Supplier Onboarding and Vendor Digital Identity for State Street Corporation Global Services' Procurement Operations

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Abstract

This report is a documentation of our team's progress in researching and analyzing vendor digital identity for State Street Corporation Global Services' supplier onboarding and payment process. Our project presents the responsibilities of the Global Services division as well as reasons why stronger digital identity management is vital to corporate and financial security. The results of our project include insights of how to better understand Global Services' vendor digital identity characteristics, specifically vendor parent to vendor child relationships, a business process map of the supplier onboarding and payment process, and vendor payment data analysis in Excel and Python. A mock-up Tableau dashboard was also created to influence the design of a future vendor risk dashboard. We anticipate that future project teams will use our project as a building block to understand and improve digital identity management for Global Services.

Acknowledgements

We would like to thank everyone who has contributed to the success of our project. First, we would like to thank our sponsor, State Street Corporation Global Services, for collaborating with WPI. Our first joint team meeting held at State Street Corporation in Quincy, MA allowed the WPI team to understand the current business needs and challenges regarding digital identity management. As a result, our interdisciplinary team was able to assign specific roles to each member based on past corporate and/or academic experience; this distribution of work was effective throughout the project period and contributed to our successes.

We would specifically like to express gratitude to Jim Hayter, David Saul, John Kelly, Chris Malley, and Ora Lassila from State Street Corporation for their guidance and expertise. More importantly, we would like to thank Jim, David, John, Chris, and Ora for being available for online Zoom meetings to review our work and provide us with insights, recommendations, and future steps. Our team was initially unfamiliar with our project topic, but with their help, we have become acquainted with the scope of our research and work.

Thank you to all of the Global Services' employees who participated in interviews, so our team could understand the supplier onboarding and payment process and create a business process map. We appreciate your time and insight on the topic.

We would also like to recognize the Boston Financial Services Leadership Council. Their initiative to create a centralized digital identity platform for the finance industry in Massachusetts is powerful and achievable through collaboration. WPI is thankful the Council chose our institution to contribute to their vision, and for partnering us with State Street Corporation Global Services.

Lastly, we would like to recognize our project advisors Kevin Sweeney, Marcel Blais, Stephan Sturm, and Michael Ciaraldi for their counsel throughout the project period. Our team is thankful for our project advisors' efforts in evolving our project scope, communicating with corporate contacts, and allowing us to grow in working on diverse teams. Our project team structure was similar to one of a corporate research and development team, so in turn, we gained valuable industry and professional experience.

Executive Summary

In this report, our interdisciplinary team details our financial technology consulting Major Qualifying Project with State Street Corporation Global Services. We established that our primary role would include reporting suggestions to Global Services regarding their procurement operation processes and future data infrastructure development. Second, our team was to collaborate with academic and corporate partners in the Boston Financial Services Leadership Council (BFSLC) on digital identity advancement in Massachusetts. This project will continue in multiple phases, where each phase is a semester long and each semester a new group of undergraduate and graduate students work on the project. This Major Qualifying Project report presents research and results from Phase I and mid-way through Phase II, September to December of 2018 and January to March of 2019, respectively.

WPI is working in partnership with State Street Corporation to analyze Global Services' supplier onboarding and payment process and to define the digital identity of potential and current vendors. Global Services has an interest in streamlining existing vendor data across all business units using a developed definition of vendor digital identity. The long-term project goal is to develop a Tableau vendor dashboard that displays internal vendor and spend data, automates steps in the supplier onboarding and payment process and maximizes efficiency. The Tableau vendor dashboard will serve as a tool to conduct risk analysis on financial transaction data. The vendor data visualization tool is to be designed for all employees who conduct supplier transactions at Global Services. Present and future WPI teams will assess opportunities for and implementation of automation and risk profiling.

Our team, in Phase I and II, developed techniques to support Global Services' business interest and the overall goal of the project. So far, we have researched and discussed with Global Services employees of the artificial intelligence tools at hand that can provide Global Services with knowledge to further support procurement business processes and decisions. Although the Phase I and II teams have not had the opportunity to implement all researched machine learning techniques on extensive internal data due to confidentiality restrictions, we have worked on 2016 to 2018 fiscal year procurement spend data. Our team produced payment analysis reports for vendors during these three years using charts and queried tables. We were able to document the

diversity amongst all vendor payments. We hope that future teams will utilize our spend data analysis as a model for extensive datasets. On another note, our team created a visual business process map of the supplier onboarding and payment process through employee interviews. The map's information serves as a resource for Global Services employees to understand who is responsible for specific tasks, why specific steps take place, and which tasks have the potential of removal, simplification, improvement and/or automation. Lastly, our team has experimented utilizing Excel, Python and Tableau software to display internal vendor and financial information. The Excel model features granular views of vendor parent to vendor child financial transactions from the 2016 fiscal year; this model specifically highlights financial discrepancies between multiple payments for a single account. Python functions the same, although on the larger spend dataset. The Excel model served as a baseline tool for our Python analysis. The Tableau dashboard, on the other hand, is an example of what future WPI teams can develop –the data in this model is artificial –given Global Services provides access to additional internal files. The Tableau model includes geospatial, financial, and risk rating analysis to contribute to vendor profiling.

All of our results serve as groundwork to assist Global Services' in their efforts towards enhancing vendor digital identity and vendor risk management. Our results also assist the BFSLC in understanding what digital identity means to State Street Corporation, an international bank holding company, in comparison to other corporate partners in the finance industry.

With our research and results thus far, our team has recommendations for the upcoming WPI teams. Our first recommendation is for Global Services to provide future teams with a baseline of when differing financial transaction payments to a single vendor warrants investigation. Second, we encourage the development of a Global Services vendor digital identity dictionary. Then, Global Services has the opportunity to manipulate existing data sets for them to become more centralized amongst their internal network. Third, we prompt future WPI teams to implement all data visualizations created in Excel and Python in Tableau, too. As Tableau is Global Services' preferred software, a dashboard with our data analysis will be useful for business operations. Next, we hope future teams will have more access to vendor attribute data. Our team suggests utilizing machine learning algorithms on Global Services' vendor attribute data to determine which vendor characteristics are the most common, variable, and

important to the supplier onboarding process. Analyzing the weights of these characteristics using the Analytic Hierarchy Process (AHP) will, in turn, provide Global Services with information on prioritization of vendor characteristics and the BFSLC with insight on vendor digital identity in the banking financial services industry. These recommendations are ways to assist Global Services in their efforts towards a better understood, efficient, and successful supplier onboarding and payment process.

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Acronym Reference Table

AML	Anti-money Laundering
AP	Accounts Payable
APAC	Asia Pacific
BFSLC	Boston Financial Services Leadership Council
BU	Business Unit
CIS	Corporate Information Security
EMEA	Europe, Middle East and Africa
ESBDR	Employee Setup and Bank Details Request Form
EU	European Union
FY	Fiscal Year
GPS	Global Procurement Services
ISRMP	Information Security Risk Management Procedure
IRQ	Inherent Risk Questionnaire
NA	North America (*the United States and Canada*)
NDA	Non-disclosure Agreement
Q&A	Question and Answer
SBDRF	Supplier Bank Details Request Form
SME	Subject Matter Expert
SMF	Supplier Maintenance Form
SSF	Supplier Setup Form
US	United States
WPI	Worcester Polytechnic Institute

Chapter 1. Introduction

As the digital world becomes more advanced, defining identity becomes increasingly difficult and complex.[1] Digital identity management is a field of interest for many companies whose data is confidential and holds high liability; fraud, data breaches, and identity theft have become common and these events lead to large financial loss. For these reasons, all corporate members of the Boston Financial Services Leadership Council are interested in defining a cross-platform, streamlined digital identity for the financial technology industry. The Boston Financial Services Leadership Council's initiative is to develop a "system for establishing sufficient trust to complete target transactions in a market normalized digital environment."[2] In other words, the Council wants to develop a reliable platform that streamlines digital identity for companies to confidently pursue their respective business affairs. The development of this platform will centralize the financial industry's communications network and minimize exposure to reputational and financial harm. Due to the complexity of their mission, the Council has invited the University of Massachusetts Lowell, Northeastern University, and WPI to contribute to the research and development of this platform. Each university is partnered with a specific sponsor; WPI is collaborating with State Street Corporation Global Services.

The first step of many to accomplishing the Council's mission is to establish what digital identity signifies for each corporate partner. Therefore, WPI has worked directly with Global Services since September of 2018 to research and study vendor identification in their business processes. Each semester a new team contributes to this project. Here is the Phase I student team:

- Corey Towner, a Master of Business Administration student,
- Jinal Jain and Gavin Yao, Data Science graduate students,
- Mikala Dunbar, an Actuarial Mathematics and Business undergraduate student,
- Weixi Liu and Lorraine Ma, Computer Science graduate students,
- And myself, Lisandra Lao, a Mathematical Sciences undergraduate student.

Mikala Dunbar and I worked on Phase I and Phase II of this project. Here are the new students from Phase II:

- Neha Misra, a Master of Business Administration student,
- Jay Trivedi, a Data Science graduate student,
- And Kai Sun, a Computer Science graduate student.

Each student was assigned different roles depending on the background of the academic major. The Master of Business Administration students served project managerial roles. The computer science students supervised the work completed in Excel, Python, and Tableau. The data science students were responsible for data management. Lastly, the Mathematics students served as business intelligence analysts. As a whole, we all served as consultants who reported to Global Services.

This report will discuss the progress from Phase I and II in defining supplier digital identity for Global Services' supplier onboarding and payment process. Our team and Global Services have discovered that defining supplier digital identity results in opportunity for a more comprehensive risk assessment of vendors. Since vendor digital identity is decentralized, our sponsor questions the authenticity of vendors' identities, specifically when conducting their supplier onboarding and payment process. Alex Pentland from Wall Street Journal states, "[m]ost people today suffer from a strange sort of psychosis: we are uncertain of our identity. For although we are (mostly) certain of who we are in our own minds, the identity we use to interact with the government, obtain services, and pay for goods is unreliable."[3] The same situation is analogous for businesses, and business to business relationships; businesses are uncertain of whom they are conducting business with and whom they are conducting business as. As a result, risk exposure increases and confidence in secure transactions decreases.

Our WPI project team has three goals to define vendor digital identity for Global Services' business processes. Our first goal is to determine which specific supplier characteristics are needed to sufficiently answer the question: "Who exactly is Global Services working with?" The answers to this essential question will allow Global Services to better identify vendors with risk and better understand whom their vendors conduct business with. Our team documented supplier parent to supplier child relationships, and our objective was to accomplish this through original Python code and Excel PivotTables. Second, Global Services is looking for our team to interview employees to design a business process map of the supplier onboarding and payment process; this map will record the responsibilities amongst the stakeholders in the business process. This report explains the process map and suggests potential business efficiency improvements based on employee feedback. Third, our team created data visualizations in Excel, Python, and Tableau. In Excel, our team analyzes global procurement spend data from the fiscal year (FY) of 2016. In Python, we examine the same set of data, but from the 2016-2018 FY. Our team decided to query the spend data when using Excel to confirm our team's Python script was functional; Python also works best on larger datasets than Excel. In Tableau, our team creates data visualizations from mock-up vendor attribute data. Due to the restriction of access to Global Services' data, our team has created this mock-data to replicate what we believe their internal vendor attribute data

looks like. These three goals produce results that will assist future WPI teams in defining a comprehensive definition of digital identity, and in managing risk for business transactions through software platforms.

