# Redesign of a Purchasing Order Tracking System for Inbound Maritime Shipments

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**Master's Dissertation**

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**Integrated Master's in Industrial Engineering and Management**

2021-06-28

# Abstract

The present dissertation was developed within Continental Group with a real objective in mind. The project focused on analysing the current raw materials procurement system and diagnosing potential gaps in visibility. The goal is to propose ways to mitigate these gaps and increase the incoming maritime supply chain predictability.

To accomplish such goal a framework for the selection, testing, evaluation and implementation of a delivery tracking tool within the current purchasing order system is suggested.

These delivery tracking tools provide third-parties with the estimated time of arrival (ETA) of cargo shipments. Therefore a system for retrieving ETAs using API calls is necessary to gather data for testing. Then, both qualitative and quantitative measures, such as forecasting evaluation metrics, play a role in the comparison of tracking tools. Lastly, the financial viability of such initiative is pondered and it is observed that cost savings can be obtained by having more reliable and up-to-date ETAs for incoming raw materials shipments. When this data is easily available there is the chance of reducing shortage situations that can lead to plant stoppages. Besides, emergency deliveries and heavy detention and demurrage fees become less common, all while saving time to the employees which were previously concerned with manually tracking the incoming shipments.

Afterwards, the integration of delivery tracking tools with the firm's SAP is explored and different approaches are required for tracking shipments coming from different types of suppliers.

The main conclusions of the dissertation were that increased supply chain visibility was needed. Plus, out of the considered tracking tools, Ocean Insights seems to be the best choice and, the cost savings can easily outweigh the cost of the tools for the present case. It was also observed that these tools can serve as a starting point for future developments and even serve as the basis for other cost avoidance initiatives.

**Key Words:** Delivery Tracking Tool, Inbound Maritime Supply Chain, ETA Evaluation Metrics.

# Resumo

A presente dissertação foi desenvolvida no Grupo Continental com um objetivo real em mente. O projeto foca-se na análise do sistema atual de aquisição de matérias-primas e no diagnóstico de lacunas na visibilidade do mesmo. O objetivo é propor formas de mitigar estas lacunas e aumentar a previsibilidade da cadeia de abastecimento marítima.

Por forma a alcançar tal objetivo, uma estrutura para a seleção, teste, avaliação e implementação de uma ferramenta de rastreamento de entregas para o atual sistema de ordens de compra é sugerida.

Estas ferramentas de rastreamento de entregas providenciam tempos estimados de chegada (TEC) de encomendas a terceiros. Assim, um sistema de angariação de TECs através de *API calls* é desenvolvido com o objetivo de recolher dados para testes quantitativos. Depois, medidas qualitativas e quantitativas (como métricas de avaliação de previsões) têm um papel importante na comparação das ferramentas de rastreamento. Finalmente, a viabilidade financeira da iniciativa é ponderada e observa-se que medidas de contenção de custos podem ser obtidas como resultado de uma melhoria nos TECs para entregas de matérias-primas. Quando esta informação se encontra facilmente acessível existe a possibilidade de reduzir situações de escassez de matérias-primas que podem levar a paragens na produção. Para além disto, entregas de emergência e multas de detenção e sobreestadia seriam muito menos comuns. Fora o tempo que seria poupado pelos colaboradores previamente alocados ao rastreamento manual das encomendas.

Seguidamente, a possibilidade de integração de ferramentas de rastreamento de encomendas com o sistema SAP da empresa é explorada. Tal integração requer uma abordagem diferente para cada tipo de fornecedor identificado.

A dissertação conclui que melhorias na visibilidade da cadeia de abastecimento são necessárias. Além do mais, das ferramentas analisádas, a Ocean Insights aparenta ser a melhor escolha para a empresa. Neste caso particular, as reduções de custos incorridos podem ser vastamente maiores do que os custos da ferramenta. Foi também observado que estas ferramentas podem servir como ponto de partida para desenvolvimentos futuros e funcionar como base para outras iniciativas de redução de custos.

# Acknowledgements

The present dissertation is the result of months of dedication, personal work and a reliable support network. The project owns a great deal of its achievements to the latter and I would like to express my deep gratitude to everyone who guided me or aided me throughout this path:

To Professor José Faria, for always being available and willing to help, while constantly offering an amazing stream of useful insights based on his personal experience.

To Eng. Diogo Silva, for being present to guide me through this experience and for being an outstanding and caring person.

To Eng. Manuel Pinheiro, for aiding me on every step of the way and continually providing me with suggestions.

To everyone on the ISCM team at Continental, notably to Rita Costa, Alexandra Iancu, Gaby Ohlmeyer, Thomas Friedemann and Alexej Rosnatovski.

To Professor Bernardo Almada Lobo, for clarifying many questions and helping me when I needed the most.

To my university colleagues Inês Ribeiro and Ernesto Vinha who were always ready to support me both on a technical level as well as on a emotional level

And finally to my father, my mother, my siblings, my aunt, my brother-in-law and my friends for their unconditional love.

*"Every man lives by exchanging."*

Adam Smith

# Contents

# Acronyms and Symbols

| | |
|---|---|
| API | Application Programming Interface |
| ASN | Advanced Shipping Notification/Notice |
| ATA | Actual Time of Arrival |
| BL | Bill of Lading |
| BOM | Bill of Materials |
| BPM | Business Process Modeling |
| C-ITA | Continental Indústria Têxtil do Ave |
| CTHS | Continental Tires Holdings Singapore |
| CTR | Container |
| DAP | Delivery at Place |
| DDP | Delivery Duty Paid |
| DPU | Delivery at Place, Unloaded |
| EDI | Electronic Data Interchange |
| ETA | Estimated Time of Arrival |
| ETL | Extraction-Transformation-Loading |
| ePO | Electronic Purchasing Order |
| FTL | Full Truck Load |
| GR | Goods Receipt |
| ISCM | Inbound Supply Chain Management |
| KPI | Key Performance Indicator |
| MAE | Mean Absolute Error |
| MBE | Mean Biased Error |
| MRP | Material Requirement Planning |
| NR | Natural Rubber |
| OEM | Original Equipment Manufacturer |
| PO | Purchasing Order |
| POD | Port of Destination |
| PR | Purchase Requisition |
| RM | Raw Material |
| RMDP | Raw Material Demand Planning |
| RMSE | Root Mean Squared Error |
| SCAC | Standard Carrier Alpha Codes |
| SCM | Supply Chain Management |
| SubRef# | Subscription reference Number |
| T&T | Track and Trace |
| VMI | Vendor Managed Inventory |
| VMOI | Vendor Managed Owned Inventory |

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# Chapter 1

# Introduction

## 1.1 The Continental Group

Continental AG is a German manufacturer of parts and equipment for the automotive industry, most notably tires. Founded in 1871 in Hanover, the company started off as a soft rubber manufacturer and would eventually grow to become one of the top global original equipment manufacturers (OEM) suppliers for the automotive industry. As it grew, the company systematically broadened the scope of its operations and expanded its target market.

Today, Continental group offers a wide variety of components, systems and services such as brakes, safety systems, commercial vehicle services, a large range of tires, and powertrain components. The company has operations in more than 30 countries, employs around 240 000 people worldwide and presented a revenue of nearly €44.5 billion in its 2019 annual report. As of 2019 Continental AG ranked second largest OEM supplier in a study by Berylls (2019).

Figure 1.1 presents the current organizational structure of Continental AG:

| Group | Continental AG | | | | |
|---|---|---|---|---|---|
| Group Sector | Automotive Technologies | | Rubber Technologies | | Powertrain Technologies |
| Business Area | Autonomous Mobility and Safety | Vehicle Networking and Information | Tires | ContiTech | Vitesco Technologies |

Figure 1.1: Continental AG organization structure

The present project was developed at Continental Indústria Têxtil do Ave (C-ITA) which is present within the Rubber Technologies Sector most accurately in the Tire Business Area. This Area is responsible for the manufacturing and development of a large range of mobility solutions. Its product lines include tires for a wide spectrum of applications, from trucks, buses and cars to bicycles and motorcycles. It also encompasses both the 22 tire plants and the 2 suppliers of fabric for these same plants - one of which is C-ITA.

## 1.2 The Supply Chain

Although developed at C-ITA, the present project was integrated within the Inbound Supply Chain Management (ISCM) corporate department inside the Tires business area of Continental. Therefore, the primary focus will be placed in understanding, diagnosing issues and proposing measures to optimize such supply chain. The project is broad enough that its applicability might transcend its current boundaries, meaning that some knowledge could be transferred to other inbound or outbound supply chains inside Continental AG. However, for the time being, only a presentation of the inbound supply chain for Continental Tires will be conducted.

The tire manufacturing supply chain is globally interconnected. At the time of writing, Continental operated 24 production locations worldwide which were supplied by over 2000 other companies. Starting out from the tire composition it is possible to understand the relative weight of each raw material (RM) group for the manufacturing process and, more importantly, it allows the mapping of where these same RMs are being imported from. Figure 1.2 displays the amount, in kilograms, of each RM category necessary for the production of a typical tire. These categories are, in descending order of weight contribution: synthetic rubber, fillers (also named carbon black), natural rubber, chemicals, metallic reinforcements (steel) and lastly textile reinforcements.

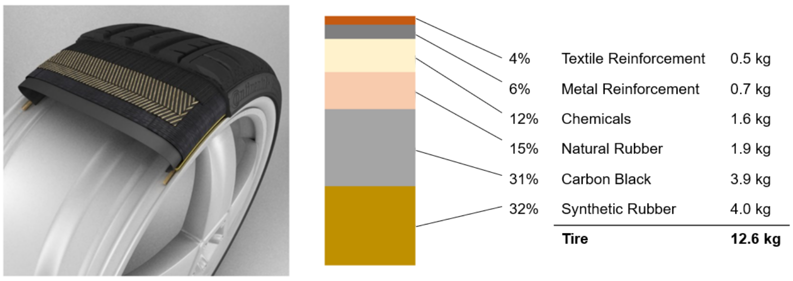



Figure 1.2: Typical tire composition

Dividing the world into 5 regions (North America; Europe; South America; Asia and Africa) can be useful to understand the degree to which Continental's supply chain is globalized and reliant on far away suppliers. Depending on the RM category, the share of RM imported from a different region varies between 10 and 85%. Goods travelling between different regions are almost always carried by ship and the lead time, from the moment the materials are requested until its supply, is around 6-8 weeks. Even within the same region it is common to find fairly long trips such as the supply of fillers from Russia to Portugal, for which both sea and land freight is possible.

Alongside the necessary RM for the tire plants to operate, it is also relevant to consider the inputs required for the upstream textile plants. These inputs are yarn and chemicals from the Asia Pacific region, which means that they too are dependent on very distant and not flexible suppliers for their RMs. As mentioned previously, these textile plants also integrate the Tire business area of Continental and are vertically integrated with the tire plants. C-ITA in Portugal and Aldora Mills in the United States of America are effectively operating as Continental's main suppliers of textile reinforcements for their respective regions but export very little overseas. Besides textile products, the remaining RMs involved in tire production are almost exclusively provided by external suppliers. Figure 1.3 aims at mapping the supply chain's main entities:

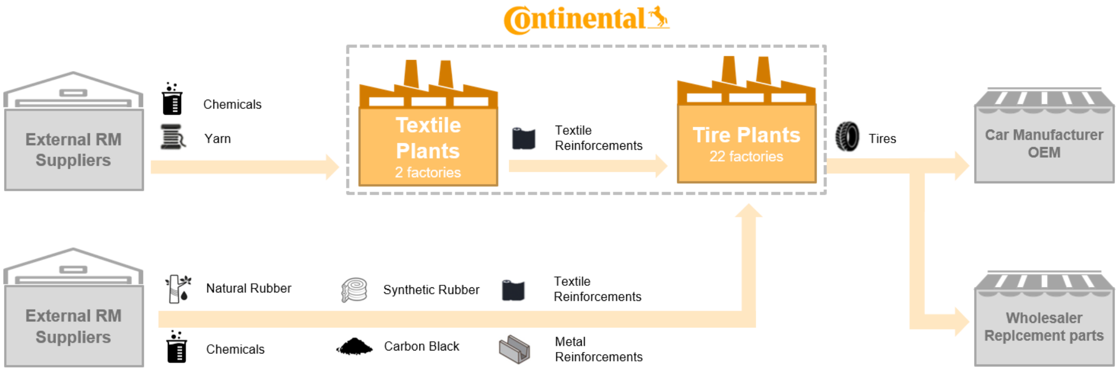



Figure 1.3: Continental Tire's supply chain

As a result of this reality it is of paramount importance to understand the role that ocean-freight inbound deliveries play on the supply chain. These deliveries are generally characterized by taking a long time and being plagued by uncertainty and sources of potential delays. Therefore, forecasting the estimated time of arrival (ETA) of a particular ocean-shipment is no easy task.

## 1.3 The Tire and Automotive Industries

Constant change in customer demands and strong competition are two dominant features that have been characterizing the automotive industry for the past few decades. These trends probably came about as the result of globalization. Besides, low customer loyalty and expectations of excellence are more common than ever before (Masoud and Mason, 2016). The situation is unlikely to change in the near future and it forces automotive manufacturers to be responsive to customers while keeping costs low. This stage of continuously adapting to changing preferences demands a great deal of flexibility on all links of the supply chain. The Tier-1 suppliers, such as Continental's Tire division are upstream partners of car manufacturers and, therefore, must find strategies to cope with the ever-growing need for the development of prototypes and rapid introduction of new products. This adds complexity to production planning and makes raw materials demand planning (RMDP) a more challenging task. Thus, it is of utter most importance to increase predictability wherever possible along the inbound supply chain.

The supply chain for the automotive industry is classified as convergent, which means that components are merged into sub-assemblies and ultimately in a final assembly (Modrak and Marton, 2014). This sort of supply chains have a shorter range of outputs (final products) than of inputs (raw materials), often this results in many suppliers producing goods for a single buyer responsible for the assembly. The same is true for the tire industry, making it reliant on many external and internal suppliers. Furthermore, eventual shortages of just one of the many RMs could be enough to compromise the whole production process, forcing companies to halt manufacture.

The tire industry also tends to have high margins and be very capital-intensive. This means that plant stoppages are particularly damaging and, consequently, missing potential sales usually outweigh costs incurred with holding extra inventory of both finished products and raw materials. Therefore, accommodating demand fluctuations became a priority for the businesses operating within the tire market. It is not uncommon for tire manufacturers to have excess capacity as it allows them to ramp up production in times of greater demand and consequently mitigate some of the risk of losing potential sales. In fact, avoiding shortages is so important that, in emergency situations, RMs can be flown in by airplane.

Besides, variations in demand at the automotive orders level tend to worsen as they “travel” upstream along the supply chain. In an attempt to assure its own production, tire plants place more or larger orders than necessary to its internal and external suppliers. In turn, internal textile suppliers do the exact same and try to reinforce its own stock levels by increasing the volumes of RMs requested to their own upstream partners. Obviously, this inevitably results in higher inventory levels, culminating into extra costs for the firm. The hazards of having understock or overstock and the present tradeoff are understood by the players operating in the tire market. The goal is to find the balance between the amount of inventory carried and the high service level required.

The rise in warehousing costs is self-evident but it is not the whole picture. At the time of writing, the company was facing regular shortages or near-shortage situations as a result of the limited supply of RMs, prompted by the Covid-19 pandemic. In crisis scenarios, where supply of RMs cannot meet demand, placing more orders to increase inventory levels will not achieve the desired outcome. Not only would it be ineffective to increase order’s volume as it could even make matters worse for Continental. If every manufacturing plant places large orders to cover their own production they might end up competing with each other for the limited supply of RMs and end up with a scenario where some plants have healthy safety stock levels at the expense of others who face near-shortage scenarios constantly. In sum, the company should strive to allocate RMs where they are most needed to minimize the overall downtime of the whole array of tire plants. Supply chain visibility is a key-enabler of a more efficient allocation of resources, allowing plants to know, with an increased degree of certainty, when incoming shipments would arrive.

In capital intensive industries, where machinery is supposed to be running at any given time, having more time and concrete data to optimize the production planning and scheduling can drastically increase its machinery utilization rate and, consequently, its output rate. This is the exact case of the tire industry and most of the automotive industry in general.

## 1.4 Project Motivation

Throughout 2020 and 2021, the Covid-19 pandemic heavily disrupted global supply chains which ended up highlighting some its major vulnerabilities. For the automotive industry this effect compounded itself with the fact that the industry is very capital intensive and consequently susceptible to vast economic damage in the face of production stoppages. As a result, the resilience, or lack thereof, of the supply chain and of the multiple players in the market was put on full display.

Companies operating within the automotive manufacturing industry were forced into a period of self-examination, where current practices and potential shortcomings needed to be pondered. Hence, the conditions necessary to justify a deep dive into potential ways of improving supply chain flexibility were met and the present dissertation project had the required corporate backing to be carried out.

## 1.5 Problem Statement and Project Goals

The present dissertation seeks to offer a comprehensive approach for the design, enhancement and implementation of a purchasing order tracking system in a pre-existing setup with increased focus on inbound ocean delivery tracking. As such, the main goal is to provide an overview of the current processes and identify gaps in visibly, inefficiencies and potential areas for improvement. This analysis will be focused on the processes carried out from the moment a purchasing order is placed until the delivery of the corresponding goods at one of Continental's facilities. Solutions or alternatives for the said problems strive to close these gaps in visibility and improve the overall predictability of the inbound supply chain.

Without good visibility, potential delays are not easily identified and, as a result, avoiding shortages becomes an arduous task. Therefore, priority was given to maritime delivery tracking, since ocean travel tends to be the longest step of the entire process and is responsible for the majority of the critical delays.

The project itself encompasses two main issues besides the analysis of the current situation:

- Proposing a framework for the evaluation of delivery tracking tools and presenting its results;
- Presenting a feasible solution for integrating such tools on Continental's system.

The dissertation will go over the whole process of adopting a tracking system. Starting with the selection of the tracking data provider, testing those same providers and assessing them based on defined quantitative and qualitative evaluation metrics. The roll-out itself was also considered and an implementation strategy for integrating external service provider into the company's systems will be proposed. The multiple steps for the adoption of a delivery tracking tools follow the timeline on Figure 1.4.

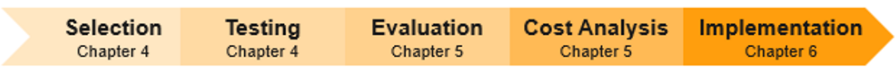



Figure 1.4: Steps for delivery tracking tool adoption

Hopefully, by the end of the project, a comprehensive solution for mitigating supply chain issues will be understood, and the supply chain visibility could be enhanced through the proposed integration of marine tracking tools into Continental's tool set.

## 1.6 Dissertation Organization

The next chapter is dedicated to the literature review. On it some relevant background for the understanding of the project and applied methodologies will be explored. The remaining chapters are as follows:

- Chapter 3 - Analysis of the Current Situation;
- Chapter 4 - Proposed Solution: Delivery Tracking;
- Chapter 5 - Tracking Tools Quality Assessment;
- Chapter 6 - Implementation Strategy;
- Chapter 7 - Conclusion and Future Developments.

On Chapter 3, the status of the purchasing order system currently employed by Continental will be thoroughly described and a diagnosis of the main issues plaguing it will be conducted. Next, on Chapter 4, the adoption of delivery tracking tools will be explored as a potential way of enhancing the current business process. Chapter 5 summarizes the methodology and array of criteria used to judge the proposed solution while also presenting its results. Chapter 6 proposes a course of action for actually integrating the solution into the company's current systems. Lastly, conclusions about the project and suggestions for future works will be present on Chapter 7.

# Chapter 2

# Literature Review

The present project is inserted into the supply chain management research field, more specifically it demands an understanding of the state of the art of inbound supply chains and how a purchasing order system works. The project also requires some comprehension of the currently available track and trace technologies as its implementation could potentially be the source of significant improvements. Plus, 'Additional Information Regarding International Shipping' will also be discussed. This way, the first subchapter is called 'Relevant Background' and the three objects of research will be the following: Supply Chain Management, Purchasing Order Systems, and Track and Trace Technologies. The second subchapter is denominated 'Methods and Tools Employed' and focuses on research fields necessary for the actual development and deployment of the project: Multilevel Process Modeling; Forecasting Evaluation Metrics; Leading Change and Relevant Technologies.

## 2.1 Relevant Background

### 2.1.1 Supply Chain Management

Increased liberalization of international trade brought the possibility of establishing truly global supply chains. The sourcing of production factors is now done at the global scale and often suppliers and buyers are distantly located from one another (Janvier-James, 2012). The increased effectiveness of marine traffic was a key enabler for the setup of these international supply chains (Fourie, 2006), which owe some of their success to the adoption of the standardized container. The term 'supply chain' evokes a "picture of how organizations are linked together as viewed from a particular company" (Jacobs et al., 2014). Therefore, any set of organizations involved in the flow of goods from its source to a customer qualifies as a supply chain (Mentzer et al., 2001). Simchi-Levi et al. (2008) defined supply chain management (SCM) as the set of processes employed to "provide the right goods or services, to the right location, in the right quantity, at the right time and at the right cost". The goal is to examine and manage a supply chain network by deciding upon a series of trade-offs between customer service and cost savings (Coyle et al., 2008). It is possible to divide supply chain management into inbound and outbound logistics. Inbound corresponds to the set of operations that need to be performed to assure the flow of tangible goods or information, from the its source to the manufacturer's facilities (Mitsumasa et al., 2016). Outbound logistics is "the process related to the movement and storage of products from the end of the production line to the end user" (CSCMP, 2013).

#### 2.1.1.1 Bullwhip Effect

Under the overarching theme of SCM, a large problem plaguing supply chains is the bullwhip effect. The bullwhip effect describes a specific phenomenon manifested in most supply chains, which is the increment in demand variability while moving upstream from the final customer to the raw material supplier (Lee et al., 1997). This is especially true for the automotive industry and its relevance for the present project is further exacerbated as Continental plants may sit one or several levels upstream from the automotive-assembly plants. According to Bhattacharya and Bandyopadhyay (2011) the causes of the bullwhip effect can be either behavioral or operational and come as a result of imperfect information. One way to mitigate this effect would be to implement a central system responsible for managing all the involved firms inventory levels and achieve an overall leaner supply chain. The implementation of such system could only be done by the adoption of EDI (Electronic Data Interchange) tools to increase the speed and accuracy of the information flow (Silva, 2014).

#### 2.1.1.2 Disruptions and Visibility

Global supply chains carry inherent risk some of which can be attributed to its increasing complexity, translated into longer and more variable lead times and increasing numbers of partners, carriers, suppliers and customers (Heaney, 2013). Risk and efficiency tend to be strongly correlated (Lee et al., 1997), as companies reduce their inventory and respective costs, they also expose themselves to greater levels of risk as small disruptions or unaccounted events might damage the firm's bottom line. The on-going Covid-19 pandemic highlighted how much external factors can disrupt the supply chains of virtually every industry on our modern world. Firms and researchers started looking for ways to improve supply chain resilience and the positive impact of visibility became apparent as companies with reliable and abundant data were more able to react in a timely and appropriate manner to delays and other disturbances (Queiroz et al., 2020).

### 2.1.2 Purchasing Order Systems

From a manufacturer point of view, SCM encompasses the processes of procurement, namely the procurement of raw materials. Traditionally, procurement was very labor-intensive and it took a long amount of time until a potential purchasing order (PO) was elaborated and submitted to a supplier. The alternative to this approach is e-procurement, which is an automated approach that strives to take advantage of business services connected by the internet to transaction goods or services (Guijun Wang and Miller, 2005). In this case, the orders placed to the supplier are called E-orders and can be further divided into two distinct categories depending on whether they were triggered by the buyer or by the seller. If the e-order is placed by the buyer, it is considered a regular electronic purchasing order (ePO). Opposingly, if the inventory of the downstream partner (buyer) is actively managed by the seller, the order is considered a VMI (vendor managed inventory) (Waller et al., 1999).

Being the redesign of a purchasing order tracking system the focus of this dissertation, it is of utter most relevance to have an overview of the general steps present throughout the whole PO's life-cycle. According to Guijun Wang and Miller (2005) the 10 stages to be performed during the procurement process are as follows: initiation, proposal, refinement, commitment, submission, confirmation, processing, shipping, delivery, payment, and closure.

The initiation of a PO consists in identifying the current or future need for stock replenishment of a given product. This step is followed by the elaboration of a proposal, where purchasing decisions regarding the selection of the source, pricing and terms of purchase, are made. Next, the prepared requisition can be refined or tuned and finally the firm is ready to assume the commitment.

The submission of the PO is the first public-process and, therefore, it is a standardized one. In this phase the PO is issued and forwarded to the supplier, containing all the relevant information. Some examples of the terms and conditions present in such a document can be (Pooler et al., 2004):

- Exact quantity, and unit of measure;
- Description of goods or services ordered;
- Unit price and currency;
- Required delivery date;
- Method of shipment and routing instructions;
- INCOTERMS (which will be further explored);
- Other special documents like Bill of Lading (BL), which acts as a trip ID.

The supplier must then acknowledge the reception of the incoming PO and choose whether to accept it or not. Meanwhile, changes may be performed by either party and change notices issued and agreed upon by both participants. As mentioned previously, the stages of order placement and confirmation can be done directly via e-orders to each parties' information systems (like SAP). The "bridge" between the buyer and seller's information systems is usually performed by an electronic data interchange (EDI) service provider. According to Pooler et al. (2004) it is estimated that a single PO has a cost between 90-150 USD for the company, and PO placement and confirmation are non-value-added activities. Therefore, automating these processes is of extreme importance, especially for low-value transactions.

Afterwards, the supplier is responsible to update its production schedule to accommodate the new order and process it. Once the production processes are concluded the goods must be shipped to the buyer's facility and an advanced shipping notification (ASN) informs the buyer of the materials in transit (Waller et al., 1999). In some cases, the buyer has contracts in place with forwarders, which are entities responsible for arranging the ocean transit with the carriers.

Once the delivery is successfully completed, a Goods Receipt (GR) is issued by the buyer, and the supplier's invoice is payed, which finally closes the process.

