Network wide visibility and Orchestration for Supply Chain

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Abstract—In this digitally transforming world, supply chain management is made digital and can fulfil customers’ demands how, where, when they want it by giving them end to end visibility. Across the whole supply chain, the proposed system aims to offer real-time visibility, orchestration, collaboration, and prescriptive solutions. The solution is a component of the next-generation resulting in enhanced Platform, which is a cognitive, real-time, connected platform. This is achieved by collecting the requirements from the user and understanding the type of process model change they need and later building the required process model for ingesting the data and load it to the customized software product they need. The data prepared is ingested using postman through API calls and at once loaded into the software. After loading the data, customer is given credentials for their customized product to login and experience the new UI and required data’s as suggested. With the solution’s collaborative and connected platform, companies can now visualize the complete supply chain for items, including suppliers, factories, distribution hubs, distributors, retailers, and customers.

Index Terms—Advanced Shipment Notification, Enterprise Resource Planning, Key Performance Indicators, Purchase Order, Sales Order, Stock Transfer Order, User Interface

I. INTRODUCTION

The supply chain deals with a real issue and real-world problem that persist in this era. Its application extends to various domains like food, pharmaceuticals, and other consumer goods, all manufacturers. By integrating artificial intelligence and machine learning, this has become autonomous Supply chain. Predictive technologies, cloud technology, and data access have changed the workplace and presented a chance to upend the SCM market. The appropriate data must reach the right people at the right time thanks to SCM technology. To fulfill the constantly changing needs of customers and to place more emphasis on sourcing strategy, supply chain management (SCM) is crucial. By managing the network of downstream companies in charge of product delivery as well as the upstream companies that offer inputs, SCM checks the availability of the appropriate product at the right time in the right location. SCM tool is used to analyze the business requirements, Customize the software to the requirements of a postman, and use data ingestion, beta testing, deployment, and maintenance. Hence optimizing a supply chain to make it resilient to these disruptions is often seen. In this product, users would deal with one such issue, namely visibility. The supply chain these days is very complex and visibility issues often arise. This paper would address that requirement to provide a birds-eye view of the entire supply chain as shown in figure 1.

II. THEORY AND FUNDAMENTALS

There are various causes that would lead to a supply chain disruption. The functionalities and features that are discussed in this project deals with predicting these disruptions and provides actions to avoid such disruptions.

A. Functionality of the Application

The functionality of the application helps the users to get the insights and resolve issues in the supply chain process.

1) Visibility

Supply chain visibility, as the name indicates is the transparency of data to make the supply chain visible. Visibility adds a lot of value to the optimization of supply chain. The data that is generally made visible is as follows: KPIs, orders, deliveries, shipments, inventory stock levels etc. This would give the company a competitive advantage over the market...
peers. It also increases the customer satisfaction.

2) Requested delivery breach
The product would provide various features that would enable the users to identify various exceptions and to take necessary action to avoid the impact that it may lead to. The product developed can display orders and shipments by dividing them into various states which would enable the users to identify the on-time status objects and other objects. In the case of insufficient supply, the product enables the users to source materials and items from a different supplier or to perform a stock transfer from nearest warehouses or distribution centers.

3) Logistics
The solution developed has the capacity to connect with the freight management systems. The freight management refers to the tracking done at the container and carrier level. The freight management provides the product with all the tracking info which would be updated by the product at the object level.

4) Role Based Access Control
The product utilizes a role-based access control to restrict the access any user has on the data available on the SaaS platform. Often, sensitive data is to be restricted from accessing. The role-based access control refers to the access depending on the roles a user has. The User would be assigned roles, and the user would be able to access all the data that can be accessed from the roles.

5) Situation Room
The situation room would provide a way to contact the suppliers of the nearby warehouse or distribution centers when there is a need to transfer stock or to divert an incoming shipment from one site to another.

B. Features of the Application
The features of the application highlights how it is different from other similar applications and how efficient the application is from user's perspective.

1) Reliability
The reliability is high on all the tools used to build process models and User Interface (UI). Reliability describes how probably miles for the software program to paint without failure for a given time frame. Reliability decreases because of inspections the code that may rely on the percentage of operations that are finished efficiently.

