# Reimagining Procurement: Differentiated vs Standardized Services

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SUBMITTED TO THE PROGRAM IN SUPPLY CHAIN MANAGEMENT
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF APPLIED SCIENCE IN SUPPLY CHAIN MANAGEMENT
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

May 2023



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**Abstract**

Our sponsor company is a leading player in the healthcare market. Its procurement organization is split into three divisions: corporate, business unit, and global services. The procurement strategy is set by corporate procurement, and then business unit and global services perform the procurement execution, and measure their procurement through metrics in experience, efficiency, and effectiveness. Our main question was whether the policies set by corporate procurement, such as supplier segmentation, are beneficial to those metrics in procurement execution, and whether the procurement process could be re-engineered to improve those metrics. We conducted an analysis of transaction data, created a Value Stream Map, and utilized process mining technology to assess the current process. We then used the principles of process re-engineering to redesign the end-to-end process. We concluded that the policies set by corporate procurement were not beneficial to procurement execution metrics, as the most effort was being placed on the least important segment of suppliers. We created a re-engineered process, which promotes technology such as machine learning, which could lead to improved procurement process metrics.

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## Acknowledgements

We want to thank our capstone advisor, Dr Chris Caplice, who provided invaluable advice and support throughout our project.

We would like to thank our sponsor company for giving us the opportunity to work on a complex, real-world problem. We would especially like to thank all the individuals at our sponsor company who generously gave their time to help us understand their organization.

We would also like to thank Toby Gooley who helped us improve the quality of the writing and content within this report.

Last but not least, we would like to thank our families and friends who have always been there when we needed them.

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# 1 Introduction

## 1.1 Motivation

Consumer health needs are constantly evolving to cover additional concerns and products. McKinsey (2020) attributes this evolution to an aging population, a boom of new health products and services, and the proliferation of accessible health data during the information age. Consumers are all striving to have control over their own health and longevity. Health companies are playing an instrumental role in expanding this wellness market by both generating and answering this consumer demand.

As a leader in the wellness market, our sponsor company's vision is to "improve access and affordability, create healthier communities, and put a healthy mind, body and environment within reach of everyone, everywhere." Founded in 1886, their products span from medical devices to consumer-packaged goods to pharmaceuticals. In 2021, they ranked #36 on the Fortune 100 company list with an annual revenue of $94B. Their procurement organization is instrumental in supporting those products and controls $35B worth of their spending as a company across about 45,000 suppliers. Recently the procurement division helped successfully create a new Consumer Health Company, demonstrating their ability to support the growth of the health conglomerate (sponsor company website, 2022).

Procurement at our sponsor is split into three different operating divisions: Global Services, Business Units, and Corporate. Global services division contains all the tactical functions associated with making purchases, such as generating purchase orders, guiding contracting processes, and managing the requisition-to-pay process. The Business Units operating division is responsible for the sourcing within the individual categories of goods & services at the sponsor company. Processes for these two divisions are standardized at the corporate level, which functions as the Center of Excellence (COE) for people, processes, data science, and analytics (sponsor, personal communication, September 29, 2022).

Corporate procurement has chosen to partner with MIT to improve on the three Es of their processes: experience, efficiency and effectiveness. Our sponsor has been continuously iterating their procurement processes over the last few years and is now looking for an objective, outside perspective on where further improvements can be made. We hypothesize that the sponsor company can achieve a significant improvement on their 3 E metrics by identifying and removing inefficiencies from their procurement execution processes.

### 1.2 Problem Statement and Research Questions

Corporate procurement has created a taxonomy of processes that covers all divisions and begins in spend management (upstream) at the strategic level and ends in source-to-settle (downstream) during execution. This taxonomy includes different accountabilities for all three divisions. These processes are structured sequentially, as they occur one after the other with little overlap, which creates potential for inefficiencies in resources and time.

Furthermore, with many of the strategic sourcing activities taking place within the spend management processes, there may be a disconnect between the prioritization of suppliers in upstream processes vs downstream processes. While the company segments their suppliers strategically during the spend management phase, they assume the suppliers are treated all the same in execution.

The questions that we will answer in this capstone are as follows:

1. Are suppliers in different segments treated differently? How do performance metrics vary in execution across the segments of suppliers?

2. What are the inefficiencies in the current procurement process at the sponsor company? How can the process be reorganized, and resources reallocated to align with strategic goals?

We researched these questions by first analyzing transaction-level data and identifying trends in metrics from the 3 E's for different segments of suppliers. Next, we performed Value Stream Mapping of the end-to-end procurement process to understand these trends and be able to explain the differences between the segments. Then, we utilized process mining to augment our knowledge of the procurement process and further identify inefficiencies. Lastly, we re-engineered the procurement process and recommended principal metrics to measure success. Our results will help the organization save money by reallocating resources from non-value add tasks to strategic projects.

# 2 State of the Art

To help us re-imagine the procurement processes at our sponsor, we researched several topics to understand the accepted best practices in these areas. We discuss these topics each in turn in the sections below.

### 2.1 Procurement Organization

At its simplest, procurement is the function and general process at an organization that buys goods or services to support the business. Simfoni (2022) notes that there are several different types of procurement: direct, indirect, goods, and services but the activities contained within them are consistent. Thus, procurement can also be defined as "the successful completion of a series of activities that cut across organizational boundaries [and are] consistent with user requirements" (Novak and Simco, 1991). This definition persists regardless of the type of good or service being purchased.

Two key factors that should determine the specific tasks required to complete a purchase are the amount of time and information. This amount is dependent on the characteristics of the good or service that needs to be purchased. For example, if the service has never been purchased before, the time needed to properly complete the transaction as well as the information around the transaction will both be high. Similarly, if the new service is deemed extremely important to the firm, the time and information investment will continue to be high. A specific series of procurement activities can correspond to the service specifically labeled as new and important. (Novak and Simco, 1991)

Basic procurement includes some variation of the following steps:

1. Identify needs within the organization and create internal categories,
2. Create a purchase request with user requirements,
3. Evaluate suppliers that meet those requirements,
4. Negotiate with the supplier to make a purchase, and
5. Create a purchase order and execute the transaction.

These steps may differ in complexity based on factors such as the size, structure, and industry regulations for a company (BillieMead, 2022). As a very large, global, and complex organization, the sponsor divided its procurement execution processes into three areas: R2P (Request to Pay), Sourcing and Contracting. Ownership of each process was given to specific individuals to lead teams in these areas. Understanding the decisions, tasks, metrics, and inefficiencies individuals utilize within these three teams is paramount to reimagining the procurement processes in our capstone.

### 2.1.1 Successful Procurement Organizations

Mature procurement organizations share several key attributes. Categories are managed at the correct geographic level, with some categories requiring local knowledge while others need to be managed globally to benefit from scale of economies. This decision requires documentation of category information. The procurement process itself must also be clearly defined and everyone should understand their responsibilities within that process. These responsibilities need to be coordinated at the local and global level and every individual must operate by a set of guiding principles. Lastly, organizations must assess the skills of their procurement employees and create plans for improvement, while continuously attracting top talent from inside and outside the company (Neuhaus, Schmitz, and Umbeck, 2014).

Other considerations that modern procurement leaders should take when shaping organizational processes center around post-pandemic market conditions. Taking steps to build resiliency into the supply base should be a major focus. Understanding which categories have had major market shifts and re-evaluating strategies within those categories, including budgeting and changing supplies, would help instill a culture of savings. Another important step would be to focus on key relationships with suppliers to help foster innovation and build value. Leveraging digital analytics would help control spend and enable employees to make quicker decisions from anywhere they are working. Lastly, utilizing agile methodologies to accelerate important projects will differentiate procurement as continuously improving department (Ahuja et al, 2020).

Understanding the qualities of a successful procurement organization helps give context to the structure of our sponsor’s processes. However, the complexity of the organization and the number of stakeholders within procurement has created inefficiencies, even while maintaining many hallmarks of a successful procurement organization.

## 2.2 Supplier Segmentation

The benefits of supplier segmentation are well documented. Porteous (2022) lists these benefits as “reduced costs”, “process improvements” and “encouraging innovation in products and services”. Overall, segmentation allows an organization to prioritize suppliers that are important to them. High-priority suppliers will be managed more closely to ensure mutual success, as they most closely resemble the priorities of the entire organization. Stronger relationships with these key suppliers will facilitate information sharing and help improve visibility in key categories, as well as foster innovation. High-priority suppliers can also pose threats to stability due to their criticality, and therefore require extra attention and resources. The process of segmentation itself can highlight these risks at the most important suppliers (PASA, 2021).

