Improved Management Practice for Freight Savings

by

Jiayue Zhao

B.S. Mechanical Engineering, Biomedical Engineering
Boston University, 2020

Submitted to the Department of Mechanical Engineering in partial fulfillment of the requirements for the degree of

Master of Engineering in Advanced Manufacturing and Design
at the

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Abstract

Waters Corporation makes hundreds of shipments daily. Optimizing distribution and reducing shipping expenditures can result in significant cost savings. This thesis deals with two main freight problems at Waters: 1. Customers who should pay but do not pay for shipping; 2. Product shortage and packaging damages that delay the shipping schedule. According to the customer service department, Waters does not charge for shipments for approximately 40% of the orders in the US, and a portion of this is done by mistake. After initial analysis, it was found that the mistake is due to 1. misalignments between Waters' internal databases 2. delayed shipping schedule that can result in unnecessary, but expensive expedited shipments. First, Waters uses three different databases for contract management (Lotus Notes), sales quotes (Salesforce), and shipments/billing (SAP). Customer master data is not completely synchronized among the three platforms. Correcting misalignments among these databases would help Waters collect more freight charges from customers who should pay for the shipping. Second, Waters pays for very expensive expedited shipping due to time constraints, stock outs, damaged inbound products, and human mistakes. We suggest strategies to reduce these problems and thus reduce the use of expedited shipping. Finally, this thesis concludes with a cost-saving analysis that focuses on misalignments between Lotus Notes and SAP for European customers and on unnecessary expedited shipments from the Global Distribution Center located in Franklin, MA.

Thesis Supervisor: Stephen C. Graves
Title: Abraham J. Siegel Professor of Management

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Acknowledgments

I would like to extend my deepest gratitude towards all personages both at MIT and Waters Corporation who have helped me in this endeavor, and made this thesis project possible:

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Chapter 1. Introduction

1.1 Problem Statement

Waters Corporation does business with thousands of customers worldwide. Every day hundreds of products are shipped domestically and internationally. According to the customer service department, Waters does not charge the shipping cost for approximately 40% of the orders in the US. A fraction of this uncharged shipping is not aligned with what is reflected in the customer contracts; in particular, this means that these shipping costs are supposed to be paid by customers but are actually paid by Waters itself. The additional shipping cost brings additional burden to Waters during the post-COVID period, as these costs can be reduced or even eliminated if a better management practice were to be employed.

The intent of this research project is to reduce Waters' overall spending on shipping and improve multi-department communication. A key evaluation metric is to make sure the cost of implementing new strategies is less than the savings from not paying for the shipments that should not be paid by Waters.

1.2 Motivation

The motivation of this project is to reduce the shipping expenditure. It is expected that correcting the misalignment between Waters' internal databases and reducing packaging damage and stockouts will bring Waters a multi-million dollar saving potential. Therefore, the team explored and proposed solutions to achieve information synchronization across Waters' three operating

platforms and process improvements at GDCs. For this project, the team is the author and a fellow student Amelie Feron.

1.3 Objective

Our key objective of this project consists of three parts:

1. Identify misalignments of shipping methods among Waters' internal databases; pinpoint the customers and orders for which there is a misalignment. Identify orders that used the wrong shipping methods.
2. Diagnose the reasons for each misalignment and propose strategies to reduce future misalignments.
3. Develop tactics to minimize inbound damaged products and damaged packaging received by GDC and minimize future delays of shipping schedule due to product quality issues.

1.4 Scope

Waters operates in three different regions: Asia, the Americas, and Europe. Since 2019, the contract information has been centralized and managed by the US customer service team. Keeping track of all data across all regions is a tedious process. Considering that Europe recently transferred its contracts to the US system, the team will focus first on analyzing European contracts between Jan 2021 and May 2021, and then before Jan 2021. The team expects that these two samples will show trends that are representative of the entire population of contracts and orders.. The execution

of this project will be limited to identifying the misalignment between databases and to reducing inbound product damage and packaging damage.

The first part of the project breaks down into: a) Identify customers whose billing information in SAP misaligns with their contracts. b) Look for additional agreements, terms and conditions for these customers, if there is any. c) If additional agreements, terms and conditions cannot be found, look for orders that these customers placed during the period. d) The savings will be the sum of all shipping costs that should be paid by customers but were paid by Waters.

The second part of the project breaks down into, a) Find out how many inbound units come with damaged packaging. b) Understand why there is damage and identity patterns of these damages. c) Calculate number of days that the shipments get delayed due to damage d) Calculate the cost that could have been saved if there were no damaged packaging issue.

Chapter 2. Background

2.1 Waters Corporation

Founded by Jim Waters in 1958, Waters Corporation is a publicly-traded analytical laboratory instrument and software company headquartered in Milford, Massachusetts. Waters develops, manufactures, and delivers high-performance liquid chromatography (HPLC), ultra-performance liquid chromatography (UPLC), mass spectrometry (MS) technology systems and support products, thermal analysis, rheometry, and calorimetry instruments, as well as other laboratory informatics. Its products are widely used in applications including drug development, food testing, and air and water quality testing. Its customers are in the academic, government, and industrial sectors.

With more than 7,500 employees, Waters operates in more than 30 countries, serving customers in more than 100 countries. It has 15 manufacturing facilities located in Milford, Taunton, Massachusetts; Wexford, Ireland; Wilmslow, around 13 miles south of Manchester, England; and Singapore. Waters also has Sites in Frankfurt, in Germany and in Japan. [1]

Publicly traded on New York Stock Exchange, Waters had $2.37 billion revenue in 2020, with a net income of $522 million. [2] [3]

2.2 Waters Products

Waters' major products include Liquid Chromatography (LC) and Mass Spectrometry (MS) instruments, consumables, and spare parts. In 2020, liquid chromatography (LC), mass

spectrometry (MS) and thermal and mechanical analysis systems represented 100,000 units in the world. Additionally, more than 50% of Waters' revenues come from consumables (CO), informatics maintenance and services, and spare parts (WGS). A significant amount of their revenue is coming from growing markets. The pharmaceutical and biomedical markets represent 64% of total sales, materials science constitutes 16%, and food, environmental and clinical markets account for 20% of the business. Asia, America, and Europe represent respectively 38%, 34% and 28% of total sales, and China accounts for 17%. Waters revenue for the twelve months ending September 30, 2021 was $2.736B, a 19.22% increase year-over-year.

The shipping costs at Waters depend on the size and weight of the product shipped and on the country of origin (Table 1).

Table 1: Freight Comparison in Europe

Country (currency)	**Product**	**Shipping cost**
UK (GBP)	LC	270
	MS	700
	CO	27
	WGS	27
Switzerland (CHF)	LC	400
	MS	800
	CO	35
	WGS	35
Sweden (SEK)	LC	3150
	MS	7000
	CO	270
Denmark	LC	2625

(DKK)	MS	5600
	CO	225
Norway (NOK)	LC	3000
	MS	7000
	CO	240
	WGS	240
Euro Zone (EUR): Spain, Portugal, Netherlands, Italy, Germany, France, Ireland, Belgium, Austria, Finland	LC	270
	MS	270
	CO	30
	WGS	30

This table presents the shipping costs by air for different products and equipment from the European Distribution Center to several European countries. If the product is not available in the European Distribution Center, Waters will do an internal transfer from the Global Distribution Center in the US, without any additional cost for the customer. LC and MS are usually shipped on pallets and represent large shipments with high shipping costs, since those instruments are roughly the size of a table, and need long distance shipping from Wexford, Ireland.

2.2.1 Liquid Chromatography (LC)

Liquid chromatography was discovered in the 1900s by a Russian botanist Mikhail Tswett. Two types of chromatography techniques exist: planar or column. In both cases, the sample is dissolved in a solvent before using a chromatographic device. The compounds of the solvent are separated by travelling at different speeds through the device.

High Performance Liquid Chromatography (HPLC) is a technique used to identify and analyze the constituent components of a variety of chemicals and material. HPLC can separate, identify and quantitate the compounds in any sample dissolved in a solvent. The solvent is the mobile phase and held in a reservoir. A high pressure pump generates and measures a specified flow rate of the solvent. An injector injects the sample into the HPLC column. The HPLC column contains a packing material (which is a stationary phase) to carry out the separation of the compounds into individual analyte bands. Those bands (Fig.1) are then detected, a chromatogram is generated, and the different constituents of the sample appear as peaks and can be quantified (Fig. 2). High Performance Liquid Chromatography improved the separation power using smaller particle sizes and allowing pressure around 400 bar to generate the solvent flow. It is used in a wide variety of industries for research and development purposes, quality control or process engineering applications. In the pharmaceutical industry, HPLC enables us to understand diseases, recognize new drugs and assure the purity of pharmaceuticals. In the food and beverage industries, it is used for nutritional labeling and compliance with safety regulations.

The Ultra Performance Liquid Chromatography (UPLC) allows better resolution, speed, and sensitivity with smaller particles in the columns and pressure capability for instruments around 1,000 bars. Research continues on columns using smaller particle sizes and increasing the instrument pressure capability up to 6,800 bars [4]. LC products are manufactured in Milford, Massachusetts, and constitute Waters' core products.

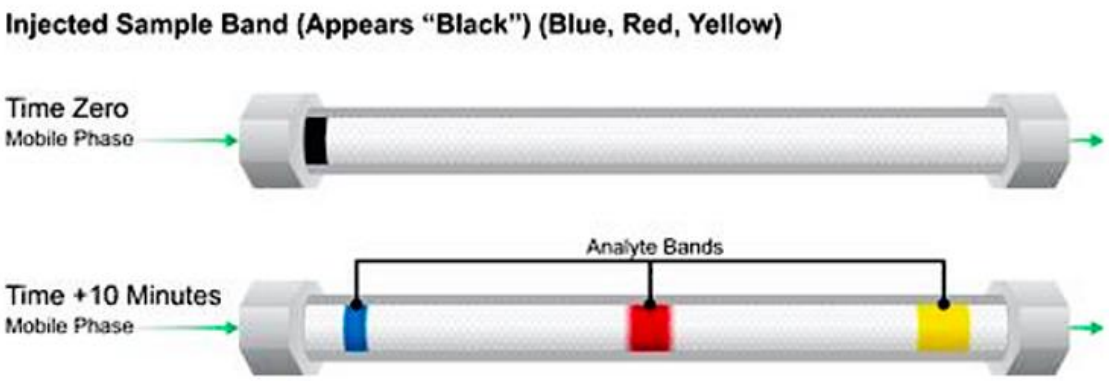

Figure 1: How a Chromatography column Works - Bands [8]

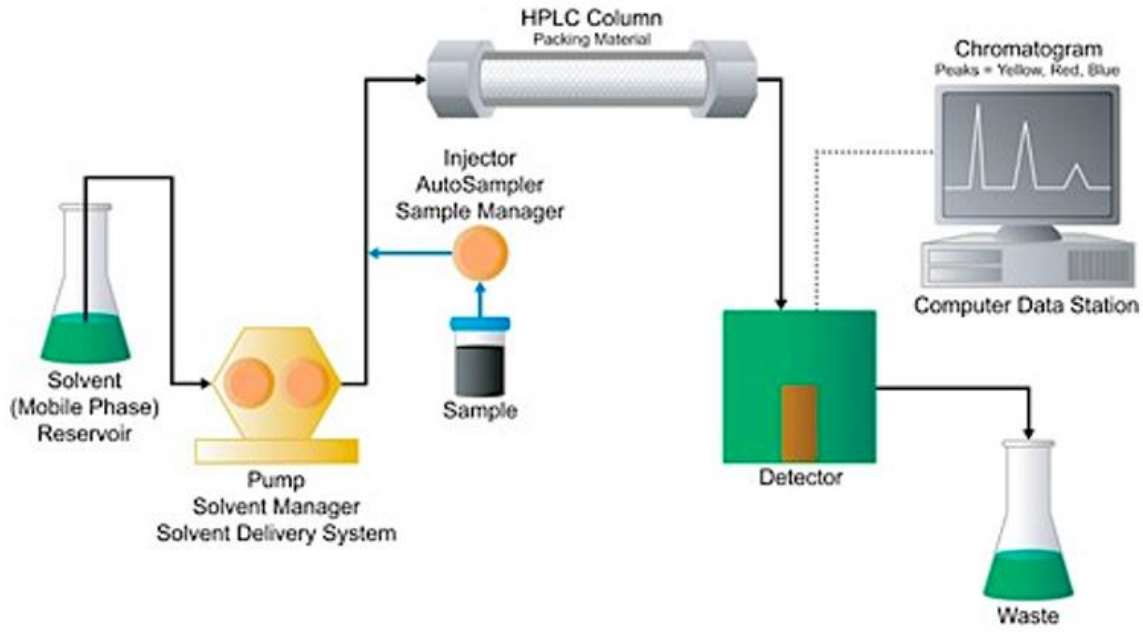

Figure 2: High-Performance Liquid Chromatography [HPLC] System [4]

2.2.2 Mass Spectrometry (MS)

The cathode-ray-tube experiments of J.J Thomson marked the beginning of modern mass spectrometry in 1897 [5]. A mass spectrometer is composed of an ion source, a mass analyzer and a detector operating under high vacuum conditions [6]. Mass spectrometry is used in chemistry, biochemistry, physics, and the pharmaceutical industry. Mass spectrometers are able to identify and quantify unknown compounds in complex samples and confirm trace components at the lowest possible levels by measuring the mass of every molecule [7]. To do so, the sample is thermally ionized by electric fields or by impacting energetic electrons, ions or photons. Then, a mass analyzer separates the ions by their mass-to-charge ratio (m/z). The lightest ions are more deflected by the magnet than the heaviest ones. A detector detects the ions qualitatively and quantitatively by their respective m/z and abundance [6]. The flux of electrically charged ions is converted into a proportional electrical current. A data system reads and converts the electrical current to digital information, and displays it as a mass spectrum [7] (Figure 4). Waters' MS units are manufactured in Wilmslow, England, and Wexford, Ireland.

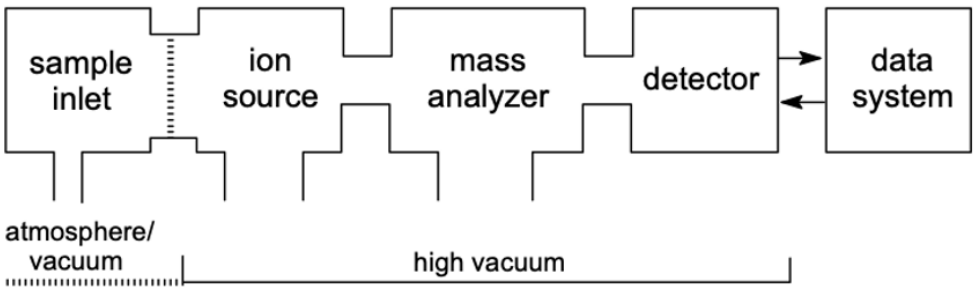

Figure 3: General Scheme of a Mass Spectrometer [6]

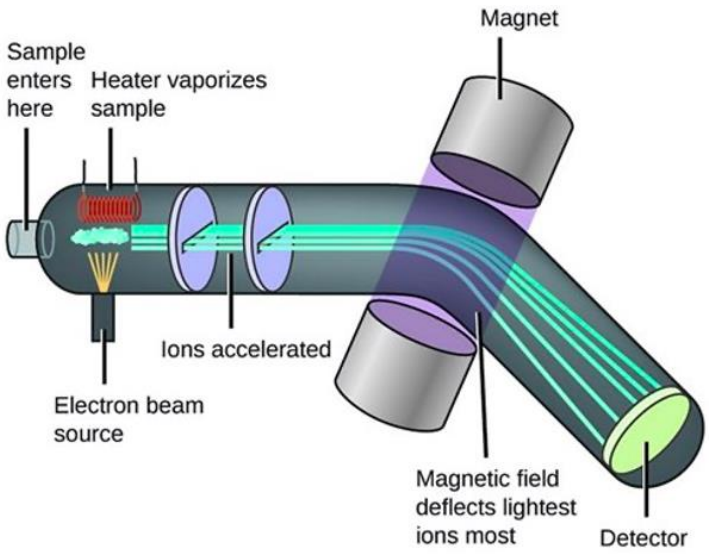

Figure 4: Schematic of Mass Spectrometer [8]

2.2.3 Consumables (CO)

Waters also manufactures consumables products such as chromatography columns for LC; sample preparation tools for LC/MS and GC/MS analysis; analytical standards and reagents to achieve optimal performance and compliance; and, vials, plates and certified containers for sample analysis [9].

2.3 Waters-MIT Collaboration

Waters Corporation and the Master of Engineering in Advanced Manufacturing and Design program have been collaborating since 2013. Each year, a team of students work for Waters Corporation in different areas such as Product Design, Research and Development, Manufacturing

Process Control, Operations Improvement, and Supply Chain. To our knowledge, this is the second project focusing on freight savings: In 2019, a team of students worked on improving packing strategy for distribution centers to reduce freight costs. This year, the project was carried out at the Global Distribution Center in Franklin, MA. [10] It focuses on two areas: 1. Correcting misalignments between customer contracts and shipping information in SAP, thus reducing shipping expenses that Waters covers for customers 2. Reducing packaging damage that leads to delayed shipping schedule and unnecessary expedited shipments.

2.4 Waters Global Supply Chain

2.4.1 Global Distribution Centers (GDC)

Waters Corporation operates three distribution centers in the world: the Global Distribution Center (GDC) in Franklin, MA, the European Distribution Center (EDC) in the Netherlands, and the Asian Distribution Center (ADC) in Singapore. Among all distribution centers, the Global Distribution Center is the largest and ships products from Massachusetts to the other two distribution centers. This distribution center was initially located in Milford, MA, and relocated to Franklin, MA, in October 2017 to meet the growing distribution capacity requirement. The warehouse is over 56,000 square-feet and contains over 14,000 SKUs of different sizes in over 20,000 separate storage locations (Fig. 5). The GDC receives products five days a week from the manufacturing facilities in the US (Milford, MA) and in Europe (Wexford, Ireland and Wilmslow, UK), and from the contract manufacturer in Singapore. Once the products are received by the GDC, they are inspected for damages, and put on different shelf spaces depending on their sizes, waiting for their future

shipment (Fig. 5&6). As COVID slowed down planned manufacturing activities, the safety stock level decreased dramatically by 60%[1] in 2021.

Figure 5: Global Distribution Center

[1] Interview with Water Warehouse Manager Rich Gorden July 2021

Figure 6: HPLC Columns on Shelves

2.4.2 Customer Service Department

Whenever the sales team captures a new customer, it passes the customer information to the customer service department to create a quote on either Salesforce or Lotus Notes, a Customer Relationship Management tool (CRM). These are what Waters calls “direct customer order”. The customer service team will set up a customer strategic account in either Lotus Notes (Fig. 7) or Salesforce, with a blanket sales order and other additional agreements in addendums (Fig. 8&9). A blanket sales order represents a structure for a long-term agreement between Waters and its

customer. A blanket order is typically generated when a customer has committed to purchasing large quantities that are to be delivered in several smaller shipments over a certain period of time with a predetermined pricing structure.

The addendum database gathers sales and service addendums. At Waters, an addendum is a detailed description of additional changes that have been negotiated after the contract is published (Fig. 9). The addendum forms part of the sales contract. It serves as an additional agreement when the customer wants to change the terms and conditions of the contract. To initiate a shipment for the "direct customer order" requires a purchase order number, and a credit card number for payment.