We have discovered that formalizing vendor digital identity for Global Services' internal corporate environment is multi-faceted. However, there are many resources that can assist Global Services and WPI in accomplishing our goals throughout this long-term project, including the other corporate and academic partnerships of the Council, academic research in digital identity, and trial and error of different machine learning techniques. Our team has established building blocks for upcoming teams, and we anticipate our work will guide Global Services towards a centralized internal network.

Chapter 2. Background

Global Services presented three objectives to our team: research strategies to improve data accuracy and integrity regarding vendor digital identity, analyze the supplier onboarding and payment process, and design data visualizations to assist in the decision-making processes of the supplier onboarding process and in financial transaction management. The background chapter provides information that is useful in understanding how and why we approached and accomplished our assigned tasks. This chapter starts with discussing the corporate structure of State Street Corporation, our sponsor, and the functionality of their Global Services division. Second, the chapter presents two case studies related to data security that encourage advancement in digital identity and data engineering practices. Third, we review Global Services' current risk management practices. Finally, the chapter ends with discussing our access to data and how Tableau, Python, Excel, and their functions have assisted our team in creating data models for Global Services.

2.1 State Street Corporation

Our sponsor, State Street Corporation, is a financial services and bank holding company operating in over 100 countries and is accountable for over 10 percent of the world's financial assets,[4] managing over 36 trillion dollars.[5] State Street partners with institutional investors all over the world to provide comprehensive financial services, including investment management, investment research and trading, and investment servicing.[6] The organization has four divisions: State Street Global Advisors, State Street Global Markets, State Street Global Services, and State Street Global Exchange. Our team is working in collaboration with the third division, Global Services, regarding their procurement business operations.

2.1.1 State Street Corporation, Global Services

Global Services' procurement division is responsible for many tasks, and our team focused on their supplier onboarding and financial transaction processes. Procurement is the sourcing and purchasing of goods and services for business use from an external source.[7] Procurement is divided into four sectors at Global Services: [8]

- Local Procurement
- National and International Procurement
- Information Technology Procurement
- Goods and Services
    - Equipment

- ○ Facilities/Building Services
- ○ Professional Services
- ○ Other Services

Global Services' goal is for all vendor relationships to remain sustainable and mutually-beneficial. Thus, Global Services must go through multiple steps in order to confirm a vendor is the best fit for their needs. These steps can be categorized into verifying a supplier's digital identity, assessing risk, and authenticating transactions.

2.2 What is Digital Identity?

Technology experts define digital identity as, "an online or networked identity adopted or claimed in cyberspace by an individual, organization or electronic device. These users may also project more than one digital identity through multiple communities. In terms of digital identity management, key areas of concern are security and privacy."[9] This quote supports that digital identity changes due to environment, and many sources define digital identity in different ways.

The Boston Financial Services Leadership Council's (BFSLC) goal is to define a unique digital identity for each vendor that conducts business in the financial services industry. Many vendors have different identities with various firms. Although the industry has tried to address this issue, "current identity authentication [still] lacks standards across firms, is inefficient, encourages fraud, and hinders innovation partnerships with startups," states Bill Guenther.[2] Even though we know what digital identity is, we do not know the specific parameters necessary to centralize vendor identity in one system. This project strives to figure out these parameters, and the Council has provided our team with direction into how the system would function. The BFSLC's preferred system would be open, reliable, easy to use, inclusive, scalable, efficient, and synergistic.[2]

If the BFSLC redefines digital identification, companies in the finance industry will minimize exposures and increase successes and trustworthy transactions. In detail, the benefits include fraud loss prevention, efficiency, infrastructure cost reduction, impacts on business missions and public policies, and brand building.[2]

Once digital identity is appropriately defined, the Council would like to launch a regional collaborative pilot amongst the corporate members. Through exploratory trials, adjustments will be made, and the Council will be able to share the authentication system with corporations in various industries. The financial services industry is one of many industries affected by decentralized identity.

2.3 Data Security Crises

Ever-changing modern technology calls for up-to-date methods of data security. Many companies are susceptible to hacking and data breaches if data security is not of top priority. In recent times, there have been many examples of data breaches that have exposed customers' digital identities and confidential information such as their names, credit/debit card numbers, and more. In the next two subchapters, we will discuss the details associated with Target's data breach in 2013 and Marriott's Starwood database security incident in 2014. These two incidents emphasize why Global Services must invest in strong data security practices and in research of vendor digital identity. These two investments will also allow the company to better understand exposures associated with business relationships.

2.3.1 Target Data Breach, 2013

Target, one of the United States' largest discount retailers, [10] announced a data breach in 2013 of over 110 million customers' personal information. The customers' personal information can also be considered their digital identity within Target's databases. Between the dates of November 29 and December 15 of 2013, the data breach exposed customer's names, mailing addresses, phone numbers, email addresses, and credit/debit card numbers, expiration dates, and card verification values (CVV). [11] In response to the data breach, Target decided to "provide one year of free credit monitoring and identity theft protection to all guests who shopped at its U.S. stores" between those dates. [11] Providing these resources to those affected was expensive. Moreover, reporting the details of their data breach took a toll on store sales, but Gregg Steinhafel, Target's chairman in 2013, emphasized that "'understanding and sharing the facts related to [the] incident [was] important to [him] and the entire Target team.'"[11] As expected, the public reacted to this event, and Target's net earnings in the United States were greatly affected, as shown below in Figure 1.

Figure 1: Bar chart of Target's net earnings from 2007 to 2017, in millions of U.S dollars.[12]

From 2010 to 2012, Target achieved steady net earnings of above 2.9 billion dollars. Although in 2013, there is about a 1 billion dollar decrease in net earnings, which through inference, is due in part to the data breach in late November. The following year resulted in negative net earnings, a trend uncommon to this major retailer. The negative trend in net earnings in 2014 may have been a result of the company promising those affected by the data breach a year's worth of free credit monitoring and identity theft protection.

Target's data breach and the financial reparation after this event affected the financial success of the company for two years. In spite of the fact that the retailer saw a positive trend of financial results in 2015, the company was in debt to this data breach.

2.3.2 Marriott's Starwood Network Data Breach, 2014

On September 8, 2018, Marriott International's internal security tool alerted the hotel brand of a breach in their Starwood guest reservation database. The data breach was of guest information pertaining to reservations at Starwood locations on or before September 10, 2018 in the United States. There had been unauthorized access to this network by an unauthorized party since 2014.[13] Marriott believes approximately 500 million guests have been affected by this breach. On November 30, Marriott International released a statement on its website declaring their apologies for this database security

incident. All affected guests whose emails were in the Starwood guest reservation database were notified. The email sent to affected guests included the information displayed on Marriott International's website, as well as complete information to Marriott's call centers by state, detailed information on identity and fraud theft resources, how to install fraud alerts, how to install a credit freeze on an account, and more.

Because this data breach has been discovered in the past few months, no statistical data has yet been released by third party data vendors. Although, we can infer that sales will be affected as were the sales of Target in 2013 and 2014 after their data breach incident.

2.4 Global Services, Risk Management

State Street Corporation places high importance on research for advancement in digital identity and digital identity data security. Data breaches can occur to any company like Target and Marriott International, and companies with strong risk management protocols will succeed in preventing these costly breaches. On another note, with strong digital identification of potential and current vendors, State Street will be aware of current events and circumstances that may affect business relationships. In other words, if a major data breach affects the business of a State Street vendor, State Street will know and be able to make the appropriate business decisions.

State Street Corporation Global Services follows risk management procedures for a few reasons during the supplier procurement process. First, Global Services must know all information about a vendor prior to forming a relationship with them. They must be able to answer many questions, some of which include: Is the risk worth the vendor relationship? Is there anything about a vendor that can affect State Street's reputation and success? Will the potential vendor transactions be monetarily safe and secure? Second, State Street is held responsible to check regulatory requirements for the majority of countries in the world. In order to ensure safe transactions with potential vendors, Global Services checks watchlists, sanctions, and anti-bribery and corruption indicators against them. Watchlists are used to see if a potential vendor is on a terrorist or crime watch list. Risk management has protocols to ensure these checks are successful. Past and present vendors have never been associated with any watchlists, although screening remains very important in the event that a vendor is indeed on the list. Risk Management also enforces sanctions against vendors, their contractors, and countries of origin (*if applicable*) to advocate for anti-money laundering (AML). Furthermore, anti-bribery and corruption indicators are produced through third party media and data sources. These indicators then become a part of a vendor's profile, if appropriate. World events, including geo-political events, criminal associations, and natural disasters, for example, may link a supplier to levels of risk. Screening vendors against watchlists, sanctions, and anti-bribery and corruption indicators mitigate these potential risks, and the screening process continues throughout the duration of a contract.

Global Services' risk management approach also applies to protecting internal operations. To ensure the protection of State Street's finances and distribution of work during the supplier onboarding and payment process, duties are distributed amongst many departments. Refer to Figure 2, the business map of the supplier onboarding and payment process created by the Phase I WPI team.
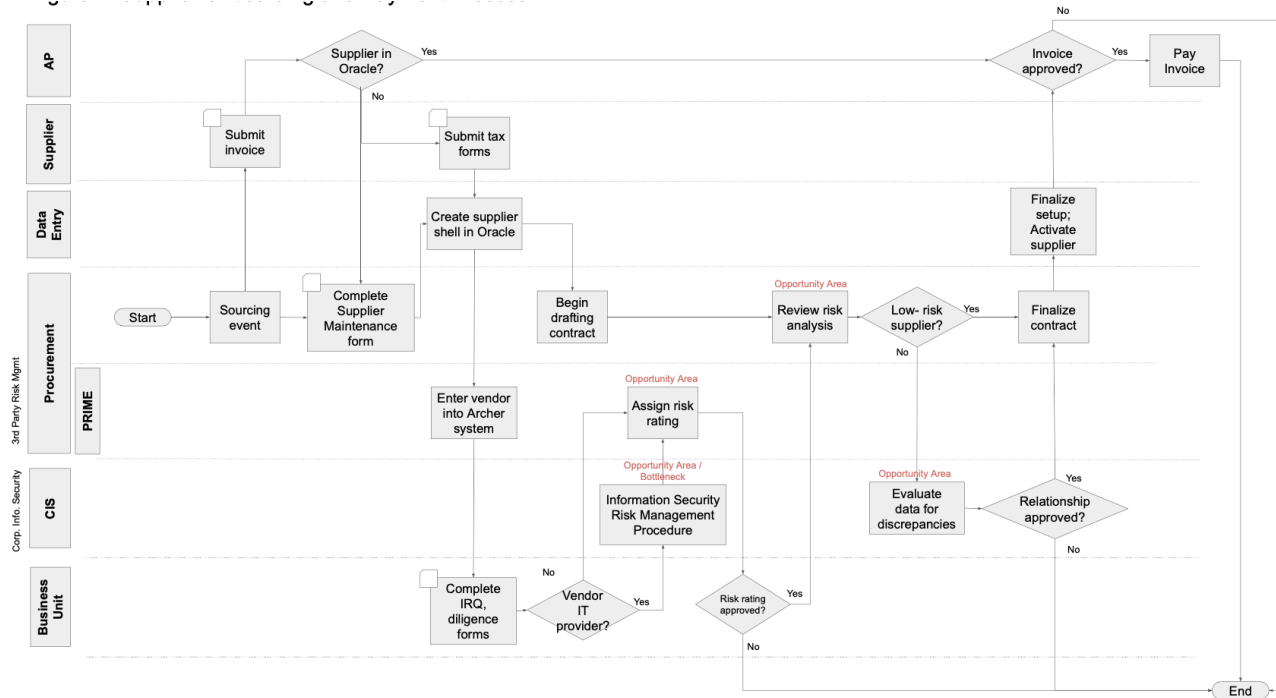
Figure 2: The supplier onboarding and payment process of Global Services. Visual design created by the Phase I WPI team.