### 2.2.1 Matrix Method

There are several methodologies for segmenting suppliers. The most common is a matrix approach similar to the Kraljic Matrix, which is a two-by-two grid with profit impact on the y-axis and supply risk on the x-axis (Prokuria, 2021). The Kraljic Matrix (see Figure 1) is intended to segment products for a company but can be applied to suppliers with some slight modifications: the y-axis becomes value while the x-axis becomes spend. According to Porteous (2022), “Value is defined as how important a supplier is in terms of business continuity.” The top right corner, therefore, represents strategic suppliers that are critical to the company’s ability to operate successfully. The most resources should be devoted to managing the suppliers that correspond to the suppliers in this quadrant, while the proportion of the overall number of suppliers is typically about 10-15% (Porteous, 2022). Diagonal to this quadrant is the non-critical suppliers quadrant, which represents the low value and low spend suppliers. These suppliers should require the fewest resources to manage. The other two quadrants, leverage suppliers (high value and low spend) and bottleneck suppliers (low value and high spend) fall somewhere in between the previously mentioned quadrants for amount of required resources.

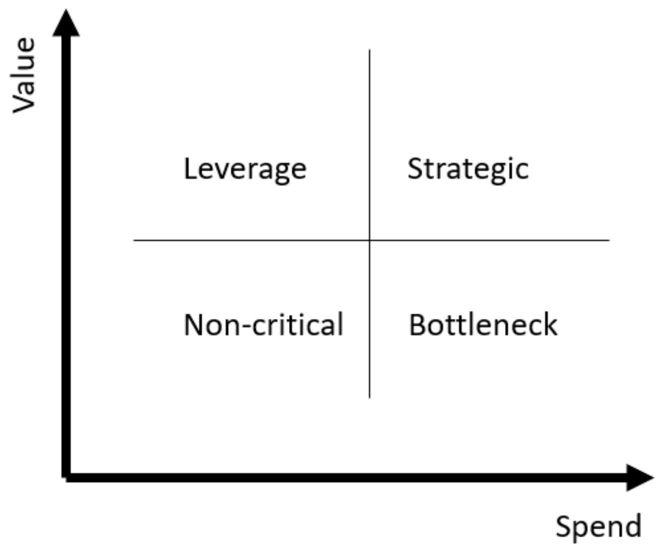



**Figure 1** *Supplier Matrix Segmentation*

*Note.* Adapted from SCMDOJO. (2022). *3 Types of Supplier Segmentation Matrix You Can Use to Classify Suppliers.* https://www.scmdojo.com/supplier-segmentation/.

### 2.2.2 Other Methodologies

Organizations may choose to use alternative segmentation methods based on their maturity and preferences. There are many other factors to consider while segmenting suppliers. One example is by Supplier Performance Management Actions. This matrix (see Figure 2) considers "number of resources and time to invest in the development and management of supplier relationships alongside the procurement expertise level" (Ahmed, 2022). On the y-axis, the matrix examines the strategic importance of each supplier, and on the x-axis, the dependence on the supplier. The resulting segmentation suggests strategies for measuring performance management for each type of supplier.

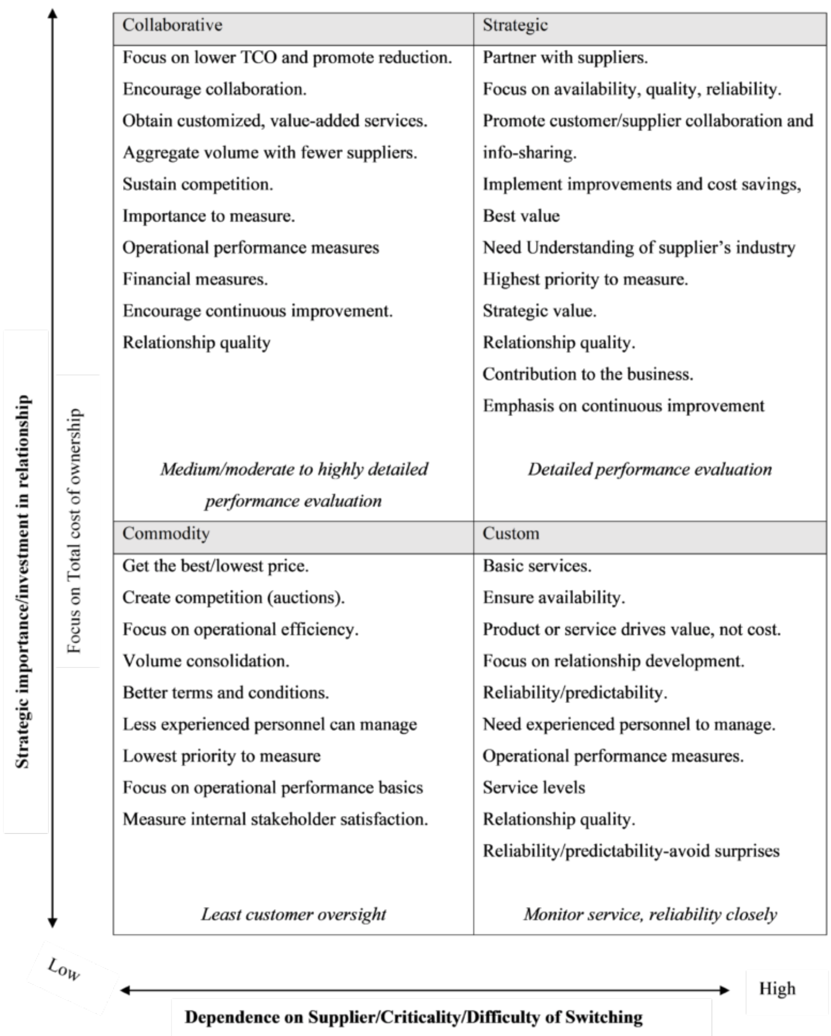



**Figure 2** Supplier Performance Management Actions Matrix

*Note.* From SCMDOJO. (2022). *3 Types of Supplier Segmentation Matrix You Can Use to Classify Suppliers.* https://www.scmdojo.com/supplier-segmentation/.

One simple but effective method for supplier segmentation is the pyramid method. One key aspect of the pyramid is that “as we move up the pyramid, the value of suppliers increases and the number of suppliers in that category decreases” (Porteus, 2022). Organizations can decide how they want to define these tiers, and some factors that can be considered are spend, complexity of products purchased, risk, and potential. Typically, this method is common with smaller organizations (Porteus, 2022).

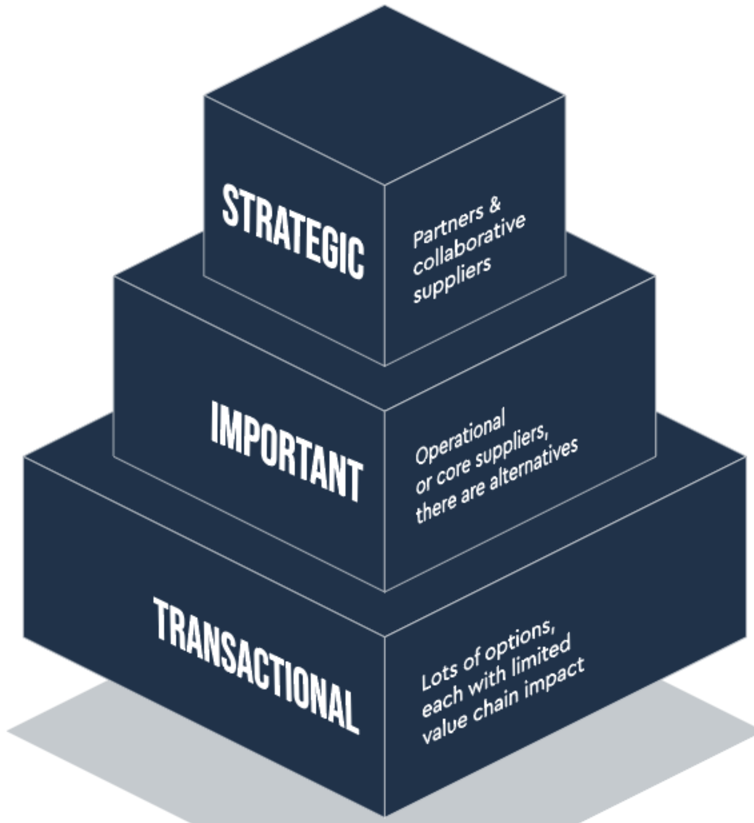



**Figure 3** Segmentation Pyramid

*Note.* From Sievo. (2022.) *Supplier Segmentation 101- Strategic Suppliers and Future Success.* https://sievo.com/blog/supplier-segmentation-101-strategic-suppliers-and-future-success.