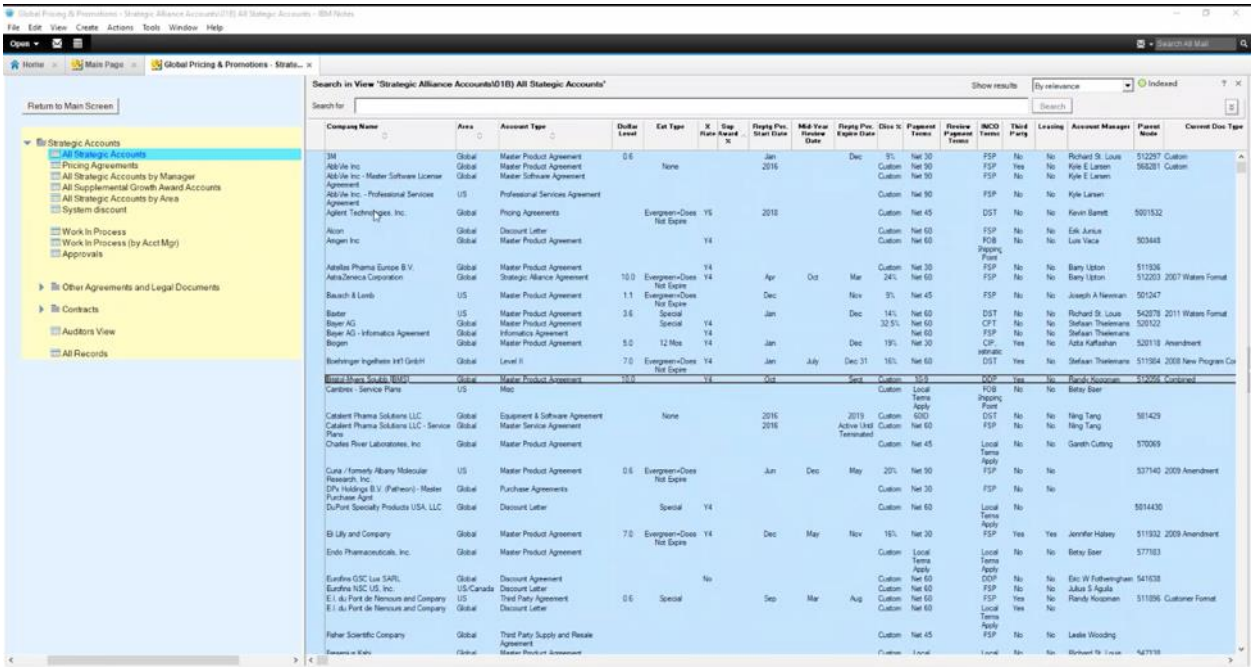

Figure 7: Strategic Accounts in Lotus Notes

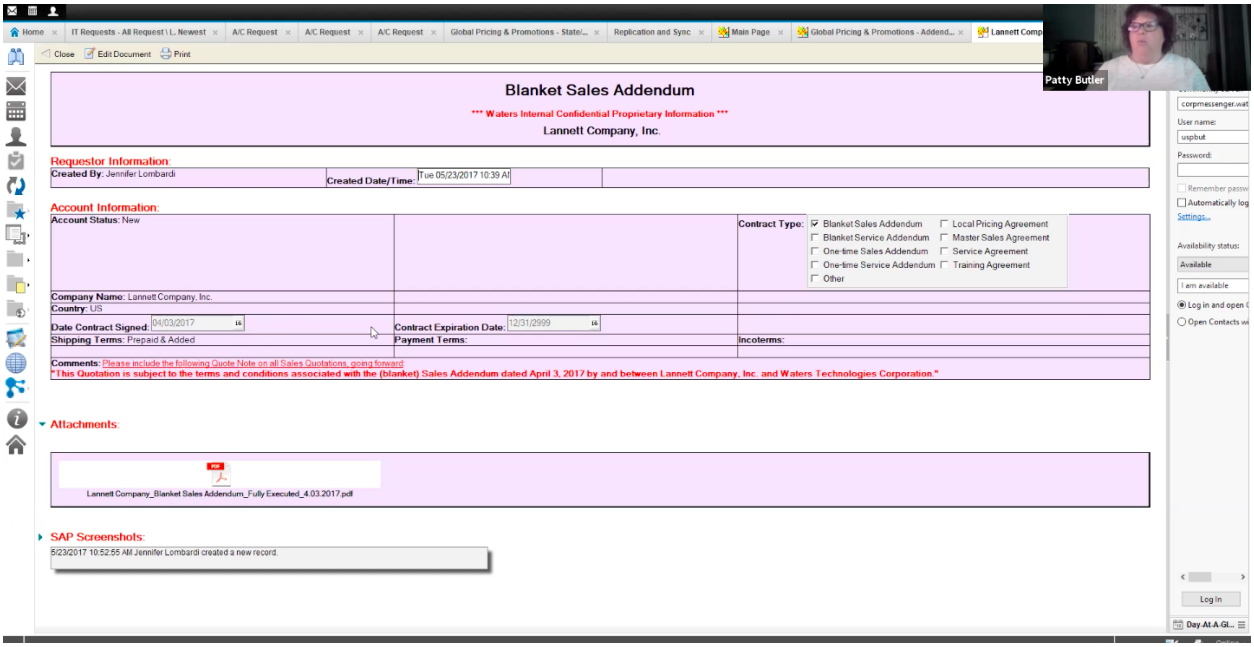

Figure 8: Blanket Sales Addendum

ADDENDUM

THIS ADDENDUM, (hereinafter "Addendum") by and between Waters Technologies Corporation (hereinafter "Waters") and Lannett Company, Inc., including any affiliates (minimum 50% majority-owned) (hereinafter "Buyer"), (both referred to as "Parties"), specifically alters, amends and revises the Waters General Sales Terms and Conditions (the "Waters Terms") in each Waters quotation attached hereto as Exhibit A and made a part of this Addendum ("Quotation"). Each Quotation shall specifically reference this Addendum.

WITNESSETH:

WHEREAS, Buyer and Waters are entering into the Addendum to amend the Waters Terms with respect to the Quotation, attached hereto as Exhibit A;

WHEREAS, the Parties desire to enter into this Addendum in order to give effect to the foregoing.

NOW THEREFORE, in consideration of the mutual promises set forth herein and for other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Parties hereto hereby agree as follows:

1. Item 2. Taxes and Payment. In the third sentence, "shipment" shall be deleted and replaced with "receipt of invoice".

2. Item 2. Taxes and Payment. The fourth sentence shall be deleted in its entirety and replaced with the following;

   "An interest charge equal to 1% per month (12% per year) will be added to quotations outstanding beyond 30 days after payment due date."

3. Item 7. Waters Right of Possession. This section shall be deleted in its entirety and replaced with "Intentionally Omitted".

4. Item 12. Governing Law. In the first sentence, "Commonwealth of Massachusetts" is replaced with "State of Delaware".

5. Item 14. Additional Terms and Conditions. This section shall be deleted in its entirety and replaced with the following:

Figure 9: Addendum

2.4.3 Field Service Department

The sales team acquires new customers and passes the customers to the customer service department, which then initiates the quote on Salesforce. The customer service department deals with presales and quotes, and enters orders in the systems. The field service team works very closely with the customer service group and the global distribution center for timely response to any product-related issues.

The customer service department is not the only order entry department. The field service team enters orders when an installation on a system or a repair is required. The field service team is still considered as "customers" and their orders are still treated as customer orders, but since they are Waters' internal employees, Waters absorbs the shipping expenses of these orders.

Field Service Logistics[2]:

When a customer has a problem with their product and speaks with Waters' experts center over the phone, if the issue cannot be resolved over the phone, the field service department dispatches a field service specialist to visit the customer onsite and evaluate the issue. Once the specialist evaluates the issue, he/she will contact the field service logistics group to order the new parts needed, via email and phone, or online through Lotus Notes or Compass (part of the Salesforce Compass system).

After the order is placed and service is completed, the specialist writes a field service report on what is taken from the inventory, and states in the report whether this customer has a Waters

[2] Interview with Field Service Support Logistics Manager, Ron M Creasia July 2021

service contract (which entitles them to a service that is covered under the warranty). If not, the field service logistics group will process the order in SAP and invoice it to the customer.

After the field service specialist places the order for customers, the logistics group creates the order in SAP, and GDC ships out the order. At this point, the order looks exactly the same with other orders placed by the customer service team. The only difference is that it is created by a field specialist, and it is considered as a replacement order, and does not require a purchase order number. Waters calls it a "pre-purchase order" because they are not dealing directly with the customer. 80% of the time, the customer has a Waters service contract, meaning the field service is covered under their warranty. Then the order is entered as an overnight priority, where GDC uses next-day FedEx priority delivery shipped out at 10:30 p.m. All freight costs are absorbed by GDC's budget.

Initial Hypothesis

The initial hypothesis of the root cause, while later proved not true, was that the customer service department treated field service orders (pre-purchase orders) as normal customer orders. At Waters, the shipping cost of normal customer orders are supposed to be paid by customers by default if no additional agreement is specified in the contract, while the shipping cost of a field service order should be paid by Waters. We hypothesized that since the customer service team and any other data management teams were not familiar with the field service logistics, they might fail to differentiate between a field service order and a normal customer order. Therefore, the customer service department might wrongly assume the shipping cost of these field service orders were supposed to be paid by the customers, but in fact these shipping costs were correctly absorbed by Waters. Therefore, the customer service team may wrongly identify these orders as misalignments.

However, after a thorough investigation with the field service department, there was no evidence of any mistake in the process. All the field service orders were well managed, and shipping expenses were correctly covered by Waters. The customer service team was well informed and was able to differentiate between a pre-purchase order and a normal customer order.

2.4.4 Order Entry Team

The order entry decides which shipping methods to use based on product availability and lead time. If there is an urgent request, the order entry team will approve express shipping. Usually, exceptional demand and low inventory level causes the order entry team to switch to express shipping, since GDC cannot fulfill the order immediately and will need to wait for replenishment inventory coming in. Once an express shipment decision is made, the order entry team passes the decision to GDC. The GDC usually carries 4-6 weeks of safety stock. If manufacturing is on track, the order entry team only deals with large, unexpected orders. Replenishment inventory usually has a lead time of a month, and the 4-6 weeks safety stock can serve as the buffer of this lead time. However, it has been different during the pandemic. This safety stock level is usually 40% of the level before pandemic. Therefore, the order entry department is more likely to issue express shipping during the pandemic.

2.5 Waters Customer Master Data

2.5.1 SAP

SAP stands for “Systems, Applications, and Products” in Data Processing. SAP is a German multinational software corporation based in Walldorf, Baden-Württemberg, that develops enterprise software to manage business operations and customer relations [11]. The SAP Warehouse Management system (WMS) is widely used in Waters GDCs, which provides flexible, automated support in processing all goods movements and in managing stocks in its warehouse complex. The system supports scheduled and efficient processing of all logistics processes within the warehouse. Some general SAP functions include:

- Order creation and verification
- Shipping label generation
- Billing information
- Invoice generation
- Customer master data storage
- Receiving order information quoted on Salesforce

SAP also serves as Waters’ internal financial system. It stores order information, invoices, and shipping costs. SAP is serving the downstream of Salesforce and Lotus Notes. Salesforce feeds its information to SAP as the reference for workers at GDCs. There is no direct feed of information from Lotus Notes to SAP. Lotus Notes is a static database containing strategic accounts and contracts and is used as a reference when the order entry team creates orders and needs to confirm contract terms.

Central Management Server (CMS)

The Content Management Service (CMS) is a service of the information management infrastructure provided by the Knowledge Provider within the framework of SAP Web Application Server. The central feature of the CMS is that it is designed to be compatible with different types of storage media. In other words, the CMS functions as an interface between content servers and the SAP system. The CMS system database is maintained by the Central Management Server (CMS) and stores the following information:

- User
- Server
- Document
- Configuration
- Authentication [12]

Due to the versatility of SAP, Waters' GDC combines SAP with CMS to centralize the management of domestic and international shipments from different carriers.

2.5.2 Salesforce

Salesforce.com, Inc. is an American cloud-based software company headquartered in San Francisco, California. It provides customer relationship management (CRM) service and also provides a complementary suite of enterprise applications focused on customer service, marketing automation, analytics, and application development. On October 16th, 2019, Waters Corporation

collaborated with Salesforce and started using its Sales Cloud Einstein, Service Cloud and Einstein Analytics as its primary customer relationship management software. [13]

The former CRM system that Waters uses is Lotus Notes (or HCL Notes). Waters is currently migrating from Lotus Notes to Salesforce due to its larger power, user-friendliness, and automation. Waters has currently done the process of migrating all customer data from the central region of the U.S. and a part of Europe to Salesforce.

2.5.3 Lotus Notes (Now Called IBM Notes)

Lotus Notes, now called IBM Notes, is a cooperative client-server software platform. Lotus Notes is the client part of the software platform, while Lotus Domino is the server. Lotus Notes is a desktop workflow application providing instant messaging, email, calendars, blogs, personnel directory and forums to organizations [14]. In 2018, Lotus Notes was acquired by HLC and became HLC notes. HCL Notes provides business collaboration functions, such as email, calendars, to-do lists, contact management, discussion forums, file sharing, microblogging, instant messaging, blogs, and user directories. In addition to these standard applications, an organization may use the Domino Designer development environment and other tools to develop additional integrated applications such as request approval / workflow and document management. [15]

At Waters, all customers' strategic accounts and global contract databases are stored in Lotus Notes. Waters is currently in the process of implementing Compass from Salesforce to replace Lotus Notes, the old Customer Relation Management platform. Compared to Lotus Notes, Salesforce is more powerful than Lotus Notes since Lotus Notes requires more manual operation and is not as user-friendly as Salesforce. Currently, the sales team has already transitioned to

Salesforce. The field service is still using Lotus Notes but has started the process of transitioning to Salesforce in June 2021.

2.5.4 Information Flow

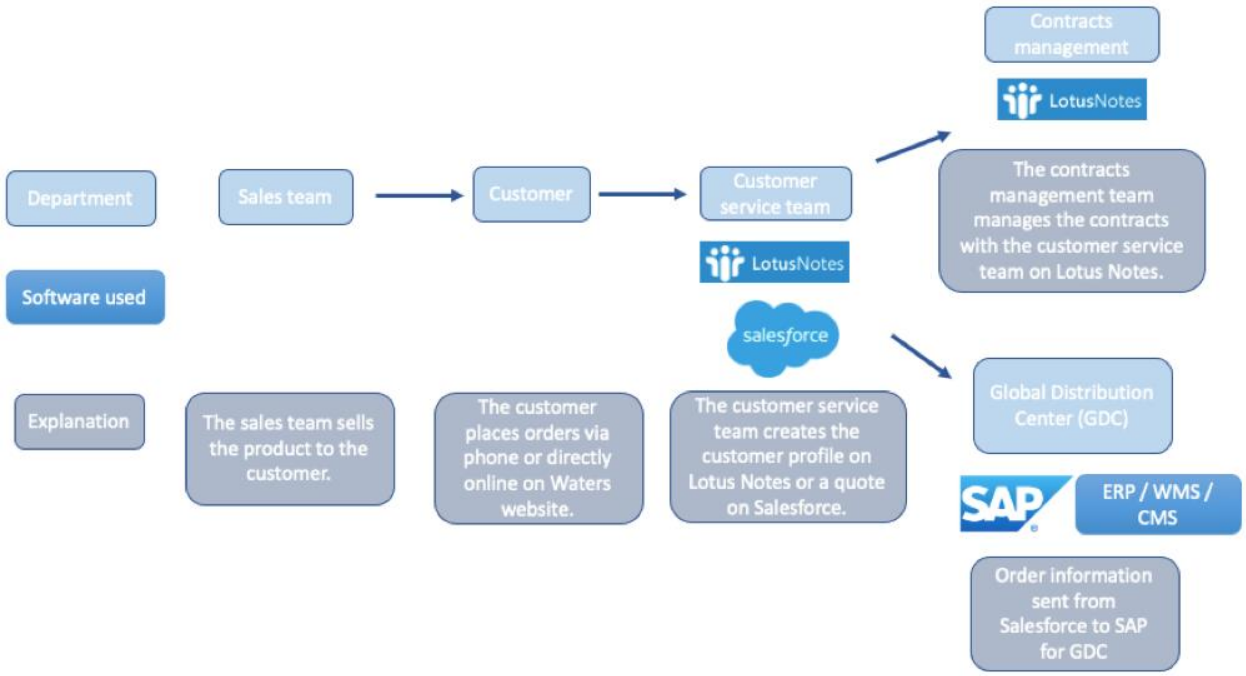

Figure 10: Value Stream Map of Information Flow

2.5.5 Transition to Salesforce

Waters transitioned from SAP CRM to Salesforce in 2019 to strengthen customer relationships, provide better services, and scale its offerings internationally. Due to the nature of products and broad geographical coverage, more than half of Waters' employees are in the sales and service department, and they work closely with customers to establish, calibrate, and deploy technologies in labs worldwide.

To make sure the products and services are delivered to customers properly, Waters needed a cloud based Customer Relationship Management platform to strengthen collaboration globally and scale across offices in 35 countries and 14 manufacturing facilities. Salesforce perfectly fits Waters' customer-centric culture. With Salesforce, Waters' employees gain insights and provide recommendations based on previously closed contracts and buying trends. Salesforce allows them to better adjust their offerings to customers and to reduce sales cycles. Salesforce also allows Waters to better learn about their customers, to understand their needs, and to meet their expectations. [16]

2.6 Incoterms

The Incoterms® are a set of 11 individual rules issued by the International Chamber of Commerce (ICC), which define the responsibilities of sellers and buyers in international transactions. The International Chamber of Commerce (ICC) was founded in 1919 to facilitate international trade. ICC published the first Incoterms® rules in 1936 to standardize trade practices around the world. These rules have been updated and developed since then. "Incoterms®" is an acronym standing for international commercial terms and is a trademark of the ICC. Unlike national trade arrangements, Incoterms® regulations are international industry standards, fostering clarity and consistency in business. They are widely used in international commercial transactions or procurement processes. Incoterms® rules specify the obligations of sellers and buyers and smooth the process by stating who is responsible for each step of the transaction. They provide guidance for purchasing order fulfillment, shipment packaging and labeling for freight transport, and preparation of an origin certificate at a port [17] Incoterms part I indicates who is responsible for

the product when it leaves the warehouse until it reaches its destination, while Incoterms part II indicates who pays for freight.

2.6.1 Incoterms Part I

Incoterms Past I includes CIP, DST, FSP and Local Terms Apply.

CIP (Carriage and Insurance Paid) means that the seller is paying for freight and insurance to deliver products at a specified location and to an appointed party. The seller assumes all risk until the products reach the first carrier. Then the buyer is responsible for all risks until the place of destination.

DST (Destination based) means that title and risk of loss does not pass until delivered to the customer. Therefore, the seller is responsible for all risks until the product reaches customer destination.

FSP (Free on Board Shipping Point) means that the customer is paying for freight once the product leaves the warehouse. The seller is no longer responsible for the product when leaving the shipping dock.

Local Terms Apply means that there are additional local terms and agreements that apply to a specific customer or order, and that override the general contract terms of that customer's parent company. Usually these terms specify whether the customer is responsible for the shipping cost, and when the shipping cost should be billed.

2.6.2 Incoterms Part II

- **Absorbed:** This is a general term describing the situation in which Waters paid for the freight charges and the customer did not pay for the freight.
- **Absorbed Contracts:** a) The customer does not pay for the freight because it is written in the contract or the addendum. b) The customer is a subdivision of a large company, where the shipping is directly charged to the company's main strategic account.
- **Absorbed Other:** The freight charge is absorbed due to other reasons.
- **Absorbed Sales:** The freight charge is included in the sales. Therefore the customers do not need to pay twice.
- **Absorbed Service:** the order is created by a field service team member as the replacement of an existing product under warranty. Usually Waters does not charge for shipping. The shipping cost is directly absorbed to the GDC budget.
- **Collect:** the customer is not charged by Waters for freight because they will get charged to their collection number, and pay directly to the carrier.
- **Freight Included to Destination:** the customer is paying for freight.
- **Prepaid & Added, (sometimes shown as "**", "***", "****":** Waters prepays for the freight and adds the charge to the invoice. Every region is different regarding how freight charges are added to the invoice. In Europe, it is automated based on either the order reason selected on the quote or the carrier on the order if a quote has not been created. If automated freight does not pull in or the customer needs a customer freight amount, it can be manually added too. In the US, the standard conditions are entered into SAP, shipping cost is generated. Then, the order entry might adjust the cost charged to customers based on different situations.