A study conducted by the Aberdeen Group in 2013 concluded that companies that were considered "leaders" in their respective market were 1.74 times more likely to track ASNs than "all others", 2 times more likely to track customs clearance events and 3.4 times more likely to track in transit status events (Heaney, 2013). The findings suggest that closing gaps in inbound supply chain visibility constitutes an important step towards becoming an industry leader.

### 2.1.3 Additional Information Regarding International Shipping

#### 2.1.3.1 Advanced Shipment Notification/Notice (ASN):

An ASN is a specific kind of EDI message sent from the supplier to the buyer containing a description of the shipment that is being dispatched (Pinto, 2001). Each ASN is assigned to a PO and it usually contains information regarding times of issue and receipt for specific quantities of the ordered goods (SAP-Documentation, 2016). Other attributes of the shipment may also be provided, like the estimated time of arrival (ETA), the weight of the shipment, the number of shipped units or the production date. The supplier is expected to provide the ASN within 24 hours of shipment, and, since this is done via EDI it is expected that e-orders are accompanied by an ASN, although it is possible to get an ASNs for all kids of orders.

#### 2.1.3.2 INCOTERMS:

The International Commercial Terms (Incoterms) were first developed by the International Chamber of Commerce in 1936 and renewed several times since then, being the latest one in 2020 (Suraraksa et al., 2020). Its main role would be to minimize ambiguity amongst trading partners by clearly attributing responsibilities to buyers or suppliers (Bergami, 2012). These responsibilities encompass all aspects of international trade such as costs, risks, documentation and more, defining the exact boundary from which the ownership of the goods is transferred from the seller to the buyer (Stapleton et al., 2014). As of 2020 there are 11 conditions, 7 of which are meant for multi-modal transportation (land, air, and water) and 4 exclusively to maritime shipments (Ronai, 2020). Only 3 out of the 7 multi-modal incoterms are relevant for the present project (Figure 2.1).

**Delivery at Place, Unloaded (DPU):** When operating under the Incoterm DPU, the seller is responsible to deliver the unloaded goods to a contractually agreed upon place of destination in the buyer's country. The designated place might be a terminal of transportation, a logistics center or similar facilities such as ports, airports, railway stations or warehouses. The costs and risks are incurred by the seller until the goods arrive at the terminal. From that point onwards, these burdens are transferred to the buyer, including the clearance of goods for import at the country of destination.

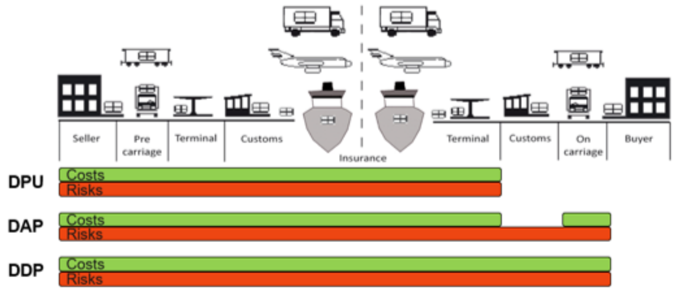



Figure 2.1: Costs and risks per Incoterm

**Delivery at Place (DAP):** Under DAP, the goods are also delivered by the seller at the place of destination in the buyer's country, but this time without unloading. When using DAP, the place of destination should be the buyer's premises and not a tranportation terminal. The seller is responsible for all costs and risks until the goods reach the buyer's facilities, except for the customs clearance cost at the country of destination.

**Delivered Duty Paid (DDP):** The Incoterm DDP is the one that assings the greatest amount of responsibilities to the seller. Under DDP, the seller is responsible for delivering the goods at the buyer's premises and bears all costs and risks of the whole transportation process. The only exception is the unloading of the goods theselves that should be performed by the buyer (AIT, 2020).

### 2.1.4 Track and Trace Technologies.

As mentioned previously, the importance of tracking a PO must not be understated and it is pertinent to understand how the tracking of physical entities takes place and the currently available technologies. Tracking is broadly defined as the process of following the location of entities in transit, while tracing is the process through which the information regarding the location of the given entity is retrieved (Kärkkäinen et al., 2004).

The application of tracking and tracing (T&T) technology can be extended to a multitude of industries, perhaps most notably its almost universal usage by parcel shipping carriers such as DHL, FedEx and UPS. Regardless of the industry to which these concepts are applied, the goal tends to be to improve the predictability of a given supply chain. For manufacturing firms, the tracking of shipments strongly influences its ability to meet customer service and contributes greatly to the management of logistics networks. Opposingly, lack of visibility may bring production to a halt or cause damaging coordination problems (Shamsuzzoha and Helo, 2011a). According to Kärkkäinen (2005) and Shamsuzzoha and Helo (2011a), some of the most remarkable reasons for implementing tracking systems include:

- Generation of exception notices, since tracking facilitates the detection of disruptions along the supply chain;
- Serving as a basis for logistical metrics and analyses;

- Enhancing the firm's capability of diagnosing and addressing weaknesses in the supply chain, which may allow for the reduction in lead times;
- Optimization of inventory management by empowering the firm to plan production or operations further ahead;
- Improvement of logistics co-ordination by establishing a link between the physical goods in transit and the information system.

Currently, there are two main ways of tracking an entity. Tracking often takes place by setting up a system of checkpoints where a given entity is identified as it concludes one or many predefined stages, resorting to an automatic identification technology such as bar-codes or radio frequency identification (Huvio et al., 2002). An alternative to the usage of this technologies would be to follow a "paper trail" by relying on logistics or transactions documentation like customs clearance. Most recently, physically attaching a GPS device to the desired vessel of transportation (e.g. ship or truck) and transmitting real-time information to a centralized system regarding the location of the vehicle and consequently its cargo has become more common.

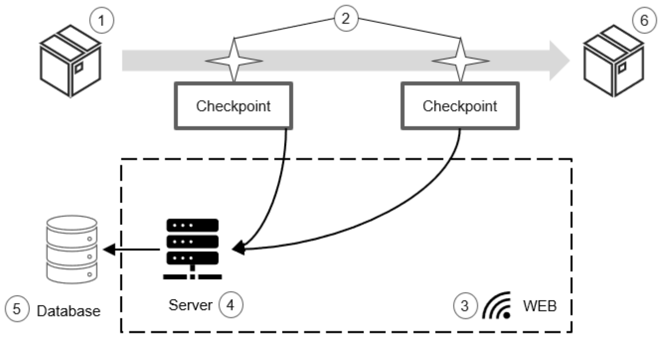



Figure 2.2: T&T system - adapted from Huvio et al. (2002)

Taking ocean vessel tracking as an example: The goods, located inside a container, would be shipped from the suppliers selected port of origin (1) to the designated port of destination (6). While in transit the vessel carrying the containers would be registered by checkpoints (2) located along the route, such as transshipment ports. At each checkpoint the information would be provided to a server which in turn stores it on a database. Usually this information encompasses at least three attributes: the location of the checkpoint itself, the identification of the entity in transit (e.g. the vessel), and the actual time of arrival (ATA) of said entity (Stefansson and Tilanus, 2001).

Tracking and tracing of logistics networks have been gaining momentum in the global SCM field. It is now considered a source of competitive advantage for manufacturing firms (Van Dorp, 2002) and key for satisfying higher customers' demands. Proper T&T systems allow for a more efficient co-ordination of logistic flows by detecting delays or other exceptional situations earlier and, consequently, mitigating its potential damage (Willersdorf, 1990).

One crucial element to increase transparency is to obtain accurate and up-to-date arrival time predictions, also known as estimated time of arrival. ETAs are particularly hard to determine for intermodal freight transport networks where goods are carried by multiple methods of transportation such as lorries and ocean vessels. The ETA information can be used as a tool for early support of operations and aid in the decision-making process for the allocation of resources. Actors along the supply chain can use ETA information to increase resource utilization and reduce risk buffers, such as safety stock and lead-time buffers. Since information is available earlier on, it is possible to automate measures to take in cases of delays by resorting to a rule-based approach or to notify customers about said delays, which tends to increase customer satisfaction. In some cases, it is also possible to alter the transportation plan mid-transit. When faced by a major delay, the company might want to change the mode of transportation (from ocean vessel to air freight for example), to avoid the delay and its repercussions.

Currently several barriers stand in the way of widespread adoption of T&T systems. Most of the available systems were designed for a single organization, therefore multi-organizational communication is still complex due to problems regarding the operational scope, the information architecture, and the accessibility of T&T information (Shamsuzzoha and Helo, 2011b).

## 2.2 Methods and Tools Employed

### 2.2.1 Multilevel Process Modeling

The present work strives to diagnose problems or inefficiencies in the current purchasing order system and proposes ways of solving those same issues. Therefore, helpful techniques of business process modeling/mapping (BPM) were used throughout the project.

Anjard (1998) defined a process as a series of activities with the goal of converting inputs into a desired output of superior value. This output can be either a product, a service or merely an information. Ron Anjard goes even further and claims that “the performance of individuals is only as good as the process will allow it to be”. According to him, most processes (especially cross-functional ones) that take place in an organization are not documented, nor are they measured or managed. As a result, no improvement is likely to occur. Process mapping is the methodology used to identify, document, analyze and improve any kind of processes.

Damelio (2011) highlighted the advantages of mapping a firm’s processes and operations. He argues that the main reason to map any process is to gain workflow visibility and gain insights on the specific task and steps that constitute a process. The concept of workflow was initially used to partition manufacturing activities into well-defined tasks, identifying roles and rules (Georgakopoulos et al., 1995). This concept has transformed itself with the introduction of information systems and computer programs which perform certain tasks and enforce pre-established rules (Sharp and McDermott, 2002).

Process mapping can, therefore, model both physical flows of goods and information flows alike. The used maps are usually either ’Relationship Maps’, which depict the organization’s segments and its many internal or external interactions, or ’Cross-Functional Maps’ (Damelio, 2011). A cross-functional map illustrates the workflow and how it “crosses” several functions inside the organization or other external entities. It is also known as a swimlane diagram, characterized by the fact that each of its bands/lanes represents one entity (e.g. department or firm) that is implicated in the business process. Each participant's lane contains several activities and the workflow is represented from left to right such that the business process or process-phase can be traced from start to finish (Georgakopoulos et al., 1995).

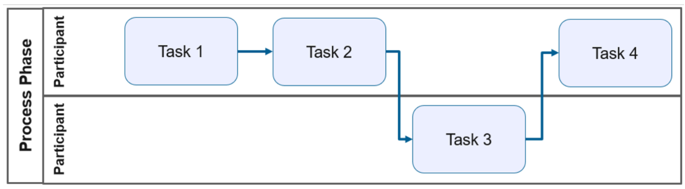



Figure 2.3: Swimlane example

Swimlane diagrams have been gaining popularity and are used as a tool to facilitate communication. Contrary to the relationship map, which only shows the parts of the organization, the cross-functional map is able to detail the work performed within each individual organizational part.

A process mapping is often completed at multiple levels of detail. This approach is called multilevel process modeling and the procedure is similar to the "peeling of an onion". All process maps must be developed using a top-down approach. Firstly, the mapping process is done at the macro-level of the process. This level is used to define the scope, boundaries, trigger and output of the business process (Anjard, 1998). Usually there are no decision points or databases at this level and the analysis can be aided by a 'fact sheet'. The second level of detail zooms onto the multiple phases of the process and represent each by the aforementioned swimlane diagram. While being more detailed, on this level the visual representation should be as simple as possible and therefore referring back to previous actions should be avoided as this breaks the linear flow of activities (Jacka and J. Keller, 2009). Finally, activities inside the swimlane diagrams can be further broken down by the usage of flowcharts, which aim at clarifying any potential ambiguity of the considered task.

### 2.2.2 Forecasting Evaluation Metrics

A component of the present dissertation will be the comparison of forecasting data from multiple providers, regarding the estimated time of arrival of a given container to its port of destination (POD). Therefore, literature about the evaluation of forecasts in general and the quality assessment of ETAs are of particular interest for the project.

Error measures, also called performance metrics, have integrated the evaluation framework of multiple fields. One of them being forecasting, which resorts to performance metrics to quantify the deviation of the predicted value from the actual observed one, and may support supply chain management (Botchkarev, 2019). No single forecasting accuracy measure is superior in all aspects and for all applications to all the others. Therefore, the choice of the accuracy measure is necessarily subjective, however it is highly influenced by the nature of the data (Chen and Yang, 2004). The exact categorization of errors measures is not agreed upon on the current literature. Hyndman and Koehler (2005) opted to divide them into the following groups:

- Scale-dependent measures;
- Percentage-error measures;
- Relative-error measures;
- Scale-free error measures.

Scale-dependent metrics are based exclusively on scale-dependent errors (Hyndman and Athanasopoulos, 2018), meaning that errors are expressed in the same units as the data (variable of interest) under analysis (Botchkarev, 2019). This category comprises measures such as MAE, MBE and RMSE.

The Mean Absolute Error (MAE) measures the average magnitude of the error while disregarding the direction of the deviation itself. Being simply the average of the absolute difference between the predicted value and the observed one, all individual differences have the same weight. Its popularity can be attributed its ease of understanding and computing (Hyndman and Athanasopoulos, 2018) and it is appropriate when the costs incurred are proportional to the forecasting error (Notton and Voyant, 2018). It can be described by Equation 2.1, where $y_i$ and $x_i$ are the actual observed value and the predicted value respectively.

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|y_i - x_i| \tag{2.1}$$

When the actual deviation is considered instead of the absolute deviation, positive and negative errors partially cancel each other out and the result is the Mean Bias Error (Eq. 2.2). The MBE represents a systematic error of a forecasting model to under or over forecast (Kato, 2016).

$$MBE = \frac{1}{n}\sum_{i=1}^{n}(y_i - x_i) \tag{2.2}$$

Root Mean Squared Error is more sensible to larger forecasting errors than to smaller ones. Hence it should be used when small errors are tolerable and result in little costs, but large errors are particularly undesirable and damaging (Notton and Voyant, 2018). There is no consensus regarding the reliability of RMSE for comparisons across series. Some argue that economic consequences should not be evaluated by forecasters, but by planners and decision makers (Armstrong, 2001) and point out that its lack of reliably is exacerbated by mistakes or outliers in the dataset (Armstrong and Collopy, 1992). Despite criticism, RMSE is still widely used in both an academic and business environment for its unique features (Fildes and Goodwin, 2007). Another disadvantage of RMSE, comparatively to MAE, is its difficult interpretation.

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(y_i - x_i)^2} \tag{2.3}$$

The remaining categories are all scale-independent and, therefore, Botchkarev (2019) argues that only two categories should be considered, scale-dependent and scale-independent, being included in the latter: percentage-error measures, relative-error measures and scale-free error measures.

The most popular percentage-error metric, and error metric in general, is the Mean Average Percentual Error (MAPE), which has the advantage of being easy to interpret and explain. However, being a percentual-error, it takes infinite or undefined values in the presence of a zero (0) in the data series, has the disadvantage of placing a heavier penalty on positive errors (Hyndman and Koehler, 2005) and large percentual errors are prone to appear when the value of the original series is small (Chen and Yang, 2004).

$$MAPE = \frac{100}{n}\sum_{i=1}^{n}\left|\frac{y_i - x_i}{y_i}\right| \tag{2.4}$$

The last two categories shall not be further explained as they will not be approached throughout the present project.

An assessment of the available literature regarding the evaluation of ETA forecasts was also conducted. In predicting ETA for commercial flights, Ayhan et al. (2018) resorted to RMSE as a metric for the forecast evaluation. This approach was also chosen by Roy et al. (2006), also in the context of estimating the time of arrival of aircrafts. In 2019, in forecasting the ETAs of cargo trains along a railway section, Prokhorchenko et al. (2019) opted for MAE as the criterium of comparison. Lastly, Konstantinou (2019) used both MAPE and RMSE to assess the quality of multiple machine learning algorithms and their ability to estimate the time of arrival of a truck.

### 2.2.3 Relevant Technologies

#### 2.2.3.1 Extract, Transform, Load

Extraction-Transformation-Loading (ETL) processes are software processes designed to ease the loading and periodic refreshment of data warehouse contents (Vassiliadis, 2009).

The first step of the ETL approach consists in extracting data from multiple heterogeneous sources such as flat files or databases (Vikas, 2009). Secondly the retrieved data undergoes a sifting and purging procedure which resorts to query tables or other appropriate tools to convert it into its ideal state for the desired application. This phase includes processes of cleaning, copying, interpreting, arranging and checking consistency of the data at hand (Tayade, 2019). Lastly, the transformed data is loaded onto the designated database.

#### 2.2.3.2 Application Programming Interface

An application programming interface (API) is a shared boundary across which information is exchanged by different software entities. It defines the calls and requests of information that are possible to execute, as well as general rules of how to make them.

Web APIs are the interfaces used between an enterprise and applications that utilize their data or informational assets. They are responsible for specifying the data provider and the respective URL for its API-users (Rudrakshi et al., 2014).

### 2.2.4 Leading Change

No developed initiative serves any practical purpose in an organization, unless it is widely adopted and becomes part of the firm's mode of operating. As the common saying goes "no man rules alone", and it is hard to overstate how important it is to remember these words when trying to enact change. Therefore, a review of the current models and reasons to lead change was carried out. Change in the modern world occurs faster than ever before and, the inability to adapt has resulted in the downfall of organizations that were, at one point in time, considered industry leaders. As a result, efficient change management has become one of the most critical skills that any organizational structure can possess. This is not to say that change is always a force for good - rather that change is inevitable (Qadri et al., 2015).

Change management can be defined as the process of continuously recalibrating a firm's direction, capabilities or structure in order to better serve its employees and the marketplace (Moran and Brightman, 2000). However, it is also relevant to state that change management activities may be constrained to a specific area, such as a specific business process or system functionality (Qadri et al., 2015).

#### 2.2.4.1 Kotter's 8 Step Change Model

In his book 'Leading Change', first published in 1996, John P. Kotter strives to provide a useful framework for change management. The book describes a step-by-step approach that will prove itself useful for the actual roll-out of the present project and can be summarized as follows (Kotter, 2012):

1. *Establishing a sense of urgency* - This comes from market examination and its competitive realities, which allows for the identification of current and potential crisis or opportunities.
2. *Forming a powerful guiding coalition* – An powerful-enough and cohesive group should be assembled to lead the change effort.
3. *Creating a vision* – The vision should direct the changing efforts, making the team develop strategies to achieve it.
4. *Communicating the vision* - Vision and strategies must be communicated internally to exhaustion as a way of clarifying the direction of the organization.
5. *Empowering others to act on the vision* – A leader must try to remove obstacles to change and endorse others in their pursue of risk-taking or non-traditional ideas.
6. *Creating short-term wins* – Performance improvements must be clear and visible to everyone as a way to motivate all parties.

7. *Consolidating improvements* – The increased credibility earned by the new system should be leveraged to change the structures and policies that do not fit the desired vision.
8. *Institutionalizing new approaches* – Establishing connections between the new behaviors and enhanced corporate success and anchoring changes in the corporation's culture is of paramount importance.

#### 2.2.4.2 Resisting Change

Almost every change initiative will face a cycle of resistance to change. Starting by the denial of the problem, followed by the recognition of the need to change, tailed by an agreement on the required change and lastly the search for a solution. To make matters worse, usually different groups within the organization go through these phases at different paces, starting with the executives and slowly descending the multiple layers of the firm. Change leaders must balance order and stability required by its employees with adaptability and readiness for transformation (Moran and Brightman, 2000).

Finally, it is important to mention that sometimes the external environment 'makes the leader'. Often, perceived crises act as catalyzers for change and force organizations to adapt and leaders to emerge (Paglis and Green, 2002). A great leader should be able to 'tell a story' and craft a convincing narrative, guiding the organization through the desired path (Ganz, 2010).

# Chapter 3

# Analysis of Current Situation

The present chapter aims at providing a comprehensive overview of the purchasing order system that Continental has currently in place. The analysis of the *AS-IS* state allows for the recognition of flaws or inefficiencies throughout the whole process. The mere identification of potential issues is already valuable on its own, but the ultimate goal is to develop solutions to mitigate, eliminate or even transform these problems into potential sources of competitive advantage.

The methodology used to understand the purchasing order system, and gain insights on its multiple phases, was the Multilevel Process Modeling. Using this methodology, the process is partitioned into several sequential phases (Figure 3.1) with milestones in-between. Additionally, the responsibility of each phase is assigned to one or several participants and each phase is further divided into smaller steps. Then, a responsibility matrix is developed (Figure 3.2), and the multiple steps of each phase can be represented using swimlane diagrams which will be showed throughout this chapter. The first step must be the definition of the process boundaries. The PO process was determined to start with the recognition of the need for a certain RM, and finish with the payment of the delivered stock of RMs at one of Continental's plants.

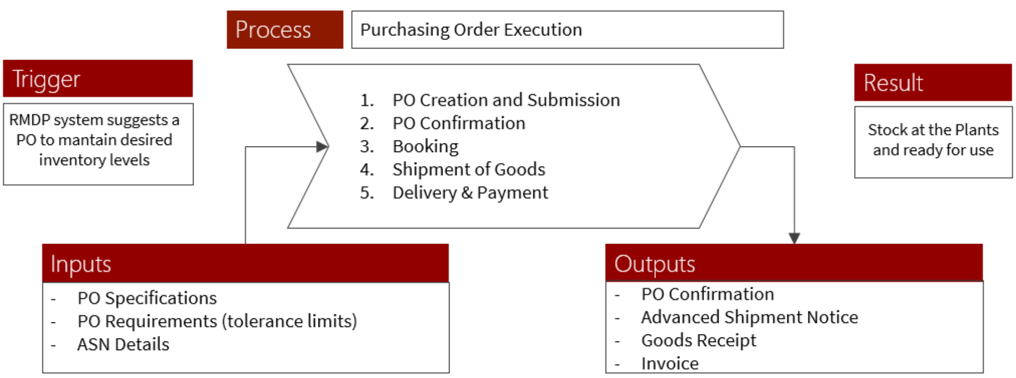



Figure 3.1: Business process factsheet

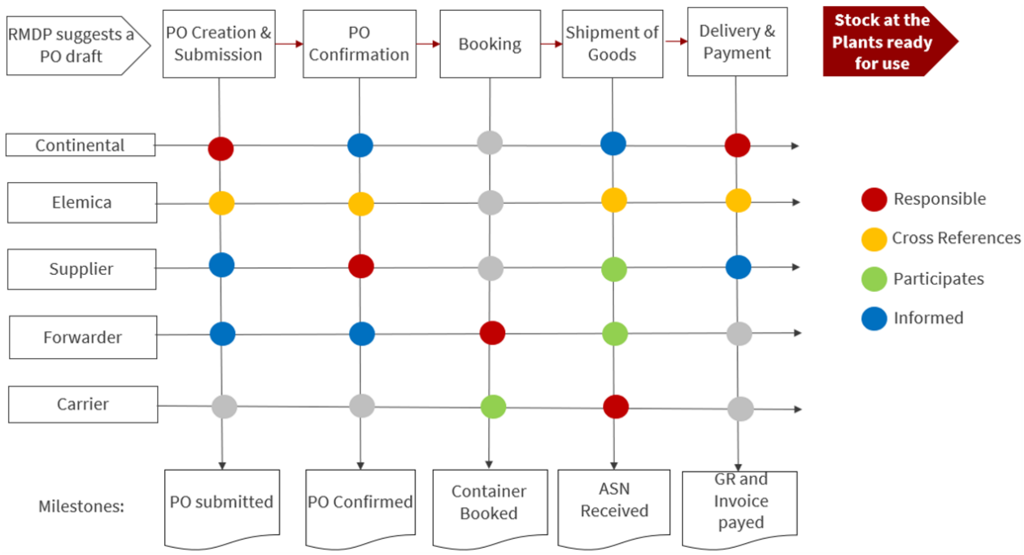



Figure 3.2: Business process responsibility matrix

## 3.1 Process Phases

### 3.1.1 Business Process Trigger

Continental has an automatic system in place responsible for the identification of potential shortages of raw materials and suggestion of actions to avoid such scenarios. This system is running on the SAP and it is denominated Raw Materials Demand Planning (RMDP). It operates as follows:

Information about the tire production demand (finished goods) based on already placed POs and order forecasts from customers are combined with the respective tire specification present in the Bill of Materials (BOM) in SAP P20, which is the global manufacturing platform. Here the tire production demand is adjusted to machine availability capacity/constraints, resulting in a global predicted demand for each date and each RM (RM demand). Afterwards the information is translated to the regional SAP TEMPO system like EMEA P50, which is the SAP system for Europe, responsible for the inbound and outbound operations. In P50, the supplier and packaging specifications are attributed to the required RM and an MRP (Material Requirement Planning) run takes place considering the current levels of inventory, RM demand, open POs, lead times and safety stocks required. When the predicted inventory in any point in the future is below the safety stock, a potential PO is drafted, and the responsible party is notified. This PO draft is called a Purchase Requisition (PR) and only contains partial information for the final PO. Usually it contains the Material ID, the quantity to be ordered, the required delivery date and the preferred supplier.

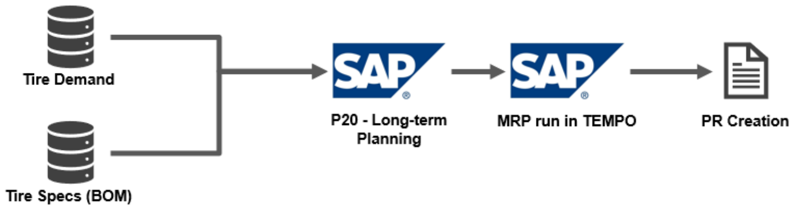



Figure 3.3: RMDP Run

### 3.1.2 Purchase Order Creation and Submission

After checking the RMDP system, Continental's purchasing department is responsible for completing the PR and converting it into a PO. This must be performed by an employee because a PO is a legally binding document and it would not be wise to leave such responsibility exclusively to an automated system. Yet, as the data quality of inputs such as the ETA increase, a fully automated system becomes an ever-closer reality. At this stage the designated buyer should initiate the creation process of a PO, add any extra information he deems necessary to the PR and confirm or edit what was proposed by the RMDP system. At this step it is also important for the buyer to provide the 'confirmation control key', the 'quantity tolerance' and whether or not an acknowledgment of the PO submission in needed from the supplier's side. The 'confirmation control key' is a small code sent to suppliers that specifies the accepted deviation of the confirmed delivery date to the requested one, within which the PO will automatically be accepted by the system. The 'quantity tolerance' is self-explanatory and specifies the percentage (based on the ordered quantity) up to which an over/under-delivery of an item will be accepted.

