Make vs. Buy Optimization for Industrial

Manufacturing & Distribution Businesses

by

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B.S., Mechanical Engineering, Northeastern University, 2016

Submitted to the MIT Sloan School of Management and the Department of Mechanical Engineering in partial fulfillment of the requirements for the degrees of

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and

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Abstract

In organizations producing products ranging from complex assemblies to individual components for customers, strategic decisions whether to make or buy the components required for the final product can have significant implications on the organization's income statement, balance sheet, and value proposition in the market. Existing literature describes broad frameworks for evaluating these make vs. buy decisions, but a gap exists in how these decisions should be treated in organizations that are vertically integrated across manufacturing and distribution, especially with a commoditized product. Here we show the development of a broad strategic sourcing framework and detailed item-level analytical tool to aid in these make vs. buy decisions for manufacturer-distributors in commoditized markets. We show that the novel combination of internal capability and capacity data, external supplier segmentation, and a total cost of ownership approach to the financial impacts of a supplier choice can significantly aid in the identification and prioritization of strategic sourcing opportunities. We expect these new methods and tools to have a significant positive impact on the profitability of the partner organization, reduce the total level of inventory required in their network, and improve their value proposition to customers in the market.

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Contents

List of Figures

List of Tables

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Glossary

Estimated Annual Units (EAU)	A measure of estimated annual demand in eaches used in the quoting process to provide suppliers insight to expected annual demand for quoting purposes.
Each (Eaches)	A single unit of a particular item or SKU
M or ME	The equivalent of 1,000 eaches of a particular item or SKU
Proposal	Forecasted purchase order (by the ToolsGroup inventory optimization algorithm) with some quantity, expected PO placement data, and expected receipt based on current lead time.

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1 Introduction

1.1 Project Motivation

Optimas OE Solutions (Optimas) provides full supply chain solutions and engineering support for engineered external threaded fasteners, internal threaded fasteners, unthreaded fasteners, and other c-class components (e.g., gaskets, stamped parts, fittings, consumables, etc.). Customers are generally categorized in two ways: automotive and commercial vehicles and general industrial equipment (e.g., agriculture machinery, construction/mining equipment, power generation equipment, etc.). Optimas is uniquely positioned as a vertically integrated competitor with a distribution network of over 50 distribution centers and two manufacturing sites located in the United States and the United Kingdom to serve key customers in the external threaded fastener market. While the manufacturing business is relatively small when viewed in terms of total revenue, the manufacturing sites are significant contributors to cash generation for the business.

Originally, this project was motivated by increased uncertainty around global supply from vendors, resulting in increased difficulty serving customers through the distribution network. Additionally, Optimas' portfolio of global suppliers had exploded in recent years as the business attempted to source unique items for customers. As a result, the company found itself in a position with an outsized reliance on suppliers from Asia, which typically require large minimum order quantities (MOQs). In many cases, months to years-worth of customer demand were required to be purchased at one time, in order to achieve the benefits of lower unit pricing. However, global supply chain pressures impacting logistics costs and raw material inflation were identified to be depressing margins. Simultaneously, it was estimated that the U.S. manufacturing facility was operating at approximately 35-40% of its total capacity.

This unique combination of external market forces served as the impetus to develop a robust internal manufacturing strategy for the U.S. manufacturing site, considering external market forces, to optimize the make vs. buy decision at the SKU level for the external threaded product portfolio.

1.2 Problem Statement

As a global distributor, Optimas manages the sourcing (including manufacturing), warehousing, and distribution of more than 100,000 items globally across three main categories: external threaded, internal threaded, and unthreaded / other c-class components. In the Americas region (United States, Mexico, and Canada) these items are sourced from over 1,200 global suppliers including the internal Optimas manufacturing facilities in Wood Dale, IL and Barton, UK, which both only supply in the external threaded category.

The external threaded category makes up approximately 40% of total sourcing spend in the Americas, with the Wood Dale manufacturing plant as the single largest supplier accounting for approximately 40% of annual spend in the category. Anecdotally, it is assumed that the Wood Dale manufacturing plant is significantly underutilized for a relatively low mix, high volume environment. The Optimas leadership team estimates approximately 30-40% utilization for the shop. Additionally, the Wood Dale manufacturing plant's product portfolio was developed as the result of various management teams' strategies over the years. Current Optimas leadership is concerned that the plant is not fully taking advantage from its core competencies as we procure similar items made at the Wood Dale plant from other suppliers, both domestic and international. It should be noted that products manufactured by Optimas manufacturing plants contribute both a manufacturing margin and a distribution margin to the bottom line of Optimas' overall financials.

Beyond the four walls of Optimas, the external supplier base in the external threaded category accounts for approximately 60% of annual spend spread across approximately 1,200 domestic and international suppliers. Like many businesses across the industrial economy, Optimas has dealt with higher-than-normal turnover in the sourcing and procurement organizations, and therefore has not built and aligned around a clear supplier strategy for the business. Additionally, due to the high level of turnover, Optimas has not been able to develop strong, strategic partnerships with its supply base. One hypothesized implication of this from Optimas leadership is that Optimas is subsequently paying a markup in the global marketplace compared to its competition. The business has been working to stabilize the organizational structure and begin to develop both a supplier strategy and stronger partnerships with suppliers. The strategy is centered around long-term agreements to volume from Optimas and pricing and lead time commitments from suppliers. Additionally, products sourced externally only contribute a distribution margin to the bottom line of Optimas' overall financials.

Faced with the pressures of inflation from suppliers, increasing lead times across the board from external suppliers, and the high service level requirements from customers Optimas has seen total inventory expand across its distribution network and gross profit margins contract as a result. The question that this thesis attempts to address is the following: how can Optimas improve the total cost of ownership of external threaded components through a combination that leverages the best of both external suppliers and internal manufacturing plants?

1.3 Research Questions

The topic of improving a business' income statement and balance sheet performance through sourcing and procurement improvements is a playbook that has been studied in various settings, but significantly less so at the scale and commoditization of the global fastener industry with an eye on optimizing the level of vertical integration in the business. To that end, the following research questions are posed to guide the research for this thesis.

1. What approach to developing a strategic sourcing framework incorporates the necessary attributes to consider that can enable Optimas to improve its financial performance?
2. What data is currently available for the Optimas product portfolio and internal / external suppliers that can be utilized to apply the strategic sourcing framework and what additional data will need to be captured?
3. How can Optimas identify and quantify opportunities to better align the sourcing of individual items from internal and external suppliers in accordance with the strategic sourcing framework developed?
4. What immediate actions can Optimas take to rebalance the product portfolio to best take advantage of internal manufacturing core competencies and external supplier capabilities?

Question 1 involves understanding and applying the existing body of research to Optimas' business situation and scale, identifying the key elements in the make vs. buy decisions to be made at the item level. Question 2 attempts to understand current quantitative and qualitative data that can enable the business' ability to practically apply the strategic sourcing framework and uncover data gaps. Question 3 requires the experimentation of developing a make vs. buy decision model at scale of which the business can provide feedback. Question 4 provides a forum for this work to prescribe immediately actionable recommendations to the business based on the final model developed as a result of the work in Question 3.

1.4 Hypothesis

The hypothesis of this thesis is that through the design and implementation of a strategic sourcing framework and decision support model, Optimas may be able to show through a proof of concept in the external threaded category that it is possible to optimize the insourcing and outsourcing of products and product families to maximize financial and competitive value. By defining the right lenses through which to view insourcing and outsourcing at the product and product family levels, Optimas may bring together information that was previously siloed or not quantified in a novel way that allows for cross-functional thinking and system optimization rather than optimization within siloes that have competing priorities. The expected business impacts of this hypothesis would be expanded margins in product categories where they are depressed today, reduced inventory when considering all costs related to sourcing, and an improved competitive advantage in the supplier market, and strengthened relationships with customers due to increased integration between the sourcing and procurement team and the manufacturing operation.

With these hypotheses in mind, we will also assume that other existing efforts in the business to address excess inventory level and margins from the commercial perspective are successful and do not negatively impact the efforts of this work.

1.5 Thesis Overview

This thesis consists of six chapters. The first chapter, of which this section is the conclusion, introduces the problem statement, guiding research questions, and proposed hypothesis of the project. **Chapter 2** will dive into the existing body of research surrounding strategic sourcing and make vs. buy decision making. This chapter will provide the context within this project exists relative to the current best practices and methods outlined in published research. In **Chapter 3** we will dive deeper into Optimas' business context and history providing perspectives on the current global fastener supply chain, Optimas' internal capabilities, and how the business has found itself in its current position. **Chapter 4** will provide an overview of the relevant data and sources currently available, data created for this project, and proposed future available data. In addition, we will review the exploratory data analysis carried out as background research for this project. In **Chapter 5** we will walk through the design of the strategic sourcing framework tailored to Optimas' business needs and the global fastener market. We will then describe the development and implementation of an item-level make vs. buy opportunity identification tool that leverages the strategic sourcing framework and provides actionable insight to the Optimas team. Next, in **Chapter 6** we will share the initial findings from the model and the short- and long-term business opportunities. Finally, in **Chapter 7** we will summarize the conclusions from this project and provide recommendations for future work.

2 Literature Review

To understand this work in the context of the existing body of research on strategic sourcing and make vs. buy decision making, we conducted a literature review. We focused on four key aspects of the existing research, including existing frameworks for broad strategic sourcing, existing frameworks for make vs. buy decision making, and the impacts of the COVID-19 pandemic on strategic sourcing.

2.1 Strategic Sourcing Frameworks

Strategic Sourcing is a relatively well-established methodology for managing complex procurement organizations that began to come to the forefront of supply chain management in the 1990s. The consulting firm, A.T. Kearney is typically attributed with the development of the well-known "7 Steps of Strategic Sourcing" (Slaight, 2004). These seven steps include:

1. Category Profiling – understand the nature of the procurement spend
2. Supplier Market Analysis – identify incumbent and other suppliers in the context of the category, typically segmented using a Kraljic Matrix (Kraljic, 1983)
3. Supplier Capability and Cost Analysis – survey suppliers to better understand capabilities and key cost drivers
4. Sourcing Strategy Development – taking the outputs of the first three steps, segment suppliers and develop a strategy for engaging with them
5. Request for Proposal (RFP) Preparation – design an appropriate RFP and send to suppliers
6. Negotiation and Supplier Selection – apply the organizations evaluation criteria to bids received and negotiate with suppliers

7. Implementation – identify winning supplier(s) and implement procurement change, if moving away from incumbent

The focus of this particular work is centered on the first four steps in the Kearney framework, primarily concerned with understanding the category market in terms of products and suppliers and developing the supplier strategy. An important aspect of this process includes the segmentation of suppliers utilizing a two-by-two matrix approach first developed by a McKinsey director, Peter Kraljic, in his 1983 Harvard Business review article. His approach focuses primarily on the first four steps in the Kearney seven step framework and is focused on the quantitative and qualitative analysis of the supplier ecosystem. The Kraljic matrix, depicted in Figure 1, is utilized to segment suppliers based on their risk / complexity (e.g., geopolitical risk, monopolistic suppliers, technological complexity of products, etc.) and their impact to profit (e.g., supplier cost profile, value proposition, profitability of items sold procured from specific supplier, etc.).

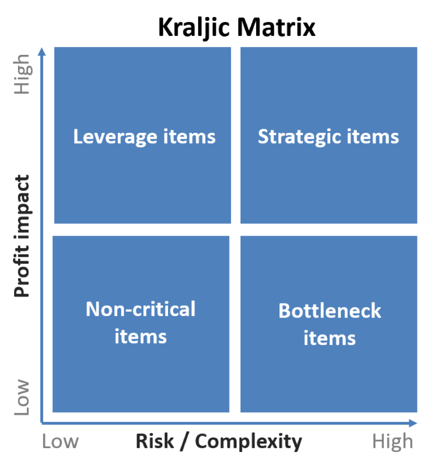


Figure 1: Sample Kraljic Matrix with Quadrants

Following segmentation utilizing a Kraljic matrix, supplier markets can be managed appropriately based on their quadrant. Strategic items typically require the most long-term thinking and active management and may be the best candidates for make vs. buy decisions. Bottleneck items typically require some kind of volume insurance, potentially through dual-sourcing, and control of vendors. Leverage items are best suited to leveraging the full purchasing power of the organization and order volume optimization. Finally, noncritical items are the best candidates for purchasing efficiency and inventory optimization. These items may also be candidates for product standardization.

While Slaight and Kraljic's frameworks focus more on the management of external procurement, others including Venkasten (1992), Sislian and Satir (2000), and Gottfredson et al. (2005) propose additional frameworks presented below (Figure 2 and Figure 3), both of which begin their frameworks with an assessment centered around determining a product's alignment with the core competencies of the organization. Prahalad and Hamel (1990) define a straightforward, three-part test for what the core competencies of an organization are. A core competence must 1) "provide potential access to a wide variety of markets", 2) "make a significant contribution to the perceived customer benefits of the end product," and 3) "be difficult for competitors to imitate."

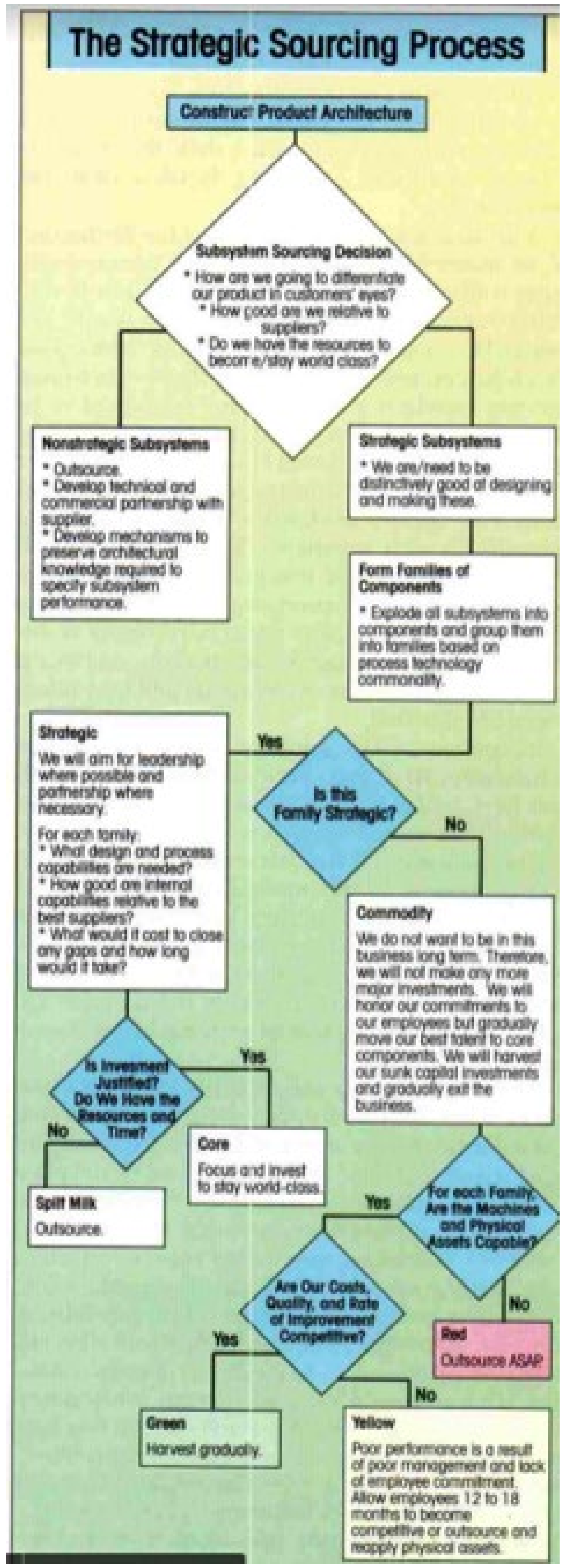


Figure 2: Venkatesan Strategic Sourcing Framework

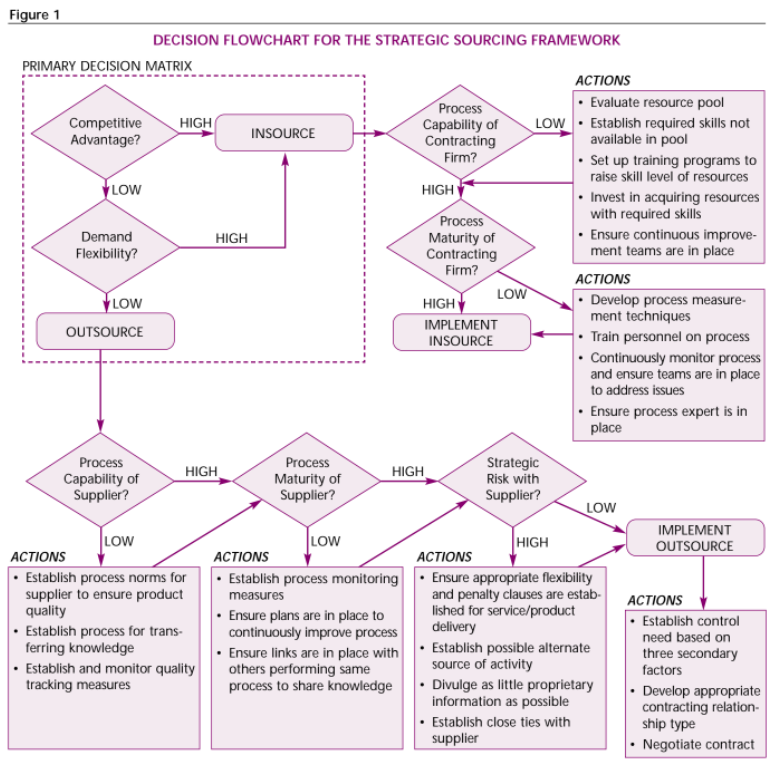


Figure 3: Sislian and Satir Strategic Sourcing Framework

Specifically, in Gottfredson et al.'s (2005) work, they provide a framework for further evaluating the strength of core competencies or capabilities along a matrix comparing cost per transaction (e.g., at, above, or below the industry mean) with the organization's ability to perform the specified function (e.g., poor, sufficient, or better than required).

