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On-time Delivery Management

Factors Affecting Purchasing OTD Performance
Analysis for Two Key Suppliers in Company X

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Abstract

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This thesis aims to identify the factors affecting Purchasing On-Time-Delivery (OTD) performance of two key suppliers in Company X. Their OTD performance had big fluctuations and brought impact on the OTD commitments to Company X's customers.

This thesis utilized the action research approach and relied on mixed methods. Data collection was conducted via internal document analysis, interviews and statistics. The theoretical framework of the thesis focused on the topics of agile supply chain, collaboration, capacity and buffer management.

The current state analysis revealed that the factors affecting OTD performance are various as there are commonalities but also variability in suppliers. The thesis proposed that OTD improving can be done from different aspects by improving capacity management, buffer management and cross-functional collaboration.

The outcome of this thesis is an OTD analysis tool. Based on statistics of OTD failure factors, this tool demonstrated the feasibility and sustainability of conducting further deep analysis from multiple dimensions, such as different product families, categories, raw materials and manufacturing processes. It provided strong data support for focusing on the main factors affecting OTD in practice and guided the stakeholders to explore and develop effective OTD performance improvement solutions for effective action-taking.

Keywords: On Time Delivery, Agile Supply Chain, Capacity Management, Buffer Management, Collaboration.

The originality of this thesis has been checked using Turnitin Originality Check service. The author has employed artificial intelligence as an aid in the thesis and takes full responsibility for the content of the thesis. A detailed explanation of how AI was used can be found in Appendix 7

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Glossary

| | |
|---------|---|
| CN | Credit Note |
| DN | Delivery Note |
| ECN | Engineering Change Notification |
| ERP | Enterprise Resource Planning |
| FG | Finish Goods |
| GR | Goods Receiving |
| HMDS | Hexamethyldisilazane |
| LT | Lead-time |
| MOQ | Minimum Order Quantity |
| MP | Mass Production |
| OTD | On Time Delivery |
| PC | Polycarbonate |
| PF | Product Family |
| PL | Packing List |
| PMMA | Polymethyl Methacrylate |
| PMMA-HT | Polymethyl Methacrylate -High Temperature |
| PO | Purchasing Order |
| PR | Production Report |
| PVD | Physical Vapor Deposition |
| Q2 | Quarter 2 |
| RMA | Return Material Authorization |
| SCM | Supply Chain Management |
| WIP | Work in Process |

1 Introduction

It was widely acknowledged that delivery performance is one of the key performance indicators (KPI) to “provide businesses with invaluable insights into their operational efficiency “(Hassett. C., 2023). In this thesis, I chose Company X as the case company for my research, where I have been serving since 2013. Company X is a medium-size company with headquarter in Finland, which has been founded for over twenty years, focusing on products’ design, supply, and solution provider to the global market as a leading player. Company X setups two branches in China and North America respectively, supplying to global customers with shipping from its distribution centers, locating in Asian, Europe and North America respectively. In Company X, the On-time Delivery (OTD) metrics have been used to measure the delivery performance in both streamlines in its supply chain: upstream to customers and downstream from suppliers. In this thesis, I focused on the research on its downstream OTD only, and chose two representative suppliers from Company X, supplier A and supplier B as the major objectives, trying to dig out the factors that affect their delivery performance.

2 Current State

This section mainly explains the current downstream supply chain situation in Company X.

2.1 Supply Chian and OTD in Company X

As of the very beginning when Company X was founded, Company X focuses only on product development and marketing, outsourcing all the production to its long-term cooperating factories locating both in Europe and China. This means whether Company X could fast respond and fulfill its customers’ orders highly depends on its self-owned buffer stocks’ resilience and how fast it could

get new replenishments from its suppliers. According to “agile supply chain” concept from Christopher, M. (2011), agile management ultimately results in on-time delivery (OTD), for both getting new replenishment from suppliers and shipping to customers with the right products, right quantity and right effective time. OTD means fast response and company competency. That is why Company X attaches so much importance to OTD in its supply chain management (SCM), putting OTD as the core metrics to evaluate its supply chain and supplier performance. Therefore, how to enable the suppliers to perform well to ‘meet our needs’ (Lees, Nuthall and Wilson, 2020:429) is crucial to Company X’s procurement team as well.

2.2 Procurement in Company X

According to the purchasing report in 2024, Company X purchased from 27 suppliers in total. However, 89.5% of the yearly purchasing value and 91,8% volume was mainly from its top 5 key suppliers. In 2024, the records from Company X’s ERP system presented there were 8704 pcs goods receiving transaction records in total, while 6047pcs records were from the three major suppliers. Supplier A and Supplier B, which were selected as the research objects in this thesis, happened to be two of the three suppliers. They shared together more than 37% of the yearly overall purchasing value (Company X Power BI Report, 2025) and contributed a large number of their delivery transaction records. Their OTD performance is representative and crucial to Company X’s overall OTD performance for both downstream and upstream in the whole supply chain.

However, when Company X’s procurement team monitored Supplier A and Supplier B’s OTD performance, their OTD performance was observed to be very volatile and fluctuated heavily from January of 2023 and quite often below the OTD target 90% that the company required to its suppliers. Especially for Supplier B, whose OTD performance was particularly poor. According to Company X’s OTD report from its Power BI system for supplier B as below Figure 1, supplier B’s OTD dropped dramatically to below 80% from January of 2023 with the whole year only achieved OTD 90% target

four times in 2023 (Company X Power BI Report, 2025). The situation in 2024 not only has it not improved, but it's gotten even worse. Supplier A's situation was better than Supplier B, but the 2023 yearly average OTD performance was also below target and resulted in 89.2%. And according to the OTD report also from Company X Power BI (2025) as Figure 2, there're six months' OTD performance below target in 2023.

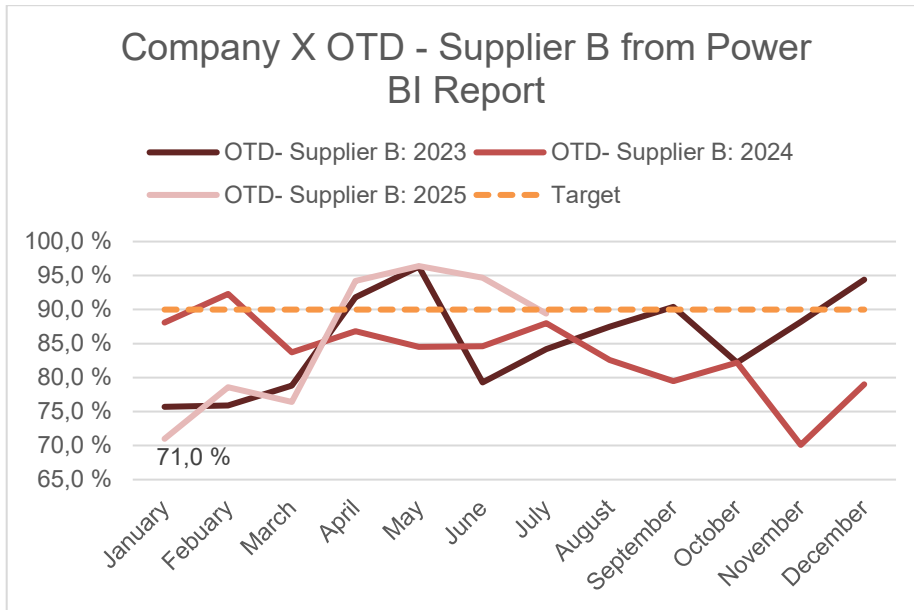


Figure 1: OTD-Supplier B with data from Power BI (Company X)

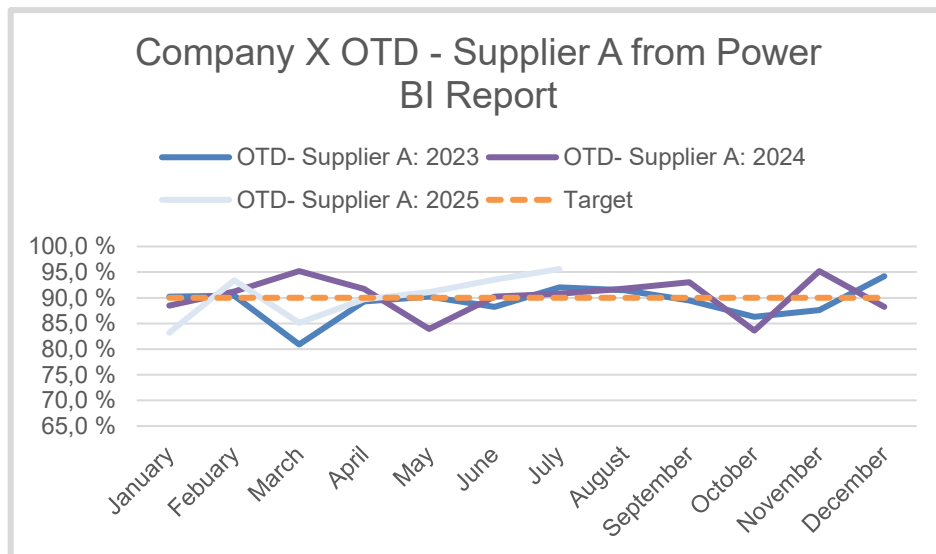


Figure 2: OTD-Supplier A with data from Power BI (Company X)

What happened to supplier A and B's deliveries? Why were their OTD performances up and down like a roller coaster? What are the factors and root causes affecting their OTD performance? How does Company X procurement team manage and minimize the exceptions during production and delivery to improve the overall OTD performance? How to shorten overall availability lead time so that to be more agile response to the customers' needs. These are what this thesis aims to find out.

2.3 Diversity Product Trend

“Our society is more diverse than ever before “(Usman, S.H., 2023), and whether a company's competition could be kept up with is starting to be determined by “the ability to manage the value chain from the customers' point of view” (Piller, F., et., 2012). To more comprehensively meet the needs of various markets and specific needs of customers, product design is increasingly moving towards small-scale and diversified trends. Joseph Pine proposed the concept of “mass customization” in the early 1990s, which has become a “leading idea” for achieving this increasingly diverse world. But Piller and his team pointed out also in their serial articles regarding “mass customization” that “the essence of mass customization” was getting profit from difference, but “in practice is quite complex” and challenging to production with resulting in also supplying lead time is inevitably getting longer.

For Company X, in 2024, according to the suppliers' delivery transaction records from Company X's ERP system, in total 1873 products belonging to 168 different product families have been delivered from suppliers. And the highest variant amount of product family A has been ordered with 159 different product codes in total. The statistics below in Table 1 presents how the diversity of product family A looks like. There were a total of 443 different product codes concerning A and 442 of them were on the selling list and introduced to the market and customers. That means the dedicated factory needs to prepare to produce 442 different products if orders come.

And in relation to the challenges brought to production planning and production, and how it affects the supplier's OTD performance, it will be elaborated later in Section 7.2.2. One additional point to be highlighted here is that, for company confidential consideration, the other products' names, that are mentioned in the subsequent analysis in this thesis, will also be replaced with simplified capital letters like A.

Table 1: Company X product codes numbers for product family A

| Product Family | A |
|--------------------|------------------------------|
| Category | Count of Product Code |
| Tape | 1 |
| Accessory | 1 |
| Single Components | 153 |
| Assemblies | 288 |
| Grand Total | 443 |

3 Research Questions

In section 2.2, I have found out that Company X's procurement team has observed OTD performance for its Supplier A and Supplier B were volatile and fluctuated heavily since 2023. And when Company X discussed with the suppliers their OTD, they found the results were different respectively. And when the purchaser used the transaction data downloaded from the ERP system that Company X uses and manually calculated the OTD by using Microsoft Excel, the results were different from Company X OTD report from its Power BI system as well. Therefore, for Company X's procurement team, to improve the OTD performance, it's crucial to find answers to the questions below:

- 1) How does OTD accuracy deviation happen?
- 2) What affects Supplier A and Supplier B's OTD performance?
- 3) What can be done to improve the OTD performance of Supplier A and Supplier B to achieve the 90% OTD target?

4 Methodology & Data Sources

This part including both the methodologies that have been used, and the sources for data collecting to support the study and analysis for this research.

4.1 Methodology

To answer the research questions that were raised in Chapter 3, mixed methodologies were used during the research progress.

4.1.1 Quantitative Approach

Bryman Alan (2012) defined quantitative research as “a research strategy that focuses on quantifying the collection and analysis of data”. In Chapter 2, I have mentioned that Company X measures suppliers’ OTD performance by taking data references from suppliers’ delivery records which were recorded by Company X’s logistics team to its ERP system when getting delivery notes from suppliers, so called Delivery Transaction records. The research is aiming to find the factors that affect OTD performance, therefore, the starting point was collecting historical archival data.

At the beginning, I designed to collect the Delivery Transaction data of Supplier A and Supplier B’s only in the past 24 months over January 2023 to December 2024. But along with the thesis progress and time goes by, the data collection was expanded to July 2025. These massive data were primarily screened by adopting quantitative method and in total 6461pcs valid data were kept finally as the database for final statistics and analysis. Section Chapter 5 will explain how the data screening was done.

4.1.2 Qualitative Approach

A qualitative approach is used when the research “aims to produce detailed descriptions and uncover new insights about the studied phenomenon” (McLeod, S., 2025). Categorization of OTD Failure Factors. This research aims

to find the factors that affect Company X Supplier A and Supplier B's OTD performance. For most of the OTD failed cases, suppliers provided explanations of why the deliveries were delayed. As the factors that cause delivery delays and OTD failures in practice operations are complex and diverse, suppliers' explanations are often described orally in the form of sentences. Qualitative analysis was also used to categorize these chaotic descriptions. After categorizing the factors for those OTD failure records, the research again turned back to using a quantitative approach to make statistics for those categorized factors that led to delivery delay and OTD failure, thereby identifying the crucial points for improving actions.

