**HUMBER INSTITUTE OF TECHNOLOGY**

**AND ADVANCED LEARNING**

**(HUMBER COLLEGE)**

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**ASSIGNMENT 1 – CASE STUDY ANALYSIS**

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# **Executive summary**

Optimization is a major concern in supply chains around the world. Reducing costs and elevating or even maintaining service levels can be a difficult task, especially when several constraints in production, transportation and lead times need to be taken into consideration. Technological tools and programs offer potential solutions by addressing complex optimization problems and generating efficiencies that significantly reduce operational costs.

In this study, we examine a dataset that compiles historical information about orders, plants, ports, and associated transportation costs for a manufacturing company. The main objective is to optimize overall transportation costs while considering constraints related to specific production facilities for certain products, exclusive connections between ports and production plants, as well as vendor-managed inventory (VMI) agreements and warehouse capacity limitations. Using Python, we have developed a model that incorporates these supply chain constraints and determines the optimal plant and port for each order type.

Implementing an optimization strategy offers several benefits to the company. It enables cost reduction by minimizing overall costs, leading to improved profitability. The strategy enhances operational efficiency by streamlining processes, reducing lead times, and optimizing resource utilization. Moreover, it improves customer care or service by efficiently meeting demands, ensuring consistent supply for customers with VMI arrangements, and delivering better performance. Additionally, the optimization solution provides decision-makers with valuable insights and recommendations for improved strategic planning and operational decision-making.

However, implementing the optimization strategy may encounter various challenges. These challenges include data availability and accuracy, managing complex constraints, addressing the dynamic nature of the supply chain, ensuring effective communication and collaboration among stakeholders, overcoming resistance to change, and gaining acceptance for the optimized solution. Overcoming these challenges necessitates careful planning, robust algorithms, and continuous adaptation of the optimization solution to evolving supply chain dynamics. Supply chain optimization is a complex ongoing process that requires continued examination and revision, as new constraints arise, or the existing ones evolve and change.

# **Introduction**

This report presents an optimization strategy for a supply chain logistics problem, with a particular focus on the development of an efficient production and transportation scheduling approach. Our goal is to optimize the assignment of orders to plants, carriers and ports while considering different constraints and requirements of the dataset.

The optimization strategy aims to minimize costs by creating a schedule that considers factors such as plant capabilities, port connections, and vendor-managed inventory (VMI) arrangements. By developing an efficient assignment of orders, selecting suitable ports, and considering VMI restrictions, the company would be able to reduce production costs, transportation expenses, and additional costs associated with the supply chain logistics system.

The following sections of this report will explore in detail the problem statement, the proposed model, benefits, and challenges associated with the optimization of production and transportation scheduling in the supply chain department of a manufacturing company.

# **Problem statement**

This study aims to optimize production and transportation scheduling in a supply chain logistics system to minimize costs while considering various restrictions. The goal is to assign a specific set of orders to suitable plants and carriers, considering the following factors:

1. Plant Selection: Determine the most appropriate plant to process each order, considering that each plant can only handle certain products.
2. Port Selection: Identify the optimal port from which to ship each order to its destination, considering that each plant is connected to specific ports.
3. Vendor Managed Inventory (VMI): Consider that some customers can only be serviced by a designated plant due to VMI arrangements.

The objective is to create an efficient production and transportation schedule that minimizes overall costs, including production costs, transportation costs, and any additional costs associated with VMI restrictions. The solution should optimize the assignment of orders to plants and carriers, considering the specific constraints and limitations imposed by the supply chain mapping.

# **Optimization solution**

According to the problem statement, the company has some restrictions, viz., plant selection, port selection and VMI. Based on the restrictions, the optimization strategy should minimize the supply chain cost while keeping the output optimal by selecting the most optimal route. For this, we will first have to establish some relationships between the variables. These are

1. Plant to port relation
2. Plant to product relation
3. Customer to plant relation

**Plant to Port Relationship:**

Through this relationship, we are trying to identify which ports are accessible by a certain plant and how many plants can access any given port.

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Through establishing this relationship, we can set the most optimal supply routes from plants to ports and, in the process, minimize freight costs.

**Plant to Products Relationship:**

Plant-to-product relationship is also essential for our optimization strategy as it will allow us to determine the number of products that can be produced in a certain plant. By identifying the number of products that can be made in each plant along with the plant capacities, we can optimize the production plans accordingly, which can reduce inventory handling costs and prevent over/under utilization of plant machineries.