Lastly, the PO is ready to be saved and sent to the supplier via EDI - being Elemica the designated EDI service provider. After submission, changes to the PO are still allowed as long as the supplier is informed, and such changes acknowledged.

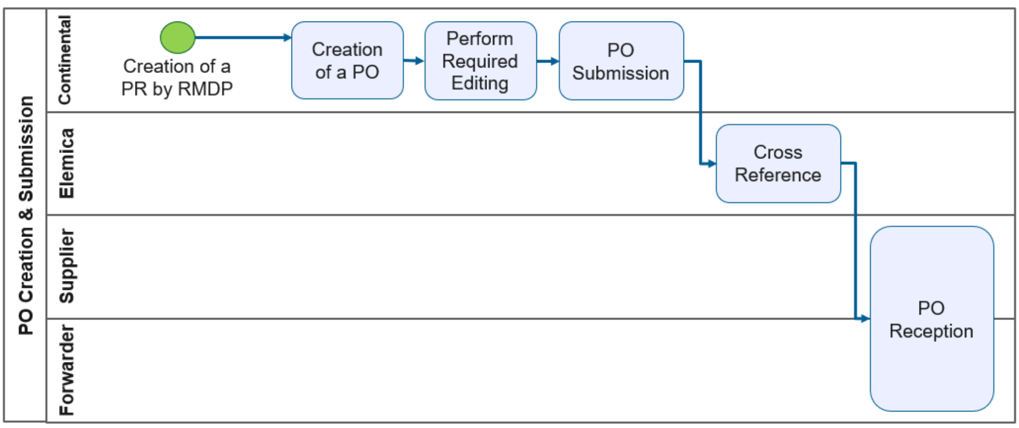



Figure 3.4: PO creation & submission (swimlane)

### 3.1.3 Purchase Order Confirmation

Once the PO is received by the supplier, it should check the PO specifications/requirements and complete the PO fields regarding the committed delivery date and committed quantity. These fields specify the delivery date and quantity agreed upon by the supplier. From the moment the PO is received, the supplier has 48 hours to submit the PO confirmation via EDI. If the committed delivery date and quantity are within the tolerance limits the PO is indeed confirmed and its confirmation is added to Continental's system, updating the RMDP and sent to the forwarder. If the supplier did not comply with the tolerance limits proposed by Continental, the PO can either be manually accepted or updated and sent back to the supplier, who must confirm the updates before the new PO confirmation is added to the system.

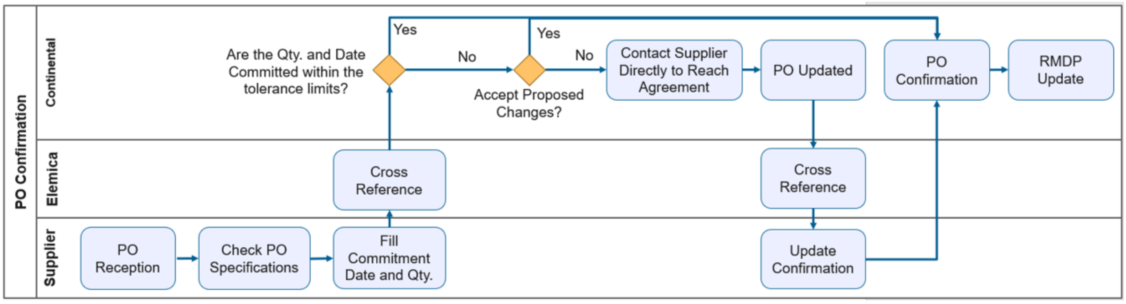



Figure 3.5: PO confirmation (swimlane)

### 3.1.4 Booking

Upon receiving a PO confirmation, the forwarder is the entity responsible for performing a container booking request. This request must be confirmed by the carrier, which is the company actually operating the vessels, and the forwarder must inform the supplier that the shipment is ready.

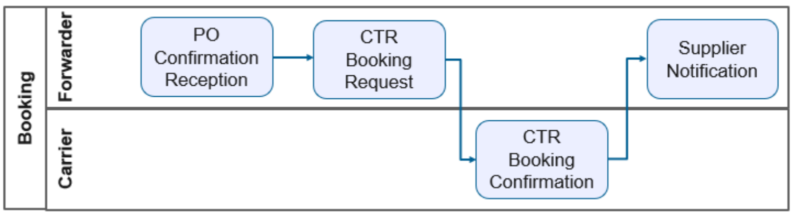



Figure 3.6: CTR Booking (swimlane)

### 3.1.5 Shipment of Goods

At this phase, the supplier has met all the conditions necessary to initiate the shipment of goods. When the RMs leave the supplier's facilities, the supplier has 24 hours to create an ASN and submit it via EDI to Continental. The ASN is a detailed document with information regarding a pending delivery, and the cornerstone of any delivery tracking initiative. It is composed by 7 **mandatory** fields and 3 optional ones, that can be filled by the supplier.

- **Shipped Date:** date of departure
- **ETA at Plant:** Estimated day of arrival at the Continental plant
- **Shipped Qty:** total net weight of the shipment
- **Gross weight:** total gross weight of the shipment
- **# of Ship Units:** number of shipped packages (pallets, rolls etc.)
- **ASN#:** The shipping reference number
- **Lot Details (Lot #, Lot Qty, # of Ship Units and Production date)**
- Carrier: the name of the carrier
- Trailer# or CTR#: license plate of the trailer or container number
- BL: Bill of Lading number

Perhaps the most notable field is the ETA at plant, which provides the date that the supplier expects cargo to arrive at the specified Continental facility. This ETA updates once again the RMDP and it can be updated by the supplier at any time. In theory the burden of tracking the shipment could be on the supplier's side and, consequently, every time the supplier had access to a more recent ETA, it should be communicated to Continental. In reality, this is rarely the case and the vast majority of suppliers do not proactively update the ETA provided mid-trip.

Assuming the journey was successful, the container arrives at the port of destination (POD) and the forwarder is responsible for arranging the on-carriage of the cargo. The forwarder must arrange the delivery and book a delivery time slot at Continental using the TIME platform, which is tool used by Continental to schedule the unloading of a truck at the warehouse.

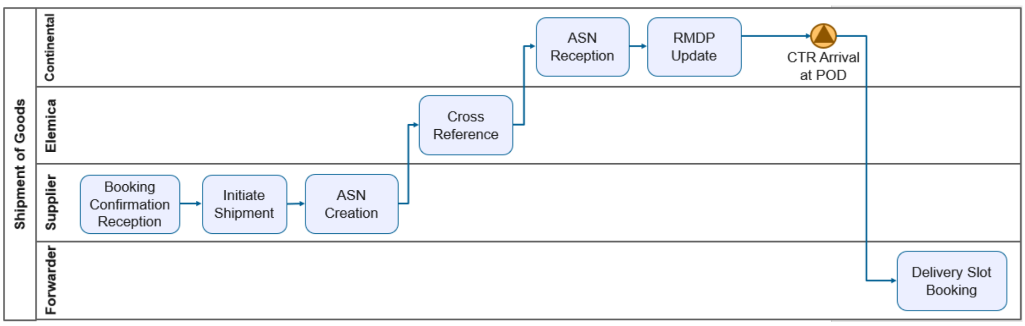



Figure 3.7: Shipment of Goods (swimlane)

### 3.1.6 Delivery and Payment

As the on-carriage is coming to an end, Continental must prepare itself for the reception of the goods. The delivered RMs are unloaded and stored at the RMs warehouse and the RMDP is updated. A Goods Receipt is created based on the ASN and sent to the supplier via EDI. The payment of the invoice sent by the supplier marks the end of the entire business process.

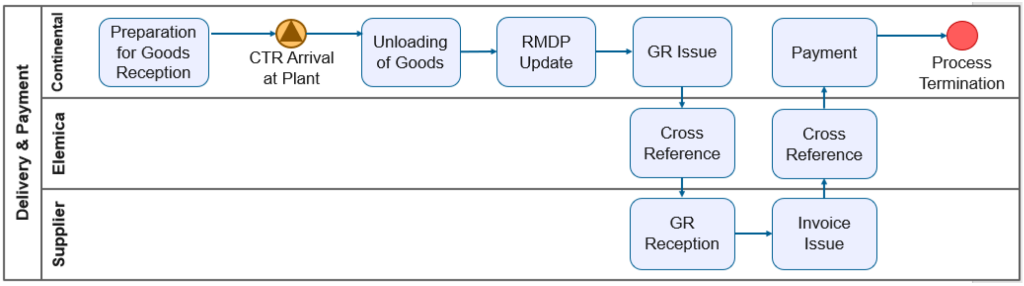



Figure 3.8: Delivery & payment (swimlane)

## 3.2 EDI and E-orders Connection Types

Throughout the whole process, the connection between the multiple participants has been largely dictated by the EDI provider. In this case the provider is Elemica, a software company responsible to manage the necessary interactions between the several involved parties and serves as the interface through which PRs, POs, ASNs and other documents, are submitted and/or confirmed. It is of paramount importance to understand how exactly these interactions take place and deep dive into the multiple connection types that shape them.

Currently, Continental has at least some form of EDI established with 90% of its suppliers. However, any supplier with any kind of electronic data interchange in place with Continental falls under this category, so the 90% figure might be deceiving since it is possible for a single supplier to have one, two or three EDI connections at once. EDIs can be established in 3 different steps along the business process.

- **E-Order EDI:** An EDI can be set up in the ordering process itself, which mediates all interactions regarding PO and ASN submission and/or confirmation between the supplier and Continental, as well as GR and invoice issues. These EDI processes are called E-orders.
- **OCEAN EDI:** Another EDI process that can be present between Continental and some designated forwarders (DHL and Kerry Logistics) is called OCEAN EDI. In this exchange, the PO submission and confirmation is automatically sent to the forwarders by Continental.
- **TIME EDI:** Lastly there might also be in place an EDI connection between the forwarder and Continental for the unloading slot management solution TIME. TIME is an up-to-date online calendar-application that enables suppliers to check availability and book time slots for a delivery at Continental's premises.

The interactions mediated by OCEAN and TIME EDIs, while nice to have, only add convenience and agility to the process, not providing any extra shipment information to Continental.

However, suppliers with an EDI connection allowing for the placement of E-orders are automatically bound to send an ASN with each shipment, which provides a series of new information that the buyer did not have access otherwise (such as the ETA at plant).

Currently, the E-order share by PO-line is around 70%. A PO-line or PO-line item corresponds to at most a full truck load (FTL) worth of materials and multiple PO-lines can be included into a single PO. E-order EDI connections can be further divided into two categories designated Regular Electronic POs (ePOs) or Vendor Managed Inventory/ Vendor Managed Owned Inventory (VMI/VMOI). Regular Electronic POs account for over 98% of E-orders and POs electronically submitted by Continental to the vendor fall under this category. In VMI/VMOI the vendor is the one responsible for placing an E-order based on Continental's demand forecast and minimum and maximum stock level settings in Elemica. The only difference between VMI and VMOI is that raw materials in VMOI are with consignment, meaning that Continental does not pay for the materials until they are consumed by the production process.

### 3.2.1 E-orders Connection Types

For the aforementioned E-orders, the EDI connection between the supplier and Continental is performed by a product of Elemica called "Elemica O2I" (order to invoice). Elemica O2I offers two types of connection, which are different in nature: Portal and Hub.

- **Portal:** Consists in a 'System to Portal' connection between Continental and the supplier. Where the SAP system of Continental exchanges information electronically with Elemica, while the supplier must log onto the online portal with its credentials and insert the relevant information for the PO and ASN manually. This connection type is usually adopted for medium size suppliers that provide Continental between 50 and 500 FTL worth of goods every year.
- **Hub:** It is a 'System to System' connection between Continental's SAP system and supplier's order management system (SAP/Oracle/etc.), where all information is exchanged electronically and automatically, with reduced human intervention. Hub is the preferred connection type with large suppliers that supply 500 FTL or more per year.

As stated previously, only 70% of all orders are E-orders, being the remaining 30% manual orders also designated non-E-orders. Manual orders are characterized by the lack of automatic information interchange between Continental and the supplier's system in what regards the placement and confirmation of POs. In these cases, information regarding the PO itself is exchanged solely via e-mail, fax or over the phone. Not only are these orders more prone to human errors, they also almost never provide Continental with the ASN information as it would be very time consuming. Fortunately, Continental and Elemica have developed a system called Quicklink that aims at solving this exact issue.

- **Quicklink:** Consists in a sharable link that Elemica can send via e-mail to the supplier with a 'one-time' portal connection. This allows the supplier to access a webpage that works like the Elemica Portal and input all the required fields of both the PO and the ASN. This way the process is still manual for the supplier but automatic for Continental. Currently, manual connections take place between Continental and small suppliers that send less than 50 FTL per year to Continental's facilities, and Quicklink will allow them to place E-orders instead.

In sum, orders can either be E-orders (70%) or manual orders (30%). E-orders can be regular ePOs or VMIs depending on whether it is the responsibility of Continental or the supplier to place the PO. These E-orders are currently executed through the EDI service provider Elemica via either Portal or Hub and provide Continental with the appropriate ASN. Manual orders do not provide Continental with ASN but the situation can change by the implementation of Quicklink. The ideal scenario would be to have 100% of the suppliers connected via EDI for the placement of E-orders.

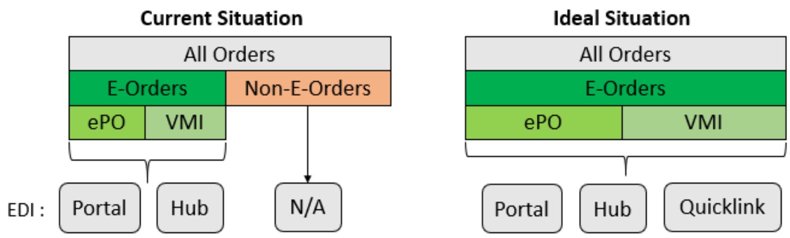



Figure 3.9: Current vs Ideal EDI connection situation

## 3.3 Delivery Terms

In this subsection the terms of delivery will be explored as they are a rather important part of the process and any changes to the current purchasing order system would have to take them into account. Firstly, the most relevant International Commercial Terms (Incoterms) for continental were already described in chapter 2.1.3.2 and its implications will now be discussed. Secondly the two possible alternatives of delivery terms employed by continental will be clarified.

### 3.3.1 Detention and Demurrage Costs

Having estabished the Incoterms most comonly used by Continental it is possible to check for potential sources of extra-costs that the firm might have to incur in case some of its obligations are not fulfilled.

Continental has a set amount of time to complete the container pickup, if aplicable, and the return of the container to the port. In both DPU and DAP Incoterms, Continental is liable for exceeding the 'free-time' that it is entitled to if it delays the customs process or if it delays the unloading and return of the container. Under Incoterm DPU Continental is also liable for delaying the container pickup from the designated terminal and the average exceeding charges are around 100USD per day, which is a heavy fine compared to the alternative of storing the container in the warehouse. Regarding the Incoterm DDP, there is only one way for Continental to violate the agreed 'free-time', which is a delay in unloading and returning the container to the designated port. All of the previously mentioned violations result in preventable costs. Increased costs inevitably result in lower margins for the company and, therefore, its avoidance could be a sorce of competitive advantage. In sum, Continental is liable for free-time violation on the scenarios described in Figure 3.10.

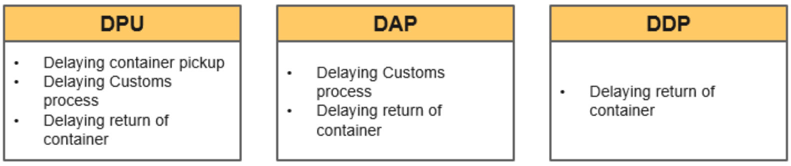



Figure 3.10: Sources of detention and demurrage costs per INCOTERM

### 3.3.2 Conti D-terms vs Supplier D-terms

Continental classifies the kind of relationship with its suppliers according to whether they operate under Continental delivery terms (Conti D-terms) or under their own delivery terms (Supplier D-terms).

For a supplier to be under Conti D-terms there are some requirements that must be met. Firstly, there must be a contractual relationship with said supplier on DPU, DAP or DDP Incoterms. The Incoterm chosen will influence the logistic costs incurred by Continental. Secondly, the supplier must be using one of Continental's designated forwarders, which, at the time of writing, can either be Kerry Logistics or DHL. Under Conti D-terms, the forwarder is connected via EDI to Continental's SAP system to allow for the exchange of information regarding the placed POs (OCEAN EDI connection). The forwarder should then proactively contact the supplier to arrange the shipment based on the agreed upon PO delivery date, which is the ETA at plant. This way, shipments from suppliers under Conti D-terms can be registered on the forwarders database and consequentially tracked by the forwarder. Having suppliers under Conti D-terms presents significant advantages for Continental. It increases supply security, ensures a smother customs process, increases the flexibility in near-shortage situations and can help to avoid origin taxation of ocean freight as overseas logistics are not taxed in the European Union.

If a supplier is not under Conti D-terms it is almost certainly operating under Supplier D-terms. In this scenario the supplier is solely responsible for arranging the delivery of goods using a forwarder of their choosing. There is also a very small share of deliveries performed under F-terms, where Continental is responsible for the shipment, but these are so rare that they were not further considered.

## 3.4 Summarizing Relationships and Connections with Suppliers

First and foremost, tire plants' suppliers can be divided into internal suppliers and external suppliers. The three largest internal suppliers of Continental are C-ITA, Aldora Mills and Continental

Tires Holdings Singapore (CTHS). C-ITA and Aldora Mills are producers of textile reinforcements, while CTHS is the main supplier/reseller of natural rubber (NR). It is also important to mention that all of these internal suppliers have external suppliers of their own, which means that they occupy both the position of buyer and supplier inside Continental.

The external suppliers' relationship with Continental differs according to the kind of EDI connections in place (or lack thereof). Figure 6.1 attempts to summarize all the different methods employed by Continental to establish a connection with the external suppliers:

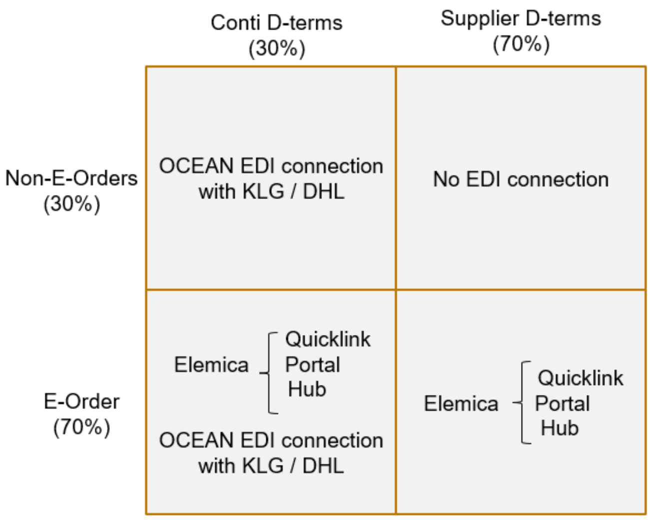



Figure 3.11: Kinds of external suppliers EDI connections

With the present overview it becomes apparent that the PO process modeled throughout the subchapter 3.1 was developed with a couple of assumptions in mind. The purchasing order process modeled assumes that the supplier is external to the company and has both an EDI E-order connection established and is operating under Conti D-terms. The process was modeled for this particular case as it is the most complex branch of them all and the ideal scenario for external suppliers to be operating in. What this means is that, as Continental moves into the future, more attempts will be made to get all external suppliers to be placing E-orders and operating under Conti D-terms.

## 3.5 Identification of Potential Inefficiencies and Visibility Gaps

Much deliberation and many meetings with the ISCM team were held to determine what were their suggestions on what phases of the business process were in need of improvement. There seemed to be a consensus that the major cause of inbound shipment delays was taking place during the ocean transport of RMs. The 'shipment of goods' phase is, incidentally, the business process phase that takes the longest and in which the firm most notably lacks visibility over the process. From the moment a PO is confirmed until the goods arrive at the designated POD, the only shipment status that can be received by Continental's system is the ASN which contains an ETA at plant.

As mentioned previously, this ETA at plant is rarely updated by the supplier, effectively limiting the ability of Continental to track shipment status and react accordingly.

Currently, when Continental faces an imminent RM shortage situation, it has limited resources to track the shipments that carry the required goods. Fortunately, the designated forwarders offer some resources to aid the company in tracking its shipments. Both DHL and Kerry Logistics provide Continental with what they labeled as “daily reports”. These reports are Excel files sent by e-mail to each plant by their specific assigned forwarder and contain a list of all on-going shipments and several already-completed ones. For each shipment it is provided an ETA at POD, which can be valuable information. However, this solution presents considerable drawbacks:

1. Contrarily to what the name suggests the “daily reports” are not updated daily, usually Continental gets two or three reports a week for each forwarder.
2. The data is largely perceived as unreliable by the plants and therefore the information regarding the ETA is not taken at face value.
3. The reports are sent by e-mail instead of being integrated into Continental’s SAP.
4. Reports only contain information regarding the incoming shipments sent by suppliers operating under Conti D-terms as those are the ones performed by the designated forwarders.

Another solution employed by the plants to track their cargo involves getting the information regarding the container number (CTR#) or bill of lading (BL) and the carrier name of a particular shipment. This can be obtained either by directly asking the supplier or by resorting to one of the “daily reports” depending on whether the supplier is under Supplier D-terms or Conti D-terms respectively. After retrieving the necessary data, an employee must search for the T&T solution present on each Carrier’s website and insert the CTR# or BL. Then, the carrier should return an ETA for the shipment. Yet, this solution presents problems of its own. The whole process is very labor-intensive and time-consuming, the data is often deemed as unreliable and getting the CTR#, BL and carrier name is not always easy. Besides, the information is not centralized, so for each shipment the employee might have to visit a different carrier’s website.

One more issue was brought up when discussing potential inefficiencies in the business process. As stated previously, if Continental exceeds the free-time that a container is allowed to be at the POD waiting for pickup or if the company takes too long to return said container, additional fees must be paid. These fees are then billed to Continental and there is no reliable system in place to verify the legitimacy of such charges or any way to have an overview of the containers in danger of exceeding free-time and attempt to avoid the situation altogether.

Before any solution can be proposed it is important to state the assumptions made. It is assumed that, by the time the present project is implemented, Continental will not yet have established an EDI connection with 100% of its suppliers. However, Quicklink will already be in place and allowing for the placement of E-orders even for the smallest of suppliers. The company could ideally have an 100% ASN coverage by the time the proposed initiative is employed, nonetheless, the system was designed to be more resilient and account for the transition period since not all suppliers will agree to start placing E-orders right away.

# Chapter 4

# Proposed Solution: Delivery Tracking

From the previously identified vulnerabilities in the incoming supply chain, it was decided that a delivery tracking initiative was to be tested. The goal of such project would be to design, test and implement a system to provide plants with the most reliable and up-to-date ETAs possible for their respective incoming shipments. This would take place with the help of specialized third-party service providers. The tracking of the containers would take place during the "Shipment" phase of the business process, namely from the moment Continental receives an ASN until the arrival of the shipment at the POD (Figure 4.1). This is the phase that takes the greatest amount of time and the main source of delays.

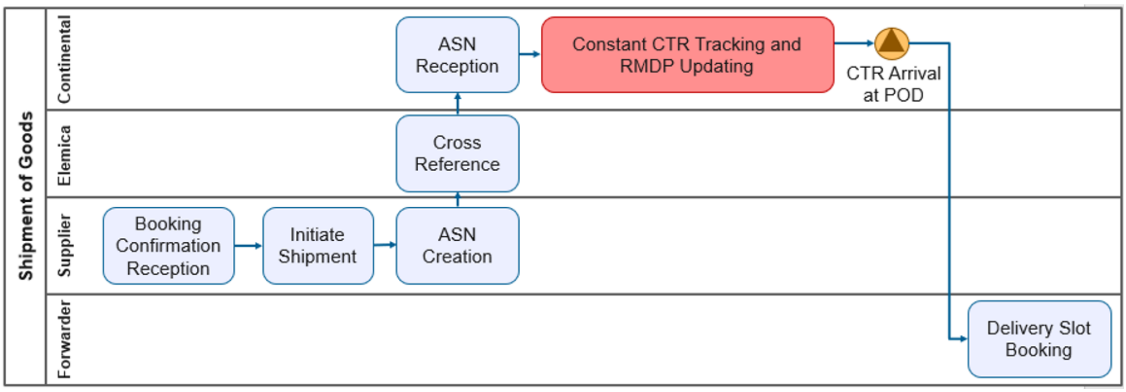



Figure 4.1: Proposed solution: shipment of goods (swimlane)

## 4.1 Presenting the Tracking Data Providers

First and foremost, it was necessary to scout the market for already-available track and trace tools. These tools are offered by data providers that specialized themselves in gathering information regarding the shipment of goods all around the world and make it available to interested parties through an API or a web-based solution.

Initially, 13 different data providers were scrutinized to check whether or not they met the requirements for being considered for the testing phase. The set of criteria used was the following:

- The provider offered an API option to retrieve the desired data;
- The provider's data was available for all regions of the world and for most countries;
- The provider offered ocean tracking;
- The provider covered the three major carriers used by Continental, which were the Mediterranean Shipping Company (MSC), Maersk and Hapag-Lloyd.

Failing to meet one or more of these requirements would automatically disqualify the data provider. No relevant information was available for 2 of the providers and therefore they were immediately disregarded. All the remaining 11 providers offered some sort of API option and covered most of the world, therefore these criteria did not narrow down the pool of candidates. Regarding ocean tracking, it was found that 2 of the providers did not offer this service at all and another 3 providers were using external sources of data for this mode of transportation.