The six gray boxes on the left represent the parties associated with the supplier onboarding and payment process. Each stakeholder is responsible for the duties in each row on the grid. The distribution of work ensures that no one party has too much influence over the process, and that each party has the ability to amend any faults from previous steps. Although there are many positives to the distribution of work, there is also high risk of human error and process delay. Our team is responsible for understanding each of the steps in Figure 2, and the ones we have focused on in this project will be explained in Chapter 4.2.

Many of the steps in the supplier onboarding and payment process include information that is valuable for record keeping at State Street. To name a few, the information from the Supplier Maintenance Form (SMF), the entry of vendor information into the Oracle System, and the financial payment information of a completed transaction are examples of data that must be displayed in an interface for State Street employees. Our team created interfaces for data display in Excel, Python and Tableau.

2.6 Access to Data

Due to confidentiality restrictions, our team has had trouble acquiring internal Global Services data that would contribute to our vendor digital identity studies. Although, we have gained access to process forms, business process maps, and fiscal year procurement spend data.

2.7 Excel, Tableau, Python and their Functions

Excel is a software used by all corporations. The software is easy to use, well known, and helpful in its ability to organize and display information. Our team utilized the software's PivotTable functions to explore the fiscal year procurement spend data provided by Global Services.

Tableau is the preferred software for data display within Global Services. Due to the accessibility, functionality, and usability of the software, we hope that future teams will be able to create a Tableau dashboard for internal employees once vendor attribute data is accessible. WPI aims to build this dashboard into a support tool for Global Services to better oversee vendor relationships and business decisions. The dashboard must also serve the purpose of contributing to improved digital identity practices. In effort to streamline the supplier onboarding and payment process, Global Services should refer to and analyze the data on this dashboard. With the access to visual data models and the potential to utilize machine learning algorithms in this software, our team understands Tableau will positively influence Global Services.

Because we did not have the appropriate data to build the requested Tableau dashboard, our team decided to write Python code to assist in the data analysis and visualization of the spend data provided by Global Services. Python is also a well-known coding language in corporate environments. Due to the volume of data at State Street, we know using a software with versatile functionality is important.

Chapter 3. Methodology

The primary steps in addressing the BFSLC's initiative are to understand how Global Services defines digital identity in their procurement business operations and to analyze how digital identity affects risk management. The following tasks support these two primary steps:

1. Compile vendor characteristics associated with vendor digital identity in the supplier onboarding and payment process
2. Develop a business process map of the supplier onboarding and payment process
3. Design models in Excel, Python and Python to display financial transaction data and supplier parent to supplier child relationships

3.1 Aggregate Vendor Digital Identity Information

We have gathered vendor identification attributes through business process forms and internal spend data. Although we have no access to vendor identity data, we have compiled identification information from various sources to provide insight on what vendor digital identity means to our sponsor.

Global Services provided our team with access to some of their business process forms, including their Supplier Setup Form (SSF), Supplier Maintenance Form (SMF), Supplier Bank Details Request Form (SBDRF), and the Employee Setup and Bank Details Request Form (ESBDR). The SSF includes the SMF, SBDRF, and ESBDR in the same Excel file, under the tabs "Supplier Details," "Supplier Bank Details," and "Employee Setup and Bank Details," respectively. The functionality of all forms, except the ESBDR, is explained in the "Supplier Setup Instructions" tab. Refer to Appendix A to view the Supplier Setup Form. There are descriptions and instructions on the how processes work and how the forms are utilized in this file, so our team found time to read and understand it.

Global Services is interested in learning more about supplier parent to supplier child relationships. We utilized the financial spend data provided by Global Services to document these associations. In the dataset, there are two fields that we used to analyze this bivariate relationship: Supplier Parent Code and Supplier Child Code. The spend data file includes data from the FY of 2016, 2017, and 2018. The variables in this dataset are taxonomy number, month, in year/month format, year, region, supplier parent code, supplier child code, and spend, in

dollars. We chose to query the file to only include transaction data from the 2016 FY for our work on Excel PivotTables. Refer to Appendix B for the 2016 FY dataset. We utilized the entire global procurement spend data file from FY 2016 through 2018 to test our Python script and experiment using various methods until we found the ones that were most successful. Refer to Appendix C for the 2016-2018 FY dataset. Because we used a subset of the data for Excel and the entire dataset for Python, we had the ability to test the accuracy of our data visualization tools. The two data fields, Supplier Parent Code and Supplier Child Code, were concatenated in Excel and Python to display the desired vendor relationship.

3.2 Create Supplier Onboarding and Payment Process Business Map

Our team conducted interviews with many employees in the Global Services division to understand the supplier onboarding and payment process. The purpose of these interviews were also to comprehend the distribution of work amongst the six contributors to this process, including the supplier, AP, data entry, procurement, CIS, and BU. All interviews were remote and conducted through WebEx. Before each interview, Mikala and I, the business intelligence analysts of the project, created business agendas and sent them to the employees who would be in attendance the following day. This way, the employees had background on why we were having the meeting and an idea of the questions we were going to ask. The questions were categorized into four topics: goals, process, challenges, and wish list. We had the opportunity to conduct three different interviews. The first interview was with Alejandro Migu Rodriguez and John L Kelly, who onboard suppliers. Refer to Appendix D for our first interview's business agenda. The second interview was with Patrick Daly, Joy E Ingham and James Durickas, who oversee vendor engagements, conduct ongoing screening of vendors, and assess risk of vendor relationships. Refer to Appendix E to review the business agenda for the second interview. Lastly, we conducted an interview with Eric Self, an expert on data entry of vendor information. Refer to Appendix F to review the associated business agenda. These pre-written questions were to ensure we would gather information on future goals, process analysis, process challenges, and desirable process changes. During the interviews, one person was the interview lead and the other was the interview transcriber. Because of these interviews, we were able to understand departmental responsibilities and their effect on the success of the supplier onboarding and

payment process. We were also able to receive feedback from employees to then relay back to our direct Global Services contacts.

3.3 Develop a Tableau Model

We were told that Tableau was the major platform utilized by employees in the Global Services division. Therefore, we made it a goal to find ways to develop a Tableau model for this project. Our team decided to adopt well-known vendor identity attributes to create a mock data set. Refer to Appendix G. The vendor identity attributes we included in our mock data set include:

- Quantitative variables
  - *Vendor Rank*: 1-10, where 1 is a high risk profile vendor and 10 is a low risk profile vendor
  - *Billing Zip Code*: zip code where mail payments are sent
  - *Billing Country Code*: where the vendor country is located on a list of all 195 countries in the world
  - *Invoice #*: a vendor's unique invoice identifier
  - *Invoice Date*: date the vendor invoice was created
  - *Due Date*: date vendor payment is due
  - *Invoice Amount*: principal payment on vendor invoice, in dollars
  - *Amount Paid*: number of dollars paid out on invoice payment
  - *Check #:* check identifier if there has been a payment on invoice
  - *Check Date*: date the check was issued
  - *Amount Due/Balance*: amount left to pay on invoice, in dollars

- Qualitative variables
  - *Vendor #*: internal vendor identifier
  - *Vendor Name*: name of vendor
  - *Region*: where the vendor is located (US, EU or EMEA)
  - *Billing Address*: where to mail payments
  - *Billing City*: city where mail payments are sent

- ○ *Billing State*: state where mail payments are sent
- ○ *Source*: sourceable or non-sourceable payment
- ○ *Status*: overdue, open, or closed invoice payment
- ○ *Remarks*: summary of invoice payments (paid, lack of reserves, disputed invoice, N/A)

The mock-data set includes 20 different vendors, or rows of data. The majority of the quantitative fields are different for each vendor to simulate variability in financial payments, risk, and vendor identifiers. We made sure to include some similarities, too, in a few of the categorical qualitative data fields, so we could create insightful data visualizations on regional, geospatial, and financial information. This data was then put into Tableau to create financial bar graphs, vendor risk bar charts, geospatial maps, and data filters. We received feedback from our direct contacts from Global Services on our Tableau dashboard model, and these recommendations for further improvement will be discussed in chapter 5.

3.4 Develop data visualizations in Excel

Our team created data visualizations in Excel using the financial spend data from FY 2016. The dataset is inclusive of global procurement spend information and vendor identity attributes. Because Mikala and I are the only teammates in semester two with completed NDAs and registered Box.com access, I had to manipulate the data to avoid compliance issues. Thus, all of the information displayed from this data set has been modified. Once all team members are cleared to utilize the original data, the same methods will be implemented on the original set.

This set of data is valuable to our team because we have the ability to measure anomalies in financial payments to vendors. Although we were not provided with a baseline to determine these anomalies, we were able to calculate the differences in payment totals to unique vendors. The anomalies will be easy to find with the work we have accomplished thus far once the baseline(s) is provided. The spend data was also utilized to document supplier parent to supplier child relationships. The vendors, whether a parent or child vendor, are recorded using internal identifiers (e.g., L-1386722).

The spend data is from the FY of 2016 and includes 92 rows of information. The fields in the dataset are the following:

- Quantitative variables
    - *Taxonomy Number*: unique code required for category mapping
    - *Month*: (year/month format) month and year of transaction
    - *Year*: year of transaction
    - *Spend*: money paid out in transaction, in dollars

- Qualitative variables
    - *Region*: unique code required for region mapping
    - *Supplier Parent Code*: unique code required for supplier parent mapping, internal identity for parent vendors
    - *Supplier Child Code*: unique code required for supplier child mapping, internal identity for child vendors

We utilized all 92 rows of data in our data connection to Excel PivotTables. We created PivotTables to analyze the following parameters:

- Supplier Parent Code to Supplier Child Code Relationships
- Number of Transactions per Supplier Parent Code
- Number of Transactions per Supplier Child Code
- Number of Transactions and Sum of Payment Totals per Supplier Child Code
- Maximum and Minimum Payments per Supplier Child Code

3.5 Develop Data Visualizations in Python

We developed a Python script, so that Global Services would have the opportunity to efficiently analyze large global procurement spend datasets. The Excel data visualizations were performed on the spend data from FY 2016, and the Python data visualizations were performed on the original spend data from 2016-2018 FY. The data visualizations in Python are more

detailed compared to those in Excel. In Python, we created queried data tables and plots. The code is accompanied with instructions on how to run the Python script, too. In the event that future teams are not provided with additional spend data, Global Services can now run the Python script on internal, classified data. The Python script creates the following tables through different queries:

- Table 1: Global Procurement Spend Data
  - Fields: Taxonomy Number, Month, Year, Region, Supplier Parent Code, Supplier Child Code, Spend, Parent_Child

- Table 2: Parent_Child Spend per Month
  - Fields: Parent_Child, Month, Spend

- Table 3: Parent_Child Spend per Year
  - Fields: Parent_Child, Year, Spend

The above tables were utilized to construct plots that analyze variables against spend. The Python code creates the following plots:

- Unique Parent_Child Spend per Month
  - Plot type: Scatterplot
  - Independent variable: (*year/month format*) Month
  - Dependent variable: (*in USD*) Spend

- Unique Parent_Child Spend in _____ (*insert year*)
  - Plot type: Bar chart
  - Independent variable: Year
  - Dependent variable: (*in USD*) Spend

- _____ (*insert year*) Yearly Spend per Parent_Child
  - Plot type: Bar chart
  - Independent variable: Parent_child

- ○ Dependent variable: (*in millions of USD*) Yearly spend

- ● Spend on Top 25 Vendors in Year _____ (*insert year*)
  - ○ Plot type: Bar chart
  - ○ Independent variable: Parent_child
  - ○ Dependent variable: (*in millions of USD*) Spend

The Python script creates detailed analysis of the financial spend data from the 2016-2018 FY. The user is able to modify certain parameters in the code to analyze data from different years, or different parent_child supplier identifiers. As long as the data fields are the exact same, Global Services will be able to run the code on their internal spend data. The insights from the Python tables and plots will be discussed in chapter 4.1.3.2, and the Python code and HTML file can be found in Appendix H and Appendix I, respectively.

