# Developing a Business Intelligence Solution for the Foisie Business School

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# Abstract

The goal of this project was to identify key performance areas and develop key performance indicators for the Foisie Business School to create a business intelligence solution to inspire data driven decision making and improve their organizational performance management processes. To achieve this goal, we followed iterative rapid application development methodology to gather business requirements, create a database and develop three interactive BI dashboards. The final dashboards display the KPAs the FBS Biggest Exports, Resource Allocation, and Faculty Performance.

# Executive Summary

In order for organizations to set goals and track progress, a set of metrics needs to be created to measure the organization against the methods of organizational performance management (U.S. Office of Personnel Management, 2019). The art of business intelligence (BI) allows organizations to create and show metrics in a dashboard form to provide easy to understand displays and utilize data driven decisions (Işık, 2013). These metrics are Key Performance Indicators (KPIs) and can be categorized into Key Performance Areas (KPAs). Throughout the course of 2019-2020, the team worked with the Foisie Business School (FBS) to develop a set of metrics to be displayed using a BI tool to help the FBS measure success.

The FBS created a Management Plan to help figure out the main performance areas of the school and compile information together about these areas. The plan was created using charts made in Excel from data sets and was used by the FBS to help determine their project towards set goals in the prior year. The team was given the ability to read through the Management Plan and analyzed the areas and metrics proposed. From there the MQP team created a set of metrics from the Management Plan and some additional metrics based on research for the FBS. The FBS currently uses ad-hoc queries and static charts to display their KPIs. To improve this reporting system, the team worked to display the metrics using interactive performance dashboards through a BI solution (Foisie Business School Management Plan, 2019). The transfer to interactive dashboards with a live data source will help minimize the time FBS administration spends on creating and analyzing various reports. The three main performance areas that the team focused on in this project were "Resource Allocation," "Faculty Performance," and "Biggest Export." Accordingly, the team developed three dashboards to operationalize and visualize the KPIs under each of these three performance areas. The first dashboard, "Biggest Exports," would help the FBS generate visual reports on which students outside the business school were taking business classes. This would allow business school administration to determine which courses had the biggest pull to students outside the business school and market these courses at their most popular audiences. The second dashboard, "Resource Allocation," was to display metrics related to the number of students in the school and the amount and types of classes over time. This was to help the school schedule the following year and have the ability to make decisions based on past trends and to offer more sections of popular classes and run less of the classes that were not at capacity. The third dashboard, "Faculty Performance," would help display the number of credit hours each instructor was teaching with their rank as a filter. This would help the FBS compare faculty over time with respect to their ratings and credit hours. The dashboard shows the rating of each instructor based on question two of the student course report evaluations.

In order to display the team's KPIs through an interactive performance dashboard, the team had to decide on which BI platform to use for this project. It was decided to use Tableau due to its

functionality and potential for later integration into WPI's dashboard system. In order to display the KPIs for the dashboards, a sizable amount of data was necessary. In order to store the data, a MySQL database was created by the team through a WPI server. The team acquired data from the WPI Registrar and the WPI Provost office with help from the team's sponsor. Based on the available data, metrics relating to student demographics was either cut from dashboards or created by the team to simulate the potential functionality of the dashboard. Throughout the project the team used Rapid Application Development (RAD) to create iterations of the dashboards based on constant user feedback from the team's advisor, sponsor, and key stakeholders.

After creating initial prototypes, the team conducted a series of usability testing sessions. In those sessions, the team members met with several potential users in the FBS. They were guided through a series of tasks that the team had created to highlight the features of the dashboards. Based on their feedback, the team made the relevant changes to the dashboards.

The team recommends that these dashboards be used as a reference when creating a durable application to be used by the FBS. The team encountered data and structural limitations that prevented the creation of a full-scale product, so they focused on the importance of a sound BI solution. Moving forward, establishing live data connections to the WPI database server will allow the FBS to use these KPI's to have access to a more complete picture of the business processes at WPI.

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# 1.0 Introduction

Organizational performance management helps organizations and institutions assess current efforts against benchmarks and goals. The analysis of these benchmarks and goals helps update strategies and accomplish organizational goals. (U.S. Office of Personnel Management, 2019). Educational institutions must constantly evaluate the performance of instructors, students, staff, and accreditation status. Performance management systems can provide value to show educational institutions which goals they are reaching and for which they are falling short. These goals are measured against determined metrics, known as key performance indicators (KPIs).

Business Intelligence (BI) helps organizations make data-driven decisions and improve their adaptation to change and performance through the analysis of technical and organizational elements (Işık, 2013). Performance dashboards are a type of BI tools that provide interactive dashboards that display KPIs and data sets in an easy to understand way. Institutions, such as the University of New Hampshire, use performance dashboards to measure and manage their performance to make informed decisions (University of New Hampshire, 2019). Informed decisions can help improve the performance of an institution.

The Foisie Business School (FBS) is a part of Worcester Polytechnic Institute (WPI) in Worcester, MA. Currently the FBS creates static performance reports, including tables and graphs based on data collected from various sources (Foisie Business School Management Plan, 2019). It is tedious and time-consuming to aggregate data from the sources to perform analysis. Instructors from WPI frequently request reports from the FBS administration who must in turn determine the applicable sources and aggregate the data. These tend to be repetitive and difficult to respond to with the current data organization methods. WPI Institutional Research creates performance dashboards for WPI, and these datasets can be filtered down to focus on specific data. However, the existing dashboards represent campus wide data and are designed to display indicators that pertain to WPI as a whole. The FBS would benefit from complementary dashboards that focus on their specific needs, values and goals. A BI solution can help ease the process of organizing data from multiple sources and viewing data for future analysis by the FBS. Included in this are interactive performance dashboards, that will hopefully improve the process of making data-driven decisions within the institution. The goal of this project is to develop a BI solution to improve performance management processes and data driven decisions within the FBS.

In order to develop a BI solution for the FBS to improve their performance management processes and data driven decisions the team will be:
- Developing KPIs for the FBS based on their current goals and objectives
- Designing and implementing a database to store and organize information to be used in the BI solution
- Using a BI platform to create performance dashboards

# 2.0 Background

## 2.1 Business Intelligence

BI is a field that began to emerge in the 1990s to give organizations access to "direct and timely" information (Eckerson, 2011). The field refers to a wide range of concepts from data mining to querying and reporting. It can be used to "improve decision making, cut costs, and identify new business opportunities" (Mulcahy, 2019). With the creation of various BI solutions, the result can help companies measure, manage and improve their performance based on KPIs.

Portrayed in Figure 1, the BI framework is centralized among four external elements: people, processes, management and governance (Coronel, 2016). It is comprised of external and operational data, which could then be extracted to a data warehouse or data mart, utilized for querying and reporting. The querying and reporting are then derived into data analytics and used to monitor and alert the status of business activities. These analytics outputs are put into data visualizations (depending on the BI tool) and intuitively displayed to management.
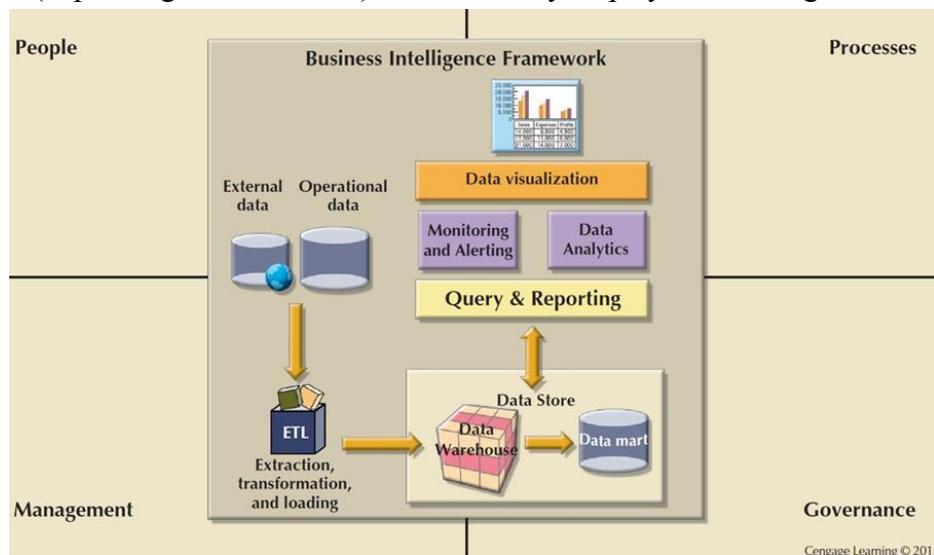


*Figure 1: BI Framework (Adapted from Coronel, 2016)*

## 2.2 Measuring Organizational Performance

Among academic writing surrounding the topic of business strategy, it is widely agreed upon that "What gets measured gets done" (Eckerson, 2011). Measuring organizational performance is key to maintaining and innovating successful business strategies keeping measurements of the numerical data produced by business activities creates company goals and provides feedback on their progress towards achieving those goals. These measurements can be displayed in a BI environment to portray the results to management. Depending on what business activities are frequently measured, those activities are most likely to excel.

## 2.2.1 Performance Indicators

Performance indicators utilize quantitative and qualitative data collected from business activities to capture an outlook on an organization's business strategy. Performance indicators are an important component to BI that "indicate" to upper management how or when to make informed operational decisions-- all of which supports strategic business planning.

There are three main types of performance indicators: risk indicators, leading indicators and lagging indicators. Risk indicators measure a business's activity that negatively impact success. These are helpful to organizations by providing warning signals for issues in a business process. Leading indicators measure a business activity that are the catalysts for lagging indicators (or outcomes). An example of a leading indicator could be measuring the number of customers contacting the sales department of a company. Lagging indicators are the results of the leading indicators. An example of a lagging indicator would be measuring the revenue for the month or high customer satisfaction. The high number of customers calling the sales department is a catalyst to the lagging indicator (outcome) of having high sales for the month or customer satisfaction.

KPIs are measurements of the business activities specific to the organization that prove most helpful in making strategic business decisions. Although an organization can measure dozens of metrics, KPIs exist in fewer numbers because they are the select indicators that "affects most of the company's critical success factors" (Eckerson, 2011). The KPIs are the measurements of the business strategy that measure the organization's most critical areas of success. For example, a retail store would have KPIs that related to measurements of sales, customer satisfaction or number of customers in the store per week. A university would have KPIs that are related to enrollment, fluctuating size of student body or academic research publications.

## 2.2.2 Performance Areas

Performance areas are the operational units of an organization that hold like business activities. Examples of a performance area for a company could be sales, supply chain, or quality, each with multiple business activities involved in those areas of performance. In order to narrow down a KPI, businesses can metaphorically peel back the layers of the performance areas. Performance also consists of result areas, or the outcomes of the performance are activities. Within the performance areas and the result areas are the indicators that are potentially utilized as a KPI. Figure 2 portrays a visual of how organizations metaphorically "peel back the layers" to identify a KPI. According to Tewari (2018), in an academic article "Approach to Identify KPAs and KPIs for Higher Education Institutions," the areas an organization should define are the following:

1. Key Performance Area (KPA) are the segments of an organization that employees must perform in to reach a key result area.
2. Key Result Area (KRA) are the outcomes of individuals performing the associated key performance area and identify an organization's most significant area of success.