Table 4.1: T&T data provider classification

| **T&T Data Provider** | **Status** |
|---|---|
| Infor Nexus | Not enough information available |
| Transporeon | Not enough information available |
| Consignor | No Ocean tracking |
| Descartes Macropoint | No Ocean tracking |
| Sixfold | Relies on external partner for data |
| Synfioo | Relies on external partner for data |
| Project44 | Relies on external partner for data |
| Searates | Meets Criteria ✓ |
| Ocean Insights | Meets Criteria ✓ |
| Vizion API | Meets Criteria ✓ |
| Fourkites | Meets Criteria ✓ |
| Cargosmart | Meets Criteria ✓ |
| Shippeo | Meets Criteria ✓ |

After the elimination process, only 6 data providers met the criteria. It was decided by the head of the ISCM team that Continental would be considering the following providers for a trial period: Ocean Insights; Searates; Vizion API. This was the case since these 3 options where the ones recommended by Continental's trusted sources.

The assessment of the data providers quality required a testing period which was divided into three phases. The first one was the pre-testing phase, where the system to perform the API calls to retrieve the ETA of incoming shipments would be set up. The second one was the actual testing phase, which lasted for nearly 2.5 months. This is the period when data for quality assessment was actually being gathered. The last phase was called post-testing phase and consisted in a period of another 2.5 months where the tested tools would still be available.

During the pre-testing phase, some issues were starting to be noticed with the provider Vizion API. When multiple API calls were performed at the same time, which was almost always the case, Vizion API often blocked the API calls and error messages would pop-up. Plus, a lack of data availability for many shipments and poor data transparency lead Continental to halt further tests with Vizion API until the identified issues are solved. Therefore, this provider will not be further mentioned.

### 4.1.1 Searates

Searates is a small subsidiary of the Dubai-based giant DP World. The data provider offers a simple 'Container Tracking' tool that merely aggregates the shipments' data from each of the carriers' websites. There are two ways of retrieving the aggregated data from Searates. One can use its online platform or perform an API call.

Searates' online application requires the user to insert the CTR# and, based on its initial characters, Searates tries to find the designated carrier. This is sometimes possible since the container numbers can convey information regarding the ownership of the container. In cases where the designated carrier is not clear, Searates will ask the user to specify it. Once the CTR# and the carrier name are inputted, the application will display the ETA at POD, the multiple past and future milestones for the container, and a map that estimates where the vessel carrying it should be located. Yet, this map is a mere estimation of the container location and it is not based on any real GPS tracking system. The retrieved container information can then be stored and organized in folders to ease multiple accesses to the same container. Still, each update of the container information consumes an API call and can result in increased costs. Screenshots of the Searates' layout can be found in Annex A.1.

### 4.1.2 Ocean Insights

Ocean Insights presents itself as a more well-rounded tool with extra functionalities. The privately held company was founded in 2012 in Germany and counts with around 90 employees. It works with data from 70 different carriers and claims to offer the best ETA forecasts in the market. Ocean Insights does not simply aggregate the data from the carriers. It gets its data from the carriers' websites, ports and terminals, and other vessel tracking tools. Additionally, a layer of human and artificial intelligence is present in order to interpret the forecasting data and improve its quality and completeness.

From a user point of view, the required inputs are the designated carrier and the subscription reference number (SubRef#). This number can either be the CTR#, the BL or the Booking number. Additional fields like the contractual ETA, tags, and a description can be provided to complete the container information or to facilitate its organization and filtering.

Once the containers are added to the platform, it is possible to have an overview of all the current and past shipped containers, as well as an array of filtering options. A common practice is to introduce the PO number, supplier name and material code in the description to easily filter the containers belonging to one of these categories.

If a particular container is selected, it is possible to check all the available details about it. The web-application allows for the visualization of an accurate map of the journey with both the typical route and the actual route of the vessel. Also, it is possible to consult the various milestones with great detail and obtain both the planned date of arrival and the predicted date of arrival at POD. The planned date or 'planned ETA' of a certain container corresponds to the last ETA provided by the carrier. The 'predicted ETA' is given by Ocean Insights' system based on its multiple sources of data. For comparison purposes, the contractual ETA can also be displayed if the user inserted it into the system. The tracking process also informs users about the actual time of arrival at POD (ATA) once the shipment is completed.

Finally, Ocean Insights displays a panel of exception notices and punctual incidents as the user logs in. The incidents list allows users to check the affected containers by a particular unfortunate event (like the Suez canal blockage) and to find out if any containers from their plant were affected or not. Ocean Insights also offers a bundle of dashboards, some of which will be further explored in subsequent chapters. Screenshots of the Ocean Insights' layout can be found in Annex A.2.

## 4.2 Design of an ETL System for Later Data Quality Assessment

After the selection of the providers, it is necessary to compare their data quality. For that, an ETL system was developed using a spreadsheet able to perform API calls. The picked software tool was ROWS for its ease of use and fast deployment.

For the development of such system a pre-testing team was assembled to check whether retrieving and comparing ETA data was feasible before allowing all plants to participate. The pre-testing team was composed by representatives of a limited number of plants and their goal would be to simply use the available tools while the ISCM team developed the necessary system for evaluating data quality in ROWS. Figure 4.2 aims at summarizing the interactions between the ROWS pages for this project:

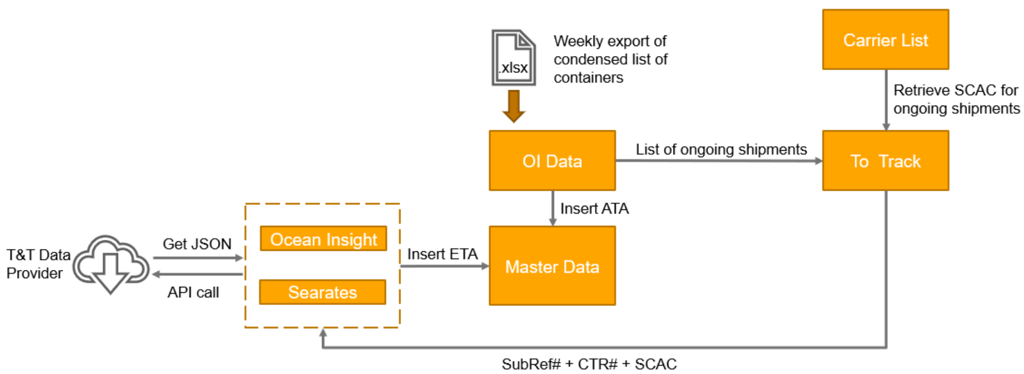



Figure 4.2: Map of ROWS' pages interactions

It was especially important that plants used Ocean Insights as it would serve as the backbone of the entire system. Ocean Insights allows for the download of a condensed list (Table 4.2) with relevant information about all the shipments ever inserted onto the platform. This allows Continental to check the ATAs for all of its containers and understand which ones already arrived and which are still in transit or preparing for the journey.

Table 4.2: Head of condensed shipping list

| CTR# | SubRef# | Description | Tags | Carrier | Transport Status | Contracted ETA@POD | Predicted ETA@POD | Planned ETA@POD | ATA@POD |
|---|---|---|---|---|---|---|---|---|---|
| FCIU628 | FCIU628 | PO:45039… | Puchov | Hapag-Lloyd | ocean transport to POD | 2021-05-12 | 2021-05-31 | 2021-05-30 | 2021-05-31 |
| UACU375 | UACU375 | PO:45679... | Lousado | MSC | ocean transport to POD | 2021-05-10 | 2021-05-26 | 2021-05-20 | 2021-05-28 |

This condensed list was updated every week by extracting it manually from the Ocean Insights platform and pasting it onto a ROWS page called "OI Data". From this list of containers, the ones that did not arrive yet (ongoing shipments) were transferred to a page named "To Track", identified by its CTR# and SubRef#. On this page, the carriers' names were converted into standard carriers' alpha codes (SCAC) based on a predefined list present in the page "Carrier List" (Annex B.1). The ROWS subscription allows Continental to perform 10 000 API calls per month. Therefore, it was estimated that if an API call were to be performed every workday per container per provider, a maximum of 189 containers could be tracked at any given time. If the number of containers to be tracked was below the defined limit, the list of containers (CTR#, SubRef#, SCAC) was copied and transferred to 2 distinct pages, one for each provider.

These pages were named "Ocean Insights" and "Searates" and they were identical in both layout and functionality. On each of them, an API call was scheduled to occur for each container every workday. The used data provider and the time stamp of the API call were also registered. These API calls were based on the container number and SCAC for Searates. For Ocean Insights, the SCAC and the SubRef# (which can be the CTTR# or the BL) were the mandatory fields for an API call. After, relevant information on a JSON format is retrieved using the command 'GET'. Then, a series of commands 'PARSE' were used to get the ETA at POD for every container. The multiple steps and commands used for performing the API calls for Ocean Insights and Searates can be found in Annex B.2 and B.3 respectively.

This information is then sent to a page called "Master Data" that keeps a record of all tracked containers and of the given ETAs provided on each day. Finally, once a container arrived at the POD the respective ATA was also added to the "Master Data" from the 'OI Data' page for every time stamp (Table 4.3).

This would already be enough to get the required records to perform the data quality comparison tests. However, it was deemed useful to develop a dashboard that summarized the information of ongoing shipments and that allowed for a quick comparison of the given ETAs from the different data providers.

The list of containers to track, present onto the page "To Track", is transferred to the "Dashboard" page. The container number is used to match this list against the list present onto the

Table 4.3: Master data records

| Provider | Time Stamp | SCAC | CTR# | ETA | ATA |
|---|---|---|---|---|---|
| Ocean Insights | 19-02-2021 | MAEU | FCBU764 | 05-03-2021 | 06-03-2021 |
| Searates | 19-02-2021 | MAEU | FCBU764 | 04-03-2021 | 06-03-2021 |

Table 4.4: Dashboard for ETA comparison

| SCAC | CTR# | Description | Tags | Contract ETA | ETA SR | | ETA OI | |
|---|---|---|---|---|---|---|---|---|
| MAEU | FCBU765 | PO4562 ... | Lousado | 06-03-2021 | 07-03-2021 | ✓ | 16-03-2021 | !!! |
| MSCU | MEDU821 | PO4578 ... | Puchov | 20-03-2021 | 20-03-2021 | ✓ | 24-03-2021 | ! |

"Ocean Insights" and "Searates" pages and retrieve all the currently given ETAs. Additional information about this list of containers can be obtained from the "OI Data" page. The "Dashboard" also contained the contractual ETAs when that information was available. This allowed for the flagging of shipments that were marked as delayed according to each provider. This flag varied in accordance to the magnitude of the delay (Table 4.4).

With the present ETL system set-up, the proof of concept was done, and the team was ready to move to the actual testing-phase. The plants' accounts on both Searates and Ocean insights' platforms were created, and the credentials provided to each participant. Plus, Ocean Insights only allowed for the tracking of 5000 containers during the testing phase. Therefore, the 5000 containers were distributed to each plant according to the amount of sea-shipments received on the previous year. This way, larger plants or plants with a greater percentage of containers arriving by ocean would be given more credits than smaller more land-dependent ones. All the 24 plants were now ready to start testing the providers web-applications and the ISCM prepared to gather and analyze the generated data.

## 4.3 From Theory to Practice: Leading Change

Throughout the roll-out of the initiative, resistance to change was inevitable and that is exactly why one must plan ahead and resort to change-management frameworks. Afterall, resistance to change is an indicator that the company's culture is consolidated and that there is a methodology in place. What this means is that future changes will be considered successful if they entrench themselves into the collective organizational conscience. Resorting to the "Kotter's 8 steps change model", it is possible to check for coherence in the chosen roll-out strategy.

**Establishing a sense of urgency** was very straightforward. The market and its competitive landscape were shifting, as the Covid-19 pandemic ravaged global supply chains. Capabilities, such as supply chain visibility, became increasingly important in a period when instability kept rising. As a result, the proof of value should be assessed before supply chains returned to its pre-Covid state as this is the most critical time for a tool like this to be reliable. Therefore, the time-frame established for the test phase was approximately two and a half months.

**Forming a guiding coalition** was done by allocating three members with different experience levels of the existing ISCM department to the task. In addition, the pre-test was initially conducted with a limited number of plants as a way to gather immediate feedback and ultimately get more people involved with the project.

**Creating a vision** was required to direct the changing efforts. The ultimate goal of the project is to provide plants with a reliable ETA effortlessly. So, the vision would be to automatically integrate the tracking data for all containers with the existing systems while demanding little to no extra-work from the plants.

**Communicating the vision** to the plants was done through the ISCM Broadcasts, which are monthly calls involving representatives of all plants and organized by the Corporate ISCM. The objective is to enable the sharing of ideas, initiatives and best practices among the plants as well as promoting new projects developed by the Corporate ISCM. These calls helped to answer questions about the present project and motivated the plants to try the new tools. With over one hundred people attending the ISCM Broadcast each month, it was the fastest and most effective way to share developments regarding the delivery tracking initiative and the vision for the future of the project.

**Empowering others to act on the vision** and removing obstacles to change were accomplished by offering constant technical support and meeting up regularly with plants that demanded more attention. Additionally, video tutorials were recorded to teach employees to use both Searates and Ocean Insights and made available so they could be re-watched as many times as necessary. In the case of Ocean Insights, the allocated container credits also enabled plants to explore what were the best containers to track in order to get maximum coverage. Continental Mabor, for example, only tracked one container per shipment instead of tracking all containers from the same bill of lading. What this means is that, if a shipment was carrying more than one container from Continental, they could all be tracked by spending just one credit. This kind of approach was then emulated by other plants that realized the potential and followed suit.

**Creating short-term wins** was originally thought to be evident. As plants started testing the tracking tools and benefiting from it, a “domino-effect” was expected to kick-in and its usage to increase radically. In reality, this was not happening since, during the testing phase, many plants were still reluctant to put in the extra-effort to retrieve the ETAs. However, an unfortunate episode shone a light on one of the greatest advantages of using the delivery tracking tools. On the morning of March 23rd, 2021, a massive container ship named Ever Given obstructed the Suez Canal in Egypt. This episode would last for almost a week and greatly disrupt the supply of goods between the Asian and European markets. Having many suppliers of raw materials located in East and South-East Asia, Continental European plants were inevitably affected by the canal’s obstruction. Fortunately, Ocean Insights was quick to notify Continental and used its “Detected Incidents” tool to condense a list of all containers on board of ships affected by the Suez crisis. This way, plants that were already uploading a significant portion of their containers to the Ocean Insights T&T tool were able to promptly check the list of delayed containers to know whether any of its shipments was affected. This tragic episode highlighted both the importance of having a resilient supply chain as well as the need for transparency and visibility of such supply chain.

**Consolidating the improvements** and **institutionalizing new approaches** will come as a result of the actual implementation of the delivery tracking initiative into Continentals’ current systems, which is, at the time of writing, still ongoing.

## 4.4 Managing the Roll-out: Increasing Engagement

The delivery tracking initiative requires plants to insert containers on the Ocean Insights platform for Continental to gather a large-enough sample to assess the tools' data quality, which means that plants' engagement was crucial. After the testing phase initiated, plants had 5 months to spend their attributed container credits but only containers inserted during the first 2.5 months would be considered for data quality evaluation. When a usage report was conducted after the first month, it was revealed that only 3.5% of the total container credits had been used so far even though 20% of the available time for the container tracking had already elapsed. The necessity to increase engagement was evident.

The first action taken was to promote once again the step-by-step video-tutorials of the utilization of the tools from a plant's perspective as previously mentioned. The tutorials were quickly shared with all the users to make sure that all functionalities were understood and that no mistakes were made inputting the data.

Next, a survey was conducted using the tool Microsoft Forms and shared at one of the ISCM Broadcasts. The goal of the survey was to gather feedback form the plants currently using the Ocean Insights platform, while simultaneously understanding the reasons stopping the remaining ones to do the same.

It was found that 70% of the respondents had received training with both Searates and Ocean Insights and an additional 15% had it with just one tool. A qualitative analysis where users were asked to rate from 1 to 5 (where 5 is very good and 1 very poor) each tool was conducted. Searates outperformed Ocean Insights by a slim margin on all evaluated dimensions, having scored 3.8 in 'Tool Functionality', 'Perceived Data Quality' and 'User Friendliness'. Ocean Insights got a score of 3.63 in both 'Tool Functionality' and 'Perceived Data Quality', while getting 3.5 in 'User Friendliness'.

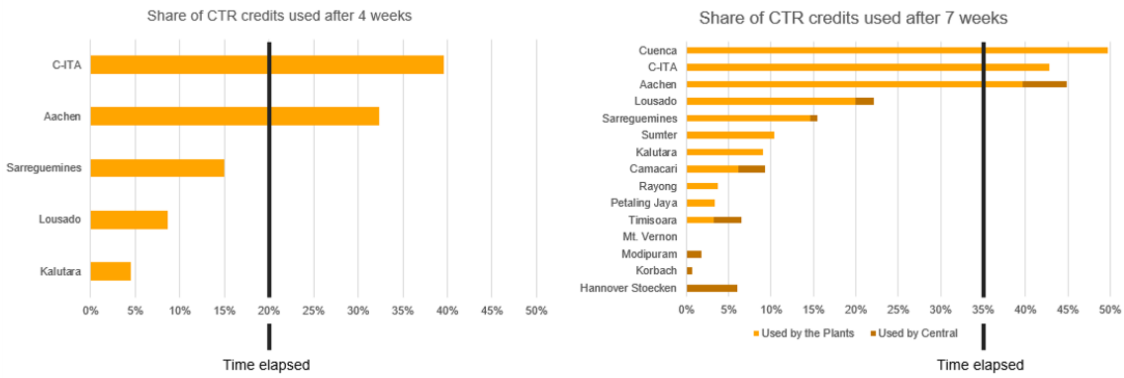
In cases of low score, respondents were also inquired about the underlying reasons for giving low ratings. Both Searates and Ocean Insights were deemed too time-consuming by some respondents and the required inputs to add a container (CTR# or BL number) were inconvenient to get. Some pointed out that Searates information was too oversimplified and that it did not offer a significant improvement from individually checking each of the carrier's websites. On the other hand, Ocean Insights was given low scores for its over-complexity, greater demand of upfront work and perceive reduced data quality. Some of this criticism was expected. By all means, Searates is easier to understand and quick to present results but worst for continuous monitorization as its container organization system is very time-consuming. Ocean Insights has more barriers to entry since it requires/allows for more information per container to be inputted and takes longer to return the respective ETAs. However, once the containers are in the system, it becomes increasingly easier to monitor them at any time and it is much easier to filter them.

Contrarily to what the three qualitative measures might suggest, when given the option between Searates and Ocean Insights, most plants would rather continue to use or start using Ocean Insights instead of Searets. Out of 24 inquired local ISCM partners (buyers), 14 stated that they would use Ocean Insights in the future; 9 opted for Searates and only 1 said that using either of them would not be worth it. Also, when asked about the perceived usefulness of tracking tools after the ocean freight market gets back to normal, only one respondent said such tools would not be necessary. This question was present in the survey since international maritime supply chains were, at the time, under significant stress due to the Covid-19 pandemic.

Lastly, plants were asked if they wished to keep their current quota of container credits or if they would rather donate part or all of them to other plants. This allowed central to redistribute credits and use some to assure that a minimum number of containers was being traced at any given time.

The usage-increment efforts came to its final stage with a series of meetings conducted with every individual plant that was interested in the initiative. These meetings were used to clarify any doubts that could remain and support the multiple teams of ISCM local colleagues.

The success of the user increase efforts was assessed by a usage report conducted 3 weeks later. At this point 35% of the testing and post-testing-time was gone, while only around 7.4% of the container credits had been spent by the plants out of which 0.9% was inserted by Corporate ISCM. This improvement was not massive, which reveals that, as it stands right now, not many plants would take full advantage of the provided tools. The feedback gathered indicates that plants want the relevant information about the shipments, like the ETA, on Continental's SAP system. This would facilitate the access to it from a plant's perspective and would avoid the extra-work of uploading all containers onto the data provider's platform. Nonetheless, this allowed for the constant tracking of around 150 containers at any given time, which was considered enough for the subsequent data quality assessment. By the end of the testing period, a total of 427 containers had been followed. A summary of the usage reports can be found in Figure 4.3.




| | |
|---|---|
| CTR credits used | 122 |
| Share of total CTR credits | 2.4% |

| | |
|---|---|
| CTR credits used | 368 |
| Share of total CTR credits | 7.4% |

Figure 4.3: Usage reports summary

# Chapter 5

# Tracking Tools Quality Assessment

The present chapter presents a framework for the evaluation of multiple data providers, the methodology followed to assess their data quality and the results for each of the considered evaluation criterion. Since this is not a unidimensional task, an overview of the main characteristics of each supplier is important, and a structured approach for the comparison was developed. The numerous evaluation criteria were divided into 4 categories: the amount of data provided; the quality of the data; the user experience; and the cost of the tool.

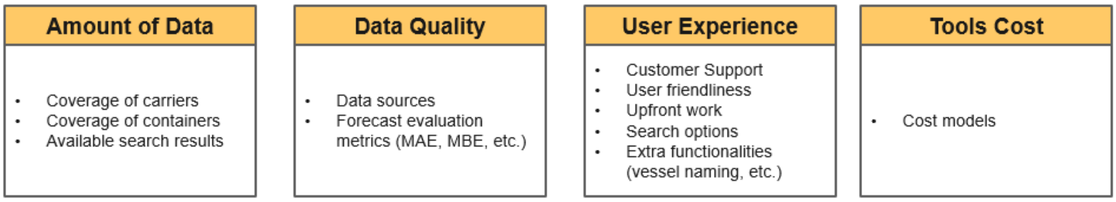



Figure 5.1: Evaluation criteria

All the above metrics will be applied to judge Ocean Insights and Searates, however a deeper and more complete analysis where a baseline is established can be useful in some cases. It would make sense to compare the tested providers with the daily reports provided by the forwarders Kerry Logistics and DHL, especially in what regards data quality and coverage ratio.

## 5.1 Amount of Data

Regarding the amount of data provided, this criterion can be further divided into 3 dimensions: the coverage of carriers, the coverage of containers and the presented search results.

### 5.1.1 Coverage of Carriers

The coverage of carriers can be easily assessed by cross-checking if all the carriers used by Continental Tires were covered by each of the service providers. Fortunately, this was the case. Even though Searates only offered data for 19 carriers, while Ocean Insights offered it for 70, all the

13 major carriers used by Continental were available in both platforms. If Continental were to consider requesting services from other carriers Ocean Insights would be a safer choice since it cover all the ones offered by Searates and much more. However, there are plans on the behalf of Searates to expand their carrier coverage in the near-term so this may not be an issue moving forward.

### 5.1.2 Coverage of Containers

The coverage of containers was defined as a percentage of the ETA requests (which are API calls in the cases of Ocean Insights and Searates) that returned a valid ETA assigned by a provider (Eq. 5.1). Since ETA requests for the selected containers were done daily, this method assures that both the number of containers tracked and the days in advance for which the ETA was provided, were considered. Therefore, one ETA request corresponds to a certain container being inquired on a certain date.

$$Coverage_i = \frac{(Number\ of\ valid\ ETAs\ returned)_i}{(Total\ number\ of\ ETA\ requests)}; \qquad i = providers \tag{5.1}$$

In order to compare the possible coverage of Searates and Ocean Insights with Continental's current system, the data provided by the operating forwarders (Kerry Logistics and DHL) was merged together and a "fictitious provider" was created. This provider was called KLGDHL and it was only possible to create it because containers tracked by DHL and by Kerry Logistics are mutually exclusive, meaning that no container is tracked by both forwarders at the same time. Then, the set of containers inserted each week by the plants on the Ocean Insights platform was used to perform the ETA requests for all the providers. The results are as follows (Figure 5.2):

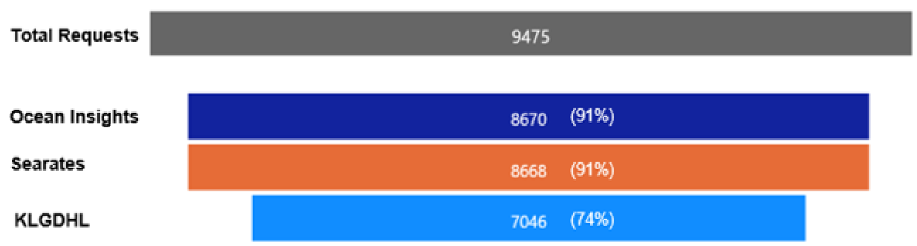



Figure 5.2: ETA requests coverage per provider

Out of the 9475 API calls performed for the 427 containers followed during the testing period, Searates and Ocean Insights were able to return a valid ETA for 8668 and 8670 respectively. These results are remarkably similar and translate in a coverage ratio of around 91% for both providers. The fictitious provider KLGDHL only contained a valid ETA on its report for 7046 cases, which represents a coverage ratio of around 74%.

The obtained discrepancy can be explained by the fact that containers from shipments under Supplier D-terms could be introduced onto Ocean Insights and therefore be part of the test set, however, these containers could not be tracked by neither Kerry Logistics nor DHL. Yet, this raises another question. It is known that only around 30% of the total inbound sea-shipments are

Conti D-terms, still KLGDHL had a coverage of 74% of all requests. After further analysis it was found out that, out of the test set, the vast majority of the inserted containers were under Conti D-terms and they represented 7373 (77.8%) of the ETA requests. This means that, for Conti D-terms containers, KLGDHL had a coverage of 95.6% since it returned a valid ETA for 7046 out of the 7373 requests, which is even higher than the 91% obtainer by its counterparts.

In conclusion, the sample set was very skewed since it had a much higher share of Conti D-term containers than what the actual situation of the firm is. After all the aforementioned considerations, knowing that around 95.6% of the Conti D-terms requests were covered by the current system and being the Conti D-terms only 30% of the shipments, it can be estimated that the real coverage when only using KLGDHL should be of only about 28.7% and not 74%. Fortunately, whether a container is under Conti D-terms or not does not affect the coverage ratio of neither Ocean Insights nor Searates meaning that they still hold a 91% coverage regardless of the D-terms composition of the testing set. This also does not affect the data quality of any of the providers. Therefore, one can admit that adopting either Ocean Insights or Searates would assure a much greater coverage of containers' ETAs than the one currently obtained by KLG and DHL daily reports.