Chapter 4. Results and Analysis

This chapter covers our team's results and analysis of vendor digital identity, the supplier onboarding and payment process, and data visualization models in Tableau, Excel, and Python. More specifically, first, we will discuss the various ways in which we aggregated vendor digital identity characteristics. Second, we will explain our design of our supplier onboarding and payment process business map. Third, our team presents mock data visualizations in Tableau that we believe will positively influence the decision making processes regarding supplier onboarding and supplier risk assessments. Lastly, we will show how we utilized the global procurement spend data to create data visualizations in Excel and Python.

4.1 Vendor Digital Characteristics

Our team was able to collect vendor digital identity attributes from the Supplier Setup Form, Supplier Maintenance Form, Supplier Bank Details Request Form, and the global procurement spend data provided by Global Services. All sources provide diverse digital identity characteristics.

4.1.1 Supplier Setup Form

First, we will describe and analyze the Supplier Setup Form (SSF). The SSF must be completed if at least one of the five situations apply: new supplier and supplier modification requests are not submitted into Oracle Subledger, new supplier requests sent via e-mail or Markview do not contain sufficient details in Invoice and backup, and new supplier modification sent via Markview or e-mail do not contain sufficient details in Invoice and backup. Oracle Subledger and Markview are internal vendor databases. The SSF is an opportunity for procurement to obtain all data necessary to onboard or update a vendor's information; the data collected through the SSF depends on which request, of the six, an employee is filing. Each request requires employees to file varying information which is described in the following subchapters. After review, our team realized the SSF holds substantial vendor digital identity information that contributes to our project goal. We observe that many of the vendor attributes required in each of these requests overlap, and even those that do not are valuable in identifying whom Global Services is creating business relationships with.

4.1.1.1 "New Supplier - RFQ Only" Request

This request is utilized to setup a new vendor for contracting purposes and the setup should only occur before contracting any products or services. This type of request is driven by the Global Procurement Services (GPS) and BU departments. Refer to Appendix J to see which data fields from the "Supplier Details" spreadsheet tab are necessary for submission.

4.1.1.2 "New Supplier - Purchasing & Payment" Request

Its purpose is to setup all new supplier requests where payment and purchasing details are required. Employees must file information from the "Supplier Details" and "Supplier Bank Details" tabs in the SSF file, and the data fields required for submission are available in Appendix K.

4.1.1.3 "New Site" Request

This request is used to add a new site to an existing supplier. The invoice backup, or the address update on the supplier letterhead, is required. Employees call the vendor or verify through email, utilizing existing supplier details, to confirm changes should be made in the Oracle system. Employees file required data fields from the "Supplier Details" and "Supplier Bank Details" tabs in the SSF Excel file; these requirements are documented in Appendix L.

4.1.1.4 "Supplier Modification" Request

Its purpose is to modify purchasing and contact information within an already existing supplier. This request is not to be used for supplier name, site, or bank details' changes. Instead, supplier name changes would be completed through the "New Supplier - RFQ Only" setup process in section 4.1.1.1; the supplier site changes would be completed through the "New Site" process in section 4.1.1.3; the bank details changes would be completed through the "Bank Details Add/Modifications" process in section 4.1.1.6. Refer to Appendix M to see which data fields from the "Supplier Details" spreadsheet tab are necessary for submission.

4.1.1.5 "Reactivate/Deactivate Supplier" Request

This request is used to reactivate or deactivate an already existing supplier. The GPS department should be involved with these requests, as suppliers are used globally. In addition, an impact analysis should be completed to confirm the desired outcome(s). Only the "Supplier Details" tab is utilized for this request, and Appendix N lists all required data fields.

4.1.1.6 "Bank Details Adds/Modifications" Request

This sixth request is used to add or modify bank details to an existing supplier. Invoice backup, or the bank details update supplier on the supplier letterhead, is required to complete this type of request. Employees call the vendor or verify through email, utilizing existing supplier details, to confirm changes should be made in the Oracle system. All required data fields from the "Supplier Bank Details" tab are included in Appendix O.

4.1.2 Parent Child Relationships

Global Services is interested in documenting supplier parent to supplier child relationships due to risk associated with third parties, fourth parties, etc. Our team used the financial global procurement spend data to record these relationships.

In Excel, we used PivotTables to document supplier parent to supplier child relationships from just the 2016 fiscal year. The original data file was too large to create our desired data visualizations. In addition, recall that the Excel data was modified and does not represent Global Services' original data. PivotTable figure 3 shows us that there are seven supplier parents, and each supplier parent has a variable number of supplier children.

Parent to Child Relationships

Supplier Parent to Supplier Child Relationships
⊙ **L-1386720**
10004661
C-S238
C-S309
C70946
CS155
(blank)
⊙ **L-1386722**
10054023
C-S393
C-S422
C75164
C90752
CS306
⊙ **USA_BOS1287212046199**
28721
⊙ **USA_BOS1287212046203**
28721
⊙ **USA_BOS1287212046205**
28721
⊙ **USA_BOS1369982046254**
36999
⊙ **USA_BOS188082046195**
8809

Figure 3: Parent to child supplier relationships from the 2016 FY global procurement spend dataset.

Figure 3 also shows us that it is possible for the same supplier child to have multiple supplier parents. For example, supplier child 28721 has three parent suppliers. These relationships are important for Global Services to take note of, as the parent to child hierarchies are unconventional.

In Python, our team created a script to document the supplier parent to supplier child relationships for all of the global procurement spend data from FY 2016-2018. This data includes 70,038 rows of data and contains many relationships amongst vendors. The data science and computer science students in Phase I and II agreed that Python would be most useful for big sets of data and large-scale data analysis. The first data table from our original script contains all of the original global procurement spend data as well as an additional column that documents the

supplier parent to supplier child relationships in a Parent_Child format. Below is a screen capture of the first 5 rows of data in this table.

	Taxonomy Number	Month	Year	Region	Supplier Parent Code	Supplier Child Code	Spend	Parent_Child
0	10.00.00.00	2016 / 01	2016	Region 1	L-1386721	C-S421	3073	L-1386721_C-S421
1	10.00.00.00	2016 / 01	2016	Region 1	L-1386721	CS305	1084	L-1386721_CS305
2	10.00.00.00	2016 / 01	2016	Region 1	L-1386719	10004660	1945	L-1386719_10004660
3	10.00.00.00	2016 / 01	2016	Region 1	L-1386719	C-S237	7692	L-1386719_C-S237
4	10.00.00.00	2016 / 01	2016	Region 1	L-1386721	C-S392	246	L-1386721_C-S392

Figure 4: Global Procurement Spend dataset inclusive of parent_child relationships.

All parent_child vendor relationships are documented and employees at Global Services can query this data to find a single supplier parent's child or a single supplier child's supplier parents. The HTML file only shows the head, or first 5 rows, of the dataset.

```
f = pd.read_excel("Global Spend for Project-v1.xlsx", skiprows = 6)
f = f.astype({'Supplier Parent Code': str,'Supplier Child Code' : str,'Month':str,'Year':str,'
Spend':int})
f['Parent_Child'] = f[['Supplier Parent Code', 'Supplier Child Code']].apply(lambda x: '_'.joi
n(x), axis=1)
f.head()
```

Figure 5: Python script to create dataset inclusive of parent_child supplier documentation.

The last line of code, f.head(), may be deleted and the entire dataset with the parent_child relationships will show in the last column.

4.1.3 Financial Payment Data

Our team has also been able to record and analyze financial payment information with the global procurement spend, FY 2016-2018, dataset.

4.1.3.1 Financial Payment Data Analysis in Excel

First, we utilized Excel and its PivotTable functionality to report findings on the 2016 FY dataset. In addition to the supplier parent to supplier child relationships reported in Figure 3, we

were able to report five more PivotTables that contained valuable insight on financial transactions.

      We wanted to record how many transactions occurred per supplier parent code in the year of 2016.

Transactions per Supplier Parent Code

Count of Supplier Child Code Transactions	
Supplier Parent Code	Total
L-1386720	39
L-1386722	26
USA_BOS1287212046199	1
USA_BOS1287212046203	1
USA_BOS1287212046205	8
USA_BOS1369982046254	8
USA_BOS188082046195	8

Figure 6: Transactions per Supplier Parent Code in 2016.

Figure 6 shows us that Global Services completed 39 different financial transactions with supplier parent L-1386720; 39 transactions varies largely in the number of times other supplier parents were paid in 2016. Factors like this are important for Global Services to take note of in the event that they would like to understand which financial reserves are for which suppliers.

      We also documented the number of transactions per supplier parent and supplier child relationship.

Transactions/Supplier Child Code

Supplier Parent Code	Supplier Child Code	Total
▣ L-1386720	10004661	8
	C-S238	8
	C-S309	8
	C70946	8
	CS155	7
	(blank)	1
▣ L-1386722	10054023	1
	C-S393	6
	C-S422	5
	C75164	4
	C90752	5
	CS306	5
▣ USA_BOS1287212046199	28721	1
▣ USA_BOS1287212046203	28721	1
▣ USA_BOS1287212046205	28721	8
▣ USA_BOS1369982046254	36999	8
▣ USA_BOS188082046195	8809	8

Figure 7: Number of transactions per parent_child relationship in 2016.

When we look at the number of financial transactions completed in the supplier parent_child view, we find there are no outstanding values in total payments to vendors. Next, we added on to Figure 7's data with an additional column of the sum of total payments.

Number of Transactions & Payment Total Per Supplier Child Code

Supplier Parent Code	Supplier Child Code	Number of Transactions	Sum of Payment
⊟ L-1386720	10004661	8	$50,858.68
	C-S238	8	$59,218.40
	C-S309	8	$18,969.32
	C70946	8	$4,951.51
	CS155	7	$46,102.34
	(blank)	1	$8,024.88
⊟ L-1386722	10054023	1	$15,800.23
	C-S393	6	$17,475.32
	C-S422	5	$8,196.82
	C75164	4	$11,909.95
	C90752	5	$4,442.64
	CS306	5	$21,530.33
⊟ USA_BOS12872120461	28721	1	$292.95
⊟ USA_BOS12872120462	28721	1	$4,366.67
⊟ USA_BOS12872120462	28721	8	$2,549,221.77
⊟ USA_BOS13699820462	36999	8	$438,797.45
⊟ USA_BOS18808204619	8809	8	$4,176,523.17
Grand Total		92	$7,436,682.44

Figure 8: Number of transactions and sum of total payments per supplier parent and supplier child in 2016.