2) Scalability
It is the property of the system to handle a growing amount of work by adding resources to the system. This application is capable of processing huge data and process models in order. All the modules are scalable as per needs.

3) Security
It is ensured by using firewalls and double factor authentication while logging into the User Interface (UI) and later enter OTP generated in Duo App for verification.

4) Robustness
Robustness when handling exceptions, the code should not break. It should be able to deal with errors that occur during execution. If any exceptions occur in the backend process model, it will take 10 to 20 seconds to restart the server.

III. DESIGN AND METHODOLOGY

[Figure 2: Block Diagram of Architecture of the Application]

The flow in the block diagram shows the main components of the implementation process in figure 2. Define requirements gathered from the customers, configure data according to the requirements of the customer using process models give real-time visibility using UI and make changes in the dynamics of transactional data by ingesting data using Postman or...
Lumin by Get, Post & Ingest methods using API calls and test the software product before deploying it into customer system whether its meeting needs of the requirements of the customer or not.

A. Freight Management

The process of efficiently and strategically delivering cargo from its point of origin to its desired destination via a network using a variety of transportation methods, middlemen, and technologies is known as freight management. The method makes use of physical resources like trucks, distribution facilities, and warehouses, as well as technology, to move freight efficiently and affordably. Businesses have long placed a high priority on their capacity to deliver goods in a timely manner, in the precise quantity, without damage, and for the lowest possible price. Cargo is transported by road, rail, sea, and air by freight managers. Intermodal transportation, which combines multiple modes, is a word frequently used to describe solutions for the best logistics and delivery. It inputs the information related to tracking of carriers, shipments, orders etc. It inputs the data related to tracking of carriers, shipments, orders etc.

B. Enterprise Resource Planning Systems

ERP software has significantly changed how organizations are able to operate, and it is directly related to corporate expansion. Successful ERP and supply chain management are essential components of business growth. These technologies, which may be obtained from supply chain specialists like QAD, combine supply chain operations under a single dashboard, enhancing visibility and streamlining cooperation between vendors and suppliers. Software for manufacturing ERP can automate supply chain procedures to increase employee productivity in other areas. The enterprise resource planner sends the data related to the quantity and the required date etc from the supplier.

C. Command Line Interface

A command-line interface (CLI) is used by a command-line interpreter or command-line processor to receive commands from a user as lines of text. By doing so, it is possible to specify environment-specific parameters, call executables, and instruct them of the tasks they are to complete. The invocation may occasionally be dependent on parameters set by the user or earlier executables. This is for the developers and support staff to change the existing model or to manually change the data present in the UI.

D. Gateway and Kafka

Apache A distributed event store and stream processing platform is called Kafka. It is a Java and Scala-based open-source system created by the Apache Software Foundation. A single, high-throughput, low-latency infrastructure for handling real-time data inputs is what the project seeks to provide. The Kafka Streams libraries are available for stream processing applications, and Kafka can connect to external systems (for data import/export) via Kafka Connect. Kafka relies on a "message set" abstraction, which naturally groups messages together to lessen the overhead of the network roundtrip and uses a binary TCP-based protocol that is designed for efficiency. This "enables Kafka to turn a burst stream of random message writes into linear writes" by resulting in larger network packets, longer sequential disc operations, and contiguous memory blocks. The duo provides the authorization to the specified input methods and also serves as a message enrichment layer.

E. Software and Microservices

In supply chain software, the term "microservices" refers to the usage of independently deployable apps to finish a business process. They have significant advantages over the conventional, monolithic form of supply chain management software and are used for a variety of purposes, from order management to customer intelligence. Managers of supply chains must comprehend microservices and how they can dramatically enhance warehouse operations. It is the core for processing the data given after the authorization and enrichment. It carries out various calculations and predictions to give the data on the UI which is accessed by web interfacing.

F. Data Analytics

It is the storage place where all the KPIs are stored for the purpose of analytics and future reference. It is also accessed from power BI to develop various dashboards, reports, visualizations etc.

