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The pursuit of a self-healing supply chain

Introduction

As a company's supply chain expands in size and complexity, efficient planning and execution becomes crucial to their success. Disruptions or delays in production or shipment of product needs to be detected and resolved quickly to prevent any impact to the business. The ability to make timely, accurate decisions related to sourcing and routing of products requires data to be gathered, processed and analyzed. The cost of this information management is increasing dramatically as more data is added to the process. Businesses need to adopt supply chain automation to reduce manual effort and speed-up the mitigation effort.

Initially, leading companies implemented process improvements to enhance information accuracy and develop analytical reporting. Supply chain planners used to manually analyze the data and determine the action required to resolve an issue, but this was too time-consuming and expensive. While computer systems reduced the manual effort to analyze the data and determine possible issue resolutions, they still required a person to select and perform the corrective action. The number of people required to review the recommended solutions and select the appropriate action was also costly. To be efficient, businesses needed processes that detected issues and automatically executed resolutions to events based on an established model and defined set of business rules to reduce the response time. The evolution of automatic issue resolution took many decades to achieve, but it still was not responsive enough to keep up with the current speed of business. As software vendors continue to develop systems with expanded data content and more mature business models, the prediction of supply chain issues before they occur and automatic execution of preventative steps can now become a reality. As supply chain systems evolve, innovative companies will be at the forefront to pursue a supply chain that avoids issues whenever possible and automatically mitigates issues that could not be prevented. The industry will continue to move closer to the ultimate goal of a self-healing supply chain.

Manual balance

Managing supply chains requires balancing the cost of goods against maintaining the desired customer service-level target. The cost of goods calculation consists of direct and indirect costs including product price, employee labor, storage expenses, and transportation cost from supply location to customer. The customer service level is critical to maintain market share by consistently meeting customer order delivery expectations or preventing lost sales by assuring inventory availability at the point of sale. Supply chain planners must balance these factors to maximize profits without risking out of stock situations. As the competition for products drives down the selling price and profit margin, transportation cost reduction has become increasingly more crucial. The supply plan is typically based on the least-cost transportation method and planners reluctantly move to higher cost solutions when necessary to resolve supply issues.

Accurate and timely demand/supply data is essential in the decision-making process to quickly assess situations and determine the proper response for the business. As supply chains get longer and more complex, the amount of data points become overwhelming thus driving the need for improved supply chain planning system. Software vendors have developed solutions with expanded visibility to pertinent data and analytical tools to support planners throughout the planning process. Planners evaluated the scenarios, determined responses and selected the best resolution to common issues. Companies documented the corrective actions to reoccurring issues and launched initiatives to re-engineer business processes to prevent them. Unfortunately, this response determination process was time-consuming and dependent on, sometimes costly, trial-and-error experimentation.

Response automation

Software advances sped up the response evaluation process and enabled virtual assessment of multiple responses in parallel without incurring business risk. Machine Learning (ML) techniques were implemented to record situations and responses and evaluate the effectiveness of each resolution to enable recommendations for future events. Additional intelligence was also integrated into the process — including weather events, holiday schedules and disruptive events — to enable assessment of business impact based on adverse events. Data from suppliers, carriers and intelligence providers were combined to provide the most accurate predictions of outcomes.

Response determination ML processes provided supply chain planners with potential resolutions, starting with impact assessment and recommendation of corrective action. The recommendations improved over time and companies developed processes to automate the responses based on business-defined guidelines and thresholds. This ensured that approval of supply chain planners was not required for response execution.

Artificial Intelligence (AI) expedited the automatic responses to further reduce manual effort in the response determination and execution process.

These steps define the pursuit of a self-healing supply chain, which absorbs input from data sources throughout the planning and execution processes and automatically executes corrective actions to disruptive events.

The AI-enabled processes help to balance the business goals of maximizing profit by reducing cost, while maintaining the target customer service levels. Supply chain planners can manage exceptions when the situation cannot be solved within the provided parameters.

Supply chain planning and execution systems have evolved into a continuum of information visibility, analytics reporting, ML-driven automation of response determination and, finally, AI-enabled automation of corrective action execution. Each area of supply chain planning and execution is supported by advancements across the range of functionality. Company size and supply chain complexity define where each business area falls between manual interactions to automatic resolution within the continuum:
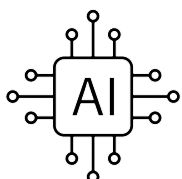
Visibility to pertinent data and adverse events at initial occurrence to better resolution

Analytics reporting of data signals to assess business impact and highlight exceptions
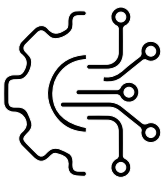
Machine learning functionality to evaluate events and recommend resolutions

Artificial intelligence–driven processes to automate corrective action execution

Demand planning continuum

Calculating demand forecast requires a considerable amount of data related to the product and location where sales will occur, market intelligence and historical sales. To improve projections, planning system initially provided data to support manual analysis and system configuration to manage demand forecast generation and enable comparison to actuals. Analytical reports were developed to process large datasets and highlight areas requiring deeper analysis to improve forecast accuracy and identify opportunities to shift demand between profitable and unprofitable locations. This process evolved into more complex algorithms and incorporated machine learning techniques to identify patterns and recommend changes. For example, artificial intelligence–aided processes can automatically execute the recommendations to further improve future projections. Steps along the demand planning continuum include :