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**Customer to Plant Relationship:**

In our given problem, one of the restrictions presents is the related to customer and plant relationship. Not all the plants can manufacture products for a given customer. Hence, we need to understand and verify the customer and plant relationship, in order to cater to the right customers through utilizing the capacities of the correct plant.

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Using all three of the relationships along with the other information available to us, such as the line graph above, which represents the manufacturing cost/unit for the plants, we will determine which plant should the order from a given customer be directed to and which port the plant should access to supply the product to the customer to minimize the overall cost of supply of the product and to utilize the given resources in the best possible manner.

# **Demo**

To demonstrate the optimization strategy, we created a new variable in our original ‘ol\_df’ dataframe named ‘decision’ which will contain a list of all the variables that will optimize the whole supply chain. Below present is a snippet of the solution:

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# **Benefits**

The optimization solution for production and transportation scheduling in supply chain logistics offers several benefits:

* Cost Reduction: By optimizing the assignment of orders to plants and carriers, as well as selecting the most efficient ports, the solution aims to minimize overall costs. This can result in significant savings in production costs, transportation expenses, and other associated costs, leading to improved profitability for the company.
* Improved Efficiency: The optimized scheduling ensures that orders are processed and transported in the most efficient manner. By considering plant capabilities and VMI constraints, the solution avoids unnecessary delays, bottlenecks, or suboptimal routes. This leads to streamlined operations, reduced lead times, and improved resource utilization.
* Enhanced Customer Service: By optimizing the production and transportation schedule, the solution helps in meeting customer demands more effectively. Customers with VMI arrangements are serviced by their designated plants, ensuring consistent supply and minimizing stockouts. Additionally, efficient transportation routing and reduced lead times contribute to improved delivery performance and customer satisfaction.
* Better Decision-Making: The optimization solution provides decision-makers with valuable insights and recommendations (Jeyanthi Prem & Karnan, 2013). It offers a systematic approach to evaluate different scenarios, trade-offs, and constraints. This enables managers to make informed decisions about production capacity planning, carrier selection, and resource allocation, leading to improved strategic planning and operational decision-making.
* Scalability and Flexibility: The optimization solution can be scaled and adapted to accommodate changes in demand, supply, or business requirements. It can handle varying order volumes, plant capacities, and transportation options, allowing the company to adapt to market fluctuations, business expansions, or changes in customer preferences.
* Resource Optimization: By optimizing the assignment of orders to plants and carriers, the solution maximizes the utilization of production facilities and transportation resources. This leads to improved resource efficiency, reduced idle time, and better overall resource allocation, resulting in cost savings and increased productivity.

Overall, the optimization solution offers a range of benefits including cost reduction, improved efficiency, enhanced customer service, better decision-making, scalability, and resource optimization. It enables companies to optimize their supply chain logistics operations, gain a competitive edge, and drive overall business performance.

# **Challenges**

The optimization solution for production and transportation scheduling in supply chain logistics may face several challenges:

* Data Availability and Accuracy: Obtaining accurate and up-to-date data on order details, plant capabilities, port connections, and VMI constraints can be challenging. Incomplete or unreliable data can impact the accuracy and effectiveness of the optimization solution (Jin et al., 2019).
* Complex Constraints: The problem involves multiple constraints, such as plant-product assignments, port connections, and VMI requirements. Managing these constraints and incorporating them into the mathematical model can be complex, requiring careful formulation and validation.
* Problem Complexity and Scalability: As the size and complexity of the supply chain increase, the optimization problem becomes more challenging to solve. The computational resources required to solve large-scale problems may be significant, and the optimization algorithm chosen must be able to handle the complexity efficiently.
* Dynamic Nature of the Supply Chain: The supply chain environment is dynamic, with fluctuations in demand, changes in plant capacities, and variations in transportation availability. Adapting the optimization solution to handle such dynamic changes and maintaining the accuracy of the solution can be a challenge (Brown, 2022).
* Communication and Collaboration: Implementing the optimization solution may require effective communication and collaboration among different stakeholders, including production managers, transportation providers, and customers. Ensuring seamless coordination and information sharing can be challenging, particularly when dealing with multiple parties and complex supply chain networks, however, it becomes particularly important as it positively influences total supply chain performance (Chowa et al., 2008, as cited in Sadraoui & Mchirgui, 2014).
* Resistance to Change: Introducing an optimization solution may face resistance from employees or stakeholders who are accustomed to existing processes and routines. Overcoming resistance to change and effectively managing the transition to the new optimized scheduling approach is crucial for successful implementation.
* Solution Interpretation and Acceptance: The optimized solution may present changes in production and transportation schedules that might not align with existing practices or expectations. Gaining acceptance and buy-in from stakeholders, such as plant managers or carrier providers, may require effective communication and explanation of the benefits and rationale behind the optimized solution.