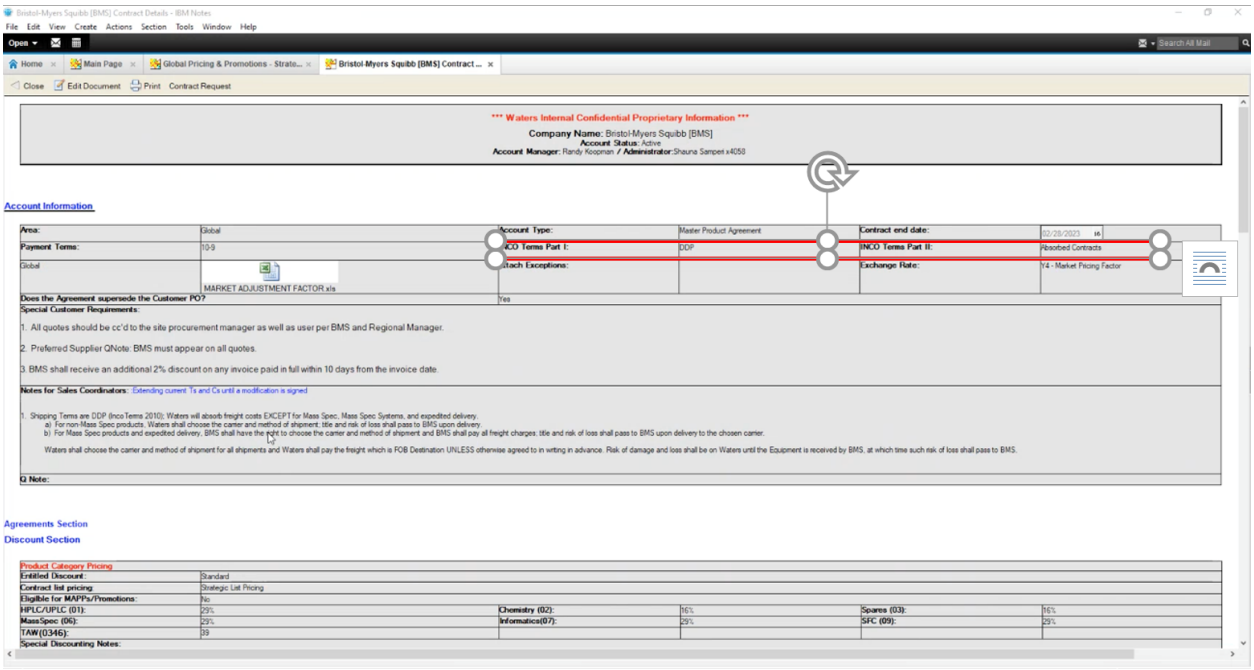

Figure 11: Contract Details – Incoterms

Chapter 3. Hypotheses and Problem Identification

3.1 Misalignment between Lotus Notes and SAP

3.1.1 Identifying Misalignments

Recently, Waters found that they had been paying for higher-than-normal shipping expenses in the past, and the annual shipping expenditure was much higher than it should be. Later on, after conducting a preliminary investigation, the team made an initial hypothesis that the higher-than-normal shipping expenses were due to misalignments between customer shipping contract terms on Lotus Notes and shipping information displayed on SAP. As discussed in Chapter 2, Section 2.5, Lotus Notes stores all customer contract information including Incoterms that defines who should be responsible for the shipping expenses, whereas SAP displays shipping information to GDC workers so they can plan shipping accordingly. Any misalignment between these two systems would mean that Waters has been paying for freight costs that should have been paid by customers according to the customer contract terms. This problem becomes more critical as Waters is currently in the process of transitioning from SAP CRM to Salesforce CRM. Lotus Notes is used to store and manage contract terms and customer profiles, while SAP CRM is used by GDC workers to prepare deliveries. Hundreds of data records (strategic accounts and contracts) are currently pending for approval before migrating to Salesforce. Identifying information misalignments across systems and correcting them before transferring all data to Salesforce becomes Waters' priority.

To identify any misalignments between Lotus Notes and SAP, the MIT team compared the two databases and focused on European customers first since the European customer master data is more organized and easy to extract.

3.1.2 Company, Customer, and Contracts

At this point, it would be very useful to explain the difference between a "company" and a "customer". A customer can be considered as a subsidiary customer, such as an international branch of a parent company. For example, Novartis France is a subsidiary customer under its parent company Novartis. A customer operates independently (placing orders, getting billed for orders etc…) in its own country, but belongs to this parent company. Usually the shipping terms and conditions of the parent company apply to all customers under the same company.

However, since customers operate independently, there are additional, local shipping terms and conditions applied to each individual subsidiary customer. These local terms and conditions override the global shipping contract of the parent company, and are effective on that specific subsidiary customer only. Usually these local terms and conditions are stored in addendums, which is an additional database for post-contract agreements. Therefore, to fully understand the shipping contact of a specific customer, one should not only look at the global shipping contract of the parent company, but also consider additional shipping terms and conditions in the addendum.

Therefore, in this project, even if a misalignment is found between global shipping contacts in Lotus Notes and shipping information displayed in SAP, it is necessary to check all the local shipping contracts in the addendum, and pinpoint the exact terms and conditions for each subsidiary customer. A very good example is Customer 116108 (France branch of Company H),

shown in Table 5. This customer has an additional agreement in the addendum, stating that this customer is not supposed to be charged for freight if its order is over 1500€ or if the order is placed online. As a result, even if the global shipping contract applied to this customer's parent Company H is "Prepaid and Added", meaning it should be charged for freight, Company H's French branch should not be charged for freight if the order is over 1500€ or if the order is placed online.

3.1.3 Summary of Three Situations

The analysis of the global shipping contracts with companies and their subsidiaries shows that there are three types of situations (Table 2):

1. There is no misalignment between global shipping contracts in Lotus Notes and shipping information in SAP
2. There is misalignment between global shipping contracts in Lotus Notes and shipping information in SAP, but the misalignment can be corrected or rationalized by additional local shipping agreements in the addendum.
3. There is misalignment between shipping contracts in Lotus Notes and shipping information in SAP, but there is no additional shipping agreement that corrects or rationalizes the misalignment.

Table 2: Summary of All Three Types of Situations

Misalignment between Lotus Notes and SAP?	Additional Agreements for Subsidiary Customers?	Need Attention?
No	N/A	No
Yes	Yes	No
Yes	No	Yes

3.1.4 Hypothesis: Customer Service Department

For each subsidiary customer, the Customer Service Department checks the customer number in the Salesforce database, and looks for global shipping contract terms of its parent company and local shipping contract terms for this specific customer. In Salesforce, the subsidiary customers' names all have the name of their parent companies. (E.g. Eurofins France) However, in SAP, each subsidiary customer of the same parent company has very different names, and these names do not contain information of which country the subsidiary customers belong to. (E.g. Eurofins Amatsigroup SAS, Eurofins Inst. Dr. Appelt Leipzig) For each subsidiary customer, the Customer Service Department translates the contract terms into applied shipping methods and passes the information to SAP. The shipping method for each subsidiary customer would apply to any orders that customer places. Workers at GDC follow whatever shipping methods shown in the SAP based on Customer Service's translation. The team hypothesized that the Customer Service Department may have difficulty identifying subsidiary customers that are part of the same parent company but appear under different company names in Salesforce. As a result, they may fail to compile the

correct information based on the parent company's global contracts and customer-specific additional agreements in the addendum, and fail to translate the contract terms into correct shipping information which they later send to SAP.

3.1.5 Misalignment Identification Method

Since it is impossible to analyze all the past data, the team used a sample of 71 active subsidiary customers for analysis. 17 of the 71 were first excluded from analysis since Waters does not do business with these subsidiary customers in Europe, and analyzing customers outside Europe requires much more time and effort to extract data. Then the team analyzed the remaining 54 subsidiary customers' shipping contracts in Lotus Notes and shipping information in SAP, and found 12 instances of misalignment. These 12 instances belong to 10 different parent companies (Table 4) as 4 of the subsidiary customers belong to the same 2 parent companies. According to the global shipping contract terms of the 10 parent companies in Lotus Notes, these 12 subsidiary customers should have paid for shipping because the global shipping contract terms of a parent company apply directly to its subsidiary customers. However, in SAP the freight charge options were shown as "Absorbed" for these 12 subsidiary customers. Since these 12 subsidiary customers were just a small portion of all subsidiary customers under 10 parent companies, the team searched for all subsidiary customers under the 10 parent companies, and found 394 subsidiary customers in total. Potentially, all of the 394 customers can have misalignment problems.

As the next step, the team first reviewed the shipping contract stored in Lotus Notes Addendum (Table 3). It was found that there are some additional agreements of freight charges that apply to specific subsidiary customers, and these additional agreements override the global shipping

contract terms for their parent companies. The team further scrutinized the shipping agreements in the addendum for each of the subsidiary customers. If no additional agreement can be found to explain the misalignment for a specific subsidiary customer, meaning the global shipping contract of the parent company still applies directly to the subsidiary customer, the team would flag these customers as "misalignment that cannot be rationalized by contract terms", or "misalignment customers" (Table 4). Then the team would suggest reviewing case by case with the Contract Management Department and Customer Service Department, and these subsidiary customers' shipping payment options may need to be corrected and updated in SAP (Figure 12).

After all subsidiary misalignment customers were identified, the team was then able to trace down the orders placed by these customers. Based on how many orders were placed by the misalignment customers, and based on the shipping expense that Waters covers for these customers, the team would then calculate the dollar value of the shipping cost saving potential. These shipping costs depend largely on the size of the products, the country they are shipped to, and the exchange rate.

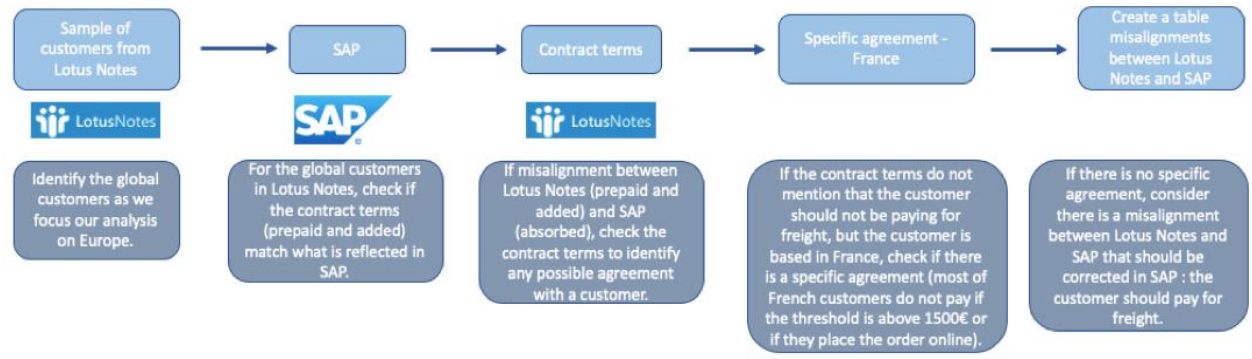

Figure 12: Methodology of Locating Misalignment

Table 3: Additional Contact Terms in Lotus Notes Addendum for Subsidiary Customers with Misalignments; These Terms and Conditions Overrides the Global Shipping Contract of their Parent Companies

Name	Additional Agreement for Subsidiary Customers	INCO Terms Part I:	INCO Terms Part II:
Company A	**Notes for Sales Coordinators**: In addition to the global contract we have an agreement for Germany (since more than 15 years now) that they do not have to pay any freight charges in Germany. **Also Note: Shipping Terms** are DST because Waters has agreed to procure insurance on behalf of Company A and will work with the carrier for any claims. Sec 2. Delivery Terms: **3.3 Delivery Terms Company A SSA document**: 3.3 Delivery Terms: Delivery Terms will be FOB Waters Shipping Point with Company A paying all applicable shipping charges, which shall include inland freight, airfreight, taxes, licenses, etc. Waters will procure insurance on behalf of Company A to cover the risk of any damaged or lost goods during transit and will facilitate delivery of replacement products as soon as possible after notification of the loss and will coordinate any freight claims with the insurer.	DST	PREPAID & ADDED
Company B	As per fully endorsed Company B Discount Agreement states: Delivery: Delivery terms will be DDP, Company B premises, Incoterms 2010 or as otherwise identified on a Waters Quotation issued by an authorized Waters representative. Title and risk of loss shall pass to Company B at delivery to Company B premises. Company B will be responsible for payment of all applicable shipping charges, including, but not limited to, taxes, inland freight, airfreight, insurance, plus any additional and applicable charges, depending on country and product(s) shipped, which shall be prepaid by Waters and added to the applicable Waters Quotation. **As per the IBM Notes**: Requesting approval for purposes of this Discount Agreement received today from Company B. Approval for applicable discounts and DDP payments terms requested for this 3 year term Agreement with option to extend further. Includes a 30 day opt out for both parties. Pricing at local list with MAF/USD Zone factor applicable to global accounts, dependent upon currency utilized for payment. Waters standard terms and warranties apply. Pricing and Discounts to be effective within 14 days of today's date = October 28, 2019. Delivery: **Discount Agreement dated July 1st, 2019: Delivery terms will be DDP, Company B premises, Incoterms 2010 or as otherwise identified** on a Waters Quotation issued by an authorized Waters representative. Title and risk of loss shall pass to Company B at delivery to Company B premises. Company B will be responsible for payment of all applicable shipping charges, including, but not limited to, taxes, inland freight, airfreight, insurance, plus any additional and applicable charges, depending on country and product(s) shipped, which shall be prepaid by Waters and added to the applicable Waters Quotation.	DDP	PREPAID & ADDED

Company C	Discount Agreement of 2018 states: Delivery terms will be FOB shipping point or otherwise identified on a Waters Quotation issued by a Waters authorized representative. Identification of the products shall occur when they leave Waters' distribution center at which time title and risk of loss shall pass to Customer. Customers will pay all shipping charges, including, but not limited to, taxes, inland freight, airfreight, insurance, plus any additional and applicable charges, depending on country and product(s) shipped.	FSP	
Company D	No Transportation data nor language found in IBM Notes except for INCO: FSP	FSP	
Company E	No Transportation data nor language found in IBM Notes except for INCO: FSP	FSP	
Company F	Special Customer Requirements: Switzerland: Swiss operations payment terms shall continue to be "0 net 60" and shipping terms shall continue according to Incoterm DDU (Delivery Duty Unpaid -Not Cleared) / Absorbed Freight – as is the current practice between Waters Switzerland and Company F. Company F **INDIA** does NOT follow the Global Contract- they have separate Local Agreements- **INCO TERMS: GLOBAL PURCHASING PROGRAM 11.01.2006 :** DELIVERY AND PAYMENT TERMS: Waters payment terms for all purchases are Net 30 days from date of shipment, unless otherwise expressly agreed to in writing by the parties. Delivery terms shall be Waters shipping point. Identification of the products shall occur when they leave Waters shipping point at which time title and risk of loss shall pass to Company F. Notwithstanding the foregoing, the parties acknowledge and agree that for Swiss operations, payment terms shall continue to be "0 net 60" and shipping terms shall continue according to Incoterm DDU (Delivery Duty Unpaid Not Cleared) as is the current practice between Waters Switzerland and Company F. 5 – Company F will pay all shipping charges, which shall include inland freight, airfreight, insurance plus any additional and applicable charges from the following list, depending on country and product(s) shipped. Taxes Value-Added Taxes Hazardous fees Handling and forwarding Import licenses Customs Clearance Import duties Consular or Legalization fees Certificates of Origin or other certificates Demurrage fees Waters will make reasonable commercial efforts to ship the Goods or provide the Services hereunder in accordance with the delivery date set forth on the Quotation provided, that Waters accepts no liability for any losses or for general, special or consequential damages arising out of delays in delivery.	FSP	

Company G	INCO 1 FSP/INCO 2 PREPAID & ADDED. INCO TERMS. **DISCOUNT AGREEMENT DATED 07/01/2018.** **APPENDIX 2. GLOBAL DISCOUNT PRICING**. Unless otherwise agreed in writing, discount pricing Is based on delivery terms DDP or OAP (INCOTERMS 2010). The time of delivery and delivery address are to be specified in each Purchase Order.	FSP	PREPAID & ADDED
Company H	Contract Terminated	50	
Company I	Company I Orders are originally Net90 and eligible for a 2% additional discount – For ROW Pricing to pull in Price Group NB needs to be added to the order/quote header for this pricing to pull in 3rd Party agreement with Company I is Net 45	FOB SHIPPING POINT	PREPAID & ADDED
Company J	**Notes for Sales Coordinators**: Waters has agreed with Company J to hold 2020 global pricing for them through December 31, 2021. Discount levels will remain the same so net pricing will not change for them. Company J uses the Global Price List and MAF. SAP is set up to reflect this. **INCO TERMS: WATERS ACCESS NETWORK AGREEMENT DATED 03/12/2018 ARTICLE 5- DELIVERY, DELA VS AND INSPECTION** 5.1. Delivery Delivery terms will be CIP (Carriage and Insurance Paid to Supplier Distribution Centre (incoterms 2010) or as otherwise stated on a Supplier quotation issued by an authorized Supplier representative. Identification of the products shall occur when they leave Suppliers distribution center at which time title and risk of loss shall pass to Company J. Company J will pay all shipping charges, including, but not limited to, taxes, inland freight, airfreight, insurance, plus any additional and applicable charges, depending on country and product(s) shipped.	CIP	PREPAID & ADDED

3.1.6 Summary of Misalignment Customers

There are in total 394 customers with mismatch of global shipping contract and SAP shipping method, and they belong to in total 10 parent companies. These 394 subsidiary customers' parent companies' global shipping contract states that the customer itself is responsible for the shipping expense, while in fact Waters paid for these shipping expenses. Of these 394 misalignment customers, 151 of them have misalignments between Lotus Notes global shipping contract and

SAP shipping information, but have no additional customer-specific agreements to rationalize these misalignments (Table 4). These 151 misalignment customers represent 38% of the 394 customers. For the rest of the 62%, or 243 customers of the 394, the team was able to find additional local, customer specific agreements to rationalize why shipping expenses were absorbed by Waters. Of the 151 misalignment customers, the team marked 145 customers with the red color, representing those who only placed orders before Jan 2021, and 6 customers with the yellow color, representing those who placed orders between Jan 2021 and May 2021. The team decided to do further analysis on these 6 subsidiary customers .

Color code for customer number:

Red: The customer should pay for the freight charges according to the global shipping contracts in Lotus Notes, but SAP shipping information shows no payment should be made by these subsidiary customers. In addition, they placed orders before January 2021 but did not place any orders between January 2021 and May 2021. The team considers them as "inactive misalignment customers". There are in total 145 out of 151 subsidiary customers falling in this group.

Yellow: The customer should pay for the freight charges according to the global shipping contracts in Lotus Notes, but SAP shipping information shows no payment should be made by these subsidiary customers. In addition, they placed at least one order between January 2021 and May 2021. The team considers them as the active misalignment customers. There are in total 6 out of 151 subsidiary customers falling in this group. The team treats these customers as our top priority for analysis. (Note: Customer 0000101505 in Belgium paid for freight but shown as absorbed in SAP. The mistake might have already been corrected for this customer.)