No provider was able to return a valid ETA for 100% of the containers for two additional reasons. In some cases, the container was missing from the providers database and they were not even able to find it. In other cases, the container was indeed returning information regarding its shipment, but no ETA had been attributed.

### 5.1.3 Search Results

Lastly, the search results themselves must also be considered. Searates only provided the most recent ETA given by the carrier, while Ocean Insights offered this information under the label of "Planned ETA", but also the contractual ETA (when provided) and a "Predicted ETA" estimated by Ocean Insights itself. This is a strong point of Ocean Insights, since it offers both the ability to compare the prediction with the date planned by the carriers and allows for the comparison of the contractual ETA with the predicted one.

## 5.2 Quality of Data

### 5.2.1 Sources of Data

The data quality is expected to be highly influenced by each of the providers' data sources. Searates only gathers data from ocean carriers, while Ocean Insights claims that additional inputs are received from vessel tracking technology, using GPS, human intelligence, artificial intelligence and port/terminal geofencing. However, the sources used are not very relevant for the selection of the provider. From a customer perspective, the ETA provided matters, but its calculation does not. Therefore, evaluation metrics were used for the assessment of data quality. Data sources are only relevant when considering future developments. More data inputs should also translate into higher chances of improving the forecast itself which is a factor to be considered when picking a medium to long-term business partner. On this front, Ocean Insights seems to have the upper hand over Searates, since there is little chance of Searates improving its forecasts quality if they continue using a single data source.

### 5.2.2 Forecast Evaluation Metrics

There are many ways through which one could assess the quality of a forecast. This subsection aims at presenting a comprehensive and complete overview of some of the most relevant quantitative metrics used. The tools used to conduct such analysis were *SHELL* and *PowerBI*. SHELL was used for data preparation, cleaning, and transformation, while *PowerBI* was reserved for the creation of a dashboard containing the relevant charts and data summaries. *PowerBI* offers some powerful data transformation functionalities and is theoretically capable of handling the present task on its own. However, it is slower and less effective when working with large sets of data, especially when dealing with dozens of *Excel* files with tens of thousands of rows each.

#### 5.2.2.1 Data Preparation

First, the multiple *Excel* reports from both DHL and KLG were automatically converted into .csv files to ease the computational burden. Then, the data was populated for the missing reports, meaning that whenever a report for KLG or DHL was missing, the previous one available was considered for that date. Using *SHELL* scripting, all the KLG files were appended together and a column with the date of the report generation was created based on the title of each report. Afterwards, an additional column with the name of the provider was added and all the irrelevant columns from the reports were eliminated. This left only the following columns: Provider; Time Stamp; Carrier SCAC; CTR#; ETA. Sometimes the reports contained an 'Initial ETA' and an 'Updated ETA'. The latter was considered whenever it was available. The same process was repeated for the DHL reports and, by the end of it, the two files were also appended together creating an enormous report called *Complete Forwarder Report*. The programming code can be found in Annex C.

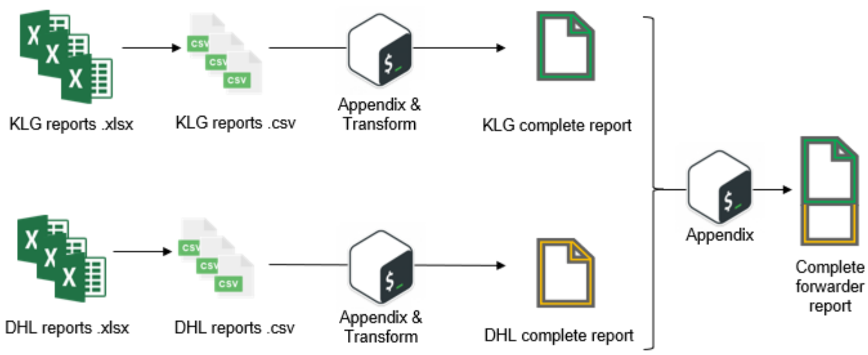



Figure 5.3: Data preparation 1st part

Table 5.1: Head of condensed shipping list

| Provider | Time Stamp | SCAC | CTR# | ETA | ATA | TG | Error | AE | SE | APE | Accuracy | Magnitude |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KLGDHL | 16-02-2021 | HLCU | TCLU33 | 03-03-2021 | 05-03-2021 | 17 | 2 | 2 | 4 | 11.8% | 1 | < 1 week |
| OI | 16-02-2021 | HLCU | UACU38 | 04-03-2021 | 05-03-2021 | 17 | 1 | 1 | 1 | 5.9% | 1 | < 1 week |

Next, the *Master Data* extracted from *ROWS*, which has the same layout as the *Complete Forwarder Report*, is merged with it on *PowerBI* in order to make sure that the ETA requests present in the final report are the same ones for all providers. This means that the same ETA requests are performed for the same containers in the same dates for every provider. The following step was to aggregate KLG and DHL into a single provider called KLGDHL and change the Provider column accordingly. After, the *Master Data* export from rows is appended to the *Complete Forwarder Report* and forms the *Complete Providers Report*. Lastly, the ATAs are added to the *Complete Providers Report* using an export from the *ROWS'* page *OI Data* and the report is ready to be used by *PowerBI* for the evaluation metrics calculation. Figures 5.3 and 5.4 illustrate the data preparation process.

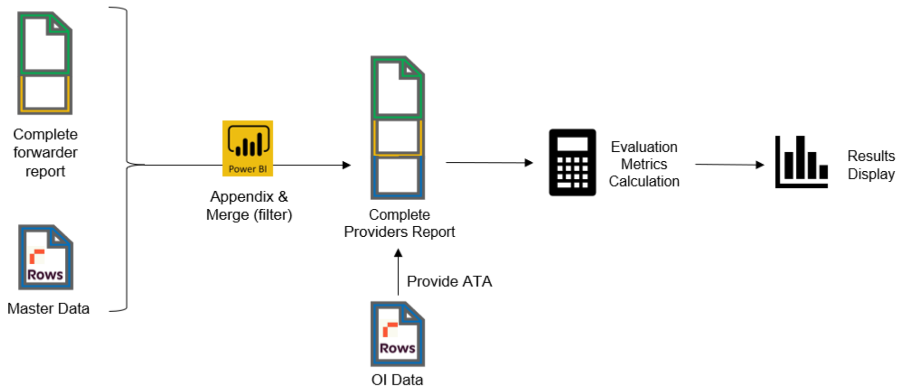



Figure 5.4: Data preparation 2nd part

Now, the report can be used to calculate the all the remaining necessary metrics such as the forecasting error and the time gap. The forecasting error is defined as the difference between the ATA and the ETA and it is expressed in a whole number of days. The time gap reflects the number of days prior to the arrival that a certain prediction was made and was the difference between the ATA and the time stamp that a prediction was made.

The final table looked like the Table 5.1 and, as it can be seen, even more custom columns and conditional columns were added to allow the calculation of the evaluation metrics described in the following subchapters. These columns included the calculation of the squared error (SE); absolute forecasting error; absolute percentual error (APE) and more. Also, all errors above 40 were deemed outliers and therefore eliminated from the database. This concluded the data transformation phase.

#### 5.2.2.2 Mean Absolute Error

The first measure used to establish a comparison between Ocean Insights, Searates and Continental's current situation (KLGDHL) was the mean absolute error (MAE). This was the case since MAE is known for being simple to understand and considers all deviations regardless of its direction and attributes weights proportionally to each one.

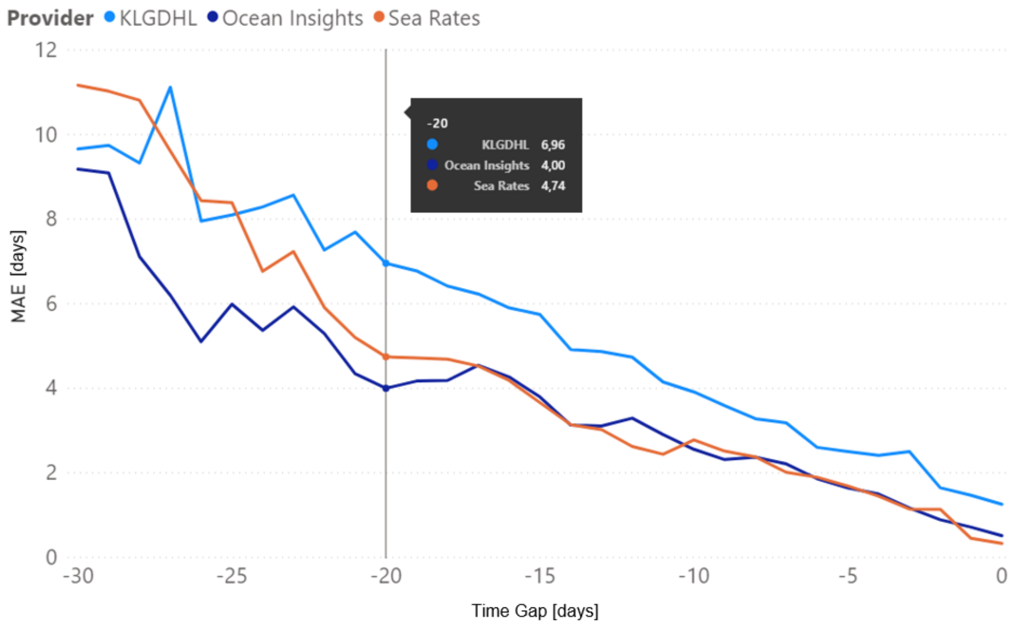



Figure 5.5: MAE per time gap

The present chart (Figure 5.5) shows how the MAE (in *days*) varies per time gap, meaning that the MAE is influenced by how close the prediction was made in relation with the ATA of the container to the POD. As expected, as the ATA approaches, the MAE gets smaller since it becomes easier for the data providers to give an accurate forecast. This is the case because one of the fundamental laws of forecasting is that: the further into the future one attempts to forecast, the greater the forecasting error.

As an example: 20 days prior to the arrival, Ocean Insights, Searates and KLGDHL on average, provided an ETA with a forecasting error of 4.00 days, 4.74 days and 6.96 days respectively.

By the analysis of the chart it is also possible to state that, throughout the last 30 days of the shipment, both Ocean Insights and Searates are considerably better than the current situation. The dates given by KLG and DHL are consistently affected by larger errors. This could be the case because their respective data providers offer worse forecasts than Searates and Ocean Insights, or it may be the result of them providing updates with less regularity than the others. Focusing strictly on Searates and Ocean Insights it is not so obvious if one is outperforming the other. On the last 20 days of the shipment both seem to be very consistent and provide very similar forecasts to one another. However, on the timeframe between 20 and 30 days prior to the arrival, Ocean Insights revealed itself slightly more reliable than Searates.

#### 5.2.2.3 Mean Biased Error

The mean biased error (MBE) is similar to the MAE with the obvious difference that errors are not presented in absolute terms, which ultimately results into negative and positive errors canceling each other out (Figure 5.6). The goal of applying such evaluation metric is to get a sense of the forecasting models' bias. In other words, it helps in figuring out how prone the model is to systematically over or under forecast.

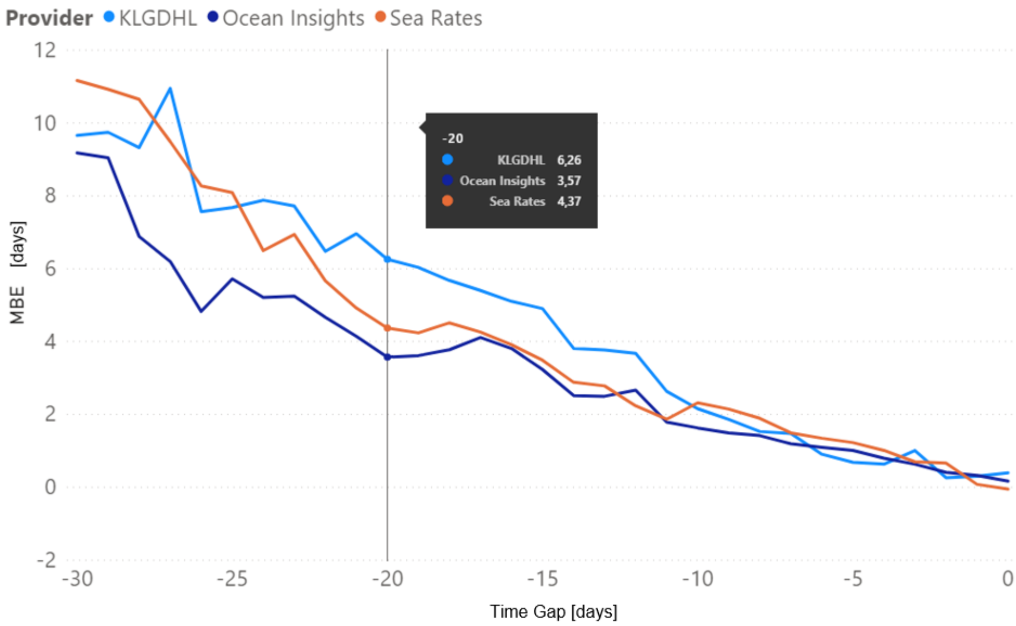



Figure 5.6: MBE per time gap

Containers which arrived with some delay relative to the ETA given by the data provider will have positive errors assigned to them. Conversely, containers arriving earlier than the ETA will have a negative error assigned. Therefore, the present chart can be interpreted in the following way: 20 days prior to the arrival, Ocean Insights, Searates and KLGDHL, on average, failed to predict a delay of 3.57 days, 4.37 days and 6.26 days respectively. As it can be observed by the chart, all forecasting models have a strong bias and tend to be too 'optimistic'. All data providers consistently fail to predict delays throughout the whole 30 days period prior to the arrival of a container. As a result, the lines on the chart are almost always entirely located above zero. If the models had no bias errors would be following a normal distribution around zero and therefore the MBEs lines would also hover around zero across the x-axis.

On the last 20 days of the shipment, no major differences can be found between the biases of the 3 providers. However, 20 to 30 days prior to the arrival of the container Ocean Insights seems to be the less biased of the three, while KLGDHL seems to be the one with a slightly stronger bias.

It would not be fair to draw such conclusions without reinforcing once more the idea that the sea-freight market was experiencing a period of extreme turbulence at the time data was being gathered. The Covid-19 pandemic caused major disruptions on the supply chains. Increased border-checks, government restrictions, increased difficulty in overseas procurement, ports congestions and constant testing performed to the crews and operators probably skewed the results as it was more likely that a shipment would experience a delay rather than being too early. Besides, the Suez-canal crisis also took place during this period which caused the rerouting of many incoming vessels coming from Asia to Europe, inevitably affecting Continental's supply chain and delaying many arrivals.

#### 5.2.2.4 Root Mean Squared Error

The evaluation metric MAE is the best choice when the costs incurred by an error in the forecast are proportional to the dimension of the error itself. However, this is not the case for Continental. A small error in the forecast does not have any real implications since its impacts can be absorbed by the safety stock. Problems arise with large errors that may result in shortages of a certain raw-material or near-shortage situations. Unrealistic ETAs that fail to predict or report delays may force the firm to incur the costs of flying-over the raw materials in order to avoid shortages or to stop production all together if shortages do occur, being the latter extremely costly.

For this reason, it was considered that greater forecasting errors resulted into disproportionally higher costs for Continental and this reality should be taken into consideration when deciding which provider to pick. In this context, the utilization of the root mean squared error (RMSE) evaluation metric makes perfect sense. RMSE is characterized by 'penalizing' more larger errors while simultaneously tolerating more small ones. It is more vulnerable to outliers, however all absolute errors over 40 were removed in the beginning to avoid an adulteration of the results.

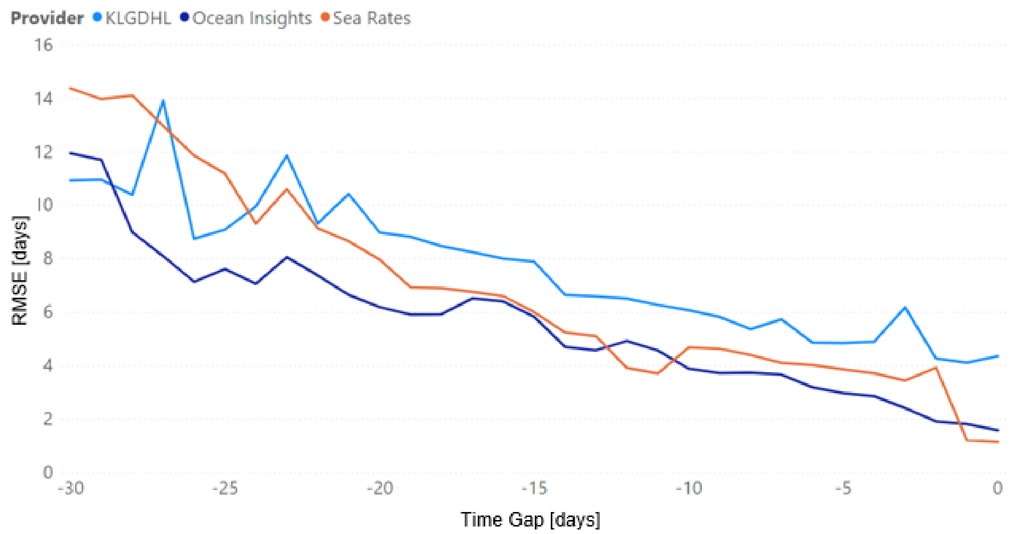



Figure 5.7: RMSE per time gap

RMSE is harder to interpret than previously used metrics. Yet, it seems that KLGDHL once again underperforms Searates and Ocean Insights in this metric (Figure 5.7).

#### 5.2.2.5 Mean Absolute Percentual Error

The Mean Absolute Percentual Error (MAPE) was also calculated in order to determine whether or not the error was proportional to the time gap between the date of the prediction and the actual date of arrival of the shipment. Therefore, it was calculated by dividing the mean absolute error for each time gap by the time gap itself.

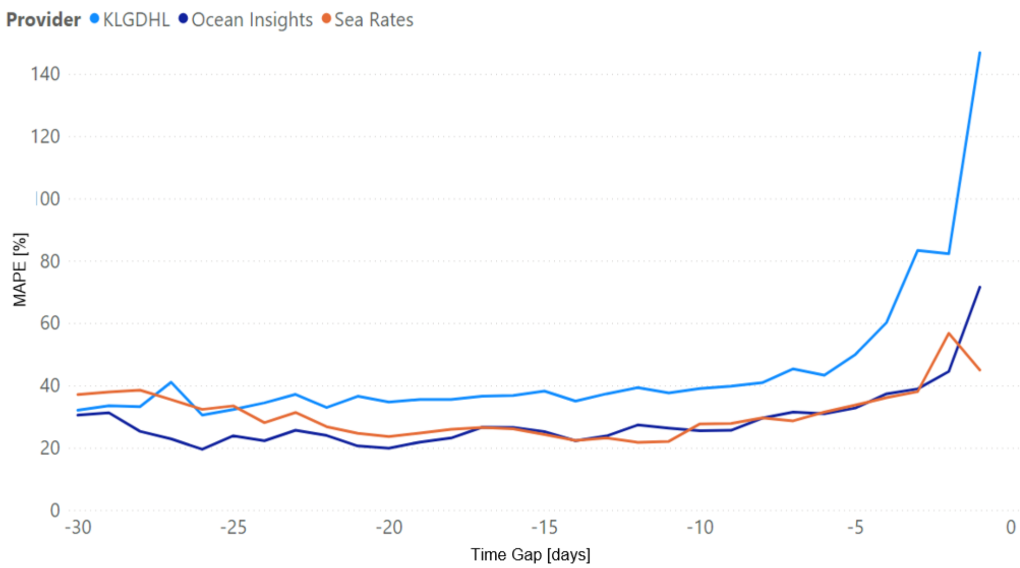



Figure 5.8: MAPE per time gap

The results mimic what was obtained by the MAE measure but allows for a better understanding of the relative dimension of the error (Figure 5.8). For example, 20 days prior to the arrival the MAE of Ocean Insights was of 4 days, which translates to 20% of the time gap. As a result, the values around which the MAPE hovers were calculated for each provider disregarding the last 4 days prior to the arrival. The same weight was given to every time gap and the results are as follows: the MAPE for KLGDHL hovers around 37.3% which is significantly more than the 25.7% calculated for Ocean Insights and 28.8% obtained for Searates. The 4 days prior to the arrival were not considered in the calculation as the MAPE tends to skyrocket since small errors towards the end automatically represent a huge error. Plus, KLGDHL's MAPE probably increases earlier since their reports are not updated as regularly. This measure was especially relevant as it allowed the summarization of the data providers performance in a single number. This comes at the expense of losing a lot of relevant information but enables an understanding of the magnitude of the differences between the multiple data providers alternatives.

#### 5.2.2.6 Accuracy Rate

The Accuracy Rate was defined as the percentage of accurate forecasts given by each provider for each time gap. A prediction was deemed 'accurate' if its absolute error was inferior or equal to a week. This was the case since it was considered that delays up to 7 days were still able to be absorbed by the safety inventory and should not result into major shortage situations.

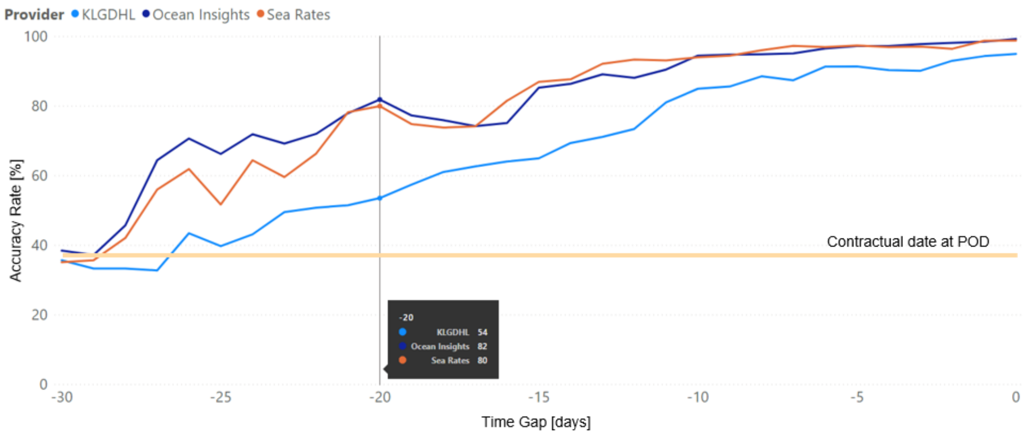



Figure 5.9: Accuracy rate per time gap

By the analysis of the chart in Figure 5.9, it is observed that 20 days prior to the arrival KLGDHL had an accuracy rate of only 54%, while Ocean Insights and Searates reached 82% and 80% respectively. This was true for most of the analyzed period, with Searates and Ocean Insights constantly outperforming KLGDHL in what concerns Accuracy Rate. However, it seems that 30 days prior to the arrival, the accuracy rate was around 39% for all providers, which is coincidently the accuracy rate that would be obtained if no tool was used. Meaning that, when the plants only have access to the contractual delivery date at POD and no additional update to the ETA is performed, the accuracy rate is very similar. This indicates that over 30 days prior to the arrival the tracking tools are not very relevant.

Further analyses were conducted to determine which provider was more likely to have errors of over one or two weeks. The developed charts can be found in Annex D. These analyses corroborated the idea that Ocean Insights was the provider less likely to return ETAs with large errors, while KLGDHL was the most susceptible to them.

#### 5.2.2.7 Problems of the evaluation method

The adopted methodology is not without its flaws. The model presents some biases since not all plants were equally invested during the testing period. The plants that were more engaged and that uploaded the greater number of containers onto the testing set were European ones. This can affect the results since they are mainly using Kerry Logistics and not DHL. Plus, plants seem to have uploaded a disproportional number of containers under Conti D-terms, as discussed previously. This is apparent since KLGDHL had a coverage of 74% and are limited to Conti D-terms, while the real proportion of Conti D-terms is only around 30% overall. The explanation for this phenomenon is two-folded. First, plants were more likely to track containers whose CTR# and BL were easier to obtain, and this was the case for Conti D-terms. Secondly, it was noticed that a significant share of the uploaded containers used for the testing set were transporting Natural Rubber and NR is almost exclusively transported under Conti D-terms by either KLG or DHL. This probably happened because plants were facing more shortages of NR than any other raw material.

## 5.3 User Experience

The overall user experience is hard to judge since it is subjective. This category was partitioned into multiple smaller dimensions which should be easier to evaluate: customer support, user friendliness, upload of containers (upfront work), available search options and other functionalities.

Regarding customer support it became apparent for the whole ISCM team that Ocean Insights was quite superior to Searates. Ocean Insights' technical support was quick and reliable, plus they were available for calls to clarify questions and offered to present the tool directly to Continental's plants. On the other hand, Searates customer support was less than ideal and the company did not reveal itself promptly available to answer questions about their future plans. However, Searates also offered the possibility of training the plants in how to use the tool.

The perceived user friendliness was measured by the survey, and Searates outperformed Ocean Insights by a slim margin. This was probably the case because of Searates simplicity and clean layout. Nonetheless, the difference was not too great and plants that have been using the tools for longer periods of time seem to prefer Ocean Insights for its superior organizational capabilities.

The upload of new containers for tracking is a dimension where Ocean Insights and Searates differ a lot. For Ocean Insights, carrier name is mandatory, as well as one of the fields container number or BL number. It also allows the input of a description, contracted ETA and many other fields. Plus, Ocean Insights is also capable of receiving lists of containers via excel and uploading them into their platform. The main drawback of Ocean Insights is the fact that new containers only return ETAs a few minutes after being uploaded and the uploading process can demand significant upfront work. Contrastingly, Searates only requires container number and, in some cases, container number plus carrier name and the ETA for that shipment appears almost instantly. One could state that it is more convenient to upload containers to Searates than to Ocean Insights.