1. Visibility into sales, promotions and historical performance

- Actual sales history with seasonality, weather and other influencing factors
- Product sales per location with lost sales versus under performance
- Product category performance model
- Execution details related to new product introduction

2. Analysis of demand issues and responses

- Forecast accuracy measurement and identification of bias
- Link locations with lost sales to locations with low sales
- Cost analysis of potential transfers to maximize sales
- Product markdown and promotion recommendations
- New product introduction location and item type analysis to define categorization

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3. Machine learning process assessment of demand issue resolution

• Regional location/product level sales shift pattern recognition

• Opportunist cost-effective forecast shift recommendations to maximize profit

• New product forecast calculation based on demand sensing and location/product categorization

4. Artificial intelligence to automatically shift demand based on events

• Demand adjustment and re-alignment for demand mismatches

• Forecast generation based on extrapolated location/product performance

• Automatic cost-effective forecast shift to meet predicted customer demand

• New product forecast submission based on demand sensing and categorization

Supply planning continuum

Supply planning requires evaluating options to cover unmet demand considering available inventory and sources of supply. Determining the best supply solution requires accurate, timely data and processes to evaluate constraints in materials, resource availability and financial impact. As supply chain systems mature, automated replenishment processes have been developed to optimize supply order quantity, purchase price and/or manufacturing cost, inventory carrying cost and transportation cost; while reducing product obsolescence and maintaining customer service level targets. Advancements in ML/AI help to improve the solutions by incorporating additional data elements and reducing manual effort to execute the plans. The supply planning continuum includes:

1. Visibility into inventory, product source location and transportation

• Supply requirements to maintain network inventory target at finished or semi-finished stage

• Current inventory in stock, in transit and on order with estimated availability dates

• Primary product source location output capacity, work in process and alternative sources

• Raw material, production resource and transportation availability and lead time

2. Analysis of supply requirements, source capacity availability and associated cost

• Inventory target level projections and issue identification (stock out, excess, etc.)

• Cost-effective alternate source option identification to resolve shortages

• Sweet spot within tolerance between over/under target

• Requirement frequency determination based on cost of goods

3. Machine learning

- Cost-effective inventory transfer recommendations between locations to maximize profit
- Purchase reorder point determination to maintain customer service level target
- Production resource assignment prioritization based on customer service level target
- Material allocation recommendation to most profitable orders
- Retention of corrective actions associated with adverse events for future issue resolution

4. Artificial intelligence

- Order scheduling to maintain customer service level
- Optimize order quantity and schedule for cost-effective purchase and transportation
- Sourcing selection to meet business target cost/schedule
- Balance cost of lost sales versus carrying and transportation cost to calculate distribution plan
- Artificial intelligence can enable automatic responses to prevent business impact
  - Automatic reorder schedule and quantity
  - Automatic supplier selection to resolve capacity shortages / cost savings
  - Automatic prioritization of supply orders based on demand signal

Transportation routing continuum

Shipment disruptions and delays also threaten supply being available when and where it is needed. Systems have been improved to monitor and detect shipments that are behind schedule to enable mitigation efforts. Shipment tracking systems can trigger exceptions for shipments based on the subsequent business impact for key products. ML/AI processes have evolved from reacting to adverse events to predicting future delays by incorporating influencing events into the analysis. Automatic rerouting to avoid late arrivals can be implemented based on thresholds to meet business goals along the continuum:

1. Visibility

- Visibility into shipments in transit with estimated time of arrival at destination based on standard lead time
- Visibility into shipments delayed in transit based on late ship date, thus resulting in updated estimated time of arrival calculated from standard lead time

2. Analysis

- Analytical reports identifying impact of delayed shipments. For example, late shipment reports with products required to meet customer orders
- Highlighting the impact to inventory target level so that the supply chain planner can determine response
- Identification of alternate sources for product to prevent supply issues with costs associated with replacement. This can help supply chain planners create transfers or purchase orders to fill the gap

3. Machine Learning

- System retains impact of delays in transit and predicts the time of arrival based on past occurrences
- Examination of responses to previous disruptions to provide alternate routes for shipments to expedite arrival, thereby helping to prevent supply issues
- Recommendation of action to resolve supply issues based on effectiveness of previous reactions

4. Artificial intelligence

- System automatically responds to disruptive events based on models and goals to maximize profit and maintain customer service level targets
- Determine best response based on previous occurrences and analysis of possible resolutions to balance cost of response versus cost of lost sales

Conclusion

Innovations in supply chain systems have enabled planners to spend more time on business process by automating many of the day-to-day activities through advancements. Enhanced processes incorporate a massive amount of data elements and analyze outcomes of many potential scenarios to determine the best solution to meet business goals, within defined tolerances. Automating responses to events reduces manual intervention for resolving issues so supply chain planners can focus on implementing process improvements and achieving business goals.

Supply chain process automation will continue to evolve as companies gain trust in associated data, analytics and decision-making. Interim solutions will be evaluated by planners and best response to an event from the possible options will be selected. As confidence in the proposed solutions generated by ML/AI processes grows, more business functions will be automated, and the pursuit of a self-healing supply chain will continue.

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John is a business technology leader with extensive experience and expertise in delivering supply chain/logistics solutions emphasizing implementation, strategy development, business process design, supply chain management, requirements planning and system integration.

With his 20+ years of supply chain experience, John has directed enterprise implementations of package and custom developed software collaborating with business and IT stakeholders to define business requirements, develop financial justification and build cross-functional teams to outline potential solutions, associated costs and expected outcomes.

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