2.2 Make vs. Buy Frameworks

Similar to the broad strategic sourcing category comes the make vs. buy decision. Rather than focusing primarily on the external supplier landscape, make vs. buy decisions incorporate the firm's internal capabilities and evaluate the tradeoffs between those capabilities and the external supplier market. Platts et al. (2002), share an interesting extension of the frameworks presented above that incorporates the internal vs. external considerations of these decisions and is presented below as Figure 4.

K.W. Platts et al. / Int. J. Production Economics 77 (2002) 247–257 249

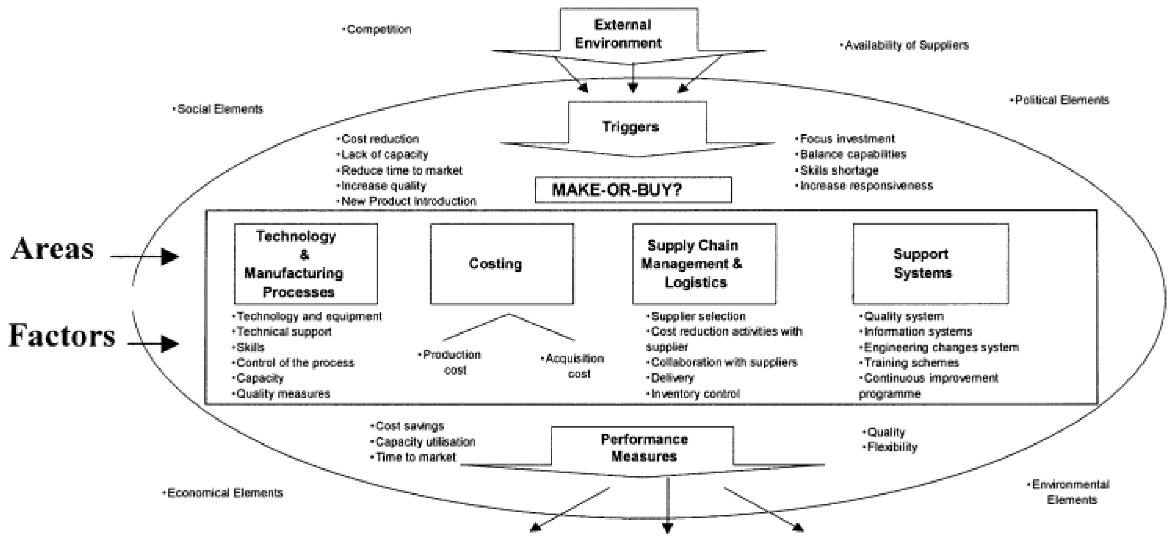


Fig. 1. A framework for make vs. buy decisions.

Figure 4: Platts et al. Make vs. Buy Framework

In the context of this work, their framework specifically explores the triggers (e.g., business reasons) that would initiate a project, such as this work, and define four areas: technology and manufacturing processes, costing, supply chain management and logistics, and support systems that each have associated qualitative and quantitative factors that can be evaluated at an item or SKU level across internal and external supply options. Taking these factors into account, they propose that the organization should determine the key performance metrics to optimize for in make vs. buy decisions that are aligned with the overall business strategy.

Serrano et al. (2018), in their extensive literature review of make vs. buy research validate and incorporate much of what is described above and conclude that the three main factors for consideration in make vs. buy decisions should center around cost, capability, and strategy, furthermore they write that make vs. buy does not have to be the only model, that plural and hybrid sourcing strategies can be advantageous as well. Parmigiani (2007) explores the reasons why some firms would concurrently source (make and buy), most of which are centered around risk management, which has become a more prevalent topic in the research surrounding supply chain management recently.

2.4 Strategic Sourcing and the COVID-19 Pandemic

Two influential McKinsey reports (2021 and 2022) provide some interesting perspective on how COVID-19 is and will continue to impact global supply chains. From the 2021 report, based on a survey of global procurement managers, respondents overwhelmingly report that supply chain resilience is a key area of supply chain improvement. In the context of the strategic sourcing and make vs. buy frameworks presented above, this focus on resiliency is a shift in strategy that will have implications for many firms. How firms go about accomplishing increased supply chain resiliency can differ, but McKinsey presents some options being implemented in industry today including nearshoring, regionalization, dual-sourcing, implementing improved analytics, and increasing inventory levels. Based on McKinsey's data, so far many companies have not made significant progress in adopting these strategic shifts, but they urge industry to improve their efforts here. McKinsey suggests that even pre-pandemic, businesses experienced one-to-two-month long disruptions approximately every four years, suggesting that some event in the future will require a level of supply chain resilience again. McKinsey suggests that business agility will become more prevalent, especially as customer demand changes become faster. As early as 2004, Lee presented the idea of the "Triple A" supply chain: agile, adaptable, and aligned. We expect that model of strategic priorities to become more prevalent in a world that continues to be volatile, uncertain, complex, and ambiguous.

3 Business Context

3.1 Optimas Supply Base and Organizational Overview

3.1.1 Overview

Optimas OE Solutions is a fastener and c-class component distributor-manufacturer focused on serving the heavy-duty truck, automotive, and industrial end markets. The business is split into two regions run by co-CEOs: Americas, headquartered in Wood Dale, IL and International, headquartered in Gloucester, UK.

3.1.2 Management and Organizational Structure

Functionally, each of the two regions operate as independent entities with mirroring organizational structures organized around the Commercial, Sourcing and Supply Chain, Operations, and Engineering functions. Additionally, several corporate functions are structured as shared services across the two regions including Finance, Legal, Information Technology, and Quality.

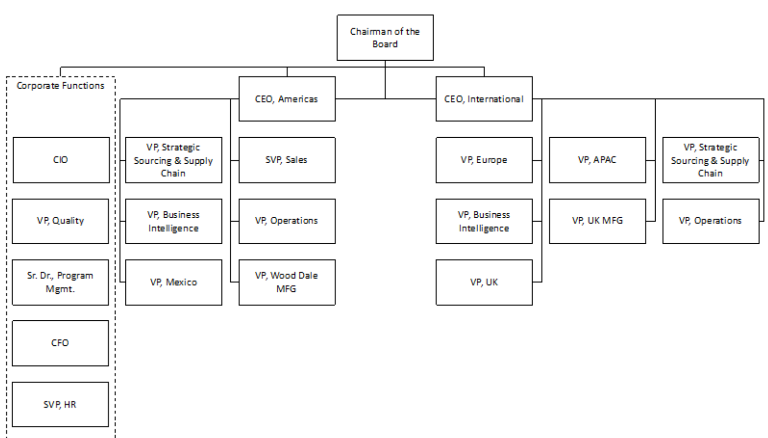


Figure 5: Optimas Senior Leadership Organizational Structure

3.1.3 Business History

In 2015, Anixter, a global public company headquartered in Glenview, IL, specializing in wire and cable management products made the strategic decision to carve out and sell its fastener distribution business and its manufacturing site in Wood Dale, IL. This business was acquired by American Industrial Partners (AIP) and became Optimas OE Solutions. During AIP's ownership, the business has focused on growing its market share and improving service to its key customers. As part of that strategy, Optimas acquired several small international fastener distributors and the Barton Cold Form manufacturing business to expand its international presence for both existing and new customers.

3.1.4 Business Situation

As of early 2022, Optimas was amid its recovery from the COVID-19 pandemic. In 2021, during the early stages of the pandemic, the business leadership at the time made the strategic decision to increase its inventory reserves through higher target service levels in its inventory management system, ToolsGroup. This decision had customers' best interests at heart. The business strove to ensure that it would be able to continue to supply fasteners and c-class components to its customers continuously to maintain the business' credibility and reputation in the market.

Unfortunately, a series of factors worked against this strategic decision. In order to ensure continuity of supply to customers, Optimas significantly increased order volumes with suppliers. At the same time, key customers were not able to operate continuously for a variety of factors, including labor relations challenges through the pandemic and shortages of other commodities required for production such as semiconductors. The combination of these two factors led to severely inflated inventory compared to pre-pandemic levels, straining the business' financial position. Additionally, as the business placed more orders from suppliers, especially in southeast Asia, actual lead times began increasing dramatically compared to historical lead times, resulting in a cascading wave of deliveries that Optimas was still contending with in early 2022 at the start of this project.

In conjunction with inflated inventory levels straining the business' balance sheet, Optimas began to face the pressures of mounting inflation like many businesses whose products have significant exposure to basic raw materials (e.g., steel for the fastener industry). With a product portfolio of over 100,000 SKUs and a complex landscape of commercial agreements with customers, Optimas' ability to drive price increases to customers lagged the raw material inflation felt from its supply chain with each new receipt of goods.

As a result of these pressures especially in the Americas, there was a critical need to better understand the internal and external supplier relationships Optimas relied upon to serve customers and optimize spend in a way that benefitted the business financially and competitively.

3.2 External Supply

3.2.1 Overview of Optimas External Supply Chain

Optimas' external supply chain is a complex network of over 1,200 raw material, semi-finished good, finished good, and value-added service suppliers located across the globe. Optimas' fastener and c-class component supply chain is predominantly based in the

United States and has significant exposure to suppliers in Southeast Asia (e.g., China, Taiwan, Vietnam, etc.) and parts of the rest of the world on a case-by-case basis.

3.2.2 Management and Organizational Structure of External Supply

Within the business, external supply of incoming product to Optimas' distribution business is managed by strategic sourcing and supply chain professionals, with separate teams reporting into each of the divisions, Americas and International. The International Division is organized into country-specific teams which brings together the commercial and sourcing teams at the lowest level and are supported by a small, centralized sourcing team that maintains tools and standards across country teams. For the purpose of this research, we focused on the Americas team, which is organized into a large sourcing and supply chain organization reporting up into a vice president on the Americas CEO's staff.

The Americas' strategic sourcing and supply chain team is functionally led by a vice president of the business with a strategic sourcing leader and a supply chain leader reporting directly into the vice president. The strategic sourcing organization is split into three sub-teams: one with strategic sourcing managers semi-aligned to high level product categories responsible for supplier selection, one focused specifically on supplier abroad responsible for the management of importation, and one focused on supplier quality and development responsible for quality measurement and collaborating with suppliers. On the supply chain side, the team is split into a large team of tactical buyers who create and execute purchase orders with suppliers and a small team of demand planners who translate expected customer demand into purchase order signals based on inventory policies set across the network.

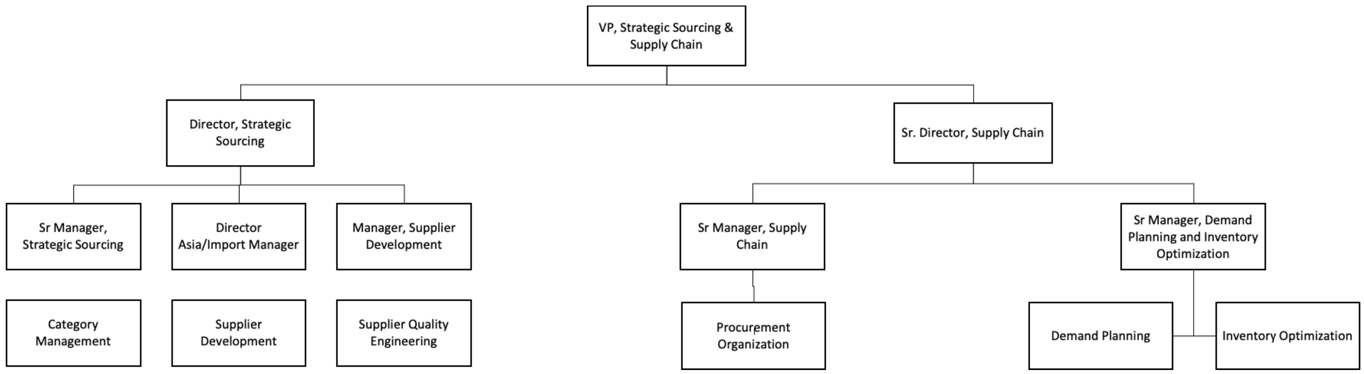


Figure 6: Americas Strategic Sourcing and Supply Chain Organization

In addition to the strategic sourcing and procurement organization, there are additional stakeholders in the new business implementation organization who are responsible for coordinating the quoting process for new and existing products and suppliers, the implementation of supply chains through the Optimas distribution network to customers, and the project management of all these activities. This team is led by a director who reports into the commercial team within the broader Optimas Americas organization.

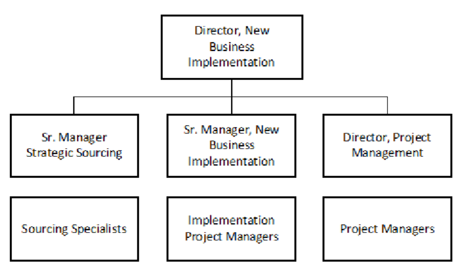


Figure 7: Americas New Business Implementation Organization

This structure presents the inherent need for cross-functional collaboration to be successful in achieving goals meant to benefit Optimas overall. In that respect there are conflicting priorities between the strategic supply chain and sourcing organization and the commercial organization that must be balanced. At a high level, the strategic sourcing and procurement team is focusing on creating, maintaining and optimizing an efficient and resilient global supply chain at the lowest cost. Antithetically, the commercial organization is incentivized to deliver the highest service level to customers at any cost. This dichotomy between priorities presents several organizational challenges that will be relevant to the design and implementation of a strategic sourcing framework and decision support model.

3.2.3 Supplier Segmentation

Optimas' supplier segmentation is captured in a custom, in-house part and supplier management portal called Connect. Connect houses the request for quote (RFQ) process, data and supplier information, some supplier quality and performance metrics, and supplier segmentation. The supplier segmentation criteria used by the business placed suppliers into one of six categories: Exit, Leverage, Critical, Maintain, Develop, or Customer Nominated. This segmentation presented several challenges and had not been updated in recent memory according to anecdotal accounts.

Table 1: Existing Supplier Segmentation Criteria

Category	Definition	Comments
Exit	• Actively exiting/will actively exit • Do not award any new business	• Need to ensure we are mitigating any risks when exiting a supplier
Leverage (Strategic)	• Strategic supplier to whom we should funnel new business	• Best practice is to negotiate volume incentives before moving business • QBRs established • Frequent communication required
Critical	• Provides parts that are critical to Optimas and our customer; not strategic partner.	• Should be managed like a strategic supplier (i.e., QBRs, frequent communication, etc)
Maintain	• Existing business will remain with supplier • New business should not be awarded unless nominated by customer.	• Need to ensure we are watching supplier performance in this category and mitigating risks to continuity of supply and/or cost.
Develop	• Potential strategic supplier currently being developed • New business should not be awarded unless approved by Category Manager	• Do not start funneling large amounts of volume into a new supplier. Set them up for success by building business volumes and complexity over time. • Frequent communication required
Customer Nominated	• Customer(s) directed source • New business should not be awarded unless nominated by customer.	• Will be managed at local levels within category management

One immediate challenge with this segmentation model was that the segments are not mutually exclusive. For instance, a supplier may be labeled develop for a specific product or group of products, perhaps based on a recommendation, but not a mandate, from a customer, while another customer may be dissatisfied with another group of products received from that supplier, requesting that Optimas work to exit the supplier.