3. Key Result Indicators (KRIs) are measurements from the key result areas that tell an organization whether the outcomes from the key performance area were successful.
4. Performance Indicators (PIs) tell an organization exactly what activities they must excel in to reach a result indicator.
5. Result Indicators (RIs) are the outcomes of the performance indicators and inform the organization of what they have done.
6. Key Performance Indicators (KPIs) tell an organization what activities have the most significant impact on an organization's key result areas.
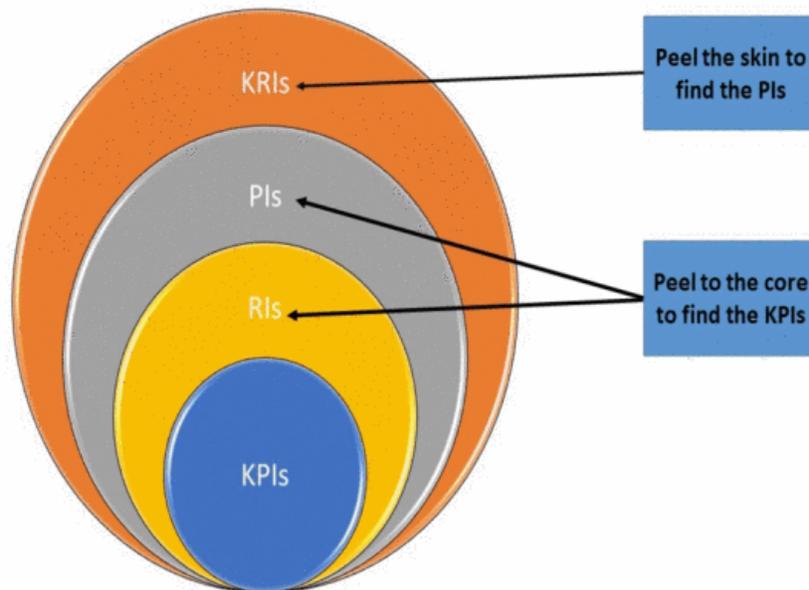
*Figure 2: Approach to Identify KPAs and KPIs for Higher Education Institutions (Adapted from Tewari, 2018)*

## 2.2.3 Selecting Appropriate Metrics for Indicators

A challenge of developing KPIs is selecting the appropriate metrics that measure the performance of an organization's various business activities. Selecting the appropriate metrics can be tricky because many factors can skew the accuracy of KPIs. For example, using customer satisfaction as an indicator based off of results from a survey could be an inaccurate measurement because surveys are often filled out carelessly. Other times, the development of certain KPIs can lead an organization to discover other informative indicators. For example, Quicken Loans created two KPIs that correlate to mortgage consultants meeting their sales quotes. The KPIs were a calculation of the amount of time spent on the phone with customers each day and the number of clients they talk to each day. Quicken Loans identified a third KPI that tracked their sales quotas every 15 minutes, which gave the company further insight into their sales performance (Eckerson, 2006).

Effective indicators for measuring performance should be measurable, objective, and actionable (Wolf, 2010). In summary, indicators must be an objective output in the form of numerical data (in order to be measurable) and the results of these values should lead to an action. For example, if the indicator "percentage of product reviews above three stars" was below a company's agreed upon goal, upper management should have an actionable conversation of what can be improved about their product to increase their number of three star or above ratings. More specifically, effective metrics should consider the following elements (Eckerson, 2006):

1. **Value**: A numerical value, such as a percentage, total number of sales, revenues, number of enrolled students, number of products sold, etc. (different values will pertain to different types of organizations).

2. **Time Frame**: The measurement must be taken in a specific and consistent time frame, for example monthly, weekly, quarterly or yearly measurements.

3. **Benchmark**: A comparison for judging a current metric's success, for example a result of the same metric from the same time frame last year, or comparing the organizations results to that of a competitor company.

4. **Targets**: Targets are numerical goals that metrics aim to achieve. Like benchmarks, they provide measurements with a meaningful value and provide a comparison of the aspired performance level and the actual. Targets can vary depending on the measurement. Target measurements can be determined by achievement over certain values, reduction in value, a value equaling zero, a value being absolute, or a value achieving a certain minimum or maximum.

5. **Ranges**: Ranges represent the different target zones for metrics, for example being "above," "below" or "within" a target.

6. **Visual Encodings**: Dashboards often use color coding systems to immediately signal key information or warnings to managers. The common visual encodings are the recognizable traffic light colors: red, yellow and green.

## 2.2.4 Understanding the Organization

Specific nuances of an organization have an effect on KPIs. For example, Direct Energy wanted to track the number of "repeat calls" by field technicians (multiple repeat calls being negative because it points to initial installation issues). However, the field technicians have multiple responsibilities like sales and replacements, so tracking repeat calls as a risk indicator was not an appropriate metric for the company (Eckerson, 2006). It can be detrimental to an organization's performance to realize company nuances after a KPI is deployed; having a full understanding of an organization's activities and tendencies is key for developing effective KPIs.

Along with organizational nuances, KPIs should also be continually updated because they have a "Natural Lifecycle." When a KPI is first introduced, it "energizes the workforce and performance improves" (Eckerson, 2006). However, over time KPIs lose their impact and should be updated. A best practice for this is to hold quarterly meetings to review KPI effectiveness.

## 2.3 Performance Dashboards

Performance dashboards are a tool that enable organizations to visualize, measure, monitor, and manage their performance (Eckerson, 2011). It allows organizations to display their KPIs in an understandable and concise manner (McAllister, 2019). The definition of performance dashboards from an industry leader, Wayne Eckerson is "a multilayered application built on a BI and data integration infrastructure that enables organizations to measure, monitor, and manage business performance more effectively"

(Eckerson, 2005). In comparison to traditional charts and spreadsheets, performance dashboards allow you to easily integrate all of your data sources, update automatically or more frequently, and to allow for the synthesis of data (Işık, Jones, & Sidorova, 2013). Performance dashboards synthesize information from a multitude of sources to provide information that moves a company in the same direction towards a common goal.
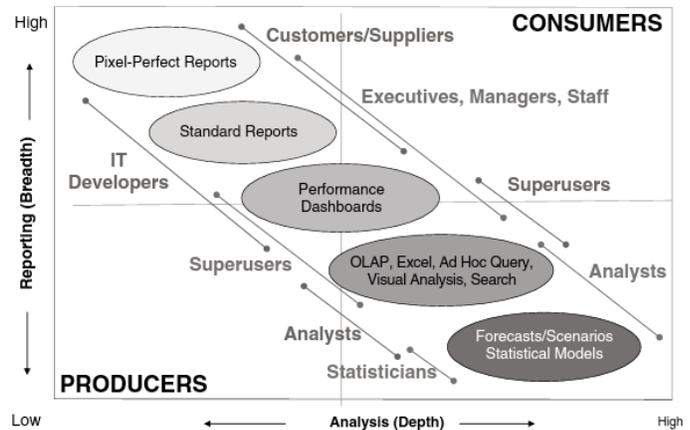
Figure 3: Dashboard Audience (Eckerson, 2011)

### 2.3.1 Performance Dashboard History and Types

The concept of using information technology to manage company metrics dates back to the 1980s when Executive Information Systems (EIS) existed but did not provide optimal value. The EIS systems were typically geared to a specific subset of people and did not offer value to the organization as a whole. They were hosted on mainframes and supercomputers which made the cost difficult to manage for the time when they emerged. Today's dashboards can be updated multiple times throughout the year in order to keep data current and the business informed. The
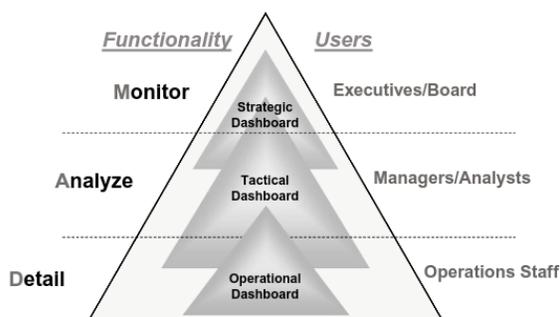
Figure 4: Dashboard Audience (Eckerson, 2011)

typical audience for performance dashboards is executives, managers, and staff. Since the target audience is at an executive level, performance dashboards must be able to deliver a large amount of data in a concise manner. The different levels of reports can be seen in Figure 4 and it is important to mind the audience since they will determine the level of complexity of the visualization of the data. The more in-depth reports should be directed towards

statisticians and analysts while the higher-level reports' audience would be executives and managers. In the middle is performance dashboards which gives a high-level report of in-depth data and is aimed towards executives, managers, staff, and supervisors. There are three types of performance dashboards: operational dashboards, tactical dashboards, and strategic dashboards. Operational dashboards monitor processes that are operational as they
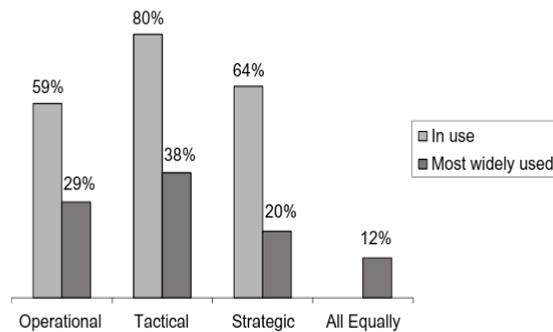


*Figure 5: Dashboard Type Use (Eckerson, 2011)*

occur (which could be down to the minute). Tactical dashboards show the performance of departmental activities, processes, and goals. Strategic dashboards show progress towards strategic goals. Organizations use the three different types of dashboards together to help them visualize and track the various aspects of their business. With the balance of the three dashboards as seen in Figure 5 tactical dashboards are the most widely used and few organizations equally use all three. Strategic dashboards are useful for tracking initiatives that apply to whole departments.

The audience for strategic dashboards is typically aimed at executives as can be seen in Figure 4. Organizations must decide on the goal of their performance dashboards based on the data available, usage, and audience in order to determine the type of dashboard that they will create. The technology for performance dashboards is constantly evolving and expanding, providing a wide range of options for development (Eckerson, 2011).

## 2.3.3 Best Practices for Performance Dashboards

As performance dashboards become more and more prevalent, studies are done on the comparison between practices across industries and organizations. As of 2007 only 47% of operational data was presented through a performance dashboard with the most being delivered through static reports (Eckerson, 2007). The TDWI (Transforming Data with Intelligence), which provides research and education on BI, compiled information from a group of companies to analyze data surrounding the use of BI in the workforce (TDWI, 2019). The report suggests only creating dashboards for reports that are not a one-time event due to the cost and time of the creation of the dashboards. Many organizations are moving to real time data from their reports and integrating the data into performance dashboards to provide the most up-to-data information. It also reminds the builder to create realistic expectations with the user. Recommendations from the report emphasizes on keeping the backend and frontend design simple for ease of creation and ease of use (Eckerson, 2007).

When creating the dashboard one of the key pieces mentioned by Eckerson (2005) is ensuring the right combination of the "threes" are used. Those are the three types of dashboards mentioned in a prior section (operational, tactical, and strategic), three types of applications (monitoring application, analysis application, management application), and the three layers (monitoring layer, analysis layer, detailed information layer) (Eckerson, 2005). If the data is not of high quality (low accuracy and consistency) or there is not enough data, then the performance dashboard is more likely to fail (Froese, 2016, and Işık, 2013). The displayed data should consider readability and be easily interpreted; if the audience is higher level management, they will not have time to delve through all of the analytics presented (Froese, 2016 and Işık, 2013). In order for the performance dashboard to be fully successful it must align with strategic goals of the organization or it will not provide the full value (Işık, 2013).

## 2.4 Business Intelligence Platforms

In order to get the biggest return on the data that is collected, many businesses turn to BI platforms. These tools make processing and visualizing data much easier for every level of employee, from a data analyst to a corporate executive. BI platforms provide an interface for developers to make performance dashboards, which are used to analyze and visualize data.

An organization can choose to develop some, or all of the four components of BI shown in Figure 1 (people, processes, management, and governance) from scratch, or purchase an out-of-box solution (Coronel, 2016). If an organization has the time and resources, they can choose to develop a platform that meets the specific needs of their data. On the other hand, if an organization does not have the time or resources, or has a standard business problem, they can opt to employ an out-of-box platform to develop a BI solution. There are many out-of-box BI platforms, and an organization must compare the platforms in terms of usability and how each platform could fit their specific business needs.

Gartner is an advising company that publishes an annual report to compare the leading BI platforms. In order to make a sound comparison, Gartner uses fifteen "Critical Capabilities" to compare top BI platforms. They are categorized into infrastructure, data management, analysis and content creation, sharing of findings, and overall platform (Howson, 2019).