### 2.3 Buying Channels

Traditionally, the procurement function at various companies has relied on a one-size fits all approach to buying goods and services. This approach means all requisitioning requests would go through the same process sequence of sourcing, contracting, ordering, receiving, invoicing and payment irrespective of the nature of the request. As this approach does not consider the specific nature of the request, it can cause inefficient allocation of organizational resources, long cycle times for the request to be completed and a frustrating experience for the requestor who may resort to maverick spending to bypass the process.

According to Karumsi and Prokopets (2020), a total of 56% of survey participants indicated that B2B buying processes do not adequately fulfill their requirements. To tackle this issue, Corporate Procurement can revamp its systems, procedures, and abilities by applying the insights gained from B2C (Business to Consumer) retail experiences. This also entails adopting a customer-centric approach, where the design is tailored to cater to the customers' needs and actions.

One way to improve the purchasing experience is by implementing buying channels. Buying channels are different variations of procurement process flows, where each flow caters to a certain type of purchase request (Karumsi and Prokopets, 2020). By assigning a purchase request to the right flow, the procurement function can eliminate unnecessary “touches,” complete requests more quickly and cheaply and provide a better experience to the requestor. A touch is any instance during the flow of a transaction where human intervention takes place.

Dovgalenko (2020) mentions five main types of buying channels along with examples:

1) Hands-free: ordering off a catalogue, direct orders from Material Requirements Planning system
2) No Purchase Order: corporate charge cards, petty cash expenses
3) Category Specific: Travel management portal
4) Vendor-managed: Vendor Managed Inventory/Consignments
5) Buyer-assisted: Purchase Requests routed by buyers to specific suppliers

The buying channels above are listed in increased order of complexity of transactions. Organizations benefit when they find ways to purchase goods and services using a more efficient buying channel.

Buying channels differ by organization. As part of this capstone, we will review the buying channels in use at the sponsor company and look at opportunities to improve them.

**2.4 Procurement Metrics**

An organization's priorities are reflected in the metrics it decides to measure. Therefore, it is important that the procurement function select the "the right set of priorities to drive value to the organization" (Belz et al., 2022)

One approach to selecting the right things to measure is to focus on the 3 E's of business value: efficiency, effectiveness and experience. (Sied, 2020) Peter Drucker (The Effective Executive, 2006) defines efficiency as *doing things right* and effectiveness as *doing the right things*. To elaborate, effectiveness measures the extent to which desired outcomes are achieved. Efficiency measures the amount of resources (people, time, money) expended on delivering a task. (Stack, 2016)

While effectiveness and efficiency metrics are inwardly focused, experience is customer-centric. For the procurement function, a customer is anyone who uses procurement services. These customers can be internal, for example, a requisitioner or a procurement associate, as well as external, e.g., suppliers. Experience metrics are important but can be harder to measure (Sied, 2020). According to Goddard (2014), organizations that create the most wealth are the ones that prioritize value to customers over internal efficiency.

Sied (2020) details the metrics, as shown in Table 1, while clarifying that "the 3 E's of value are not mutually exclusive":

Table 1: The 3 E's of Value

| Value Driver | Definition | Leading Measures | Lagging Measures | Initiative Keywords |
|---|---|---|---|---|
| Efficiency | Doing things right | Cost Savings, Cycle Time reductions | Margin improvement, Price reductions | Lean, Cost optimization, Operational Excellence |
| Effectiveness | Doing the right things | Accuracy Improvements, Defect rates | Better performance, Higher Quality, Better forecasting | Continuous improvement, Six Sigma, A3, decision support, benchmarking |
| Experience | Connecting efficiency and effectiveness to drive customer adoption | Efficiency, Effectiveness, Response times, Customer Experience Index, Net Promoter Score | Increased loyalty of existing clients, Increased Sales to net new client, Price Elasticity, Customer-centric innovation | Know your customer, consumer journey mapping, |

**Table 1** The 3 Es of Value

*Note*. From "*Efficiency, effectiveness, experience: The 3 E's of value creation"* by Sied, M.(2020). Ashling Partners. https://www.ashlingpartners.com/better-faster-stronger/.

## 2.5 Process Improvement

In our capstone project, we investigate how existing sponsor processes can be improved and differentiated based on supplier strategy. White (2019) defines process improvement as "the business practice of identifying, analyzing and improving existing business processes to optimize performance." This performance can be measured along multiple metrics as mentioned in the section above.

During our research, we found most of the process improvement literature and methodologies had its origin in the manufacturing function. However, the same ideas can be applied to procurement as well. According to Friedman & Kochersperger (2018), industrial direct procurement employees process improvement methods much more widely, owing to “its proximity to manufacturing”, as compared to other types of procurement. A radical version of process improvement, called process reengineering, was proposed by Hammer (1990) as: “finding imaginative new ways to accomplish work.”. He recommended harnessing the power of technology to thoroughly “redesign business processes... to achieve dramatic improvements”.

Process improvement can bring great benefits to the procurement function. Sheinfeld & Forman (2022) found that while procurement leaders focus primarily on sourcing and “buying better”, “more than 60% of the total value stems from operational efforts” or to put it in another way, spending better. Analyzing how organizations spend their own money can lead to significant savings and operational efficiencies.

Some of the methods that are commonly used are value stream mapping process mining are discussed below.

### 2.5.1 Value Stream Mapping

Value Stream Mapping (VSM) is a method used in lean management to map the as-is process by creating a physical map of each step. As noted by Simonsson et al. (2012), in this method the team should meticulously examine every phase to identify which aspects of the procedure can be shifted, streamlined, or completely eliminated. Each step is evaluated closely for the value it adds to the process. Teams create visualizations of the process from start to the end product to help see inefficiencies and redundancies. Key components include the customer (party that initiates the process), trigger (signal that begins the process), first step, last step, and end product. While VSM can create an effective result, the exercise can be very manual and arduous (Simonsson et al., 2012).

### 2.5.2 Process Mining

A more efficient way to create a process map is through Process Mining. This technology uses time-stamped, historical, transactional data to create a flow of the process along with all its variations. Comparison of the outputs of VSM and process mining can provide useful insights (Mertens et al., 2020). As Van der Aalst (2012) stated, “The idea of process mining is to discover, monitor and improve real processes (i.e., not assumed processes) by extracting knowledge from event logs readily available in today's (information) systems.”

Since process mining creates process maps based on time stamped event logs, the resulting flow diagram is very close to reality. Once the model is created, users can check it against the actualities of the process.

Lastly, users can enhance the model with additional data. Since the whole process combines these steps, this methodology combines business intelligence, process mapping, and data mining to create realistic process maps (Van der Aalst, 2012).

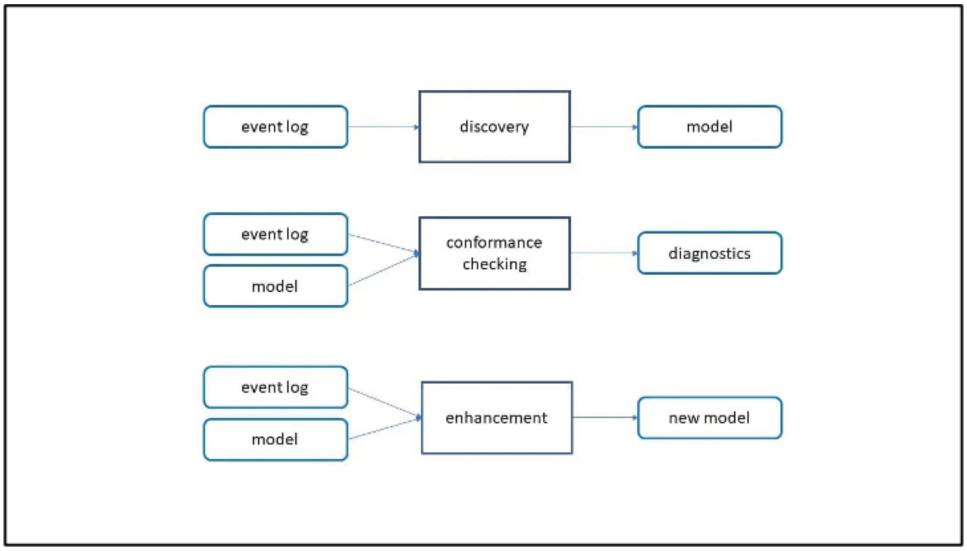



**Figure 4** Types of Process Mining

*Note.* Three types of process mining: discovery (extraction of transaction data to create a process model), conformance checking (comparison of an organization's standard process model to the model creating using process mining) and enhancement (use the output of conformance checking and any additional information to optimize the process). From IBM. (2023). *What is Process Mining?* https://www.ibm.com/topics/process-mining

Process mining is highly relevant to our capstone as a method to be able to evaluate complex processes with many steps, parties, and systems. This method allows us to combine disparate data sets across the sponsor company to find consistent measures of efficiency, effectiveness, and experience.

