader's perspective. With the model in place, traders now buy crude that will be the best deal for the entire supply chain.

The integrated planning approach utilises the synergies that exist between these functions to maximise corporate profit rather than the profit of standalone areas of the business. And

given the large volumes of feedstock, components and finished products involved, even small percentage changes can translate into huge benefits. The integrated approach considers everything and makes the best choices for overall performance. The following typical factors can significantly affect the bottom line:

- Product demand
- Product prices realisable at the market level
- Logistic costs for crudes and products
- Differentials in prices of market crudes
- Inter-refinery interactions for meeting the demand
- Evaluation of exchanges, purchases, imports and export options
- Interaction with crudes already procured
- Interaction among refineries for crude allocation, encompassing constraints of common pipeline
- Refinery configuration, flexibility and constraints
- Shutdown schedules and availability of process units at refineries.

With an integrated view, each of these and their relation to the others is considered in the final solution.

Benefits summary

IOCL has also seen numerous tangible benefits from the project, including:

- Higher margins and increased profitability
- Crude selection and allocation, which takes into account product demands, refinery capabilities and the effect of crudes already in the supply chain
- Refinery production planning that includes crude assays, unit capacities, product specifications and demands, as well as feedstock availability
- Distribution planning that includes transportation costs, taxes and duties, as well as transportation constraints
- Improved visibility into the supply chain process across the five refineries
- Improved investment analysis for all capital expenditures
- Business analysis capabilities that enable strategies to meet future scenarios; ie, specification changes, supply/distribution infrastructure changes and competitive landscape changes
- Faster, more effective decision making on exchange strategies, imports and exports
- Improved response and execution capability.

Lessons learned

A successful implementation of this

magnitude needs more than just technical competence and perseverance of the team. It requires excellent project, people and "change management" skills. It also needs changes in organisation and organisational thinking, which, as many companies know, can be as big an accomplishment as the technical project itself.

Change management:

- Support from top management and high-level sponsors who believed in the end goal and could help make it happen
- Employee buy-in, which is critical for a project as daunting as this one
- Identification of process champions and early involvement of end users
- Establishment of a good foundation, performing "as-is" and "to-be" analysis
- Ensuring all processes had owners.

Project management:

- Implementers concentrated on high-value areas and avoided getting lost in details
- The company selected a partner to provide the solution and made sure that partner was as committed to the project as IOCL was
- The company measured and reported benefits
- IOCL followed recognised and standard project management best practices.

People management:

- The needed resources for the life of the project were identified and committed
- The teams ensured the identified resources had or could quickly develop the required skills
- Role and organisation issues were addressed early in the project
- The company rewarded its champions throughout the project; when people did a good job, they were recognised.

For IOCL, the next logical step is to consolidate the gains it has made so far. The early plan is to enhance the solution to include select applications in the scheduling and MES domain. The corporate-wide plan generated by the integrated planning model would then be implemented through a hierarchy of planning and scheduling models and MES applications.

In closing

Supply chain projects in the refining business are at best intimidating and at worst disastrous. They are also necessary. In today's refining market,

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companies must make the most of what they have and sometimes do more with less. There is no room for waste or error, so they need to have the right tools, technology and people.

To be successful in such a daunting project as the one faced by IOCL, companies must fully understand their current business and work practices, and carefully evaluate what steps to take.

Leadership and process champions are critical and should be cultivated from the beginning. And selecting a vendor who can not only provide the necessary technology resources, but also act as a full partner in developing and implementing the solution will go a long way toward the final success of any project.

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