*Figure 6: Gartner Magic Quadrant for BI Platforms (Howson, 2019)*

With this report, Gartner includes a "Magic Quadrant" (Howson, 2019), shown in Figure 6, that considers the "Critical Capabilities" and breaks it down into two aspects of a BI platform that can be compared. Along the y-axis of the quadrant is "the ability to execute," which considers the current characteristics and features of the BI platform. This means they describe the actual services that a client will receive. Along the x-axis is "the completeness of vision," which considers how each BI platform envisions the market's needs. This is important to get an understanding of how each company functions and what it might try to become in the future.

The two general aspects from the "Magic Quadrant" are comprised of the following concepts in order to determine a BI platform's position within the quadrant:
1. Ability to Execute
   a. Product or service
   b. Overall viability
   c. Sales execution/ pricing
   d. Market responsiveness/ record
   e. Customer experience
   f. Operations
2. Completeness of Vision

a. Market understanding
b. Marketing strategy
c. Sales strategy
d. Offering (product) strategy
e. Vertical/ industry strategy
f. Innovation
g. Geographic strategy

Since it is important for organizations to consider their specific business needs when choosing a BI platform, the "Magic Quadrant" is a customizable instrument that potential clients can input their preferences to determine which product will best suit their user requirements. They can choose which of the above concepts are most important, and the "Magic Quadrant" will weight them accordingly.

## 2.4.1 Power BI

Power BI, initially released in 2014, is a Microsoft product that describes its platform with the tagline, "Go from data to insights in minutes. Any data, anyway, anywhere. And all in one view" (Power BI: Interactive Data Visualization BI Tools, 2019). Power BI offers several products including Power BI Desktop, Pro, Premium, Mobile, Embedded, and Report Server.

In the Gartner report (Howson, 2019), the main strengths of Power BI are its comprehensive product vision and ease of use for complex analysis. However, Power BI's weaknesses are that it offers many products and therefore users need a higher level of understanding of each when purchasing one for their company.

## 2.4.2 Tableau

Tableau, founded in 2003, says that its primary focus is "helping people see and understand data" (Tableau: Business Intelligence and Analytics Software, 2019). There are several products that clients can choose from for BI tools- Tableau Desktop, Server, Online, Public, Reader, Viewer. These can be used independently or in conjunction, depending on the specific needs of a company.

In the Gartner report (Howson, 2019), Tableau's main strength is its user interface that allows for simple exploration and manipulation of data. This makes it easier for administrative employees to make use of such a dashboard, without needing a technical background. One of its main weaknesses, however, is Tableau tends to have a more complicated contracting and sales policy than competitors.

### 3.4.3 Qlik

Qlik, founded in 1993, says that users can "Blaze trails daily – with the only end-to-end data management and analytics platform built to transform your entire business" (Qlik, 2019). Users can choose to use products that are intended for analytics, data integration, or developers.

In the Gartner report (Howson, 2019), the main strengths of Qlik were its extensive features for clients to take advantage of, great customer service and product visions. Oppositely, the product flow and mitigation experience can present challenges for clients. Qlik has lost momentum in recent years.

### 3.4.4 ThoughtSpot

ThoughtSpot, founded in 2012, says that users can "use search to get granular insights from billions of rows of data. Or let AI uncover insights from questions you might not have thought to ask." (ThoughtSpot, 2019).

In the Gartner report (Howson, 2019), the strengths of ThoughtSpot are its innovative AI interface, strong sales and operations, and a high momentum and growth rate. However, there are gaps in its products, and it is a small vendor with limited connections.

### 2.4.5 Implementation at WPI

| Platform | Cost | BI Tools |
|---|---|---|
| Power BI *(Power BI: Interactive Data Visualization BI Tools, 2019)* | *Power BI Pro* - $9.99 monthly price per user<br>*Power BI Premium* - $4,995 monthly price per dedicated cloud compute and storage resource | Desktop, Pro, Premium Mobile, Embedded |
| Tableau *(Tableau: Business Intelligence and Analytics Software, 2019* | **For Tableau Server**<br>*Tableau Creator* - $70 monthly price per user<br>*Tableau Explorer* - $35 monthly price per user (min. 5 Explorers)<br>*Tableau Viewer* - $12 monthly price per user (min. 100 Viewers)<br>**For Tableau Online**<br>*Tableau Creator* - $70 monthly price per user<br>*Tableau Explorer* - $42 monthly price per user (min. 5 Explorers)<br>*Tableau Viewer* - $15 monthly price per user (min. 100 Viewers) | Desktop, Server, Online, Public, Reader, Viewer |

| Qlik<br>*(Qlik, 2019)* | *Qlik Sense Business* - $30 monthly price per user<br>*Qlik Sense Enterprise* - $70 (Professional) / $40 (Analyzer) monthly price per user | Analytics: Sense, View; Data Integration, Developer Platforms |
|---|---|---|
| ThoughtSpot<br>*(ThoughtSpot, 2019)* | Contact for pricing | Architecture, SpotIQ, Mobile, Embedded Analytics |

*Table 1: Matrix Comparing Top BI Tools*

Table 1 details the BI products and pricing for the top four BI tools identified by the Magic Quadrant.

Tableau offers several methods that users can take advantage of in order to share dashboards with others. Tableau Online is a cloud-hosted version of Tableau that allows users to develop and view dashboards. Unlike Tableau Server, the dashboards and data used with Tableau Online are held in the Tableau Cloud. Tableau Server allows organizations to host their own dashboards and pull information directly from their internal datastores. Tableau Public allows users to upload their dashboards so that other users who follow them can use the information. Tableau Reader is a free tool that allows users to view dashboards created on Tableau Desktop. However, Tableau Reader is limited and only allows users to access workbooks (Tableau: Business Intelligence and Analytics Software, 2019). Tableau also allows organizations to host a server on which organizations can allow many users to view and edit dashboards.

## 2.5 Business Intelligence in Educational Institutions

Performance dashboards and BI can be seen in a wide range of educational institutions from nationwide programs, to public and private elementary, middle, high schools, and universities. For example, the Public Montana Universities use Tableau to track overall enrollment degrees awarded, and demographics (Montana University System, 2019). With all of the data combined from the various universities it allows users to easily compare subgroups of the university and manipulate the data all within the dashboard. The NYC public school system uses a scorecard type of a performance dashboard to track the performance of the students in their school. This data is displayed in a custom dashboard which has a limited number of interactive buttons (NYC Department of Education, 2018). NYC's dashboard is harder to manipulate for various scenarios in comparison to the dashboard for Montana public universities. Both of these dashboards offer a variety of BI tools that are useful in analyzing institutional data.

In higher education, Bentley University utilizes Tableau dashboards to visualize and manage their activities pertaining to AACSB (Association to Advance Collegiate Schools of Business) accreditation. The Bentley dashboard allows the public, who are external consumers, to view

data for the same purpose for the past five years and compare progress over time (Bentley, 2016).
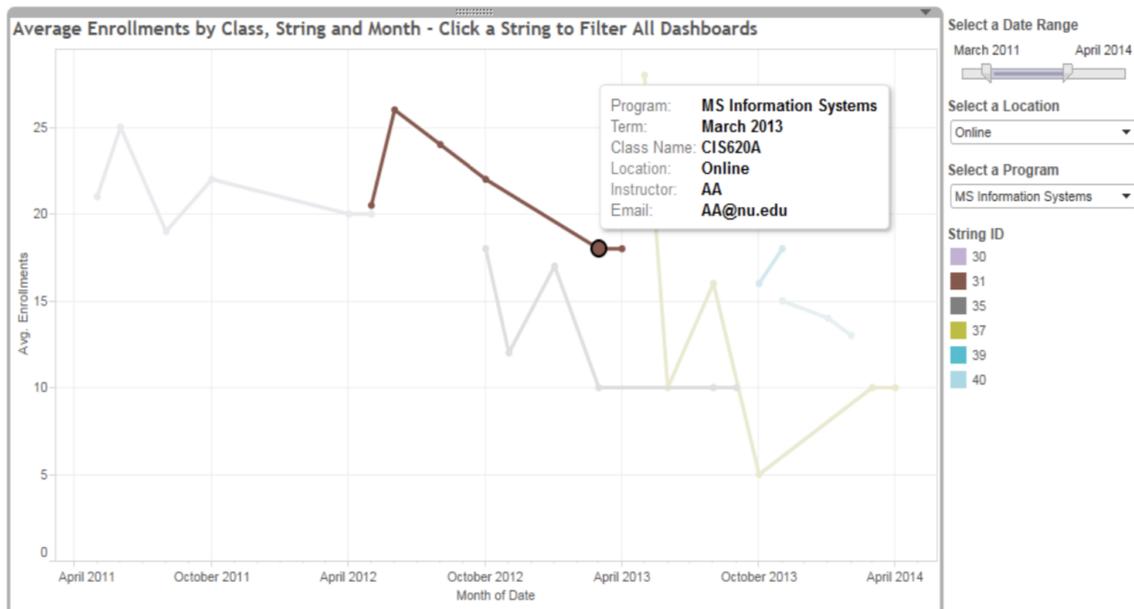


*Figure 7: Dashboard from National University (Wyne, 2015)*

At National University, located in San Diego, California, the school has been using performance dashboards since 2015. Academic literature by Wyne, from National University, highlights examples of how other higher education institutions use performance dashboards. One example is Richland College in Dallas, Texas which had five different KPIs, which each received a score. When added up, they give a total key performance index score. These KPIs analyze the areas of meeting community education needs, student success, and employee success (Wyne, 2015). Another example is from The University of Texas (UT). UT created dashboards in order to allow public access to data collected by its nine universities. This is similar to the Montana Public University system dashboards mentioned in the previous section (Montana University System, 2019). By utilizing performance dashboards to compare data across universities, it gives the public consumers a broad look at the KPIs for the school system. Its dashboards allow the public to view information regarding student enrollments, number of degrees awarded, student/faculty ratio, research expenditures, and cost of a four-year degree. National University created a performance dashboard that helped management make informed decisions regarding the scheduling and staffing of courses. Figure 7 shows an interactive line graph of average enrollment by class. The dashboard included information of the enrollment count of the class and trends of enrollment over time, the average GPA of students taking the course, instructor information and qualifications, and assessments of the teacher in past courses. National University chose to use Tableau for their performance dashboard. In order to store their data, they used an Oracle Database known as "Oracle 11g" (Wyne, 2015).

## 2.5.1 Performance Dashboards for Internal Uses

Once an institution can collect enough data and identify their KPIs, they can use these to create a useful performance dashboard. A performance dashboard can be used for either external or internal uses. An example of an internal use is provided from the University of New Hampshire's Department of Institutional Research and Analysis (UNH), which uses BI dashboards in order, "to provide UNH academic and administrative units with data they need to make informed



*Figure 8: Bentley Dashboard (Bentley University, 2019)*

decisions on policy changes and initiatives and to explore trends among applicants and current UNH students" (University of New Hampshire, 2019). Like other institutions, UNH chose to use Tableau for their performance dashboards. They have used these dashboards to create analytical summaries of applicants, students, and other universities. One interesting statistic that UNH monitors is information about admitted students to find where those who do not attend UNH, most frequently end up. The University's data on student admissions allows UNH to find its biggest competitors and find out the reasons why applicants are more interested in them (University of New Hampshire, 2019).

Bentley University uses BI to aid in understanding itself and its external environment. Bentley's Office of BI and Enrollment Systems uses tableau to analyze issues in order to promote strategic planning. Some of their Tableau performance dashboards are available to the public and are good examples of interactive Tableau dashboards. Figure 8 displays a visualization of Bentley vs. its peers in the category of MBA Applicants, there are multiple charts and tables that are great examples of a performance dashboard. These public dashboards are generally all related to undergraduate and graduate demographic information, but specifically there is one focused on their AACSB accreditation that may be useful (Bentley University, 2019).