Table 4: Summary Table of Misalignment. These Customers have Incoterm “Prepaid and Added” in Lotus Notes but shown “Absorbed” in SAP. No Additional Local Agreements can be Found to Rationalize these Misalignments

Company	Sales organization	Customer number	Lotus Notes Incoterms (Part 2)	SAP Incoterms (Part 2)
Company A	FR01	0000116549	Prepaid & Added	Absorbed
Company B	FR01	0000111785	Prepaid & Added	Absorbed
	DA01	0000107769	Prepaid & Added	Absorbed
	DA01	0000108120	Prepaid & Added	Absorbed
	DA01	0000108121	Prepaid & Added	Absorbed
	DA01	0000108169	Prepaid & Added	Absorbed
	DA01	0000108170	Prepaid & Added	Absorbed
	SP01	0000275068	Prepaid & Added	Absorbed
Company C	UK01	0000208021	Prepaid & Added	Absorbed
	UK01	0000208027	Prepaid & Added	Absorbed
	UK01	0000208028	Prepaid & Added	Absorbed
	UK01	0000208029	Prepaid & Added	Absorbed
Company D	FR01	0000115502	Prepaid & Added	Absorbed
	FR01	0000115518	Prepaid & Added	Absorbed
	FR01	0000142699	Prepaid & Added	Absorbed
	FR01	0000194435	Prepaid & Added	Absorbed
	FR01	0000751752	Prepaid & Added	Absorbed
	FR01	0000816580	Prepaid & Added	Absorbed
Company E	FR01	0000117280	Prepaid & Added	Absorbed
Company G	DA01	0000108129	Prepaid & Added	Absorbed
	DA01	0000108130	Prepaid & Added	Absorbed
	DA01	0000108131	Prepaid & Added	Absorbed
	DA01	0000108132	Prepaid & Added	Absorbed
	DA01	0000108133	Prepaid & Added	Absorbed
	DA01	0000108134	Prepaid & Added	Absorbed
	DA01	0000108135	Prepaid & Added	Absorbed
	DA01	0000108136	Prepaid & Added	Absorbed
	DA01	0000108137	Prepaid & Added	Absorbed
	DA01	0000108138	Prepaid & Added	Absorbed
	DA01	0000108139	Prepaid & Added	Absorbed
	DA01	0000108140	Prepaid & Added	Absorbed
	DA01	0000108141	Prepaid & Added	Absorbed
	DA01	0000108142	Prepaid & Added	Absorbed
	DA01	0000108262	Prepaid & Added	Absorbed Sales

	DA01	0000108269	Prepaid & Added	Absorbed
	DA01	0000118238	Prepaid & Added	Absorbed
	DA01	0000190164	Prepaid & Added	Absorbed
	DA01	0000192782	Prepaid & Added	Absorbed
	DA01	0000192792	Prepaid & Added	Absorbed
	DA01	0000192852	Prepaid & Added	Absorbed
	DA01	0000192869	Prepaid & Added	Absorbed
	DA01	0000193286	Prepaid & Added	Absorbed
	DA01	0000193703	Prepaid & Added	Absorbed
	DA01	0000193704	Prepaid & Added	Absorbed
	DA01	0000194230	Prepaid & Added	Absorbed
	DA01	0000194238	Prepaid & Added	Absorbed
	DA01	0000194972	Prepaid & Added	Absorbed
	DA01	0000195533	Prepaid & Added	Absorbed
	DA01	0000195804	Prepaid & Added	Absorbed
	DA01	0000195851	Prepaid & Added	Absorbed
	DA01	0000201155	Prepaid & Added	Absorbed
	DA01	0000202001	Prepaid & Added	Absorbed
	DA01	0000203575	Prepaid & Added	Absorbed
	DA01	0000204173	Prepaid & Added	Absorbed
	DA01	0000204809	Prepaid & Added	Absorbed
	DA01	0000205272	Prepaid & Added	Absorbed
	DA01	0000205526	Prepaid & Added	Absorbed
	DA01	0000206454	Prepaid & Added	Absorbed
	DA01	0000208285	Prepaid & Added	Absorbed
	DA01	0000208296	Prepaid & Added	Absorbed
	DA01	0000208339	Prepaid & Added	Absorbed
	DA01	0000208552	Prepaid & Added	Absorbed
	DA01	0000209349	Prepaid & Added	Absorbed
	DA01	0000209959	Prepaid & Added	Absorbed
	DA01	0000209960	Prepaid & Added	Absorbed
	DA01	0000209961	Prepaid & Added	Absorbed
	DA01	0000215596	Prepaid & Added	Absorbed
	DA01	0000217364	Prepaid & Added	Absorbed
	DA01	0000235955	Prepaid & Added	Absorbed
	DA01	0000235956	Prepaid & Added	Absorbed
	DA01	0000235961	Prepaid & Added	Absorbed
	DA01	0000235962	Prepaid & Added	Absorbed
	DA01	0000235963	Prepaid & Added	Absorbed

	DA01	0000235964	Prepaid & Added	Absorbed
	DA01	0000235965	Prepaid & Added	Absorbed
	DA01	0000235966	Prepaid & Added	Absorbed
	DA01	0000235967	Prepaid & Added	Absorbed
	DA01	0000235968	Prepaid & Added	Absorbed
	DA01	0000235969	Prepaid & Added	Absorbed
	DA01	0000235970	Prepaid & Added	Absorbed
	DA01	0000243512	Prepaid & Added	Absorbed
	DA01	0000716851	Prepaid & Added	Absorbed
	DA01	0000716922	Prepaid & Added	Absorbed
	DA01	0000717138	Prepaid & Added	Absorbed
	DA01	0000729109	Prepaid & Added	Absorbed
	DA01	0000729448	Prepaid & Added	Absorbed
	DA01	0000731704	Prepaid & Added	Absorbed
	DA01	0000738399	Prepaid & Added	Absorbed
	DA01	0000739010	Prepaid & Added	Absorbed
	DA01	0000746805	Prepaid & Added	Absorbed
	DA01	0000748115	Prepaid & Added	Absorbed
	DA01	0000750230	Prepaid & Added	Absorbed
	DA01	0000750493	Prepaid & Added	Absorbed
Company H	FR01	0000116108	Prepaid & Added	Absorbed
Company I	FR01	0000115860	Prepaid & Added	Absorbed
	FR01	0000116116	Prepaid & Added	Absorbed
	FR01	0000116340	Prepaid & Added	Absorbed
	FR01	0000116343	Prepaid & Added	Absorbed
	FR01	0000116676	Prepaid & Added	Absorbed
	FR01	0000116678	Prepaid & Added	Absorbed
	FR01	0000116717	Prepaid & Added	Absorbed
	FR01	0000116791	Prepaid & Added	Absorbed
	FR01	0000116880	Prepaid & Added	Absorbed
	FR01	0000116920	Prepaid & Added	Absorbed
	FR01	0000116923	Prepaid & Added	Absorbed
	FR01	0000116947	Prepaid & Added	Absorbed
	FR01	0000116950	Prepaid & Added	Absorbed
	FR01	0000116961	Prepaid & Added	Absorbed
	FR01	0000116979	Prepaid & Added	Absorbed
	FR01	0000116982	Prepaid & Added	Absorbed
	FR01	0000117323	Prepaid & Added	Absorbed
	FR01	0000117331	Prepaid & Added	Absorbed

	FR01	0000117337	Prepaid & Added	Absorbed
	FR01	0000117341	Prepaid & Added	Absorbed
	FR01	0000118071	Prepaid & Added	Absorbed
	FR01	0000118294	Prepaid & Added	Absorbed
	FR01	0000188294	Prepaid & Added	Absorbed
	FR01	0000190448	Prepaid & Added	Absorbed
	FR01	0000194236	Prepaid & Added	Absorbed
	FR01	0000756906	Prepaid & Added	Absorbed
	FR01	0001004017	Prepaid & Added	Absorbed
	GE01	0000116880	Prepaid & Added	Absorbed
	GE01	0000116961	Prepaid & Added	Absorbed
Company J	FR01	0000112181	Prepaid & Added	Absorbed
	FR01	0000115931	Prepaid & Added	Absorbed
	FR01	0000115951	Prepaid & Added	Absorbed
	FR01	0000193411	Prepaid & Added	Absorbed
	FR01	0000212167	Prepaid & Added	Absorbed
	FR01	0000213705	Prepaid & Added	Absorbed
	FR01	0000267422	Prepaid & Added	Absorbed
	GE01	0000120890	Prepaid & Added	Absorbed
	GE01	0000122917	Prepaid & Added	Absorbed
	GE01	0000122918	Prepaid & Added	Absorbed
	GE01	0000122921	Prepaid & Added	Absorbed
	GE01	0000124466	Prepaid & Added	Absorbed
	GE01	0000125317	Prepaid & Added	Absorbed
	GE01	0000125318	Prepaid & Added	Absorbed
	GE01	0000192298	Prepaid & Added	Absorbed
	GE01	0000198649	Prepaid & Added	Absorbed
	GE01	0000226007	Prepaid & Added	Absorbed
	GE01	0000263706	Prepaid & Added	Absorbed
	GE01	0000282715	Prepaid & Added	Absorbed
	BE01	0000101206	Prepaid & Added	Absorbed
	BE01	0000101491	Prepaid & Added	Absorbed
	BE01	0000101505	Prepaid & Added	Absorbed
	BE01	0000101555	Prepaid & Added	Absorbed
	BE01	0000118308	Prepaid & Added	Absorbed
	BE01	0000204312	Prepaid & Added	Absorbed
	BE01	0000229365	Prepaid & Added	Absorbed
	BE01	0000717434	Prepaid & Added	Absorbed
	BE01	0001021219	Prepaid & Added	Absorbed

3.1.7 Orders Placed by Misalignment Customers Jan - May 2021

The team considered the 6 misalignment customers who placed orders between Jan and May 2021 as our priority. After identifying the misalignment, the team did a thorough analysis of orders placed by 5 out of 6 customers who placed orders between Jan and May 2021. This is summarized in Table 5. Note that customer 0000101505 is excluded from Table 5 because this customer did pay for shipping, but was incorrectly recorded in SAP as an "Absorbed" customer. Therefore, the misalignment problem did not exist for this customer, but it was just a recording error in SAP. What this customer did was aligned with the global shipping contract in Lotus Notes and should not be a concern for the misalignment analysis.

Table 5: Order Placed by 5 Misalignment Subsidiary Customers (who belong to 5 Parent Companies) who Placed Orders between January and May 2021

Company	Customer number	Country	Document#	Created on	Item Net Value	Freight cost	Curr
Company B	275068	SP	316036728	18/03/2021	590,8	0	EUR
	275068	SP	316038391	18/05/2021	17,25	0	EUR
	275068	SP	316038391	18/05/2021	344	0	EUR
	275068	SP	316038677	27/05/2021	3 159,00	0	EUR
	275068	SP	316038677	27/05/2021	0	0	EUR
Company H	116108	FR	306066936	20/01/2021	1 326,20	0	EUR
	116108	FR	306066936	20/01/2021	663,1	0	EUR
	116108	FR	306067557	01/02/2021	644,65	30	EUR
	116108	FR	306067557	01/02/2021	0	0	EUR
	116108	FR	306067557	01/02/2021	810,35	0	EUR
	116108	FR	306067557	01/02/2021	0	0	EUR
	116108	FR	306068048	10/02/2021	172,29	30	EUR
	116108	FR	306068048	10/02/2021	142,29	0	EUR
	116108	FR	306068049	10/02/2021	1 878,60	0	EUR

	116108	FR	306068049	10/02/2021	316,2	0	EUR
	116108	FR	306068049	10/02/2021	1 878,60	0	EUR
	116108	FR	306068049	10/02/2021	316,2	0	EUR
	116108	FR	306068050	10/02/2021	2 282,85	0	EUR
	116108	FR	306068050	10/02/2021	0	0	EUR
	116108	FR	306068169	12/02/2021	1 719,50	0	EUR
	116108	FR	306068169	12/02/2021	0	0	EUR
	116108	FR	306068169	12/02/2021	760,95	0	EUR
	116108	FR	306068169	12/02/2021	0	0	EUR
	116108	FR	306068169	12/02/2021	1 288,20	0	EUR
	116108	FR	306068169	12/02/2021	0	0	EUR
	116108	FR	306068451	17/02/2021	45,57	0	EUR
	116108	FR	306068514	18/02/2021	45,57	0	EUR
	116108	FR	306068514	18/02/2021	91,14	0	EUR
	116108	FR	306068514	18/02/2021	91,14	0	EUR
	116108	FR	306068580	19/02/2021	45,57	0	EUR
	116108	FR	306068630	22/02/2021	45,57	0	EUR
	116108	FR	306068854	25/02/2021	93	0	EUR
	116108	FR	306068854	25/02/2021	93	0	EUR
	116108	FR	306068975	26/02/2021	98,58	0	EUR
	116108	FR	306068975	26/02/2021	98,58	0	EUR
	116108	FR	306069570	10/03/2021	2 578,30	0	EUR
	116108	FR	306069570	10/03/2021	0	0	EUR
	116108	FR	306069641	11/03/2021	1 153,20	0	EUR
	116108	FR	306069936	17/03/2021	1 413,60	0	EUR
	116108	FR	306070949	01/04/2021	104,4	30	EUR
	116108	FR	306070949	01/04/2021	803,52	0	EUR
	116108	FR	306071100	03/04/2021	1 229,30	0	EUR
	116108	FR	306071100	03/04/2021	0	0	EUR
	116108	FR	306071100	03/04/2021	1 521,90	0	EUR
	116108	FR	306071100	03/04/2021	0	0	EUR
	116108	FR	306071155	07/04/2021	1 229,30	0	EUR
	116108	FR	306071155	07/04/2021	0	0	EUR
	116108	FR	306071405	13/04/2021	1 337,60	0	EUR
	116108	FR	306071405	13/04/2021	0	0	EUR
	116108	FR	306071771	21/04/2021	781,2	0	EUR
	116108	FR	306071771	21/04/2021	550,56	0	EUR
	116108	FR	306072588	06/05/2021	718,2	0	EUR
	116108	FR	306072588	06/05/2021	0	0	EUR

	116108	FR	306072588	06/05/2021	810,35	0	EUR
	116108	FR	306072588	06/05/2021	0	0	EUR
	116108	FR	306072588	06/05/2021	585,2	0	EUR
	116108	FR	306072588	06/05/2021	0	0	EUR
	116108	FR	306072748	11/05/2021	644,1	0	EUR
	116108	FR	306072748	11/05/2021	0	0	EUR
	116108	FR	306072748	11/05/2021	614,65	0	EUR
	116108	FR	306072748	11/05/2021	0	0	EUR
Company G	0000108129	DA	0304037098	05/05/2021	5 892,00	0	DKK
	0000108129	DA	0304037150	05/06/2021	41 664,00	0	DKK
	0000108129	DA	0304037150	05/06/2021	474 123,00	0	DKK
Company I	116923	FR	306066193	05/01/2021	854,79	0	EUR
	116923	FR	306066633	14/01/2021	35 878,08	0	EUR
	116923	FR	306066633	14/01/2021	398,07	0	EUR
	116923	FR	306066633	14/01/2021	2 252,20	0	EUR
	116923	FR	306066830	19/01/2021	1 189,50	0	EUR
	116923	FR	306068183	12/02/2021	686,12	0	EUR
	116923	FR	306068183	11/02/2021	0	50	EUR
	116923	FR	306068183	12/02/2021	0	0	EUR
	116923	FR	306068183	11/02/2021	0	0	EUR
	267422	FR	306069291	04/03/2021	1 952,80	0	EUR
	267422	FR	306069291	04/03/2021	0	0	EUR
	267422	FR	306069291	04/03/2021	0	0	EUR
Company J	101505	BE	302047955	08/01/2021	1 719,60	30	EUR
	101505	BE	302047955	08/01/2021	0	0	EUR
	101505	BE	302047955	08/01/2021	604,8	0	EUR
	101505	BE	302047955	08/01/2021	0	0	EUR

In Table 5, 3 subsidiary customers are from France, and many special terms apply to French customers, while these terms are not stated in the customer contract in Lotus Notes. Historically, French subsidiary customers did not pay for freight if they purchased online (noted as ECOM in Waters' system, standing for E-Commerce), and this is a part of the development plan that Waters used to boost online sales. The freight cost exemption terms also applied to many other European customers in Spain, Portugal, and Italy in the past two years. Recently Waters initiated its freight

recovery program and would like to stop offering freight cost exemption for those who purchased online. However, Waters faces huge resistance from French customers. They complained about the freight recovery program and negotiated to continue benefiting from freight cost exemption. Therefore, currently French customers are still eligible for freight cost exemption, although this is not listed as a part of the contract. In addition, some subsidiary customers enjoy freight cost exemption if their order value exceeds 1500€. Again, this special term is not part of the official contract, and is only held at regional sales departments.

In spreadsheet "Listing of specific freight ECOM and threshold if about 1500€ - FR01", subsidiary customer# 116108 (Parent Company H) should not be charged for freight cost if their order is over 1500€ and if their order is placed online. This means that, even if there is no additional official agreement in the addendum to rationalize the misalignment, customer# 116108 still enjoys freight cost exemption for any orders over 1500€. For orders under 1500€, customer# 116108 is still responsible for freight costs. Therefore, the team removed all orders over 1500€ for this French customer. The team no longer considered these orders as "misalignment that cannot be rationalized". For the rest of the order below 1500€, the team went through the spreadsheet "Europe 2021 YTD F2 Invoices KL" and checked if any orders were placed online (PO type marked as ECOM). Since none of the orders was placed online, no orders were further removed.

For more analysis of orders over 1500€ and analysis of costs, please refer to my teammate Amelie Feron's thesis "Improving Management Strategies for Reduced Freight Costs", section 3.1, Table 5 "Comparison between the total net value per order for customer 116108 and the 1500€ threshold for which the customer does not pay freight". In this table, Amelie Feron presents all orders placed by subsidiary customer# 116108 and analyzed which orders exceed the 1500€ limit. Based on the

analysis, she was able to conduct a cost analysis and calculate the total saving potential in her section 4.1.

3.2 Inbound Product Quality Issues

3.2.1 Hypothesis: Damaged Inbound Units Delay Shipping Schedule

Inbound damaged product is one of the largest problems at Waters GDC and caused the majority of delays. GDC received inbound damaged products more often during the pandemic (10 to 20 per week)[3]. About 50% of the inbound damaged products are from Singapore, the Asian Distribution Center or Singapore manufacturing site. (Fig. 22, Table 9) In the past year, the pandemic and the blockage on the Suez Canal reduced the number of containers available to ship the products via ocean. More products are shipped by air than before. Usually, there are more hands and processes involved if the product is transported by air, and this explains why there are more damaged products than previous years. The damaged products are usually large instruments rather than small consumables. The damages are mainly due to the following reasons:

1. Waters' logistics providers (Horizon, Expeditor) do not take care of the product during the shipping process.
2. There is no penalty for damage to parts under $10,000 according to the contract between Waters and the logistic provider.
3. Weak packaging/carton design.

[3]File "Product-Evaluation-Log", Record of Inbound Products with Damage

When GDC receives a damaged product, it takes on average 19 days before it proceeds to the next action: send for repair, send back to supplier, send to scrap, and send to customers. If the packaging or product damage can be fixed, the quality assurance team assigns an associate every week to fix the damaged products. Otherwise, the part will need to be sent back to the supplier, and the schedule will be delayed even longer. The team hypothesized that all of these actions delay the shipping schedule, lead to lower safety stock level, and later on the GDC has to use more expensive express shipping to compensate for the delay.

3.2.2 Contracts with Logistics Providers

Two companies touch the products before they reach the GDC. One is Horizon, the trucking company, and the other one is Expediters, which is the company that takes the freight from the airport. Depending on Waters' agreement with these logistics providers, Waters makes claims for the damage costs to these providers. However, there is a special term included in these agreements: for any part value under $10,000, Waters should absorb the cost of any damage. Since most of the inbound products are valued under $10,000, Waters absorbs most of the cost of damage. Waters sometimes may still be able to offset the cost by filing a claim with FedEx or Expeditors, but most of the time the cost goes to Waters.

3.2.3 Quality Assurance Team Logistics

The quality assurance team uses a shared smartsheet that helps keep track of the damaged products which come in and out of the global distribution center. Whenever the team identifies any damage,

either upon receipt or in the storage location, they enter the damage information on the sheet. When submitting a form, the employee indicates a) in which distribution center the shipment is received, b) the part number, c) the purchase order number, d) the method of shipping, e) the origin of the part, f) the damage type and the location of the damage (Fig. 13). They take a picture of the damaged product so that they can evaluate the damage at the Milford manufacturing center because the facilities are just 20 minutes away, and they are able to get an immediate answer. Depending on the type and the severity of the damage, the quality assurance team decides whether the product can be repackaged and put to stock right away without affecting the shipping schedule, or if it would have to go back to the manufacturing center and be re-tested (Fig. 14).