4.1.3 Action Research

Action research is "a highly interactive method" (Tegan, G., 2023). It was implemented throughout the entire research progress, cooperating with Company X's Power BI administrator to investigate the root causes leading to the OTD computing deviation, unifying the consistent rules for subsequent OTD calculation. For the factors that led to OTD failure, not only the archived suppliers' delivery records from Company X's ERP system and the archived Production Report (PR) from suppliers were reviewed, but also interviews were conducted from time to time with suppliers when necessary.

4.2 Data Source

Data sources "act like signposts" to guide you to "find information" to "kick off your research journey" (Ranica, 2024). This part focuses on explaining where the data that was used for this research is collected from and why they are crucial to support the subsequent research.

As mentioned in Section 3.1, at the beginning, this research was designed to collect the archived Delivery Transaction-Records of Supplier A and Supplier B's only in the past 24 months from January 2023 to December 2024. But along with the thesis progress and time goes by, the data collection was expanded to July 2025.

4.2.1 Power BI Report

The starting point of data collection was the company's official Power BI regarding the purchasing's OTD tracking reports. (Referring to Figure 1 and Figure 2 in Section 1.2.2, Chapter 1). As Power BI OTD report presents only as graphic chart format, though the data labels in these charts could tell how the OTD performance was, but they were just results, where OTD fails, readers don't know. That's why I must check back the original data source-Delivery Transaction records from Company X's ERP system.

4.2.2 Delivery Transaction Archives

Company X deployed its ERP system early in 2010, but it wasn't until the spring of 2022 that the function to archive the Original Confirmation for orders, which to be interpreted in the next section 4.2.3, was developed in its ERP and is usable to both Customer Service Team and Procurement Team during the daily operation. By then, Company X's OTD evaluation with comparison to Original Confirmation started to be measured and became the main metrics for OTD evaluation. The company level of minimum 90 percent OTD target was also set based on this.

One point needs to be highlighted here: as Company X's branch in China uses a different ERP system from Company X headquarter and they take in charge the purchasing independently. Company X hasn't done integration for the two ERP system data so far. The Power BI reporting system collects data only from the ERP that was being used by Company X headquarter, that meant the reporting system for purchasing OTD performance evaluation was not taking Company X's branch in China into account. So does the database that was used to do the analysis in this thesis.

4.2.3 Production Reports (PR)

Production Report is a tool designed with Microsoft Excel. As Company X and its suppliers use different ERP systems, for daily work convenience and enable the sharing of information to all relevant stakeholders on the same page, this

PR tool was introduced and deployed broadly to Company X's suppliers for daily order confirmation use, especially to three major suppliers of Company X. The selected research objectives Supplier A and Supplier B are the two suppliers of the three major ones.

Company X's purchasing team normally issues Purchasing Order (PO) to suppliers on a daily basis and require suppliers to confirm the delivery schedule for the new PO in two working days if there is no exception. PR is the tool that is agreed and dedicated to feedback this information with updating frequency requested at least twice per week. The original PR template is provided by Company X to its suppliers. It's acceptable for suppliers to make modifications according to their practice, but never less the information below must be included in the PR:

1) the information from Company X's Purchasing Order (PO):

- PO Number (PO)
- PO Date: when the PO was received by supplier
- Company X's Product Code and its Standard Description
- Quantity: how many certain products are ordered
- Requested Delivery Schedule.
- PO Type: is it a trial order, pilot run order, normal mass production order, factory buffer order?

2) the information from supplier:

- The machine and Injection Mold information that to be used to produce the certain product.
- The estimated delivery schedule that they could achieve, so called Delivery Confirmation.

This is the most important information that PR provides. The first Confirmed Delivery Schedule was defined as Original Confirmation which

is the most original data source for OTD computing. Company X's purchasing team collects PO Delivery Confirmation from PR and updates it to the PO in ERP, and it defaults this first-time updated schedule as Original Confirmation, which is the most crucial metric that Company X uses to measure the OTD performance as mentioned in Section 4.2.2. If the Delivery Schedule can't be given when the PR was sent to Company X, the supplier is required to share the story behind it.

The Confirmed Delivery Schedule would be changed if an exception happened, such as unforeseen material shortage or quality concerns, or maybe mold or machine issues during production and so on. These were some of the factors leading to OTD failures that this thesis is aiming to dig out. If the supplier could foresee, they wouldn't be able to ensure delivery on time due to any of these exceptions, which means not able to deliver no later than the schedule that they originally confirmed, supplier takes responsibility for giving alerting to Company X beforehand, then confirms an updated new Delivery Schedule when it's possible to make delivery. Per this new delivery schedule, Company X defined it as Final Delivery Confirmation, which is also an important metric for Company X to measure its suppliers' OTD performance, as it is the reference that Company X could take to confirm the shipping schedule to its customers.

In general, in this research, the Archived Delivery Transactions from Company X's ERP system are the basic data source for computing and analysis its suppliers' OTD performance, while PR from suppliers is the source to ERP Delivery Transaction, providing not only the most original schedules source for OTD performance computing, but also the most original source for factor categorization and analysis of OTD failure.

5 Theoretical Framework

OTD is an essential performance metric in evaluating supplier effectiveness within a supply chain. It directly influences customer satisfaction, inventory

costs, and the overall efficiency of the whole supply chain operations. In a global and volatile market environment, ensuring deliveries from suppliers punctually has become a critical concern for companies aiming to maintain competitiveness. This literature review explores three key academic contributions by Christopher (2023), Chopra and Meindl (2016), and Goldratt (2014) respectively. Their works present a multi-dimensional understanding of the factors that influence supplier OTD, combining agility, coordination, and constraint-based thinking, and collectively offer theoretical frameworks that help to explain the dynamics behind supplier OTD performance.

5.1 Agile Supply Chain

Christopher (2023) points out that the traditional Supply Chain, which relies heavily on efficiency and cost-minimization, is increasingly vulnerable to disruptions and demand fluctuations. However, agility enables companies to quickly respond to unpredictable market conditions, without sacrificing service levels. For suppliers, agility means having the flexibility to adjust production schedules, expedite shipping when necessary, and collaborate closely with buyers in real-time. Christopher (2023) emphasizes the importance of agility in the modern Supply Chain and agrees with Michael Porter that the modern Supply Chain has become “Value Chain”. He mentions that agility is the ability to quickly respond and cost-effectively to volatile demand and supply conditions, which highly depends on visibility, flexibility, and quick reconfiguration, all of these directly impact a supplier’s capability to deliver on time.

In Company X, for products that are crucial to the company's sales volume, due to the wide range of customers and stable demand of high volume, Company X changed from original Make-to-Order Supply Chain model to Make-to-Stock model for these high-volume products. By taking reference with 6-12 months of historical sales data with considering both Volume and Shipping Location, Company X “identify customers' needs” (Christopher, 2023, P39) in advance, place orders to suppliers in advance to schedule the production, so that to prepare sufficient inventory in the corresponding logistics centers, hence, to

ensure fast response to coming customers' orders, "match supply with demand" (Christopher, 2023, P99) and perfectly deliver the order "on-time, in-full" (Christopher, 2023, P43). The Factory Buffer operation model that Company X deployed to Product Family Y in Supplier A and Product Family A in Supplier B (Section 7.2.2.1) is another effective solution that Company X adapts to the era of Agile Supply Chain and the Age of Mass Customization (Piller, F., et., 2012).

5.2 Precise Coordination and Collaboration

Chopra and Meindl (2016, P33) argue that "for a company to succeed, all functional strategies must support one another and the competitive strategy". In their Value Chain in a company as Figure 3, same as Christopher (2023), they all consider "service" to be a crucial and ultimate goal in the company's value chain, and they all believe that the key to achieving this goal lies in on-time delivery. They argue also that the key to achieving consistent OTD performance lies in the precise coordination across functions-procurement, production, and distribution. They identify synchronization of these functions as a critical factor influencing OTD.

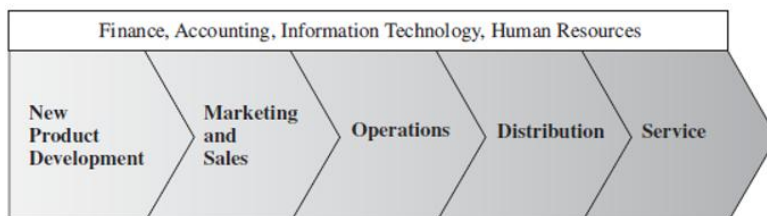


FIGURE 2-1 The Value Chain in a Company

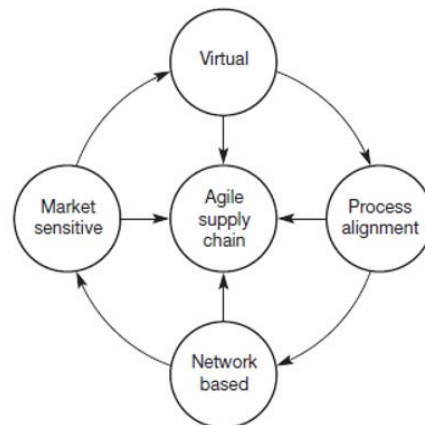
Figure 3: The Value Chain in a Company (Chopra and Meindl, 2016, P32, FIGURE2-1)

They emphasize it's important to integrate planning, demand forecasting, safety stock policies, and highlight the production sequencing. When any of these elements are misaligned, for example, if the raw material that was purchased by procurement delayed or production capacity is not enough, the upstream and downstream chain will be broken, resulting in affecting delivery commitments, so called OTD Failure. Hence, they emphasize the importance of planning hierarchy and cross-functional coordination and collaboration, which can

provide a systematic picture of how OTD can be guaranteed (Chopra and Meindl, 2016).

They also believe that it's important to "supply chain coordination" to "share information" and consider beforehand "impact its actions have on other stages". And good "supply chain coordination" can "increase total supply chain surplus" (Chopra and Meindl, 2016, P261). In Christopher's Agile Supply Chain model (Figure 4), he argues also that "a confederation of partners linked together as a network" is one of the important "ingredients of agility". But if the network would like "to be truly agile", "a much higher level of collaboration and synchronization is required" (Christopher, 2023, P103-104)

Figure 5.4 The agile supply chain



Source: Adapted from Harrison, A., Christopher, M. and van Hoek, R., *Creating the Agile Supply Chain*, Chartered Institute of Logistics and Transport, 1999

Figure 4: The Agile Supply Chain (Christopher, 2023, P103-104, Figure 5.4)

This research also paid attention to the coordination and collaboration among OTD relevant stakeholders. For instance, the discussion and brainstorming between Company X procurement team and Power BI Owner help to achieve the OTD computing principles, so that the OTD deviation and confusion brought by the deviation has been mitigated. Another outstanding example to show the importance of coordination and collaboration to safeguard the OTD is for the production priority discussion and coordination for Pilot Run PO and Mass Production PO when there's Moldbase Sharing or Common Machine conflict across Company X Procurement Team, Company X Project Team and Suppliers.

5.3 Capacity and Buffer Management

Christopher (2023), Chopra and Meindl (2016) and Goldratt (2014) all essence the importance of Capacity and Buffer Management to OTD safeguarding in their work on supply chains. Christopher (2023, P139) suggests identifying constraints- “the slowest activity in a chain”, so called “Bottleneck”, to optimize the production. While Chopra and Meindl (2016, P60-63) think capacity, after it was invested, “will have difficulty responding to demand fluctuations”. So, they argue it’s important to use “safe inventory” to “counter uncertainty”, such as “in case demand exceeds expectation”.

Goldratt started the definition of “constraints” at first. In his theory of constraints as elaborated in *The Goal* (2014), he posed the concepts of capacity constraint management and buffer management. He argues that the effective management of bottlenecks, no matter if it’s in procurement, manufacturing, or logistics, is crucial to ensure the flow goes smoothly to meet the due dates. And buffering can help to counter uncertainty, no matter in time or inventory, is a critical approach for improving OTD (Goldratt, 2014).

Therefore, based on the theory of capacity management and production optimization, when planning new capacity investments and production locations, Company X takes not only cost into consideration, but also being market and customer oriented. For those high-volume products which are shipped to European customers majority, Company X developed long-term partnerships to cooperate with in Europe to shorten the delivery lead-time to improve customer service, so that risk of all eggs in one basket is being mitigated as well.

It’s a big renovation for Company X that its production planning was changed from Make-To-Order to Make-to-Stock model for those high-volume products. But this was still not enough to response agilely to the volatile market and customers’ diverse needs. To utilize the capacity and optimize production, Company X co-works with its suppliers by deploying

the Factory Buffer Operation Model with its suppliers to react to those products families which have plenty of diverse variants. In Section 7.2.2.1, there will be more detailed interpretation about how this Factory Buffer Operation Model works.

Goldratt (2014, P348) argues “longer time buffers mean more safety time, expectations are ... a higher percentage of orders will be completed on or before their respective due dates” through “elongating the lead time and increasing work in process (WIP)”. In practice in Company X, the concept of Factory Buffer Operation Model is just to by pulling-in some of the production process to build buffer for common components in advance with keeping WIP inventory in factories, so that less production process would be needed when the call-off order coming, hence, faster response to the delivery requirement and more insurance to the OTD.

6 Implementation: Data Screening, Statistics and Analysis

This Chapter focuses on presenting what I deal with the collected data mentioned in Chapter 4 during the research process, to get the answers for the research questions. Also, in Section 4.1 when I talked about the research approaches in this researcher, I mentioned the validity of the data that were collected. That means before I start to statistic the data I collected, it's necessary to tidy and screen the data to ensure the data used for this research was valid and could truly reflect the OTD performance and explain why OTD failed. But before explaining why it's necessary to do data screening, it's better to explain how OTD was computed in Company X.

6.1 OTD Computing in Company X

This section will tell how the OTD performance was computed in Company X.

6.1.1 Metrics for OTD Computing

There are three metrics that are being used for OTD computing in Company X.

1) Actual Delivery Schedule

This is the schedule when the delivery from the supplier was made. Company X's ERP system defaults the Actual Delivery Schedule as when the Goods Receiving (GR) action was done in ERP by its logistics team with reference to the Packing List (PL) or Delivery Note (DN) from suppliers.