## 2.5.2 Use of Performance Dashboards in Non-US Institution

While creating a performance dashboard for the FBS it is useful to research metrics that reveal student and faculty performance. The Academy of Economic Studies in Bucharest, Romania implemented a performance dashboard that did just this. There were different types of metrics used for the performance dashboards related to educational institutions. According to Muntean, author of "Performance Dashboards for Universities," useful metrics include the following enrollment numbers (Muntean, 2010):

- Enrollment by undergrads
- Enrollment by graduates
- Enrollment by Ph.D. students
- Total students enrolled
- Total graduates

Some other metrics useful for analyzation of students:

- First year retention rate
- Number of degrees and Ph.D. awarded
- Graduation rates
- Percent of students employed after graduation
- Percent of students pursuing a master's degrees
- Number of total degrees awarded



*Figure 9: Performance Dashboards for University Management (Muntean, 2010)*

Faculty is also an important area to be measured. They are a vital sector in determining the overall performance of a university. Revealing the credibility of faculty measures can help upper management know the direction they are headed and decisions they must make to change that direction (Muntean, 2010). Some of these metrics include:

- Number of Ph. D holders
- Student to Faculty ratio
- Average faculty salary by rank
- Number of courses offered
- Faculty involvement in research projects

Dashboards that provide information about the faculty salaries and rank would be private and meant for viewing the internal performance of the university. These metrics provide a basic framework of how to measure a universities' performance. In Figure 9 located above are the

different areas that a university would measure using performance dashboards. However, all universities are different and must adjust metrics based on their particular goals (Muntean, 2010).

### 2.5.3 Success Factors of Implementing Performance Dashboards

The University of Cambridge has defined a few success factors of their own. The University of Cambridge has similarly identified the necessity for high quality data, suggesting that without accurate data, BI reporting may be harmful. A university should have accurate data, defined KPIs, and a clear direction for their university as a business in order to get the best results from a BI system. No two institutions are alike, and it is important that a university understands its current performance and its goals with BI, before implementing. Cambridge cites the following recommendations for universities who do not have clear sources for accurate data:

- Ensure BI has a vocal advocate in the administration
- Use seasoned BI vendors
- Tools should integrate with other strategic initiatives
- Perform data cleansing early on
- Research the right tool for the institution's requirements. (often home built or custom legacy systems restrict the use of most out-of-box BI solutions)
- Establish an effective data governance structure involving administrative officers
- Identify specific goals for the BI initiative
- Do not focus only on the technical aspects of the BI solution, recognize the business value and ensure it is adequately provisioned.

Once there is reliable data proper security should be in place to avoid issues when handling private institutional or personal data. A university must always be cautious with people's privacy and what they do with student and faculty data. There should be several different policies a university has in place regarding people's information and privacy. It is best if sensitive data can be housed securely by the university, to avoid problems with privacy (Guster, 2012).

## 2.6 Business Intelligence at WPI

The use of BI solutions for improving management processes is now a common and strategic practice in higher education. WPI utilizes Tableau for performance management and data visualization.

WPI Institutional Research hosts a Tableau Server for internal organizational BI solutions, as well as shares several public Tableau dashboards. The public dashboards display generalized data and KPIs of the entirety of WPI, for example an all-degree student to faculty ratio, retention rate (Figure 10), an interactive map of domestic and international students, and "WPI at a Glance." Several of the dashboards can be drilled down by different categories such as

department, degree level, gender, major, etc. The performance dashboards currently created by WPI provide a high-level view of important institutional data. WPI proves to be a sophisticated organization that is already implementing business intelligence into their management processes.

The resulting dashboards from this MQP will complement the dashboards already provided by WPI Institutional Research. The dashboards created in this project will provide KPIs and querying capabilities that will be internal and data specific to the FBS. Additionally, the layout, capabilities and visuals will be primarily influenced by the goals, values and needs of the FBS Tableau consumers and users.



*Figure 10: IR Data Dashboard: Retention Rates (WPI, 2018)*
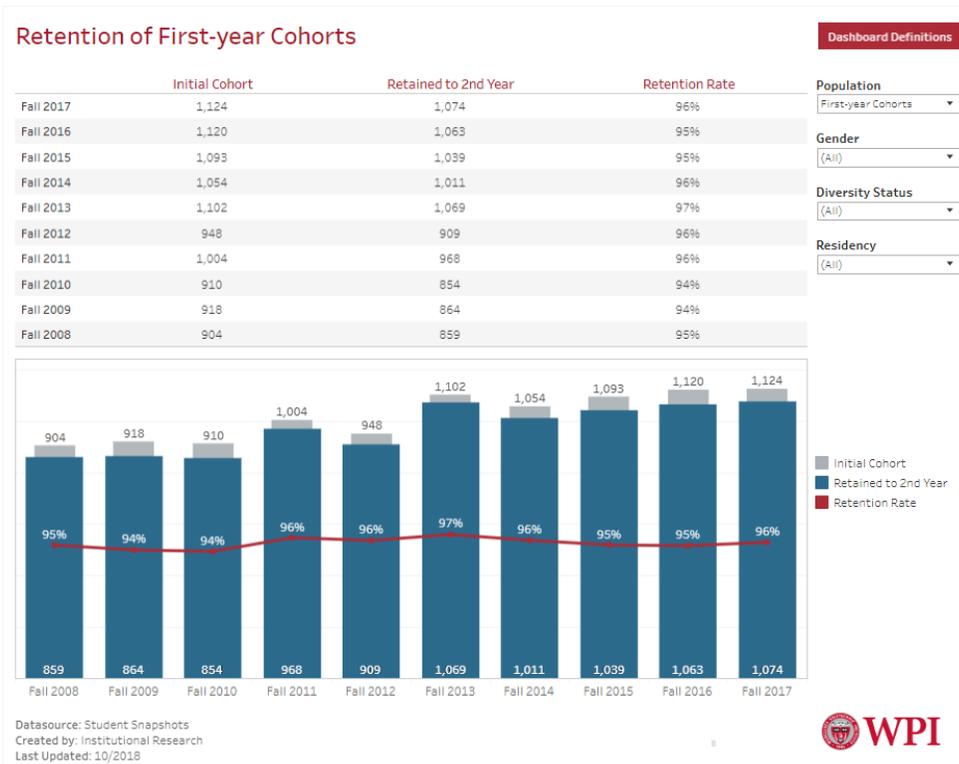
## 2.7 Conclusion

BI improves an organization's management processes through measuring and monitoring KPIs. The insight provided by BI solutions allow for more effective decision making and successful business strategies. Performance dashboards are a useful BI tool that allow for a top-level management to comprehend, visualize and interact with complex data. Various institutions utilize performance dashboards as part of their BI solutions and prove successful in tracking and improving their management processes. Within the FBS holds an opportunity to improve its management processes by creation of FBS specific KPIs displayed in custom performance dashboards.

# 3.0 Methodology

In creating a BI solution for the FBS, a system development strategy based on the needs of our project must be chosen. This project consists of two major components, identifying and developing KPAs and KPIs, and developing the BI system. To identify and develop KPAs and KPIs, the team will follow methods of user requirements gathering, which reveals what must be accomplished in order to make the system as useful as possible for the users. Additionally, the provided data records and any other data that needs to be collected must be thoroughly understood for proper development and implementation of the performance dashboard. After KPA and KPI development, the team will design the BI system and follow the system development methodology to create multiple iterations of the system until we've reached three final prototypes.

## 3.1 Comprehending the Available Data

Operational and external data are the building blocks of the BI framework (Coronel, 2016). Operational data (internal to the business unit that is being analyzed) comprised the majority of the data used for this project. The data was recorded by the WPI Provost Office and the WPI Registrar. The data received from the Provost office contained information relating to faculty, their rank, and the classes they taught while the information received from the WPI Registrar contained information on all of the classes, faculty that taught them, course ratings, course capacity, and course actual size for 2010-2020. These two data sets were exported using Microsoft Excel spreadsheets for easy filtering and sorting capabilities. A goal of this project was to convert the data from Excel spreadsheets into a database that will be linked to a BI tool, making for convenient, efficient data analysis, visualization, and reporting.

### 3.1.1 Understanding Objectives from the FBS Management Plan

The FBS has created metrics from the data it has recorded in the "Foisie Business School 2018-2019 Management Plan."  The management plan outlines the objectives of the business school and has provided metrics that relate to the objectives using the recorded data. A detailed list of the objectives can be found in Appendix F. These objectives guided the team's focus on which performance areas and metrics to select for our development of key performance indicators and performance dashboards

## 3.2 Developing Key Performance Indicators

KPIs are a driving force behind a BI solution. To find an organization's perfect KPI(s) is advantageous to its management processes and what makes BI solutions so valuable. Ensuring that they contain accurate, informative and useful data is critical to utilizing KPIs in making informed business decisions.

The following proposed methodology, shown in Figure 11, ensured the project fulfills the first objective:

1. Developing KPIs for the FBS based on their current goals and objectives.

According to Eckerson, "What is measured, gets done" (Eckerson 2011). To elaborate, the information an organization calculates and measures as its indicators for success are the business activities that show the most influence on the organization's success. Therefore, these indicators, KPIs, are success measurement tools that organizations should implement for a prosperous business. KPIs can energize a workforce by presenting goal metrics to meet. They can also act as warnings to business failure or when activities are not meeting their targets.
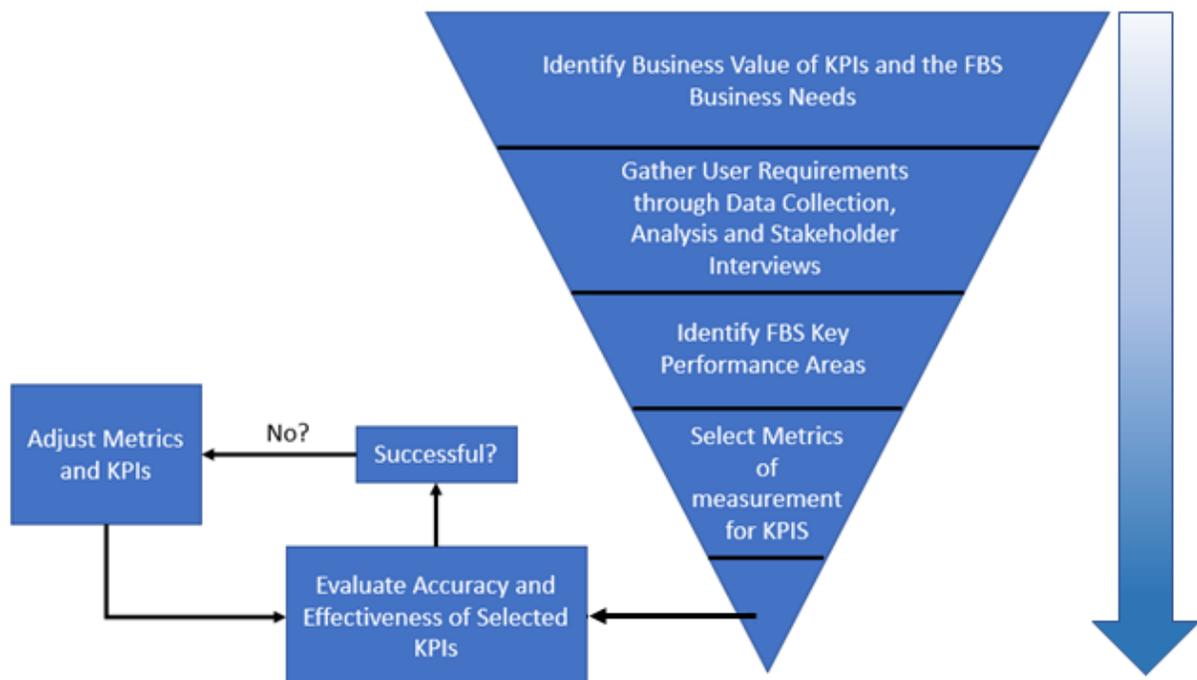


*Figure 11: Methodology for Developing and Implementing KPIs*

## 3.2.1 Identifying Key Performance Areas

Key performance areas are the areas within an organization that house the business activities most critical to success. For FBS, these areas are listed as objectives, shown below in Figure 12. The team identified three major KPAs based on the goals of the FBS Management plan. The KPAs with their corresponding goals are the following:

1. FBS Biggest Exports: This area concentrates on unique aspects of the FBS that make it successful, innovative and unique compared to the other departments at WPI. Our sponsor continually requested to determine what was the FBS "Biggest Export". The KPIs in this KPA aim to answer managerial questions like, "What classes are the most

popular among all WPI students?" Answering questions like this help the FBS leverage their unique strengths and have the greatest impact on the WPI community.