Additionally, the segmentation criteria are highly qualitative and do not provide quantifiable metrics to support segmentation. This presents the challenge of constantly changing segmentation based on shifting sentiment among the Optimas strategic sourcing managers.

Finally, the Optimas supplier segmentation does not provide a clear strategy or set of desired actions based on the segment a supplier is placed in. This has allowed significant variation in the management of suppliers in the same category across strategic sourcing managers.

As this work will outline the design and implementation of a strategic sourcing framework for the business in subsequent sections, we will further examine the existing framework as it compares to adopting best practices to achieve the desired outcomes of this work.

3.2.4 Supplier Quality and Performance Management

The supplier quality and performance management organization within the strategic sourcing team is also worthy of a deep dive. The team is comprised of a manager and two supplier quality engineers reporting into the strategic sourcing leader. With a supply base as large as Optimas', this team is likely under-resourced to adequately perform the duties expected of it. As a result, this team has largely been acting reactively in its support of the supply chain organization by managing and executing supplier audits and supplier improvement programs.

In an ideal state, the supplier quality and performance management organization would become a much more proactive piece of the strategic sourcing team, focusing on supporting the management of both top quartile and bottom quartile suppliers. In the top quartile, using this organization as a conduit for improved supplier partnership through the implementation of quarterly business reviews and supplier awards will be critical to successfully executing on a more robust supplier segmentation and strategy. Additionally, the ability to identify supplier-related issues proactively will be a critical function of this organization through the development and implementation of a supplier scorecard focused on key operational metrics that translate into Optimas' customer satisfaction and service level.

3.3 Internal Supply

3.3.1 Overview of Internal Suppliers

Optimas owns and operates two internal suppliers: the Wood Dale manufacturing facility in Wood Dale, IL and the Barton Cold Form facility in Droitwich, UK. These two suppliers are part of a vertical integration strategy for Optimas to exercise control further up the value chain from its roots as a distribution business, building this capability out through acquisitions under its AIP ownership. These two internal suppliers are an important part of Optimas' global supply chain, representing two of the largest global suppliers by total annual spend in the external threaded category.

3.3.2 Wood Dale Manufacturing

Wood Dale Manufacturing Overview

The approximately 140,000 sq. ft., ISO 14001 and IATF 16949 certified Wood Dale, IL production facility (Wood Dale MFG) specializes in the production of complete external threaded fasteners, leveraging a combination of internal cold heading and thread rolling capabilities with the robust secondary processing (e.g., heat treating, plating, patching, machining) market in the greater Chicago area. The facility operates more than 100 pieces of equipment (e.g., cold heading, thread rolling, and other machines) across two, 10-hour shifts. The facility primarily serves Optimas Distribution as its primary customer (approximately 90% of spend) ultimately serving end customers in the Heavy-Duty Truck, Industrial, and Automotive end markets (e.g., Cummins, Paccar, and Harley Davidson) with the remainder of sales direct to end customers, primarily in the Automotive end market. In turn, Wood Dale MFG is the single largest supplier to Optimas Distribution accounting for approximately 15% of total Americas purchasing and approximately 40% of external threaded fastener spend in 2021.

Wood Dale Manufacturing Management and Organizational Structure

Wood Dale MFG operates as its own entity within the Optimas Americas division. The Wood Dale MFG team is organized into four main functional areas: Operations, Production, Sales (Intercompany and External), and Quality reporting into Wood Dale MFG via dotted line from the global Optimas Quality Organization.

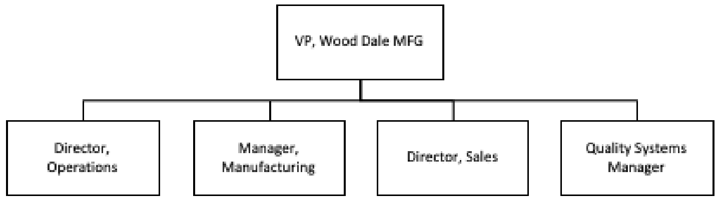


Figure 8: Wood Dale MFG Organization

Wood Dale Manufacturing History

Ber-Lee Fastener was founded in Elk Grove, IL in 1957. Just over a decade later, the company was reincorporated as National Threaded Fastener in Bensenville, IL in 1972. The company was later acquired by QSN Industries in 1990 and then sold to Anixter Fasteners in 2008. In 2015, Anixter, a global company specializing in wire and cable management products made the decision to carve out and sell the fastener business, including distribution and manufacturing. This business was acquired by AIP and became Optimas OE Solutions.

Wood Dale Manufacturing Capabilities

Wood Dale MFG's capabilities support the production of external threaded fasteners from raw material, in the form of extruded or drawn wire, through packaged finished product. In addition, Optimas Distribution operates a distribution center co-located with the Wood Dale facility. Wood Dale MFG can support volumes from prototyping runs through full-scale production.

Figure 9: Wood Dale MFG Cold Heading Department

Wood Dale MFG's generalized process begins with coils of various steel alloy (or other metal) wire in various rough diameters. These coils are loaded onto a drawing machine in-line with a cold heading machine to bring the wire diameter to the specific diameter needed for the part with tight tolerances. This step allows Wood Dale MFG to stock significantly less raw material SKUs. The drawn wire is then fed into a cold heading machine where it is formed into a blank part. Then, the part is loaded into a thread rolling machine where threads are added. Following these forming operations, parts are typically set to be outsourced to vendors for secondary operations. Secondary operations include heat treating, plating, drilling, grinding, patching, assembly, cleaning, sorting, and more. Parts then return to the Wood Dale facility for sorting (if applicable), boxing and shipping either to the distribution center or direct end customer.

Figure 10: Wood Dale MFG Generalized Process Flow

Wood Dale MFG's primary material processing capability is cold heading. Cold Heading is the process of applying force to a metal wire, at room temperature, causing the material to flow into dies, reforming the metal wire into the desired shape by upsetting or extruding. Upsetting is the process of reducing the overall length of the material being formed and increasing the diameter along some portion of the length. Extruding is the process of reducing the diameter and increasing the length of the material being formed.

Wood Dale MFG's secondary material processing capability is thread rolling. Thread rolling is the process of producing threads by the action of a form tool which when pressed into the surface of a cold formed blank displaces material radially. Cold headed blanks slide along feed rails and are pressed between two form tools, one stationary and one sliding.

This combination of cold heading and thread rolling is a high throughput, relatively low cost production process which can output up to 200 pieces/minute when balanced appropriately.

Finally, Wood Dale MFG has in-house tooling production capabilities, allowing the site to create and maintain the custom tooling required to produce the engineered fasteners the site specializes in. Having this capability in-house significantly reduces tooling lead time which is critical for new part setup, allows for easier tooling maintenance, and opens opportunities for tooling modification either during manufacturing development or to repurpose tooling for obsolete products.

Wood Dale Manufacturing Business Situation

Wood Dale MFG finished 2021 strong with revenues split between 95% intercompany sales to Optimas distribution and 5% direct sales to external end customers. With no signal of sales strength weakening in 2022, the management team built a 2022 budget showing increased revenue expectations, with a split of approximately 90% intercompany sales and 10% direct sales, reflecting the management team's intention to bolster Wood Dale MFG's direct sales. The budget was built based on an expected 5% organic growth of the Wood Dale MFG P&L, proposed 10% price increases across the board, and fixed direct sales target. The Wood Dale MFG management team has a strategic vision to build the Wood Dale MFG business as a strategically important, independent revenue stream for Optimas. To achieve this vision, aggressively chasing and winning additional business from Optimas Distribution and external end customers is critical to success. In 2021, nearly 40% of Optimas Distribution's spend on external fasteners was with Wood Dale MFG. To achieve the long-term financial targets at Wood Dale MFG, with a 90/10 intercompany/direct split, Optimas will need to win significant additional spend from Optimas Distribution, shifting Optimas Distribution's spend to approximately 33% external suppliers and approximately 67% Wood Dale MFG. Realizing this shift will require Optimas to identify and execute on transitioning to the right mix of products for both Optimas Distribution and Wood Dale MFG. This means manufacturing in-house the appropriate product types and volumes to achieve revenue goals within the capacity constraints of the factory.

Adding to the urgency of the strategic make vs. buy initiative, in the first quarter of 2022 Wood Dale MFG missed its revenue expectations. Significant efforts by the business to reduce the Wood Dale MFG backlog identified over-purchasing and led to a material amount of cancellation or deferral activity on purchase orders placed by Optimas Distribution. This initiated a re-forecast for the year based on a depressed intercompany backlog. This resulted in a new, significantly reduced revenue and EBITDA forecasts for the remainder of 2022. This re-forecast reenergized Make vs. Buy efforts for the benefit of the Wood Dale MFG P&L's ability to achieve the 2022 re-forecast.

3.3.3 Barton Cold Form

Barton Cold Form Overview

Like the Wood Dale manufacturing facility primarily supports the Americas business as an internal manufacturing capability, the Barton Cold Form facility supports the International business. The approximately 63,000 sq. ft. production facility in Droitwich, UK was acquired by Optimas in 2015 to expand its internal production of complete external threaded fasteners to the UK and European markets. The Barton facility operates more than 50 pieces of production equipment (e.g., cold heading and secondary operation machines). Like the Wood Dale facility, Barton's primary customer is Optimas Distribution, but maintains a higher share of direct sales to customers (approximately 20%) due to its more recent acquisition. As a result, the Barton manufacturing facility, like its sister facility in Wood Dale, is one of the largest suppliers to the Optimas distribution business, especially in the International division.

3.3.4 Additional Considerations for Internal Manufacturing

While Wood Dale MFG and Barton Cold Form both specialize in the high-rate production of complex, cold formed fasteners, there is a market for smaller production runs. Due to the nature of the tooling and changeover costs, it is not economical to produce a batch on the order of less than thousands of fasteners. As a result, there have been some small efforts at Optimas, primarily led by Barton Cold Form to address this missing gap in their production capabilities. First, in addition to its cold heading capabilities, Barton Cold Form has installed a small number of swiss-style lathes to produce low volume, short lead time production runs of external threaded fasteners for specific customer applications.

Additionally, Optimas has begun to experiment with additive manufacturing to prototype unique designs prior to attempting full scale production. At this time however, there is no plan at Optimas to utilize additive manufacturing methods to produce components for customer use in production. One of the leading issues preventing further adoption of additive manufacturing methods in engineered fastener production is the qualification of additively produced materials, especially metals, for use in critical applications (e.g., wheel bolts, structural engine fasteners, etc.). While it may be possible to produce additively manufactured components with similar mechanical properties to those produced from bulk material after post-processing, there is still work to be done on feasibly quantifying and managing the significant variation across runs from additive production methods. This research team expects that the adoption of additive manufacturing techniques in the fastener space will have to be initiated by end customers pulling the technology from suppliers like Optimas and will likely begin with components used in non-critical applications.

4 Data Sources and Analysis

4.1 Sources

Most data utilized for this research was compiled from Optimas' enterprise resource planning (ERP) systems: NetSuite for the Distribution business and Epicor for the Wood Dale Manufacturing business. Where possible, data was pulled for exploratory data analysis (EDA) or into the development of the make vs. buy opportunity model through Structured Query Language (SQL) from the company's cloud-based data lake and data warehouse. This on premises system pulled data over from the ERP systems in regular, near-live intervals and in addition captured daily snapshots of certain tables to allow for enhanced historical data analysis. Where this was not possible, Excel extracts from the ERP systems were taken using the systems' designed search and query templates in the graphical user interface (GUI). Many of the queries used to perform EDA were built on top of existing queries built by my Optimas supply chain, Optimas business intelligence, and AIP colleagues throughout the course of this research.

Additional data was gathered from static, offline sources including qualitative information regarding item and supplier segmentations and internal manufacturing capabilities.

The combination of these sources resulted in creation of a primary data set with the business's item master table (e.g., the primary source for information regarding every current and historical SKU supplied by the business) as the backbone. Additional sources were bolted on to the underlying data set to perform calculations and logical operations in line with the framework developed to provide decision support to the Optimas sourcing and procurement team. The data analysis below describes the initial insights derived from the underlying data that informed the development of the subsequent framework and model.

4.2 Data Quality

Before sharing the initial findings of the exploratory data analysis, it is imperative to pause for a brief commentary on data quality. In 2021, the Optimas distribution business went through an ERP transition from a locally hosted mainframe application to NetSuite, a cloud-based ERP system. Several data quality issues were created as a result of this transition and while the Optimas information technology team has been diligently addressing many of these concerns, it is critical that we note them here.

First, there is the issue of data continuity. The transition from the mainframe system to NetSuite was done at the warehouse level, with the first warehouses cutting over to NetSuite in April 2021, but the last warehouses did not cutover until the end of 2021. In the data lake and data warehouse, this has presented sales and consumption data continuity issues. The business intelligence and information technology teams have created some standard methods to stitch the data together and wherever required, that standard was utilized in this work to mitigate those issues. We expect that there may still be discrepancies or discontinuities that affect the precision of total annual spend and related metrics at the product level, but for the purposes of this research the relative magnitude of spend should be sufficient.

Second, the item segmentation represented in NetSuite was coded manually to the distribution business' set of standards but is recognized to be incomplete and does not necessarily align with the item segmentation used by the Wood Dale and Barton manufacturing site ERP systems. While the item segmentation is incomplete, anecdotally and with some data verification we expect that for the external threaded category, which is the focus of this research, that the records are approximately 95% complete and accurate. As this work is adapted to additional product categories in the future, additional work to ensure the completeness and accuracy of the item segmentation in the ERP will be critical to success.

Finally, as part of the transition to NetSuite, the business intelligence and information technology teams have not completed the setup of all the tables and views in the data lake and warehouse to mirror the level of granularity and accessibility that the mainframe system provided. As a result, some data sources (including the item segmentation master) that were required for this research were pulled manually into static files that were periodically updated from the ERP system's graphical user interface.

4.3 Data Exploration and Analysis

Exploratory data analysis was performed on several sets of business data to better understand the different lenses that would eventually make up the strategic sourcing framework and be the backbone of the make vs. buy opportunity dashboard. Most of this initial analysis was conducted either in Excel or Tableau with live connections to the SQL server database. Analysis performed in Excel was primarily intended for quick, rough analysis, while Tableau was typically reserved for more complex, multi-data source analysis requiring precision and enhanced visualization.

4.3.1 Item Segmentation

The foundation of this research is built on a master dataset of all approximately 100,000 products that move through the Optimas supply chain and all the relevant attributes related to each product that can be used to segment these products into meaningful subsets to match items to primarily internal suppliers with the production capabilities to manufacture those items. This item segmentation is the critical backbone for all subsequent exploratory data analysis and strategic sourcing framework implementation.

In the NetSuite ERP system, the item segmentation was pulled from the General Part Lookup Attribute Data query in the cloud-based user interface; a certified report built by the business intelligence team to capture all 25 attributes associated with each product. This product attribute data includes information such as product category and subcategory, diameter and length, material, special attributes, quality standard, and more. The product data integrity team encoded the product attributes during the transition to the NetSuite ERP system, capturing existing data where applicable and continuing to work through unidentified attributes through this research effort. For the purposes of this work in the external threaded category, we expect that the data accuracy and completeness for this category is approximately 95%.

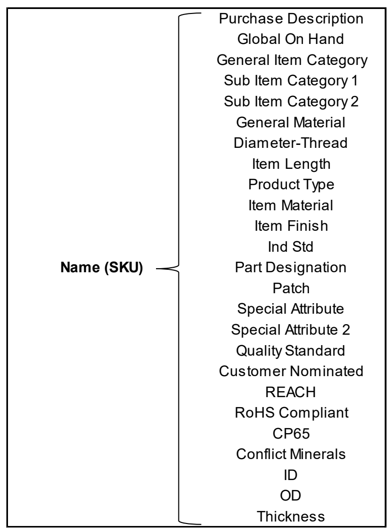


Figure 11: SKU-level Product Attributes Available in ERP

Keeping all items in scope, Optimas' portfolio of 98,302 products was broken down by subcategory. We see that the largest category by SKU count is external threaded fasteners, representing approximately 35% of all SKUs. This was critical to reinforce the decision to pilot the efforts of this research in the external threaded category. It is also important to note the size of the unclassified category at approximately 37% of all SKUs. Based on interviews with the product data integrity team, the unclassified category represents two main categories: obsolete products (not sold in the past 18 months) at the time of transition to

NetSuite and non-fastener products (other c-class components) that have yet to be categorized. We do not expect the size of the unclassified category to present any issues in this research.