Once the containers are uploaded, the available search options are very different. Ocean Insights allows plants to filter their containers according to any criteria they want. Since the plants can insert whatever description they see fit, as long as they fill the description, they can filter containers per PO, Material, Supplier, or anything they believe to be useful. Searates is quite more limiting. On Searates, saved containers can be manually organized into folders according to Material ID, PO, etc. but this process is quite time consuming and therefore not widely adopted.

Lastly, when looking at other incorporated tools or functionalities we can see that both Ocean Insights and Searates provide the name of the vessel carrying the container. Vessel naming is really convenient as it allows users to track the vessel manually using external tools such as Marine Traffic. This allows users to check for discrepancies and conduct plausibility checks on shipments with doubtful ETAs for example. Both providers also make a journey-map for visualization available, yet, the Ocean Insights interactive map is superior as it is based on real information and not mere estimations of where the vessel should be, which is the case of Searates. Ocean Insights also has an incident list to warn users about exceptional events such as congestions in a certain port and provide a list of the affected containers. Finally, Ocean Insights provides a vast array of dashboards that facilitate the visualization of many metrics such as the carriers' performance based on the company's past shipments for example. The carriers' performance dashboard can be used to evaluate the carriers themselves and negotiate better terms with them based on the extra information. Another dashboard particularly relevant is the 'POD-Detention/Demurrage' panel that aims at summarizing potential sources of costs associated with detention or demurrage by highlighting which containers are waiting at the POD or for empty-return and for how long. Both examples of dashboards are available in Annex A.2.

## 5.4 Cost of the Tools

Unsurprisingly, the last great factor to be considered when picking a data provider is the cost of its services. When it comes to cost, the comparison is not as straight forward as one might think. Searates and Ocean insights have distinct methods of estimating prices and charging its customers.

Ocean Insights method is quite simple. It charges 5 000 € upfront as an implementation fee and then it charges a fixed amount per container tracked. The implementation fee shall not be further considered as this is a cost already incurred during the testing phase and, as such, it is a sunk cost that no longer affects future decisions. The fixed amount per container was negotiated with the company to be 3 € per container for the testing phase. However, it is likely that, if Continental chooses to continue to use Ocean Insights services this amount could get lower. The idea of having a delivery tracking system in place is becoming a popular one among different areas of Continental. Therefore, it is to be expected that, the more areas of Continental adopt the delivery tracking system, the more bargaining power the firm will have over the data provider. The annual cost of Ocean Insights services depends on just 2 variables: number of containers tracked per month (CTR/month), price per container tracked (€/CTR). Resulting in the Equation 5.2:

$$OI\ Annual\ Cost = 12 \times (No\ of\ CTR\ Tracked) \times (Price/CTR) \tag{5.2}$$

Searates method of calculating charges is very distinct from Ocean Insights. First of all, Searates does not charge customers per container tracked, rather it does it per API call. With Searates, the customer pays a monthly subscription of 828 $ for 'packs' of 30 000 monthly API calls. This results in a cost of around 0.028 $ per API call. However, if the customer exceeds the 30 000 API calls in a given month, an additional 828 $ will be charged for another pack of 30 000 API calls regardless of how many were used after the 30 000 API calls ran out. Plus, not used API calls are not transferred to subsequent months.

This begs the question of how many API calls are required on average for a single container. The question is relevant because Continental Tires knows that it usually receives around 3500 containers transported by ocean per month but converting this number to the required number of API calls requires some assumptions. The entire goal of the delivery tracking program is to provide the firm with reliable and up-to-date ETAs, therefore it was considered that daily updates of the

| Searates | |
|---|---|
| No of CTR Tracked per month | 3500 |
| Subscription cost ($) | 828 |
| No API calls per Subscription | 30000 |
| API calls per CTR | 50 |
| USD-EUR | 0.83 |

| Ocean Insights | |
|---|---|
| No of CTR Tracked per month | 3500 |
| Price per CTR tracked (€/CTR) | 3 |

Figure 5.10: Variables summary

containers' ETAs were to be expected. It was also assumed that an average inbound shipment from overseas suppliers to a Continental plant was of around 50 days. Hence, the required number of API calls was of 50 per container tracked.

As a result, the following variables are at play when calculating the annual cost of Searates services: number of containers tracked per month (CTR/month), number of API calls per container tracked (API calls/CTR), price of monthly subscription ($/month), API calls per monthly subscription (API calls/ subscription) and finally the present exchange rate of dollars to euros, which was considered 0.83 USD/EUR (Eq. 5.3). Figure 5.10 summarizes all the considered variables and respective values for both providers.

$$SR\,Annual\,Cost = \left\lceil \frac{No\ CTR/month \times No\ of\ API\ calls/CTR}{No\ of\ API\ calls/subscription} \right\rceil \times Price/month \times 12 \times Exchange\ rate \tag{5.3}$$

When an average of 3500 containers are tracked every month, it is possible to estimate that Ocean Insights' services would cost approximately 126000 € and Searates' would cost 59616 € per year. The difference between the two providers is very significant, with Ocean Insights costing around 2.1 times more than Searates, which translates to an absolute difference of 66384 €.

After reaching such results it was of paramount importance to ponder ways of reducing these costs as much as it was feasible. Fortunately, the experience obtained from the testing phase allowed the team to realize that not all containers must be tracked. In order to get reliable ETAs it was only necessary to track one container per shipment. Getting information regarding two containers travelling in the same vessel was redundant and therefore there was a huge opportunity for cost savings. To every group of containers performing the same trip a common BL number is assigned, hence it was possible to know which containers were redundant to perform API calls for. It seemed that the natural solution would be to perform the API calls based on the BL number instead of the container number. However, this revealed itself impossible since Searates does not accept BL numbers as keys for API calls and Ocean Insights charges for all the containers with the same BL number if the BL number is used as the key. It was then necessary to only feed the data providers with one container number per BL, which demands some more work from Continental's side.

For cost estimation purposes it was necessary to find how many containers, on average, share the same BL number. After analyzing a set of shipments from multiple plants it was considered that a BL had, on average, 2.6 containers assigned. This resulted in yet another variable to be added to the cost equations (Figure 5.11; Eq. 5.4 and Eq. 5.5).

| Searates | |
|---|---|
| No of CTR Tracked per month | 3500 |
| Subscription cost ($) | 828 |
| No API calls per Subscription | 30000 |
| API calls per CTR | 50 |
| USD-EUR | 0.83 |
| No of CTR per BL | 2.6 |

| Ocean Insights | |
|---|---|
| No of CTR Tracked per month | 3500 |
| Price per CTR tracked (€/CTR) | 3 |
| No of CTR per BL | 2.6 |

Figure 5.11: Updated variables summary

$$OI\ Annual\ Cost = 12 \times \frac{No\ of\ CTR\ Tracked}{CTR/BL} \times (Price/CTR) \tag{5.4}$$

$$SR\ Annual\ Cost = \left\lceil \frac{\frac{No\ CTR/month \times No\ of\ API\ calls/CTR}{CTR/BL}}{No\ of\ API\ calls/subscription} \right\rceil \times Price/month \times 12 \times Exchange\ rate \tag{5.5}$$

This drastically reduced costs for both solutions. Under these circumstances, Searates' services would cost 29808 € annually, which is a reduction of exactly 50% from its previous value. Ocean Insights' services would now cost 48462 € per year, representing a reduction of around 61.5%. Ocean Insights is still at a higher price point, charging 1.63 times more than what Searates charges. Yet, on absolute terms the difference is just 18654 €, down from the previous 66384 € price premium. The results can be observed in Figure 5.12 which illustrates how the differences in annual costs vary according to the number of containers being tracked each month.

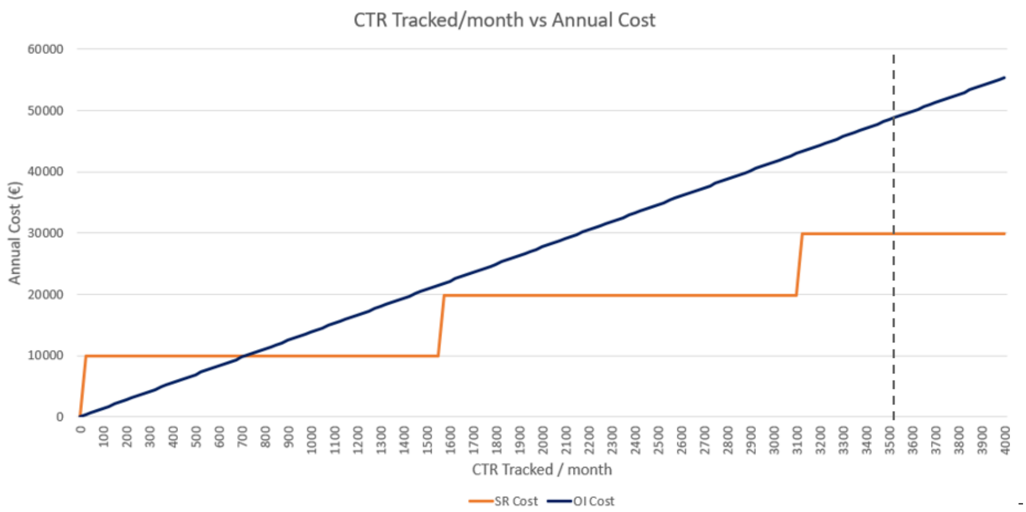



Figure 5.12: CTR tracked per month vs annual cost

## 5.5 Results Discussion

The questions that remain are whether or not it is financially worth it to employ these tools at all, and if so which one.

Quantifying the potential cost savings possible to obtain by implementing these tools is not a straightforward task. The main source of savings should come from the avoidance of near-shortage situations as plants would be given more time to react to potential shortages if given a reliable ETA. The vast majority of near-shortage situations are caused by ocean-shipping delays and the bulk of the costs to incurred to avoid this situations consist in a mix of flying the raw materials in (switching from land/sea to airfreight), using an alternative supplier on short notice or exchanging raw materials between different Continental plants. The latter is a way cheaper alternative than resorting to airfreight. On average these shortage costs usually amount to well under 1M€ per year, however, on the first 4 months of 2021 alone the shortage costs registered were already many times over the value of previous years due to the massive supply chain disruption caused by the Covid-19 pandemic. The goal is for the delivery tracking tools to enable plants to identify potential shortages in advance and escalate the situation sooner than what is achievable with the current setup. The rational is that this would allow plants to replace emergency inbound airfreights and other costly methods of replenishing the raw materials inventory, by cheaper ones such as the transfer of raw materials between Continental's plants. If this was the only benefit of the delivery tracking tools, on a regular year, a reduction of 4 to 8% in shortage costs would be needed to justify the cost of Searates or Ocean Insights respectively. On an exceptional year, like 2021, the required shortage cost reduction would be massively lower and less than 1.5% reduction in costs would already justify the tools.

Additionally, it is important to mention that buyers from all Continental tire plants need to invest some effort in manually tracking critical container, by going to every single carriers' website separately. This task would be made much easier by the employment of delivery tracking tools, that would save buyers a lot of time when it is needed the most, which is in crisis-situations like the present one.

Deciding on whether to contract Ocean Insights or Searates is another issue. The company must ask itself if Ocean Insights presents sufficient advantages in relation to Searates in order to justify a 18654 € premium.

Regarding the amount of available data, it is safe to admit that for now there are no significant differences between Ocean Insights and Searates in what concerns carrier coverage and container coverage. However, when considering search results, Ocean Insights definitely produced a more complete report that allows greater transparency by clearly stating its own estimate of the ETA versus the estimation made by the carriers.

Data quality metrics definitely tilt in favor of Ocean Insights. All forecasting evaluation metrics used seem to suggest that Ocean Insights starts to provide its users with more accurate ETAs with greater advance than Searates. This is very important since the whole purpose of getting ETAs of inbound shipments is to detect delays as soon as possible and react accordingly. The greater the time gap between a reliable ETA and the actual date of arrival, the greater the chances of avoiding shortages or near-shortage situations.

In what concerns the overall user experience, Ocean Insights outperformed Searates in almost every dimension evaluated. Significant weight was given to Ocean Insights' superior customer support as it would play a crucial role during the implementation phase where Continental would have to integrate the data providers' data into its current system. Plus, talks with Ocean Insights led the ISCM team to believe that the provider had a clear direction to follow in the future and its data quality would continue to improve. Track and trace technologies were the backbone of Ocean Insights' business model; therefore, it was very unlikely that improvement to the existing tools would cease to be performed. The same conclusions could not be withdrawn from Searates since container tracking does not play such a central role on their business.

Besides all this, Ocean Insights provides its customers with the ATA at POD for all containers. This characteristic is extremely important as it allows users to check the amount of time a certain container spent waiting for pickup at port. Plus, it also offers a dashboard for detention and demurrage avoidance (Annex A.2), which allows plants to know which containers have been waiting the longest at POD or that need to be returned. A pilot test conducted in Timisoara, where detention and demurrage costs were closely monitored resulted in a reduction of 71% in detention and demurrage costs, from around 175000 € annually to just over 50000 €. This reduction came as a result of mitigating the number of days the containers were exceeding the free-time contracted and by renegotiating the number of days Continental's containers were entitles to be stored at the POD or an Continental's facilities. Information retrieved from Ocean Insights can serve as the basis for a future detention and demurrage cost avoidance system, which ultimately could be used by all plants and result into yet another source of savings.

Lastly, during the testing phase, Ocean Insights was successfully acquired by another company called Project44. Project44 is a Chicago-based company focused on providing its customers with advanced delivery visibility and exception management. It specialized itself in over-the-road tracking, meaning that its efforts have been more concentrated on land transport. However, Project44 stated its desire to enhance its business model and provide full end-to-end real-time visibility. To achieve this goal, multi-modal shipments would have to be covered. This lead Project44 to acquire Ocean Insights in an attempt to combine their land-tracking capabilities with Ocean Insights' expertise in ocean-tracking. If they are successful in integrating their systems, it should be possible for their customers to have a more reliable ETAs at plant. Ocean Insights proved itself competent in providing relatively more reliable ETAs at POD than some of its competitors, however, Continental would still have to take into account the on-carriage from the POD to the plant. With Project44 this issue might be partially solved as an ETA at the plant could be provided to its customers with increased confidence.

In sum, Ocean Insights asserted itself as a very reliable and well-rounded potential partner for Continental. The support team is professional, and the company seems to have the drive to improve its services. Besides, Ocean Insights outperformed the other providers on almost every metric considered, with special emphasis on its superior data quality. The main disadvantage of Ocean Insights is certainly its relatively higher price point and significant implementation costs. However, this price difference could potentially be cancelled out by the fact that its previously discussed unique features allow for more opportunities for cost-saving-initiatives. Overall, Ocean Insights allows for cost savings by aiding in shortage-avoidance, freeing time for the buyers, reducing detention and demurrage costs and by providing more information regarding the carriers' performance which may allow Continental to negotiate better terms with them. The inbound shipments of Continental Tires alone should already be enough to justify the acquisition of such a tool. Plus, if outbound shipments from Continental Tires or shipments from other Continental business areas started to be tracked, the bargaining power of Continental AG would increase and the cost per container tracked could be further lowered.

# Chapter 6

# Implementation Strategy

After the choice of the tracking data provider it is necessary to develop a comprehensive implementation plan in order to integrate the provider's information into Continental's current systems. The low engagement levels with the tools revealed by the plants during the testing phase made clear that many buyers were not willing to invest a lot of time retrieving the ETAs from the Ocean Insights' web-platform. Hence, the goal of the implementation phase was to get reliable and up-to-date ETAs for all relevant shipments directly into Continental's SAP TEMPO system.

As explored earlier, it was of great importance for Continental to get the container number, the bill of lading and the carrier SCAC to be able to perform the API calls. These 3 attributes will, from now on, be referred to as 'keys for delivery tracking' or 'tracking keys'. Thus, there are two main steps to undergo: gathering the tracking keys and actually performing the API calls. Plus, API calls return ETAs at POD, so it is also essential to convert them into ETAs at plant.

## 6.1 Gathering the Keys for Delivery Tracking

First of all, it is necessary to add fields to the SAP system so that the tracking keys can be stored. Suppliers only get the keys for delivery tracking on the day of shipping and they are already established fields on the ASN. Continental's SAP system is not yet prepared to store and display the keys for tracking and solving this issue is the natural first step. Otherwise, gathering data while being unable to properly store it and display it, renders the former irrelevant.

The categorization of the suppliers based on its established connections with Continental was already done on Chapter 3. The same classification will be used to discuss tailored ways for the company to retrieve the keys for delivery tracking from different suppliers. All percentages are based on the overall number of PO line items for external suppliers (Figure 6.1).

Starting by analyzing the external suppliers, these are divided into 4 categories based on whether they can place E-orders or not and whether they are operating under Conti or Supplier D-terms.

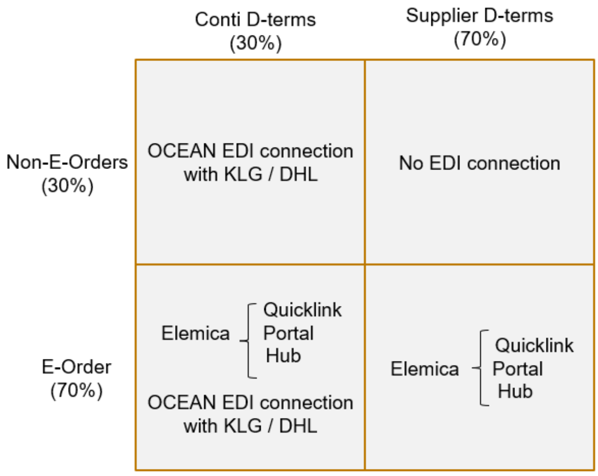



Figure 6.1: Kinds of External suppliers EDI connections

### 6.1.1 E-order Suppliers under Supplier D-terms

For the E-order suppliers operating under Supplier D-terms its only way to electronically exchange information with Continental is through the placement of e-orders using Elemica. It has already been established that this connection type is further partitioned into Quicklink, Portal and Hub. It should be assured that, regardless of the connection type, the supplier is able to properly provide the keys for delivery.

Fortunately, Quicklink was already requesting the container number, the bill of lading number and the carrier SCAC as optional information to be provided by the suppliers at the time of ASN creation. This means that only minor changes would have to be applied to the interface.

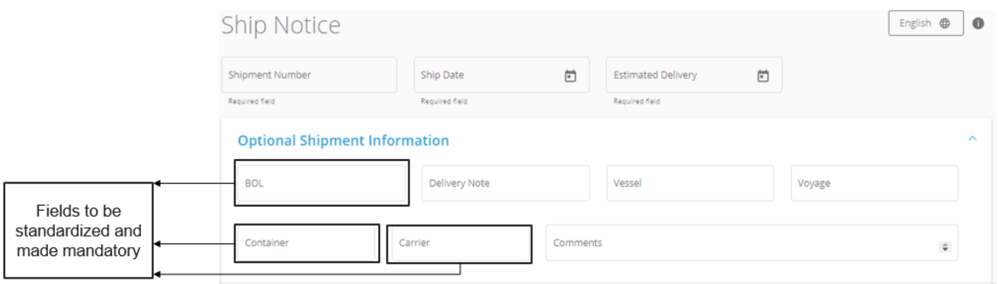



Figure 6.2: Quicklink ASN creation panel

The textboxes for the container number and bill of lading have to assure that its inputs are valid by removing any spaces, tabs or any special characters. The textbox for the carrier name should also be replaced by a dropdown menu with a list of the carriers' names and respective SCACs to standardize the data and avoid human errors like typos. It would also be adequate to remove the term 'Optional' and mark these fields as mandatory even though a submission of an ASN with the tracking keys empty would still be allowed. Marking the fields as mandatory would just indicate to the supplier that not complying would mean incurring a penalty in a potential supplier KPI. This new proposed KPI will be discussed further ahead in this chapter.

Similarly, Portal was also prepared to gather this kind of information from the suppliers. When filling the ASN on the online platform, the supplier may select one or more PO line items and proceed to create an encompassing ASN for all the marked items. This ASN form is also prepared to store information regarding the keys for delivery tracking. The bill of lading number and container number textboxes should undergo the same considerations as before to ensure consistency when filling them, while the carrier list is already a dropdown menu.


Figure 6.3: Portal ASN creation panel

The Hub suppliers automatically transfer information between their system and Continental SAP through Elemica. Since the ASNs are already being transferred it should be technically feasible to add the tracking keys' fields to those same ASNs and transfer them accordingly. However, it is unclear how easy it is for the Hub suppliers to get the keys for tracking into their system in the first place. Hub suppliers should then be divided into three categories in order to understand the required efforts that each would have to undergo.

- **Suppliers that have the necessary fields onto their system and are actively filling the tracking information** are the easiest ones to connect. For these cases Continental just has to enter talks with Elemica to request the transfer of the additional data, assuming that Continental's SAP system is already prepared to receive it and that it was properly standardized.
- **Suppliers with the necessary fields onto their system but that are not actively filling them** are very similar to the first case. In these cases, the course of action for Continental is the exact same one as before with the additional step of making sure that suppliers understand that delivery tracking information is now a requirement.
- **Suppliers whose system is not prepared to receive the delivery tracking keys** are the hardest to gather information from. Each of these suppliers must be analyzed individually and the solution tailored to its particular needs. Just like when Hub connections were first implemented, Continental would have to undergo a project-like approach for each and every supplier under these conditions. A team would need to be assembled and work with the supplier directly to solve the situation.

### 6.1.2 Non-E-order Suppliers under Conti D-terms

Focusing now exclusively on suppliers with an OCEAN EDI connection established but with no ability of placing E-orders, the strategy to gather the tracking keys is significantly different. While this subset of suppliers is not able to electronically submit an ASN with the tracking keys, they are operating under Conti D-terms, which means that they are using either Kerry Logistics or DHL as their forwarder. From previous analysis of KLG and DHL daily reports, one can affirm that DHL has nearly a 100% coverage of all tracking keys for all of its containers. Kerry Logistics on the other hand tends to have a bill of lading and carrier name for all shipments but fails to provide the container number in some cases. This is an unfortunate reality that could be discussed with Kerry Logistics as it is expected that a forwarder would be able to provide the container number for any shipment. The goal would be to receive the delivery tracking keys from the forwarders through Elemica into the firm's SAP system.

### 6.1.3 E-order Suppliers under Conti D-terms

For suppliers with both EDI connections established (OCEAN and E-order) it would be expected that information could be retrieved from the supplier and completed by the forwarder if necessary. However, as a way to avoid conflicts of data, Elemica only allows for one entity to create an ASN and edit its details. Meaning that it is not possible to complete the details on a given ASN created by the supplier with potentially missing tracking keys from the forwarder. This way, suppliers operating under these conditions should be treated the same way as the E-order suppliers operating under Supplier D-term. The burden of providing the tracking keys falls onto the supplier himself in the moment an ASN is first generated (or shortly after).

### 6.1.4 Non-EDI connected Suppliers

There are cases of suppliers that are neither able to place E-orders nor are they operating under Conti D-terms. This means that there is no automatic way for Continental to exchange information with them. Such limitations pose a great deal of additional work for Continental and this situation is most prevalent on small-scale suppliers. The solution is then two-fold:

First, Continental should try to convince some of them to start using Quicklink since it requires no set-up at all. This approach would be ideal as it would effectively assure that the suppliers on this quadrant would be able to place E-orders and, as a result, be transferred to the category of E-order suppliers operating under Supplier D-terms.

The alternative would be for the buyers at Continental to directly contact the suppliers via e-mail or phone call and request the tracking keys. Once received, the buyers would have to manually insert this information into the SAP system onto every PO line item that was missing it. This solution is not idyllic since it demands additional work from the plants' side and is very time-consuming. It should be seen as a last resort and used only during a transition phase until all the non-EDI suppliers start using Quicklink or other electronic connection methods.

### 6.1.5 Ensuring Compliance from External Suppliers

Ensuring supplier compliance with the newly imposed requirements should also be done in a structured manner. Three steps can be performed to aid into the transition from the current situation to a scenario where most or all suppliers will feel compelled to comply with the new specifications and provide the delivery tracking keys.

First, it is important to inform them and explain why Continental is requiring additional information. For that, each plant or lead buyer is responsible to contact their own suppliers and brief them on the subject. Secondly the supplier requirements manual (SRM) should be updated to reflect these changes. The updated SRM adds a step requiring the suppliers to provide the delivery tracking keys for multi-modal shipments with sea transports involved.

Lastly it was important to make the suppliers accountable for the new task at hand. A KPI was created to check to which extent different suppliers will be complying with the updated requirements. Currently, the used KPI to evaluate how complete is the shipment information provided is called ASN completeness. This KPI reflects the average percentage of the five mandatory fields of the ASN by any given supplier. These fields are: lot quantity, number of shipped units, lot number, production date, and weight.

In addition to this KPI a new one will be added and named delivery tracking (DT) completeness. DT completeness will not be calculated as a direct percentage of the filled tracking keys' fields as that would not reflect the usefulness of the information provided. The Table 6.1 is a proposal of how the different combinations of provided keys should be considered for a given shipment.

Table 6.1: DT completeness

| Provided Information | DT Completeness |
|---|---|
| N/A | 0% |
| Carrier or CTR# or BL | 50% |
| Carrier + BL | 90% |
| Carrier + CTR# | 90% |
| Carrier + BL + CTR# | 100% |

This method of evaluating DT completeness reflects more closely the actual situation. Any given key on its own is not enough to accurately track the shipment, therefore only a 50% completeness value should be attributed. As for combinations of Carrier SCAC with either the BL or the CTR#, the provided information is already sufficient to reliably track the shipment. Yet it increases Continental's costs as it loses the ability of pooling the containers from the same BL together and saving on the overall number of containers tracked. Unsurprisingly, when a shipment has the three fields filled a score of 100% should be attributed as it allows Continental to both track the shipment and reduce the number of containers that need tracking. This is the result of the previously explored situation where multiple containers share the same BL and, therefore, only one of them needs to be tracked.