2) Original Confirmation and Final Confirmation

In Section 4.4.3, I have explained that the estimated delivery schedule when the supplier could make delivery to Company X was called Delivery Confirmation in Company X. The first-time confirmed delivery schedule was called Original Confirmation. And Final Confirmation is the schedule when the delivery basing the Original Confirmation has to be postponed due to the happening of exception.

6.1.2 How OTD Computed

Company X compares the Actual Delivery Schedule versus the Confirmed Delivery Schedule with both the Final Confirmation and Original Confirmation. If the delivery was done within 5 days compared to the confirmed delivery schedule, this delivery will be judged as On Time, that means OTD Okay. If delivery was done more than 5 days later than the confirmed delivery schedule, it will be a OTD failed delivery. This formula could be presented as Figure 5 below.

Though Company X measures OTD Performance compared to both Original Confirmation and Final Confirmation respectively, the OTD performance compared with the Original Confirmation is the most important indicator to evaluate the true delivery performance. What Company X's OTD minimum target 90% aims to achieve is also Original Confirmation. In this thesis work, the

OTD I talked about later, if there is no special statement, it generally also refers to the OTD performance compared with Original Confirmation.

| | | | | |
|----------------------------------|---|----------------------------|-----|------|
| | | | | OTD |
| Date of Actual Delivery Schedule | - | Date of Confirmed Delivery | < = | 5 |
| | | | > | 5 |
| | | | | OKAY |
| | | | | FAIL |

Figure 5: Company X OTD Computing Formular

To let the readers understand more easily how Company X counted OTD performance, besides Figure 5 above, I'd like to give an example to explain it in detail. For instance, if a purchasing order (PO) for 10000 pcs product X was placed and sent to the factory on 2.9.2024. Supplier firstly confirmed delivery could be done on 19.9.2024. The schedule 19.9.2024 here was the Original Confirmation that Company X called. Let's see how the OTD was computed in different seniors.

1) Delivery On-time and OTD Okay

Ten thousand pieces in this PO were successfully delivered on 19.9.2024. When the logistics team receives 10000 pcs to ERP, the system will generate a purchasing delivery transaction record. As the delivery met the delivery what the supplier originally confirmed. The system will judge this delivery as Delivery-On-Time. Hence, this transaction record will be judged as OTD okay.

2) Delivery Earlier and OTD Okay

If there was no pre-alerting or any special emphasis on the supplier that Company X didn't accept earlier delivery than the certain PO requested, Company X normally was fine and happy to see that supplier deliver earlier than the confirmed schedule. For above 10000 pcs PO, if the supplier delivered earlier than its original confirmation, e.g. they delivered the whole batch one week earlier on 12.9.2024. Once the goods-receiving was done in ERP, transaction record for this delivery was generated and compared with the

original confirmation, as it was not later than 19.9.2024, the system regarded the OTD for this earlier delivery okay as well.

3) Delivery Delayed and OTD Failed

The 3rd scenario is about delivery-delay. Like the above 10000 pcs PO which was originally confirmed for delivery on 19.9.2024. But in case exceptions happened during production or any other process, which led to the fact that delivery would not be able to complete on time anymore. Suppliers normally will update a new delivery schedule, called Final Confirmation. For example, let's suppose the updated new delivery schedule here now was postponed to 26.9.2024, Company X refreshed the new schedule 26.9.2024 to ERP by following, but ERP archives the Original Confirmation 19.9.2024 in the system, too. If the supplier delivered the full PO 10000 pcs on 26.9.2024, then the system would count the OTD compared with final confirmation OK but failed to the Original Confirmation.

4) Partial Delivery

Company X normally accepts suppliers to arrange delivery partially as well if no special statement was given to suppliers, especially for those critical PO or PO with big quantities. For all the partial deliveries earlier than the original confirmation, the system regarded these transactions' OTD okay. On the other hand, if it was a transaction which was recorded as the delayed delivery wasn't made within 5 days compared to the Confirmed Delivery Schedule, OTD failed. Still taking above PO as example: if some of the 10000 pcs were delivered still within 5 days of the Original Confirmation, e.g., not later than 25.9.2024, then these partial deliveries not later than 25.9.2024 would be regarded as OTD Okay, but balance that delivered on 26.9.2024 or even later than 26.9.2024 will all be regarded as OTD Failure compared to Original Confirmation

6.2 Data Screening

Now I have got to know how OTD performance in Company X was computed. But why do I still need to do data screening when computing the OTD? This part

will answer why data screening is necessary in this research and how it was done.

6.2.1 PO Types

As explained in Section 6.1, OTD computing in Company X is based on the archived delivery transaction against PO to suppliers, however, not all the POs to suppliers are measured with OTD due to different characteristics of the PO. There are 5 different types of POs as below that were issued to suppliers according to different types of business needs:

1) Tooling Order

This is when the new project officially starts between Company X and its supplier. As introduced in Chapter 1, Company X provides products for its customers. These products are mainly made of different types of resins, produced with injection molds and machines. These molds were specially designed by Company X and manufactured by its suppliers, which normally would be kept in suppliers' factories for continuous production. Company X categorizes all mold related orders as Tooling Order with product code in ERP system and PO to supplier starting with "Tooling".

2) Trial Order

As mentioned in Tooling Order part above, the products that Company X provides on the market are mainly made of different types of resins, that means it's possible and normal that there would be different versions of one product due to different raw materials it was made of. PMMA (Polymethyl Methacrylate) and PC (Polycarbonate) are the two major types of raw materials for Company X's products. If one product was primarily designed to be made of PMMA only, the sample will be produced and verified for mass production along with the mold verification. It's necessary to arrange mold trial and sample verification again if there is a request with raw material other than PMMA, despite the initial request being from Company X internal or external. For an order that was

placed for such a new material test purpose or any other mold related trial request to the supplier, Company X uses the dedicated code "Trial Cost" in ERP to place the order to its suppliers, so called in Company X Trial Order.

3) Pilot Run PO

The Pilot Run PO in Company X is placed to supplier by following request from Project Manager after the sample from the certain newly developed mold has been approved for mold continuous-production capability verification purpose. Normally, it is the quantity of output with 8 hours continuous production. Since this is the first batch of Mass Production from a certain new mold, the quality of the product needs to be tested again before this product can be officially released to be Production Ready, so-called Mass Production approval as well in Company X. Per the first delivery against the Pilot Run PO, the related stock wouldn't be released to sell to customers until the sample from Pilot Run batch was approved.

In practice, not all Pilot Run would pass in one go. If there's any anomalies during Pilot Run production progress, or if the sample's dimension measurement results were out of tolerance requirements, or if the sample's test fails, the Pilot Run will be rejected by Company X and one more round needs to be arranged. This type of PO will be delivered also after production is completed, but due to potential uncontrollable risks, such as Mold Modification necessity by following Engineering Change Note from Company X, the delivery schedule for Pilot Run PO is usually uncertain and difficult to guarantee. Therefore, it's necessary for Company X to consider whether Delivery Transactions for Pilot Run POs should be taken into consideration when computing OTD for suppliers.

4) Mass Production PO

In Company X, a product will be officially deployed and start to ship to customers only after it is approved to be Production Ready, so-called Mass Production. The PO that is placed when production is in Production-Ready

status is called Mass Production PO. The Delivery Transaction record for Mass Production PO is the original archived data source for OTD computing in Company X. The delivery of Mass Production PO means that Company X can continue to supply the market and customers. In another word, the On-Time Delivery plus the right quantity for the Mass Production PO guarantees and directly affects Company X's Delivery Performance to its customers.

Among Mass Production POs, there're also some POs placed as buffer inventory purposes. Some of the Buffer POs are required to deliver to Company X directly. Some are kept in Suppliers' factories locally, as stock buffer for coming Factory Call-off Operation Model as agreed between Company X and Suppliers for some Product Families which have plenty variants, e.g., Am in Supplier B that was mentioned in Table 1 in Section 2.3., and also Y in Supplier A. This Operation Model will be further interpreted in Chapter 7.

For those buffer POs whose stock to be kept in the factory, Company X Purchaser usually manually adds memos in the corresponding PO line such as "new factory buffer order" when placing the PO to suppliers. And internally in Company X's ERP system, such PO lines' "deliver to" location will be recorded to the dedicated Virtual Warehouse Locations which are set up specially for factories. Table 3 in later Section 6.2.2 interprets how these Virtual Warehouses Locations correspond to different PO types.

5) Other Spot PO

Besides the above 4 main PO types, there're also some temporary one-time purchases from various suppliers. Since these temporary one-time purchased items are quite diverse, and most of them are one-time or temporary purchases, Therefore, Company X does not set up dedicated product codes for each of these purchase items respectively in its ERP system. When necessary to place such PO, Company X usually uses the unified code "1B" plus specific description for the purchased content.

6.2.2 Warehouse Locations

As mentioned in Chapter 1, Company X ships products to its customers globally from its 4 distribution centers, locating in 3 different continents. These are management from physical aspects for delivery, inventory and logistics warehousing. But in ERP, in addition to having a one-to-one warehouse code for warehouse management, Company X creates different virtual locations, so-called warehouse numbers in ERP, corresponding to different PO types and inventory management purposes. When placing PO to the supplier that requests true physical goods delivery related, the correct warehouse number is required to be used in the PO in ERP. Hence, when delivery happens and Company X logistics team does Goods Receiving to ERP, the Delivery Transaction will be generated and also the warehouse number information will be archived to tell where this delivery will be sent to. Table 2 as below presents only some of the major warehouse locations that Company X set up in its ERP for daily delivery, shipping and inventory management. It's important that the PO is placed on the right warehouse number, so does the Goods-Receiving to ERP for the deliveries from suppliers, as the warehouse number information is one of the key criteria for data validation screening for OTD performance computing.

Table 2: Warehouse Numbers in ERP in Company X

| Warehouse Number | Warehouse Location | Remark |
|------------------|----------------------------|--|
| 3 | Europe | Normal Mass Production PO. Main warehouse for deliveries from suppliers in Europe, and customer orders to be shipped from Europe |
| 2 | China-Normal | Normal Mass Production PO. Main warehouse for deliveries from Suppliers in China, and customer orders to be shipped from China |
| 333 | China- Incoming Inspection | Normal Mass Production PO, stock will be transfer to China-Normal if incoming quality checking okay |
| 99 | China-Pilot Run | in ERP, where the Pilot Run PO should be delivered to. Stock will be transferred to China-Normal after the Pilot Run was approved. |
| 222 | Supplier A | Normal Mass Production PO, Stock keeping in Factory of Supplier A |
| 17 | Supplier B | Normal Mass Production PO, Stock keeping in Factory of Supplier B |

6.2.3 Data Validation Screening

Company X's logistics team records each movement of the inventory changing in corresponding warehouses and warehouse locations by generating corresponding transaction record archiving in ERP. So far in ERP in Company X, eight different types of transactions have been set up, to reflect the needs of corresponding daily business operation. Type 6 is the dedicated one for all transactions relating to Purchasing Orders. In another word, Transaction Type 6 archives all of the deliveries from Company X's suppliers. These Type 6 transaction data archived are the original database for Company X's OTD computing for its suppliers. This is why when downloading these transaction reports from ERP as a database to compute the Suppliers' OTD results, it's necessary to screen the data, choosing Transaction Type 6 only at first, to ensure the "data validation" and "data quality" (Wikipedia).

In Company X, from January 2023 to July 2025, its ERP system has archived in total 25529pcs transaction records according to the statistics in Table 3 as below under Transaction Type 6. But are all the transactions under type 6 valuable and valid for Company X's OTD computing? The answer is No, and it's still necessary to undergo further "data cleansing" (Wikipedia).

As Section 6.2.1 is interpreted, in Company X, usually only Pilot Run PO and Mass Production PO have deliveries with true physical goods moving to Company X's warehouses. Then according to Table 2 in above Section 6.2.2 presents and concerning to the selected research objectives Supplier A and Supplier B, as they are in China, that meant in this research, only Type 6 Transactions with "delivery to" as Warehouse 2, Warehouse 99, and Warehouse 333 should be counted.

And then, when I introduce the PO type of Pilot Run in Company X, the delivery for Pilot Run PO is always uncertain due to uncontrollable risks, such as the Engineering Change Notification (ECN) from Company X, or technique issues happens during production, Company X decides to exclude the Delivery Transactions for Pilot Run PO from Suppliers' OTD computing, after discussion

and agreement are achieved between Company X Purchasing team and Company X's Power BI Reporting System administrator. This means that all deliveries for the Pilot Run POs will not be counted in the OTD data pool. Hence, in this research, for Supplier A and Supplier B, the data validation screening was undergone with criteria meanwhile satisfied as Transaction Type: Purchasing Type (6) as below:

- 1) Warehouse Location: Warehouse 2, Warehouse 333
- 2) Supplier: A and B
- 3) Period: January of 2023 to July 2025

After this screening, the Delivery Transactions from Supplier A and Supplier B that are valid for the OTD computing in this research were shortened to 6450pcs (Table 4) in total finally.