2. Resource Allocation: This area concentrates on helping the FBS management more efficiently allocate professors and classrooms and better determine how many numbers of course sections run. This KPA is an operational KPA but will overall help the FBS make better managerial decisions.

3. Faculty Performance: This area concentrates on better allocating instructors based on their existing number of credit hours, as well as tracking their performance using ratings. Having a better understanding of the faculty performance area helps the FBS achieve their goals relating to having high quality instructors with exceptional ratings.

Once identifying the performance areas of the organization, we selected measurements from those areas.

## 3.2.2 Selecting Metrics

KPIs are an informative management tool for organizations, but only when selecting the most relevant metrics. The selected metrics must take into consideration the various nuances of the organization. To ensure the team selects the proper metrics we performed a thorough requirements gathering of the FBS. Requirements gathering to help us accomplish the following tasks:

1. Understand the business need for Performance Dashboards of the FBS's Business Activities.
2. Understand the business value of implementing Performance Dashboards of the FBS's Business Activities.
3. Understand the user requirements for the Performance Dashboards and the metrics they display.
4. Identify specific business activity nuances of the FBS to avoid developing irrelevant performance indicators.

User requirements gathering is the process of understanding what must be accomplished for a project. Requirements gathering is extremely important to ensure everyone's expectations for the project are in line. Typically, knowledge is gained from key stakeholders through techniques like interviews, surveys, observation, and many more. The main stakeholders that we gathered requirements from are:

● Dr. Brent French, FBS Finance and Operations
● Dr. Diane Strong, Interim FBS Dept. Head
● Dr. Steven Taylor, Interim FBS Dean
● Kris Sullivan, Associate to the Provost

These stakeholders will be the primary users of the FBS's performance dashboards and will be most affected by this project.

Aforementioned in section 2.2.3, the metrics used to develop effective KPIs should contain the following elements. These elements are summarized below and guided the team when selecting metrics and developing our KPIs.

1. Value
2. Time Frame
3. Benchmark
4. Targets
5. Ranges
6. Visual Encodings

Metrics currently being collected by the FBS, according to the FBS Management Plan, are:

1. Faculty sufficiency
2. MBA enrollment
3. MS enrollment
4. MBA Student Satisfaction
5. MS Student Satisfaction -- MS numbers declining
6. MS STEM enrollment -- declining
7. PhD enrollment -- unstable funding
8. % of WPI Undergraduate Students with FBS Majors
9. % of WPI Undergraduates Students with FBS Minors
10. Research Outputs
11. External Research Funding
12. FBS courses taken by non FBS majors
13. Business minors completed by non-FBS students
14. FBS Students GPS and IQP Credit Hours Delivered
15. FBS Directors for project centers

| Status | In Good Shape | Potential Issues | Serious Issues |
|---|---|---|---|
| **Objectives** | BS Program | Accreditation | MS Programs |
| | Research | MBA Program | |
| | Business Education for non-FBS Students | Relationship with Community | |
| | Projects Program | PhD Programs | |
| | Interdisciplinary Programs | Scholarly Leadership for I&E | |
| | Goverance and Operations | | |

*Figure 12: Objectives and Corresponding Status Table (Derived from the FBS Management Plan)*

Figure 12 displays the objectives outlined in the FBS management plan and their corresponding status in terms of how the FBS feels they are succeeding at meeting the objectives. Understanding the organization's objectives and whether they are achieving their goals or targets helped the team develop useful KPIs. Along with the organization's objectives, the team gathered requirements through stakeholder interviews, data analysis from the FBS and research conducted in the background. We then found a key performance area of focus to develop KPIs for.

After a comprehensive understanding of the FBS business needs, values and gathering user requirements, the team determined which metrics to choose from the relevant performance areas. The team collected this data and incorporated it into usable data. From this, KPIs were developed and displayed using performance dashboards created in a BI platform.

## 3.3 Determining Development Methodology and Platforms

After the development of effective KPIs, the team moved forward with objectives two and three of implementing a BI solution. BI platforms help an organization visualize and interact with their data. From advanced querying, drill downs, interactive maps and graphs, technological advances were made in developing powerful tools for displaying organizational performance. To fully utilize a business intelligence platform to display the FBS KPIs, the team adhered to the following methodology to fulfill the remaining objectives:

1. Design and implement a database to store and organize information to be used in the BI solution
2. Use a BI platform to create performance dashboards

## 3.3.1 System Development Methodology

Different system development methodologies are more beneficial to some projects than others based on time constraints, business familiarity with technology, team availability and so on. Figure 13 summarizes the pros and cons of different methodologies based on the attributes of a system development project.

| Usefulness in Developing Systems | Waterfall | Parallel | V-Model | Iterative | System Prototyping | Throwaway Prototyping | Agile Development |
|---|---|---|---|---|---|---|---|
| With unclear user requirements | Poor | Poor | Poor | Good | Excellent | Excellent | Excellent |
| With unfamiliar technology | Poor | Poor | Poor | Good | Poor | Excellent | Poor |
| That are complex | Good | Good | Good | Good | Poor | Excellent | Poor |
| That are reliable | Good | Good | Excellent | Good | Poor | Excellent | Good |
| With short time schedule | Poor | Good | Poor | Excellent | Excellent | Good | Excellent |
| With schedule visibility | Poor | Poor | Poor | Excellent | Excellent | Good | Good |

*Figure 13: Criteria for Selecting a Methodology (Adapted from Allan, 2015)*

RAD uses computer tools and special techniques to help project teams more quickly design systems. There are three types of RAD: iterative development, system prototyping development and throwaway prototyping development. Iterative development breaks down the analysis, design and implementation phases into several versions that are worked on in order. The beginning versions are developed quickly and tested for usability and feedback, then the next version is worked on to address issues found in the first version. System prototyping is a methodology that bundles analysis, design and implementation into one step to quickly make a prototype. The prototype is tested then re-enters the analysis, design and implementation phase for improvements. Throwaway prototyping development has a thorough planning and analysis phase then quickly creates design prototypes (less function than actual prototypes) for quick feedback and redesign. Once the analysis, design, implementation and design prototype phases are finalized the actual prototype and implementation begin.

Based on the attributes of the given project, the team decided to use iterative development because it has excellent grades in the most constraining elements of our project -- short time schedule and schedule visibility. As aforementioned, iterative development is the process of planning, analyzing, designing and implementing the minimal viable product. The minimal viable product is introduced and tested as a "version" and analyzed for improvements and added features. In a timed manner, the first version prototype reenters the analysis, design and

implementation phase. After the agreed upon improvements are implemented, the second version is released for testing, and so on until the prototype resembles the desired final product. See Figure 14 for a visual of the iterative development methodology.
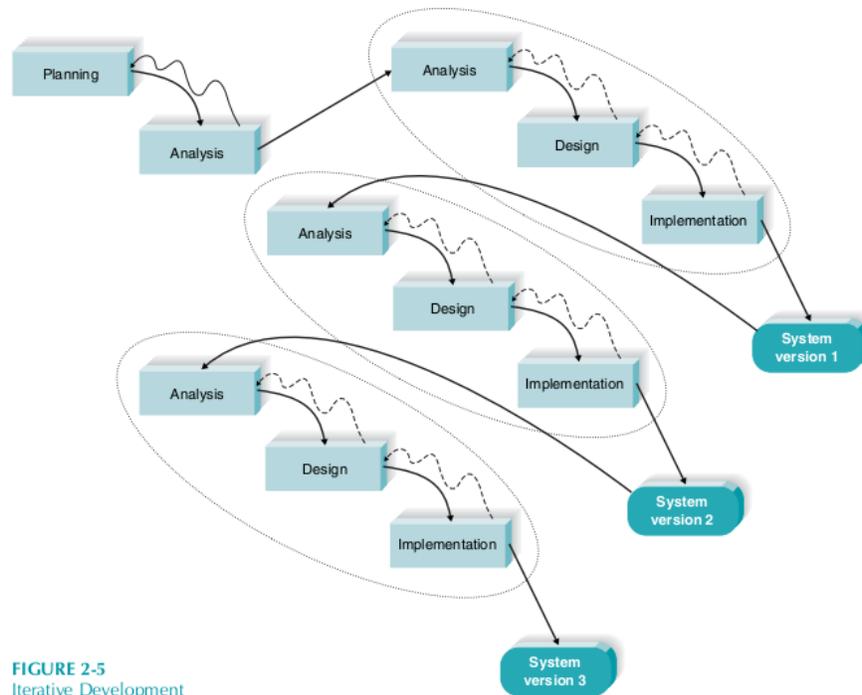


FIGURE 2-5
Iterative Development

Figure 14: Iterative Development (Allan, 2015)

## 3.3.2 Business Intelligence Platform

The team decided to use Tableau Online to create and display the dashboards for this project. The FBS had specific user requirements for this project, which were considered when choosing this BI platform. Primarily, the FBS wanted to be able to view, edit, and manipulate the dashboards and associated database after the completion of this project. The dashboards created on Tableau Online can be shared and edited by other users that have the correct credentials. In addition to the features that Tableau Online offers, WPI already has the infrastructure in place to make the implementation of this dashboard feasible. The FBS already makes use of Tableau in some of their operations. This ensures that some of the potential future users of these dashboards will already be familiar with the system.

## 3.3.3 WPI Data Sources

In order to get a wider amount of data to fully represent the developed KPIs, the team worked with the WPI Registrar and the WPI Provost office in order to receive data relating to class data and faculty data. From the registrar the team was able to receive data related to courses which helped us adhere to KPIs related to resource allocation and the biggest export of the FBS . In

conjunction with our sponsor the team received data from the WPI Provost office relating to Faculty. This data set helped create a broader picture of the information we had collected and display KPIs related to faculty and resource allocation. The data sets were received in an Excel spreadsheet that would need to be exported into a database solution. For data related to students we were not able to receive any data sets due to confidentiality and data used in the project was created by the team based on the numbers found on the WPI Institutional Research Dashboards.

### 3.3.4 Database Management System

In order to create a useful dashboard, a company must ensure that their data is stored in an organized way. There are many options to choose from when picking a database management system. A few important things to consider are usability, security, functionality, support, and scalability (Eburne, 2014). Like the decision to choose a BI technology, choosing a database management system also requires careful consideration of the client's specific user requirements.

There are many database management systems that can be used for a variety of projects. Considering the scope of this project, the team looked at Microsoft Access and MySQL.

|  | Cost | Size of use | Installation Setup |
|---|---|---|---|
| Access | WPI already has access to a license | Home or small business | Windows |
| MySQL | Open source or commercial versions | Scalable to businesses | Windows, Linux, macOS, etc. |

*Table 2: Comparing Database Management Systems (Adapted from Microsoft Office and MySQL Technical Specifications*

After collecting the data, the team chose to use a MySQL database. Some important factors the team considered were the size of the data and necessary security precautions to protect confidential records. Budget, existing infrastructure, and current training of the client were also relevant details that were considered.

## 3.4 Implementation

The implementation phase was a crucial step of this project. The team developed a database and Tableau dashboards while working alongside FBS administrative staff who were able to provide details on the current data available and goals for the project.

### 3.4.1 Developing the Database

In order to create useful dashboards, there needs to be a well-constructed database. The team worked with WPI's Information Technology department and the WPI Academic and Research Computing (ARC) team to create a SQL Server database on the WPI network. Using this network, the team built a relational database that contained the data that was used for this project. The team organized the data and created relationships between tables that structure the information in a way that can be referenced and used to determine patterns. From the data the team collected and created the team was able to create an Entity Relationship Diagram (ERD) to display how we wanted our database to be created.