This PivotTable view shows Global Services the number of transactions and the amount of money paid out in these transactions in 2016. For the vendors with a total number of 8 transactions, the minimum sum of payment is $4,951.51 and the maximum is $4,176,523.17. If Global Services is concerned about volume of payments per supplier parent_child relationship, this view tells them their vendor information. Next, we recorded the maximum and minimum payments per supplier child code. Refer to figure 9.

Maximum and Minimum Payments per Supplier Child Code

Supplier Child Code	Max of All Payments	Min of all Payments	Sum of all Payments
8809	$ 692,406.18	$ 284,450.34	$ 4,176,523.17
28721	$ 292.95	$ 292.95	$ 292.95
36999	$ 104,612.49	$ 30,910.87	$ 438,797.45
10004661	$ 20,108.14	$ 1,945.01	$ 50,858.68
10054023	$ 15,800.23	$ 15,800.23	$ 15,800.23
28721	$ 501,328.27	$ 4,366.67	$ 2,553,588.44
C-S238	$ 7,692.48	$ 5,851.70	$ 59,218.40
C-S309	$ 2,385.73	$ 2,361.02	$ 18,969.32
C-S393	$ 12,851.74	$ 246.79	$ 17,475.32
C-S422	$ 3,073.81	$ 1,024.60	$ 8,196.82
C70946	$ 1,022.35	$ 11.21	$ 4,951.51
C75164	$ 4,293.23	$ 1,892.76	$ 11,909.95
C90752	$ 1,682.82	$ 95.64	$ 4,442.64
CS155	$ 11,696.59	$ 2,859.77	$ 46,102.34
CS306	$ 9,260.14	$ 1,084.65	$ 21,530.33
(blank)	$ 8,024.88	$ 8,024.88	$ 8,024.88

Figure 9: Records of the maximum, minimum and total payments, in dollars, made to individual supplier child codes in 2016.

The PivotTable in Figure 9 has conditional formatting that highlights when the maximum and minimum payments of a unique supplier child are not equal. Many differences in payments are drastic, such as the maximum and minimum payments of supplier child code 28721. Global Services now has records of these measures and can explore why payments are so dissimilar.

4.1.3.2 Financial Payment Data Analysis in Python

We also conducted financial payment data analysis in Python on the global procurement spend data from the 2016-2018 FY. As mentioned in chapter 4.1.2, our script first creates a new set of data, inclusive of the original variables and an additional row with the supplier parent_child relationships. Refer to figure 4 for a visual. Second, the script creates a second dataset that queries the supplier parent_child identification, month, and spend variables.

	Parent_Child	Month	Spend
0	10001_10001	2018 / 08	246
1	10001_10001	2018 / 09	241
2	10001_10001	2018 / 10	483
3	10007_10007	2017 / 11	2470
4	10007_10007	2017 / 12	6177
5	10007_10007	2018 / 01	14802
6	10007_10007	2018 / 02	1982
7	10007_10007	2018 / 03	4942
8	10007_10007	2018 / 04	17804
9	10007_10007	2018 / 05	3866
10	10007_10007	2018 / 06	2242
11	10007_10007	2018 / 07	6247
12	10007_10007	2018 / 08	3389
13	10007_10007	2018 / 09	6928
14	10007_10007	2018 / 10	3543
15	10011888_10011888	2016 / 04	-238
16	10031_10031	2018 / 02	748
17	10041_10041	2017 / 12	11
18	10041_10041	2018 / 01	29
19	10041_10041	2018 / 02	25

Figure 10: Data query to include supplier parent_child, month, and spend variables from FY 2016-2018.

Figure 10 shows every financial transaction for each supplier parent_child pair, and records when each payment took place. There is trend shown in Figure 10, where for each parent_child, the payments are conducted monthly, if not a single transaction. Now, Global Services can be aware of financial transactions that happen too often, on time, or too late. To support the usability of the data table in Figure 10, we created a scatter plot to represent the relationship between month and spend for a unique parent_child supplier.

Figure 11: Scatterplot representing the relationship between year/month and spend, in dollars, for a unique supplier child code..

Here, you can visually see the change in spend, in dollars, from one month to another for parent_child vendor 100007_10007. You may see this graph for every vendor if you change a line in the Python script.

```
vendor = '10007_10007'   ##### change vendor name here

k = m.loc[m['Parent_Child'] == vendor]
k.plot(x = 'Month',y ='Spend',figsize = (12,8),title = 'Result for vendor
' + vendor)
plt.xticks(np.arange(len(k)), k['Month'], rotation=90)
plt.show()
```
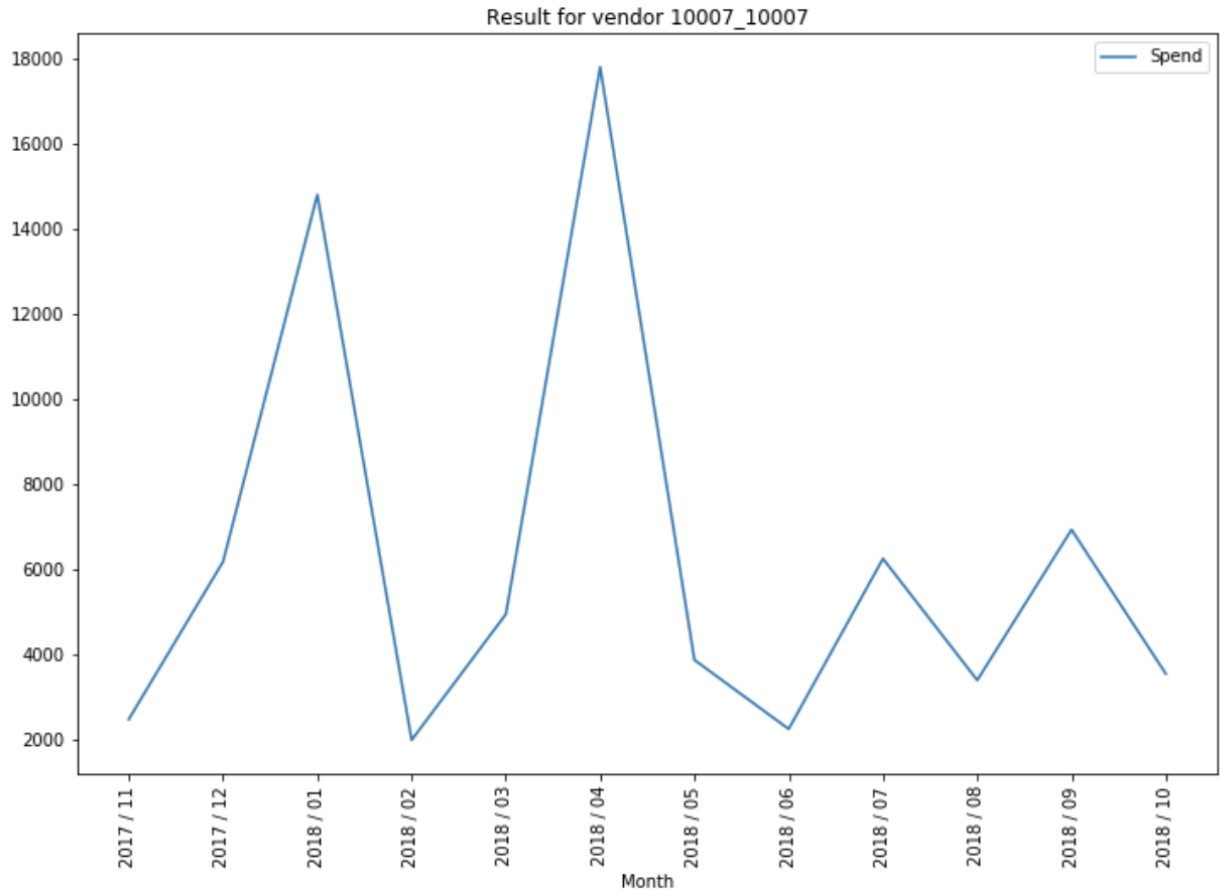
Figure 12: Python script to create scatter plot representing the relationship between year/month and spend, in dollars, for a unique supplier child code.

The first line of code that declares the vendor variable is what needs to be changed to view another vendor's information. Next, we created another table that filters the parent_child supplier relationship, year, and spend, in dollars.

	Parent_Child	Year	Spend
0	10001_10001	2018	970
1	10007_10007	2017	8647
2	10007_10007	2018	65745
3	10011888_10011888	2016	-238
4	10031_10031	2018	748
5	10041_10041	2017	11
6	10041_10041	2018	601
7	10048_10048	2017	3511
8	1004_1004	2017	2883
9	1004_1004	2018	2436
10	10063_10063	2017	2562

Figure 13: Data table with parent_child supplier relationship, year, and spend, in dollars, from FY 2016-2018..

For this table, we are able to see how much money was paid out to a specific supplier parent_child pair each year in 2016-2018, if applicable. Let's take vendor 10011888_10011888 for example.
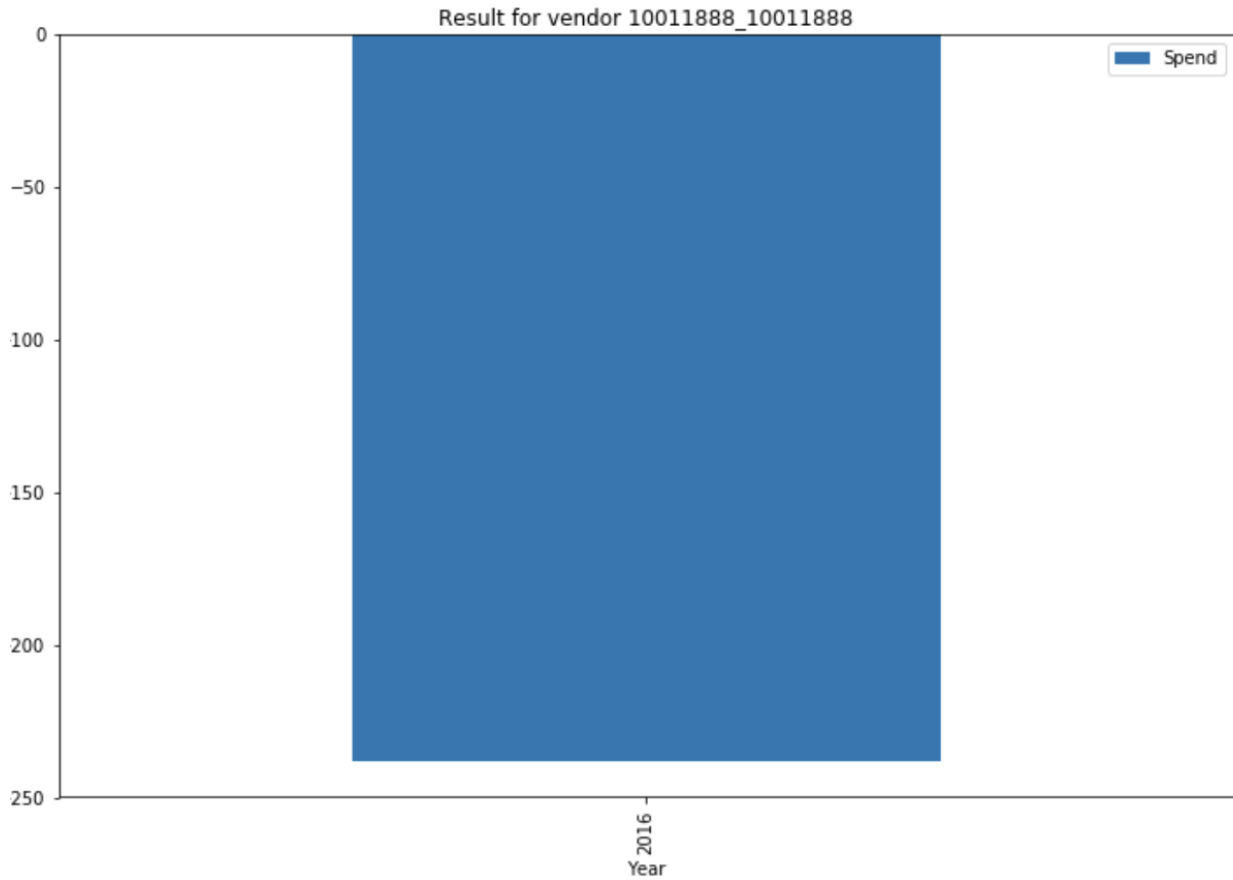
Figure 14: Bar chart showing change in spend over a single year period for a unique vendor.