Table 3, Company X Delivery Transactions Archived in ERP (January 2023 to July 2025)

| Count of Tilausno | Quantity of PO | <2.1.2023 | 2023 | 2024 | 2025 | Grand Total |
|--------------------|----------------|-------------|-------------|-------------|------|--------------|
| warehouse num | | | | | | |
| 2 | | 4400 | 5067 | 3089 | | 12556 |
| 0 | 4 | 2175 | 1840 | 1018 | | 5037 |
| 4 | | 1 | 842 | 535 | | 1378 |
| 1 | | 1064 | 113 | 55 | | 1232 |
| 3 | | 340 | 570 | 264 | | 1174 |
| 99 | | 529 | 384 | 255 | | 1168 |
| 222 | | 3 | 440 | 404 | | 847 |
| 17 | | 32 | 41 | 757 | | 830 |
| 5 | | 268 | 335 | 181 | | 784 |
| 333 | | 23 | 32 | 122 | | 177 |
| 11 | | 39 | 66 | 28 | | 133 |
| 9 | | 77 | 35 | 9 | | 121 |
| 999 | | 7 | 11 | 2 | | 20 |
| 6 | | 19 | | | | 19 |
| 777 | | | 14 | | | 14 |
| 15 | | | | 12 | | 12 |
| 12 | | 3 | 3 | 3 | | 9 |
| 888 | | | 7 | | | 7 |
| 666 | | 4 | 1 | | | 5 |
| 16 | | 4 | | | | 4 |
| 79 | | | 1 | | | 1 |
| 555 | | | | 1 | | 1 |
| (blank) | | | | | | |
| Grand Total | 4 | 8988 | 9802 | 6735 | | 25529 |

Table 4: Company X OTD Computing for Supplier A & B, (January 2023 to July 2025)

| Count of Delivery/original cfm | |
|--------------------------------|-------------|
| Row Labels | Grand Total |
| B | 2941 |
| Fail | 454 |
| OK | 2487 |
| A | 3509 |
| Fail | 358 |
| OK | 3151 |
| Grand Total | 6450 |

6.3 OTD Performance

After data screening by following the criteria combination in Section 6.2.3, I got the valid data for this research, and computing the OTD performance result for Supplier A and Supplier from January of 2023 till July of 2025 as below Figure 6. Company X aims to achieve the OTD target of minimum 90%. This goal applies to Suppliers' OTD evaluation as well. But from Figure 6 as above, I can see that Supplier A and Supplier B's OTD performance fluctuated heavily, especially for Supplier B, whose OTD was extremely poor and turned even worse starting from the summer of 2024 till the first quarter of 2025.

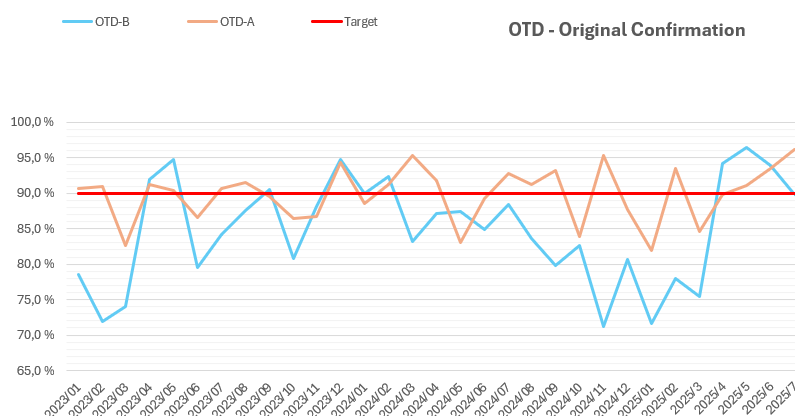


Figure 6: OTD-Original Confirmation for Supplier A & B, Company X

6.4 OTD Failure Factors Categorization

There is an old Chinese saying that says people should not just know the fact only, but also the reason behind it. For OTD, it's not enough to know only how

suppliers did, but more important to understand where the OTD failed, and why OTD failed. In this research, one of the main objectives is to find those factors affecting Supplier A and Supplier B's OTD performance.

In Section 6.2.3, I have got the valid data for this research after screening and sorted out 812pcs OTD-Failed Delivery Transactions of Supplier A and Supplier's with period from January of 2023 to July 2025 as Table 5 (Section 6.2.3) presented above. The research then entered the most tedious but necessary step – tracing back the stories why these deliveries failed OTD.

In Section 4.4.3, I have introduced that the Production Report (PR) was used between Company X and Supplier A and Supplier B for PO Delivery Confirmation communication, and Suppliers reported the root cause in PR for any exception that would lead to delivery-delay. These delivery-delay related explanations in PR were parallelly updated to corresponding PO in ERP as well, but still some records were missing or unclear so that I have to trace back or double check those archived PRs.

As mentioned in Section 4.2, the factors that cause delivery delays and OTD failures in practice operations are complex and diverse, and suppliers' explanations are often described orally in the form of sentences, hence, qualitative approach was used to categorize these chaotic descriptions after getting clear with the back stories about why the 812pcs Delivery Transactions failed in OTD. In the research, basing explanations from Supplier A and Supplier B, the factors leading to OTD-Failure were finally classified into 14 categories in total as Figure 7:

Categories of OTD-Failure Factors

- | | |
|-------------------------|---------------------------------|
| 1) Mold Issue | 8) Unintended System Alteration |
| 2) Production Delay | 9) Multiple Issues |
| 3) Quality Issue | 10) Machine Issue |
| 4) Material Shortage | 11) Force Majeure |
| 5) Machine Availability | 12) Production Issue |
| 6) Mold base Sharing | 13) Engineering |
| 7) Human-induced Error | 14) Labor Shortage |

Figure 7: Categories of OTD-Failure Factors

7 Results: Findings, Actions, Evaluation

This chapter will focus on the results of this research: through the statistics and analysis of data that I collected for this research, what was found, the corresponding solutions and actions.

7.1 OTD Computing Results' Deviation

As mentioned in Section 2.2, Company X's Procurement team observed Supplier A and Supplier B's OTD results were different between what they calculated basing the archived Delivery Transaction data and the results from Company X's Power BI reports. This section will reply to how this happened and what has been done to mitigate this deviation.

7.1.1 Why Deviation

When OTD from Company X Power BI report for Supplier A and Supplier B were noticed to be volatile and heavily fluctuated, Company X Procurement Team started to investigate details to check those OTD Fail transactions from Power BI report and found besides those delayed deliveries which had clear comments for the root course, other OTD Fail were due to:

- 1) Delivery Confirmations were missing in the POs

This had happened to both Pilot Run PO and Mass Production POs. For Pilot Run PO, as mentioned in Section 6.2.3, as the delivery for Pilot Run PO was always uncertain due to uncontrollable risks, it's hard for the supplier to give an accurate schedule on time, or difficult to ensure the original confirmed delivery schedule unchanged, so that usually, there's neither any Requested Delivery Date in Pilot Run PO when it was issued to supplier, nor the Delivery Confirmation was updated to ERP.

For Mass Production PO concerning those high-volume products, Company X usually has kept suitable level buffer inventory on-hand. The PO was issued to

suppliers also for future buffer purposes with quite big quantities. As Company X is not in a hurry to get replenishments for these high-volume products, suppliers have been authorized to arrange production for these high-volume products according to their own pace to utilize the capacities, and priority would be given to the critical PO if there's machine availability conflict. Therefore, though PO for high-volume products would still be given a Requested Delivery Date to the supplier, it's normally with a long lead time, acting as just reference to the supplier to plan the production and delivery. And Company X normally leaves the Delivery Confirmation for such high-volume products' PO empty in ERP.

2) Minus Line in PO

When checking the root cause for OTD computing result deviation in July of 2024 for Supplier A, I found that in Power BI database, the minus lines that in the PO which were added for Credit Note (CN) purpose for Return Material Authorization (RMA) due to Customer Complaint as Table 5 were also counted for OTD computing. This led to the total OTD Failure lines for Supplier A in July 2024 increasing 3pcs more, and 1pcs more also for OTD OK as Table 6.

Table 5: Company X Power BI Database-Supplier A-OTD- July 2024

| orig_promised_date | promised_date | shipped_date | on_tim_requested | on_tim_promised | on_time_original_promised | ProdNo | delay_orig_promised | prodno_approved_date | qty | YEAR | YEARMO |
|--------------------|---------------|--------------|------------------|-----------------|---------------------------|--------|---------------------|----------------------|------|------|--------|
| 20240715 | 20240715 | 20240731 | 0 | 0 | 0 | 18xxxx | 16 | 2021-07-19 | -603 | 2024 | 202407 |
| 20240701 | 20240701 | 20240731 | 1 | 0 | 0 | 13xxxx | 30 | 2013-02-08 | -191 | 2024 | 202407 |
| 20240703 | 20240703 | 20240731 | 1 | 0 | 0 | 13xx6x | 28 | 2013-02-08 | -144 | 2024 | 202407 |
| 20240726 | 20240726 | 20240731 | 1 | 1 | 1 | 13xxxx | 5 | 2013-02-08 | -450 | 2024 | 202407 |

Table 6: Company X Supplier A-OTD-July 2024

| Supplier A -OTD- July 2024 | | | |
|----------------------------|--------|--------------------|--------|
| | OTD OK | Total Transactions | OTD |
| Power BI Data | 139 | 153 | 90,8 % |
| Research Data | 140 | 151 | 92,7 % |
| Deviation | | | -1,9 % |

In practice, Company X does GR for the minus line in PO as well which then generates a transaction record. However, this is mainly for Credit Note handling purpose, it's not a delivery from supplier, but Dummy Returning to supplier with physical being scrapped locally in warehouse for that quality concerned stock as agreed between Company X and Supplier. Therefore, logically, these records added to the PO due to RMA refunds with Credit Note (CN) should not be included in the OTD calculation.

3) Split Delivery Transaction Records

This is another finding when checking Supplier A's OTD in July 2024, when comparing it with the Power BI OTD database. From above Table 6, it presents the statistics for Supplier A's Delivery Transactions in total in July 2024 are 153pcs versus 151pcs, and OTD OK lines with 139pcs V.S. 140pcs. As above Table 5 presents, Power BI database counts the 4pcs RMA Refund lines to OTD computing, if ticking the 4pcs, the OTD basing Power BI database should be: OTD OK reducing 1pcs with 138pcs in total, and Total Transactions reducing 3pcs with 149pcs in total, then the final OTD result should be 138pcs divided by 149pcs equals 92.6%. In the database that is used for this thesis research, I have excluded all the Delivery Transactions with minus quantity already during data screening phase, that meant the 4 minus quantity records in Table 5 were not counted to research OTD computing. Then what is the 2pcs deviation in the research database? Below Table 7-8-9 give the answer.

From the research database Table 7, it records Supplier A delivered in total 5160 pcs product S1xxx0 on 1.7.2024, but ERP achieved 5160 pcs splitting with 2 Delivery Transactions: 1800 pcs and 3360 pcs respectively. While in the Power BI database, there's only one transaction record for S1xx00 with quantity just 5160pcs (Table 9). The same thing happens with product 1xxx2 Delivery Transaction on 3.7.2024 as well (Table 7 & Table 8). So, the 2pcs more Transaction Records in the research database which are originally from Company X's ERP Archived Delivery Transaction records were consolidated to one Transaction in Power BI database.

Table 7: Company X Delivery Transaction-Supplier A-July 2024-S1xxx0 & 1xxx2

| Date of GR to ERP | Warehouse No. | Transaction Type | Supplier | PO No. | Product Code | Delivery Year / Month | Delivery Date | Quantity | Delivery /original cfm |
|-------------------|---------------|------------------|----------|--------|--------------|-----------------------|---------------|----------|------------------------|
| 29.5.2024 | 2 | 6 | A | 30xxx4 | S1xxx0 | 2024/07 | 1.7.2024 | 1800 | OK |
| 1.6.2024 | 2 | 6 | A | 30xxx8 | 1xxx2 | 2024/07 | 3.7.2024 | 39600 | OK |
| 1.6.2024 | 2 | 6 | A | 30xxx8 | 1xxx2 | 2024/07 | 3.7.2024 | 13200 | OK |
| 29.5.2024 | 2 | 6 | A | 30xxx4 | S1xxx0 | 2024/07 | 1.7.2024 | 3360 | OK |

Table 8: Company X Power BI Database-Supplier A-July 2024-1xxx2

| orig_promised_date | promised_date | shipped_date | on_time_original | ProdNo | delay_orig_promised | prodno_approved_date | qty | YEAR | YEARMO |
|--------------------|---------------|--------------|------------------|--------|---------------------|----------------------|-------|------|--------|
| 20240718 | 20240718 | 20240703 | 1 | 1xxx2 | -15 | 2024-05-30 | 52800 | 2024 | 202407 |

Table 9: Company X Power BI Database-Supplier A-July 2024-S1xxx0

| orig_promised_date | promised_date | shipped_date | on_time_original | ProdNo | delay_orig_promised | prodno_approved_date | qty | YEAR | YEARMO |
|--------------------|---------------|--------------|------------------|--------|---------------------|----------------------|------|------|--------|
| 20240627 | 20240711 | 20240701 | 1 | S1xxx0 | 4 | 2013-12-05 | 5160 | 2024 | 202407 |

Then if I consolidate the splitting Delivery Transaction records for 1xxx2 and S1xxx0, the research data gets also 138pcs OTD OK and 149pcs Total Transaction records for Supplier A in July of 2024, which brings OTD computing resulting in 92,6%, the same as Power BI after excluding the Minus Quantity Transaction (Table 10). During the research, such Split Delivery Transaction cases were found not only to Supplier A in July 2024, but also to Supplier B, and OTD computing in other months with deviations.

Table 10: Company X Supplier A-OTD-July 2024 After Correction Done

| Supplier A -OTD- July 2024 | | | |
|---|--------|--------------------|--------|
| | OTD OK | Total Transactions | OTD |
| Power BI Data | 139 | 153 | 90,8 % |
| Research Data | 140 | 151 | 92,7 % |
| Deviation | | | -1,9 % |
| Power BI OTD excluding RMA Refund Lines | 138 | 149 | 92,6 % |
| Research OTD Excluding Duplicated GR | 138 | 149 | 92,6 % |

7.1.2 Actions for Deviation Mitigation

The discussion and studying for OTD Deviation have been conducted since November 2023, not only between Company X and its suppliers, but mainly internally in Company X between the Purchasing Team and Power BI Owner to find the root cause of OTD deviation and solution to mitigate it. The principles of OTD Computing were not achieved at all at once but were gradually improved through discussions and research among internal stakeholders along with the problems that were exposed and discovered. The following is the consensus reached so far on how to compute OTD.

1) Pilot Run Delivery Exemption from OTD Computing

In Section 6.2.1 when talking about the Pilot Run, I already know the particularity of the Pilot Run. Since delivery uncertainty and delay are not always because of the supplier, Company X decides to exclude Delivery Transaction for Pilot Run PO from OTD Computing.