### 3.4.2 Developing the Dashboards

After determining the KPAs and KPIs, the team connected the database to Tableau. Three dashboards were created: FBS Biggest Exports, Resource Allocation and Faculty Performance. These KPAs were chosen from the team's and the FBS Management Plan KPAs and KPIs due to the availability of data. These areas would also help the FBS schedule classes easier and provide value to the school.  Each week the dashboards were revised with the help of advisor and team feedback. From our advisory meetings, the team took note of discussion between advisor and team and then in team meetings would create edits and improve on dashboards. This kept the editing of dashboards constant in order to create the best value for the FBS. Each week the team met with team sponsor, Dr. Brent French to help provide insight on the direction of the project and the functionality of the dashboards the team presented. This helped the team stay on track to create dashboards that would provide value to the FBS. Dr. French provided constructive feedback every two weeks on the dashboards that allowed the team to make adjustments based on the wants of the FBS. The revision process of the dashboards included troubleshooting errors in the database and calculated fields, determining what graphics best displayed the data, determining how to best highlight key information, and deciding on how to clearly organize the dashboard. We utilized several types of graphics like tree maps, having the color of charts depict information, bar charts, trend lines and cards.

After the team was satisfied with the resulting dashboards, a key next step was having potential users of the system test the dashboards. Feedback from the usability test sessions would provide the team final recommendations to develop the dashboards.

### 3.4.3 Usability Testing

Usability testing is a critical element of implementation because it tests the usability and user experience of the prototype. A viable usability test should adhere to the following characteristics:
1. Primary testing goal is to improve the usability of the product.
2. The participants of the test represent real users.
3. The participants perform real tasks.

4. Diligent notes are recorded of the user's actions and feedback.
5. Results of the test are analyzed and issues with the systems are used as recommendations for improving the system (Dumas, 1993).

For the dashboard, the user interface must display information that is relevant to the user and have an intuitive layout and functionalities. For usability testing of this project, the team tested primarily for two elements including 1) user experience of the design, layout and usability of the dashboard, and 2) usefulness of the information and KPIs being displayed. The team chose the following participants for user testing because they represent potential consumers of the performance dashboards and were acclaimed as being knowledgeable in the topic of our project. The second element helped provide feedback on the usefulness of the KPIs displayed on the dashboard. The participants of our user testing were the following:

- Michael Elmes, Professor
- David Saul, Executive in Residence
- Norm Wilkinson
- Diane Strong
- Laurie Stokes

### 3.4.4 User Manual and Pass-Along Guide

The team created a user manual and a pass-along guide that can be used by the FBS in the future. The user manual (see Appendix D) is a document that future users can reference when using the dashboards and explains how to explore the KPIs. The pass-along guide (see Appendix E) is a document that explains how the dashboards can be recreated. This is to be used by the FBS if they choose to implement dashboards on a different instance of Tableau.

## 3.5 Project Plan

Our full Gantt chart and project plan can be seen in Appendix A.

# 4.0 Results

The resulting business intelligence solution are three Tableau dashboards to help FBS senior management make strategic and tactical business decisions. The dashboards are designed to display the selected KPIs and improve management processes.

## 4.1 Requirements Gathering

The finalized KPIs were developed after holding interviews with stakeholders of the FBS. These interviews were our most valuable requirements gathering activity because we received direct FBS insight into the business needs and challenges. The purpose of these interviews was to identify the FBS operational processes that could be improved or simplified using interactive dashboards, and which areas of the organization highlight successful business strategy. From the interviews, the team created a list of KPIs that they thought would best represent the wants and needs of the stakeholders. From the list of KPIs the team found three themes between them; Resource Allocation, Faculty, and Biggest Export. The different KPIs were mapped to each of these themes to create the concepts of three different dashboards. From there the team was able to determine which data pieces would be necessary in order to fully display all of these KPIs. KPIs highlighted in green are the ones that are seen in the final dashboards. The team focused on undergraduate programs and thus KPIs related to grad programs were not displayed. Other KPIs were not used due to the availability of data. The KPIs that were displayed with available data were of high importance to the team's key stakeholders.

## 4.2 Database Design

The team worked with various WPI offices to gather data to operationalize the selected KPIs. Once the team had the data an ERD was created to help transfer the data into a relational MySQL database. Working with the WPI Academic & Research Computing the team implemented security measures while creating the database. The database created was modeled after an ERD created by the team which can be seen in Figure 15 below. The ERD displays the eight different tables created to best represent the relations between the data that was received. The tables are as follows:
1. Course: information on the individual course including the department it belongs to, the course level, the course cost, and the amount of credits
2. Department: holds the names of the different WPI academic departments
3. Faculty Rank: holds information on the different WPI faculty rank and track options
4. Course Detail: holds the information on each section of a course that is run including the faculty that taught the course, the course rating from the evaluation, the term, year, the number of students who took the course, the capacity of the course, and the time and location of the course

5. Faculty: contains information linking faculty to departments and ranks with their first and last name
6. Majors: list of WPI majors and which department they are associated with
7. Students: This table contains nominal information on students and demographics related to student
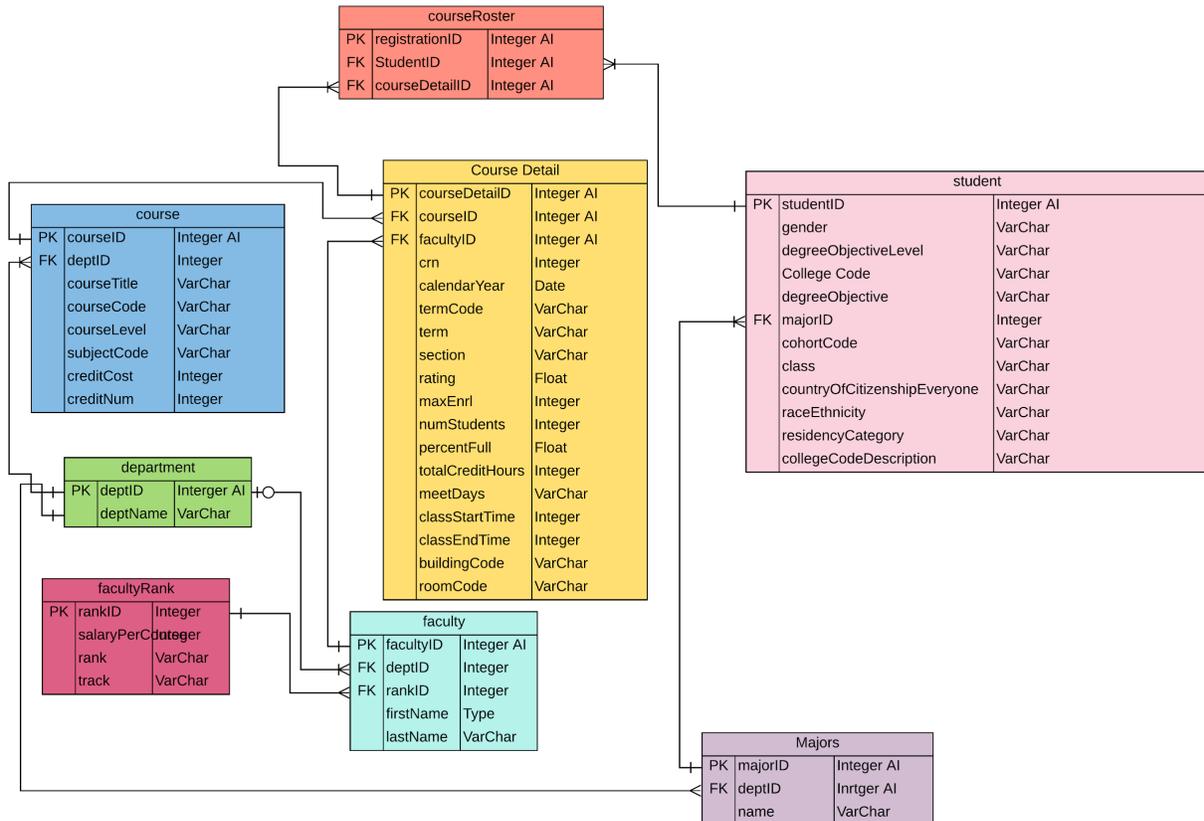8. CourseRoster: connects students to different course sections



Figure 15: ERD

## 4.2.1 Gathering the Data and Sources

The team worked with the WPI Registrar and the WPI Provost office in order to fully represent the developed KPIs with a wide amount of data relating to courses and faculty. The WPI Registrar provided us with data from the WPI Bannerweb system that contained information related to years, terms, course, course type, course level, instructor, enrollment (actual and capacity), class ratings and, credit hours. From this the team filtered out data for courses that were IQPs, MQPs, projects such as independent studies, and duplicate data. These data points were filtered out as to not create outliers in the dataset and to focus on the classes that faculty were teaching on a regular basis. The data was received in an excel spreadsheet that would need to be exported into a database solution. In conjunction with our sponsor the team received data from the WPI Provost office relating to Faculty. This data set included information such as faculty rank, track, and department. This data set helped create a broader picture of the

information we had collected and display KPIs related to faculty and resource allocation. All data used in this project was static (not live) data exported to excel sheets collected during October and November of 2019. Ideally in the full solution the FBS could utilize live connections to WPI systems. A summary of the data collected can be seen in Table 3.

| | Instructors | Years | Majors | Courses | Sections | Course Level |
|---|---|---|---|---|---|---|
| Total | 103 | 10 Years (2010-2019) | 6 (All FBS majors based on WPI IR numbers) | 172 (from the FBS) | 1,874 (from the FBS) | 2 (undergrad and grad) |

*Table 3: Summary of Received Data*

## 4.2.2 Data Preparation

The data used in this project needed to be adjusted and cleaned in order to be used in the project. The team filtered out IQPs, MQPs, and Independent studies from the project as to not create outliers in the data. During usability testing it was pointed out to the team that some of the classes present in the dataset were independent studies under the name of regular classes and this was creating outliers in the data. After usability testing, any class that only had one student taking the class was then filtered out from the dataset to further remove outliers and focus in on the classes the users cared the most about. The data received from the registrar related to classes contained classes that were independent studies classified under regular classes. These data points were not filtered out until usability testing began and participants explained that the registrar recently changed the naming conventions of independent studies.

The team was not able to acquire any data related to students due to confidentiality restraints. The team still wished to display the potential of having student data in use with the faculty and course information, so the team created placeholder student data to be used in the dashboard to show the potential functionality of having student data. All of the 2019 FBS business students were recreated based on the percentages found on WPI Institutional Research's public Tableau dashboards. Additional non-FBS students were created to display functionality on the Biggest Export dashboard.

## 4.2.3 Security

The team worked closely with the WPI ARC department in order to create the best security solution for the MySQL database. The team explored potentially having confidential data on the database so they wanted to make sure no one could access or steal our data. The goal of this security was to be able to have a system that cannot be accessed by anyone that is not intentionally given access.

The first step was hosting the database on WPI servers, which allows WPI to manage their own data and not worry about issues with a third-party company. The team then created a safe password that would not be stolen or guessed. The team then identified the vulnerabilities and added SSL protection as another layer of security. SSL protection requires a specific file on one's computer (an SSL private key) in order to log into and edit the database. At this point the database was considered appropriately secure and ready to store data. The team worked with the WPI ARC to limit IP addresses on the system, but because the data was all public for this project it was not necessary.

## 4.3 Prototyping

From the available data, the team created initial prototypes of the dashboards to visualize the KPAs and KPIs that were created. From online resources, the team learned about the functionality of Tableau and was able to utilize the software to create three dashboards titled "Biggest Exports," "Resources Allocation," and "Faculty Performance." These dashboards were subsequently shown to potential users for testing and feedback was used to adjust the dashboards.

## 4.4 Dashboard 1: Biggest Exports

### 4.4.1 KPAs and KPIs

Biggest Exports KPA refers to what courses are making the largest return on investment and what types of students in particular are taking those courses. Analysis of these areas could help the FBS identify why some courses are more popular than others, and potentially implement strategies to improve other courses.