For this vendor, we see that vendor 10011888_10011888 owed Global Services about $250 in 2016. As this form of payment to Global Services is uncommon in this data set, this is interesting to note. All vendor spend transactions can be recorded if the parent_child supplier code is changed, as noted in the description of Figure 12.

Lastly, we wanted to display the top 25 parent_child suppliers in a specific year. This way, Global Services has access to who they are spending the most money on in the course of a FY.
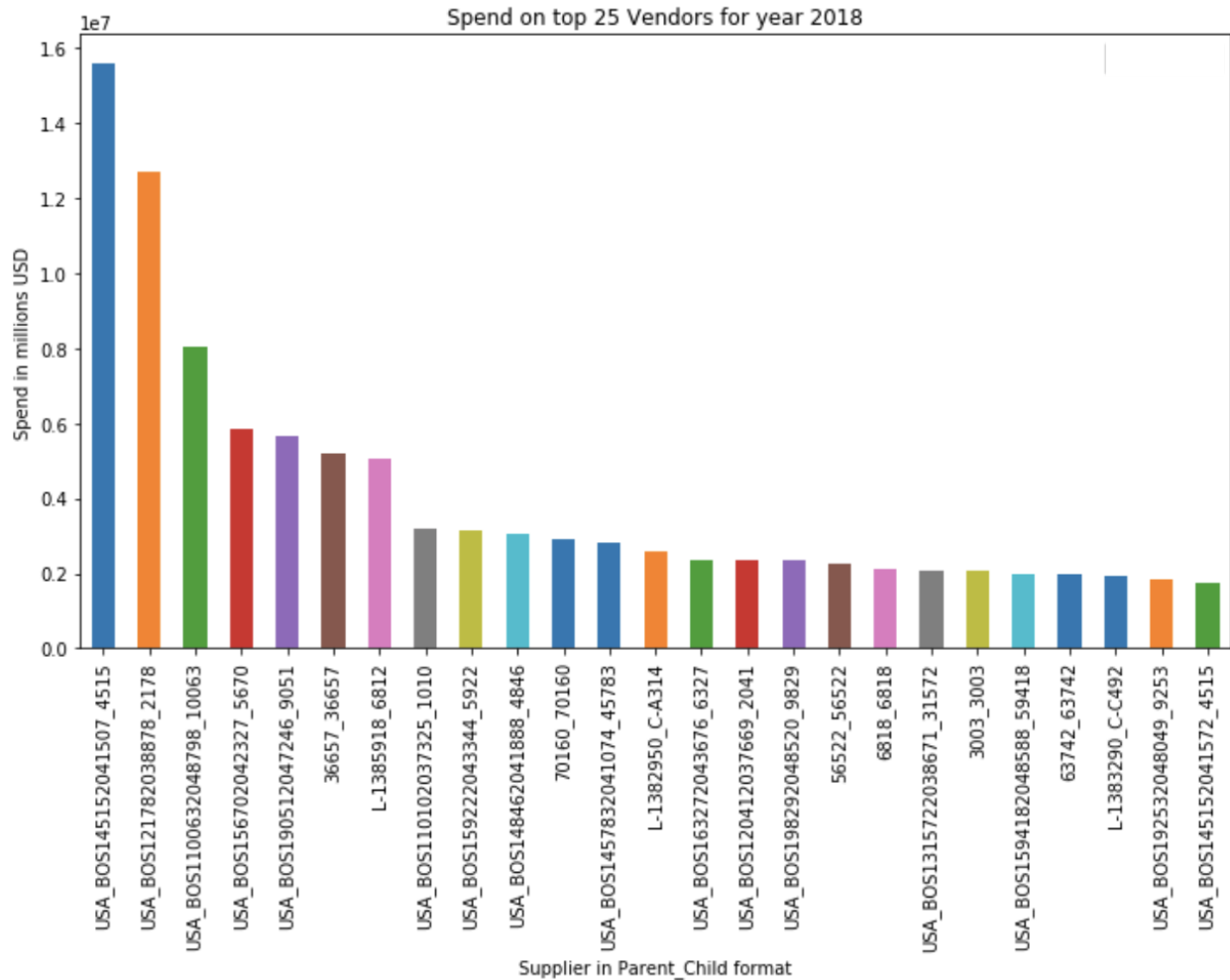
Figure 15: Spend, in millions of US dollars, on top 25 vendors for 2018 FY.

There is a decreasing exponential trend which indicates that Global Services paid out the leftmost vendor on Figure 15's x-axis more than 1.5 million USD in the 2018 FY. This amount is drastically different from the amount paid out to the rightmost parent_child supplier on the x-axis, who was paid about $200,000.

Overall, we created the Python script and data visualizations to aid Global Services in understanding the financial transactions occurring over longer periods of time. Due to the functionality of our script and as long as the variables are the same in the primary data table, as shown in figure 4, Global Services can run the script on additional internal global procurement spend data.

4.2 Supplier Onboarding and Payment Process Business Map

Global Services provided our team with the task of creating a business map for the supplier onboarding and payment process. Through interviews with subject matter experts (SME) in the process, we were able to synthesize the information and produce a flow chart of the different tasks assigned to different departments. Below is figure 2, the business process map.
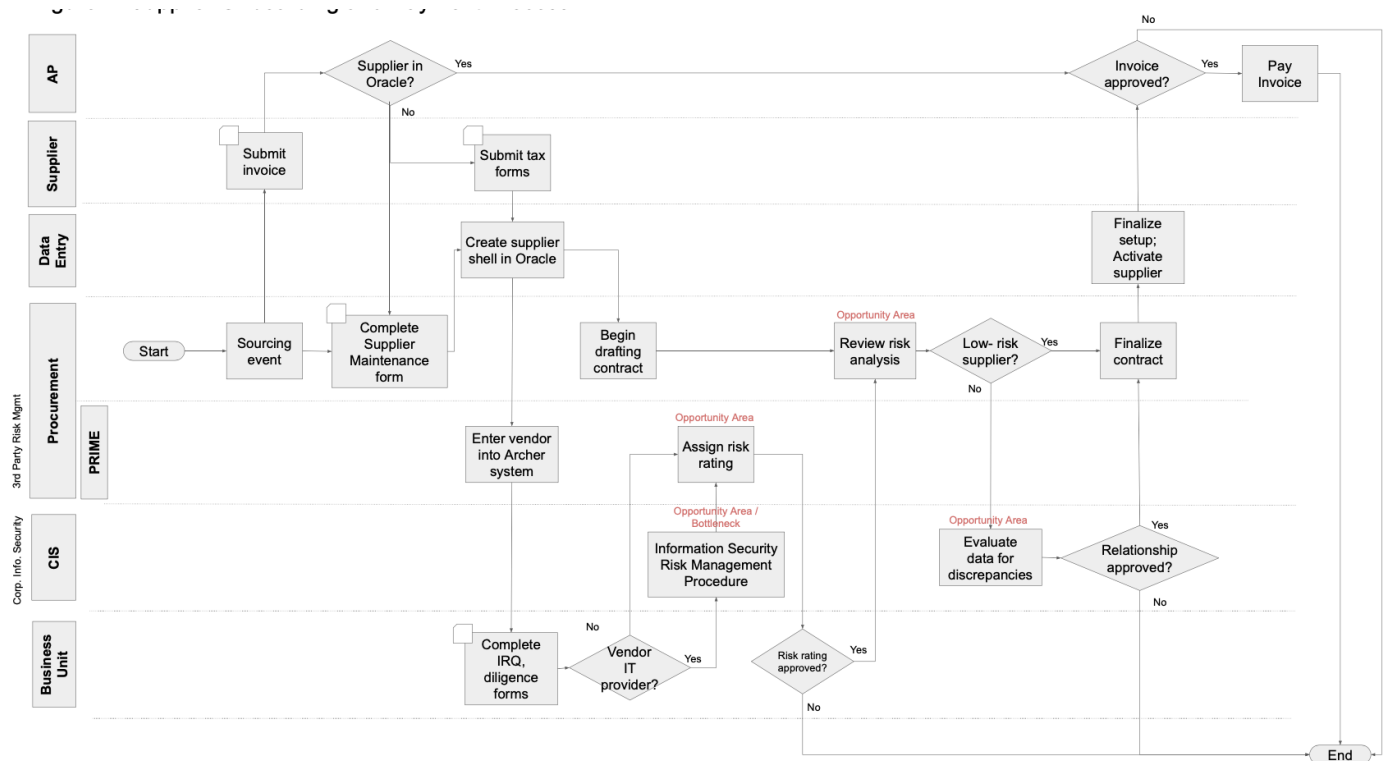
Figure 2: The supplier onboarding and payment process of Global Services. Visual design created by the Phase I WPI team.

There are 21 tasks present in this business map. Some of these tasks are comprehensive, and therefore contain sub-tasks. Due to this business process map, we have provided Global Services employees with the opportunity to understand the trajectory of the supplier onboarding and payment process. There are four steps with an "Opportunity Area" tag in red. These are the four areas our team has begun to address in this project: assign risk rating, Information Security Risk Management Procedure (ISRMP), review risk analysis, and evaluate data for descriptions. There are many ways that we have explored each area, but there is work needed to fully understand the opportunity areas present in these four categories.

We conducted interviews with those involved in the supplier onboarding and payment process. During the interviews, employees relayed information about inconsistencies in communication amongst departments involved in the process. Others stated training is needed for employees in this process, so everyone can understand the responsibilities of all six parties (listed on the left hand side of Figure 2). On another note, the business process map also allows future WPI teams and Global Services to analyze where there may be room for simplification, automation, and as a result, removal, of certain tasks. The goal of the supplier onboarding and payment process is maximization of successful transactions and minimization of time costs.