2) Warehouse Locations Exemption from OTD Computing

As Pilot Run PO was not taken into consideration for OTD evaluation, when screening data, Delivery Transaction happens to Pilot Run Warehouse Location is exempted from OTD Computing. To Supplier A and Supplier B in this research, the corresponding Warehouse Location to their Pilot Run POs is Warehouse China-Pilot Run (Section 6.2.2., Table 2). Besides Warehouse China-Pilot Run for Pilot Run PO, the Delivery Transactions happening in Warehouse Supplier A and Supplier B (Section 6.2.2., Table 2). that were set up specially for Factory Buffer POs were also excluded from OTD computing as well. In summary, the consensus is that when computing OTD, only Delivery Transaction Archives in ERP for deliveries to Warehouse locations in China-Normal and Incoming Inspection (Section 6.2.2., Table 2) will be counted.

3) Delivery Confirmation Exemption from OTD Computing

As mentioned in Section 7.1.1, Delivery Confirmation Missing cases usually happen to those high-volume products' PO, or PO delivered earlier before Delivery Confirmation updating to ERP. Therefore, it's suggested and agreed that the OTD will be defaulted as OK if Delivery Confirmation is missing in the Delivery Transaction record.

4) Five Days' Time Range for GR

In Company X, the Goods Receiving (GR) was updated to ERP by the Company X Logistics Team. Delivery Transaction is generated and archived after the GR, which is the data source for OTD computing. But in practice, GR would not be updated on the same day when Company X gets Delivery Note from the supplier due to special reasons. Since this is not the supplier's fault, it's unfair to the supplier to treat this delivery as an OTD failure. This is why Company X evaluates OTD OK for all deliveries which were done within 5 days compared with the Original Confirmation, so does the early-delivery and partial deliveries earlier before the Original Confirmed Delivery Schedule. This could be referred to the OTD Computing Formula in Figure 5 in Section 6.1.2.

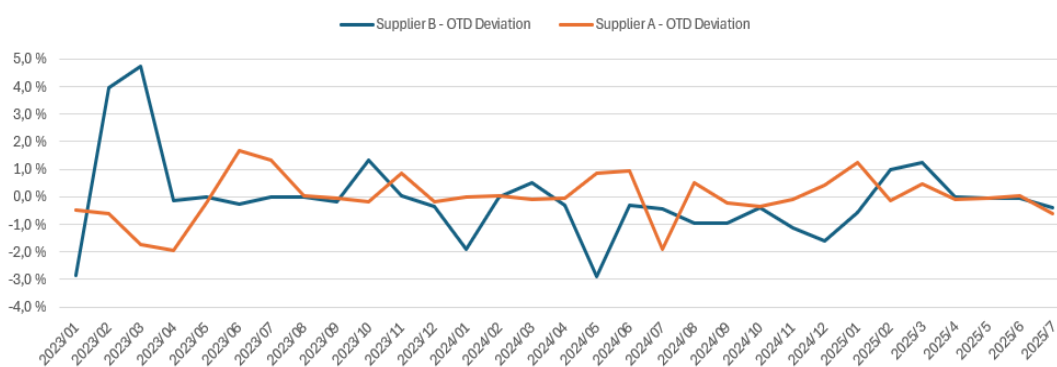


Figure 8: OTD Deviation- Company X Power BI Results V.S. Research Results

All in all, with above principles of consensus that have been achieved, the OTD deviation has been visibly narrowed gradually as above Figure 8. However, due to the limitations of the system and tools that are being used now in Company X and the complexity in real practice, this is the effective

solution based on problems that have been found so far. It does not mean that this computing model can avoid or solve other anomalies that may occur or be discovered in the future.

7.2 Factors Affecting OTD Performance

As what Figure 1 and Figure 2 in Section 2.2 present the big fluctuation situation of the OTD performance of Supplier A and Supplier B, to improve it, it's important to dig out the stories behind it, so that corresponding improvement and enhancement could be more targeted and focused.

7.2.1 Analysis of OTD-Failure Factors

In this research as Section 6.4 mentioned, I have classified the factors that led to OTD -Failure into 14 categories in total. After statistics of the total 812pcs OTD-Failure records in the research data, I found that the factors, especially those highly-frequently-occurred ones affecting OTD-Failure are variant to supplier A and Supplier B. From the statistics as Table 11 of the first appendices of this thesis for the summary for Supplier A and Supplier B together, with the data scope from January 2023 to July 2025, the top 5 factors that lead to OTD-Failure are Mold Issue, Production Delay and Quality Issue, Material Shortage and Machine Availability respectively.

For Supplier A, the top 5 factors affecting OTD are the same as the summary result, but the positions are different for Production Delay, Quality Issue and Material Shortage as Table 12 (Appendices 2) presents. While for Supplier B, as the statistical result in Table 13 (Appendices 3), the top 1 factor of OTD-Failure is changed to Production Delay, then Mold Issue and Mold Base Sharing by following. Machine Availability is also one of the major factors that stand in the position of top 4. But different from Supplier A, the Material Shortage and Quality Issue were not in the top 5 list. Mold Base Sharing and Unintended System Alteration took the places and contributed more to the OTD-Failure by occupying the position of Top 3 and Top 5 respectively in the list. And regarding the common factors for both

Supplier A and Supplier B in the top 5 list, I would like to give more interpretations for you.

7.2.1.1 Mold Issue

In Section 6.2.1, I have come to know that products in Company X are produced with injection molds and machines. Injection machines are expensive, and the structure of these molds is precise and complex. The diversity of Company X 's products results in a large number of molds, which are up to several thousand. This can be seen from the complexity of the Product Family A (Section 2.3, Table 1). During the production process, mold abnormalities may occur due to various reasons, which will affect production progress and even lead to delivery delays in serious cases. Through this research with data statistics for Supplier A and Supplier B from January 2023 to 2025, I found that Mold Issue was crucial to the OTD results for both Supplier A and Supplier B.

Though the positions of Mold Issue in top 5 major factors leading OTD-Failure to Supplier A and Supplier B are different, it contributed 32% to OTD-Failure (Appendices 3, Table 13) and took the top 1 position in Supplier A. For Supplier B, it stood in top 2 position with 30% contribution to the overall OTD-Failure factors' statistics.

The statistics, as Table 14 (Appendices 4), show that Supplier B encountered a variety of mold-related issues during production. Apart from those that were not specified explanations but were just simply labeled "Mold Issues" as a general explanation for delivery delays, Hot Runner related issues were the most significant factor in Mold Issue Category. For Supplier A, it's the same. Although the data statistics for supplier A don't have as many complex reasons as Supplier B, the case quantity that Supplier A simply labeled "Mold Issues" as a general explanation for delivery delays but without further specifications is nearly double compared with Supplier B.

7.2.1.2 Production Delay

Production Delay contains various root causes. In this research, though all the 812pcs OTD-Failure records have been reviewed one by one with original records tracing back to both ERP Archived Delivery Transaction records and historical Production Reports (PR) from suppliers, there're still many delayed-deliveries that were missing explanations to tell the stories why. These records were categorized to Production Delay while were left as "blank" to the "Factors Description 1" (Table 15). Such details-unknown Production Delay happened in Supplier B with extremely high frequency in the year 2024. It's getting better in the year 2025 so far, but still 25pcs delayed deliveries were unclear what happened. For Supplier A, the OTD-Failure because of Production Delay was less than Supplier B. But same as Supplier B, OTD-Failed deliveries with further-detail-unclear are also the major contributor to this Factor.

Table 15: OTD-Failure Factor: Production Delay

| | | | | | | |
|---------------------------------------|------------------------------|--------------|-------------|-------------|--------------------|--|
| WHS | (All) | | | | | |
| Delivery/original cfm | Fail | | | | | |
| OTD-Fail Factor Category | Production Delay | | | | | |
| Count of Delivery/original cfm | | Years | | | | |
| Toimittajanro | Factors Description 1 | 2023 | 2024 | 2025 | Grand Total | |
| ⊖ B | (blank) | 15 | 69 | 25 | 109 | |
| | Human-induced Error | 15 | 3 | 2 | 20 | |
| | Assembly | | 5 | 2 | 7 | |
| | Engineering | | 1 | | 1 | |
| B Total | | 30 | 78 | 29 | 137 | |
| ⊖ A | (blank) | 26 | 11 | 8 | 45 | |
| | Human-induced Error | | | 1 | 1 | |
| | PVD plating | | 1 | | 1 | |
| A Total | | 26 | 12 | 9 | 47 | |
| Grand Total | | 56 | 90 | 38 | 184 | |

7.2.1.3 Material Shortage

Statistics, like Table 11 (Appendices 1), present there're total 73 cases of OTD-Failure due to material shortage, and Table presents that Supplier A is the main contributor that 58 cases are from it and stands in top 3 factors

that lead to OTD-Failure in Supplier A. Therefore, it's valuable to study further to get to know what materials are short.

In this research, I classified Material Shortage into 3 categories-Raw Material shortage, Package shortage and Supplying from the second-tier supplier. According to the statistics results (Table 16), I found: Supplier A encountered Raw Material shortages, especially Raw Material of PMMA-HT. And both Supplier A and Supplier B have tray-delayed issues from the second-tier suppliers as well.

Table 16: OTD-Failure Factor: Material Shortage

| WHS | | (Multiple Items) | | | | | | | |
|--------------------------------|---------------------|-----------------------|-----------|-----------|-----------|-----------|-------|---------|-----------|
| Delivery/original cfm | | Fail | | | | | | | |
| OTD-Fail Factor Category | | Material Shortage | | | | | | | |
| Count of Delivery/original cfm | | | Years | | | Grand | Sub | Grand | |
| Supplier | Factors Description | Factors Description 2 | 2023 | 2024 | 2025 | Total | Total | Total 2 | |
| B | Package | Tray | 2 | 2 | 6 | 10 | 10 | | |
| | 2nd Tier Supplier | Seal | 1 | 4 | | 5 | 5 | 15 | |
| A | Raw Material | 184 [PMMA-HT] | 4 | 7 | 3 | 14 | | | |
| | | 169 [PC] | | 5 | 1 | 6 | | | |
| | | 6 [PC] | 3 | 1 | | 4 | | | |
| | | 51 [HTPC] | 1 | 2 | 1 | 4 | | | |
| | | 133 [PC] | 2 | 1 | 1 | 4 | | | |
| | | 104 [PC] | 3 | 1 | | 4 | | | |
| | | Other | | 1 | | 1 | | 37 | |
| | Package | Tray | 2 | 6 | 2 | 10 | | | |
| | | Carton | | | 1 | 1 | | 11 | |
| | 2nd Tier Supplier | Tape | 1 | 3 | 2 | 6 | | | |
| | | Seal | 1 | 1 | 1 | 3 | | | |
| | | Reel | | 1 | | 1 | | 10 | 58 |
| Grand Total | | | 20 | 35 | 18 | 73 | | | 73 |

Then when it goes to further analysis by Product Type, the statistics results in Table 17 tell: for Supplier A, OTD-Failure due to Material Shortage was mainly concerned with Customer Products, while in Supplier B, Standard Products had more OTD-Failure happened due to Material Shortage than Customer Products. For Supplier A, if from volume point of view, more quantities were affected due to Material Shortage as Table 18 tells, while value of Customer Products were more than double compared with the standard ones. For company confidential consideration, the accurate data of these values will not be disclosed here in this thesis.

Table 17: OTD-Failure: Material Shortage by Product Type

| | | | | | | | |
|---------------------|---------------------|-----------------------|-------------------------|-------------|-------------|--------------------|--|
| WHS | (Multiple Items) | | | | | | |
| Delivery/original | Fail | | | | | | |
| OTD-Fail Factor | Material Shortage | | | | | | |
| Count of Del | | | Years (Delivery) | | | | |
| Supplier | Product Type | Product Family | 2023 | 2024 | 2025 | Grand Total | |
| ⊖ A | ⊕ 1 [Customer] | | 6 | 18 | 6 | 30 | |
| | ⊕ 2 [Standard] | | 8 | 10 | 6 | 24 | |
| | ⊕ 4 [X(Special)] | | 3 | 1 | | 4 | |
| A Total | | | 17 | 29 | 12 | 58 | |
| ⊖ B | ⊕ 2 [Standard] | | 2 | 5 | 6 | 13 | |
| | ⊕ 1 [Customer] | | 1 | 1 | | 2 | |
| B Total | | | 3 | 6 | 6 | 15 | |
| Grand Total | | | 20 | 35 | 18 | 73 | |

Table 18: OTD-Failure: Material Shortage by Product Type -Volume

| | | | | | | | |
|------------------------|---------------------|-----------------------|-------------------------|----------------|---------------|--------------------|--|
| WHS | (Multiple Items) | | | | | | |
| Delivery/original | Fail | | | | | | |
| OTD-Fail Factor | Material Shortage | | | | | | |
| Sum of Quantity | | | Years (Delivery) | | | | |
| Supplier | Product Type | Product Family | 2023 | 2024 | 2025 | Grand Total | |
| ⊖ B | ⊕ 1 [Customer] | | 5 040 | 1 008 | | 6 048 | |
| | ⊕ 2 [Standard] | | 2 000 | 12 630 | 11 354 | 25 984 | |
| B Total | | | 7 040 | 13 638 | 11 354 | 32 032 | |
| ⊖ A | ⊕ 1 [Customer] | | 15 368 | 39 040 | 35 232 | 89 640 | |
| | ⊕ 2 [Standard] | | 32 040 | 81 920 | 20 462 | 134 422 | |
| | ⊕ 4 [X(Special)] | | 3 514 | 10 800 | | 14 314 | |
| A Total | | | 50 922 | 131 760 | 55 694 | 238 376 | |
| Grand Total | | | 57 962 | 145 398 | 67 048 | 270 408 | |

7.2.1.4 Quality Issue

Statistics in Table 19 present that in cases where Supplier A and Supplier B OTD failed due to quality issues, if counted by Product Category, those products that need to do further treatment with metalizing coating on the surface are most likely to have quality issues, which can affect the delivery on time. If further analysis about the details of quality issues, according to the statistics result in Table 20 (Appendices 5) in addition to those OTD Failure cases that could not be traced back to the specific quality reasons, product categories that need further PVD (Physical Vapor Deposition) Plating treatment, the highest quality abnormalities in the plating progress were recorded. For HMDS (Hexamethyldisilazane) plating relevant products, the overall quality stability is better than the PVD plating, if just comparing

from the quantity of OTD-Failure cases point of view. But according to the statistics, the quality improvement for the Shade's HMDS Plating from Product Family D was still not so nice in the year 2025.