KPIs that measure the success of the KPA "Biggest Exports" are course ROI, percentage of non-FBS majors enrolled in a particular class and course rating out of five. Course ROI is determined by the cost per credit multiplied by the number of enrolled students and divided by the cost of running a course. This was determined by the sponsor to be implemented in the dashboard by the team. The cost of running a course is an estimate of the assigned professor's salary, which was determined by our sponsor at the FBS. The percentage of non-FBS majors enrolled in a course is calculated by dividing the count of non-FBS majors (identified by a calculated column in our Tableau data source) and divided by the total count of students enrolled in a particular course. This measure provides the FBS insight on what students (based on major) are taking particular FBS courses. An objective of the FBS is to increase their enrollment and understanding why particular non-FBS majors enroll for FBS classes is an important step in meeting their objective.

## 4.4.2 Usability Testing

The team conducted six usability tests with potential users of the dashboard. The usability test plan is included in Appendix C.

The structure of the usability tests was to introduce the six participants in the usability testing sessions to the concepts of each dashboard and explain what each visual element was showing. For each dashboard there were 2-3 tasks that were asked of the participants to perform. For all six usability tests, every task was successfully completed. The team took note on which tasks were easily accomplished, and what challenges the users had.

Major feedback gathered from the "Biggest Exports" dashboard was:
- ROI Calculation needed to be explained in the title
- Filters were challenging to use
- ROI Calculation was backwards
- Color blind may have issues with colored tree map
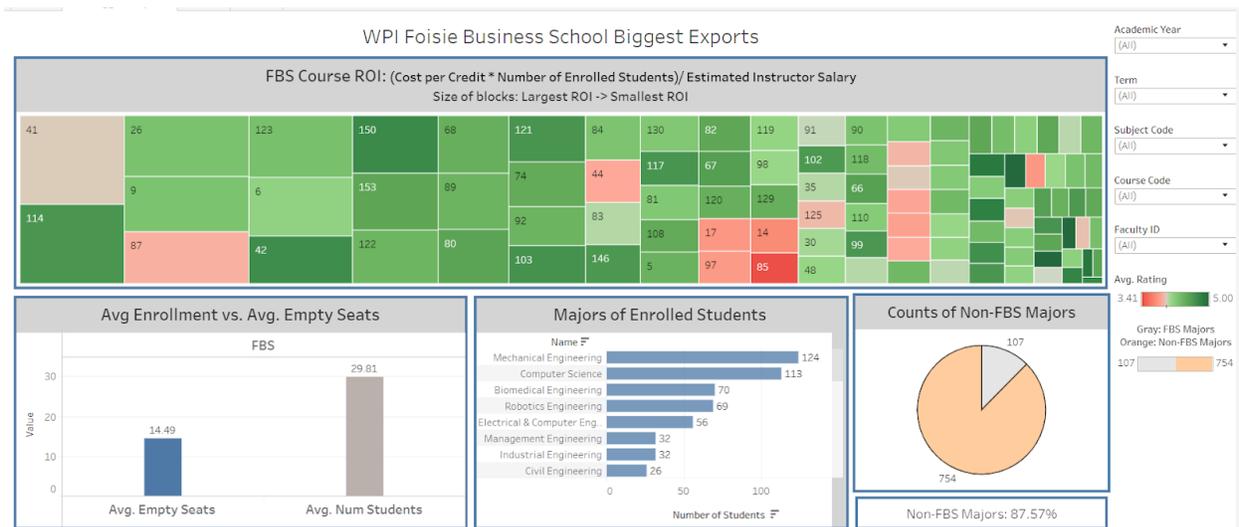- Difficult putting the filters back to default

## 4.4.3 Final Dashboard



*Figure 16: Biggest Exports Dashboard*

The final "Biggest Exports" dashboard consists of four graphics: a tree map, two bar charts and a pie chart. The tree map shows the ROI of each course over the last 10 years. As mentioned earlier, ROI was calculated using the following equation:

   (cost per credit * number of enrolled students)/ Estimated Instructor Salary

In the tree map, the size of each block represents the ROI, bigger meaning a bigger ROI and smaller meaning a smaller ROI. The tree map also utilizes color and the metric of course rating. Course rating is based on a scale of one to five and comes from a student survey that is conducted for every section of a class run. Color is utilized on a scale of green to red - red being a low rating and green being a high rating. Each square also has a tooltip that displays the course code, course title, ROI, average percent full and average rating. A tooltip is a description that appears when hovering over a certain visual. When looking at the tree map a large square with a reddish color would signify a course with a high ROI (a high number of enrolled students) but with a poor rating. Examples like this provide FBS management with better insight of the performance of FBS courses.
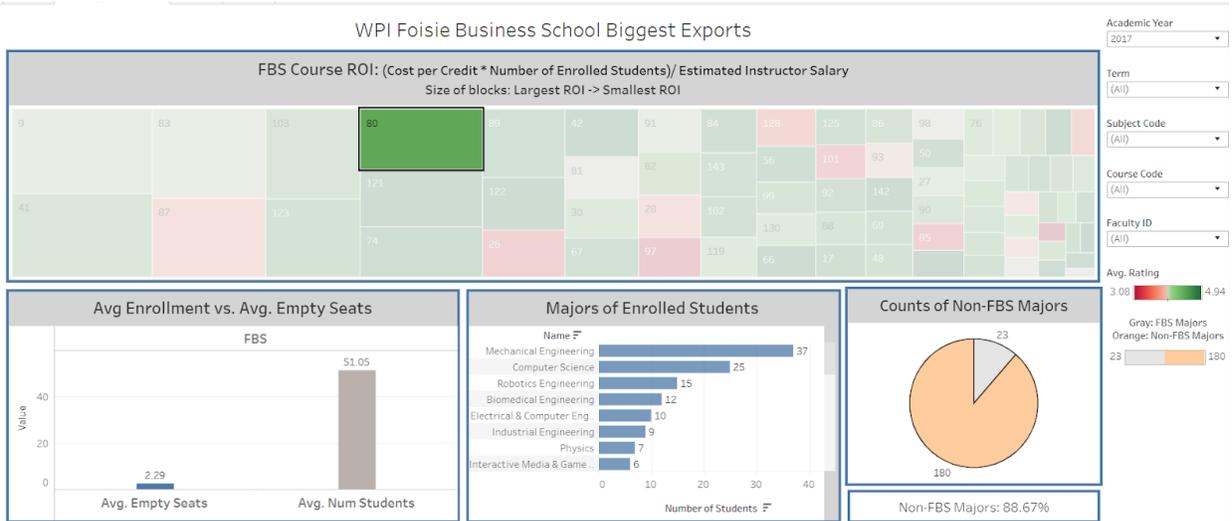


*Figure 17: Biggest Exports Dashboard with Class Selected*

The first bar chart on the lower left of the dashboard shows a comparison of two bars, the average number of enrolled students and the average number of empty seats in a class. This is a useful visual for seeing the difference between enrolled students and seats still available. Data like this provides FBS management insight into whether to run more or less sections of a course, or reserve smaller classrooms.

The bar chart in the middle bottom half of the dashboard displays the spread of majors of the enrolled students for a selected course. This displays what majors are taking what courses, which could provide useful insight into how to best market FBS courses to non-FBS students. For example, if computer science majors made up the majority of a particular MIS course, the FBS could leverage this information to market similar MIS courses to computer science majors and increase the popularity of the FBS.

The pie chart on the bottom right hand side of the dashboard shows the summary of non-FBS majors vs. FBS majors. This gives senior management an immediate interpretation of the enrollment difference between majors.

The users can use all the charts to adjust the filters on the screen. For example, if a user clicks on one of the classes in the tree map for a certain year, they will be able to see all of the majors of the enrolled students for that course. This adds value since all of the charts act together instead of separate static graphs like those that are currently used in the FBS Management Plan. Finally, the user can manipulate the entire dashboard using filters for year, term, subject code, course code, and faculty ID.

Examples of managerial questions this dashboard could answer are:
1. What are the most popular majors taking a specific course, and does this seem to be a trend with similar courses?
2. What courses in a particular department (MIS, BUS, ETR, etc.) have the highest ROI for a particular year?
3. What courses have the highest rating in a particular year?
4. Are we satisfied with the percentage of occupied seats for a particular course or department?
5. What percentage of enrolled students were non-FBS majors for a particular course?

## 4.5 Dashboard 2: Resource Allocation

### 4.5.1 KPAs and KPIs

The KPA Resource Allocation refers to the business activities of planning how many of course sections to run based on historical class enrollments, course ratings and trends.

KPIs that measure the success of the KPA "Resource Allocation" are the percentage of class full and the number of sections that were run for a particular course over time compared to the number of students. This provides the FBS with insight into which courses are meeting the enrollment capacity, which courses have low enrollment, and from this better determine how many sections of a particular course to run.

### 4.5.2 Usability Testing

Major feedback gathered from the "Resource Allocation" usability tests were:
- Add in course name to the course's percentage fill graph
- Difficult putting the filters back to default
- Make cards clearer to show key data
- Make a column that shows the section number of a class
- Filter out independent study courses
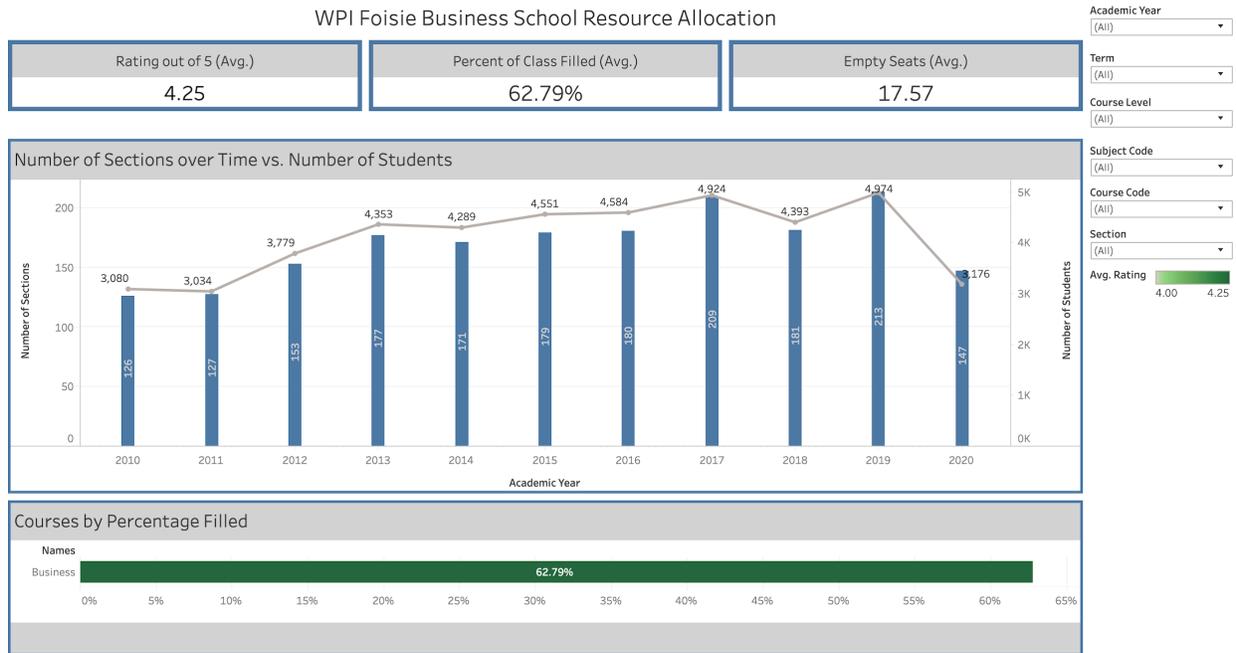
## 4.5.3 Final Dashboard



*Figure 18: Resource Allocation Dashboard*

This dashboard consists of two bar charts and three cards. The bar chart on the top shows the number of sections offered for a specific course from 2010 to 2020, along with a trend line of the total number of students. This provides FBS management feedback on how efficiently they are providing course sections. For example, if the graph displayed a year where they have many sections offered paired with a low number of students, they did not efficiently schedule course sections. Controversially, if there was a large number of students one year and a low number of sections run, this would tell FBS management that more sections needed to be run. The combined visual of number of sections run with a historical trend of enrolled students provides FBS management insight into whether enough sections are being offered based on the number of students.