4.3 Mock-up Tableau Dashboard

Our team also created a Tableau dashboard using mock-up vendor identification data. The purpose of this dashboard was to provide Global Services with a vision of a future vendor risk Tableau dashboard. We proposed an initial idea of data display which is included in figure 16 below.
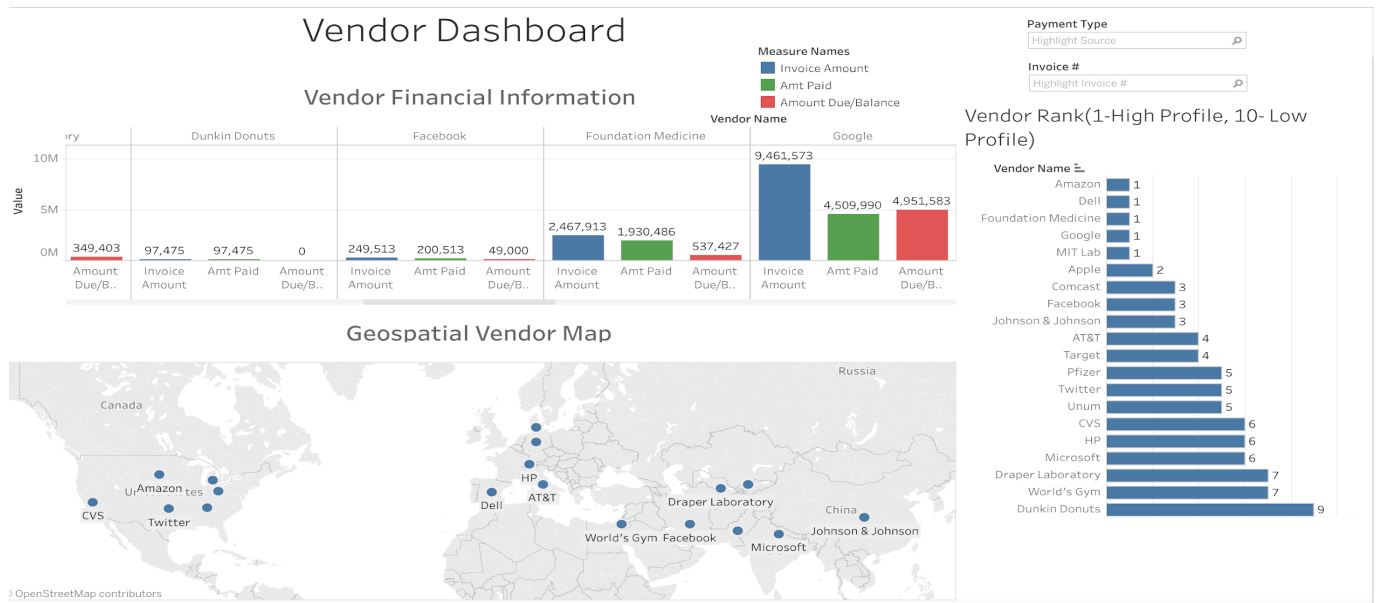
Figure 16: Tableau dashboard created with mock-up dataset of vendor digital identity characteristics.

Our team found importance in the incorporation of financial, risk, and geospatial information in our initial dashboard creation. The financial information in this dashboard includes invoice

amount, amount paid, and amount due (*all in dollars*) for a specific vendor account. These bar charts support reserving initiatives and aid employees in understanding financial transactions with vendors. Risk assessments of vendors is also important. Global Services' risk rating parameters are not available, so we invented a vendor rank that was on a scale from 1 to 10, where 1 represents a high-risk vendor profile and 10 represents a low risk vendor profile. The bar chart is organized, so there is a hierarchy in vendor risk on display, from highest to lowest. The high-risk vendors are located at the top of the chart because those are the vendors to look out for the most. Lastly, vendor geospatial information can inform Global Services of any events that may affect a vendor based on their location. Geospatial data visualizations are important, for example, in the event that natural disasters, political turmoil, and other events occur. Geospatial analysis is for Global Services to remain aware of real-time events.

Our team proposed the Tableau dashboard idea to Global Services employees. Our idea is similar to a Yelp profile for vendors. Our idea was then shared with the BFSLC and the members stated a Yelp-like vendor risk profile is one of the potential outcomes of the Council's collaboration.

Chapter 5. Conclusion

The goal of this project was to research and analyze vendor digital identity for State Street Corporation Global Services' supplier onboarding and payment process. Our team addressed our goal through documenting specific supplier identification characteristics from various forms, such as the Supplier Setup Form, Supplier Maintenance Form and Supplier Bank Request Form, and global procurement spend data from FY 2016-2018. These identity characteristics allow Global Services to better answer the question: "What is vendor digital identity?" We also interviewed employees to design and deliver a supplier onboarding and payment process business map inclusive of comprehensive tasks per stakeholder. The business map allows employees to understand what is done by other parties and visualize the trajectory of the process. Lastly, our team created data visualizations in Excel, Python, and Tableau to query, analyze, report, and understand further information about vendor digital identity, financial transactions, and risk variables.

Chapter 6. Recommendations

I have completed my share of the project. Thus, I will provide my recommendations to current and future WPI team members. All recommendations I have developed stem from our team's analysis and understanding of the supplier onboarding and payment process and of Global Services' vendor digital identity characteristics.

My first recommendation is for Global Services to provide future teams with a baseline of when a vendor transaction payment is considered an anomaly. Section 4.1.3 and its subchapters display spend data from various scopes. With a baseline, future teams will be able to find ways to flag the anomalies and automate financial risk analysis for Global Services.

My second recommendation is for future WPI teams to compile all vendor identification characteristics from all business forms into one table and report the results to Global Services to review. If approved, the vendor identity table can be shared with the BFSLC for discussion and review amongst other corporate partners.

Third, I suggest the future WPI teams to implement the same data visualizations and analysis created in Python and Excel in Tableau. As Tableau is the preferred software for querying and reviewing big data at Global Services, an updated dashboard with current results will encourage Global Services to provide us with more feedback for future work and development of the dashboard.

Next, I encourage Global Services to provide future WPI teams with vendor risk analysis data. Vendor digital identity and vendor risk analysis both work hand in hand. As we've developed insight on vendor digital identity, future teams need to work on developing insight on risk analysis factors, tools, and methods.

My fifth recommendation is for future WPI teams to consider utilizing the Analytic Hierarchy Process (AHP) which will aid Global Services' employees in making educated judgements on their complex multi criteria decisions regarding supplier onboarding and payment processes. To further explain, I will provide a definition of the AHP from *An Introduction to Management Science*. "The AHP requires the decision maker to provide judgements about the relative importance of each criterion and then specify a preference for each decision alternative using each criterion. The output of AHP is a prioritized ranking of the decision alternatives based on the overall preferences expressed by the decision maker."[14] To put into perspective, here are the AHP variables with respect to Global Services' supplier onboarding and payment process:

- *Decision maker*: employee(s) deciding on whether or not to conduct business with a vendor
- *Criterion*: vendor criterion considered when choosing if to conduct business with a vendor(s)
- *Decision alternatives*: the vendors under consideration
- *Preferences*: pairwise comparisons (e.g., if Global Services prioritizes payment transaction amount vs. location of vendor)

Once the future WPI team collects all information for the last three AHP variables, they can create the AHP model and Global Services will have an additional way to choose vendors to conduct business with.

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Appendix A: Supplier Setup Form

The Supplier Setup Form mentioned in section 3.1 is submitted as a separate file named:
Supplier Setup Form - Global.xlsx

Appendix B: Global Procurement Spend 2016 FY Dataset

The queried global procurement spend dataset mentioned in Section 3.1 is submitted as a separate file named: Queried Global Procurement Spend 2016 FY.xlsx

Appendix C: Global Procurement Spend 2016-2018 FY Dataset

The original global procurement spend dataset mentioned in Section 3.1 is submitted as a separate file named: Global Procurement Spend -v1.xlsx

Appendix D: Interview Questions for Employees who Conduct Supplier Onboarding

Date and Time: Tuesday 12/4 @ 11:30am
Interviewee: Alejandro Migo Rodriguez and John L Kelly
Lead: Lisandra
Transcriber: Mikala

Topic: Alejandro will review current state request process, WPI team will discuss what we're working towards, then Q&A.

Introductions

Goals: What are the ideal outcomes of successful supplier onboarding?

Process: Walk us through the steps of the supplier onboarding into the internal network, and discuss the parties involved in this process

Challenges: What are pain points in the current process and how do you and your colleagues work around them?

Wishlist: What are ways the process could be improved/streamlined/automated?

Additional Questions:
Current business process:
- General overview of supplier setup form
- Who fills out the form? Who receives/processes them?
- How much time does this form take compared to the Oracle subledger?
- Are there any auto-fill features for forms?
- Which takes longer? Supplier modification or new supplier requests?
- How common are each type of request (referring to supplier modifications and new supplier requests)?
- What security measures are taken regarding the SMF?
- Do bank detail requests require additional security measures?

Future business process plans:
- What future plans does State Street have that would affect this form/process?

Appendix E: Interview Questions for Employees who Conduct Risk Assessments and Oversee Vendor Engagements

Date and Time: Thursday 12/6 @ 9:30 AM
Interviewee: Joy E Ingham, James Durickas, and Patrick Daly
Lead: Mikala Dunbar
Transcriber: Lisandra Lao

Topic: Global Services employees will discuss the processes for reviewing vendor engagements, assessing risk and conducting ongoing vendor screening.

Introductions

Goals: What are the ideal outcomes of a successful new supplier onboarding?

Process: Walk us through the steps of the ongoing screening process and what risk management steps are taken.

Challenges: What are pain points in the current process and how you get around them?

Wishlist: What are ways the process could be improved/streamlined/automated?

Backup Questions:
Current business process:
- Provide an overview of vendor management after onboarding
- What current risk management features do you have in place?
- How often is the risk profile of a company analyzed?
- What process areas do you believe are vulnerable?
- What is the ongoing screening process like?
- What are examples of red flags that State Street considers when thinking of cutting ties with a vendor? Does this happen?

Future business process plans:
- What future plans do you see for the risk management of vendors? Ongoing vendor screening?
- Would a real-time risk assessment dashboard be useful or feasible?

Appendix F: Interview Questions for Employees who Conduct Data Entry

Date and Time: Thursday 12/6 @ 11:30am
Interviewee: Eric Self, Alejandro Migu Rodriguez, John L Kelly
Lead: Mikala Dunbar
Transcriber: Lisandra Lao

Topic: Eric will review the details of processing requests for entry of new suppliers or updates of existing suppliers within Oracle.

Introductions

Goals: What is the ideal outcome of a successful new supplier onboarding? A successful update of an existing supplier?

Process: Walk us through the steps of the new supplier update/entry process within Oracle.

Challenges: What are pain points in the current process and how you get around them?

Wishlist: What are ways the process could be improved/streamlined/automated?

Backup Questions:
Current business process:
- Provide an overview of processing requests for entry of new suppliers in Oracle
- Describe the Supplier Hub and functionality of Oracle
- What information in Oracle is different than information in other internal databases?
- Is the process of updating existing suppliers easy? Is this something that happens often?
- What is the most common change to existing suppliers in Oracle?
- How do you distinguish between an update of an existing supplier vs. a new supplier entry?
- What kind of legal checks or identity checks occur before entering vendor data into Oracle?
- What is the style of data entry? Drop down vs. fill in?
- How easy is it to fix human error in Oracle if something is entered incorrectly?