Addressing these challenges requires careful planning, effective data management, collaboration among stakeholders, robust algorithms, and continuous monitoring and adaptation of the optimization solution to the evolving supply chain dynamics.

# **Conclusion & Recommendations**

In this report, we analyzed a comprehensive dataset with the supply chain information of a manufacturing company. Our primary objective was to optimize overall transportation costs while considering constraints specific to production facilities, port connections, VMI agreements, and warehouse capacity. Through the development of a Python model, we successfully incorporated these constraints into the optimization process, determining the optimal plant and port for each order type.

The model successfully identifies the plant and port combination that minimizes costs for each order based on the type of product involved. The company can utilize this model on an ongoing basis to plan for orders in the upcoming months. However, it is crucial to continuously monitor and update the model to account for any changes in constraints, such as changes in transportation costs at specific ports or other evolving factors such as the inclusion of new products, and carriers, to ensure accurate and up-to-date solutions. It is also important to receive continuous input from key stakeholders in the supply chain department such as plant managers, demand planners and transportation and logistics teams to ensure that the model accurately reflects real-life scenarios.

Through effective model monitoring and stakeholder communication, the company can fully leverage the benefits of the optimization strategy, leading to improved supply chain performance and overall business success.

# **References**

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# **Appendix 1**

Work Breakdown Structure

| **Task ID number** | **Task name** | **Responsible** | **Rol** |
| --- | --- | --- | --- |
| **0** | **Transport cost minimization** |  |  |
| **1** | **Definition** |  |  |
| 1.1 | Evaluate supply chain processes susceptible to optimization | Supply Chain and Data Analytics Teams |  |
| 1.2 | Define optimization strategy | Supply Chain and Data Analytics Teams |  |
| 1.3 | Deliniate project scope and definition | Milena Rocha | PMO |
| 1.4 | Establish inputs required to deploy optimization strategy | Data Analytics Team |  |
| 1.5 | Identify project risks and governance | Milena Rocha | PMO |
| 1.6 | Determine resource dependencies | Milena Rocha | PMO |
| 1.7 | Designate project team | Supply Chain and Data Analytics Teams |  |
| 1.8 | Develop project plan | Milena Rocha | PMO |
| 1.9 | Create Business Requirements Document (BRD) | Supply Chain Team |  |
| 1.9 | Project kick-off | Milena Rocha | PMO |
| **2** | **Design** |  |  |
| 2.1 | Establish the data framework and architecture | Sidhart Gupta | Data Architect |
| 2.2 | Data acquisition | Lakshya Saxena | Data Engineer |
| 2.3 | Data exploration | Deepanshi Garg | Data Analyst |
| 2.3 | Data cleansing | Deepanshi Garg | Data Analyst |
| 2.4 | Functional Design Document (BRD) | Farid Ganem | Business Analyst - Supply Chain |
| 2.5 | Technical Design Document (TDD) | Deepanshi Garg | Data Analyst |
| **3** | **Development & Testing** |  |  |
| 3.1 | Build prototype solution | Kapil Sharma | Developer |
| 3.2 | Test prototype solution | Deepanshi Garg | Data Analyst |
| 3.3 | Adjust solution according to test results | Kapil Sharma | Developer |
| 3.4 | Monitor and assess overall solution performance | Deepanshi Garg | Data Analyst |
| 3.5 | Business user acceptance testing | Farid Ganem | Business Analyst - Supply Chain |
| **4** | **Execution & Deployment** |  |  |
| 4.1 | Production environment set up | Lakshya Saxena | Data Engineer |
| 4.2 | Enablement of data pipelines | Sidhart Gupta | Data Architect |
| 4.3 | Go-live | Milena Rocha | PMO |
| **5** | **Project closure** |  |  |
| 5.1 | Leasons learned | Milena Rocha | PMO |
| 5.2 | Final documentation submission | Milena Rocha | PMO |

# **Appendix 2**

Python Code for the optimization Algorithm is attached as a PDF file with the report.