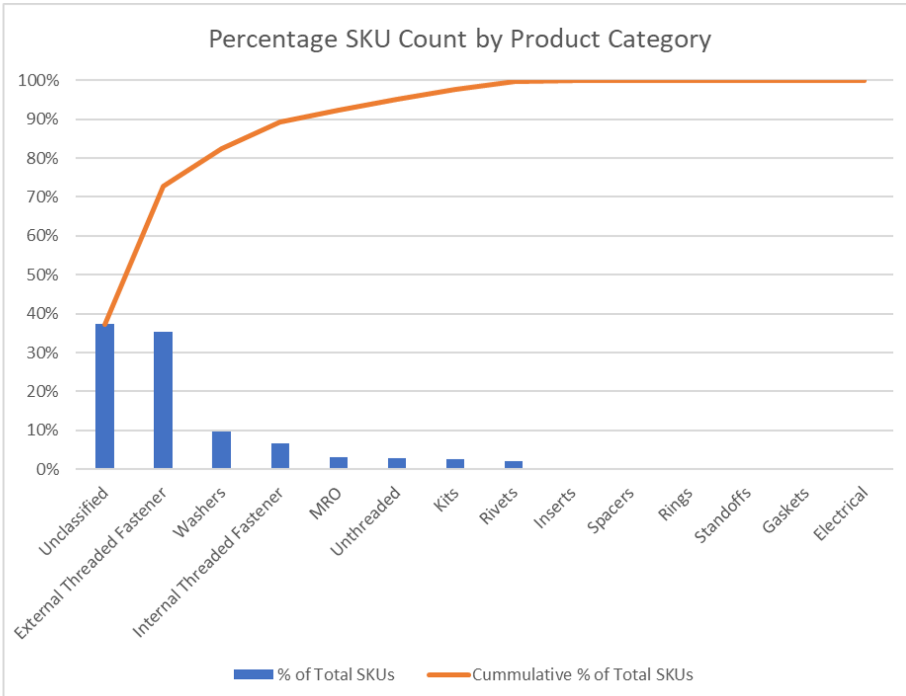


Figure 12: Unique SKUs by Product Category

When we dive deeper into the external threaded category, we see 193 defined subcategories simply defined by type of externally threaded fastener (e.g., screw, bolt, stud, etc.) and some key identifying feature (e.g., head type, full vs. partial thread, etc.). The breadth of this category is quite significant as well with the relatively nondescript "Screw-Hex Cap" subcategory holding the largest share of SKUs at 29%. Unfortunately, this level of detail will likely not be sufficient when attempting to align item attributes to supplier capabilities, so we will likely have to dive deeper into the remaining attributes such as diameter, length, material, and more in interesting combinations to adequately assess if a particular supplier has the capability to manufacture a product.

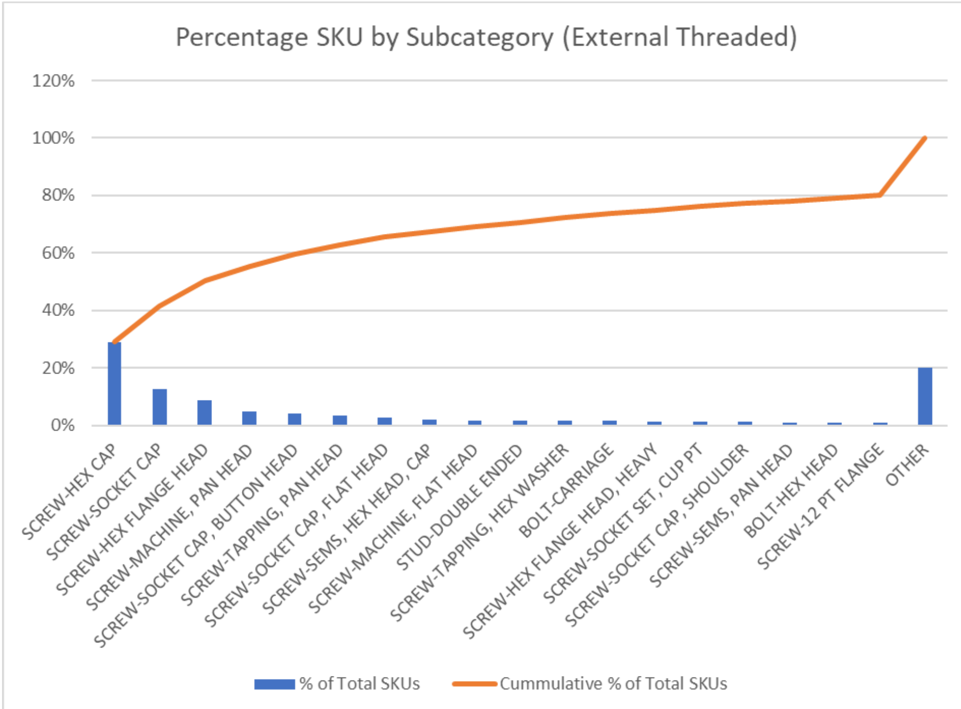


Figure 13: Unique SKUs by Subcategory within External Threaded

An additional note relates to the ubiquity of this item segmentation scheme, especially when considering internal suppliers. Both Wood Dale and Barton utilize different internal ERP and MES systems (Epicor) from the distribution business, which come with their own schema for associating attributes to SKUs. For the purposes of this research, with the intention of optimizing internal and external procurement, we will utilize the NetSuite item segmentation as the dominant segmentation source. We expect this to sufficient since every SKU procured by the distribution business exists in both NetSuite and Epicor. However, the corollary is not true due to the production of product for external direct sales both Wood Dale and Barton maintain as part of each's business model. As a result, we will utilize the unique SKU identifier as the key when merging data sources across NetSuite and Epicor when necessary.

4.3.2 Wood Dale Capacity and Capability

Wood Dale MFG Capability

Figure 14: Representative Products Produced by Wood Dale MFG

Wood Dale MFG currently utilizes its production capabilities to supply approximately 1,300 active SKUs ranging in diameter/size from 1-64 (M2) through 7/8” (M22) and 0.25” (6mm) through 9.75” (220mm) in length, with a preference for 5/16” - 7/8” (M8 - M22) parts. Parts in five product families make up the majority of Wood Dale’s portfolio including: Heavy Hex Flange Bolts, Double End Studs, Shoulder Bolts, Hex Head Cap Screws, Pan Head Screws, and Button Head Screws. Wood Dale MFG has capabilities to process 23 different materials across low carbon steels, stainless steels, brass, aluminum, and steel heat treated between SAE J429 classes 4 and 12 (ASTM F568M classes 4.9 and 12.9). Wood Dale MFG is the holder of several product feature licenses, giving them the ability to meet specific customer requests, including Remform©, Taptite©, MATthread©, Philips© Square Drive and Motorq©. Additionally, the factory specializes in SEMS washer assembly (e.g., integral washers assembled before thread rolling) and secondary processed machined features including shaving.

Product Families: Hex Flange Bolts, Double End Studs, Shoulder Bolts, Hex Head Cap Screws, Pan Head / Button Head Screws

Materials: Low Carbon, Medium Carbon Alloy Steel, Stainless Steels, Non-ferrous Alloys (Copper, Aluminum, Brass)

Sizes: Small (M2) - Large Diameter Bolts (M22), up to 200mm length

Features: Licensed Products (e.g., Taptite, Remform, MAThread, etc.), SEMS Washers, Machined Features

Figure 15: Overview of Wood Dale MFG Production Capabilities

This product capability information was then mapped across the 25 product attributes in the General Part Lookup Attribute Data query for both items that Wood Dale does and does not currently manufacture.

Additionally, the Wood Dale MFG team performed a profit and volume analysis across product types, sizes (diameters), and ranges of estimated annual units (in M, or thousand eaches) to capture which combinations contributed the most to total gross profit and volume. Figure 16 below identifies several combinations of product type, sizes, and volumes that would be most desirable to the Wood Dale operation based on the factory's current gross profit and volume structures where green represents largest contribution / most desirable, yellow represents a neutral contribution, and red represents the smallest contribution / least desirable.

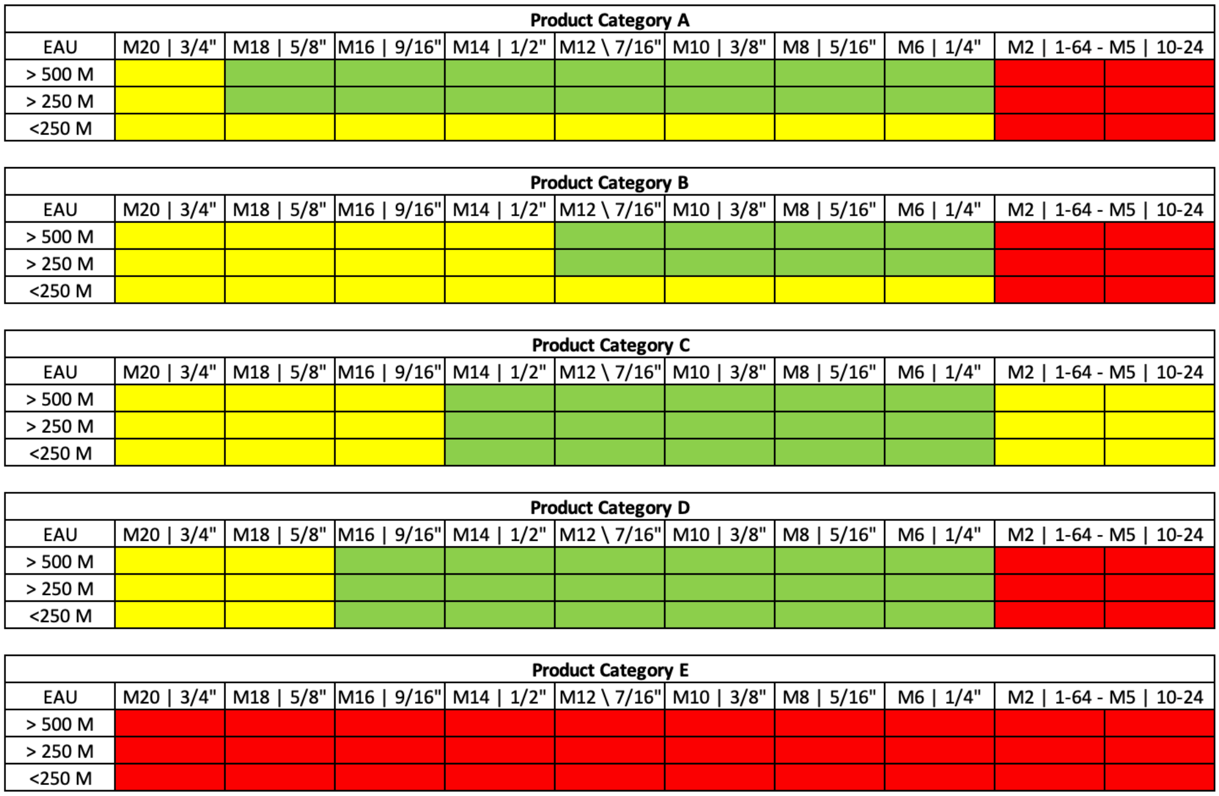


Figure 16: Wood Dale Profit Volume Analysis

Wood Dale MFG Capacity

As background for this research effort, it was critical to understand the limits of Wood Dale MFG's capacity. Based on rated machine speeds, we knew that cold heading had the slowest cycle time on average across the processing steps on site and with that process at the beginning of the value chain, it was easy to identify these machine centers as the rate limiters or bottlenecks of the factory. Therefore, we set out to build a rough-cut capacity model across all cold heading machine centers to better understand both the total theoretical capacity and a more realistic demonstrated capacity based on prior performance. Please note, the rough-cut capacity model only accounts for demand from the distribution business and does not incorporate any demand for direct to end customers. Finally, we connected Wood Dale's manufacturing capabilities at the product family level to the cold heading machine centers to be able to match capacity opportunities or constraints with specific product lines.

Data Sources

Estimating Wood Dale's manufacturing capacity required the use of six main data sources from Epicor, NetSuite, and ToolsGroup. First, from Epicor, we utilized net production quantity data pulled from the data lake at the daily and machine group level and aggregated to the monthly level by machine group to capture historical demonstrated output in eaches.

$$Net\ Production\ QTY = Production\ QTY - Scrap\ QTY$$

Second, also from Epicor, we pulled the cold heading routing steps for the highest revisions of all finished goods produced by Wood Dale to be able to translate finished goods to machine IDs (and therefore machine groups) and calculate total machine hours required for proposals or purchase orders being utilized as the demand signal. This equation assumes that each purchase order or proposal indicates a fresh machine setup. This conservative approach to setup time was favored to provide a worst case view of load and is in line with the business' goal of reducing changeover times to enable faster responses to order and reduce the need for pooling orders.

$$Total\ Machine\ Hours\ Required = Setup\ Hours * \frac{Order\ or\ Proposal\ QTY}{Routing\ Run\ QTY} * Routing\ Run\ Time$$

Third, from Epicor, we incorporated a mapping from machine ID to machine group. For example, the H100 machine group consists of 10 individual machines that each have its own machine ID. The cold heading routing steps pulled from Epicor specify a primary machine ID, so this mapping is required to aggregate to the machine group level.

Fourth, and finally from Epicor, we captured metadata and assumptions for each of the machine groups across a range of metrics: machine group description (e.g., nominal diameter size and blow-die combination), average setup time, and average machine speed (eaches per min and eaches per hour).

Fifth, from NetSuite, we captured purchase orders placed by the distribution business to Wood Dale MFG and applied the total machine hours equation above to each one. This data set would be used to calculate metrics based on historical demand and any forward demand within the stated lead time for a given SKU.

Sixth, from ToolsGroup, we captured proposals (expected future purchase orders) to be placed by the distribution business to Wood Dale MFG and applied the total machine hours equation above to each proposal. This data set would be used to calculate metrics beyond lead time away from the present, essentially incorporating forecasted future demand into the model (up to 12 months from the present).

Model Structure

At a high level, the rough-cut capacity model is structured to present a view on expected load, either to theoretical or demonstrated capacity, by machine group and month incorporating both purchase orders and proposals from the present through 12 months in the future. In order to maintain consistency across part sizes and complexities, rather than using production quantities, the model utilizes required production hours to calculate capacity and load.

$$Load_{Machine\ Group,Month} = \sum_{Machine\ Group,Month} \frac{Total\ Machine\ Hours\ Required}{Total\ Machine\ Hours\ Available} * 100\%$$

In calculating load as a percentage by machine group and month, the numerator (total machine hours required) utilizes the same equation whether calculating theoretical or demonstrated capacity while the denominator (total machine hours available) varies based on the assumptions utilized.

Theoretical Capacity

When calculating load compared to theoretical capacity, the goal was to ascertain expected factory ability to perform compared to the maximum theoretical output of the plant. This assumes running all machines within a machine group at 100% overall equipment effectiveness (OEE), for both, 9-hour shifts (18 hours/day of available time), for the total number of working days in a particular month.

$$Theoretical\ Total\ Machine\ Hours\ Available_{Machine\ Group,Month}$$
$$= \#\ Machine\ IDs * \#\ Working\ Days * Available\ Time * OEE$$

The results of this theoretical capacity analysis, when aggregated across all machines over the 12-month time horizon, yielded a surprisingly low total average factory load of 33%. This is in line with the anecdotal estimates provided by Wood Dale MFG leadership. As a result, we determined that it would be prudent to further refine the assumptions utilized and calculate an average factory load utilizing some form of demonstrated capacity.

Demonstrated Capacity

When calculating load compared to demonstrated capacity, the goal was to ascertain the expected factory ability to perform compared to historical output of the plant. There were two ways we calculated total machine hours available for demonstrated capacity. Both required modifying the OEE assumption from the theoretical capacity model to more accurately represent past performance.

First, using 12 months of historical production data from Epicor, we calculated a historical, estimated OEE by machine group and month aggregated to the machine group level. This calculation deviated from the capacity model in utilizing production quantity rather than hours using the equation below.

$$Estimated\ OEE_{Machine\ Group,Month} = \frac{\sum_{Machine\ Group,Month} Total\ Production\ QTY}{\#\ Machine\ IDs * \#\ Working\ Days * Available\ Time * \ Avg\ Eaches\ per\ Hour_{Machine\ Group}}$$

Based on this calculation, we saw an average estimated OEE across all machines at approximately 24%, with some machines performing as high as 40% on average. In the best months, all machine groups on average reported a maximum estimated OEE of 41% with some machine groups performing as high as 62%.