### 2.5.3 Process Re-engineering

Process Re-engineering is a management approach focused on analyzing and redesigning the core business processes within an organization to achieve significant improvements in efficiency, effectiveness, and customer satisfaction. This method attempts to "compress linear processes" (Hammer, 1990) and move to a cross-functional, global model around a particular outcome. Anyone who requires the output of a process for their role is enabled, with technology and data, to perform that process on their own. In addition, all data that a particular cross-functional team produces is also managed by them and they are also completely aware of any parallel activities running with other teams. This team is enabled to make decisions about their own work instead of receiving hierarchal directives (Hammer, 1990). Process re-engineering typically involves the following steps:

1. Identify the processes: Determine the core business processes that need improvement or re-engineering within the organization.

2. Analyze the current state: Document and analyze the existing processes to understand their current performance, strengths, and weaknesses. This may involve collecting data, mapping process flows, and identifying bottlenecks or inefficiencies.

3. Set objectives: Establish clear goals and objectives for the re-engineering effort, such as cost reduction, improved customer satisfaction, or increased process efficiency.

4. Redesign the processes: Develop new, innovative ways to carry out the business processes, focusing on eliminating unnecessary steps, reducing complexity, and streamlining workflows. This may involve leveraging new technologies, automating tasks, or reorganizing teams and responsibilities.

5. Implement the changes: Communicate the redesigned processes to all stakeholders, provide necessary training, and execute the changes in the organization. This step may involve piloting the new processes, monitoring their performance, and making adjustments as needed.

6. Monitor and improve: Continuously track the performance of the re-engineered processes to ensure they are meeting the established objectives. Make adjustments and improvements as necessary to maintain optimal performance (Hammer, 1990).

The case for process re-engineering is strong at our sponsor company. Tasks are often performed sequentially and information loss throughout the process negatively impacts cycle time. Directives, such as supplier segmentation, often come from corporate procurement and may not be utilized by downstream teams. Process owners are often subject to tunnel vision for their own specific set of tasks, which can increase costs. For example, extended pricing negotiation time during the contracting process may result in higher overall cost of a transaction due to the increased efforts of a sourcing professional.

**2.6 Robotic Process Automation**

Robotic Process Automation (RPA) is a type of automation technology that uses software robots to automate repetitive and rules-based tasks. RPA can be easily used to automate tasks that follow certain rules, such as category cards at the sponsor. Category cards are documents that contain the rules for how sourcing associates should approach certain transactions and suppliers. RPA software can be programmed to interact with enterprise software systems, like ERP (Enterprise Resource Planning) or CRM (Customer Relations Management.) Normally, tasks within these systems would require human interaction, such as logging into different systems, copying and pasting data, and filling out forms (IBM, 2023).

RPA has become increasingly popular in recent years as a way to improve efficiency and reduce costs in business processes. The sponsor company could use RPA to automate some of their tasks within procurement that require little analysis.

# 3 Data and Methodology

This chapter describes the data and methodology used to answer our research questions. Our two key questions cover the following topics: an understanding of how different segments of suppliers are treated in the downstream procurement processes and the identification of the resulting inefficiencies in the procurement process. It contains sources of information, the software tools employed, and the different techniques used to gain insights into and improve the sponsor company's procurement process.

To understand how different segments of suppliers are treated in procurement execution, we began with understanding the procurement process end to end with qualitative interviews with process owners across Request2Pay (R2P), Sourcing, and Contracting. Then, we extracted transaction-level procurement data from process mining software tool that our sponsor used, to help us evaluate metrics within the process.

We created summary statistics for cycle time and a number of activities to understand how transactions within different segments of suppliers behave. After evaluating these statistics, we examined the steps within the end-to-end procurement process in depth across all segments of suppliers, with the goal of identifying the source of the differences in transaction performance between the supplier segments.

We performed Value Stream Mapping to understand every step of the procurement process and identify which steps brought value to the end product. Through this exercise, we saw where the manual steps and redundant steps occurred. We confirmed our findings of manual steps by looking at a report called Wait Time, which quantified the amount of idle time for a transaction in specific steps of the procurement process.

Lastly, in order to improve the identified inefficiencies within the procurement process, we reformed the process end-to-end using Process Re-engineering. The resulting process could improve cycle time and the number of activities for transactions across all segments of suppliers, and thus improve the overall buying experience for the user.

### 3.1 Data Extraction and Preparation

The process mining system was our main source of transaction and process data and played a key role in understanding how different segments of suppliers are treated in downstream procurement. We filtered the information to North American transactions for our chosen category. All data in the system covers the year 2020 and onwards. We focused on transactions that were contracted through work orders, which ensured that each case corresponded to an actual purchase. This filter eliminated any cases that were related to contract creation, with no actual purchase involved, such as the creation of a Master Services Agreement (MSA) with a supplier.

We found that there were several data points that fell far outside of the expected range of data that were skewing out results. Any data points that fell outside a specific range were removed from our analysis. To find the lower range limit, we used the equation Q1 – (1.5* IQR), with Q1 being the first quartile and IQR representing the Inter Quartile Range. Similarly, we found the higher range limit using the equation Q3 + (1.5*IQR), where Q3 is the third quartile. Any data points falling outside this range were deemed outliers and removed. We removed 10% of data while measuring the number of activities and 18% of cycle time data.

### 3.2 Cycle Time & Number of Activity Analysis

First, we examined both the cycle time and number of activities across each of the four segments of suppliers: Transact, Growth, Essential, and Emerging (see section 2.2.2) from their system. The cycle time is the number of days, from the time a request is entered in the system, until a PO is created, that a transaction spends in the procurement process. The number of activities is the number of events that occur during the time a transaction is open in the procurement process, which we used as a proxy for effort that is needed to complete a procurement request. These metrics are representative of the two of the three Es of Value: efficiency (cycle time) and effectiveness (number of activities).

Next, to be able to further compare each segment of supplier for both cycle time and number of activities, we created box plots. These plots helped us visualize the ranges, mean, median, and Inner Quartile Ranges for the transactions of different segments of suppliers. In addition to looking at the segments individually, we also created a box plot for GEE (Growth, Essential, Emerging) suppliers (see section 2.2.2) versus Transact suppliers. This view helped us visualize statistics for suppliers that are more critical to the sponsor company versus less.

Lastly, to be able to see the overlap between cycle times and number of activities, we looked at the correlation between these two metrics for the individual transactions across all segments of suppliers. Correlation helped us identify the strength of the relationship between the two metrics. We created a plot of the correlation to help us visualize how close the two metrics we measured were related. A perfectly linear, positive correlation would have meant that the cycle time and number of activities for a transaction were always increasing together. A perfect correlation could have also implied a higher likelihood of causation, which would have told us that we didn't need to look at the variables separately.

We used cycle time and number of touches as proxies for efficiency and effectiveness metrics within the 3 Es of value of the sponsor company. There are several types of data that have been used to measure experience, the 3$^{rd}$ E of value. At our sponsor, these data types were NPS (net promotor score) and CSAT (customer satisfaction). However, we found there was not enough data to use these metrics to evaluate user experience for transactions within our target category.

### 3.3 Value Stream Mapping & Process Mining

To examine the end-to-end procurement processes, we began by performing Value Stream Mapping. We identified the main tasks occurring across all downstream functions and evaluated how each step contributed to the result of the procurement process. To create this value map, we interviewed individuals from Request2Pay (R2P), Global Sourcing, Business Unit Sourcing, and Contracting (see section 2.1). We understood which metrics were important to their function within their subset of the procurement process and found that transaction cycle time spanned the entire procurement process. Once we understood each role within the procurement process, we were able to create an end-to-end map. We utilized existing process maps provided by each of the three functions interviewed and selected the steps that were significant to the end product to create a value stream map.