Figure 3: Methodology for implementation of Application
A system’s architecture, including its internal connections, internal workflows, and the idea including whole system components, are outlined in the system design. The Figure 3 show how the data is flown in the highest level. In an abstracted way, the data is stored on the web interface where all the server lists, microservices, tasks are present. The data is modified using process model according to the customer needs and given as input to the web interface. When the user input is passed to the web interface the process starts for providing real time visibility of the goods. If the user tries to login without valid credentials, the software send alerts and errors to the developer in order to help them regarding the same. In an abstracted way, when the user logs in to the web interface dashboard, user can view the statistics of inbound shipments, outbound deliveries, purchase orders, sales orders etc. all this data is stored on the web interface where all the server lists, microservices, tasks are present. Then data exceptions are fetched from the dashboard and parsed as input to the supply page where all the order, shipment data is present then, after the order is carried out for the shipment to the end user is carried out in demand page where the item name, location for shipping is present. If the user needs to view the lot capacity of the inventory, stocks etc. data’s are present in the inventory module which gives clear picture of overall stocks present in the store. Then at last developer ingests the modified data using process model through postman or lumin and deploys the customized product into customer/user system.

A. Specifying Client Requirements
The objectives are defined and collected from the customer requirements. There would a out of box model which would be then modified according to the requirements. The customer requirements are then analyzed and classified as Process model or state machine or data model configurations.

B. Master Data Configuration
Master data refers to the static data that would remain the same throughout the life cycle of the software. It can be configured, created and deleted but the object is not modifiable. It would contain data that is static in the supply chain unlike the orders and shipments which would undergo life cycles through various stages. The Master data would include details of supply chain like participants, sites, items, sourcing lanes etc.

C. Process Model Changes
The Process model changes are done when there is any change to the data model such as adding extra fields, or making a few fields mandatory etc. This would need to be zipped using Gradle. To get the changes reflected on the UI, developers would need to restart the application. The process model is the underlying model which drives the object models and hence is the place where most of the changes are made.

D. State Machine Configuration
The State Machine Configuration is the configuration done to the dynamics of the objects in the process model. The State diagrams show the life cycle of an object. This life cycle states triggers and guard conditions etc are modified in this step. All the objects in the different modules like demand, supply and inventory modules undergo life cycles. Their configuration would be done in the state machine configuration. The Triggering of different state transitions from transitions of different object is also configured. For Example, The order which is moved to delivered state would also trigger the corresponding shipments to delivered state.

E. Verification and Deployment
The development is carried out in three different environments. The initial development is done in the first environment which is used for the sole purpose of building the software. The second environment is used to take the developed software which is working on the first environment and verify how it handles data. It is also used to check how much data the software would be able to process. Once the checking on the second environment is done, the third environment is the product given to the customer. Any changes are then pipelined through the lower environments.

IV. RESULTS AND DISCUSSIONS
All the modules like Supply, Demand, Inventory and Dashboard on the UI are designed and deployed. All the changes and debugging are done to the master data and stored which further is used for real time visualization of the data. Enterprise resource planning software is used to reduce transportation cost. ERP also focuses of prediction of data based on daily demand by using artificial intelligence and machine learning techniques. It helps the companies get more profit in omnichannel world of customers where they can buy from anywhere, integrate supply chain assets, Gain real time visibility, Predict, prescribe and pivot. Companies can now gain 95% forecast accuracy, 70% product gains, 80% stockout reduction and 25% waste reduction with the help of this tool.
The product developed is used for providing across the whole supply chain, real-time visibility, coordination, cooperation, and viewpoint. Companies can now visualize the entire flow of goods across suppliers, customers, etc., thanks to this connected and collaborative product, and customers can access the tailored product to view the stocks, hot items, and route information that the product gives alerts and notifications about the goods.

A. **Login Page**

The customer can specify people who can login apart from the support team can login to the application to avail services. User needs to enter his/her email and password for authentication. The credentials will be validated against the one which is given during the registration and will be allowed to login if the credentials match, if the credentials do not match then the user will be redirected to the same login page. If customer forgot his credential, user can contact the support team and reset password.