Returning to the total machine hours available equation presented above, we can modify this to the below to incorporate specific machine group OEE assumptions based on historical performance.

$$Demonstrated\ Total\ Machine\ Hours\ Available_{Machine\ Group,Month} = \#\ Machine\ IDs * \#\ Working\ Days * Available\ Time * OEE_{Machine\ Group}$$

After reviewing the above results with the Wood Dale MFG leadership team, the research team received feedback that purely utilizing historical production output to estimate OEE did not accurately reflect fluctuations in demand mix and that it did not incorporate any aspirational continuous improvement goals. Therefore, the leadership team proposed a third method of calculating total machine hours available by assuming an OEE goal of 70% across all machine groups. This OEE assumption is the combination of assuming 85% operator availability, 85% machine availability and 95% quality yield using the relationship below.

$$OEE = Operator\ Availability\ \&\ Machine\ Availability * Yield$$

Utilizing this final approach, we calculated total overall load of the factory across all machines over the next 12 months and saw an average load of 47%. We then further broke this down into 2 categories: load within lead time (months 1 through 4) with an expected average of 55% and load one to two lead times away (months 5 through 9) with an expected average load of 52%.

Breaking this down further as a tool for the factory leadership, we devised a traffic light management system by machine group and month and over the time horizons described above (within lead time, 1-2 lead times away, total 12 months) to provide the team with visibility to which machine group may be overloaded in certain time periods and which may have excess capacity. The research team proposed a simple categorization structure of green (0 – 50% load), yellow (50 – 80% load), and red (80 – 100% load). Using these insights, the factory leadership team, in conjunction with the sourcing and supply chain team, would be better equipped to shape demand in a way that ensured Wood Dale's ability to produce what was needed in the distribution network when it was needed.

Connecting Load to Product Families

Additionally, it is important to for this work to make connections between overloaded or underloaded machines and the specific product families for which demand would need to be shaped. To accomplish this, a consolidated view of forward 12-month purchase order and proposals was developed and mated with the General Part Lookup Attribute Data query to pull in the product type attribute for each item number. This data was then aggregated to the machine group level and organized to identify the top product families by machine group based on total required machine hours. The output of this analysis, when combined with the output of the rough-cut capacity analysis, is presented below in Figure 17.

Machine Group	A	B	C	D	E	F	G	H	I	J	K	L
# of Resources in Group	10	7	2	5	3	3	1	2	1	1	2	1
Load %[1] Within Lead Time[2]	22%	89%	49%	27%	55%	57%	45%	67%	47%	48%	25%	132%
Load % 1-2 LT Away[3]	16%	79%	26%	32%	55%	57%	33%	78%	50%	31%	38%	133%
Load % Next 12 Months[4]	16%	72%	29%	27%	48%	51%	33%	66%	45%	34%	30%	112%
Key Part Numbers / Categories	1. Screw-Tapping (Round, Pan, Hex Head)	1. Rivets 2. Screw – Hex Flange 3. Screw – Machine Round	1. Screw – Tapping Wafer Head 2. Screw – Sems, Wafer Head 3. Screw – Socket Cap	1. Screw – Hex Flange 2. Screw – Sems, Hex Head 3. Screw – Socket Cap Button Head	1. Screw – Hex Flange 2. Screw Socket Cap 3. Screw – Tapping Truss Head	1. Screw – Hex Flange 2. Screw – Sems, Hex Head 3. Bolt – Carriage	1. Screw – Machine Truss Head 2. Screw – 12 Pt Flange	1. Screw – Hex Flange 2. Screw – Sems, Hex Head 3. Stud – Double Ended	1. Screw – Hex Cap 2. Screw – Hex Flange	1. Stud – Double Ended 2. Screw – Hex Flange 3. Screw – Tapping Hex Flange	1. Screw – Hex Flange 2. Screw – Sems, Hex Head 3. Stud – Double Ended	1. Bolt – Hex Head 2. Screw – Hex Flange 3. Screw – Socket Cap

Figure 17: Rough-Cut Capacity Analysis and Product Mapping Output

4.3.3 Optimas Procurement and Spend Analysis

As discussed earlier in the 3 Business Context, the business' procurement processes require the interaction of several stakeholder groups and the use of several systems including the one previously described and Connect, an internally developed part and supplier management tool where the request for quote and resourcing processes are housed. The request for quote process is the process of the Optimas distribution business translating requests from end customers into requests from the supply base to source items. The resourcing process is very similar except that instead of being initiated by end customers, it is initiated by internal Optimas stakeholders (e.g., strategic sourcing, commercial, etc.) with the goal of improving some attribute of the current supply agreement. One additional note should be included here on the topic of dual sourcing. Optimas does effectively no dual sourcing today for two primary reasons. First, the customer supplier approval process common in the industry does not incentivize customers to approve multiple suppliers for the same part. Second, Optimas' current tools and systems are not set up in a way to handle dual supplier arrangement and allocations.

Request for Quote (RFQ) Process

The request for quote process involves translating requests from customers into requests of the Optimas supply base to identify a source and price for the part or group of parts so that the business can respond to end customer with a final delivered price per unit to the end customer to win the new business. When a new RFQ is initiated, the New Business Implementation team responsible for quoting will create an RFQ in Connect including customer part numbers (and Optimas part numbers if one already exists), descriptions, estimated annual usage (EAU), quality levels / requirements, any available drawings, and other constraints imposed by the customer. This team will then manually select a group of suppliers to send the RFQ out with a required due date based on their knowledge of the supply base and the supplier segmentation listed in Table 1.

Once all suppliers have responded to an RFQ, the New Business Implementation team coordinates with the Strategic Sourcing and Program Management teams to review the responses and nominate suppliers based on supplier segmentation, price, and any other factors they deem relevant in the process. Once suppliers are provisionally nominated, a response to the end customer is drafted including the appropriate Optimas distribution markup. If the customer awards the business to Optimas, the New Business implementation team will then work to spool up incoming product to the distribution network from the nominated suppliers ahead of the mutually agreed upon implementation date with the end customer.

Internal (Wood Dale MFG) Response to RFQ

If Wood Dale MFG is included in the RFQ or resourcing process as a potential supplier for a set of parts, the Wood Dale sales team will initiate a process to respond to the RFQ from the distribution business. This process begins with one of the two resources on the Wood Dale staff receiving the quote via the supplier side of the Connect system. He or she will download all the necessary information about the parts to quote including the drawings to the parts in the RFQ, any relevant specifications for the part, and any similar part quotes the Wood Dale team has previously prepared. The order in which RFQs are prioritized depends on what is deemed hot via email by the Wood Dale or distribution business leadership teams, otherwise the quoting team attempts to follow a first-in, first-out system.

Using the information at hand, the quoting team will typically look for seven key attributes relevant to a part (Figure 18) to determine a cost estimate. These attributes include quote quantity (from RFQ), current alloy price (from Wood Dale operations team), alloy density (from reference charts), part length (from print), part diameter (from print), part geometry (from print), and any special part features (from print). These attributes are used for intermediate calculations such as part volume, head volume, diameters in the head, and wire diameter required using the calculations below. These intermediate calculations inform which header and roller machine groups will be required to produce the parts.

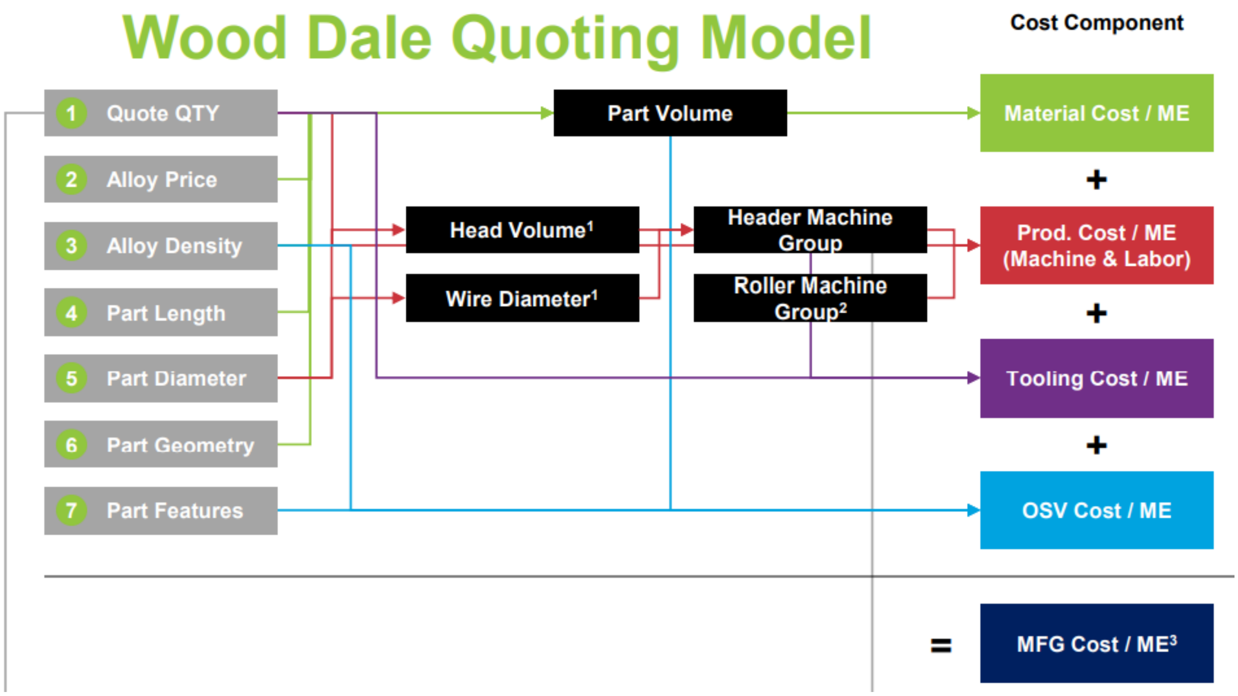


Figure 18: Wood Dale Quoting Model

$$Part\ Volume \sim Part\ Length, Part\ Diameter$$

$$Head\ Volume \sim Part\ Geometry\ (Head\ Type\ \&\ Features)$$

$$Diameters\ in\ the\ Head = \frac{Head\ Volume}{\frac{Wire\ Cross\ Section}{Wire\ Diameter}}$$

Once the intermediate calculations and machine group assignment is complete, the quoting team runs its Excel-based quote tool to calculate a Total Manufacturing Cost per ME (1 ME = 1,000 eaches, where an "each" is one unit) comprised of four parts: material cost, production cost, tooling cost, and outsourced vendor (OSV) cost. The makeup of each of these components is described in the equations below.

$$MFG\ Cost = Material\ Cost + Production\ Cost + Tooling\ Cost + OSV\ Cost$$

$$Material\ Cost = (Part\ Volume * Alloy\ Density) * Alloy\ Price$$

$$Production\ Cost = (Setup\ Time + \frac{Quote\ QTY}{Header\ Group\ Parts\ per\ Hour}) * \frac{Burdened\ Labor\ Rate}{Quote\ QTY}$$

$$Tooling\ Cost = IF(Quote\ QTY \geq Run\ to\ Cover\ Min, \frac{Tool\ Cost}{1{,}000}, \frac{Min\ Tool\ Cost}{Quote\ QTY}$$

$$OSV\ Cost = \sum_{All\ OSV\ Operations} OSV\ Price * (Part\ Volume * Alloy\ Density)\ OR\ OSV\ Price$$

Finally, the quoting team applies a markup based on the quote quantity and header machine group requires to develop a final price to the distribution business. The prepared response to the RFQ is then uploaded to Connect for the distribution business to review and a copy will be stored in Wood Dale MFG's engineering record keeping system, TS.Net.

Resourcing Process

The resourcing process is nearly identical to the RFQ process except for two key aspects: the motivations for finding a supplier and the existence of an incumbent supplier. There are three main categories of motivation for initiating the resourcing process: supplier continuity, negative margin, or reduced supply cost. The first two motivations are primarily reactive to situations in the supply base, while the third tends to be more proactive. The last two are both intended to improve product margin, but are approached with different levels of urgency or through different means.

Of the three motivations, supplier continuity is the most critical and time sensitive scenario. This motivation category typically includes incumbent suppliers who have notified the business that they no longer intend to produce these products, suppliers with significant quality or delivery challenges, or other extenuating circumstances such as supplier bankruptcy, geopolitical events, natural disasters, etc.

The negative margin motivation is also critical, but typically requires a more nuanced approach. Negative margin includes products where the purchase price from the incumbent supplier is greater than the current sales price to end customers. In many cases these products will come through the resourcing process after the Commercial team has already attempted to work with end customers to raise pricing and has not been successful.

Finally, the reduced supply cost motivation is the only existing proactive motivation for the resourcing process and is the primary driver of annual direct material sourcing cost savings, by which the strategic sourcing team is measured. When a strategic sourcing manager believes that there is a potential opportunity to reduce the unit price of a product, he or she will initiate the resourcing process to validate that hypothesis and initiate a supplier change.

Once the resourcing process has been initiated for a set of parts, the Project Management team, located within the New Business Implementation team, will begin to collaborate with the Strategic Sourcing team to ensure that there is no disruption of supply or change in the fit, form, or function of parts supplied to end customers through the resourcing process. As a result, the project management team holds weekly resourcing process status updates across all active projects and ensure the completion of five critical tollgates before a resourcing project is approved and the transition from incumbent to newly awarded supplier begins. These tollgates include:

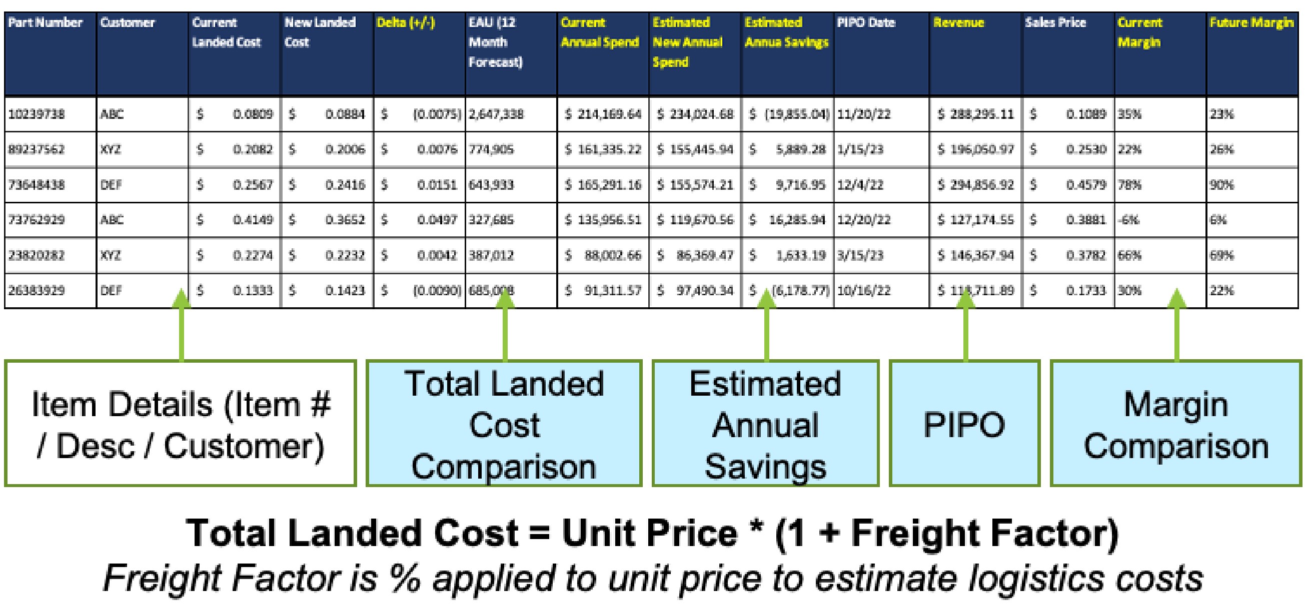
1. The completion of a feasibility check with the Program Manager responsible for the relationships with any end customers impacted by a supplier change to ensure all customer requirements are met by the new supplier.

2. The completion of contract liability checks to ensure that Optimas is within its rights as agreed upon in any long-term agreement with affected end customers to change the source of supply.
3. The receipt and evaluation of sample production parts from the proposed new supplier by the Quality team to ensure that fit, form, and function all meet requirements.
4. The development of a phase-in, phase-out (PIPO) model to ensure that adequate supply from the new supplier arrives at the Optimas distribution network as the incumbent supplier is being phased out based on the current inventory positions and lead times of both new and incumbent suppliers. At this point a special team of buyers handles the procurement of the part through the PIPO process.
5. The completion of the resourcing process with the new supplier officially being awarded the business and Optimas' records updated to reflect the new primary supplier.
6. The procurement of the part is transitioned back to the core buyer and the special buying team recuses themselves from management of the part's purchase orders.

Additionally, the Project Management team tracks the sourcing savings expected to accompany each resourcing project and aggregates that information at the strategic sourcing manager level to understand workload and performance as well as the total annual level to understand total expected financial impact to the business in sourcing cost avoidance.