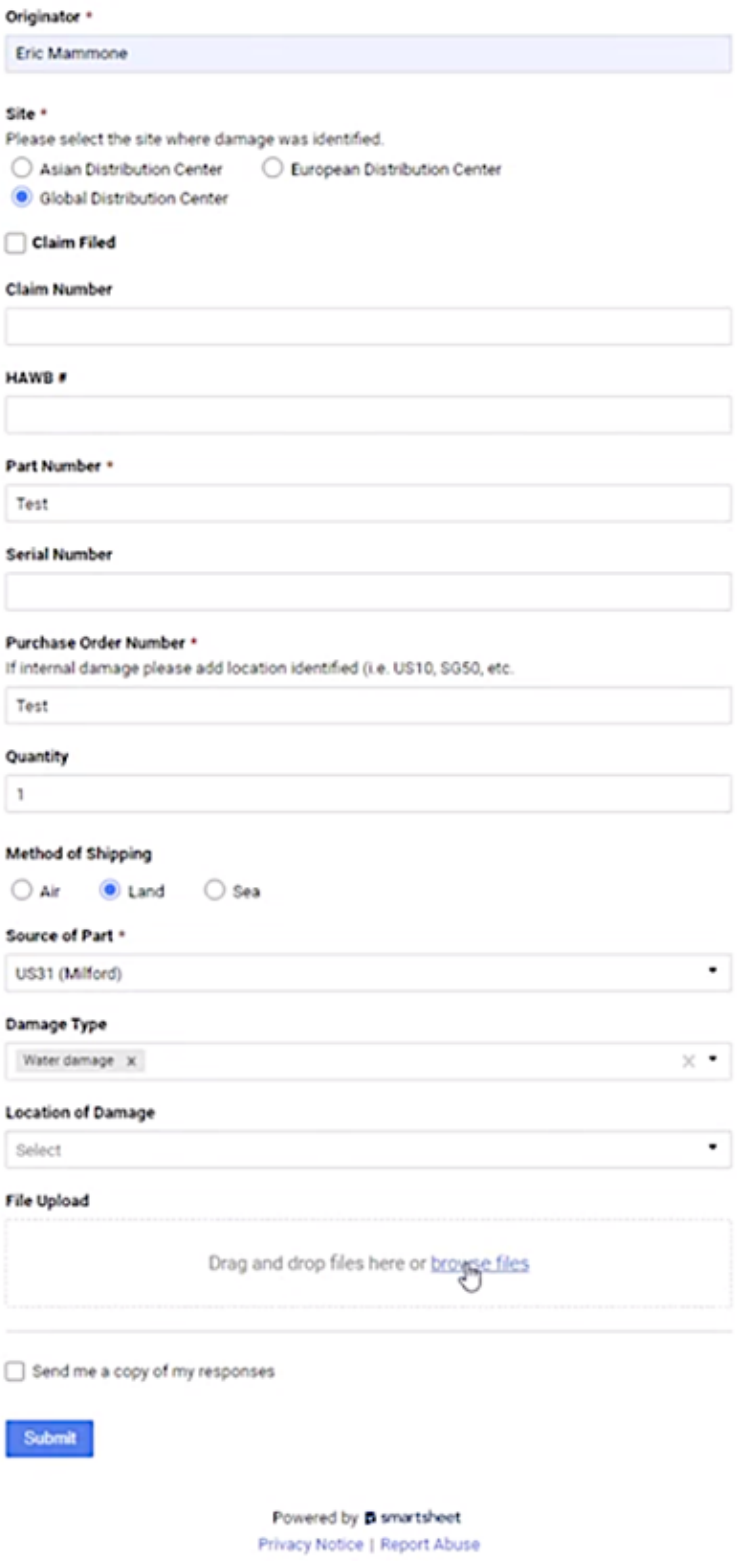

Figure 13: Smartsheet used by the Quality Assurance Team

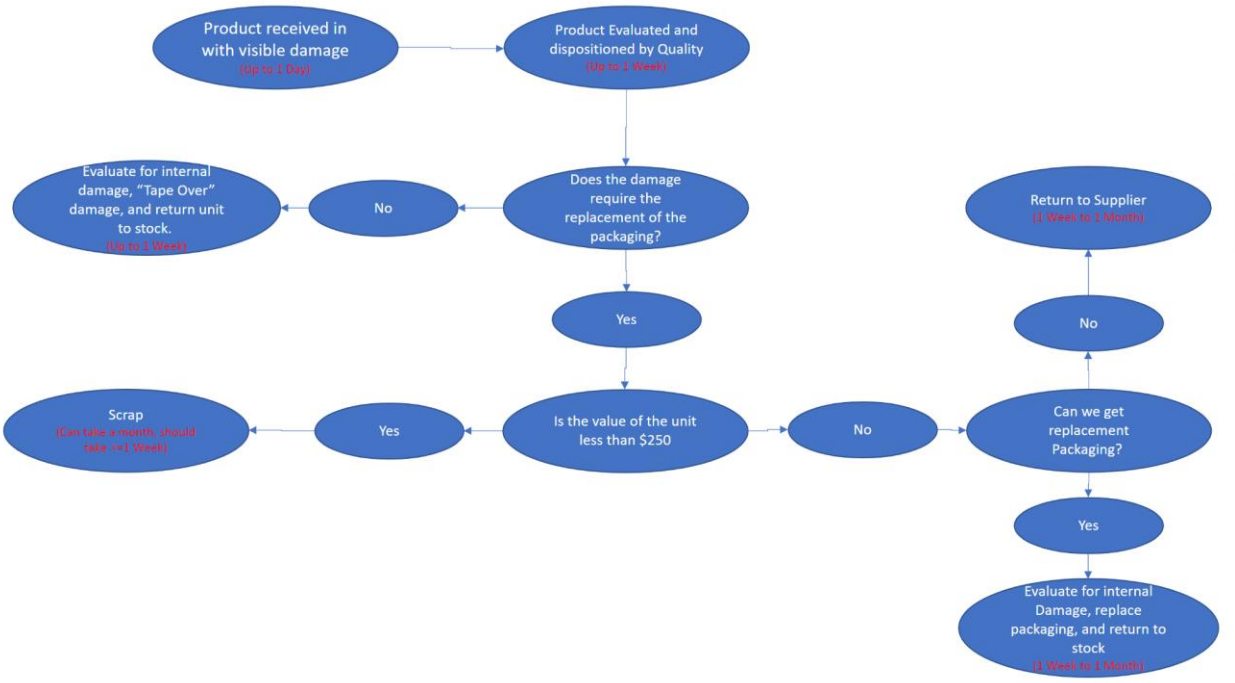

Figure 14: Shipping Damage Flowchart

3.2.4 Type of Damage

There are three major types of damages: torn packaging (Fig. 17), crushed packaging (Fig. 18), and water damage (Fig. 19).

- Torn packaging is usually created by the fork of a forklift on the side of the carton, which can cause serious damage to the part if the fork hits on the part in the packaging.
- Crushed packaging is created mostly during the loading and unloading process, where forwarders either squeeze as much cargo as possible into the container, or drop the parts on the floor by mistake.
- Water damage happens less frequently than torn and crushed packaging, since a lot of parts are shrink-wrapped before being sent out.

Sometimes, the team can get a part with damaged packaging repackaged within 30 minutes, and it does not affect the shipping schedule. However, in other cases, the replacement package is not

available because not all products are designed in the Milford manufacturing center and the matched package suppliers are not nearby. It requires additional shipments of packages from Asian or European warehouses. This delays the shipping schedule, and the order entry team might then use express shipping once the product is repackaged to get it delivered on time.

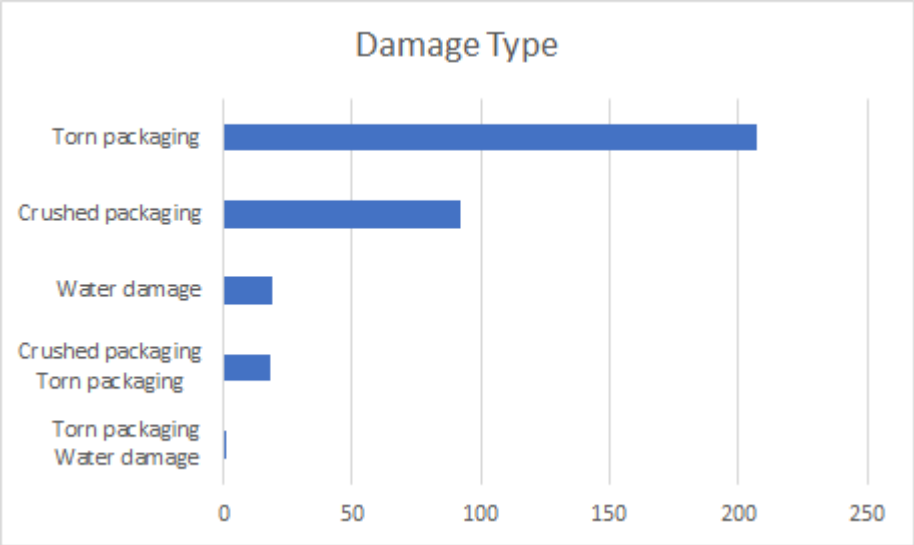

Figure 15: Damage Type – Apr to Sep 2021

Table 6: Summary of Damage Type -Apr to Sep 2021

Damage Type	**Count**
Torn packaging & Water damage	1
Crushed packaging & Torn packaging	18
Water damage	19
Crushed packaging	92
Torn packaging	207

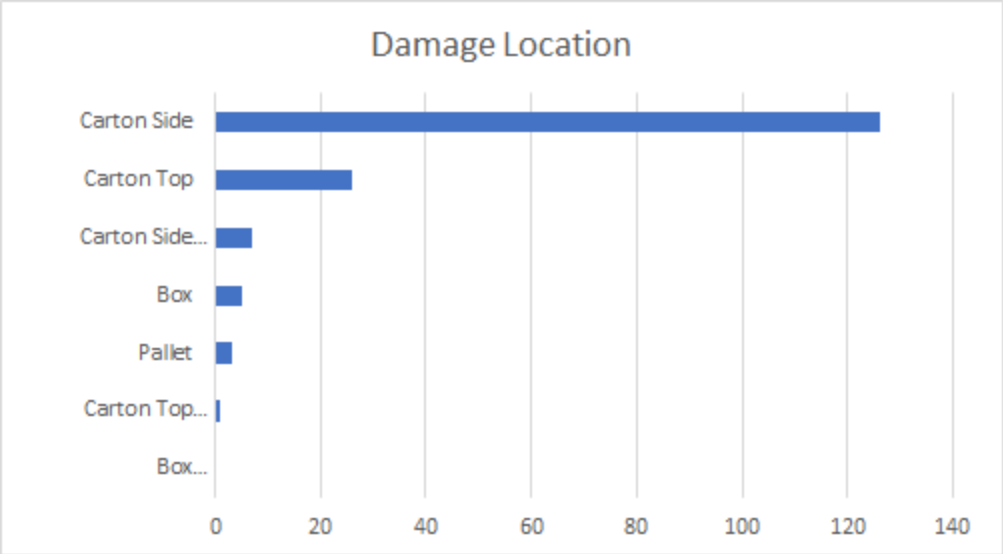

Figure 16: Damage Location Apr - Sep 2021

Table 7: Damage Location Apr - Sep 2021

Damage Location	**Count**
Carton Top & Pallet	1
Box Pallet	2
Pallet	5
Carton Side & Carton Top	23
Box	43
Carton Top	47
Carton Side	210

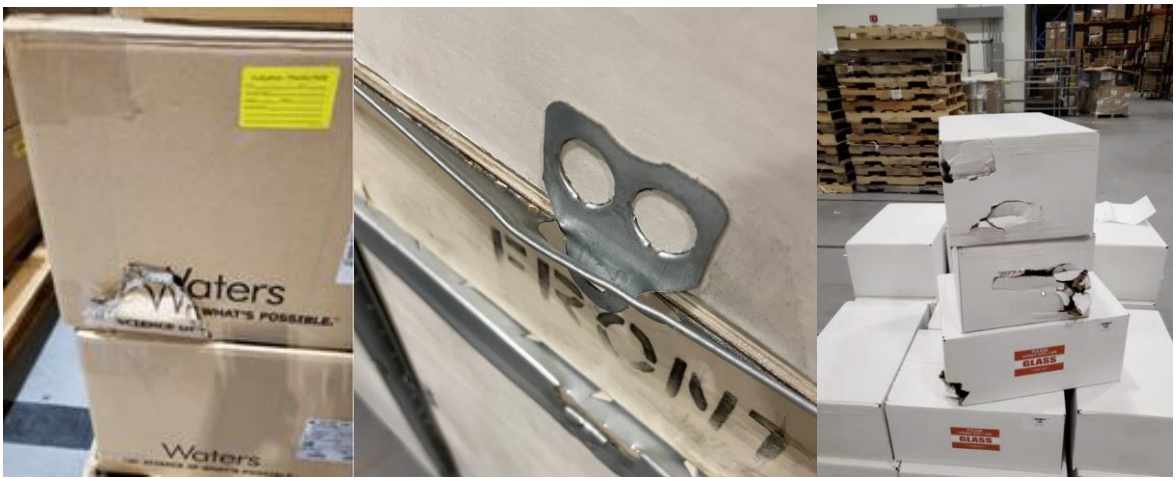

Figure 17: Torn Packaging

Figure 18: Crushed Packaging

Figure 19: Water Damage

3.2.5 Fixing Damage

Damage that can be fixed immediately: Some of the units come in on pallets, and the forklift will knock the legs off the pallet, but the box itself will be in fine shape. Usually if the damage is minor while the unit is on a high value order, the quality assurance team will quickly fix the issue with a "band-aid" solution, such as taking a hammer and nails and putting that back together, or taping over the damage. The quality assurance team will also send a planning notice ahead of time so the customer can expect the minor damage on the packaging and know that the product has already been evaluated. It saves time and avoids potential conflicts. For damaged packages that cannot be fixed immediately, they can be further broken down into two cases: products from the Singapore contract manufacturer and products from the European contract manufacturer.

Products from Singapore Contract Manufacturer:

A lot of products are designed at the Milford headquarter, and then Waters sends the design to contract manufacturers in Singapore. Therefore, Waters has its local packaging supplier in Massachusetts. If a packaging from Singapore is damaged, the quality assurance team will replace it with a new packaging if there is an available packaging either at GDC or at Waters' local supplier. In some cases, if the replacement packaging is not available, they will have to wait for the replacement packaging to be produced or order a new packaging material from the Asain Distribution Center. This delays the shipping schedule and leads to additional costs.

Products from European Contract Manufacturer:

Products with damaged packages from Europe are usually harder to handle because they are not designed at the Milford manufacturing center. Therefore, if a damaged package is received from

Europe, the team needs to order new packaging materials from Europe, which has a longer lead time (1 - 2 months).

Below is a summary of the number of days delayed on damaged parts. On average, there is a 19.66 day delay if a package is damaged.

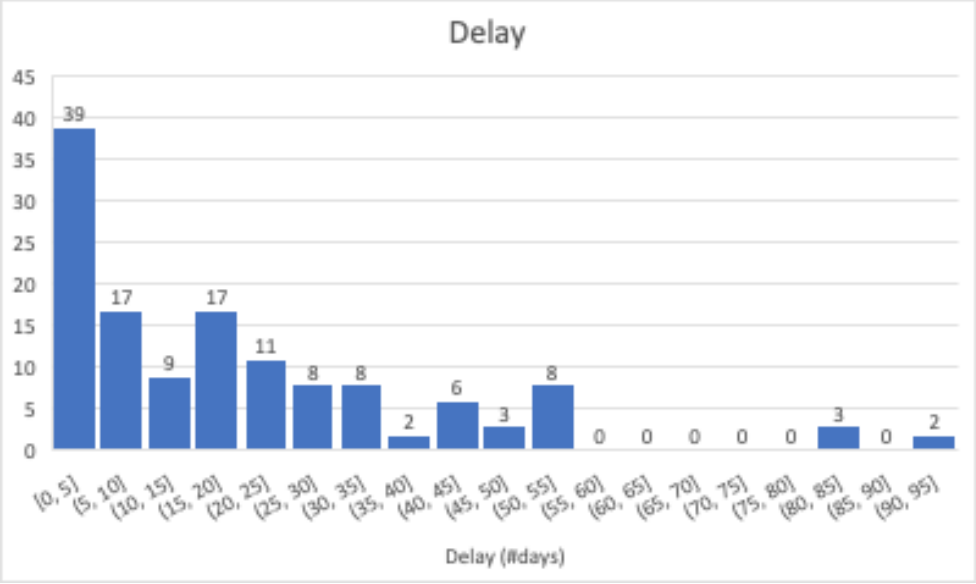

Figure 20: Histogram of Days Delayed before the Next Action on Damaged Parts

3.2.6 Disposition of Damaged Products

There are several ways the quality assurance team deals with damaged products:

Send to Customer: Damaged products are evaluated by either the quality assurance team or the Milford manufacturing center, or both, and are determined to meet the quality standards. The quality assurance team may replace the original packaging, but the parts inside will be left untouched. The product will be sent to customers. Send-to-customer accounts for 39.5% of the total cases.

Rework: Damaged products are sent to the Milford manufacturing center for repairing given the quality assurance team does not have the capability of fixing the product onsite. Usually the quality assurance team will need a confirmation from Milford manufacturing center to make sure Milford manufacturing center can handle the damage. Rework accounts for 38.6% of the case (Fig. 21).

Scrap: The damaged product is thrown away. It is not worth the time and effort to do anything with it. Scrap accounts for 9.8% of the total cases. (Fig. 21) (Note: If the value of the unit is less than $250, it goes to scrap automatically, because the cost of requesting new packaging, evaluation, and repackaging is already higher than the product value itself.)

Return to Supplier: Damaged products are evaluated by the Milford manufacturing center, but cannot be fixed in the U.S. However, it is still worth the effort to repackage the product and send it back to its original supplier (e.g. Singapore contract manufacturer) for a rework. Usually these products are high value, complex products, so only the original manufacturer has the knowledge of expertise to fix it. Return-to-supplier accounts for 12.1% of the total cases (Fig. 21).

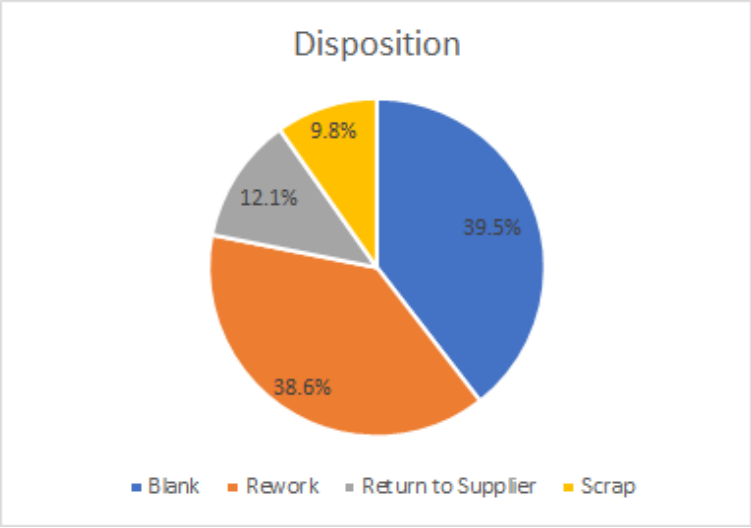

Figure 21: Disposition of Parts with Damaged Packages (Blank = Do Nothing)

Table 8: Disposition of Parts with Damaged Packages (Blank = Do Nothing)

Disposition	Count	%
Blank	137	39.5%
Rework	134	38.6%
Return to Supplier	42	12.1%
Scrap	34	9.8%

Dealing with Different Customers

Due to different cultures and working styles, customers from different countries have different tolerance on packaging damage. Usually customers from the U.S. and Europe have a much higher threshold, and they accept minor damage on the packaging. On the other hand, Asian customers can reject a shipment easily if there is a minor scratch on the package.

3.2.7 Origin of Damaged Products

A lot of the damaged products come from the Asian Distribution Center in Singapore (Fig. 22). This is because Waters receives a great portion of the inbound products from the Singapore warehouse and these products from Singapore are usually passed through several hands before arriving in the U.S.. The product will first be transported from the Asian Distribution Center to the Jewel Changi Airport, then loaded onto the plane and sent to the U.S. (typically in New York), and

finally sent by truck to Milford. The frequent loading and unloading increase the risk of damage. The packaging can be easily damaged by the fork of a forklift, or in other cases can be squeezed into a container which causes deformation of the packaging.