### 6.1.6 Internal Suppliers

The employed connection strategy for Continental's internal suppliers consists in avoiding third-party service providers altogether. Direct connections between the multiple SAP systems are to be established in order to bypass Elemica and avoid paying for the transfer of information already belonging to Continental. Besides, this will also decrease dependency on Elemica services which has been a strategic concern for the firm.

There are three major internal suppliers of raw materials: C-ITA, Aldora Mills and Continental Tires Holdings Singapore (CTHS). C-ITA and Aldora Mills are manufacturers of textile reinforcements for tire production. C-ITA is located in Europe, while Aldora Mills is situated in North America and they are responsible for the supply of textiles for its own region. For this reason, its share of outbound containers travelling via ocean is very small, usually no more than a couple of containers per month. Therefore, they represent a very small share of the overall inbound overseas containers for the tire plants, which makes its systems integration not very urgent. It was deemed that, for such a low volume of containers, it would be wiser to classify C-ITA and Aldora integration projects as ‘low-priority’ and focus more heavily on CTHS. For the time being, C-ITA and Aldora can be treated as external non-EDI-connected suppliers. Meaning that tire plants placing orders to the internal textile manufacturers can contact them directly, ask for the tracking keys and manually insert them into their SAP system.

CTHS is in a radically different position. It is responsible for around 95% of the supply of natural rubber for all tire plants. Since natural rubber is overwhelmingly grown in the tropics and most of the plants are located well into the northern hemisphere, the vast majority of natural rubber supply comes from overseas and is transported via ocean freight. Hence, monitoring the delivery would be of great interest. This led the team to classify the integration project of SAP TEMPO with CTHS as being ‘high-priority’. The preferred solution would be to start sending the tracking keys directly into SAP TEMPO from CTHS’ system, avoiding any third-party EDI providers. To achieve this, the process of creating delivery notes on CTHS side would have to be adjusted and to consider input of the key fields, just like what was done on SAP TEMPO.

### 6.1.7 Summary of Established Connections

Once the whole system is set up, it is expected that the multiple connections between the various involved entities will be as follows in Figure 6.4:

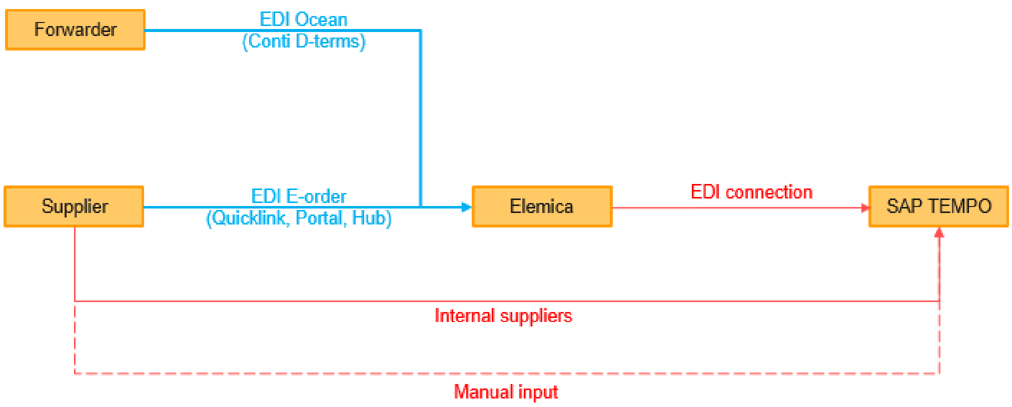



Figure 6.4: Data gathering system

Internal suppliers will be directly connected with Continental Tires SAP system. Non-EDI-connected suppliers will be contacted by the plants, allowing for the information to be exchanged through the usage of non-EDI methods and finally manually inserted and stored into Continental Tires SAP. E-order suppliers and forwarders alike should submit the tracking keys to Elemica which in turn transfers it to Continental's systems.

The flowchart in Figure 6.5 aims at summarizing the logical map to be followed for supplier-classification and data transfer:

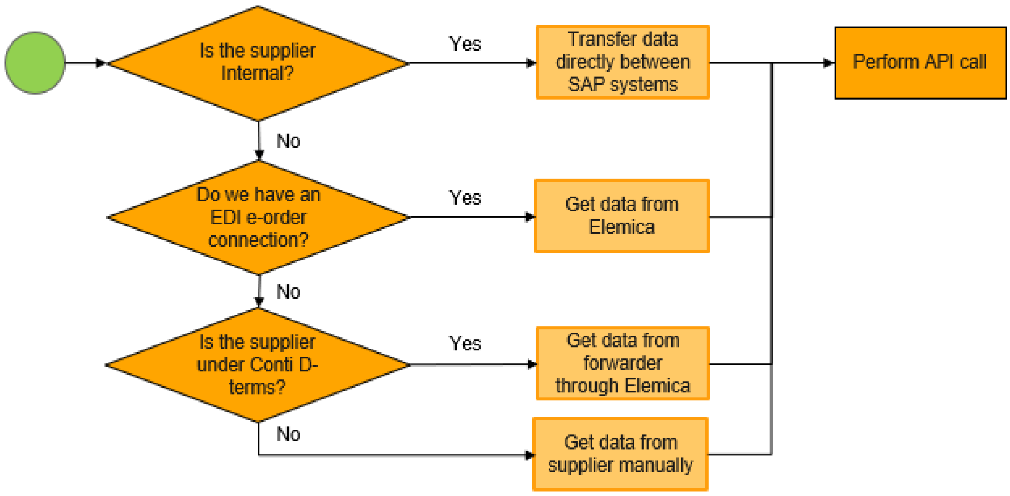



Figure 6.5: Logical system for data gathering

## 6.2 Performing API calls

With the data gathering system fully conceptualized, it is important to discuss how to perform the necessary API calls to get the ETAs from the data provider. Two main issues arise on this stage as it is compulsory to determine which entity should perform the aforementioned API calls and for which shipments/containers.

### 6.2.1 Party to Perform API calls

After some deliberation it was decided that the only sensible parties to perform the API calls would be either Elemica or Continental itself.

Elemica is a competent and reliable partner and has the necessary internal capabilities to carry-on the task. Plus, talks with the company made clear that they would be interested in establishing an API connection with a data provider since this has been on the company's agenda for some time. If Elemica were to be the one connecting with the data provider, it is also expected that they would have significant bargaining power. This would come as the result of Elemica pooling several companies interested in ocean delivery tracking together and using its greater volume to lower the agreed price to pay per container. However, it is unclear whether or not this increased negotiating power and lower prices would trickle down to Continental and represent decreased costs for the company. It is also worth noting that EDI-connected suppliers are already using Elemica's services, therefore getting the tracking keys for their shipments would be feasible for Elemica.

Despite all the previously mentioned advantages, picking Elemica also presents some significant drawbacks. The delivery keys regarding internal suppliers and non-EDI-connected ones would still have to be made available to Elemica and this information transfer is translated into additional costs for Continental. Plus, Elemica would obviously charge for the delivery tracking service. On a strategic level, Continental would become even more dependent on Elemica than it already is, and it is not clear if Elemica would want to request the ETAs from a specific provider or allow Continental to pick the one.

After plenty of internal discussion, Continental decided that increased dependence on Elemica and its subsequent costs were not desired. Therefore, the API calls must be performed by Continental itself without external support. Assuming that the tracking keys could be successfully stored onto the company's SAP, meetings with the IT team took place to understand what would have to be done to set up the system. Continental can use SAP NetWeaver Process Integration, which is a specific product of SAP, that allows for the enhancement of SAP capabilities, including the performance of API calls. This would be the preferred solution. An alternative would be to transfer the information daily from the SAP to an external data lake, perform the API calls from there and return the ETAs to the SAP.

### 6.2.2 Shipments to be Tracked

As an additional measure of cost savings, it was also explored the possibility of only tracking containers deemed urgent or crucial to avoid shortages. A potential way of doing so would be to implement a flagging system that would allow plants to mark inbound deliveries relevant for tracking and only track the flagged containers. This way, plants could flag deliveries based on a certain material susceptible to an imminent shortage or simply pick a single PO line item. This would definitely reduce the number of tracked containers and result into reduced costs for the company. However, this approach comes with plenty of shortcomings.

Firstly, only containers already in risk of shortage would be flagged, therefore, this would not be the best approach for identifying potential shortages that the company is unaware of. The lower coverage of containers would also weaken the ability of Continental to get an overview of the delivery performance per carrier/plant/supplier or any other relevant metric as very little historical information would be available. Plus, requiring plants to flag containers also increases their workload. The flagging system is also more demanding for the firm's internal capabilities and harder to implement than the alternative of just tracking all containers. This increased strain on the IT resources would certainly mean a slower implementation process.

The cons outweighed the pros and this idea was scrapped. As a result, it was decided that every container should be tracked constantly and receive daily updates from the data provider. The plan of performing one API call per day for a container of each BL was then kept.

## 6.3 Further Considerations

### 6.3.1 Converting ETA at port into ETA at plant

Having completed the previous stages, which were gathering the delivery keys and performing the API calls, attention should turn to the need of converting the ETA at POD to the more useful ETA at plant. The ETA returned by the data providers and stored in the SAP is the ETA at POD, however, this is not the most useful one from a buyer's perspective. The ETA at plant corresponds to the ETA at port plus the amount of time required for the on-carriage. Therefore, it can be calculated by the following simple equation (Eq. 6.1) where $x$ represents the number of days from the moment the vessel arrives at the port until the container arrives at the plant.

$$ETA@Plant = ETA@POD + x\ days \tag{6.1}$$

There are many ways to estimate the time for the on-carriage. For the present project two different approaches were considered.

The first one consists in developing a transit-time table (Table 6.2) which should be able to give the average on-carriage time based on the port of destination and on the plant location. This strategy has the advantages of being easy to develop and implement. However, it is hard to maintain the table updated and it is unable to adapt itself to crisis scenarios like the Covid-19 pandemic or other situations where the land-freight market is disrupted. Besides it is not very precise as it is strictly based on historical data and not on the actual journey undergone by the truck.

Table 6.2: On-carriage times matrix (POD vs Plant) - example

| | Hamburg | Rotterdam | Leixões |
|---|---|---|---|
| Lousado | 5 days | 4 days | 1 day |
| Timissoara | 4 days | 4 days | - |
| Puchov | 2 days | 2 days | 6 days |

A more dynamic alternative could consist in resorting to yet another API call with a different provider. Once the container was discharged from the ocean vessel and loaded onto a truck it should be possible to contract a data provider specialized in land-transport to track the container for the remaining part of the journey. The natural partner for this task would be Project44 since it is the parent-company of Ocean Insights and highly focused on lorry-tracking. Talks with Project44 led to the conclusion that an additional tracking key would be required from Continental if it were to track the containers in-land, which was the truck's license plate number. For the time being Continental was not prepared to provide the license plate of the designated trucks. Therefore, the first solution should be implemented on an initial stage and, the possibility of requesting Project44's services, can be considered further into the future. One could argue that the first solution is perfectly adequate for the present situation as the on-carriage rarely represents a significant component of the delays experienced and the safety stock is quite resilient to delays of less than 7 days.

### 6.3.2 Alerting Supplier in case no ASN is received

Another concern that emerged during the development of the proposed system was the realization that, in some cases supplier delays in providing the ASNs or not sending them at all could compromise the system's effectiveness. Since the ASNs would now also carry the delivery tracking keys, it is important to ensure that the supplier is notified in cases where such document has not been provided. There are two possible scenarios for Continental to not receive an ASN. Either the supplier is experiencing delays in its production and is not able to meet the deadline, or the supplier already sent the goods but did not notify the buyer.

For E-order EDI connected suppliers, there are some measures that can be taken by Continental to avoid this kind of situations. If the supplier is using Quicklink, it is anticipated that a 'expected ship date' is provided by the supplier at the time of purchasing order confirmation. This date corresponds to the date the supplier expects to ship the goods from its facilities and, consequently, this should be the date an ASN is created and sent to Continental. By having this date, it is possible to automatically notify the supplier a couple of days after the ASN creation is overdue (Figure 6.6). This way the supplier will be reminded to send an ASN in case the shipment already left its premises or warn Continental in case it is experiencing production delays and is behind schedule.

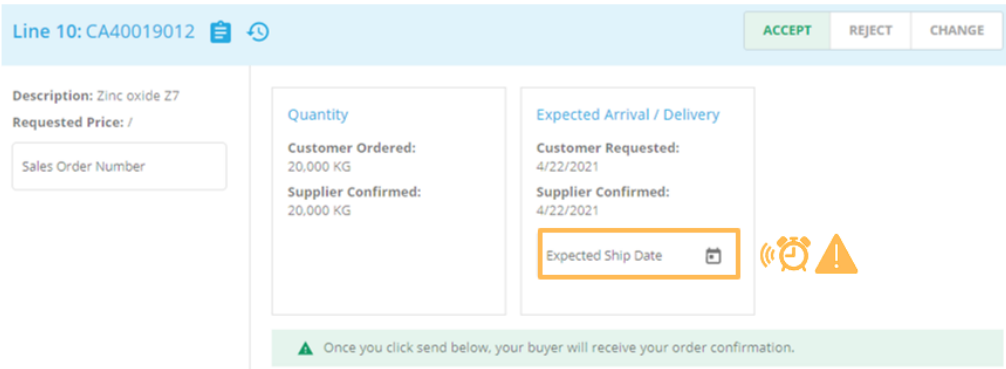



Figure 6.6: Quicklink PO confirmation panel

Suppliers using the online Portal to confirm E-orders are even easier to be notified of ASN delays. Each supplier using Portal has one or more Elemica accounts. Portal already has a built-in functionality that allows suppliers to access the user preferences on the setting menu and select from an array of 'Event Notifications' (Figure 6.7). The 'Event Notifications' list includes an ASN creation reminder, which should let the supplier know when it is missing an ASN. This functionality also encompasses options to warn the user about the placement of new POs or the lack of POs confirmations sent. The subscription of this 'Event Notification' is voluntary for suppliers, however, this could be highly encouraged by Continental or even made mandatory. This would also allow the supplier to inform the buyer that it is missing an ASN because the raw materials are not yet ready for expedition or that they were already shipped but no ASN was generated.

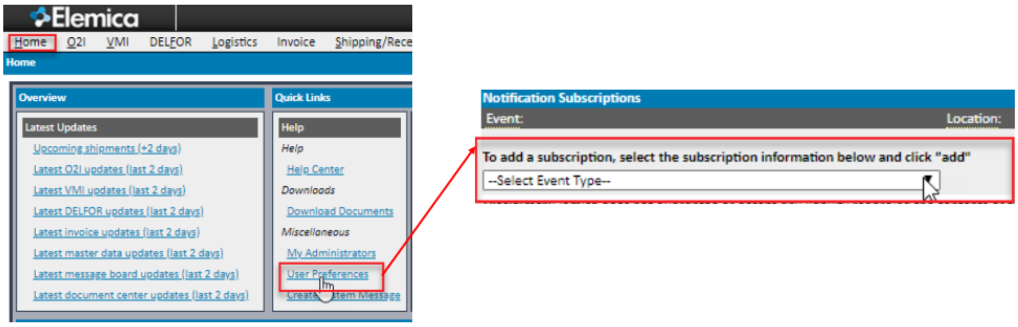



Figure 6.7: Portal event notifications

No straightforward solution is available for suppliers placing E-orders via Hub.

For OCEAN EDI suppliers, the forwarder is the one sending the tracking keys through Elemica to Continental's SAP. Therefore, in these cases, the container number, bill of lading and carrier SCAC should be available as soon as the booking is completed. If the booking is not completed this means that the goods have not yet been shipped and therefore the supplier is late.

Suppliers with no EDI connections established are much harder to contact and understand the causes for a missing ASN. One possibility would be to use historical data. It is possible to keep track of all the expected delivery times form one region to another based on past experience and define an expected date of departure. This would be done by looking at the requested delivery date and subtracting the expected duration of a journey between any two locations. If the current date exceeds the expected date of departure the supplier would be contacted by the buyers. This solution could even potentially work for all kinds of suppliers. However, it is harder to implement, time-consuming and highly imprecise as it does not account for the fact that two trips between the same locations can have widely different durations based on factors such as the selected carrier or the number of transshipment ports visited. With a large enough data set, a system could be developed in the future to account for all of this issues and guarantee that an automatic reminder would be sent to the supplier if no ASN is received after the date Continental was expecting to get one. This solution would require a project of its own to be implemented and should be considered as a potential future development to increase supply chain transparency.

# Chapter 7

# Conclusion and Future Developments

The present project offers an analysis and diagnose of major issues within the inbound supply chain of the company, namely in what regards the purchasing order process. It was identified that the aforementioned supply chain was lacking transparency and buyers were presented with few options to identify disruptions in inbound shipments.

The employment of delivery tracking tools as a way to enhance supply chain visibility will make it possible to quickly and reliably check for delays in the supply of raw materials. This will allow the tire plants to get consistent and up-to-date ETAs for their shipments, which in turn lets them react accordingly and mitigate the chances of having a shortage of raw materials.

A complete framework for the evaluation of delivery tracking tools was also used, allowing for a deep understanding of the upsides and downsides of the considered tracking data providers. It also aided in the assessment of the tools cost-effectiveness. In the end, Ocean Insights asserted itself as a more well-rounded company, offering an array of useful extra-functionalities, and also as a potential long-term partner for Continental. .

Finally, a comprehensive implementation strategy was also proposed with multiple scenarios explored and a clear step by step plan developed. The main takeaways being that Continental should integrate as many suppliers as possible via EDI to track all inbound shipments with minimal effort. Plus, Continental can perform the API calls to get the ETAs itself and for all incoming containers.

In sum, the project offered a deep dive into the possibility and practical aspects of employing delivery tracking tools into the current purchasing order system. The project started out as a hypothesized way of decreasing supply risk, avoiding shortages of raw materials and subsequent plant stoppages. However, its scope revealed itself broader and the universe of possibilities for cost savings greatly increased as more functionalities of the delivery tracking tool of Ocean Insights was explored.

After the implementation phase is completed, buyers should be able to save significant chunks of time that were previously spent in container tracking. Plus, in the medium-term, it is possible to use the tools extra-functionalities to reduce detention and demurrage costs and negotiate better terms with the contracted carriers. Some other medium to long-term enhancements could also comprise the development a system to alert suppliers in case an ASN is missing and the integration of another tracking data provider like Project44 to convert the available ETAs at port into ETAs at plant for the inbound shipments.

Furthermore, future developments should also consist in exploring the possibility of implementing delivery tracking tools into other business area inside the Continental Group, using the present project as a benchmark. Delivery tracking initiatives are already being explored by Contitech and by the Tire division for the outbound logistics as well.

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# Appendix A

# Tools Layouts

## A.1 Searates' Tool Screenshots

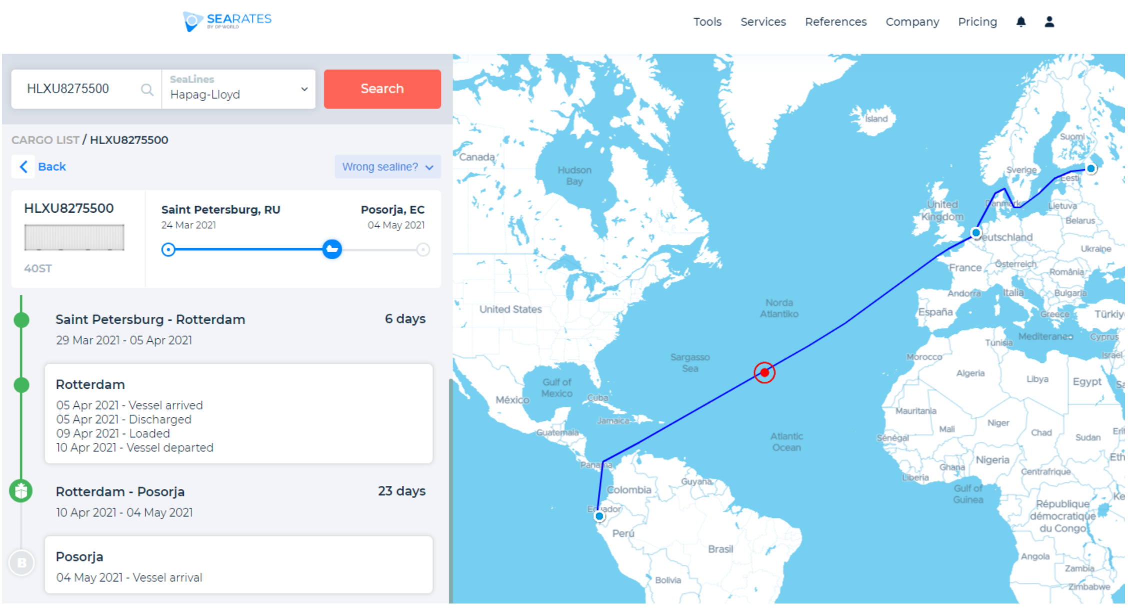



Figure A.1: Example of a tracking request

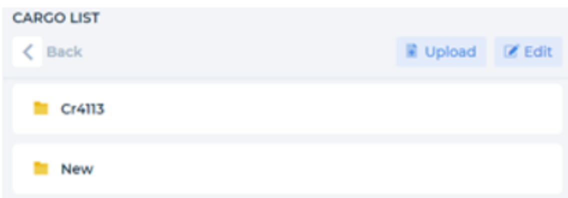



Figure A.2: Example of folders organization

## A.2 Ocean Insights' Tool Screenshots

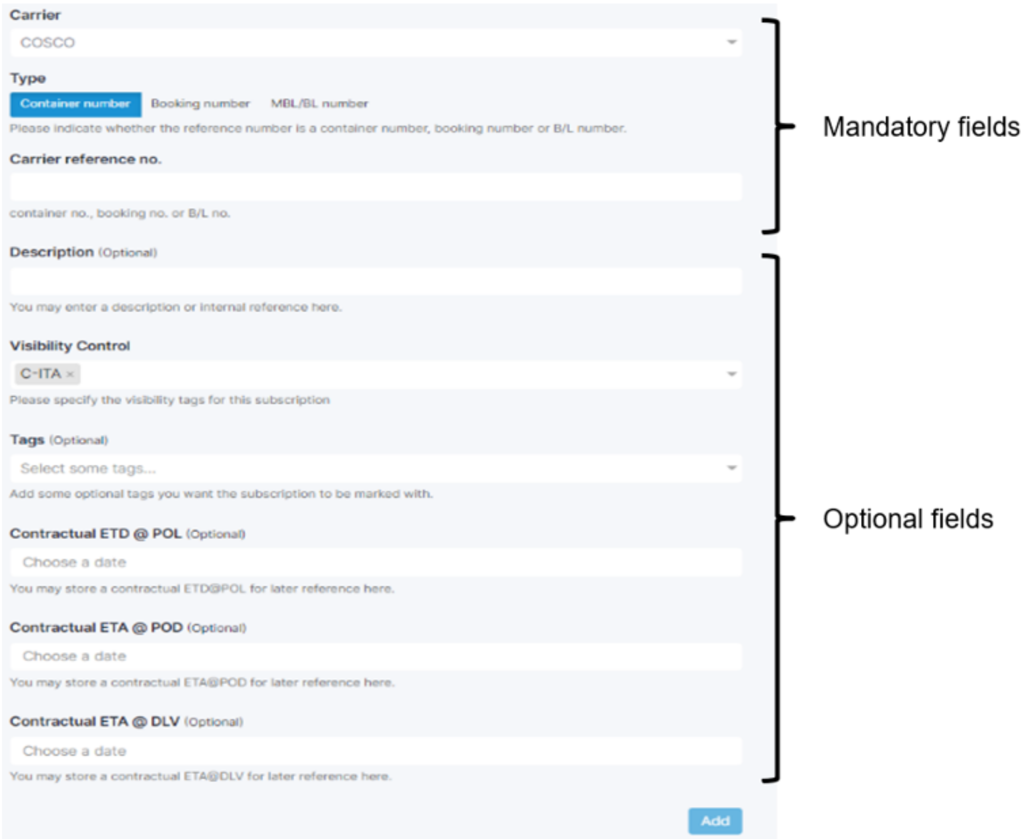



Figure A.3: Input fields for delivery tracking

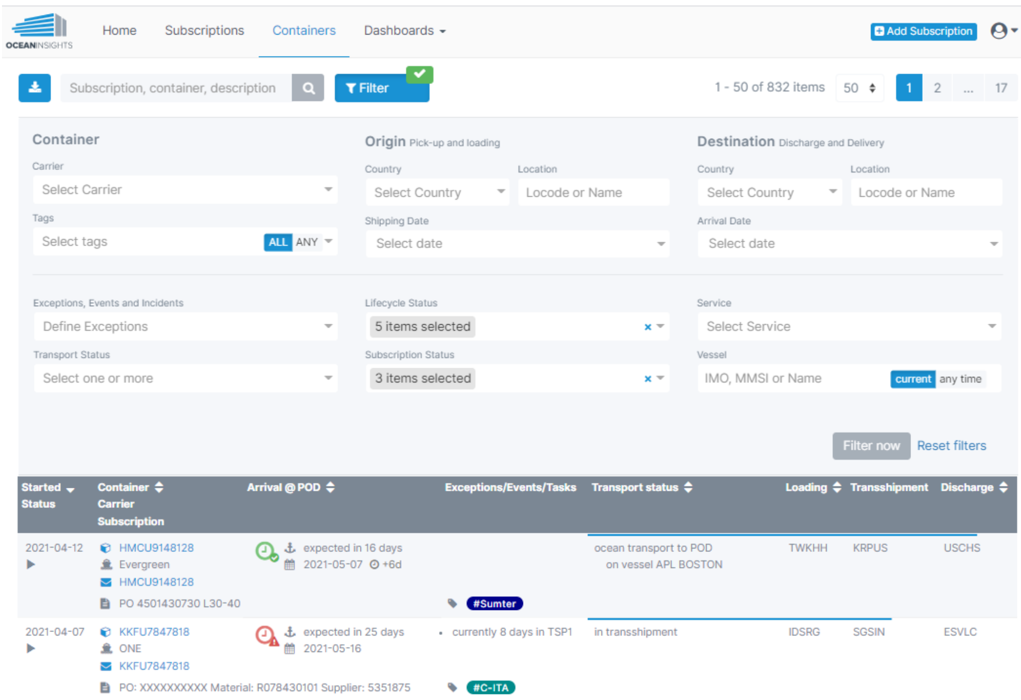



Figure A.4: Filtering options and container list

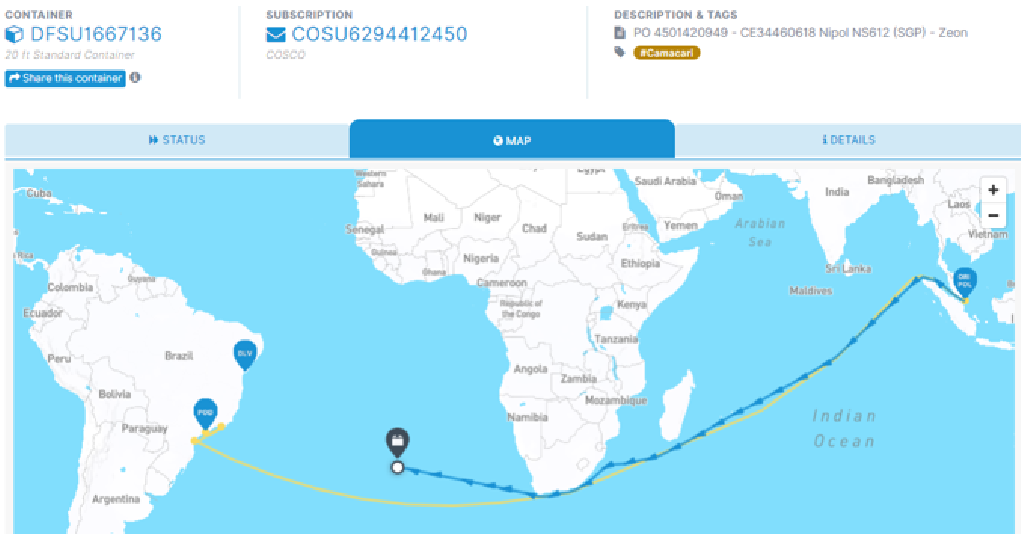
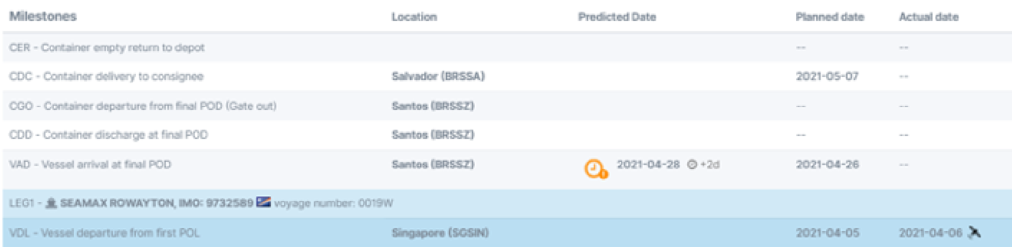