Quote Analysis for RFQ and Resourcing Processes

Upon receipt of all responses to an RFQ, the New Business Implementation and Strategic Sourcing teams analyze and review the responses and select a supplier to nominate. This process primarily rests on a comparison of total landed cost between suppliers. The goal of the total landed cost comparison is to incorporate logistics costs into the comparison to attempt to more evenly compare suppliers across different geographies. The total landed cost equation relies on a set of freight factors, expressed as a percentage of unit cost, that are updated annually by the logistics team based on actual logistics costs between geographies. For parts that Optimas has currently set pricing with end customers, it is possible to extend this total landed cost comparison to estimate the expected gross margin of each supplier as well.



Part Number	Customer	Current Landed Cost	New Landed Cost	Delta (+/-)	EAU (12 Month Forecast)	Current Annual Spend	Estimated New Annual Spend	Estimated Annua Savings	PIPO Date	Revenue	Sales Price	Current Margin	Future Margin
10239738	ABC	$ 0.0809	$ 0.0884	$ (0.0075)	2,647,338	$ 214,169.64	$ 234,024.68	$ (19,855.04)	11/20/22	$ 288,295.11	$ 0.1089	35%	23%
89237562	XYZ	$ 0.2082	$ 0.2006	$ 0.0076	774,905	$ 161,335.22	$ 155,445.94	$ 5,889.28	1/15/23	$ 196,050.97	$ 0.2530	22%	26%
73648438	DEF	$ 0.2567	$ 0.2416	$ 0.0151	643,933	$ 165,291.16	$ 155,574.21	$ 9,716.95	12/4/22	$ 294,856.92	$ 0.4579	78%	90%
73762929	ABC	$ 0.4149	$ 0.3652	$ 0.0497	327,685	$ 135,956.51	$ 119,670.56	$ 16,285.94	12/20/22	$ 127,174.55	$ 0.3881	-6%	6%
23820282	XYZ	$ 0.2274	$ 0.2232	$ 0.0042	387,012	$ 88,002.66	$ 86,369.47	$ 1,633.19	3/15/23	$ 146,367.94	$ 0.3782	66%	69%
26383929	DEF	$ 0.1333	$ 0.1423	$ (0.0090)	685,0[illegible]8	$ 91,311.57	$ 97,490.34	$ (6,178.77)	10/16/22	$ 11[illegible],711.89	$ 0.1733	30%	22%

Figure 19: Sample Total Landed Cost Comparison

One of the main disadvantages of this system is that it does not incorporate any balance sheet impacts of sourcing decisions. This includes both net working capital impacts via payment term differences across suppliers and expected inventory requirements in the distribution network based on supplier minimum order quantities and lead times.

Current Spend Analysis

The final section of exploratory analysis required developing a common view of current annual spend within the external threaded category. This proved to be a somewhat challenging task considering the rolling ERP system transitions over the course of 2021 and therefore the rolling shifting of purchase order records from one system to another over that period. Utilizing some of the previously developed queries developed by the business intelligence team and help from the third-party consultant team assisting the Sourcing organization, we were able to build this common view.

At a high level, Optimas' total trailing 12-month sourcing spend analysis showed that external threaded fasteners are the largest single category representing 330 unique suppliers and 7,700 unique SKUs.

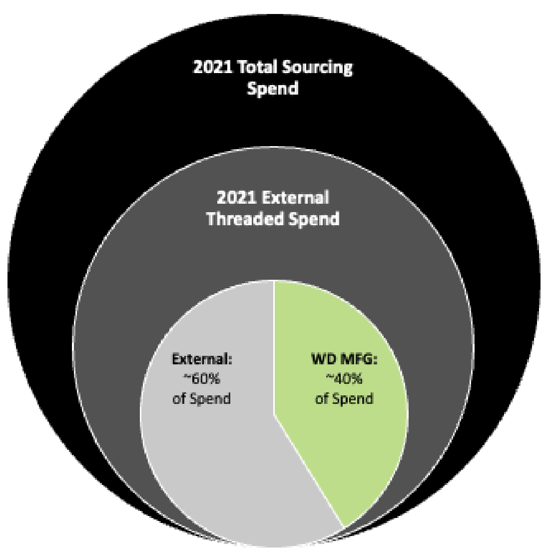


Figure 20: Trailing 12-Month Spend Analysis Breakdown

Wood Dale MFG (supplier name "Optimas Manufacturing) is currently the single largest supplier in the category with approximately 30% of the annual spend. The remaining 70% of spend is made up of a long tail of suppliers with approximately 10 other significant suppliers (> $1 million annual spend) and hundreds of suppliers with small spend.

Additionally, the array of product types is quite significant as well but hex and hex flange screws stand out as the dominant ones by trailing 12-month annual spend.

TOP SUBCATEGORIES
SCREWS-HEX
SCREWS-HEX FLANGE
SCREWS-SEMS SCREW
STUDS-DOUBLE ENDED STUD
SOCKET PRODUCTS-PIPE PLUGS
SOCKET PRODUCTS-SOCKET CAP
SCREWS-THREAD ROLLING-TRILOBE
SCREWS-MACHINE SCREW
SCREWS-TAPPING SCREW
BOLTS/HEX CAPS-BOLT-OTHER

Figure 21: External Threaded Top 10 Product Categories by Spend

4.4 Data Summary

With an understanding of current state internal manufacturing capability and capacity, procurement processes and spend, and the financial evaluation of sourcing activities, we have the buildings blocks upon which we develop a model for optimizing these activities of the business to achieve the desired business outcomes defined in the problem statement and hypothesis.

5 Strategic Sourcing Framework and Decision Support Model

This chapter is intended to describe the design and implementation of the strategic sourcing framework and decision support model to support Optimas' business goal of optimizing internal and external procurement for cost, supply chain effectiveness, and competitive advantage.

5.1 Strategic Sourcing Framework

The strategic sourcing process developed by professionals at A.T. Kearney and others relies heavily on defining the category profile, understanding the dynamics of the supply market, and the development and execution of a strategic sourcing strategy aligned with the business goals. The classic seven steps (as defined by A.T. Kearney) are:

1. Profile the Category
2. Select the Sourcing Strategy
3. Generate the Supplier Portfolio
4. Select Implementation Path
5. Negotiate and Select Suppliers
6. Integrate Suppliers
7. Monitor the Supply Market

This section focuses primarily on Step 2. The following section (Section 5.2) will focus primarily on Steps 3 through 5, the selection of suppliers at the SKU level, and assumes that no major new suppliers will enter Optimas' supply chain considering the vast array of current suppliers. Much of the category profile (step 1) was covered in Chapter 4 in the Exploratory Data Analysis and we will revisit that briefly here.

5.1.1 Framework Overview and Factors

We define a strategic sourcing strategy for Optimas as a logical approach to maximizing the value for the overall business at the SKU level by optimizing the appropriate competitive and financial balance between internal and external supply. The development of this strategy evolved through the process of developing a series of lenses through which to view the supply of each SKU in the Optimas portfolio.

At first, this effort's goal was primarily financial, with an emphasis on investigating the financial impact between internal and external sourcing. This would become the first lens of the framework: financial impact. The initial hypothesis was that internal sourcing reaped double the reward for Optimas overall as a business by capturing a manufacturing profit and a distribution margin, compared to exclusively the distribution margin captured by externally sourcing products. As referenced earlier in this work, Optimas' RFQ evaluation is based on a total landed cost comparison. Our hypothesis is that there is a more nuanced total cost perspective that would lead Optimas to make different decisions for the benefit of the system, rather than just the sourcing organization. With the aim of increasing financial gain for Optimas, this approach attempts to insource all products at the lowest total landed cost. When considering the practicality of this strategy however, we uncovered three primary constraints that would become the remaining pieces of the sourcing strategy.

First, it became clear that Wood Dale Manufacturing had a very specific set of core competencies and that Optimas' portfolio of products far exceeded these competencies. This became the second lens of the framework: capability.

Next, it became obvious that there must be some constraint on Wood Dale's ability to meet the global demand for every part they could produce. A machine group-level capacity analysis would be critical to understanding Wood Dale's ability to meet the demand of parts it had the capability to produce. This became the third lens of the framework: capacity.

Finally, insourcing and outsourcing cannot be done in a bubble without the context of the competitive market in which Wood Dale and competing external suppliers exist in the eyes of Optimas. Therefore, we determined that the Optimas supplier strategy needed to be incorporated into the framework to ensure that the business leveraged the strengths of high-performing external suppliers in tandem with leveraging internal suppliers. This became the fourth and final lens of the framework: supplier strategy.

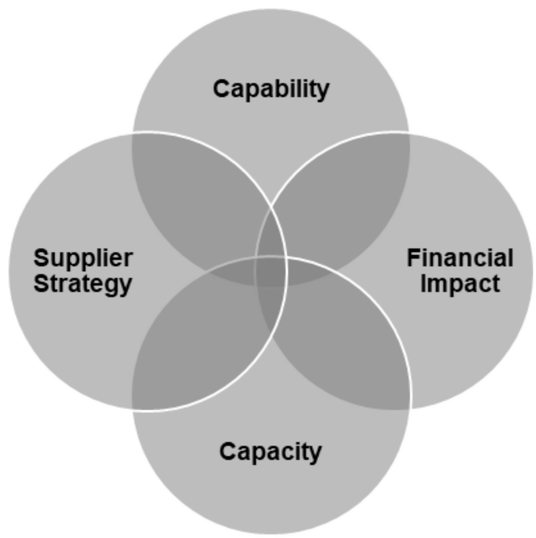


Figure 22: Optimas Strategic Sourcing Framework

5.1.2 Financial Impact

Considering, financial impact was the primary motivation for this effort, it was important that we were thoughtful in our approach to quantifying the impact of sourcing decisions. In working with the senior leadership at Optimas, there was a consensus that total landed cost was likely too simplistic of a model and was potentially driving too much sourcing from international suppliers with longer lead times and higher minimum order quantities than other suppliers. While the business was potentially achieving significant financial benefit to the income statement as a result of this decision making, it was at the expense of the balance sheet due to higher inventory requirements in the distribution network from these longer lead times and higher minimum order quantities.

As a result, we wanted to explore alternative methods to quantifying sourcing decisions. We evaluated three potential methods: a simple total cost of ownership model, a gross margin return on inventory model, and a return on investment (ROI) model. Next, we selected one approach to incorporate into this framework. Finally, we developed some additional financial estimation for potential insourcing opportunities by creating a simple should cost model for Wood Dale.

Total Cost of Ownership (TCO)

The first model we evaluated utilizes total cost of ownership (TCO). TCO is intended to be a comprehensive evaluation of all costs associated with the ownership of some product (in this case, finished goods inventory). At Optimas, we determined that there are three primary direct costs, including unit price, logistics costs, and holding costs, and several indirect costs, including primarily supplier performance costs. In the development of the TCO model for this application, we focused primarily on the direct costs, essentially building on the total landed cost model (unit price and logistics costs) by adding holding costs.

Calculating holding costs, required making some simplifying assumptions about the business' procurement model to calculate an average inventory on hand comparison by incorporating minimum order quantity and lead time quoted in a supplier's response to an RFQ. By making some simplifying assumptions, we were able to calculate the average inventory on hand in terms of quantity and dollars to compare between practice.

$$Average\ Inventory\ On\ Hand\ (QTY) = \frac{MOQ}{2} + \left(\frac{EAU}{365} * Lead\ Time\ in\ Days\right)$$

$$Average\ Inventory\ on\ Hand\ (\$) = Average\ Inventory\ On\ Hand\ (QTY) * Unit\ Cost$$

The simplifying assumptions made here include considering EAU in the RFQ as the actual annual demand for the part, simplifying this demand to be deterministic, simplifying lead time to be deterministic, and ignoring variations in average inventory on hand when ordering less than once per year due to MOQ and EAU mismatches.

In short, this model allows for a comparison of total landed cost as the income statement impact in addition to the holding costs as the balance sheet impact. We provide a simple example of this comparison below in Figure 23.

	Supplier 1	Supplier 2	*Units*
EAU	250,000	250,000	ea
Optimas Sales Price	$0.10	$0.10	$/ea
MOQ	600,000	300,000	ea
MOQ in Years of Stock	2.40	1.20	yrs
Unit Cost	$0.065	$0.075	$/ea
# Orders / Year	0.41666667	0.83333333	
Time b/wn Orders	876	438	days
Lead Time	150	150	days
Daily Demand	685	685	ea
Reorder Point	102,740	102,740	ea

Supplier 1	Annualized	Supplier 2	Annualized
P&L Impact		**P&L Impact**	
Sales	$25,000	Sales	$25,000
Quantity Sold (EAU)	250,000	Quantity Sold (EAU)	250,000
(-) Cost of Goods	($16,250)	(-) Cost of Goods	($18,750)
Gross Profit	$8,750	Gross Profit	$6,250
Gross Margin	*35.0%*		*25.0%*
Balance Sheet Impact			
Average Inventory		Average Inventory	
Quantity On Hand	402,740	Quantity On Hand	252,740
QTY Mths	19.3	QTY Mths	12.1
Value On Hand	$26,178	Value On Hand	$18,955

Figure 23: Total Cost of Ownership Example

Future work to expand on this TCO model could include the evaluation of expected excess and obsolete reserve costs due to ordering frequency and the incorporation of supplier performance indirect costs such as costs of poor quality and costs of poor service.

Gross Margin Return on Inventory (GMROI)

The second model we evaluated was one utilizing gross margin return on inventory (GMROI) as the key metric. This is an extension of the simple TCO model we developed, simplifying the income statement and balance sheet impacts down to one key metric. GMROI is the ratio of gross profit to average inventory, where the ratio represents the gross profit margin (as a percentage) the business can expect to capture over or below its average cost.

$$Gross\ Margin\ Retrun\ on\ Inventory = \frac{Gross\ Profit\ (\$)}{Average\ Inventory\ (\$)} = \frac{EAU * (Sales\ Price - Unit\ Cost)}{Average\ Inventory\ (\$)}$$

This model is a good balance between gross profit dollars, gross profit margin, and average inventory cost; the three key metrics of the TCO model. It would also be possible to set some hurdle rate for GMROI that the business should aim to meet or exceed on every sourcing decision.

Return on Investment (ROI)

The third and final model evaluated was the development of a return-on-investment model (ROI) for every sourcing decision, treating each RFQ as its own project, projecting out a pro forma income statement and pro forma balance sheet, calculating the expected contribution to free cash flow, discounting those cash flows at the business' weighted average cost of capital and only making sourcing decisions that have a net present value greater than zero. This model is used by the business when evaluating taking on new customer accounts to estimate the total impact to the business, typically across the entire portfolio of SKUs that Optimas would provide to the customer.

This ROI model is very detailed and incorporates considerations for gross profit, operating expenses, excess and obsolete expectations, inventory investments, working capital investments, and fixed asset investments if applicable. While this level of detail is appropriate for customer account level evaluation, it is likely too time consuming and detailed for SKU-level supplier evaluation.

Model Selection

Ultimately, we decided to incorporate all of the factors of the TCO and GMROI models into the strategic sourcing framework to add additional nuance and detail to the existing total landed cost model without overwhelming the strategic sourcing managers with too much information. By taking this approach, rather than purely incorporating the GMROI output, we maintain visibility to the average inventory cost and allow for expansion of the TCO model in future iterations to include the indirect costs discussed in previous sections.

Wood Dale Cost Estimation

When Wood Dale is being considered as a potential supplier, we can utilize the existing knowledge of the quoting process to make some informed estimates in the exploratory phase. By diving into the Wood Dale income statement and making some simplifying assumptions, we developed a simple model to get to a rough Wood Dale price to the distribution business. This allows us to screen the entire product portfolio that Wood Dale has the capability and capacity to produce.

Looking back at the Wood Dale quoting model presented in Chapter 4, there are four main cost components: material cost, production cost, tooling cost, and outsourced vendor operation cost. In the aggregate, we can recreate these costs, less material costs, by pulling this information out of the Wood Dale income statement over some period such as trailing 12-months and developing a conversion cost model for the factory.

Conversion cost is defined as the cost to turn some raw material into a finished good. This includes the labor, other variable, and base costs of the factory and can be calculated at some functional unit of measure, in this case per 1,000 eaches shipped. The results of the development of the conversion cost model are presented below in Figure 24.