Table 19: OTD-Failure Factor–Quality Issue–by Product Category

| | | | | | | |
|---------------------------------------|----------------------|--------------|-------------|-------------|--|--------------------|
| WHS | (Multiple Items) | | | | | |
| Delivery/original cfm | Fail | | | | | |
| OTD-Fail Factor Category | Quality Issue | | | | | |
| Toimittajanro | (All) | | | | | |
| Count of Delivery/original cfm | Factors | Years | | | | Grand Total |
| Product Category | Description 2 | 2023 | 2024 | 2025 | | Total |
| ▢ 12 [Painted Product] | PVD Plating | 6 | 11 | 3 | | 20 |
| | Tray | | | 1 | | 1 |
| | HMDS Plating | | 1 | | | 1 |
| ▢ 2 [Assembly] | (blank) | 16 | 1 | 2 | | 19 |
| | PVD Plating | 1 | 1 | | | 2 |
| ▢ 32 [Shade] | HMDS Plating | | 7 | 5 | | 12 |
| | (blank) | 1 | 1 | | | 2 |
| ▢ 34 [Product Category 3] | (blank) | | 4 | 6 | | 10 |
| ▢ 35 [Product Category 2] | (blank) | 2 | | 6 | | 8 |
| ▢ 33 [Product Category 1] | (blank) | 2 | 1 | 1 | | 4 |
| ▢ 25 [Accessory] | (blank) | 1 | | | | 1 |
| ▢ 9 [Base part] | (blank) | 1 | | | | 1 |
| ▢ 8 [Holder] | (blank) | | 1 | | | 1 |
| Grand Total | | 30 | 28 | 24 | | 82 |

7.2.1.5 Moldbase Sharing and Machine Availability

During this research, I noticed that Moldbase Sharing and Machine Availability were another 2 important factors affecting OTD results as Table 11-12-13 indicate (Appendices 1-3), especially for Supplier B, both Moldbase Sharing and Machine Availability are in the list of Top 5 major factors leading to OTD-Failure (Appendices 3, Table 13). When I went to further analysis as Table 21 and Table 22 present, the research found that Product Family A had biggest problems with both Moldbase and Machine availability, and the situation was even getting worse in year 2025 which had stimulated total 11 OTD-Failure cases due to “Waiting for Machine” (PRs from Supplier B).

Table 21: OTD-Failure Factor–Moldbase Sharing

| | | | | | |
|---------------------------------------|------------------|-------------|-------------|--------------------|--|
| WHS | (Multiple Items) | | | | |
| Delivery/original cfm | Fail | | | | |
| OTD-Fail Factor Category | Moldbase Sharing | | | | |
| Toimittajanro | (Multiple Items) | | | | |
| | | | | | |
| Count of Delivery/original cfm | Years | | | | |
| Product Family | 2023 | 2024 | 2025 | Grand Total | |
| 444 [A] | 7 | 14 | 3 | 24 | |
| 422 [F] | 2 | 4 | | 6 | |
| 390 [O] | | 1 | 4 | 5 | |
| 437 [Y] | | 3 | | 3 | |
| 459 [B] | 2 | | | 2 | |
| 414 [D] | | 2 | | 2 | |
| 364 [C] | | 1 | | 1 | |
| 472 [G] | | 1 | | 1 | |
| 329 [P] | 1 | | | 1 | |
| 441 [S] | | 1 | | 1 | |
| Grand Total | 12 | 27 | 7 | 46 | |

Table 22: OTD-Failure Factor–Machine Availability

| | | | | | |
|---------------------------------------|----------------------|-------------|-------------|--------------------|--|
| WHS | (Multiple Items) | | | | |
| Delivery/original cfm | Fail | | | | |
| OTD-Fail Factor Category | Machine Availability | | | | |
| Toimittajanro | (Multiple Items) | | | | |
| | | | | | |
| Count of Delivery/original cfm | Years | | | | |
| Product Family | 2023 | 2024 | 2025 | Grand Total | |
| 444 [A] | | 6 | 11 | 17 | |
| 437 [Y] | 7 | 4 | | 11 | |
| 414 [D] | 2 | 3 | 1 | 6 | |
| 441 [S] | | 2 | 2 | 4 | |
| 459 [B] | | 2 | | 2 | |
| 364 [C] | | | 1 | 1 | |
| 458 [A1] | | 1 | | 1 | |
| 190 [H1] | | | 1 | 1 | |
| 472 [G] | | 1 | | 1 | |
| 339 [C1] | | 1 | | 1 | |
| 448 [C2] | | | 1 | 1 | |
| Grand Total | 9 | 20 | 17 | 46 | |

In Section 6.1.2, I have introduced how OTD in Company X was computed. It is the comparison between the schedule when the delivery was actually done and Original Delivery Confirmation that Company X got from the supplier. That meant, though I have plenty of variants for Product Family A which are sharing the same mold base, but if the production sequence was

well planned by throughout consideration of Moldbase and Machine Sharing truth of A, the problem of “Waiting for Moldbase” or “Waiting for Machine” (PRs from Supplier B) shouldn’t happen. In another word, the Moldbase or Machine conflicts are avoidable with well-planned production queues. And the remaining thing will be just waiting for production and delivery one by one according to the planned queue instead of that delivery was blindly confirmed while not being able to ship on time. That’s why, for Supplier B’s Product Family A cases, I don’t want to define the root course of OTD-Failure as Capacity Constrain. Therefore, rather than saying that the OTD-Failure for A was caused by Moldbase Sharing and Machine Availability issues, it is better to say that it was due to human planning errors.

For Product Family O (O) from Supplier A, it stands out in the statistic. I defined it as Capacity Constrain that presents itself directly as a Moldbase Sharing issue in practice. From Table 23 in Appendices 6 in this thesis, I could see that the demand for O increased from the year 2023 total 130549pcs to 206712pcs in the year 2024 with a growth rate as high as 58.3%. According to the quarterly volume breakdown to quarterly, I could see from Table 25 that demand started to boom from the Fourth Quarter (Q4) of year 2024 and continued to the Second Quarter (Q2) of year 2025.

For O, Company X developed only one Moldbase in Supplier A, sharing 7 different variants meanwhile in O Family. The daily capacity for O is only 1200pcs with weekly output maximum 8400pcs if production is continued on weekends. From Q4 2024 to Q2 2025, Supplier A delivered 178596 pcs in total, including both Single components and Assemblies (Appendices 6, Table 23), which meant it took at least 149 calendar days to complete production even if just keep on producing one variant continuously without any interruption.

However, the reality is that Company X has only one set of molds with one Moldbase sharing into 7 variants, and as the customers’ orders are not all for the same variant. As Table 25 shows, during the period from Q4 2024 to Q2 2025, Company X received deliveries from Supplier A for all the 7 variants of

O Family's products. This means production can't consistently focus on just one variant, as the company must fulfil all other variants as well. This means also that production must be repeatedly changed over different variants. Each changeover means production stopping and half day capacity losses at least. Furthermore, since customers' orders don't come all at once, the production plan then has to adjust constantly from capacity optimizing and efficiency consideration.

Besides above production changeover and optimizing that affect delivery, Public Holidays during that period is another point that needs attention. There're not only Christmas and New Year holidays, but also 7 days of Chinese National Holiday in October of 2024 and another 7 days of Chinese Lunar New Year holiday at the end of January of 2025. These holidays make the overall production lead time tighter.

Hence, for O, the consequences of poor OTD performance are predictable due to Capacity Constraint because of Moldbase Sharing issue.

7.2.2 Actions to Improve OTD

This Section mainly explains what measures I have taken to improve OTD performance according to the main factors affecting OTD performance during this research process.

7.2.2.1 Capacity Utilization and Production Planning Optimization

For problems like Product Family O (Section 7.2.1.5), which are obviously caused by mold capacity limitations resulting in long production and delivery Lead Time (LT) and affecting OTD performance, Company X invest new bigger mold for O in another supplier, with expectation to the estimated daily capacity in the near future to be increased to 5000pcs in average. Now the sample testing and approving progress for different variants are keeping on going.

For Product Family A in Supplier B, as mentioned in Table 1 (Section 2.3), it's an extremely complex Product Family with a total of 443 product variants. The combination of its 153 single components generates 288 different assembly

product codes. For these single components, they are transformed with different beam variants whose specifications are different or made of different raw materials. Company X invested in each specification 2 sets of mold bases, one for PMMA material, and one for PC material only. That meant no matter which mold base, it's being shared to 7 different beam variants' production. If inserts change over frequently among variants, it means capacity lost and longer production and delivery lead time. Therefore, it's very crucial to both utilize the capacity and optimize production planning without increasing existing capacity.

Starting in November of 2023, Company X started to deploy the Factory Buffer Operation Model for Product Family A with Supplier B, to cope with the 288 complex and diverse assemblies (Section 2.3, Table 1). The operation process could be referred to in the flow chart in Figure 9 as below.

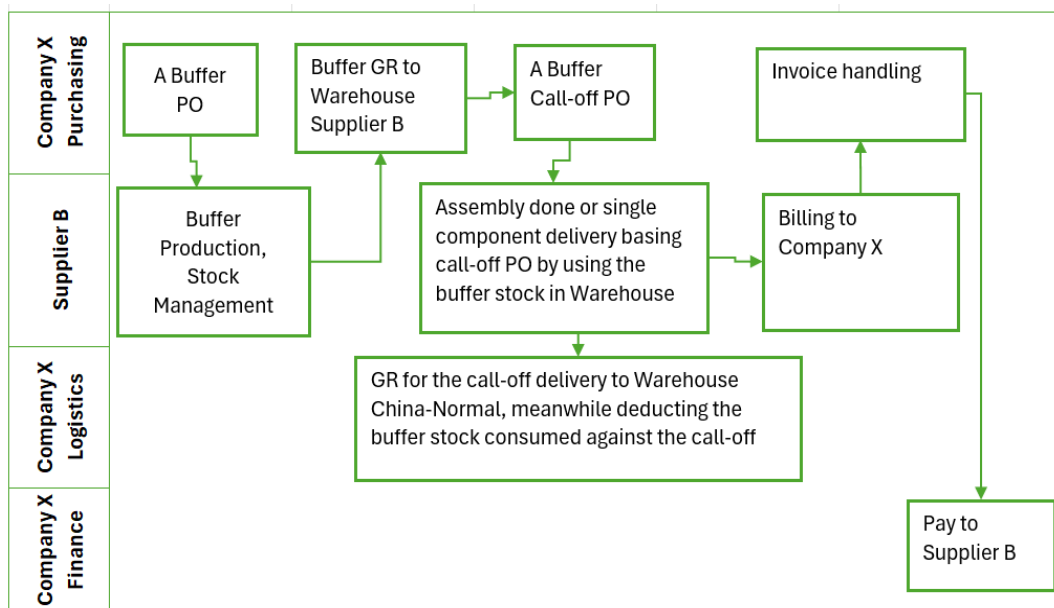


Figure 9: Product Family A: Factory Buffer Operation Model Flow Chart

This Factory Buffer Operation Model enables suppliers to take initiative to arrange production in advance to build semi-finished buffers to quickly response to Company X's call-off PO. Meanwhile, Company X-Owned stock in Supplier B was only at component level, and it is unnecessary to order assemblies by following the MOQ (Minimum Order Quantity), this model helps to not only reduce the possible high Finish Goods (FG) stock level in

Company X side but also make capacity utilization possible. So far, this Factory Buffer Operation Model has been deployed also to other Product Families similar to A such Product Family Y and L in Supplier A. Both parties benefit from this model, gaining flexibility and efficiency to fast response to customers' orders.

Then regarding the production planning optimization concern, according to the statistical results, Supplier B's OTD Failure on Product Family A was not really caused by Moldbase Sharing issue but insufficient consideration when making production plans. They often overlooked the reality of common mold bases and machines for products. As a result, it often happened that they didn't notice the conflict until the last minute when the mold or machine for the product which was planned to produce had been occupied to produce other products already. Starting from August of 2024, the Production Review meeting was organized and scheduled on a weekly basis every Friday morning between Company X and Supplier B. The main agenda in this meeting is focusing on the production and delivery status' review for backlogs and planned deliveries in the coming two weeks.

7.2.2.2 Equipements' Regular Maintenance

This refers mainly to machine or mold related issues.

According to the statistics in Table 11 (Appendices 1) for Supplier A and Supplier B's delivery from January of 2023 till July of 2025, Mold Issue is the top 1 factor leading to OTD-Failure. Therefore, good mold maintenance habits are crucial to ensure that the mold is in good condition and thus ensures the smooth progress of production. Hence, Company X requires suppliers to do regular checking and maintenance for all the molds, especially for the molds that are being used with high frequency.

7.2.2.3 Material Buffer

To mitigate the OTD Failure concerning Material Shortage, which is from the second-tier suppliers, Company X reached agreement with Supplier A and B to always keep buffer stock in factories at agreed-level and promised to take

the excess in case there will be. The buffer level was estimated by taking reference to historical consumption and will be adjusted to comply with the demand trend. Besides this, Company X also reviews with them the availability status for key raw materials in the regular meetings on a weekly basis.