Since the GDC receives the largest quantity of product from the ADC and the Singapore contract manufacturer, resolving product damages coming from Singapore is treated as the priority in the next section.

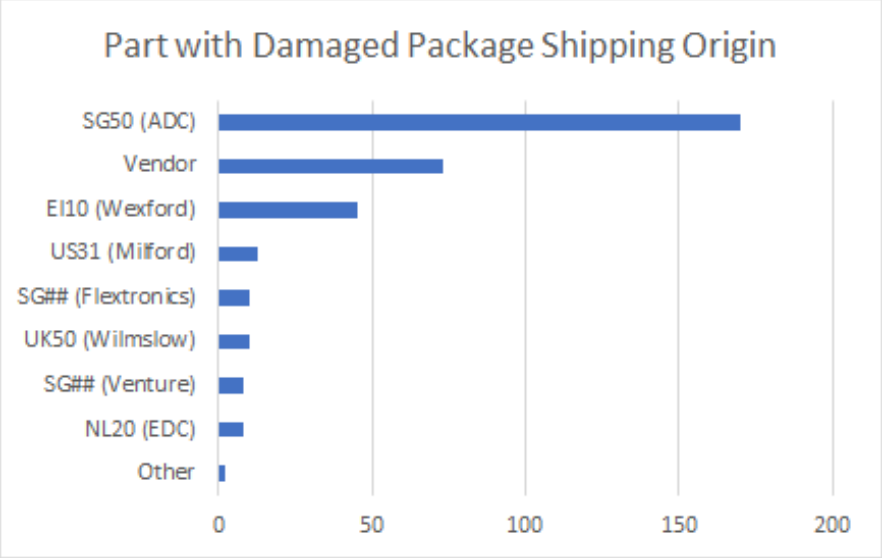

Figure 22: Part with Damaged Package Shipping Origin –Apr to Sep 2021

Table 9: Part with Damaged Package Shipping Origin - Apr - Sep 2021

Shipping Origin	Count
Other	2
NL20 (EDC)	8
SG## (Venture)	8

UK50 (Wilmslow)	10
SG## (Flextronics)	10
US31 (Milford)	13
EI10 (Wexford)	45
Vendor	73
SG50 (ADC)	170

3.2.8 Inbound Products Shipping Methods

Waters uses three major shipping methods: air, sea, and land transportation. (Fig. 23) Air shipping is widely used during covid, but more susceptible to shipping damages because the parts are passed through more hands. As shown in Fig. 23, air shipping accounts for 68.9% of the total damaged cases. Expeditor, a Seattle-based global logistic company, provides most of the air shipping services for Waters. Resolving damaging issues caused by Expeditor air shipping should be treated as a priority in dealing with inbound product damages.

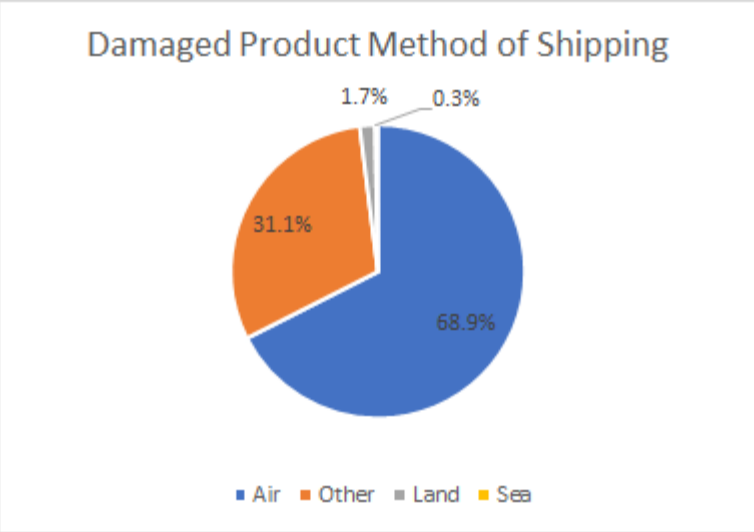

Figure 23: Part with Damaged Package Methods of of Shipping

Table 10: Part with Damaged Package Methods of of Shipping

Method of Shipping	Count	%
Air	239	68.9%
Other	108	31.1%
Land	6	1.7%
Sea	1	0.3%

3.2.9 Cost of Parts with Damaged Packaging

Around 60% of the damaged products have a value under $10,000 (Fig. 24). Based on the contract with Expeditor, Waters absorbs all the extra expenses caused by the damage for products under $10,000. This means Waters absorbs the majority of the cost damage. Thinking from the

Expeditor's perspective, since they do not need to be responsible for the majority of the damage cost, they do not treat the shipments with enough care, and this is one of the most common feedback from the U.S. quality assurance team and Singapore ADC workers. Even if ADC workers add a “fragile” label on the package, it is not uncommon to see packaging damage on these labeled packages[4].

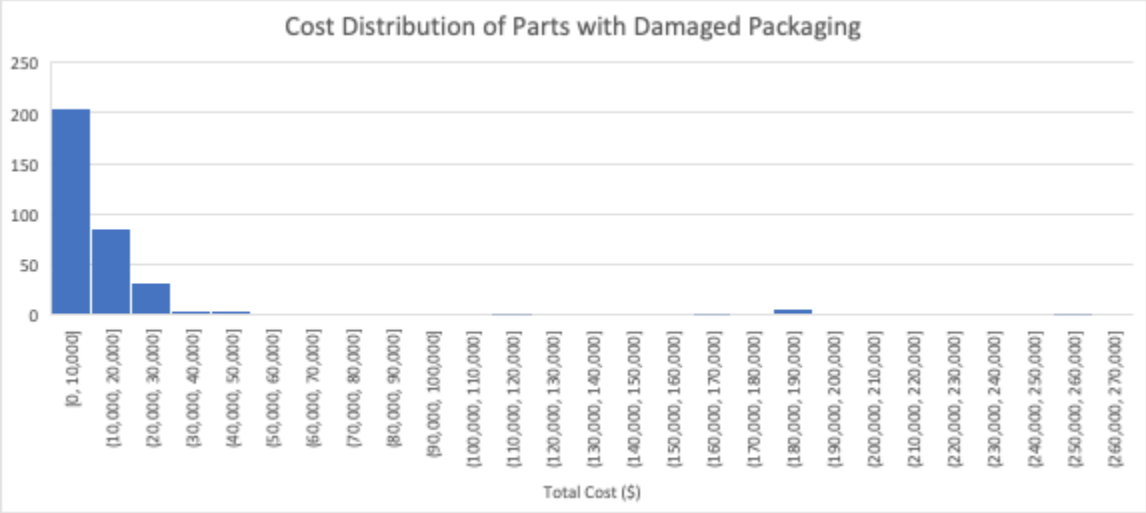

Figure 24: Cost Distribution of Parts with Damaged Packaging

3.2.10 Inbound Parts with Damaged Packages: Singapore ADC

For all inbound products with damaged packages, Singapore ADC accounts for more than 50% of the cases. Therefore, the sections below will focus on U.S. inbound shipments from ADC. Using the quality assurance spreadsheet[5], the team was able to filter out all cases coming from ADC. By

[4] Interview with ADC workers

[5] File “Product-Evaluation-Log.xlsx”, a spreadsheet that records all inbound shipments with packaging damages

comparing the ADC damage statistics with the rest, the team was able to pinpoint the root cause specific to ADC and resolve the problem one by one.

Based on Fig. 25 and Fig. 26, it was found that ADC has a very similar type of packaging damage compared to the rest of the shipping origins. Torn packaging and crushed packaging are still the most common type of damage while the carton side and carton top are still the most common damage locations.

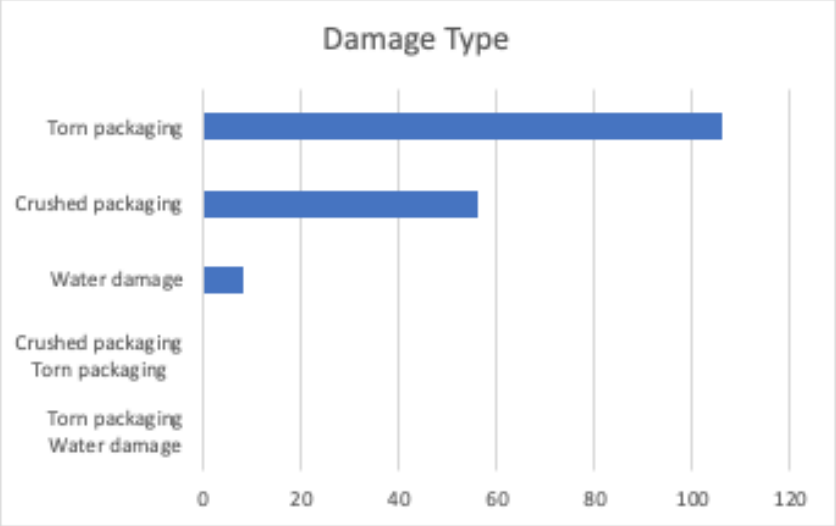

Figure 25: Damage Type – ADC Apr to Sep 2021

Table 11: Damaged Type - ADC Apr to Sep 2021

Damage Type	Count
Torn packaging & Water damage	0
Water damage	0
Crushed packaging & Torn packaging	8
Crushed packaging	56
Torn packaging	106

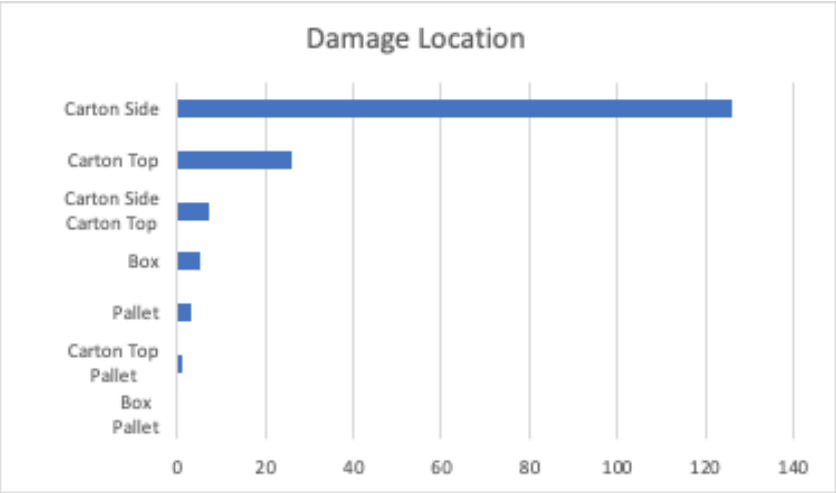

Figure 26: Damage Location - ADC Apr to Sep 2021

Table 12: Damage Location - ADC Apr to Sep 2021

Damage Location	Count
Box & Pallet	0
Carton Top & Pallet	1
Pallet	3
Box	5
Carton Side & Carton Top	7
Carton Top	26
Carton Side	126

For GDC inbound shipments with damage from ADC, “Rework”, “Send to customer”, “Return to supplier”, and “Scrap” accounts for 57.6%, 31.8%, 5.3%, and 5.3% respectively (Fig. 27). Compared with the average of all the damage cases, where “Rework” accounts for 38.6% , “Send to customer” accounts for 39.5%, “Return to supplier” accounts for 12.1%, and “Scrap” accounts

for 9.8%, “Rework” accounts for a much higher percentage. One explanation is that most of the products sent from ADC are designed at Milford headquarter. Therefore, Milford has good knowledge and expertise fixing minor damages. However, even if damaged products can be sent to Milford manufacturing center right away, it usually takes weeks[6] to evaluate the damage, get them fixed, and put them back on the shelf.

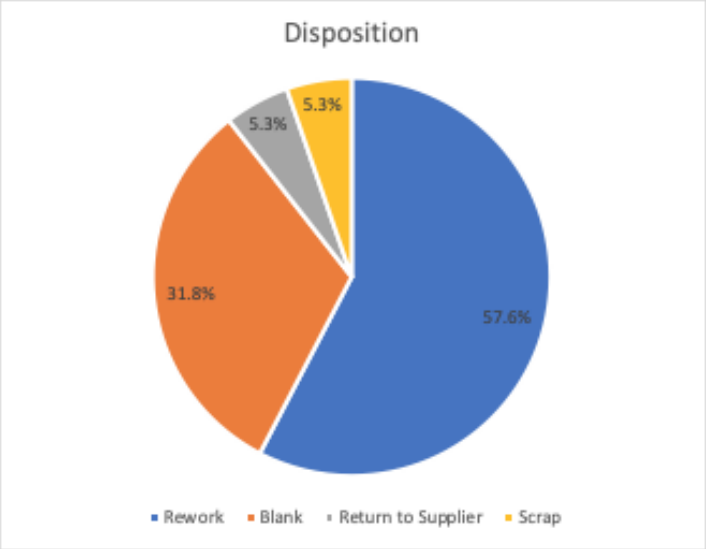

Figure 27: ADC - Disposition of Parts with Damaged Packages (Blank = Send to Customers)

Table 17: ADC - Disposition of Parts with Damaged Packages (Blank = Send to Customers)

Disposition	Count	%
Rework	98	57.6%
Blank	54	31.8%
Return to Supplier	9	5.3%
Scrap	9	5.3%

[6] Interview with the U.S. quality assurance team

As shown in Fig. 28, during the pandemic, ADC used much more air shipping compared to the rest of the shipping origins, and 88% of the damage were caused by air shipping. Therefore, ADC's problem is focused on air shipping and Expeditors.

Figure 28: ADC - Part with Damaged Package Methods of of Shipping

Table 18: ADC - Part with Damaged Package Methods of of Shipping

Method of Shipping	Count	%
Air	151	88.8%
Other	19	11.2%
Land	0	0.0%
Sea	0	0.0%

For products with damage from ADC, the average delay is 17.68 days (Fig. 29), which is slightly lower than the all case average. Using 17.68 days as a reference, any packaging damage found at GDC will significantly delay the shipping schedule, and this problem can be more serious at the end of the quarter, where there is the need for revenue recognition, while the incoterms are DST,

meaning that title and risk of loss does not pass until delivered to the customer. However, the number can be biased since the U.S. quality assurance team does not record all the delays for all the cases.

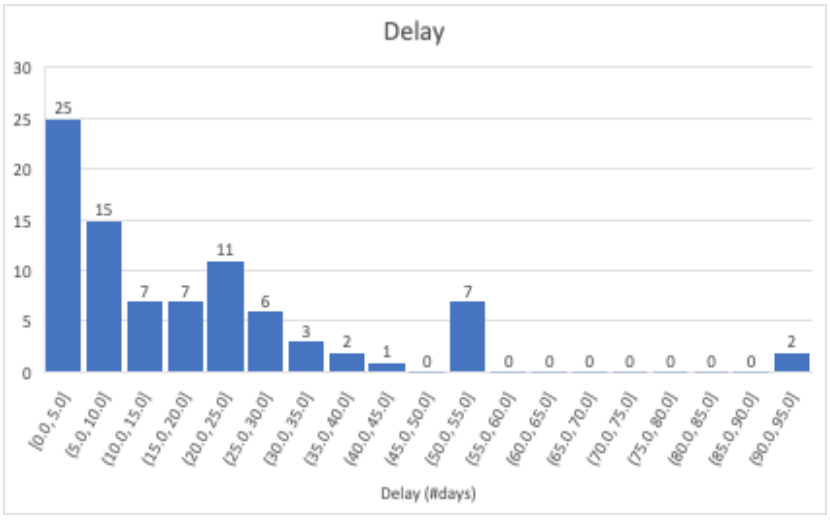

Figure 29: Histogram of Days Delayed before the Next Action on Damaged Parts

The average value of damaged products is $9778 (Fig. 30), and around half of the products (49.5%) have a value under $10,000, and Expeditor is not responsible for the cost of these damages.

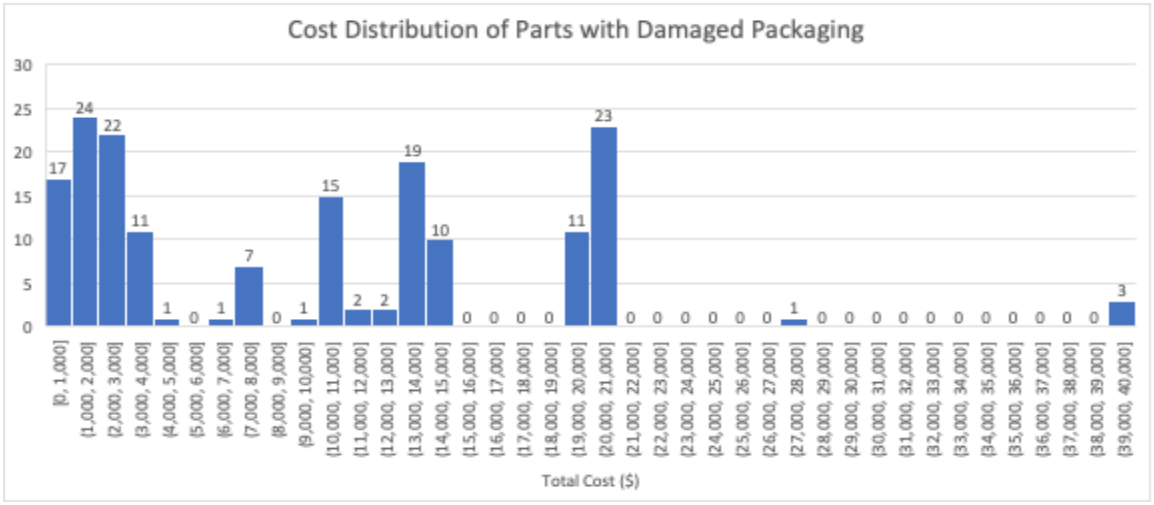

Figure 30: ADC - Cost Distribution of Parts with Damaged Packaging

3.2.11 Most Frequently Damaged Parts from ADC

Some parts are more likely to be damaged compared to others. Using the quality assurance spreadsheet "Product-Evaluation-Log", the team was able to find the twelve most frequently damaged parts in the past six months (Apr 2021 - Sep 2021). These most frequently damaged parts can be a starting point of reducing damages. Specific strategies will be designed to reduce the damage of these parts.

From Fig. 31 and Table 19, it was found that the two most frequently damaged parts, "e2695…" and "Acquity…" had 24 and 19 cases of damaged respectively in the past six months. In addition, these two parts both have relatively high part values. "e2695…" has a unit part value of $20,700 and "Acquity..." has a unit part value of $13,905. Damage on these parts can cause significant loss, and any delay on shipping schedule, may lead to delayed payment from customers and negatively impact Waters' cash flow.