Next, we used the 3-step approach to process mining: process discovery, conformance and enhancement (see section 2.5.2). We mapped the flow of a transaction by using process mining to detail the end-to-end procurement process, as it exists today, for the chosen category. We compared this process map, generated by process mining, and compared it to the Value Stream Map that we created. The process mining map allowed us to see how frequently transactions followed a “normal” path through the procurement process for different segments of suppliers. Additionally, we could see which tasks were done in which procurement systems.

In addition to creating a process mining map, the system allowed us to identify the cycle time associated with different steps of the procurement process, helping us classify non-value add tasks. This metric was defined as Wait Time, which we were able to extract from the system for individual steps.  Wait Time corresponded to the number of hours a transaction spent at each step in the process flow. We identified a particular set of steps, which we classified as "nonvalue add." This set included steps that were administrative in nature and often involved a re-labeling of a transaction, which provided little value to the end product: a purchase order. One example of such a step was "Change Case Owner," which contributed significantly to the overall cycle time of a transaction but has no bearing on the final purchase order. We identified the average and total amount of time each of these re-labeling steps added to the total cycle time of a transaction. Some of these steps can be attributed to human error and represent re-work while managing a transaction. For example, the subcategory associated with a transaction may have to be changed several times within the span of a single transaction to fix initial mis-labeling. These changes add significant time to the overall cycle time of a transaction.

### 3.4 Process Re-engineering

After understanding the current procurement processes at our sponsor, as well as best practices for organizing procurement, we leveraged process re-engineering methodologies (see section 2.5.3) to re-imagine the existing processes.  The main steps included questioning all manual steps that we previously identified in the Value Stream Map, the role of everyone that was involved for each step, and the technology that was currently available at our sponsor to perform those steps. We utilized our personal knowledge of technologies to empower individuals to perform specific tasks, which allowed us to compress the end-to-end procurement process.

# 4 Results and Analysis

In this chapter, we presented the main findings of our work. We started by comparing the metrics for cycle time and number of activities for different supplier segments in section 4.1. In section 4.2, we showed the results of both Value Stream Mapping and Process Mining for identification and rectification of process inefficiencies. We end, in section 4.3, with the results of our process re-engineering.

### 4.1 Cycle Time & Number of Activities Analysis

First, we started by analyzing the cycle time and number of activities for transactions across all segments for suppliers. As demonstrated in Table 2, we found that growth suppliers had the greatest number of transactions (194) but the fewest number of suppliers (2). These two Growth suppliers are ERP and CRM software providers. Every procurement category across the company utilizes these systems; therefore, these transactions form the bulk of the dataset.

We found the longest average cycle times corresponded to the Essential and Transact supplier segments while the emerging supplier had the highest median cycle time. The longest cycle times belong to Transact suppliers. Essential and Transact suppliers also have the highest variability, as measured by standard deviation, although this could simply be due to the higher number of suppliers that constitute those segments.

The segment-wise data for number of activities performed to complete a transaction follows a pattern similar to cycle time. Transactions for essential suppliers involve the highest number of activities, on average. The transactions with the highest number of activities belong to transact suppliers. Essential and Transact suppliers show higher variability in the number of activities than growth and emerging suppliers.

| Segment | Growth | Essential | Emerging | Transact |
|---|---|---|---|---|
| # of cases | 194 | 60 | 30 | 14 |
| # of suppliers | 2 | 6 | 1 | 6 |
| CT (days) [Avg] | 18 | 70 | 43 | 68 |
| CT (day) [Median] | 10 | 39 | 42 | 39 |
| CT (day) [Lower Range] | 2 | 1 | 13 | 2 |
| CT (day) [Upper Range] | 28 | 107 | 78 | 128 |
| Standard Deviation (days) | 27 | 92 | 20 | 73 |
| # of activities [Avg] | 48 | 107 | 88 | 120 |
| # of activities [Median] | 39 | 86 | 86 | 102 |
| # of activities [Lower Range] | 29 | 49 | 60 | 47 |
| # of activities [Upper Range] | 66 | 186 | 139 | 227 |
| Standard Deviation (#) | 28 | 71 | 22 | 55 |

**Table 2** Summary Statistics for Cycle Time and Number of Activities in Supplier Segments

In our box plots (see Figures 5-8), when visualizing the segments individually, we noticed that Transact suppliers had a higher number of activities and cycle times. Similarly, the combined cycle time and number of activities for Transact suppliers versus GEE were also notably higher.