7.2.2.4 Quality Improving for Metalizing Products

The data in Statistical Table 19 (Section 7.2.1.4) indicates that in cases where OTD fails due to Quality Issue, products that require further metallization treatment (PVD Plating and HMDS Plating) have the most quality abnormalities, especially for products that are outsourced to second-tier supplier for PVD Plating. In this research, the products concerning further Plating treatment are only from Supplier A, with HMDS Plating processed in Supplier A's factory after injection completed, while PVD Plating is from the outsourced second-tier supplier's factory where the plastic parts after injection need to be sent to. Statistics as illustration in Table 24 indicate that Product Family D contributes the most OTD-Failure cases concerning HMDS Plating quality issues. Besides modifications were made to the mold to ensure the injected plastic parts' quality, it's also required that before the HMDS plating recovers to normal average defect rate, factory should make statistics for defecting yield rate and produce more plastic parts' buffer by taking reference to the monitored defect rate statistics, so that to ensure there would be enough plastic parts sent for plating. Beyond these, 100% quality inspection is also essential.

For Product Family N, it contributes also to the most OTD-Failure cases (Table 24) due to PVD Plating Quality Issue. This might be because of the explosive demand increasing in the year 2024. From Table 25, I could see that the delivered volume for products that need further plating treatment in 2024 for N from Supplier A has increased 126% compared to 2023 from 96096 pcs to 217175pcs. Among the Product Family N's total 15 OTD-Failures, 9 delays happened in the year 2024 and 7 were in Q2. That meant the volume increasing meanwhile brought the risk of higher OTD-Failure as

well. As the PVD plating is done in factory of outsourced second-tier Supplier, compared with HMDS Plating, Company X requires Supplier A not only to consider reasonable higher yield rate for plastic parts preparation for plating and 100% inspection before outgoing to Company X, but also the whole operation process management and improvement between Supplier A and Plating factory.

Table 24: OTD-Failure Factory-Quality Issue-Plating

| WHS (Multiple Items) | | | | | | | | | | | | | | |
|--|----------------|----------|----------|----------|----------|------------|----------|----------|-----------|------------|----------|----------|-----------|-------------|
| Delivery/original cfr (Multiple Items) | | | | | | | | | | | | | | |
| Count of Delivery/ | Product Family | Years | | 2023 | | | | 2024 | | | | 2025 | | Grand Total |
| | | 2023 | Quarter | Qtr2 | Qtr3 | 2023 Total | Qtr2 | Qtr3 | Qtr4 | 2024 Total | Qtr1 | Qtr2 | Qtr3 | |
| PVD Plating | 197 [N] | | | 4 | 4 | 7 | 2 | | 9 | | 2 | | | 15 |
| | 201 [J] | | | 2 | 2 | 2 | | | 2 | | | | | 4 |
| | 99 [M] | 1 | | | 1 | | | 1 | | | | | | 2 |
| | 86 [H] | | | | | | | | | 1 | 1 | | 2 | 2 |
| PVD Plating Total | | 1 | | 6 | 7 | 9 | 2 | 1 | 12 | 3 | 1 | | 4 | 23 |
| HMDS Plating | 414 [D] | | | 1 | 1 | 2 | | 3 | 5 | 2 | 3 | | 5 | 11 |
| | 444 [A] | | | | | | 2 | | 2 | 1 | | | 1 | 3 |
| | 434 [E] | 1 | | | 1 | | 1 | | 1 | | | | | 2 |
| | 86 [H] | | | | | | 1 | | 1 | | | | | 1 |
| HMDS Plating Total | | 1 | 1 | 2 | 2 | 4 | 3 | 9 | 3 | 3 | | 6 | 17 | |
| Grand Total | | 2 | | 7 | 9 | 11 | 6 | 4 | 21 | 3 | 6 | 1 | 10 | 40 |

Table 25: OTD-Failure Factory-Quality Issue-Plating-N Volume

| Supplier | | | | | | | | | | | | | | | | | | |
|----------------------|------------------|-------|----------|--------|------|--------|--------|------------|--------|--------|--------|--------|------------|-------------|--------|-------|--------|------------|
| Product Family | | | | | | | | | | | | | | | | | | |
| Sum of Quantity | Product Category | Years | | 2023 | | | | 2024 | | | | 2025 | | Grand Total | | | | |
| | | 2023 | Quarters | Qtr1 | Qtr2 | Qtr3 | Qtr4 | 2023 Total | Qtr1 | Qtr2 | Qtr3 | Qtr4 | 2024 Total | | Qtr1 | Qtr2 | Qtr3 | 2025 Total |
| 12 [Painted Product] | | | | 47 376 | | 38 640 | 10 080 | 96 096 | 29 279 | 71 976 | 62 160 | 53 760 | 217 175 | 24 528 | 42 000 | 5 040 | 71 568 | 384 839 |

7.2.2.5 Cross-function Communication and Process Enhancement

During the research, it's found that the scheduled production would also be interference by Company X internal stakeholders rather than Procurement Team. In Company X, mass production (MP) orders are followed by the Procurement Team, while the Pilot Run and Trial Orders concerning mold or new materials are monitored by Company X's Project Team. This type of order usually shares the same machine or mold used for mass production order, so that production conflicts are inevitable. If communication among the three parties (Project Team, Procurement Team, Supplier) is not on the same

page, the scheduled production plan for the MP orders would be interrupted, resulting in production and delivery delays.

To improve this situation, I have repeatedly stated to suppliers that prioritizing MP orders is the basic rule for Production Planning. But if there's an urgent order from Project Team requiring them to jump the queue, the supplier must check whether this will affect the scheduled production and confirmed delivery. If it will, they must promptly report this to both Company X 's Procurement and Project Teams. The production priority must be determined by Company X after internal communication. If the production sequence adjustment that was from Company X will lead to related OTD-Failure, it's agreed that Company X will modify the Original Confirmed Delivery Schedule in Company X's ERP system, so that this delivery will not be computed as OTD-Failure after delivery done.

7.2.2.6 Human-induced Error Mitigation

Company X's products are highly commonly produced by the same machine and normally share the same mold base as well, if the products are from the same Product Family. Product Family Am presents as a good example of this. So far, none of Company X's top 4 suppliers have such a smart tool that could help the production planners to deal with the production planning automatically. Though they state ERP systems are being deployed in the company for daily operation use, none were smart enough to help to solve such Moldbase-Sharing and Machine Sharing realities. In Supplier A and Supplier B, as I introduced, all the daily production planning was manually scheduled by MS Excel files. Murphy's Law says that "Anything that can go wrong will go wrong". This definitely applies to such manual work for this complex Production Planning as well.

For those OTD failures caused by incorrect production plans for Moldbase-Sharing or Machine-Sharing that are not detected in advance or even forgetting to add the product to the shipping list that there's buffer stock available in the factory, can I say they are possible to be completely avoidable? Therefore, Company X emphasizes suppliers cross-checking both

the Moldbase and Machine availability status before they plan the production and make delivery confirmation. For Company X's Procurement Team, it's important also to double-check whether there's obvious Moldbase or Machine conflict when getting PR from suppliers, working together with suppliers to mitigate such possible overlooked conflict.

7.2.2.7 OTD Monitoring and Regular Review

OTD is the first topic in the regular weekly meeting with Suppliers. In that meeting, Company X shares the up-to-date OTD performance is, and Suppliers report the potential risk of Delivery Delay. In another dedicated regular weekly Production Review meeting with Supplier B, Company X shares to Supplier B the details for those OTD-Fail Delivery Transactions, checking the potential delivery risk not only for the planned delivery in the coming next week, but also prolonging the checking time scale to the weekly delivery plan after next week, trying to work together with Supplier B for actions taken to avoid the possible delivery delay if there will be.

7.3 Evaluation

This section will be telling the evaluation results after I got to know the back stories about why OTD failed and how the improving status was going on after corresponding actions were taken in Company X.

7.3.1 OTD Deviation Mitigation

As Section 6.1.2 mentioned that this research has achieved the principles in Company X about how to compute OTD. And also, from Figure 9 (Section 7.1.2), it's glad to see that the OTD Deviation has been improved continuously, and more and more close to zero from Q2 2025. This trend change indicates that reaching a consensus on unified data screening and computing principles is positive and effective in ensuring relevant stakeholders' understanding of OTD and their awareness of the actual OTD performance. Figure 5 in Section 5.4 shows also the OTD performance curves for Supplier A and Supplier B comparing the minimum 90% OTD target. The fluctuations still exist, but for

Supplier A, the performance has been continuously improved in the year 2025 already from 83.2% in January to 95.6% in July. Supplier A has been keeping on above target for 3 months already from May to July.

7.3.2 OTD Target Achieving and Continuous Improvement

Unfortunately, Supplier B's OTD performance was not really starting to turn out well until April of 2025 and has kept on achieving a 90% target continuously for 3 months. July 2025 OTD slid down below 90% again, but the gap was just 0.6%. Along with the monitoring up to August in this research, it came back above 90% with the final result as 93.3%. In summary, through the continuous efforts and monitoring from both suppliers and Company X, the OTD performance of both Supplier A and Supplier B has been going in a positive direction, and OTD-Failure caused by human-induced errors were becoming less and less.

8 Conclusion and Closing Words

It is widely acknowledged that OTD performance is the most intuitive indicator of a company's ability to agilely respond to the volatile market and provide customers with high quality precise and diverse services. It is crucial for a company to succeed in the ever-changing and volatile competitive world. While monitoring, managing, and continuous improvement for OTD performance is a long-term process that requires precise coordination and collaboration among all relevant stakeholders. By statistics and analysis of the archived delivery transactions in Company X's ERP system, this research studied the OTD performance over the past 31 months from January 2023 to July 2025 for two of Company X's key suppliers- Supplier A and Supplier B, identifying factors influencing their OTD performance and focusing on the key common factors for further analysis and actions. The statistics and analysis results in this thesis for factors influencing OTD performance provide strong and objective data support for initiatives to improve OTD performance.

And it's also through the study and continuous day-to-day actual cooperation with the selected suppliers; I observed that the frequent turnover of the key position in production function obviously had a substantial negative influence on the OTD performance. From November of 2024 till summer of 2025, the production planner for Company X's order handling in Supplier B has been changed 4 times. Such frequent personnel changes resulted in serious disruption to the production scheduling, increasing the errors of planning, delaying the order confirmations and deliveries. These situations exposed not only the human resource' managing problem in key operational positions, but also reveal the flaws of internal management, including the personnel handover and backup system, training system, and risk management mechanism in Supplier B.

From operation perspective, the lack of standardized production planning procedures and smart digitalized process documentation made Supplier B result in too much dependence on individual experience. In Supplier B, definitely the production planner is the key person who takes charge of production planning and scheduling, needs to comprehensively coordinate and control all aspects, including machine, facilities, molds, workers, materials, and even out-going logistics. This role's precise full picture controlling capability is crucial to ensure the accuracy of order confirmation and delivery. Unfortunately, because of the flaws of internal management in Supplier B, it took longer than average lead time for every new planner to rebuild the knowledge and understanding of Company X's products and orders. Their lack of understanding capacity and products or orders' priorities reduced the efficiency and accuracy of production scheduling and delivery confirmation.

Additionally, the instability of personnel also hinders the accumulation and continuous improvement of Supplier B's knowledge, so does the development of seamless cross-function collaboration. While these are just the major factors to an agile and responsive supply chain. Without stability and common understanding, the organization's ability to respond to demand changes and maintain consistent OTD performance was severely weakened. And in Supplier B, the insufficient handover and training mechanism aggravate this problem. The

loss of operational knowledge is accumulated every when there's departure of the planner, which leads to more and more weaker personnel and process foundation, and then with result in unreliable order confirmation and delivery.

Beyond the human factors, the study also highlights the possibility of using smart digital technologies in mitigating the risks associated with the personnel changes. The use of integrated supply chain management systems for customer order management, production planning, facility and capacity management, and also stock management can significantly improve the data accuracy and reduce the human-induced errors, especially the dependence on individual experience. Smart digital technologies make the workflows standardized, archiving and sharing data timely. This helps to minimize the disruption caused by personnel turnover.

So, from a broader supply chain management perspective, if the company aims to gain advantage in the era of agile supply chain, it does be necessary to put the human resource risk into the supplier management and evaluation framework as well if it would like to pursue robust OTD performance. Chopra and Meindl (2016, P45) have argued that "a company's partners in the supply chain" could be possible to "determine" its success as well, as it is "intimately tied to its supply chain". Though individual resignation is uncontrollable event, the organization's ability to mitigate the impact by its systematic processes for training, job-rotation, and knowledge management.

Ultimately, through this research on factors influencing OTD performance for the two key suppliers of Company X - Supplier A and Supplier B, I learned that OTD performance could be impacted by not only those various factors that appear above the water, but also under the water. Robust OTD performance, or in another word, let's say supply chain resilience, depends not only on physical or financial assets, but also much on human and informational system. When selecting or assessing suppliers, definitely their production capability and delivery performance are essential, but their human resource stability and digital technology maturity should be considered as well.