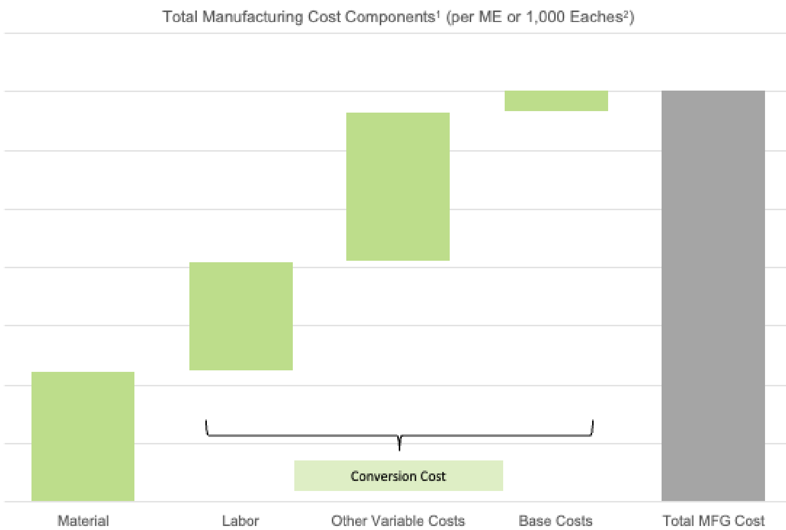


Figure 24: Wood Dale Conversion Cost Model

Translating this to a Wood Dale price estimation for a given SKU, utilizing part weight and material we can calculate a total material cost. By adding the conversion cost and some markup assumption for Wood Dale, we can arrive at an estimated Wood Dale price to the Optimas distribution business for initial evaluation without the lead time of the Wood Dale quoting process.

$$Material\ Cost = Part\ Weight * Material\ Cost\ Assumption$$

$$Estimated\ Wood\ Dale\ Price = (Material\ Cost + Conversion\ Cost) * Wood\ Dale\ Margin$$

5.1.3 Capability

When considering a part or portfolio of parts, we must consider whether a supplier should be considered for nomination based on their core competencies based on the business' perception of them. It was determined that external supplier core competency identification was beyond the scope of this work, however significant emphasis was placed on defining the core competencies of Wood Dale manufacturing.

As discussed in detail in 3 Business Context, Wood Dale MFG's core competencies include the cold heading and thread rolling of external threaded fasteners with diameters from M8 through M22 and lengths from 6mm through 220mm across five primary product categories: Heavy Hex Flange Bolts, Double End Studs, Shoulder Bolts, Hex Head Cap Screws, Pan Head Screws, and Button Head Screws.

Later in this work, we will discuss in more detail how this information was coded into the decision support tool to filter down only on opportunities for insourcing products to Wood Dale Manufacturing.

5.1.4 Capacity

Specifically, when considering Wood Dale as a potential supplier, it is critical that we incorporate a perspective on Wood Dale's capacity to produce the part or portfolio of parts we are interested in. In 4.3.2.2 Wood Dale MFG Capacity, we described in detail the process of developing a simple machine group level capacity model and a mapping between product groups and machine groups. With Wood Dale at approximately 40-50% load compared to capacity, we recognize that there is opportunity to fill the factory with additional work, but when we review the machine group level results in Figure 13 we see that some machine groups like Machine Group L are already overloaded while others like Machine Groups A and D have significant capacity to allocate to new products that could be easily adapted to production on those machines.

5.1.5 Supplier Strategy

Next, in the context of Optimas' global supply chain, it is critical to incorporate the competitive strategy perspective into this framework. As previously discussed in 3.2.3 Supplier Segmentation, Optimas had a basic outline of supplier categories, but the segmentation was almost entirely qualitative, and the strategies associated with each were vague. At the outset of this work, it was apparent that this segmentation would need to be updated and actionable strategies developed for each segment.

As part of this effort in conjunction with the third-party consulting team Optimas contracted with, the Strategic Sourcing team refreshed the supplier segmentation with procured product complexity and procured value as the primary considerations. One major outcome of that work was the creation of four simple categories with the following names and criteria:

1. **Strategic:** Suppliers with trailing 12-month spend >$500K and high sourcing complexity
2. **Leverage:** Suppliers with trailing 12-month spend >$500K and lesser sourcing complexity
3. **Tactical:** Suppliers with trailing 12-month spend <$500K and lesser sourcing complexity
4. **Bottleneck:** Suppliers with trailing 12-month spend <$500K and high sourcing complexity

Applying these categories to the external threaded category, we developed the Kraljic Matrix below in Figure 25 and focus on the following strategies. For high complexity

Strategic and Leverage suppliers, the business should grow spend with these partners who are augmenting internal production capabilities in novel ways and work to put in place long term partnership agreements that deliver outsized value to both parties. Tactical and bottleneck suppliers should be managed for cost performance and exited as much as possible, especially those located in areas with high geopolitical risk such as China and Taiwan.

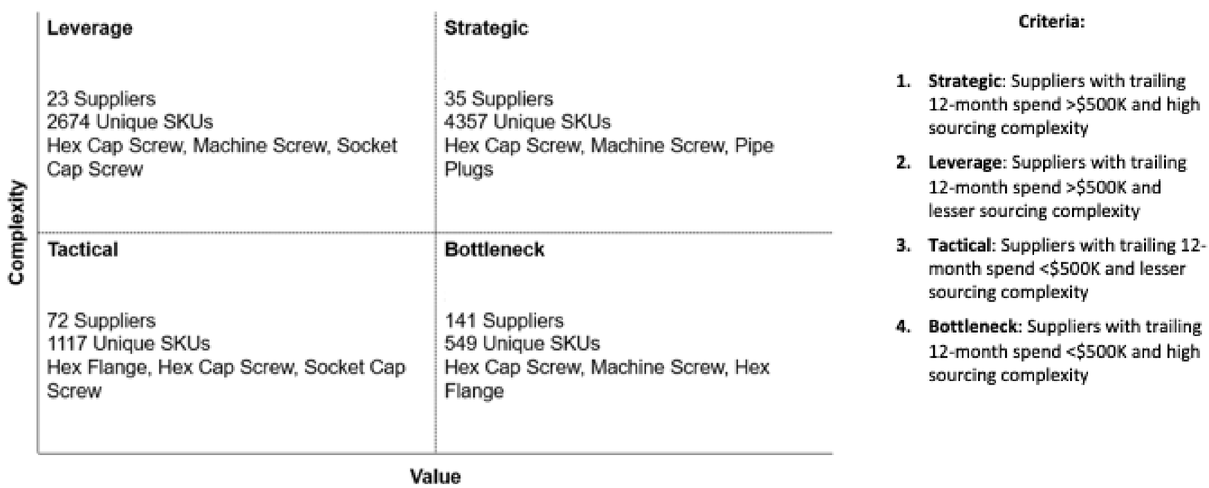


Figure 25: Optimas Supplier Strategy Kraljic Matrix

Ensuring that these strategies are incorporated into sourcing decisions is critical to ensure that Optimas is appropriately managing its supply base and consolidating or growing spend with the right suppliers and exiting the others that do not represent critical, long-term partnerships.

5.1.6 Framework Summary

In summary, we arrived at the strategic sourcing framework presented in Figure 22 by logically approaching the management of the Optimas supply base in the context of the business objectives laid out in 1.4 Hypothesis. Ultimately, that led this team to the incorporation of four lenses into the framework: financial impact, capability, capacity, and supplier strategy. In the subsequent sections we will address the next steps in the strategic sourcing process through the development and implementation of a decision support model for supplier selection when evaluating internal versus external supply.

5.2 Decision Support Model

5.2.1 Decision Support Model Overview

Turning the strategic sourcing framework developed in 5.1 Strategic Sourcing Framework into an actionable plan for the business was the key piece of this work. This was done by applying the four lenses of the framework to the entire external threaded product portfolio at the SKU level through the development and implementation of a decision support model for the strategic sourcing organization. This model provides a granular enough level of detail for a strategic sourcing manager to compare an incumbent supplier with Wood Dale based on the four lenses of the framework: financial impact, capability, capacity, and supplier strategy.

5.2.3 Model Data Inputs and Structure

Building the decision support model required the novel combination of several existing data sources to achieve the level of granularity required for SKU-level analysis. An emphasis was placed on utilizing information from the Optimas data warehouse and data lake and minimizing the amount of static data files. The three main data sources for this model then were: the item segmentation data source outlined in 4.3.1 Item Segmentation, a custom connection to the ERPs through the data lake and data warehouse outlined in Appendix A: Decision Support Model SQL Query, and the static sourcing spend data source.

As described in 4.3.1 Item Segmentation, the item segmentation data source, a static extract from the NetSuite ERP system (due to its not being available in the data lake or data warehouse), was the backbone of this decision support model. For every unique SKU, this data source contained 25 attributes to describe the product which would enable the identification of products that matched Wood Dale's core competencies.

Next, the custom SQL-based connection to the data lake and data warehouse (full code available in Appendix A: Decision Support Model SQL Query), pulled together all relevant data necessary analysis and evaluation of sourcing decisions. This query utilized the distribution network's item sourcing table as its backbone. The item sourcing table contains every active supplier for every active SKU. These item sourcing records were then joined with other relevant information from various tables including the defined supplier's cost and minimum order quantity, vendor location, average sales price to customers, primary customer, inventory position, and part weight.

Finally, as discussed in 4.2 Data Quality, it was necessary to incorporate trailing 12-month spend data and supplier categorization based on the segmentation developed in 5.1.5 Supplier Strategy. This was done through a static data sourcing called the Sourcing Spend Cube that was produced by the internal business intelligence team in collaboration with the third-party consultants who advised the business on the development of the supplier strategy.

5.2.4 Model Supplier Comparisons

For every supplier and SKU combination the decision support model compares the incumbent supplier with Wood Dale across 5 key metrics outlined in Figure 26 including: unit cost, margin, minimum order quantity (MOQ), lead time, and average inventory.

Incumbent	Wood Dale
Unit Cost	Est. Unit Cost
Sales Price	
Margin ($ / %)	Est. Margin ($ / %)
EAU	
MOQ	Est. MOQ
Lead Time	Est. Lead Time
Average Inventory (QTY / $)	Est. Average Inventory (QTY / $)

Figure 26: Decision Support Model Incumbent vs. Wood Dale Comparison

It should be noted that Wood Dale estimated unit cost is calculated using the following equation, in alignment with the discussion in 5.1.2 Financial Impact. The model allows for an adjustable alloy price assumption as the steel indices change with market conditions or if other unique alloys are being evaluated.

$$Est. Wood\ Dale\ Unit\ Cost = (Part\ Weight * Alloy\ Price\ Assumption) + Conversion\ Cost$$

Additionally, average inventory is calculated as described earlier in 5.1.2 Financial Impact, by leveraging EAU, MOQ, and lead time information for each supplier.

5.2.5 Sample Model Output

Bringing all the above together, the decision support model has four main sections. First, at the right, we have a series of filters to drill down on specific attributes to filter for Wood Dale MFG capabilities across material, diameter, length, and any special attributes. We also have two parameter fields for inputs on Wood Dale conversion cost and alloy index price assumptions. Next, in the top left (enlarged in Figure 27), we have a tree diagram that a user can dive into to explore product types where the size of the area on the diagram corresponds with the number of unique SKUs that meet the criteria.

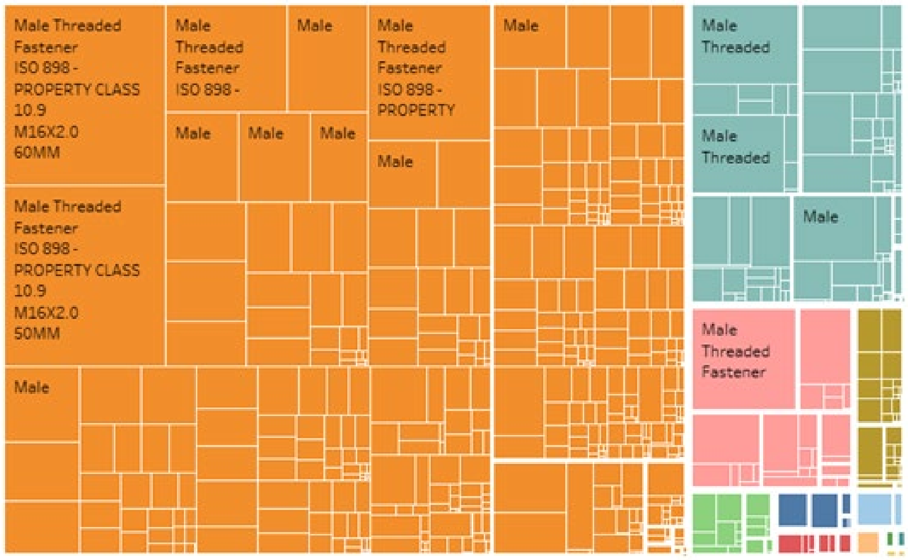
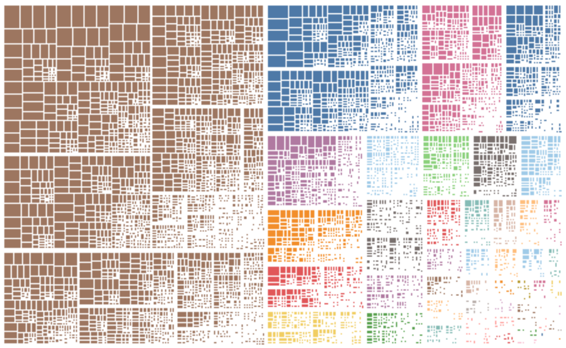


Figure 27: Item Tree Detail Enlargement

Third, in the top right, we have the Kraljic Matrix overlaid on the supply base with the ability to drill down into any of the specific categories or see the distribution of suppliers in a selected product type. Finally, at the bottom, the all-item detail table contains each active supplier-SKU relationship including selected item attribute data from the item segmentation data source as well as the five key metrics discussed in 5.2.4 Model Supplier Comparisons. The dashboard shown in Figure 27 is live and was published to the Optimas internal Tableau server for the strategic sourcing team to utilize in identifying new resourcing projects or evaluating responses to RFQs

Filtered Item Tree Map (Category Only / Items)



Kraljic Matrix

Value Category	Complexity Category: Low	Complexity Category: High
High	13,528	10,330
Low	7,141	2,066

Product Type: (Multiple values)

Item Material: (All)

Diameter-Thread: (All)

Item Length: (All)

Special Attribute: (Multiple values)

Special Attribute 2: (Multiple values)

Product Type

- BOLT-BANJO
- BOLT-CARRIAGE
- BOLT-HEX HEAD
- BOLT-LAG, HEX
- SCREW-12 PT F..
- SCREW-HEX CAP
- SCREW-HEX CA..
- SCREW-HEX FL..
- SCREW-HEX FL..
- SCREW-HEX FL..
- SCREW-MACHI..
- SCREW-MACHI..
- SCREW-MACHI

WD MFG Conversion Co..: [redacted]

Steel Price Assumption ..: $0.80

All Item Detail

VENDOR_N..	VENDOR_N..	ITEM_NBR	Segmentati..	Purchase D..	Product Type	Item Materi..	Diameter-T..	Item Length	Special Attr..	Special Attr..	Quality Sta..	Shipping Lo..	LT (Days)	MC
[redacted]	113350	[redacted]	Null	M16-2.0 X 1..	SCREW-HE..	ISO 898 - P..	M16X2.0	190MM	- None -	- None -	PPAP 3	Null	120	
			Null	M16-2.0 X 1..	SCREW-HE..	ISO 898 - P..	M16X2.0	180MM	- None -	- None -	PPAP 3	Null	120	
			Null	3/8-16 X 3/..	SCREW-HE..	SAE J429 - ..	3/8-16	3/4	- None -	- None -	PPAP 3	Null	120	
			Null	3/8-16 X 2 1..	SCREW-HE..	SAE J429 - ..	3/8-16	2-1/2	- None -	- None -	PPAP 3	Null	120	
			Null	3/8-24 UNF ..	SCREW-HE..	SAE J429 - ..	3/8-24	2.000	- None -	- None -	PPAP 3	Null	120	
			Null	1/2-13 X 2.0..	SCREW-HE..	SAE J429 - ..	1/2-13	2.000	- None -	- None -	PPAP 3	Null	120	
			Null	3/8-16 X 1-..	SCREW-HE..	SAE J429 - ..	3/8-16	1-1/2	THREAD 1.25	- None -	ISIR	Null	102	
			Null	M10X1.50 ..	SCREW-SO..	ISO 898 - P..	M10X1.5	65MM	- None -	- None -	COMMERCI..	Null	120	
			Null	M10X1.5 X ..	SCREW-SO..	ISO 898 - P..	M10X1.5	35MM	SPS ONLY	- None -	PPAP 3	Null	120	
			Null	M12X1.75 ..	SCREW-HE..	ISO 898 - P..	M12X1.75	20MM	DURLOK	- None -	COMMERCI..	Null	120	
			Null	M10X1.50 ..	SCREW-HE..	ISO 898 - P..	M10X1.5	23MM	- None -	- None -	PPAP 3	Null	120	
			Null	3/8-16 3A X ..	STUD-SING..	LOW CARB..	3/8-16	.580	- None -	- None -	PPAP 3	Null	120	
			Null	M8X1.25 X ..	SCREW-SO..	ISO 898 - P..	M8X1.25	100MM	- None -	- None -	PPAP 3	Null	120	
			Null	M6X1.0 X 2..	SCREW-SO..	ISO 898 - P..	M6X1.0	25MM	- None -	- None -	PPAP 3	Null	120	

Figure 28: Sample Decision Support Model Output

6 Initial Findings and Future Work

6.1 Immediate Business Opportunity

The goals of this work as stated in 1.4 Hypothesis were twofold: to improve financial performance and improve competitive positioning through improved make vs. buy decision making by designing and implementing an actionable strategic sourcing framework. By extension, this also means enabling a shift from reactive resourcing projects taking priority (e.g., supplier continuity and negative margin projects) to more proactive projects such as: exiting direct competitors as suppliers, supply base rationalization, reducing reliance on international supply and importation, and margin expansion. The decision support model has helped the strategic sourcing team identify several immediate business opportunities in each of these proactive categories that we will briefly describe below.