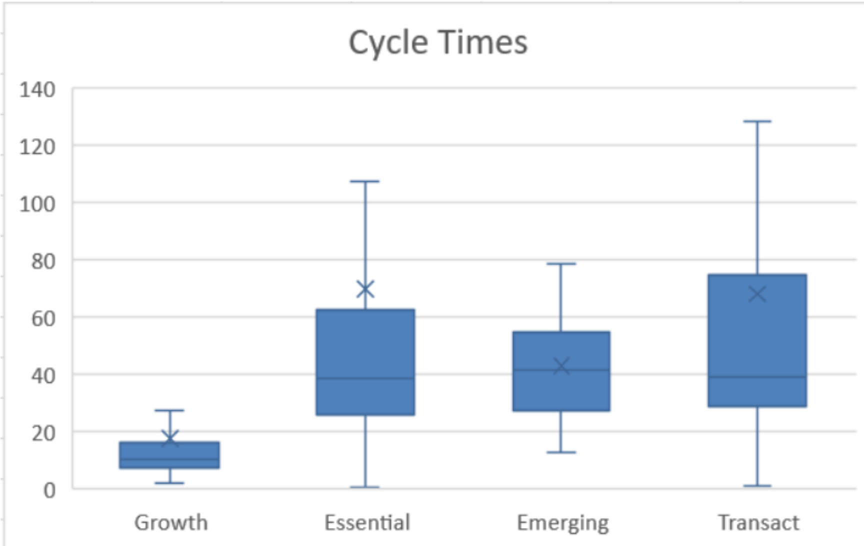



**Figure 5** Box Plots for Cycle Times of Individual Supplier Segments

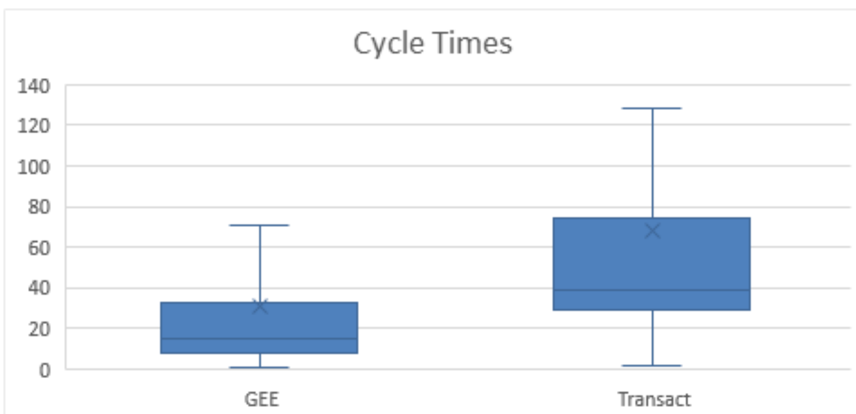



**Figure 6** Box Plots for Cycle Times of Combined Supplier Segments

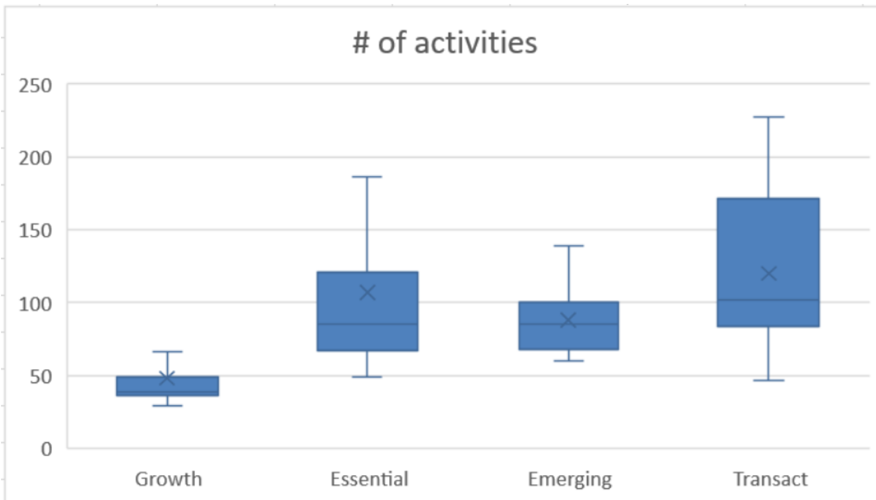



**Figure 7** Box Plots for Number of Activities of Individual Supplier Segments

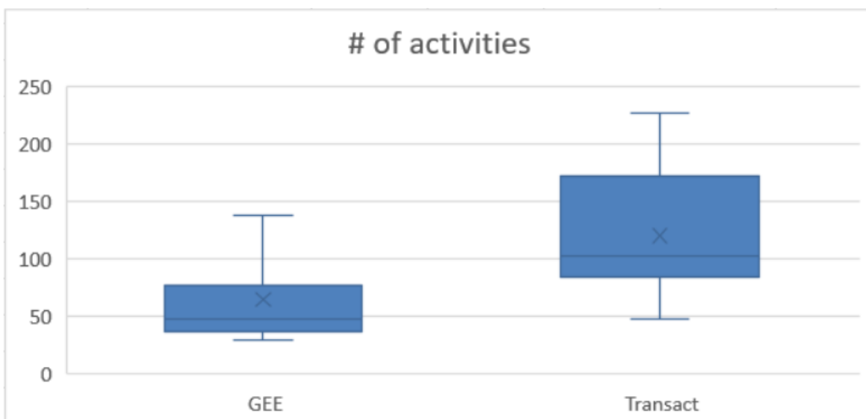



**Figure 8** Box Plots for Number of Activities of Combined Supplier Segments

In our analysis of the correlation between Cycle Time and Number of Activities (see Figure 9), we saw that there is a positive and mostly linear relationship between the two variables. We found the correlation between cycle time and number of activities to be 0.71, which indicates a fairly strong correlation.

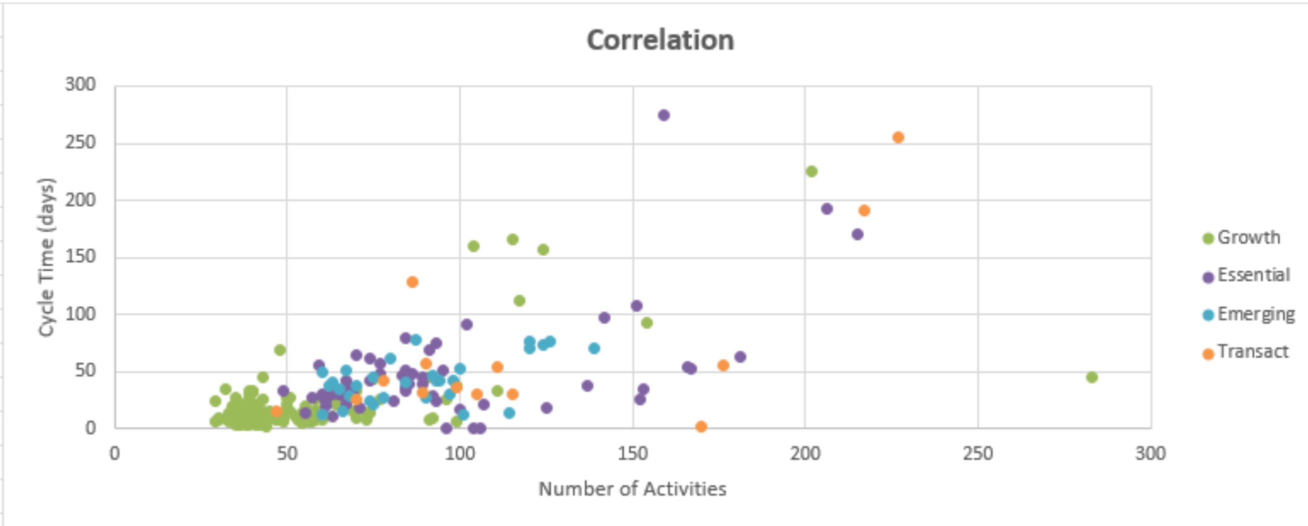



**Figure 9** Correlation Plot between Cycle Time and Number of Activities

*Note* Each segment of supplier is labeled with a different color.

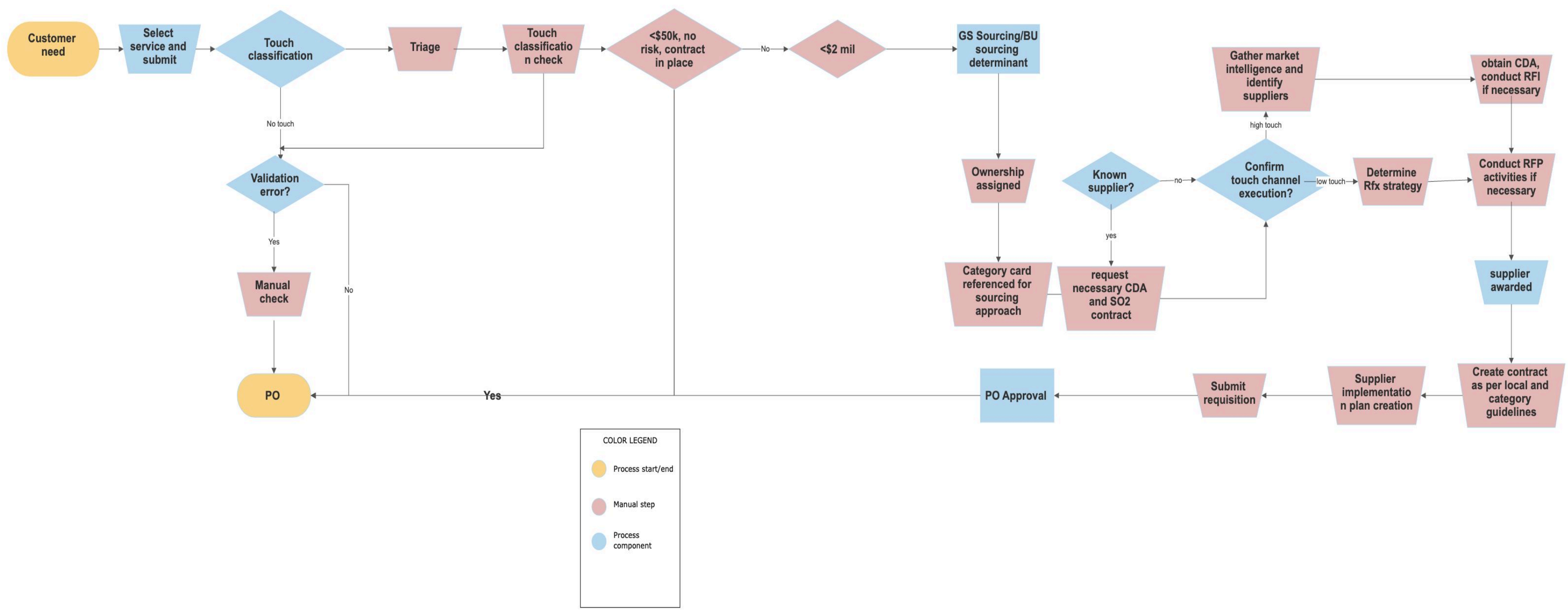
### 4.2 Value Stream Mapping

After conducting interviews with different process owners at the sponsor company, we mapped the procurement process from Request Initiation to Purchase Order Creation, as demonstrated in Figure 10. We created a Value Stream map that includes any step that brings ultimate value to the end product. We highlighted the manual steps within the process in pink, which would both add to the cycle time of a transaction across the supplier segments as well as increase the number of activities and effort for a transaction. The process begins when a user initiates a request in the system. If the service/product is available in a catalog, a PO is created, indicating a “no touch” request. Any requests that don’t match this criteria face many manual checks and re-checks throughout the remainder of the procurement process.

There are currently many stakeholders involved in the procurement process. Request2Pay (R2P) associates manage many of the manual administrative tasks at the beginning and the end of the process, including triaging the request to Global Sourcing or Business Unit sourcing associates. This delineation depends on the dollar value, risk, and contract criteria of the request. A central component that is repeatedly referenced throughout the process is the category card, which dictates how the sourcing group manages the request, the sourcing strategy, preferred suppliers, and new supplier onboarding. Both R2P and sourcing associates frequently check the category card for guidance on request management.

Figure 10

Value Stream Map




*Note* A Value Stream Map of all steps that add value in J&J's end-to-end procurement process. This process includes steps from R2P, sourcing, and contracting.

Next, we extracted and reviewed end-to-end process flows and KPI data for the our category. Overall, we found there was very little overlap in the process flow between different transactions. A process flow variant represented the specific path of an individual transaction. We were able to aggregate process flow variants and find commonalities between them. The most common process flow variant for the suppliers within the category represented less than 1% of transactions within the category. This low percentage indicates that most transactions take different paths through the procurement process. Figure 11 represents the most common process flow for all transactions within the category.