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Appendices

- 1 Table 11: OTD-Failure Factors: Supplier A & B - January 2023 to July 2025 (Section 7.2.1)

| Toimittajanro | (All) | |
|------------------------------|--------------------------------|--------------|
| WHS | (Multiple Items) | |
| Delivery/original cfm | Fail | |
| | | |
| OTD-Fail Factor Category | Count of Delivery/original cfm | Percentage |
| Mold Issue | 241 | 30 % |
| Production Delay | 188 | 23 % |
| Quality Issue | 82 | 10 % |
| Material Shortage | 73 | 9 % |
| Machine Availability | 46 | 6 % |
| Moldbase Sharing | 46 | 6 % |
| Human-induced Error | 33 | 4 % |
| Unintended System Alteration | 32 | 4 % |
| Multiple Issues | 24 | 3 % |
| Machine Issue | 16 | 2 % |
| Force Majeure | 15 | 2 % |
| Production Issue | 7 | 1 % |
| Engineering | 6 | 1 % |
| Labor Shortage | 3 | 0 % |
| Grand Total | 812 | 100 % |

- 2 Table 12: OTD-Failure Factors: Supplier A-January 2023 to July 2025 (Section 7.2.1)

| WHS | (Multiple Items) | | |
|---|------------------|--------------------------------|--------------|
| Delivery/original cfm | Fail | | |
| | | | |
| OTD-Fail Factor Category | Toimittajanro | Count of Delivery/original cfm | Percentage |
| <input type="checkbox"/> Mold Issue | A | 113 | 32 % |
| <input type="checkbox"/> Quality Issue | A | 60 | 17 % |
| <input type="checkbox"/> Material Shortage | A | 58 | 16 % |
| <input type="checkbox"/> Production Delay | A | 51 | 14 % |
| <input type="checkbox"/> Machine Availability | A | 20 | 6 % |
| <input type="checkbox"/> Human-induced Error | A | 15 | 4 % |
| <input type="checkbox"/> Multiple Issues | A | 12 | 3 % |
| <input type="checkbox"/> Unintended System Alteration | A | 9 | 3 % |
| <input type="checkbox"/> Moldbase Sharing | A | 8 | 2 % |
| <input type="checkbox"/> Production Issue | A | 7 | 2 % |
| <input type="checkbox"/> Machine Issue | A | 5 | 1 % |
| Grand Total | | 358 | 100 % |

3 Table 13: OTD-Failure Factors: Supplier B -January 2023 to July 2025
(Section 7.2.1)

| | | | |
|---------------------------------|----------------------|---------------------------------------|-------------------|
| WHS | (Multiple Items) | | |
| Delivery/original cfm | Fail | | |
| OTD-Fail Factor Category | Toimittajanro | Count of Delivery/original cfm | Percentage |
| Production Delay | B | 137 | 30 % |
| Mold Issue | B | 128 | 28 % |
| Moldbase Sharing | B | 38 | 8 % |
| Machine Availability | B | 26 | 6 % |
| Unintended System Alteration | B | 23 | 5 % |
| Quality Issue | B | 22 | 5 % |
| Human-induced Error | B | 18 | 4 % |
| Force Majeure | B | 15 | 3 % |
| Material Shortage | B | 15 | 3 % |
| Multiple Issues | B | 12 | 3 % |
| Machine Issue | B | 11 | 2 % |
| Engineering | B | 6 | 1 % |
| Labor Shortage | B | 3 | 1 % |
| Grand Total | | 454 | 100 % |

4 Table 14: OTD-Failure Factor: Mold Issue (Section 7.2.1.1)

| | | | | | |
|---------------------------------------|------------------------------|--------------|-------------|-------------|--------------------|
| WHS | (All) | | | | |
| Delivery/original cfm | Fail | | | | |
| OTD-Fail Factor Category | Mold Issue | | | | |
| Count of Delivery/original cfm | | Years | | | |
| Toimittajanro | Factors Description 1 | 2023 | 2024 | 2025 | Grand Total |
| B | (blank) | 3 | 21 | 15 | 39 |
| | Hot Runner | 8 | 16 | 5 | 29 |
| | Inserts | 9 | 5 | | 14 |
| | Ejector Pin | 6 | 4 | 1 | 11 |
| | Leakage | 3 | 1 | 7 | 11 |
| | Flash | 3 | 2 | 1 | 6 |
| | Texture | 4 | | 1 | 5 |
| | Burr | 3 | 1 | | 4 |
| | Modification | | 3 | | 3 |
| | Coil Heater | 2 | | | 2 |
| | Awaiting Approval | | 2 | | 2 |
| | Scratching | | 2 | | 2 |
| | Sticky | | 1 | 1 | 2 |
| | Code Marking Missing | | 1 | | 1 |
| B Total | | 41 | 59 | 31 | 131 |
| A | (blank) | 18 | 24 | 27 | 69 |
| | Hot Runner | 14 | 8 | 8 | 30 |
| | New Mold | | 6 | | 6 |
| | Burr | | 2 | | 2 |
| | Texture | | 1 | | 1 |
| | Modification | | 1 | | 1 |
| A Total | | 32 | 42 | 35 | 109 |
| Grand Total | | 73 | 101 | 66 | 240 |

5 Table 20: OTD-Failure Factor–Quality Issue–by Details of Quality Issues (Section 7.2.1.4)

| | | | | | | |
|---------------------------------------|-----------------------------|--------------|-------------|-------------|--------------|--|
| Delivery/original cfm | Fail | | | | | |
| OTD-Fail Factor Category | Quality Issue | | | | | |
| Supplier | (All) | | | | | |
| Count of Delivery/original cfm | | Years | | | | |
| Factors Description 1 | Product Category | 2023 | 2024 | 2025 | Grand | |
| ▢ (blank) | 2 [Assembly] | 12 | 1 | 1 | 14 | |
| | 34 [Product Category 3] | | 1 | 2 | 3 | |
| | 35 [Product Category 2] | 1 | | 2 | 3 | |
| | 33 [Product Category 1] | 2 | | 1 | 3 | |
| | 8 [Holder] | | 1 | | 1 | |
| | 25 [Accessory] | 1 | | | 1 | |
| (blank) Total | | 16 | 3 | 6 | 25 | |
| ▢ Plating-PVD | 12 [Painted Product] | 6 | 11 | 3 | 20 | |
| | 2 [Assembly] | 1 | 1 | | 2 | |
| Plating-PVD Total | | 7 | 12 | 3 | 22 | |
| ▢ Plating-HMDS | 32 [Shade] | | 7 | 5 | 12 | |
| | 12 [Painted Product] | | 1 | | 1 | |
| Plating-HMDS Total | | | 8 | 5 | 13 | |
| ▢ Customer Complain | 34 [Product Category 3] | | 3 | 3 | 6 | |
| | 33 [Product Category 1] | | 1 | | 1 | |
| Customer Complain Total | | | 4 | 3 | 7 | |
| ▢ Dimension | 35 [Product Category 2] | 1 | | 4 | 5 | |
| Dimension Total | | 1 | | 4 | 5 | |
| ▢ Raw Material | 2 [Assembly] | | | 1 | 1 | |
| | 9 [Base part] | 1 | | | 1 | |
| | 32 [Shade] | | 1 | | 1 | |
| Raw Material Total | | 1 | 1 | 1 | 3 | |
| ▢ Seal | 2 [Assembly] | 3 | | | 3 | |
| Seal Total | | 3 | | | 3 | |
| ▢ Flash | 32 [Shade] | 1 | | | 1 | |
| Flash Total | | 1 | | | 1 | |
| ▢ Awating Approval | 2 [Assembly] | 1 | | | 1 | |
| Awating Approval Total | | 1 | | | 1 | |
| ▢ Gate Cutting | 34 [Product Category 3] | | | 1 | 1 | |
| Gate Cutting Total | | | | 1 | 1 | |
| ▢ Package-Tray | 12 [Painted Product] | | | 1 | 1 | |
| Package-Tray Total | | | | 1 | 1 | |
| Grand Total | | 30 | 28 | 24 | 82 | |

6 Table 23: OTD-Failure Factor, O Volume, Supplier A (Section 7.2.1.5)

| WHS | | (Multiple Items) | | | | | | | | | | | | |
|--------------------------------------|-------------|------------------|---------------|---------------|---------------|---------------|----------------|---------------|---------------|---------------|----------------|----------------|--|--|
| Delivery/original cfm | | (Multiple Items) | | | | | | | | | | | | |
| Product Type | | (Multiple Items) | | | | | | | | | | | | |
| Supplier | | A | | | | | | | | | | | | |
| Product Family | | 390 [O] | | | | | | | | | | | | |
| Sum of Quantity | | Years | Quarte | | | | 2024 | 2025 | | | 2025 | Grand | | |
| Product Category | Tuotenumro | 2023 | 2024 | | | | 2024 | 2025 | | | 2025 | Grand | | |
| | | Qtr1 | Qtr2 | Qtr3 | Qtr4 | | Qtr1 | Qtr2 | Qtr3 | | | | | |
| 2 [Assembly] | | | | | | | | | | | | | | |
| | A1xxx2_O-x1 | 4 752 | | | 5 544 | 30 096 | 35 640 | 22 968 | 4 752 | | 27 720 | 68 112 | | |
| | A1xxx9_O-x2 | 4 752 | 4 752 | | 4 752 | 11 088 | 20 592 | 13 464 | 5 544 | | 19 008 | 44 352 | | |
| | A1xxx8_O-x3 | 4 752 | 4 752 | | 4 752 | 7 920 | 17 424 | 8 712 | 9 504 | | 18 216 | 40 392 | | |
| | A1xxx7_O-x4 | 5 544 | | | 5 544 | 10 296 | 15 840 | 13 860 | 4 752 | | 18 612 | 39 996 | | |
| | A1xxx3_O-x5 | 4 752 | | | 5 544 | 15 840 | 21 384 | 4 752 | | | 4 752 | 30 888 | | |
| | A1xxx4_O-x6 | 7 824 | | 4 752 | 4 752 | | 9 504 | 5 544 | | | 5 544 | 22 872 | | |
| | A1xxx8_O-x7 | 7 128 | | | 4 752 | 4 752 | 9 504 | | 4 752 | | 4 752 | 21 384 | | |
| 2 [Assembly] Total | | 39 504 | 9 504 | 4 752 | 35 640 | 79 992 | 129 888 | 69 300 | 29 304 | | 98 604 | 267 996 | | |
| 33 [Product Category 1] | | | | | | | | | | | | | | |
| | 1xxx5_O-x2 | 29 304 | 10 296 | 10 296 | 4 752 | | 25 344 | 3 168 | 19 008 | 4 752 | 26 928 | 81 576 | | |
| | 1xxx4_O-x3 | 20 557 | 10 296 | 5 544 | 10 296 | | 26 136 | 14 256 | 11 880 | 5 544 | 31 680 | 78 373 | | |
| | 1xxx1_O-x1 | 14 256 | 9 504 | | | 1 584 | 11 088 | | 4 752 | 4 752 | 9 504 | 34 848 | | |
| | 1xxx3_O-x4 | 9 504 | | 4 752 | | | 4 752 | 4 752 | | | 4 752 | 19 008 | | |
| | 1xxx2_O-x5 | 4 752 | | 5 544 | | | 5 544 | 4 752 | | | 4 752 | 15 048 | | |
| | 1xxx3_O-x6 | 792 | | | | | | 792 | 4 752 | | 5 544 | 6 336 | | |
| | 1xxx7_O-x7 | | | 792 | | | 792 | | 1 584 | | 1 584 | 2 376 | | |
| 33 [Product Category 1] Total | | 79 165 | 30 096 | 26 928 | 15 048 | 1 584 | 73 656 | 27 720 | 41 976 | 15 048 | 84 744 | 237 565 | | |
| 8 [Holder] | | | | | | | | | | | | | | |
| | 1xxx6_O-H1 | 10 296 | | | | | 3 168 | | | | | 13 464 | | |
| | 1xxx1_O-H2 | 1 584 | | | | | | | | | | 1 584 | | |
| 8 [Holder] Total | | 11 880 | | | 3 168 | | 3 168 | | | | | 15 048 | | |
| Grand Total | | 130 549 | 39 600 | 31 680 | 53 856 | 81 576 | 206 712 | 97 020 | 71 280 | 15 048 | 183 348 | 520 609 | | |

7 Statement of Artificial Intelligence Use in this Thesis

To complete this thesis, I used OpenAI's ChatGPT web on-line free version to assistant:

- 1) to search and recommend books, literatures that highly related to the topic that my thesis aiming to research.

I asked ChatGPT's help to search for 5 professional books and 10 academic papers regarding OTD related topics, summarizing also the core viewpoints of them. Key answers what I got were as below:

- Christopher, M., 2011. Logistics & supply chain management. The key points in this book were about "Logistics network design (such as hub-and-spoke networks) directly impacts OTD (Over-Delivery) efficiency" and "Agile supply chains improve delivery reliability by rapidly responding to changes in demand". The view on "Agile Supply Chain" attracted me a lot as it's very much in line with the topic of my thesis, so that I chose this book to read as my main literature supporting to during the research progress of my thesis.

- Lean Thinking by J. P. Womack, D. T. Jones was the second book that ChatGPT suggested. But as it introduced the key points of this book was about “Lean principles to eliminate waste and continuous improvement so that to improve OTD rates, for example, by reducing inventory backlog and delivery fluctuations through JIT (Just-in-Time) production”, which is impractical to what Company X was on-going with its suppliers, I didn’t take this book in consideration to read and as my thesis theory reference anymore.
- Global Logistics and Risk Management by J. Manners-Bell was another book that ChatGPT recommended by I gave up, as it mainly talked about how “policy risks and customs clearance delays would bring threats to OTD”.
- S. Chopra & P. Meindl’s Supply Chain Management: Strategy, Planning, and Operation is the second book that I took away to study, as ChatGPT’s introduction the key points about this book were saying that “The key to OTD lies in the precise coordination of all links in the supply chain (procurement, production, and distribution)”. This was just the problem what I observed during the past co-working with Company X’s suppliers, that is how essential it was for collaboration cross functions to affect the OTD performance.
- The Goal: A Process of Ongoing Improvement from M, Goldratt was the last book that ChatGPT suggested. I picked up this book to read and treated it as one of the knowledge foundations of my thesis was because ChatGPT summarized one of the key-contributing of this book was about “Buffer Management”.

The three recommended books from ChatGPT that I picked up as the main knowledge foundation for my thesis have been recorded in the reference list of this thesis already. But per the 10 papers that ChatGPT

suggested, after reviewing the key points it summarized, I didn't go further study of any one as they were not so much close relative to my topic and the real practise in Company X.

- 2) Another aid from ChatGPT in this thesis that I used was to ask ChatGPT to have brainstorm research design and thesis structure. Regarding the research design, as the data source what I could use for my thesis' topic study were mainly from those achieved data from Company X, the idea from ChatGPT was not practical to my thesis, so that the research design idea from ChatGPT was not adopted. For the structure suggestion from ChatGPT, it would be helpful greatly. But after I went through the requirement of Metropolia's master thesis template, I had to give up what ChatGPT suggested and composed this thesis according to the required templated only.

Above are the throughout explanation how the AI had been used in this thesis from the very beginning. And as the author of this thesis, I am responsible for all the content.