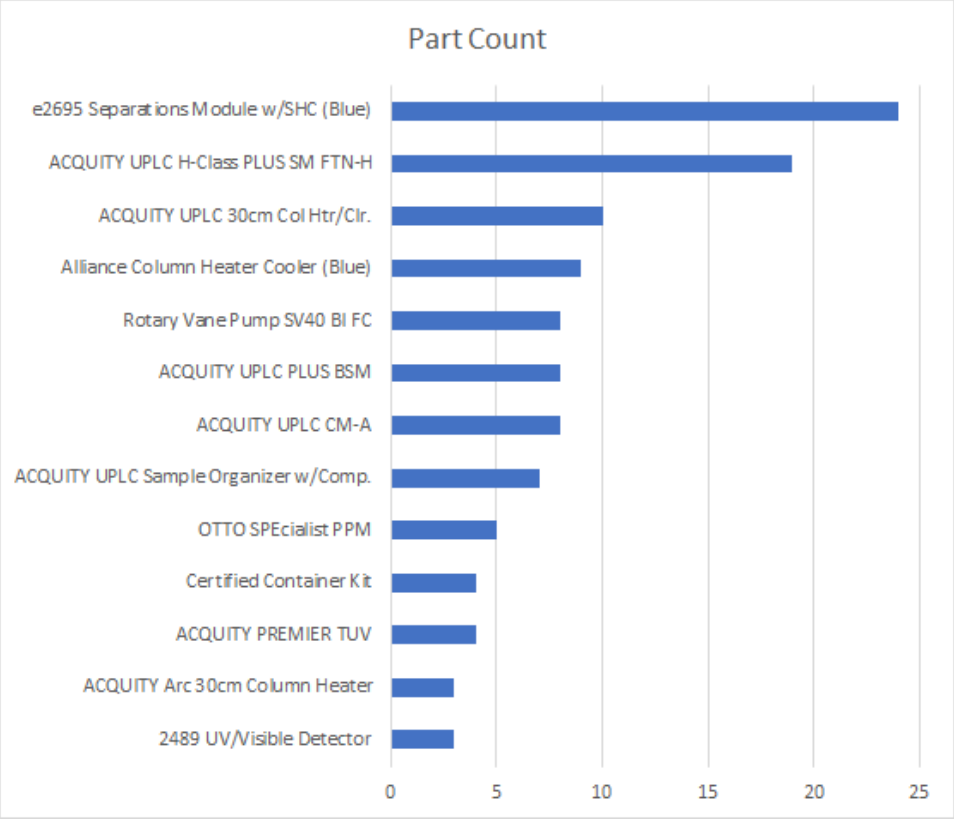

Figure 31: the Twelve Most Frequently Damaged Parts from ADC, Ranked by Total Count

Table 19: the Twelve Most Frequently Damaged Parts from ADC, Ranked by Total Count

Part Number	Part Description	Count	Part Value ($)
186269506	e2695 Separations Module w/SHC (Blue)	24	20,700
186015085	ACQUITY UPLC H-Class PLUS SM FTN-H	19	13,905
186015011	ACQUITY UPLC 30cm Col Htr/Clr.	10	2,385
186179100	Alliance Column Heater Cooler (Blue)	9	2,115
186015043	ACQUITY UPLC CM-A	8	3,735
186015082	ACQUITY UPLC PLUS BSM	8	19,980
186006347	Rotary Vane Pump SV40 BI FC	8	2,747.95
186015014	ACQUITY UPLC Sample Organizer w/Comp.	7	10,485
725000682	OTTO SPEcialist PPM	5	6,821.79
N/A	Certified Container Kit	4	295.37
186002487	2489 UV/Visible Detector	3	7,470
186017008	ACQUITY Arc 30cm Column Heater	3	1,125

Rates of damage

Based on Waters' internal spreadsheet "GDC Daily Metrics", Waters GDC received a total of 52196 shipments between April 1st 2021 and September 11th 2021. Based on the quality assurance team's "Product Evaluation Log", there were 348 damages detected. This represents 0.6% of the total shipment received. Looking at the two most frequently damaged parts "e2695…" and "Acquity…", the rate of damage is much higher. Between April 1st 2021 and September 11th 2021, there were in total 24 cases of damages of "e2695" from 74 shipments received at GDC and 19 cases of damages of "Acquity…" from 46 shipments received at GDC. They represent 32% and 41% of damage rates. Given the two most frequently damaged parts happen much more frequently than the average, efforts can be first made to these two parts.

3.3 Other Reasons that Lead to Higher Shipping Expenses

3.3.1 Low Safety Stock Level and Exceptional Demand

During the pandemic, Waters' inventory of parts dropped by 60% due to lower production rate. This situation is especially critical at the end of June 2021 (Q2) because the pandemic slowed down the production at Milford and caused a shortage problem of 10-20 different high value parts. When a replenishment part arrives while several orders are waiting for the same part, the priority is typically given to the most expensive orders, unless there are deals with the customers. Moreover, sometimes exceptional demand poses a lot of pressure on the warehouse. Lower safety stock level and exceptional demand delay a lot of shipping schedules and later on the warehouse needs to use more expensive expedited shipments to meet the deadlines.

3.3.2 End of the Quarter Time Constraints and Late Shipments

The GDC absorbs a lot of the shipping expenses when they do not get the parts out on time from Waters' inhouse manufacturing and then they have to send the order using express shipping under time constraints. This problem is more important at the end of quarters (last week of March, June, September, and December） because there are a lot of orders created within a short period of time for revenue recognition while the end of quarter usually happens to be some major holidays (e.g. July 4th and Christmas). Many last-minute orders are placed because Waters offers customers discounts to bring in as much before the quarter ends. Some orders are destination based (DST) which means that the customer should receive the product before the deadline while some orders must just leave the distribution center to count as part of Q2. On the other hand, Waters' inhouse

manufacturing capacity cannot fulfill all production requirements under a short period of time. As a result, the distribution center has to ship these orders using express shipping methods that generate additional costs because there are usually agreements with customers: if the product cannot be shipped within the lead time with ground shipping, the entry team will automatically switch it to air shipping. Shipping cost is a function of weight and shipping distance. If a heavy European or a heavy Asian order is behind schedule and needs express shipping to get them in time for their customers, the shipping cost is enormous. The GDC absorbs these shipping costs.

3.3.3 Unnecessary, Expensive Shipping Methods

Another issue is incorrect shipping methods being used. Sometimes GDC places an overnight delivery which turns out to be unnecessary as it does not need to be at the customer's place in the next three or four days. In addition, Workers may use expensive express/overnight shipping for priority customers in Massachusetts. However, express/overnight shipping is not necessary as ground shipping can still deliver the products on time due to the proximity of customer locations.

The outbound shipment follows 12 standardized steps described in "GDC Outbound Shipping Process Manual". To avoid GDC workers using unnecessary but expensive expedite shipping methods, the team identified several pitfalls in the manual and suggested opportunities for improvement.

At step #1 and #2, the material handler follows the "Delivery Due List", and sorts the shipments by shipping methods and places the shipments into respective bins. However, in SAP, there is a map indicating where the product is shipped to. Workers are supposed to use the map as a reference to decide which shipping methods should be used, while the majority do not bother to review the

map case by case, but blindly follow shipping methods stated in the “Delivery Due List”. For example, for a customer in Massachusetts, even if on SAP the shipping method is stated as express shipping, the GDC workers can still look at the map, check how close the customer location is, override the default express shipping method, and use standard shipping instead. Currently, Waters does train its warehouse workers on these topics, but with 500 deliveries a day, Waters cannot check if each shipping method is chosen properly.

From step #3 to #11, before the parts are sent out, GDC workers have enough time to check the customer location and reconsider the shipping methods. They can select the cheapest shipping method as long as the part can be delivered on time, and move parts from one bin to another.

At step #12, the material handler has one last chance to change the shipping method before he/she uploads the shipments to the FedEx truck. He/she can take one last look at the shipping destination and decide whether the parts should be uploaded to the truck. However, none of the above are written in the “GDC Outbound Shipping Process Manual”.

GDC Outbound Shipping Process Overview

1. Deliveries are created from Sales Orders in SAP (using transaction VLlO - Sales Orders, Fast Display (Delivery Due List)).

2. Once the deliveries are created they are counted and sorted by the shipping method and placed into respective bins.

3. The Material Handlers take the deliveries, go to the locations specified and proceed to pick the materials required for each delivery. If the material that is needed on the delivery is not found in the location specified on the delivery note, the Material Handler fills out a NIL

(not in location) form (Ref. Local Procedure DIST-004) and bring it to the Sr. Inventory Control Specialist to investigate. Once solved, the Sr. Inventory Control Specialist will inform the Material Handler of his findings.

4. When the Material Handler completes the preparation of the delivery, the Material Handler initials in the “Picked By Field”.

5. Carts with completed deliveries are brought to the pack bench.

6. Once at the pack bench, the Material Handler proceeds to scan the barcode on the delivery note which represents the Transfer Order that will be verified as picked. This process is done through the Catamaran system which interfaces with SAP

7. If a picking error is discovered, the Material Handler fills out a Picking Discrepancy form and brings it to the Sr. Inventory Control Specialist to investigate. Once solved, the Sr. Inventory Control Specialist will inform the Material Handler of his findings.

8. When the verification process is complete, an address label which has the delivery number barcoded on it is printed and placed on the box.

9. The box then goes to the shipping station where it is processed through a system called CMS which interfaces with SAP.

10. The box is placed on the scale, the barcode on the address label is scanned. The information about the shipment is added on the CMS screen. The Material Handler selects the F2 key (meaning the product has been shipped), the Tracking Labels are generated and placed on the box. The box is placed on a cart which when filled is brought to the dock area to be picked up by the assigned carrier.

11. The delivery is “Post Goods Issued” in the background on SAP. This means that the customer is invoiced, and the order is removed from SAP.

12. FedEx trucks come in, bringing the products to Expeditor, the main logistic carrier. The type of shipping freight is based on the delivery service time the customers want and their personal preference of carrier type. There are some exceptions. For example, for shipments over 151 pounds, the customer is not paying for freight. In step 8, the CMS generates a FedEx label for domestic shipments. The CMS will also send the information to FedEx that charges the GDC on a weekly basis. The GDC pays for all the shipping costs directly to FedEx.

3.3.4 Company Dynamic Challenges

Another issue is the fast-paced dynamic within the company. Workers are moving to different positions and new training is always required. During the Covid, because there was a shortage of labor, GDC workers were busier than they were in the past, which made it even harder to keep everyone on the same page.

Chapter 4. Freight Saving Strategies

Freight saving strategies consist of three parts. The first part (Section 4.1) discusses strategies regarding how to correct, look for, and avoid misalignments of Lotus Notes and SAP. The second part (Section 4.2) discusses strategies regarding reducing packaging damages. The third part (Section 4.3) discusses additional strategies that can be carried out at GDC.

4.1 Misalignment between Lotus Notes and SAP

This section discusses strategies to correct, look for, and avoid misalignments between Lotus Notes and SAP. It does not discuss any monetary related topics such as cost analysis and saving potential. For cost analysis and saving potential, please refer to my teammate Amelie Feron's thesis, section 4.1 "Correction of Misalignment between Lotus Notes and SAP".

4.1.1 Correcting Existing Misalignments

Misalignment Overview

In section 3.1, the team was able to identify 10 parent companies that have misalignment between Lotus Notes and SAP. According to the global shipping contract terms of the 10 parent companies in Lotus Notes, there were 394 subsidiary customers who belong to these 10 parent companies that should have paid for shipping because the global shipping contract terms of a parent company apply directly to its subsidiary customers. However, in SAP the freight charge options were shown

as “Absorbed” for these 394 subsidiary customers. Then, the team found that 151 of the 394 have misalignments between Lotus Notes global shipping contract and SAP shipping information, but have no additional customer-specific agreements to rationalize these misalignments. The team considers customers involved in these instances as misalignment customers.

Next, the team focused on 6 customers out of these 151 customers. These customers placed at least one order between January 2021 and May 2021. The team considers them as the active misalignment customers and treat these customers as the top priority for analysis.

Finally, the team looked at the orders placed by these 6 subsidiary customers. In total there were 80 orders placed by these customers between Jan 2021 and May 2021, shown in section 3.1.8. However, three French customers on this list enjoy freight cost exemption if their orders exceed 1500€ or if their orders are placed online. The team was able to sort out a table summarizing order values and highlighting those over 1500€.

Correcting Misalignments

Correcting existing misalignment consists of two parts: 1. Correcting mistakes in either Lotus Notes or SAP and 2. Renegotiating contract terms with misalignment customers.

1. *Correcting Mistakes in either Lotus Notes or SAP:* Since the misalignments have been found for subsidiary customers who placed orders between Jan 2021 and May 2021, Waters should correct the misalignment right away. Any shipping information not reflected correctly on SAP should be corrected based on:
    a. Parent company’s global shipping contract
    b. Additional contract terms in addendum specific to regional subsidiary customers
    c. Unofficial, special terms that was not part of the official contract

For the rest of the 145 “inactive customers”, namely those who placed orders before Jan 2021, it is likely that some of them will place orders in the near future. Therefore, the easiest way to correct misalignments is whenever a customer places an order, checking 1. shipping contract of the parent company 2. Customer specific contract in the addendum 3. unofficial, local terms with the local sales team. In addition, it would be very helpful for local sales teams to frequently communicate any local agreements with the central customer service department to make sure all contract information is updated in the system.

2. *Communicate Contract Terms with Misalignment Customers:* If Waters is the only supplier of that customer, and if this customer cannot find any alternative products from other suppliers, Waters should use its supplier power and communicate the correction with the customer. Although it is difficult to reclaim all the shipping expenses not paid by the customers, it is important to clarify any updated terms and conditions with the customers and make sure Waters does not absorb any future shipping expenses for these customers.

4.1.2 Identifying More Misalignments

Due to the limited availability of data, the team was only able to analyze misalignment customers who placed orders between Jan 2021 and May 2021. Therefore, the team analyzed 6 out of 151 misalignment customers. For the rest of the 145 misalignment customers who did not place any orders between Jan 2021 and May 2021, although the team did not consider them as the top priority, they indeed placed a huge amount of orders before Jan 2021. These orders must be traced as soon as the data is available. Once more misalignment orders are found, Waters should contact the customers and be clear which party is responsible for future shipping cost.

In addition, due to the limited availability of data, the team was not able to analyze for U.S. customers. According to the Customer Service Department, the U.S. customer data is even less organized compared to European customers'. Therefore, the team envisions there are huge improvement opportunities to correct misalignments for the U.S. customers. Waters can use the same misalignment method described below to identify more misalignment and correct them accordingly.

Misalignment Identification Method

Misalignment identification consists of six steps as described in section 3.1:

1. Define the scope of analysis: geographical region and time.
2. Identify Misalignments of Global Shipping Contract in Lotus Notes and SAP Shipping Information.
3. Check Local Contract Terms in Addendums.
4. Pinpointing Misalignment Subsidiary Customers.
5. Tracing Orders Placed by Misalignment Customers.
6. Determining Order Value and Looking for Special Terms not Listed in Contracts.

4.1.3 Avoid Future Misalignments

From interviews with the Customer Service Department and Contract Management Department, the team believes that the transition from Lotus Notes and SAP to Salesforce will facilitate the centralization of data, and therefore avoid data duplication and data misalignments. In the future, Waters can quote orders and manage contracts in the same system, and all departments will use

the same system to manage and extract data. Any change of contract can be synchronized on the system instantly. GDC workers can directly refer to the shipping contract stored in Salesforce so they no longer need to worry about misalignments between Lotus Notes and SAP.

For the moment, however, the contract information still needs to be manually checked case-by-case, which is tedious and time consuming. During the interviews, Waters' employees complained about the difficulty of keeping track of data since contracts are not stored in a single system. In addition, multiple departments complained that there was not sufficient communication, and each department has a different understanding of the contract. The team recommends creating a position under the customer service department to make sure that all contracts are up to date. Whenever a customer places an order in the future, Waters should check all contract terms for that customer. If there is a misalignment, Waters can correct that misalignment immediately in SAP. Since many of the subsidiary customers have the same name with their parent companies except a country name extension, the team were told that it would be much easier to identify the mistake when a subsidiary customer places an order. Moreover, misalignment customers will progressively disappear from SAP when their contracts terminate, which can alleviate the problem to some extent. That being said, when Waters signs new contracts with any existing customers, it is recommended that Waters keeps all of their new contracts in one system (e.g. Salesforce) and organize them well. Therefore, Waters can progressively move away from contract information being in multiple systems.

4.2 Inbound Product Quality Issues

This section discusses the recommended freight saving strategies 1. before the parts are sent out at ADC 2. after the parts are sent out and arrive at GDC. Each strategy's feasibility is evaluated as a part of the recommendations. Most of the strategies are created based on the interviews with ADC workers or the U.S. quality assurance team.

4.2.1 Foam Packaging and Form Stock Filling Empty Spaces

Foam packaging and foam stock protect products from scratches and abrasions during transportation. It serves as a soft, protective buffer against damages. Foam packaging and foam stock is currently used on many parts at Singapore warehouse and contract manufacturers, but is recommended to be more widely used for all packaging. [22] As shown in Fig. 32, the torn packaging created by the forklift did not extend beyond the foam packaging, and the parts inside the packaging were successfully protected. On the other hand, in Fig. 33, the carton without foam packaging was susceptible to torn packaging, and the damage went beyond the carton layer.

Figure 32: Foam Packaging Prevented Further Damage inside

Figure 33: Damage Extended inside without Foam Packaging

Foam packaging is available in many forms and different materials. Each of them is used for different purposes. Here the team recommends two forms: charcoal foam and pick and pull grid foam. Both foam is made from the same material, but charcoal foam can be used as a secure fit foam packaging while pick and pull grid foam can be used as foam stock filling empty spaces.

Charcoal Foam

Charcoal foam provides extra protection to delicate, small items. It is lightweight and easy to handle, meaning it does not increase the packaging weight and thus does not increase the shipping

cost. Charcoal foam can be customized to meet the needed specifications to ensure a secure fit. It is most commonly used for small parts and can be recycled and reused for the same parts. Charcoal foam can be a good fit of Waters' best selling consumable, columns. It can serve as an additional buffer inside the packaging.

Pick and Pull Grid Foam

Pick and pull grid foam can be easily separated by hand and be inserted between the part and its outside packaging. It can be used as foam stock which fits nicely in any empty spaces inside the packaging. Pick and pull grid foam can protect the parts from all angles from crushed packaging and serve as internal support, so the outside carton is less likely to deform under pressure.

4.2.2 Shrinkwrap

Shrinkwrap is a plastic film that wraps around packages as an additional protective layer. A heat gun is then used to apply heat on the shrinkwrap surface and causes the plastic to shrink. As the film shrinks, it conforms to the shape of the products and seals itself. Different from foam packaging, Shrinkwrap is applied outside the packaging rather than inside. Shrinkwrap is mostly used to prevent water damages on packaging, which happens often during air shipping from Singapore to the U.S.[23] The team recommends Waters to apply shrinkwrap on all shipments. Smaller items such as columns should be placed in a shrink wrap bag, and then be heated with a handheld heat gun. They can even be bundled using shrinkwrap to save space. Large items such as LC instruments may use a shrink wrap machine, which can wrap, heat, and seal all at the same time. [23]

Waters can also use shrinkwrap as an impact indicator due to its vulnerability to stretch and collision. Since shrink wrap seals and holds its shape once applied, any physical impact during the transportation will be noticed immediately.

The Singapore ADC has been using shrinkwrap for a variety of shipments, and it has been proved that shrinkwrap can effectively prevent water damage. Between April 2021 and September 2021, zero cases of water damage were found on shipments from ADC compared to 19 cases of water damage from other origins. Given shrinkwrap is cheap and easy-to-apply, it is highly recommended that Waters use shrinkwrap for all shipments regardless of their origin.

4.2.3 Fragile Label

A fragile label is used to label packages with high value, but containing easy-to-break parts. Usually the label comes with orange or red colors to alert the material handler to take extra care of the item. The label is usually applied at the surface of the carton where the handler can easily see it. The cost of a fragile label is negligible compared to the value of the product. Applying a fragile label to a packaging is a simple process that takes less than 5 seconds, while it can decrease the chance of the item being mishandled. It is recommended that warehouses apply fragile labels to all outbound shipments as an additional warning to the carrier. Considering fragile labels are now overused, and considering handlers are processing thousands of packages a day and may not notice fragile labels on every single item[7], it is recommended to apply the fragile labels at carton top and

[7] Interview with an ADC Material Planner

carton side for each packaging to give the carrier maximum notice, since these two places account for more than 90% of all places of damage.

4.2.4 Impact and Tilt Indicators

Impact and tilt indicators are used to detect, record, and prevent mishandling during transportation. The orange color raises awareness that special handling is required, and tells the material handlers that any occurrences of improper conditions will be recorded. The device is recommended to be placed on frequently damaged and expensive parts.

Cost-wise, each impact indicator costs about $3, which is much lower than the cost of damages. Based on analysis in section 3.3.11, the two most frequently damaged parts “e2695…” and “Acquity…”, have damage rates of 32% and 41% respectively, while each part costs $20,700 and $13,905 respectively. This means that, for every two or three parts shipped, there could be one damage case. The deposition of all cases were either “Rework” at GDC or “Return to Supplier” at Singapore, which takes on average 17 days. Assuming every three impact and tilt indicators can prevent one damage on these two products, meaning on average, $9 can potentially prevent one rework or one returning for these thousands of dollars parts, the savings is tremendous even only considering the rework labor cost or returning shipping cost.