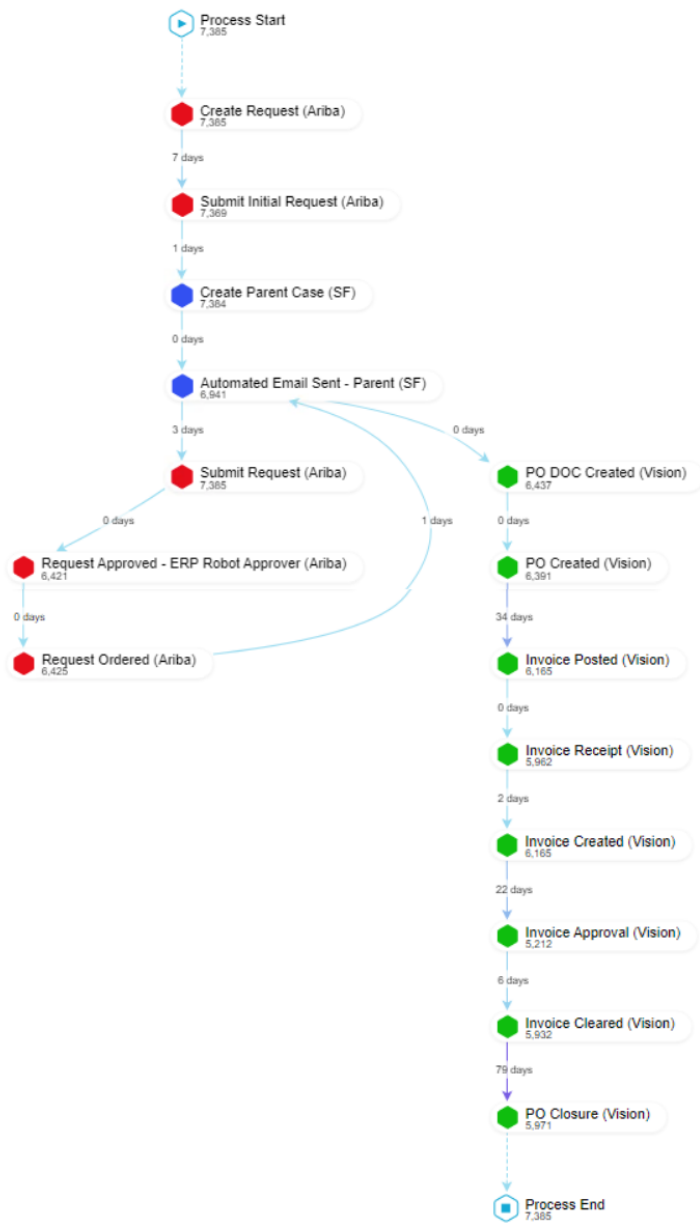



**Figure 11** Most Common Variant of Process Flow from Process Mining

*Note* The different systems in which the process steps are conducted are represented by different colors.

Looking at the process maps, we were able to identify common administrative steps. Some of the steps were re-labeling steps undertaken to fix a human error that occurred earlier in the process. These re-labeling steps add significant idle time to the overall process. As demonstrated in Table 3, these idle waiting times for re-labeling steps within the category, within the last 3 years (2020-2022), amounted to 227,495 hours. Assuming a standard 40-hour work week, this idle time translates into 5,687 weeks of work or 113 people years. This idle for this subset of steps accounted for 2.5% of total cycle time for transactions within our category.

| Activity | Sum of # Occurrences | Average of Wait Time per Step (hours) | Sum of Total Wait Time (hours) |
|---|---|---|---|
| Change Case Owner - Parent (SF) | 2,108 | 49 | 5,041 |
| Change Category - Child (SF) | 775 | - | - |
| Change Category - Parent (SF) | 2 | - | - |
| Change Category Taxonomy - Child (SF) | 106 | 39 | 382 |
| Change Category Taxonomy - Parent (SF) | 64 | - | - |
| Change Priority - Child (SF) | 719 | 151 | 54,370 |
| Change Priority - Parent (SF) | 1,182 | 56 | 10,007 |
| Change Routing Tier - Child (SF) | 1,957 | 67 | 126,630 |
| Change Routing Tier - Parent (SF) | 410 | 59 | 12,455 |
| Change Sub-Category - Child (SF) | 189 | 24 | 5,816 |
| Change Sub-Category - Parent (SF) | 1,169 | 24 | 1,710 |
| E Sign Signer Changed (Icertis) | 382 | 32 | 8,449 |
| Status - Child: Pending Supplier Add / Change Approval (SF) | 7 | 376 | 2,635 |
| Total | 9,070 | 72 | 227,495 |

**Table 3** Wait Time for Each Re-labeling Step (hours)

*Note*. Wait Time data from 2020-2022

## 4.3 Process Re-engineering

After undergoing the Value Stream Mapping process, we created a new, re-engineered procurement process flow that would reduce end-to-end transaction cycle time and the number of activities for a particular transaction, as seen in Figure 12. The new process flow relied heavily on Machine Learning (ML) classification algorithms to replace manual administrative transaction activities, particularly in the early steps. Requests were automatically augmented with suggested information, such as a supplier, and subsequent routing requires no human intervention. Other technologies that removed human touches were routing logic macros, which helped triage a request, and Artificial Intelligence, which could help gather market intelligence in the sourcing stage. Adding these technologies removed many steps from the procurement process that previously included checking and double check information entered by a human. This information was prone to errors and delays. Relying on technology would remove these steps and improve transaction metrics.

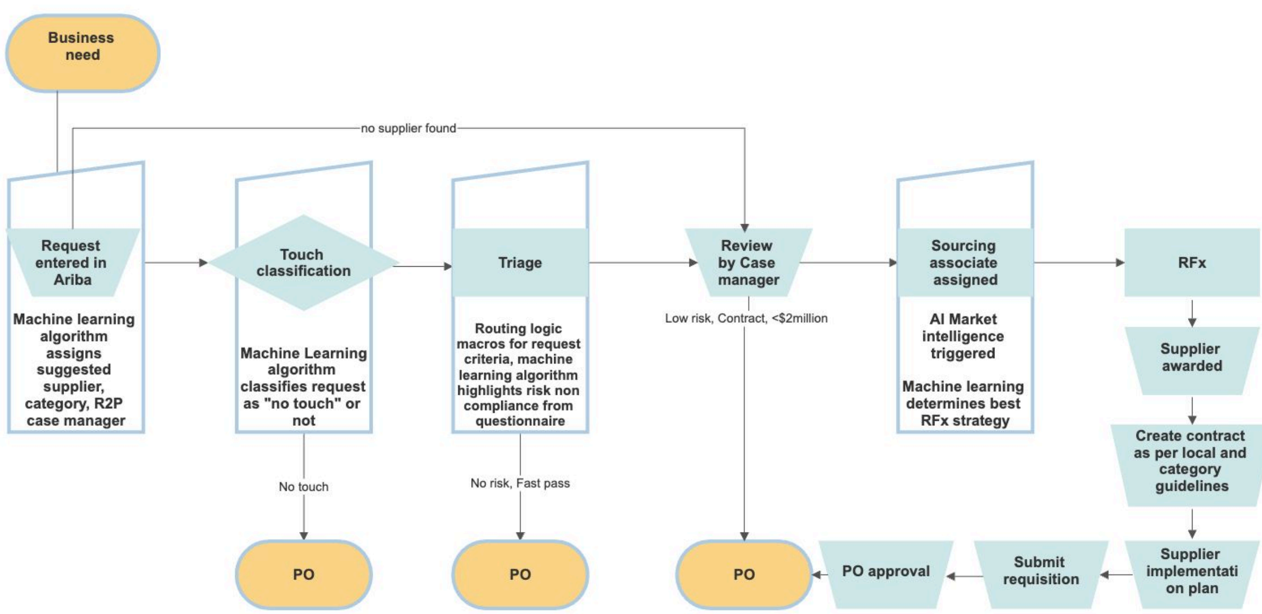



**Figure 12** Re-engineered Procurement Process Flow

The re-engineered process flow would change the roles of the parties involved on each transaction. R2P associates would act as case managers for each request, managing it from conception through Purchase Order (PO). One important responsibility of R2P associates would be to manage the principal metrics associated with each transaction. Each associate would be equipped with a case dashboard that would monitor end-to-end cycle time and number of human activities as the request progressed through the process. R2P associates would be compensated for the achievement of goals around these metrics, which would motivate the associates to focus on not only transaction speed but also information accuracy. Sourcing associates would also be compensated on the same metrics for each transaction in which they are involved. The role of sourcing associates would also change in the new process. They would only be involved in a transaction if an RFP or RFQ was deemed necessary or additional market intelligence was required. Additionally, sourcing associates would no longer fall into Global Sourcing or Business Unit sourcing roles. Each sourcing associate would be empowered with the same information to make decisions on transactions. Flattening the organization would remove the number of stakeholders included on each transaction and reduce information loss through handoffs.