B. **Dashboard Page**

The Dashboard is a customizable UI that can be setup to the specifications necessary. It forms a part of analytics where user can grab insights on the data present in other pages. It includes things like KPI indicators. This takes required fields like exceptions and states as input and KPI can also be added that need to be displayed which then process to display necessary and related gathered customer data, which as a result generates the visualizations and insights of the required fields.

C. **Supply Page**

The supply refers to the supply that the client company gets from its sources. It would have the details of orders, shipments and deliveries. It can be customized by the support team on request to show more or less data. The Supply page has details about POs and STOs. For a customer, it would generally refer to the procurement of raw materials. When a supplier cannot meet the required quantity or delivery date, stock from different distribution centers or warehouses can be taken by STO. This takes input of data ingested through postman or lumin and upload of ERP CSV file. After ingesting the data, the same data is added to the existing data or objects, which allows customer to view where the item shipping is from, mode of shipment, hot items, in transit items etc.

D. **Demand Page**

The Demand page where the required fields are defined under node modules. Here, name is the parameter that is mapped to json file and label is the parameter which is used to display on the UI. This is of type string and the searchable property on the UI is enabled, unsearchable is the property present in the advanced filters section on the UI. The Demand page has details about SOs. For a customer, this refers to the retailer he would give the product to or the end-user directly. This takes input of data ingested through postman or lumin and upload of ERP CSV file. After ingesting the data, the same data is added to the existing data or objects, which allows customer to view where is the item shipping to, mode of shipment, hot items, in transit items etc.

E. **Inventory Page**

The Inventory refers to the stocks present in the warehouse which is in the shipment state. Once the customer gets access to real-time visibility of the product, one can notice the real-time flow of goods, lot size and whether the item is falling under hot items or not. These data is modified by the developer based on the customer requirements. Software testing is done to check for bugs and to determine if the system produces results that meet expectations. In order to guarantee that the client receives software free of errors, this activity is essential. This is done by running the developed software and evaluating the performance of the system. This assists in finding flaws and errors in the code and bridges the gaps between functionalities that are lacking.
F. Analytics Page

The Analytics view provides users with a visual analysis of the site and inventory, in one place. The KPI metrics and filters for these metrics are based on configurations and may vary.

![Analytics View](image.png)

Figure 5: User Interface of the Application developed

The major functionality is with the solution’s collaborative and connected platform, companies can now visualize the entire flow of goods across suppliers, factories, distribution centers, distributors, retailers and customers. This end-to-end visibility gives all upstream and downstream partners access to “one version of truth” across the extended supply chain, enabling planners to correlate any events or exceptions impacting supply and demand in real time. In addition, within allowed lead times, the enterprise can publish purchase orders to suppliers through the control tower and receive confirmations. Any exceptions generated in this process can be collaboratively resolved within the control tower. Suppliers can then create advanced shipment notices (ASNs) which are downloaded to ERP systems to generate inbound deliveries/scheduled receipts. Suppliers can use the Web UI to transact with the control tower and can alternatively use Excel to mass upload/download their confirmations.

V. CONCLUSION

The product developed would help the customers predict and avoid supply chain disruptions. It enabled the customer to have a birds eye view of the supply chain. The end to end visibility is also achieved. In the end, it's all about choosing the correct supply chain solution for the customer’s unique requirements, also one which is sustainable and adaptive. Most planners spend 50-70% of their time fighting the fires of supply disruption. More than any other phase of the supply chain, when disruptions occur—time is money. The software product resolution capability employs machine-learning to continuously learn from rapidly changing transactional data and digital signals. It absorbs network-wide data at scale, correlates events and associated responses to spot trends and anomalies, predicts potential disruptions, analyzes possible responses, and provides planners with prioritized, cost-effective resolutions. The control tower’s resolution capability allows users to take prompt remedial action, perform what-if research on potential solutions, and make more automated and lucrative business decisions, reducing risk and seizing opportunities. The customer requirements are gathered by business consultants by direct interaction with the customer and thereby, defining the scope of work. Customizations are made according to the specified requirements and ingestions of data are carried out. Ingestions are done using postman and lumin. Configure the UI pages and also the dynamics concerning the transactional data. Running the web application hosted on azure cloud would give the software high availability.

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