There are three types of devices that are recommended to be placed on frequently damaged parts: impact indicator, impact recorder, and tilt recorder. [24]

Impact Indicators

The impact indicator is placed on the packaging. The indicator will turn red if the packaging experiences any physical impacts.

Figure 34-1: Impact Indicator

Impact Recorders

Impact recorders monitor and report in real-time any physical impacts experienced by product during transportation. The recorders record the direction, amplitude, and duration of impact force.

Figure 34-2: Impact Recorder

Tilt Indicators

Tilt Indicators detect unacceptable tilting on the products. Usually a tilting can happen when the product falls off from a pile or is held upside down during transportation. The recorder will record the maximum angle of tilting and reveal to the receiver whether the tilting should be a concern.

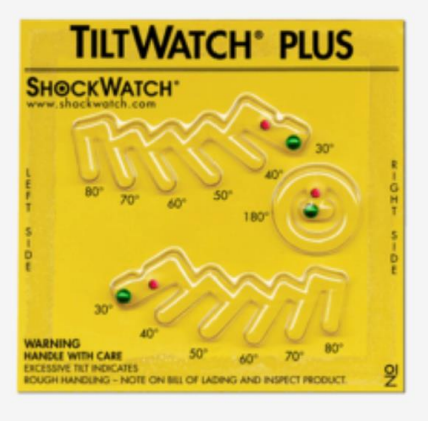

Figure 34-3: Tilt Indicator

4.2.5 Contact Renegotiation

Waters' air shipping provider, Expeditor, has a contract with Waters stating that, for any damage on parts under $10,000, Expeditor is not responsible for the damage. Even for those above $10,000, Waters needs to file a claim at the end of the business season to get money back, which is a long and time-consuming process. Getting compensation money from Expeditor seems to be very difficult. According to ADC workers and the U.S. quality assurance team, Expeditor does not treat Waters' packages with care, and they believed the exemption clause is a contributing factor. If Waters continues to have the exemption clause in the contract, the damaged packaging problem will not be resolved.

Given Expeditor is providing shipping services for the majority of Waters' products during the pandemic, removing the exemption clause in the contract will save Waters a lot of money. More importantly, by removing the exemption clause, Expeditor will be responsible for any damage they cause on Waters products, and thus treat shipments with more care. This can be considered as an effective way to reduce damage, reduce delay, and increase service level.

Waters can modify the contract in two ways. The ideal solution is to remove the exemption clause completely so Expeditor would be responsible for any damage during transportation. Waters can also seek to decrease the compensation threshold. For example, decreasing the threshold from $10,000 to $2,000 will allow 76% of the product covered, compared to 50.5% at the $10,000 threshold.

Another part of the contract renegotiation should focus on the claiming process. During the interview, the quality assurance team mentioned that even if they find damages on parts over $10,000, the claiming process is usually tedious and time-consuming. As a result, many times Waters gives up the opportunity to claim the money back. Therefore, a transparent, efficient claiming process is needed to speed up any compensation claims.

4.2.6 Shipping insurance

Shipping insurance provides financial protection against any unexpected loss, damage, or theft that happens before a package can reach its destination. Most carriers cover a shipment's declared value up to a certain amount at no added charge. But this limited coverage is not the same as insurance. Shipping insurance reimburses up to the full shipment value, plus freight, regardless of how the damage or loss occurred. Insurance policies can either be purchased from a carrier or a third-party

insurer and are available for single shipments or as a longer-term customized plan. Shipping insurance is typically used by manufacturers and distributors of large or high-value items, as well as businesses with international shipments that go through multiple modes of transportation. [26]

The team recommends Waters to purchase shipping insurance for the two most frequently damaged parts, “e2695…” and “Acquity…”, which had 32% and 41% rates of damage in the past six months, with a unit part values of $20,700 and $13,905. Given their high damage rates and high part values, purchasing the insurance will likely give high return on investment.

4.2.7 Drop Test

A packaging drop test provides information that allows designing a suitable packaging and securing the goods during transport. If a packaging passes the drop test in a lab environment, it is likely that the packaging will survive the same physical impact during transportation. Drop test reduces unnecessary costs or loss due to damage.

A drop test should be conducted in several steps: [25]

1. **Choosing the sample:** The sample should be chosen at random from the same packaging systems. The sample should be representative of the population.
2. **Determining the surface to perform the test:** A drop test should be performed on a platform that comply with international regulations.
3. **Dropping the unit:** The different drop test standards determines how many times and from what height the unit should be dropped. The numbers are also based on size and weight of

the item. For instance, a standard drop test for an item between 1 and 9 kilograms would include dropping 10 times from a height of 76 cm.

4. **Testing all angles of the packaging:** The drop test should allow the sample to fall over all desired areas, including fragile places on the packaging such as joints.
5. **Checking the state of the goods inside:** Here the team should decide whether the state of the parts inside the packaging is still acceptable. The packaging passes the drop test if there is no or minor damage to the parts. Small deformation of the packaging is considered normal. On the other hand, if any significant damage occurs, it is recommended that Waters redesigns the packaging to prepare for any further damage.

Drop tests are used by ADC for many packaging designs. It is recommended that all other distribution centers and contract manufacturers perform drop tests for frequently damaged parts and improve its packaging designs.

4.2.8 Polystyrene Packaging

Polystyrene packaging has all the advantages of shrinkwrap, foam packaging, and cartons. It is waterproof, durable, lightweight, and highly customizable to all product sizes and shapes. It can be reused for the same parts again and again. It is highly recommended by the quality assurance team since they found zero damage cases from those coming with polystyrene packaging. In addition, due to its lightweight nature, Waters can easily ship the packaging back and forth between multiple shipping origins to make the best use of the packaging.

However, polystyrene packaging is not without disadvantages. Waters' instruments are big and heavy, while polystyrene needs molding to produce the packaging that fits these parts. Unit tooling

cost and part cost is much higher than other packaging options. Polystyrene packaging is usually used for products with high minimum order quantity. However, most of ADC's instruments do not have this volume.

In addition, polystyrene is not environmentally friendly, given its high cost of recycling. Any upgrade of existing product series requires Waters to redesign for new packaging. All past polystyrene packaging can be wasted, while the new molding cost is enormous.

As a result, it is recommended that Waters use polystyrene packaging on products with high minimum order quality and that have no recent plans of upgrades. In addition, a cost analysis should be conducted to determine the savings from having less damage and the costs of producing and recycling polystyrene packaging.

Figure 35: Polystyrene Packaging

4.2.9 Packaging Safety Stock

Packaging safety stock has been widely used at ADC but not GDC. The quality assurance team highly recommends packaging safety stock as it will save time and effort to order replacement packaging from its shipping origin. As shown in Fig. 36, currently, there is a lot of unused shelf space at GDC. Waters can fully utilize these shelf spaces by having packaging safety stock for the most frequently damaged parts. Another advantage of having packaging safety stock is the low implementation cost. Sending safety stock packages in bulk costs much less than the total cost of sending one packaging at a time, and there is zero additional cost of storing these packaging safety stocks.

However, since Waters is not able to transfer the shipping label from the original packaging to the new packaging, a new shipping label needs to be reprinted when a packaging safety stock is used. Therefore, before GDC orders any packaging safety stock, it has to make sure that a barcode machine is available onsite that is the same as the one used at shipping origin. In addition, workers at GDC must know which shipping label to reprint before they decide to use packaging safety stock.

Referring to Fig. 36 and Table 20, it was found that the two most frequently damaged parts, “e2695…” (part# 186269506) and “Acquity…” (part# 186015085) both have relatively high part values. Therefore, Waters should first prepare packaging safety stock for these two parts.

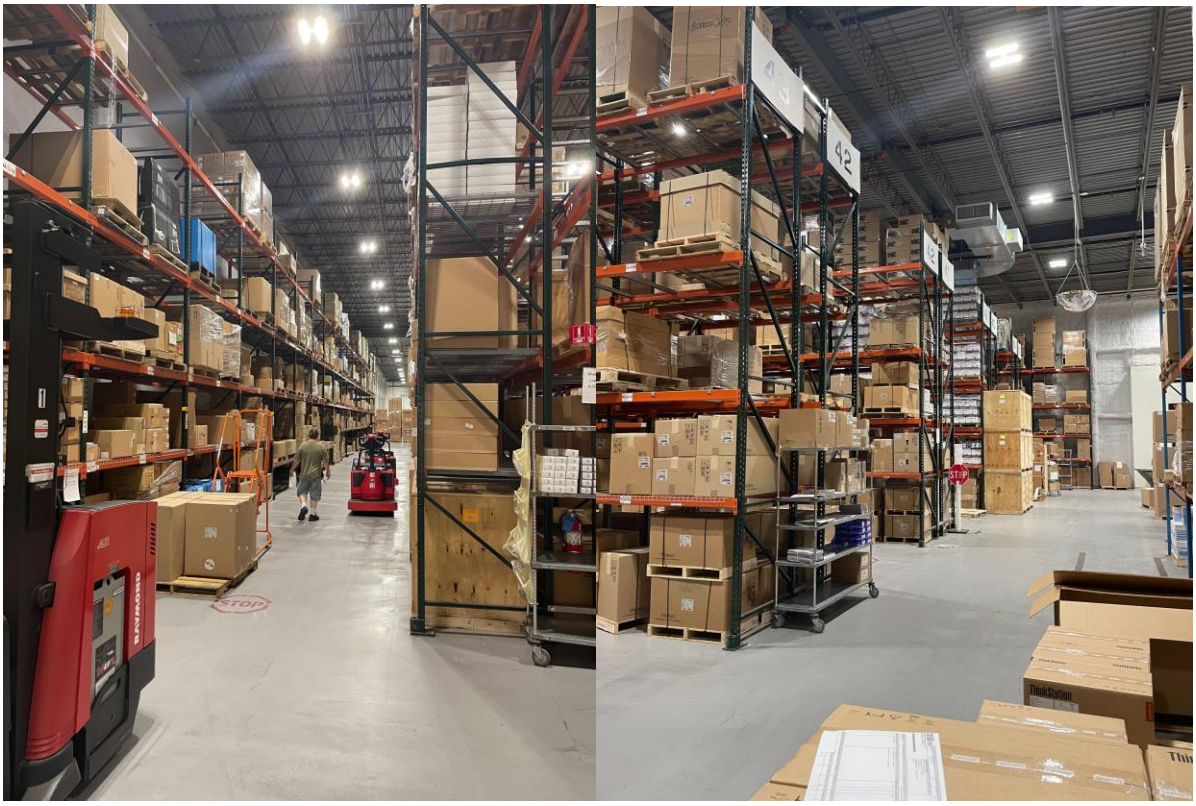

Figure 36: GDC Warehouse Shelf Space

4.2.10 Quality Assurance Spreadsheet

The quality assurance team usually goes onsite twice a week to assess all damaged products and make the decision for each of the products. Should they go to scrap? Should they be sent to the Milford manufacturing center for testing? Should they be sent back to the supplier? However, it usually means the quality assurance team can make the decision one or two days after the damaged product is received. If everything can be updated quickly and carefully on the spreadsheet, the team can view everything on their desktop soon after the damaged product is received, and they will know directly what the problem is and to plan ahead.

To make sure the quality assurance team can evaluate the parts as soon as possible, and to make sure the quality assurance team is not blindsided, it requires the warehouse workers to take pictures of the damaged packaging more carefully at all angles and upload them to the quality assurance spreadsheet. Currently, the warehouse workers enter the damage information on the spreadsheet using a form that is only compatible with desktop computers. Whenever the workers see a possible damage, they take the picture, and wait till the break to upload the pictures using a desktop computer at the warehouse corner. If later they find a picture missing, which is crucial to the quality assurance team's evaluation, they may not have a chance to retake the picture. If the team can facilitate the form on a tablet, the workers can take advantage of the tablet camera to take pictures and scan barcodes, and upload them to the quality assurance spreadsheet right away.

4.2.10 Scrap Account

Some of the consumable stuff such as well plates and covers, does fall under the category of "going to scrap directly" because their unit value is less than $250 dollar and it is not worth the effort to fix the damage. It would be an efficiency gain for the quality assurance team to have a scrap account.

4.2.11 Barcode Machine at GDC

Whenever GDC replaces a damaged packaging with packaging safety stocks, it needs to reprint the label of the products, including a few barcodes and the product's unique serial number (Fig. 37). This requires a barcode machine that is identical with the one used at the shipping origin.

Without the reprinted shipping labels, Waters cannot send the repackaged products to the customers.

Since GDC receives the most damaged products from ADC, it is highly recommended that the GDC keeps a few ADC barcode machines onsite to prepare for any barcode reprinting jobs.

Figure 37: GDC Shipping Label and Barcode

4.2.12 Pallet Protections

Some damages happen on the pallets instead of the cartons. While customers do not receive pallets, damaged pallets still indicate that the products have been mishandled, and inspections are required for those with damaged pallets. Waters uses wooden pallets that are much cheaper than plastic pallets. The wooden pallets can be easily damaged by inappropriate use of forklifts. Once the pallet is damaged, the fastener inside the wooden pallets can easily damage the packaging sitting on top

of it. Therefore, GDC workers should treat the pallets with more care during transportation, and use plastic pallets as an alternative if needed.

4.3 Other Strategies

4.3.1 More Training Offered to GDC Workers

In section 3.3.3, it was mentioned that a lot of times, incorrect shipping methods are used at GDC. For example, sometimes GDC places an overnight delivery which turns out to be unnecessary as it does not need to be at the customer's place in the next three or four days. In addition, Workers may use expensive express/overnight shipping for priority customers in Massachusetts, whereas ground shipping can still deliver the products on time.

In SAP, there is a map indicating where the product is shipped to. Workers are supposed to use the map as a reference to decide which shipping methods should be used, while the majority do not bother to review the map case by case, and blindly follow shipping methods stated on SAP. As mentioned in section 3.3.3, the "GDC Outbound Shipping Process Manual" includes 12 steps of standardized outbound shipping procedure, but none of them asks the workers to check the customer location on SAP and reconsider the shipping method before sending the part out. It is recommended that Waters includes an extra step after step #2 for workers to check the map on SAP as a standardized procedure. This one additional step can help Waters avoid costs of using unnecessary express shipping.

In addition, more training should be offered to GDC workers regarding how to use the map as a guide to decide which shipping method should be used. With hundreds of daily shipments at GDC,

Waters is not able to check on the shipping method case by case. Therefore, Waters should strive to let the workers form a habit of thinking before making decisions on shipping methods. For example, the management team should encourage the workers to override the default shipping method for customers in Massachusetts, even if SAP states the shipping method as express shipping. The GDC workers should also learn how to think independently and override the default shipping method on SAP when necessary.

4.3.2 Maintain GDC Safety Stock Level in Post-Covid Period

During the pandemic, Waters' safety stock level dropped by 60% due to lower production rate at Milford manufacturing center. At the end of June 2021 (Q2) there was a shortage problem of 10-20 different high value parts. During this period, exceptional demand posed huge pressure on the GDC since it reduced Waters' ability to maintain service level, and later on the warehouse needed to use more expensive expedited shipments to meet the deadlines.

Safety stock level is critical when facing exceptional demand. As the pandemic goes away and as workers come back, Waters should prioritize production and to restore its safety stock back to the level before the pandemic, and thus allow more flexibility to exceptional demand and inbound part damages.

Chapter 5. Conclusion and Future Work

5.1 Summary

Waters makes hundreds of shipments every day. Optimizing distribution and reducing shipping expenditure can result in significant cost saving potential. In this thesis, the team deals with two main freight problems at Waters Corporation: Part 1. Customers who (by contract) should pay but do not pay for shipping; Part 2. Product shortage and packaging damages delay the shipping schedule.

For part 1, the team found that the higher-than-normal shipping expenses were due to misalignments between customer shipping contract terms on Lotus Notes and shipping information displayed on SAP. The team dove into these misalignments and targeted 10 parent companies. Of these 10 companies, the team identified 151 subsidiary customers that might have had misalignments, and focused on 5 who placed orders between Jan 2021 and May 2021. The team found 80 orders placed by these 5 subsidiary customers, and documented the excess shipping costs due to Waters (see Feron, 2021). Then the team proposed three freight saving strategies, including 1. Correct existing misalignments 2. Identify more misalignments in the system 3. Avoid future misalignments. The team hopes these three steps can act as a guide for Waters to fix the misalignment problems.

For part 2, the team conducted multiple interviews with Waters quality assurance team and ADC workers. The team found that Waters pays for very expensive expedited shipping due to time constraints, stocks out, damaged inbound products, and human mistakes. Strategies are offered to reduce these problems and thus reduce the use of expedited shipping. The team focused on the

packaging damage problem specifically, and found that most damages are torn and crushed packaging. The team hypothesized that the increase in packaging damage was due to the increased usage of air shipping, where items are passed through more hands, which increases the risk of packaging damage.

The team then focused specifically on inbound damaged packaging from Singapore ADC, since it accounts for 50% of the total damages. The team compared the damage statistics of parts from ADC with the rest of the received shipments, and found that ADC uses air shipping more frequently, which can be the reason why there are more damaged packages from ADC. After that, the team sorted out the 12 most frequently damaged parts and their part numbers. Strategies are proposed for these most frequently damaged parts, including foam packaging, shrinkwrap and dunnages, fragile label, impact and tilt indicator, contract renegotiation, shipping insurance, drop test, polystyrene packaging, packaging safety stock, quality assurance spreadsheet, scrap account, barcode machine, and pallets protections.

5.2 Conclusions

This project identifies several opportunities for Waters to reduce its operation cost and boost its financial performance. Since the customer master data and customer contract are not aligned in Waters' systems, many times misalignment problems cannot be found easily. In other cases, some misalignments cannot be investigated because of the complexity of Waters' customer master data structure. For example, in this project, the misalignment of U.S. customers was not investigated because it would take more time and effort to extract the data and compile them in an organized form.

The team also found a lot of communication and training improvement opportunities. For example, regional sales departments should communicate more frequently with the customer service department regarding unofficial special terms. Workers at GDC should be better trained to use the map as a guide for them to choose freight options. These improvements may not directly impact Waters' income statement and balance sheet, but resolving these issues can be critical for Waters to maintain efficient, transparent management practice, and to increase its operational efficiency.

5.3 Challenges

During the six months of execution of the project, the team strived to investigate a variety of problems and to estimate the cost saving opportunities. However, the project was carried out during the COVID period and the majority of the investigation was done remotely. It was difficult to get access to the data that was critical to identify misalignments and perform an accurate cost analysis. Consequently, some information presented in this thesis was collected from interviews with Waters employees and was based on the team's own interpretation of the interview transcript.

5.4 Future Work

In the future, Waters Corporation should continue this project by considering the strategies proposed in chapter 4. Strategies can be carried out in two parts, for misalignments and for packaging damages respectively.

For misalignments, the team recommends Waters to correct all misalignments between Lotus Notes and SAP for customers who placed orders between Jan 2021 and May 2021. These

customers are active customers, meaning they place orders more frequently than others. Since the misalignment has already been identified in this project, Waters can use the results right away. As the next step, Waters may use the same misalignment identification method proposed in section 4.1.2 to scrutinize all of the 151 customers in Europe and their orders before Jan 2021. The team expects more misalignments to be corrected. Waters should then extend the analysis to the U.S. customers once the U.S. customer master data is available.. To prevent future misalignments, the team recommends creating a standardized customer order review process. Orders from different departments can be collected on a single platform (such as SAP), so there will be no more confusion regarding customer orders created by different departments. A new tool for shipping contract review may also be developed to speed up the contract review process. Last but not least, the team recommends Waters to encourage good communication across the customer service department, contract management department, and global distribution department to make sure any updates can be synchronized across multiple departments as soon as possible.

For packaging damages, the team recommends Waters to clear out a space in GDC and have packaging safety stock for the twelve most frequently damaged parts from ADC, which are identified in section 3.3.11. There is a higher chance that these parts will need replacement packaging in the future. GDC should maintain frequent communication with Waters' other distribution centers and frequently review the quality assurance spreadsheet "Product Evaluation Log" to optimize the packaging safety stock level for frequently damaged parts. Last but not least, the team recommends Waters to repeat the packaging damage analysis for other distribution centers as did in section 3.3, and customize the strategies for packaging damages at different distribution centers.

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