6.2.1 Direct Competitor Exit

Two significant resourcing projects were developed direct from the decision support tool, both aimed at reducing the reliance on direct competitors. Supplier A is one of the largest external suppliers for external threaded fasteners by annual spend. After going through a difficult relationship with Supplier A due to delivery issues, a review of the portfolio of products at Supplier A returned approximately 30 SKUs that could readily be moved to Wood Dale achieving margin expansion and average inventory reduction as direct benefits. Supplier B is also a significant supplier in the category and located close to the Wood Dale site. The strategic sourcing methodology presented in this work helped the team to identify and quantify a full supplier exit on approximately $3 million in spend with expected margin expansion and average inventory reduction as direct benefits. Indirect benefits include reducing reliance on a direct competitor which is competing for similar end customer business and local resources such as labor and outsourced vendors.

6.2.2 Supplier Rationalization

With a supply base of over 1,000 unique vendors, one of Optimas' business goals is to consolidate spend, reducing the sheer number of suppliers requiring management by a strategic sourcing team with limited resources. As such, the decision support tool has helped us quickly identify suppliers with very low spend in the leverage and bottleneck segments that produce products that Wood Dale could produce in the short or long term. Two prime examples are suppliers C and D, both located in southeast Asia with estimated annual spend less than $500k at each spread across less than approximately 25 SKUs. All the SKUs fall into Wood Dale manufacturing's core capabilities and would run on machine groups with capacity available.

6.2.3 International Import Reduction

Finally, given the business' assessment of the geopolitical risk of supplier in southeast Asia, particularly those based in China and Taiwan, we were able to utilize the decision support model to do full country-level evaluations of the supply base in the region. Specifically in China, one supplier (Supplier E) comprises approximately 70% of estimated annual spend in the country and as a result of the current tariffs in place and increasing shipping times, the business has felt a significant impact on both margin and inventory. Using the framework and tool developed as part of this work, the business was able to segment the approximately $3 million spend with Supplier E and identify approximately $1 million dollars of spend that could be transferred to Wood Dale based on current capabilities and capacity at or below the current total landed cost from Supplier E.

6.2 Long Term Business Opportunity

As we uncovered the immediate business opportunities above in 6.1 Immediate Business Opportunity, it became apparent that there are several opportunities for future work in this area to further maximize the business impact. We have identified four areas of long-term opportunity and future work that are detailed below.

First, there is a clear opportunity to expand the scope of this work to include a capability and capacity analysis for the Barton Cold Form internal manufacturing business. For this addition to be most successful, however it will be necessary for the international business to finalize the convergence on one ERP system for their distribution business.

Second, there is an opportunity to include indirect costs in the TCO model to better quantify the impacts of supplier performance. This additional functionality rests on the successful development and implementation of an updated supplier scorecard model and tool (one centralized system is not currently in use in the Americas business). The supplier development team is actively working on the supplier scorecard update to include performance, quality, delivery, and risk metrics that can be incorporated into future versions of the strategic sourcing framework and decision support model.

Third, as the strategic sourcing team continues to consolidate the supply base and build stronger relationships with a smaller number of suppliers, it will likely become possible to incorporate a better understanding of external supplier capability and capacity into the framework and decision support model, enabling this work to transform from a classic make vs. buy effort to a much broader strategic sourcing effort across the entire supply base.

Finally, as the Optimas business continues to explore the optimal level of vertical integration through this and other work, there remains significant opportunity within the internal suppliers (Wood Dale and Barton) to improve their competitiveness. This includes dramatic lead time reductions through supply chain velocity improvements that could result in significant outperformance compared to external suppliers. This also includes upgrading the facilities' current production equipment and adding additional capabilities to improve the set of items that can be produced and the speed at which they can be produced. Additionally, utilizing the foundations of the conversion cost model developed as part of this work, the internal suppliers should continuously focus on cost improvements just as external suppliers would. Wood Dale and Barton's continued push toward operational excellence will only enhance the benefits of the level of vertical integration explored in this work.

7 Conclusion

In conclusion, the work presented in this thesis displays the impact of applying strategic sourcing methodologies in businesses with both distribution and manufacturing capabilities for relatively simple finished goods such as external threaded fasteners. Through the application of these methods in the unique business context observed, it is possible to appropriately optimize and leverage the level of vertical integration in the right product categories to achieve a financial and competitive advantage. Especially as supply chains retool themselves for an appropriate balance of efficiency and resiliency following the COVID-19 pandemic, we will continue to see companies like Optimas working on similar make vs. buy and strategic sourcing initiatives including insourcing, reshoring and nearshoring, and dual sourcing. By taking advantage of these opportunities, firms can capture benefits such as improved margin, reduced average inventory requirements, improved competitive position within the market and with customers, and better supply chain coordination.

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Appendix A: Decision Support Model SQL Query

```
Select  a.[ITEM_NBR]
              ,a.[DESTINATION_LEGACY_LOC_CODE]
              ,a.VendorNBR
              ,[DESTINATION_LOC_NAME]
              ,[CONTROL_TYPE]
              ,[SERVICE_CLASS]
              ,[EO_FLG]
              ,c.[CUSTOMER_NBR]
              ,[CUSTOMER_NAME]
              ,c.[SALES_PREFIX_CODE_NAME]
              ,[Avg_Unit_Sales_Price]
              ,([Avg_Unit_Sales_Price]-[BASE_COST_VEND]) as Est_Unit_Margin
              ,[VENDOR_NBR]
              ,[VENDOR_NAME]
              ,[MIN_LEAD_TIME]
              ,[MINIMUM_ORDER_QTY]
              ,[Base_Cost_VEND]
              ,[LocOHQTY]
              ,[LocOHValueUSD]
              ,[QTYonOrder]
              ,([QTYonOrder]*[POUnitPrice]) as ValueonOrderUSD
              ,QTYOrdered
              ,QTYReceived
              ,POSpend
              ,[StatFrcst]
              ,[WorkingFrcst]
              ,[PrevconsFrcst]
              ,[CustFrcst]
              ,[HistSales12Mo]
              ,(([PrevconsFrcst]+[HistSales12Mo])/2) as CalcEAU
              ,[PartWeight]
              ,j.[LOC_COUNTRY_CODE]
              ,[COUNTRY_CODE]
From
/*** Start with item sourcing records for Item NBR, Location, Vendor, Lead Time, Primary
Customer Number ***/
(Select [INACTIVE_FLG]
      ,[ITEM_NBR]
      ,[DESTINATION_LEGACY_LOC_CODE]
      ,[DESTINATION_LOC_NAME]
      ,Left([Vendor_NBR],6) as VendorNBR
      ,[SOURCE_LEGACY_LOC_CODE]
      ,[SOURCE_LOC_NAME]
      ,[BUYER_NAME]
      ,[CONTROL_TYPE]
      ,[CONTROL_TYPE_DESC]
      ,[INTERVAL]
      ,[REVIEW_PERIOD]
      ,[PUSHOUT_FLG]
      ,[MIN_LEAD_TIME]
      ,[AVG_DELAY]
      ,[QA_TIME]
      ,[SERVICE_TIME]
      ,[TRANSIT_TIME]
```

```
      ,[SERVICE_CLASS]
      ,[PRIMARY_CUSTOMER_NBR]
      ,[MEMO]
      ,[LAST_USER_NOTE]
      ,[CYCLE_COUNT_CLASS]
      ,[PROCUREMENT_METHOD]
      ,[FIXED_STOCK_LEVEL_DESC]
      ,[FIXED_STOCK_LEVEL_CODE]
      ,[FIXED_STOCK_LEVEL]
      ,[PUSHOUT_FLG_DATAMART]
      ,[EO_FLG_ID]
      ,[EO_FLG]
      ,[ITEM_INTERNAL_ID]
      ,[DEST_LOC_ID]
      ,[SOURCE_LOC_ID]
      ,[PROCUREMENT_METHOD_ID]
      ,[CONTROL_TYPE_DESC_ID]
      ,[FIXED_STOCK_LEVEL_DESC_ID]
      ,[SERVICE_CLASS_ID]
      ,[VENDOR_INTERNAL_ID]
      ,[VENDOR_ADDR_ID]
      ,[ENTITY_BUYER_ID]
      ,[PRIMARY_CUSTOMER_ID]
      ,[MAINFRAME_LOC_NBR_ID]
      ,[CYCLE_COUNT_CLASS_ID]
      ,[MIN_STOCK_TARGET_ID]
      ,[NOTES_USER_COMMENTS_ID]
  From [Warehouse].[vw].[ITEM_SOURCING]
  Where
       [PROCUREMENT_METHOD] Like 'Trade'
       AND [INACTIVE_FLG] Like 'F') a
Left Join
/*** Add in Vendor Cost data for MOQ and Vendor Cost by Item Number & Vendor Number
combination; FREIGHT is NOT in this cost ***/
(SELECT [Vendor_NBR]
              ,[VENDOR_NAME]
              ,[ITEM_NBR]
              ,[MINIMUM_ORDER_QTY]
              ,[Base_COST_VEND]
  FROM [IADACCES].[dlake].[VENDOR_COST]
  Where [IS_INACTIVE_FLG] Like 'F') b
On (a.VendorNBR=b.[VENDOR_NBR] AND a.[ITEM_NBR]=b.[ITEM_NBR])
/*** Add in primary customer number to sales prefix mapping ***/
Left Join
(SELECT [CUSTOMER_ID]
         ,[CUSTOMER_NBR]
      ,[CUSTOMER_NAME]
      ,[SALES_PREFIX_CODE_NAME]
  FROM [Warehouse].[vw].[CUSTOMER]) c
On a.[PRIMARY_CUSTOMER_ID]=c.CUSTOMER_ID
/*** Add in sales price ***/
Left Join
(Select [Item_NBR], AVG([ITEM_UNIT_PRICE]) as [Avg_Unit_Sales_Price] From
       (SELECT *
       FROM [IADACCES].[dlake].[ITEM_PRICES]) d
       Left Join
       (SELECT [ITEM_ID]
                     ,[ITEM_NBR]
```

```
       FROM [IADACCES].[dlake].[ITEMS]) e
       On d.[ITEM_ID] = e.[ITEM_ID]
       Where [IS_ONLINE_FLG] Like 'No' AND [IS_INACTIVE_FLG] Like 'No'
       Group By [ITEM_NBR]) f
On a.[ITEM_NBR]=f.[ITEM_NBR]
/*** Add in QTY On Hand ***/
Left Join
(Select [LEGACY_LOC_CODE]
     ,[ITEM_NBR]
     ,Sum([ON_HAND_QTY]) as LocOHQTY
     ,Sum([BIN_LOT_AMT_DAILY_RATE_USD]) as LocOHValueUSD
 FROM [Warehouse].[vw].[INVENTORY_DETAILS]
 Group By [ITEM_NBR], [LEGACY_LOC_CODE]) g
On (a.[DESTINATION_LEGACY_LOC_CODE]=g.[LEGACY_LOC_CODE] AND a.[ITEM_NBR]=g.[ITEM_NBR])
/*** Add in QTY On Order (agnostic of Vendor so we include gap buys) ***/
Left Join
(SELECT [LEGACY_LOC_CODE]
      ,[ITEM_NBR]
      ,Sum(([ORDER_QTY]-[Received_QTY])) as QTYonOrder
      ,Sum(([LINE_AMT_DAILY_RATE_USD]/[Order_QTY])) as POUnitPrice
  FROM [Warehouse].[vw].[PURCHASE_ORDER]
  Where [LINE_CLOSED_FLG] Like 'FALSE'
  Group By [LEGACY_LOC_CODE], [ITEM_NBR]) h
On (a.[DESTINATION_LEGACY_LOC_CODE]=h.LEGACY_LOC_CODE AND a.[ITEM_NBR]=h.ITEM_NBR)
/*** Add in Trailing 12 Month Spend ***/
Left Join
(Select [Legacy_LOC_Code]
              ,[Item_NBR]
              ,SUM([ORDER_QTY]) as QTYOrdered
              ,SUM([RECEIVED_QTY]) as QTYReceived
              ,((SUM([LINE_AMT_DAILY_RATE_USD]) / 7) * 12) as POSpend
From [Warehouse].[vw].[PURCHASE_ORDER]
Where ([STATUS] Not Like 'Closed' OR [STATUS] Not Like 'Pending Supervisor Approval')
AND [Created_DT] <= '2022-07-31' AND [Created_DT] >= '2022-01-01' /*(SELECT DATEADD(YEAR,
-1, GETDATE()))*/
Group By [Legacy_Loc_Code], [ITEM_NBR]) o
On (a.[DESTINATION_LEGACY_LOC_CODE]=o.LEGACY_LOC_CODE AND a.[ITEM_NBR]=o.ITEM_NBR)
/*** Filter for only locations in AMER (US/CAN/MEX) ***/
Inner Join
(SELECT [LEGACY_LOC_CODE]
      ,[LOC_COUNTRY_CODE]
  FROM [Warehouse].[vw].[LOCATIONS]
  Where [LOC_COUNTRY_CODE] Like 'US' OR [LOC_COUNTRY_CODE] Like 'CA' OR
[LOC_COUNTRY_CODE] Like 'MX') j
On a.DESTINATION_LEGACY_LOC_CODE=j.LEGACY_LOC_CODE
/*** Add in EAU by Part Number ***/
Left Join
(SELECT [ITEM_I]
      ,SUM([STAT_FRCST]) as StatFrcst
      ,SUM([WORKING_FRCST]) as WorkingFrcst
      ,SUM([PREVCONS_FRCST]) as PrevconsFrcst
      ,Sum([CUST_FRCST]) as CustFrcst
  FROM [IADACCES].[dbo].[IA_VTOOLS_GRP_DCH_FRCST_NA]
  Where [LOAD_DATE] >= '2022-07-10' /*(SELECT DATEADD(DD,-(DATEPART(WEEKDAY,
GETDATE())+6)%7, GETDATE()))*/  AND [FRCST_DATE] <= (SELECT DATEADD(YEAR, +1, GETDATE()))
  Group By [ITEM_I]) i
On a.ITEM_NBR=i.[ITEM_I]
/*** Add in Sales Orders by Part Number ***/
```

```sql
Left Join
(Select [Item_NBR]
              ,Sum(HistSales12MoCust) as HistSales12Mo
From
((SELECT [ITEM_NBR]
              ,[Customer_NBR]
      ,SUM([BILLED_QTY]) as HistSales12MoCust
  FROM [Warehouse].[vw].[SALES_INVOICE]
  Where [SHIP_DT] >= (SELECT DATEADD(YEAR, -1, GETDATE())) AND [SHIP_DT] <= GETDATE()
  Group By [ITEM_NBR], [Customer_NBR]) k
Inner Join
(Select [Customer_NBR]
       ,[SALES_PREFIX_CODE_NAME]
From [Warehouse].[vw].[Customer]
Where [SALES_PREFIX_CODE_NAME] Not Like '%OPTIMAS%') p
On k.[Customer_NBR]=p.[Customer_NBR])
Group By [Item_NBR]) q
On a.[ITEM_NBR]=q.[ITEM_NBR]
/*** Add in Part Weights ***/
Left Join
(SELECT [Item_NBR]
       , Cast([Weight] As Float) as PartWeight
 FROM [Warehouse].[vw].[Items]
 Where [IS_INACTIVE_FLG] Like '0'
       AND Cast([Weight] As Float) > 0) m
On a.[Item_NBR]=m.[Item_NBR]
/** Add in Vendor Location **/
Left Join
(Select [Vendor_NBR] as Vendor
       ,[COUNTRY_CODE]
From [IADACCES].[dlake].[Vendor]) n
On a.VendorNBR=n.Vendor
Order By a.VendorNBR Asc
```