Future business process plans:
- What future business plans for State Street affect this process?

Appendix G: Excel Mock-up Data

The mock data set mentioned in section 3.3 is submitted as a separate file named: <u>Mock-up Vendor Digital Identity Data.xlsx</u>

Appendix H: Python Script

The Python code mentioned in section 3.5 is submitted as a separate file named: <u>Global Procurement Spend Data FY 2016-2018 Script.ipynb</u>

Appendix I: Python HTML File

The Python HTML file mentioned in section 3.5 is submitted as a separate file named: Global Procurement Spend Data FY 2016-2018 HTML File.html

Appendix J: "New Supplier - RFQ Only" Request, Required Data Fields (citation to Excel doc)

"Supplier Details" Excel Tab	**Field Reference Comments**
Requestor	Input name of Requestor
Request Date	Input date request is being sent
Registration Purpose	Select area whom is requesting setup
Reason for Activation	Select why request is being completed
Request Type	= New Supplier
Tax ID	Enter appropriate tax identification information
Additional Tax ID	Enter appropriate tax identification information (*if applicable*)
Section 1: Supplier Identification Information	
Supplier Name	This name should match official tax documentation/registration, and should also be the name in which the supplier would be receiving payments.
Section 2: Address Information	
Address Purpose	= RFQ Only
Country	Enter Applicable Details
Address Line 1	Enter Applicable Details
Address Line 2	Enter Applicable Details
Address Line 3	Enter Applicable Details
City	Enter Applicable Details
Country	Enter Applicable Details
State/Province	Enter Applicable Details
Postal Code	Enter Applicable Details
Primary Product and Services Category	Enter Appropriate Product and Services Category
Supplier URL	Enter Supplier's Website Details

Section 3: Purchasing Information	
Preferred Method of Purchase Order Communication (State Street preferred method is Oracle iSupplier Portal)	
Irrespective of Preferred Method of Purchase Order Communication (please provide an email address for Purchase Order submission)	
If OSN, provide account information	
ABAC Number	
RRP	
Critical	
GEMS ID	
Section 4: Supplier Contact Information	
First Name	Enter Applicable Details
Middle Name	Enter Applicable Details
Last Name	Enter Applicable Details
Job Title	Enter Applicable Details
Department	Enter Applicable Details
Email Address	Enter Applicable Details
Phone Country Code	Enter Applicable Details
Phone Area Code	Enter Applicable Details
Phone Number (include extension with EXT)	Enter Applicable Details
Fax Number	Enter Applicable Details
Contact Full Address	Enter Applicable Details

Appendix K: "New Supplier - Purchasing & Payment" Request, Required Data Fields (citation to Excel doc)

"Supplier Details" Excel Tab	Field Reference Comments
Requestor	Input name of Requestor
Request Date	Input date request is being sent
Registration Purpose	Select area whom is requesting setup
Reason for Activation	Select why request is being completed
Request Type	= New Supplier
Operating Unit	Reference the Operating Unit reference guide. This guide shows which entities fall under which operating unit.
Tax ID	Enter appropriate tax identification information
Additional Tax ID	Enter appropriate tax identification information (*if applicable*)
Section 1: Supplier Identification Information	
Supplier Name	This name should match official tax documentation/registration, and should also be the name in which the supplier would be receiving payments.
Section 2: Address Information	
Address Purpose	Select if address is being setup for purposes of Purchasing, Payments, or both
Country	Enter Applicable Details
Address Line 1	Enter Applicable Details
Address Line 2	Enter Applicable Details
Address Line 3	Enter Applicable Details
City	Enter Applicable Details
County	Enter Applicable Details
State/Province	Enter Applicable Details

Postal Code	Enter Applicable Details
Preferred Payment Method	Enter Applicable Details
Payment Terms	Enter Applicable Details
Primary Product and Services Category	Enter Appropriate Product and Services Category
Supplier URL	Enter Supplier's Website Details
Section 3: Purchasing Information	
Preferred Method of Purchase Order Communication (State Street preferred method is Oracle iSupplier Portal)	
Irrespective of Preferred Method of Purchase Order Communication (please provide an email address for Purchase Order submission)	
If OSN, provide account information	
ABAC Number	
RRP	
Critical	
GEMS ID	
Section 4: Supplier Contact Information	
First Name	Enter Applicable Details
Middle Name	Enter Applicable Details
Last Name	Enter Applicable Details
Job Title	Enter Applicable Details
Department	Enter Applicable Details
Email Address	Enter Applicable Details
Phone Country Code	Enter Applicable Details
Phone Area Code	Enter Applicable Details
Phone Number (include extension with EXT)	Enter Applicable Details
Fax Number	Enter Applicable Details
Contact Full Address	Enter Applicable Details

"Supplier Bank Details" Excel Tab	**Field Reference Comments**
Section 1: Supplier Identification Information	
Remittance Advice Email Address	Enter the email address that the supplier would receive their payment remittance details via
Section 2: Bank Information (*as applicable - please complete applicable information based on Invoice backup received*)	
Bank Name	Enter Applicable Details
Bank Address	Enter Applicable Details
Branch Name & Branch Number	Enter Applicable Details
Country	Enter Applicable Details
City	Enter Applicable Details
County/State (*as applicable*)	Enter Applicable Details
Post/Zip Code	Enter Applicable Details
Bank Account Name	Enter Applicable Details
Payment Currency	Enter Applicable Details
Bank Account Number	Enter Applicable Details
Bank Routing Number	Enter Applicable Details
IBAN Number	Enter Applicable Details
Swift Code/BIC	Enter Applicable Details
Sort Code	Enter Applicable Details
Intermediary Bank Name	Enter Applicable Details
Intermediary Bank Address	Enter Applicable Details
Intermediary Bank Account Number	Enter Applicable Details
Intermediary Bank Swift Code/BIC	Enter Applicable Details

Appendix L: "New Site" Request, Required Data Fields (cite)

"Supplier Details" Excel Tab	Field Reference Comments
Requestor	Input name of Requestor
Request Date	Input date request is being sent
Registration Purpose	Select area whom is requesting setup
Request Type	= New Site
Operating Unit	Reference the Operating Unit reference guide. This guide shows which entities fall under which operating unit.
Section 1: Supplier Identification Information	
Supplier Name	Enter Existing R12 Supplier Name
Supplier Number	Enter Existing R12 Supplier Number
Section 2: Address Information	
Address Purpose	Select if address is being setup for purposes of Purchasing, Payments, or both
Country	Enter Applicable Details
Address Line 1	Enter Applicable Details
Address Line 2	Enter Applicable Details
Address Line 3	Enter Applicable Details
City	Enter Applicable Details
County	Enter Applicable Details
State/Province	Enter Applicable Details
Postal Code	Enter Applicable Details

"Supplier Bank Details" Excel Tab	Field Reference Comments
Section 1: Supplier Identification Information	

Remittance Advice Email Address	Enter the email address that the supplier would receive their payment remittance details via
Section 2: Bank Information (as applicable - please complete applicable information based on Invoice backup received)	
Bank Name	Enter Applicable Details
Bank Address	Enter Applicable Details
Branch Name & Branch Number	Enter Applicable Details
Country	Enter Applicable Details
City	Enter Applicable Details
County/State (*as applicable*)	Enter Applicable Details
Post/Zip Code	Enter Applicable Details
Bank Account Name (*Should Match Supplier Name*)	Enter Applicable Details
Payment Currency	Enter Applicable Details
Bank Account Number	Enter Applicable Details
Bank Routing Number	Enter Applicable Details
IBAN Number	Enter Applicable Details
Swift Code/BIC	Enter Applicable Details
Sort Code	Enter Applicable Details
Intermediary Bank Name	Enter Applicable Details
Intermediary Bank Address	Enter Applicable Details
Intermediary Bank Account Number	Enter Applicable Details
Intermediary Bank Swift Code/BIC	Enter Applicable Details

Appendix M: "Supplier Modification" Request, Required Data Fields (cite)

"Supplier Details" Excel Tab	Field Reference Comments
Requestor	Input name of Requestor
Request Date	Input date request is being sent
Registration Purpose	Select area whom is requesting setup
Request Type	= New Site
Request Comments	Enter what is being changed for the supplier. Please note: supplier name changes must be completed as a "New Supplier" setup as new compliance/identification checks should be ran
Operating Unit	Reference the Operating Unit reference guide. This guide shows which entities fall under which operating unit.
Section 1: Supplier Identification Information	
Supplier Name	Enter Existing R12 Supplier Name
Supplier Number	Enter Existing R12 Supplier Number
Section 3: Purchasing Information	
Irrespective of Preferred Method of Purchase Order Communication (please provide an email address for Purchase Order submission)	
If OSN, provide account informtion	
ABAC number	
RRP	
Critical	
GEMS ID	
Section 4: Supplier Contact Information	
First Name	Enter Applicable Details
Middle Name	Enter Applicable Details

Last Name	Enter Applicable Details
Job Title	Enter Applicable Details
Department	Enter Applicable Details
Email Address	Enter Applicable Details
Phone Country Code	Enter Applicable Details
Phone Area Code	Enter Applicable Details
Phone Number (include extension with EXT)	Enter Applicable Details
Fax Number	Enter Applicable Details
Contact Full Address	Enter Applicable Details

Appendix N: "Reactivate/Deactivate Supplier" Request, Required Data Fields (cite)

"Supplier Details" Excel Tab	Field Reference Comments
Requestor	Input name of Requestor
Request Date	Input date request is being sent
Registration Purpose	Select area whom is requesting setup
Request Type	= Reactivate Supplier or Deactivate Supplier
For Deactivation/Reactivation, provide reasoning	Enter reason for re-activation/deactivation - GPS should be involved in these requests as suppliers are used globally. Analysis should be completed to ensure desired impact.
Section 1: Supplier Identification Information	
Supplier Name	Enter Existing R12 Supplier Name
Supplier Number	Enter Existing R12 Supplier Number

Appendix O: "Bank Detail Adds/Changes" Request, Required Data Fields (cite)

"Supplier Bank Details" Excel Tab	Field Reference Comments
Section 1: Supplier Identification Information	
Supplier Name	Enter Existing R12 Supplier Name
Supplier Number	Enter Existing R12 Supplier Number
Supplier Site	Enter Existing R12 Supplier Site
Remittance Advice Email Address	Enter the email address that the supplier would receive their payment remittance details via
Request Type	= Add or Modify
Section 2: Bank Information (as applicable - please complete applicable information based on Invoice backup received)	
Bank Name	Enter Applicable Details
Bank Address	Enter Applicable Details
Branch Name & Branch Number	Enter Applicable Details
Country	Enter Applicable Details
City	Enter Applicable Details
County/State (*as applicable*)	Enter Applicable Details
Post/Zip Code	Enter Applicable Details
Bank Account Name (*Should Match Supplier Name*)	Enter Applicable Details
Payment Currency	Enter Applicable Details
Bank Account Number	Enter Applicable Details
Bank Routing Number	Enter Applicable Details
IBAN Number	Enter Applicable Details
Swift Code/BIC	Enter Applicable Details
Sort Code	Enter Applicable Details

Intermediary Bank Name	Enter Applicable Details
Intermediary Bank Address	Enter Applicable Details
Intermediary Bank Account Number	Enter Applicable Details
Intermediary Bank Swift Code/BIC	Enter Applicable Details