# 5 Discussion

In our results we found that, overall, the most effort and the longest cycle times were both attributed to the “transact” segment of suppliers, which represents the least critical group of suppliers for our sponsor. Cycle time and number of activities have significant, positive correlation, which indicates increased process complexity and longer processing are directly related and change at a similar rate. These metrics are representative of the two of the three E’s of Value: efficiency (cycle time) and effectiveness (number of activities). The greatest amount of t, so there must be inefficiencies in the process that are creating this difference and are detrimental for both efficiency and effectiveness metrics.

Our Value Stream Map included only the steps that were significant to the result of the procurement process: the Purchase Order (P.O). We were surprised by the number of manual steps included in the procurement process that were vital to that result. Additionally, we were surprised by the number of manual steps that included checking the results of previous steps. Our sponsor company has access to significant technical resources that would have been able to automate many parts of this process, particularly use of the category card in determining the overall buying strategy for the category. Referencing the category card represented a significant number of manual steps that could be eliminated in the future. Taking into consideration both the Value Stream Map and the generated process flow from Process Mining gave us an excellent perspective on both the human and systems view of the procurement process.

We found additional inefficiencies through the Wait Time report, which helped us quantify the time lost to manual tasks within the procurement process. The scale of the number of hours included in this table was shocking, since many of these steps were related to changing details of the transaction in various software systems. Removing these hours could be an easy way to improve the cycle time for transactions across all segments of suppliers.

To remove these inefficiencies that we found through the Value Stream Map, Wait Time table, and Process Mining, we created a new, streamlined process for procurement through process re-engineering. The end goal of process re-engineering is to center the process around the customer's needs. In this case, the customer is the internal requester at our sponsor and their desired outcome is a quick, accurate, and pleasant buying experience for IT software. These attributes can be evaluated through principal metrics, which measure the success of an entire process instead of specific tasks within the process. Improving principal metrics positively impacts the result of the process, not just the specific task owner. The performance of all team members on a specific request should be evaluated on a single, cumulative set of metrics. In our case, creating an overall cycle time metric would significantly improve the customer's experience, as all request team members would be incentivized to complete the request as quickly as possible. An additional principal metric that would impact the quality of the process is request accuracy, which could be measured by the number of re-work steps required when processing a request. The fewer the re-work steps, the quicker the overall cycle time. Each party owning the request is incentivized to act quickly and accurately.

In addition to streamlined KPIs across the entire process, re-engineering calls for individual ownership of the entire process. At the sponsor company this means that the same individual would be responsible for triaging, sourcing, and contracting. If one individual is responsible for the entire journey of a request, several of the process inefficiencies could be removed. For example, information loss through handoffs and errors in triaging could both be reduced. Enforcing principal metrics across the procurement process becomes much simpler if the size of the request team is significantly reduced.

Besides simplifying the team within a request, re-engineering would mean also simplifying the hierarchal global sourcing teams that handle requests. In the sponsor's case, removing the boundary between GS and BU sourcing would simplify triaging processes, especially since the process does not change significantly between the two teams. Each sourcing individual should be enabled to handle any type of request within their category. Enabling an individual to perform all of the tasks within these processes would be easier with the use of technologies, such as Machine Learning algorithms, routing logic macros, and artificial intelligence. These technologies made a significant impact on our re-engineered process flow.

Such technologies often have drawbacks.  Machine learning models can be effectively trained to make classifications based on inputs, which could be very useful when labeling a transaction with specific attributes. However, the quality of the algorithm depends on the quality of the training data available. We had difficulty extracting transaction data from some of the sponsor's systems, that could be used to train such an algorithm. Additionally, the data we were able to use from alternate sources to inform our results represented only the past three years of transactions, so the time horizon is limited. Lastly, implementing Machine Learning and Artificial Intelligence would be time intensive and expensive, requiring specialized resources and continuous improvements. Robotic Process Automation, or RPAs, would be a bridge technology that we could recommend before the sponsor makes a full commitment to Machine Learning and AI. As previously discussed, RPAs are an inexpensive and simple way to automate manual tasks, such as checking a category card for transaction triaging instructions. Since all technologies have drawbacks, we are still confident our recommendations in the re-engineered process are appropriate.

# 6 Conclusion

In this project, we have explored the questions:

1. Are suppliers in different segments treated differently? How do performance metrics vary in execution across the segments of suppliers?
2. What are the inefficiencies in the current procurement process at the sponsor company? How can the process be reorganized, and resources reallocated to align with strategic goals?

To explore these questions, we reviewed three years of purchase request transactions and data from Process Mining. We compared procurement process duration (end-to-end cycle times) and process complexity (number of activities) across different supplier segments. We found that the company spends disproportionately more time, and hence resources, on less important suppliers. If the process can be improved, these resources can be freed up for higher value tasks.

Subsequently, we mapped out the as-is process and identified inefficiencies and redundancies. Then, we applied the principles of process re-engineering to design the process flow around the end goal, i.e., meeting the needs of the requestor accurately and timely. In essence, the new process breaks away from the siloed task-oriented approach and enables seamless process flow across the organization. We recommend deploying machine learning and AI solutions to facilitate this transformation.

Implementing the newly re-engineered procurement process would require careful planning and consideration. One strategy we could recommend would be to pilot the new process with one category, create KPIs to measure the success of the pilot, and evaluate the results with management. For our process, the sponsor company would need to create a rudimentary Machine Learning algorithm or create a “dummy” environment that would simulate the results of such an algorithm to assign categories and process owners. Some KPIs that the company could measure would be the same that we have measured throughout this report: cycle time and number of activities. Our sponsor could also add net promotor score (NPS) to measure satisfaction of users.

### 6.1 Limitations

The scope of our work was constrained by the quantity and quality of data readily available. To maintain the integrity of our analysis and comparison, we only evaluated one business category (IT software) and a single type of procurement transaction (work orders). Therefore, our data analysis applies only to a subset of the overall procurement operations in the company. Similarly, we set out to measure KPIs across the Three E's: efficiency, effectiveness, and experience, but were only able to measure the first two due to data limitations. When we explored net promoter score (NPS), we were unable to use any insights from the data since it was limited in quantity and quality. In addition, our data only represented the previous year, which was partially due to the amount of data that had been integrated into the systems we used to extract our data. However, our sponsor is currently working to improve these systems by adding additional data and reporting capabilities.

Lastly, a large, complex procurement organization brings many perspectives from different individuals. While we were conducting interviews to understand the end-to-end procurement process, we were limited by the knowledge we could gain from a particular individual, simply due to their personal bias and past experiences. Our initial understanding of the procurement process relied heavily on the information provided by these individuals, so undoubtedly, some of their biases were passed on to us and our final recommendations.

### 6.2 Future Opportunities

Further research could expand our work. Possible lines of inquiry may include analyzing the direct material procurement process and assessing opportunities for re-engineering it. We focused on indirect procurement because of the complexity of the end-to-end process, and the potential for improvement, but the direct procurement process could also have potential for re-engineering. Another topic could be assessing more data to evaluate whether transaction data suggests an alternate segmentation of suppliers. One way this segmentation could be realized is by using clustering analysis. This method would require a large amount of data and would be contingent on the sponsor adding additional data to the process mining system.

Our suggested re-engineered process contains recommendations for implementing Machine Learning and Artificial Intelligence. One area of follow up could be creating the Machine Learning algorithms to classify transactions and assign them to the proper categories and R2P associates. Additionally, evaluating AI solutions for sourcing market intelligence would support our re-engineered process and act as an additional area of research.

Overall, the data could be explored further to find insights into the procurement process to improve the three E's of value (efficiency, effectiveness, and experience.) With the data available, additional metrics could be found to measure and improve these three areas. Experience is one area that future work could explore further, since we were not able to find metrics with enough data to properly evaluate this E. As the sponsor adds more data into their process mining system, evaluating this area could be possible. We look forward to seeing any follow-up work on our capstone project!

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