Figure A.5: Interactive map



| Milestones | Location | Predicted Date | Planned date | Actual date |
|---|---|---|---|---|
| CER - Container empty return to depot | | | -- | -- |
| CDC - Container delivery to consignee | Salvador (BRSSA) | | 2021-05-07 | -- |
| CGO - Container departure from final POD (Gate out) | Santos (BRSSZ) | | -- | -- |
| CDD - Container discharge at final POD | Santos (BRSSZ) | | -- | -- |
| VAD - Vessel arrival at final POD | Santos (BRSSZ) | 2021-04-28 +2d | 2021-04-26 | -- |
| LEG1 - SEAMAX ROWAYTON, IMO: 9732589 voyage number: 0019W | | | | |
| VDL - Vessel departure from first POL | Singapore (SGSIN) | | 2021-04-05 | 2021-04-06 |

Figure A.6: Shipment milestones

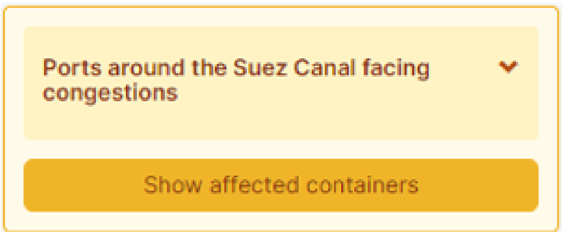



Figure A.7: Example of incident warning

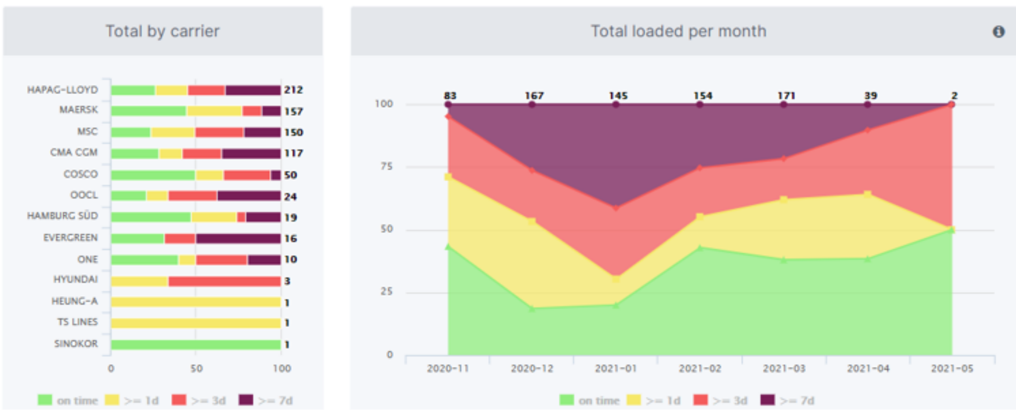



Figure A.8: On-time carriers' performance dashboard

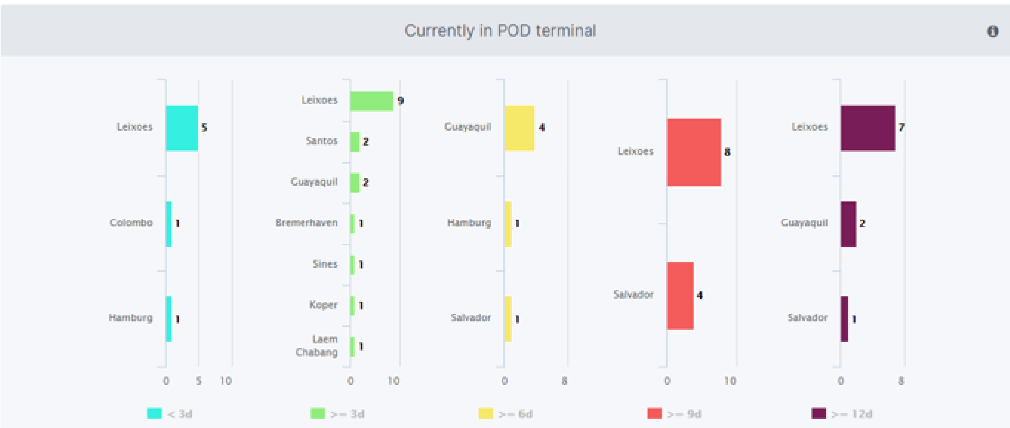



Figure A.9: Detention and demurrage dashboard

# Appendix B

# Developed ETL System - ROWS

## B.1 List of Containers to Track

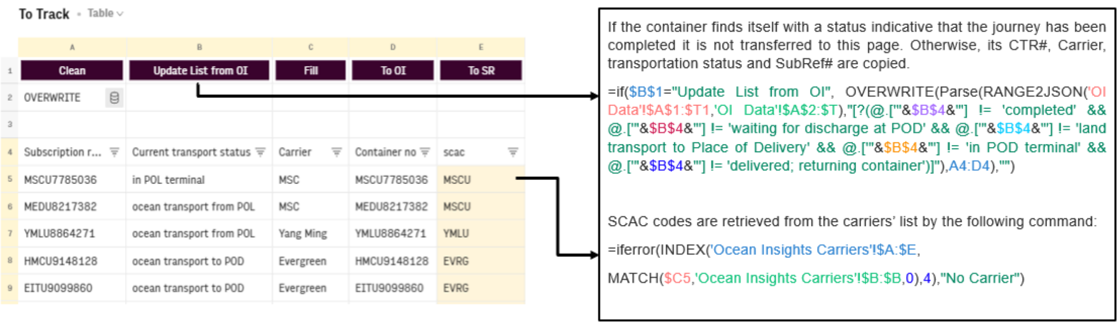



Figure B.1: 'To Track' page

| | A | B | C | D |
|---|---|---|---|---|
| 1 | OVERWRITE | short_name | official_name | scac |
| 2 | | ACL | Atlantic Container Line | ACLU |
| 3 | | Aliança | Aliança Navegação e Logística | ALIU |
| 4 | | ANL | ANL Container Line | ANLC |
| 5 | | APL | American President Lines | APLU |
| 6 | | Arkas | Arkas Container Transport | ARKU |

Figure B.2: 'Carrier List' page

## B.2 Performing API calls for Ocean Insights

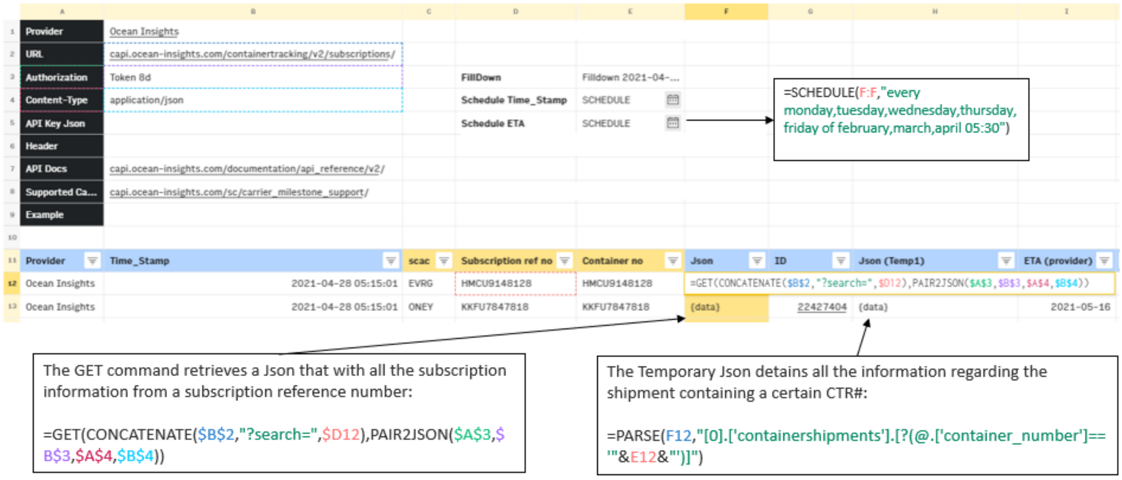



Figure B.3: Schedule and performance of API calls

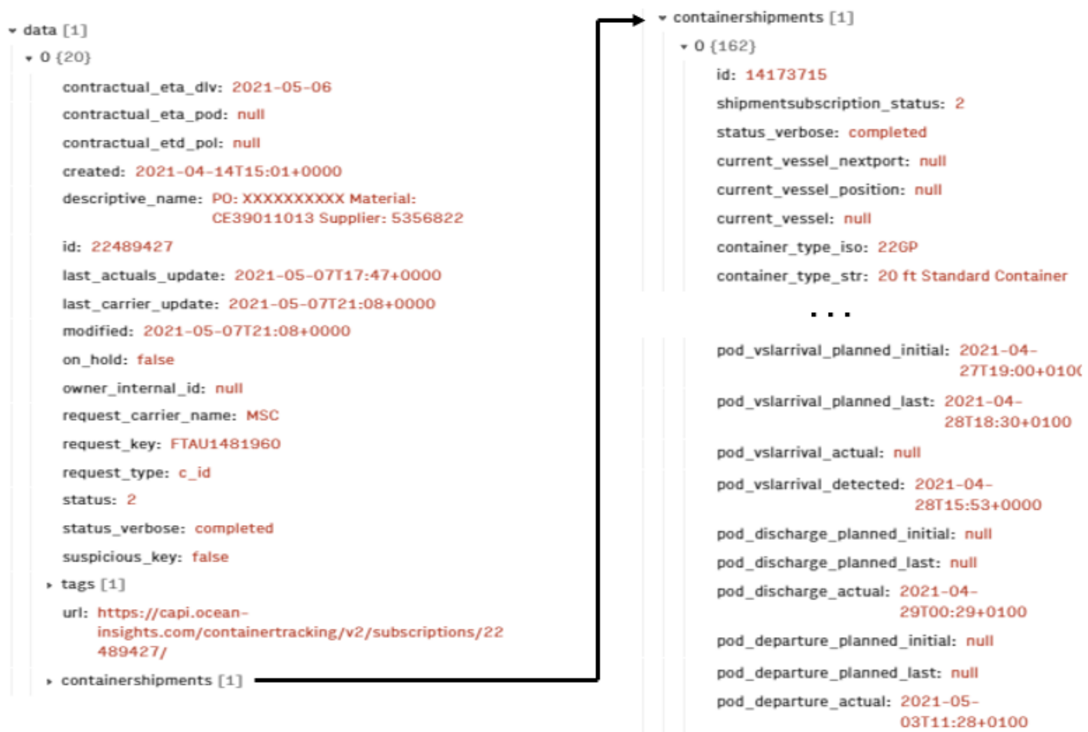



Figure B.4: Parse path for retrieving ETA – shortened

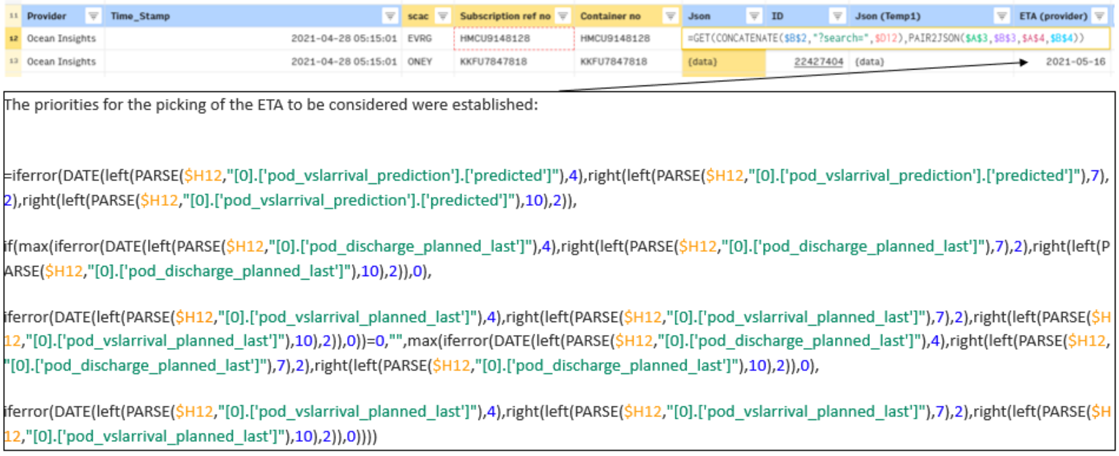



Figure B.5: Retrieving ETA at POD

## B.3 Performing API calls for Searates

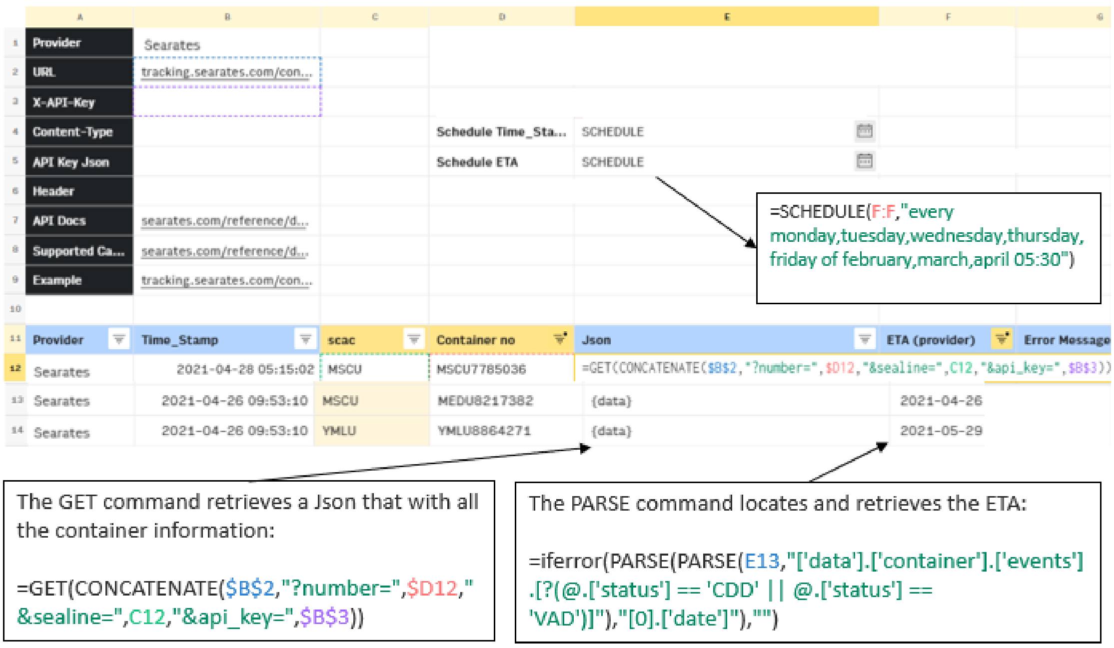



Figure B.6: Schedule and performance of API calls


Figure B.7: Parse path for retrieving ETA

# Appendix C

# Shell Script

```
#!/bin/bash
echo "" > all_data
ls -1 *.csv | while read file

do
        #sed -i -z -E 's/([^W|,])\r\n/\1 /g' "$file“
        gawk -v RS='"' 'NR % 2 == 0 { gsub(/\n/, " ") } { printf("%s%s", $0, RT) }' "$file" > temp.csv
        mv temp.csv "$file“
        data=$(echo $file | cut -d' ' -f1)
        #echo $file $data

        cat "$file" | sed 1d | awk -vFPAT='([^,]*)|("[^"]+")' -vOFS=,  -v fil="" -v data=$data
'length($16)<4 { next } length($25)==0 || $25=="1/1/1900 0:00" {print NF "," NR ",KLG," data "," $14
"," $16 "," substr($24,0,index($24, " ")) ;next} length($25)>0 {print NF "," NR ",KLG," data "," $14 ","
$16 "," substr($25,0,index($25, " ")) ;next}'  >> all_data

done
```

Figure C.1: Script for data preparation of KLG

```
#!/bin/bash
echo "" > all_data
ls -1 *.csv | while read file

do
        #sed -i -z -E 's/([^W|,])\r\n/\1 /g' "$file“
        gawk -v RS='"' 'NR % 2 == 0 { gsub(/\n/, " ") } { printf("%s%s", $0, RT) }' "$file" > temp.csv
        mv temp.csv "$file“
        ano=$(echo $file | cut -d' ' -f8 | sed 's/.csv//’)
        dia=$(echo $file | cut -d' ' -f7)mes=$(echo $file | cut -d' ' -f6)
        data=$(echo "$ano-$mes-$dia")
        echo $file $data

        cat "$file" | sed 1d | awk -vFPAT='([^,]*)|("[^"]+")' -vOFS=,  -v fil="" -v data=$data
'length($5)<4 { next } length($16)==0 || $16=="1/1/1900 0:00" {print NF "," NR ",DHL," data "," $7 ","
$5 "," $15 ;next} length($16)>0 {print NF "," NR ",DHL," data "," $7 "," $5 "," $16 ;next}'  >> all_data

done
```

Figure C.2: Script for data preparation of DHL

# Appendix D

# Errors Magnitude

## D.1 Ocean Insights

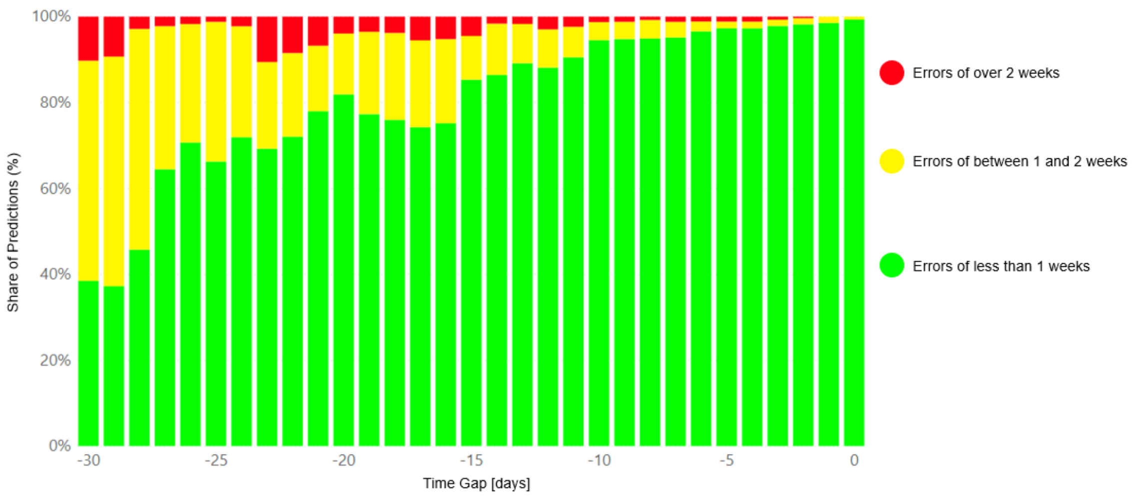



Figure D.1: Errors magnitude per time gap (OI)

As it can be observed by Figure D.1, the forecasting errors of over 2 weeks almost never represent more than 10% of the predctions provided by Ocean Insights for any time gap.

## D.2 Searates

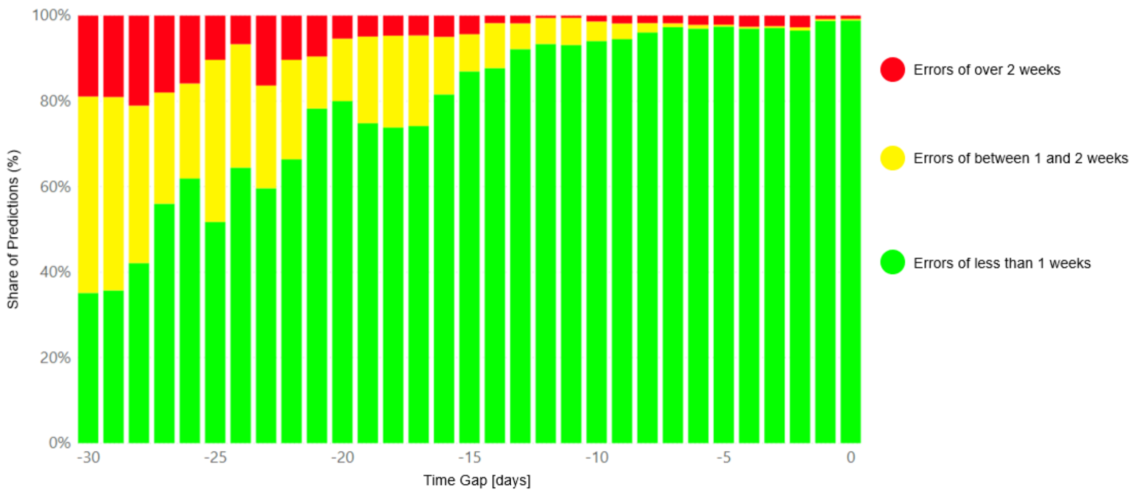



Figure D.2: Errors magnitude per time gap (SR)

Comparing to the previous chart, Figure D.2 indicates that Searates is more likely to provide forecasts with errors of over 2 weeks. However, the total share of errors larger than 1 week is still similar to the results obtained for Ocean Insights.

## D.3 KLGDHL

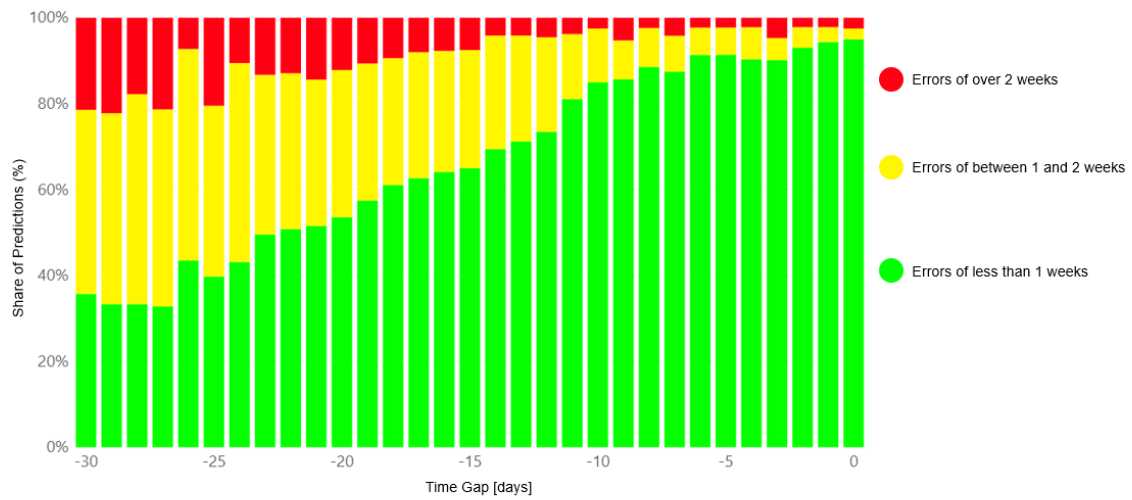



Figure D.3: Errors magnitude per time gap (KLGDHL)

KLGDHL was the one more prone to provide either errors of over 1 week or of over 2 weeks. This can be assessed by the analysis of Figure D.3, that shows how much smaller the 'green area' (area representing errors smaller than 1 week) is in comparison with Searates and Ocean Insights.