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PREDICTING SUPPLY CHAIN PERFORMANCE UNDER RAPID UNPLANNED DEMAND FLUCTUATION

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ABSTRACT

Due to COVID19, a multinational Consumer Packaged Goods (CPG) producer is experiencing significantly altered product demand profiles, with demand for some products surging and others dropping significantly. Required production and inventory levels are unknown, resulting in cost uncertainty. A simulation-based analytics capability was rapidly developed and deployed to estimate production and inventory levels required to meet this dynamic demand, utilizing existing supply chain network structure, production constraints, current inventory status, and inventory replenishment policies. This data-driven model generates outputs such as production volumes, inventory levels, and costs by region and product category, which are integrated into an analytics dashboard for near-term planning and awareness. The model and dashboard enabled the company to identify products and production plants at risk for overproduction including the estimated cost impact, and predicted required production rates and inventory levels needed to support dynamic demand on a weekly basis.

1 INTRODUCTION

The client company was experiencing significant unplanned shifts in the global demand of its 32,000+ products due to the impacts of the COVID19 pandemic. The company had production cost estimates based on pre-pandemic planning, as well as adjusted demand forecasts based on recent demand shifts. However, they lacked the capability to estimate the near term weekly impact of that changing demand on planned production rates and inventory levels. Genpact developed and delivered an analytical capability with a discrete event simulation model at its core during a three week engagement.

The system under analysis is the finished goods supply chain, consisting primarily of production plants and distribution centers (DCs). Products are produced and routed through the supply chain network from plants to DCs (and from DC to DC) to satisfy external demand. The primary goal of the simulation model is to predict required production volumes and inventory levels throughout the system to enable decision makers to accurately define appropriate production volume allocations, particularly in the face of rapidly changing demand.

2 APPROACH AND MODEL FRAMEWORK

The analytical capability was developed using Alteryx for data processing, Simio for simulation, and Tableau for results visualization. Due to the rapid nature of the project and the desire of the client to update the dashboard with weekly data, a scalable, repeatable data-driven workflow was needed. Historical data was processed to generate product lists, site lists (distribution centers and production centers), inventory lists, and sourcing lists (mapping a specific product flow from site to site). Weekly demand data was provided by the client at a SKU and site level. For a typical four-week simulation horizon, the processed

input data consisted of 32,000+ products, 1000+ sites, 36,000+ inventories, 27,000+ network links, and 27,000+ demand events.

The modeled system captured several critical business rules, constraints, and assumptions:

1. Modeled demand is external demand only, and is only realized at DCs. Plants cannot directly fulfill external demand.
    a. Demand data includes only external demand. DC-DC demand is generated by the model logic as needed, and is not included as a direct input.
2. Product is made to order at each plant, and no inventory is stored at plants. Produced product is immediately shipped to the requesting DC.
3. Plant capacity and volumes are captured at the plant level. Production lead time and shipping transportation times are included, subject to data availability.
4. Inventory at DCs is replenished by plants or other DCs subject to the supply chain network.
    a. A replenishment order is triggered when an inventory position is below the minimum inventory level value.
    b. The reorder quantity is defined to be the quantity required to bring the inventory position to the minimum inventory level value
    c. Sourcing first looks for plants with available capacity, then for unconstrained plants (e.g. out-of-region plants, vendor plants), then for DCs.

3 RESULTS AND IMPACT

The model was used to generate results for a rolling four-week window. Each week the client updates the model with current demand data and executes the model. The primary model outputs are plant-level production volumes required to meet demand and comply with inventory replenishment policies. The raw outputs from the simulation consist of all production activities (including the week, the plant, the destination site, and volume produced), and weekly inventory performance (including inventory on-hand and backordered, as well as cumulative totals of volume demanded and consumed). These results are loaded into a client-hosted Tableau dashboard that aggregates and summarizes the data (Figure 1). The client was able to use this data to adjust production levels across the supply chain to meet demand and was able to estimate the corresponding cost performance.

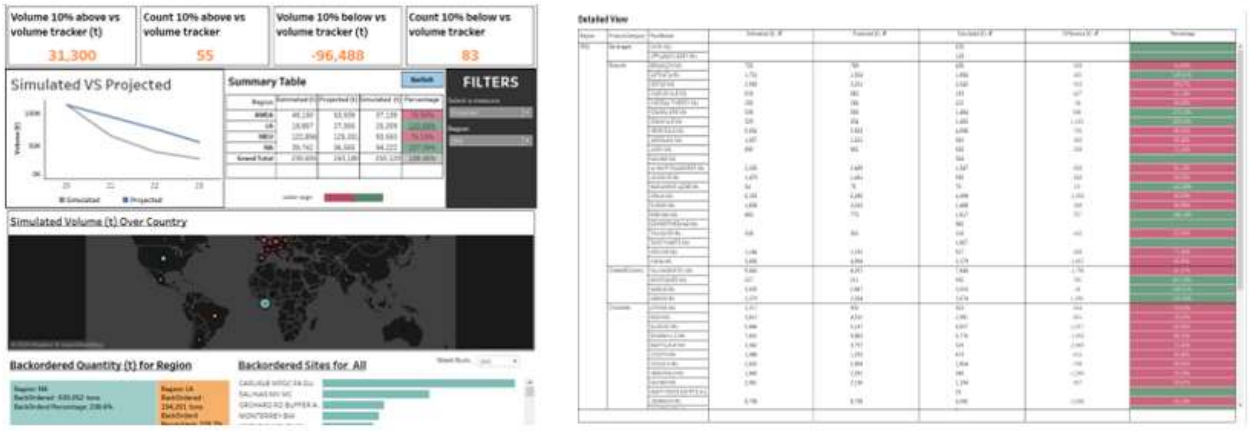

Figure 1: Overview dashboard and production plant detail dashboard.