The bar chart on the bottom of the dashboard shows courses by percentage filled, along with a color scale (red to green) of course rating, similar to the color scale in the "Biggest Exports" dashboard. This figure can be drilled down or up. "Drilling" up or down on a visual means that the visual will be expanding to a more granular view. For example, this visual originally shows overall percentage filled, but can be further drilled down by subject code and course code.
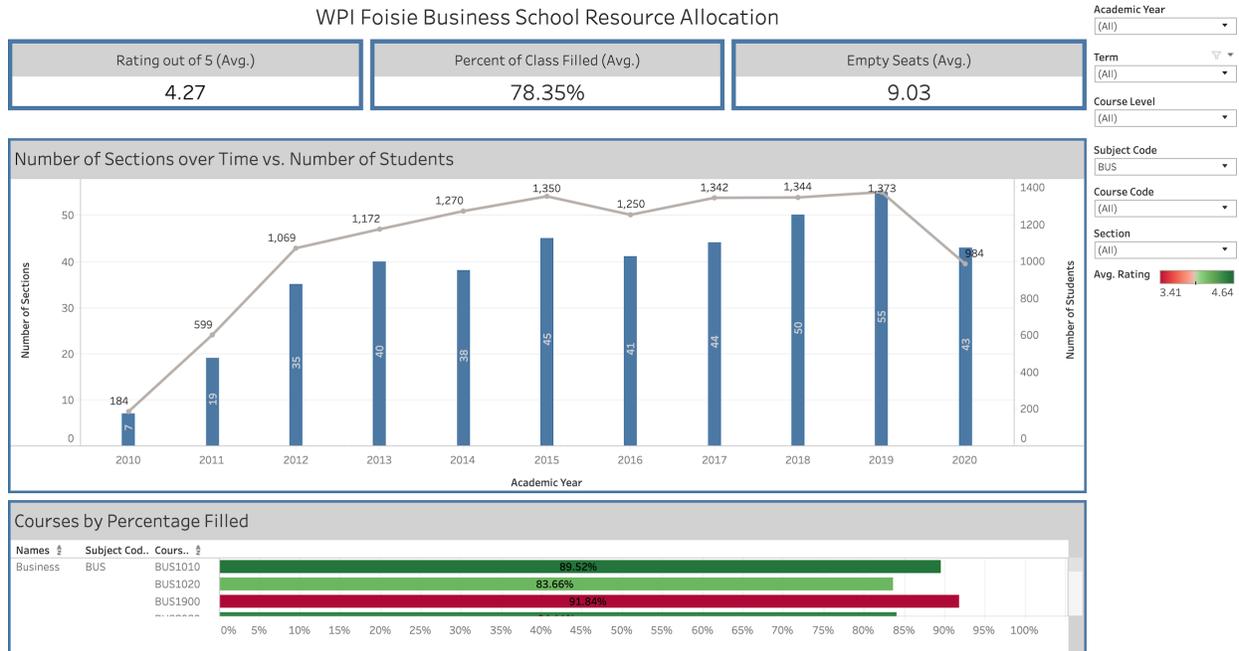
Figure 19: Resource Allocation with Drilled Down Visual

This provides FBS management with a visual of demand for each course. Figure 19 shows how changing the filters or selecting a specific course from a visual change the corresponding visuals on the dashboard. In Figure 19, Business courses are selected in the "Course Code" filter. The charts are set to filter together along with the call out cards on the top of the dashboard. Because of this filter selection, all the visuals on the dashboard change to only display data for what the user has selected. The bottom bar chart in Figure 20 is drilled down to display course code. Figure 20 seen below shows the dashboards reactivity when one course is clicked on in the bottom chart. When BUS1010 is selected in the bottom chart, the top bar chart reacts to show only the information related to BUS1010. The top three call out cards also additionally react to the selection of BUS 1010 to show that in the years 2010-2020 BUS1010 has an average rating of 4.58, 89.52% full, and has an average of 5.30 seats.
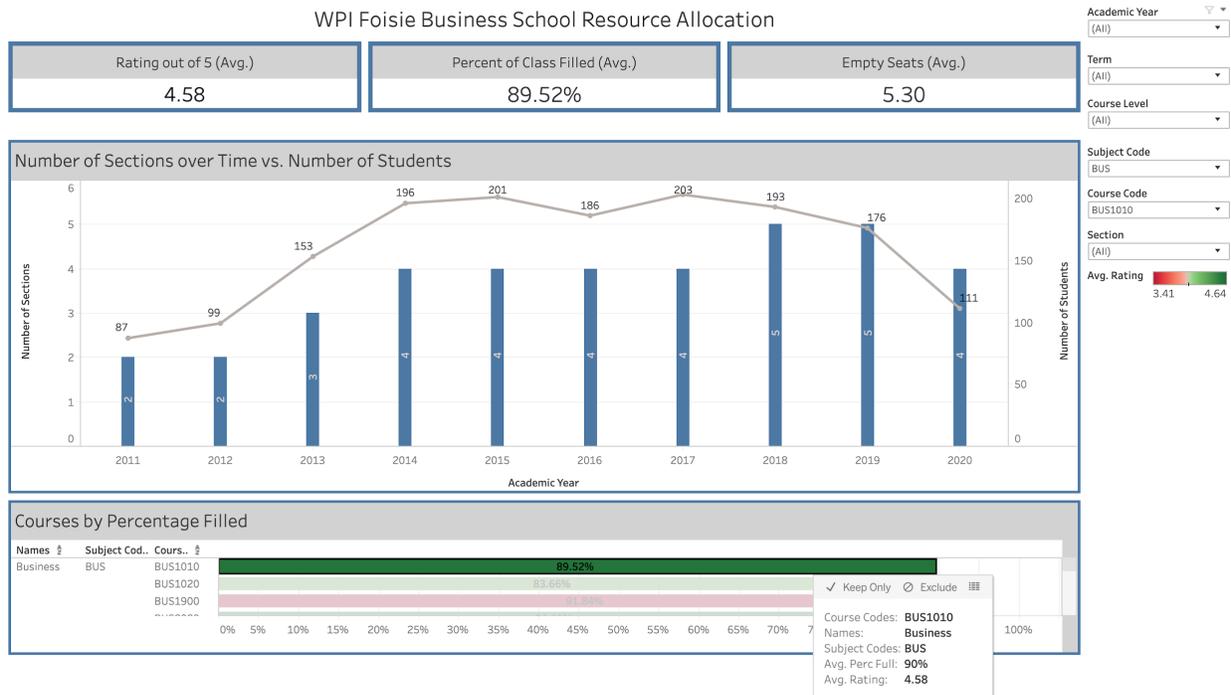
*Figure 20: Dashboard with BUS1010 Selected*

KPIs that measure the success of the KPA "Resource Allocation" are the percentage of class full and the number of sections that were run for a particular course over time. This provides the FBS with insight into which courses are meeting the enrollment capacity, which courses have low enrollment, and from this better determine how many sections of a particular course to run.

Examples of managerial questions this dashboard could answer are:
1. How many sections of a particular class were run over the last 5 years?
2. Should we increase the number of sections for a particular course based on the number of total students?
3. Which courses had the lowest percentage of filled seats for a particular year?
4. What department had the highest percentage of filled seats for a particular year?
5. Does there appear to be a correlation between the percent full and course rating?

## 4.6 Dashboard 3: Faculty Performance

### 4.6.1 KPAs and KPIs

The KPA Faculty Performance refers to faculty ratings, how many courses they have taught over the last 10 years, what courses they have taught and their credit hours. This information helps the

FBS better allocate professors to classes based on credit hours and analyze their performance over time.

KPIs that measure the success of the KPA "Faculty" are faculty ratings over time and their total credit hours. Faculty ratings over time allow the FBS to evaluate how professors and faculty are performing over time and compare their performance against other professors and faculty. Total credit hours of faculty help the FBS better allocate faculty and professors to courses according to universities rules of minimum credit hours per faculty. Comparing different faculty's total credit hours and ratings to others also provides them insight on faculty performance.

The team's final dashboard is "Faculty Performance". This dashboard consists of three cards, a tree map and a bar chart.

## 4.6.2 Usability Testing

Major feedback gathered from the "Faculty Performance" usability tests were:
- Find a way to compare two professors against each other
- Include to see a summary line for credit hours and rating over time
- Make 4.0 the "middle point" for instructor rating
- Find a way to compare two classes
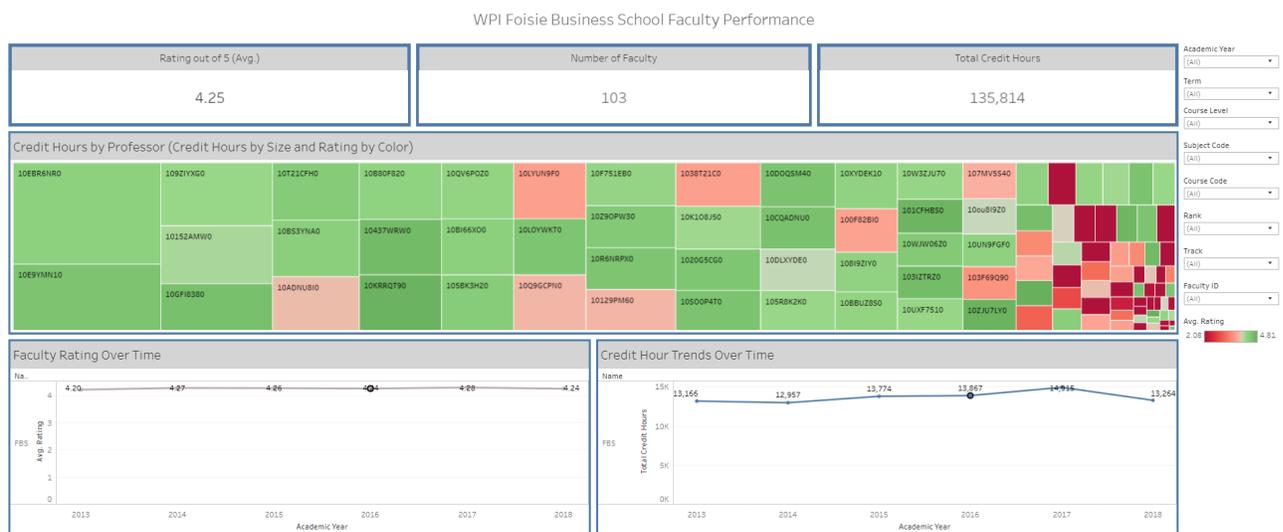
## 4.6.3 Final Dashboard



Figure 21: Faculty Performance Dashboard

The final dashboard can be seen in Figure 21 where the main visualization is the tree map that shows Faculty Performance (large blocks meaning higher total credit hours and smaller blocks meaning lower total credit hours) and color coded on a green to red scale of professor rating (green being a higher rating and red being a lower rating on a scale of one to five). This graphic provides the FBS with insight into what professors have higher or lower ratings, higher or lower

total credit hours, and what courses they taught over time. For operational purposes, this information helps FBS management better allocate their instructors to meet the required credit hours and track their success.

The line chart on the lower right half of the dashboard displays total credit hours over time (credit hours being the y axis and years on the x axis). This graphic allows FBS management to view the total credit hours over time and use this information for feedback on allocating faculty because the university has credit hour targets their instructors must fulfill. When multiple professors or departments are selected, the trend lines will appear on top of each other. These visuals also can be drilled down to course code and subject code. The comparison feature is shown in Figure 22.

The line chart on the bottom left shows a trend line that displays average rating over time. This can be filtered down to show the average rating over time for a particular department, course or professor. This provides performance feedback. When multiple professors or departments are selected, the trend lines will appear on top of each other. These visuals also can be drilled down to course code and subject code. This allows for comparison of average rating, as seen in Figure 22.
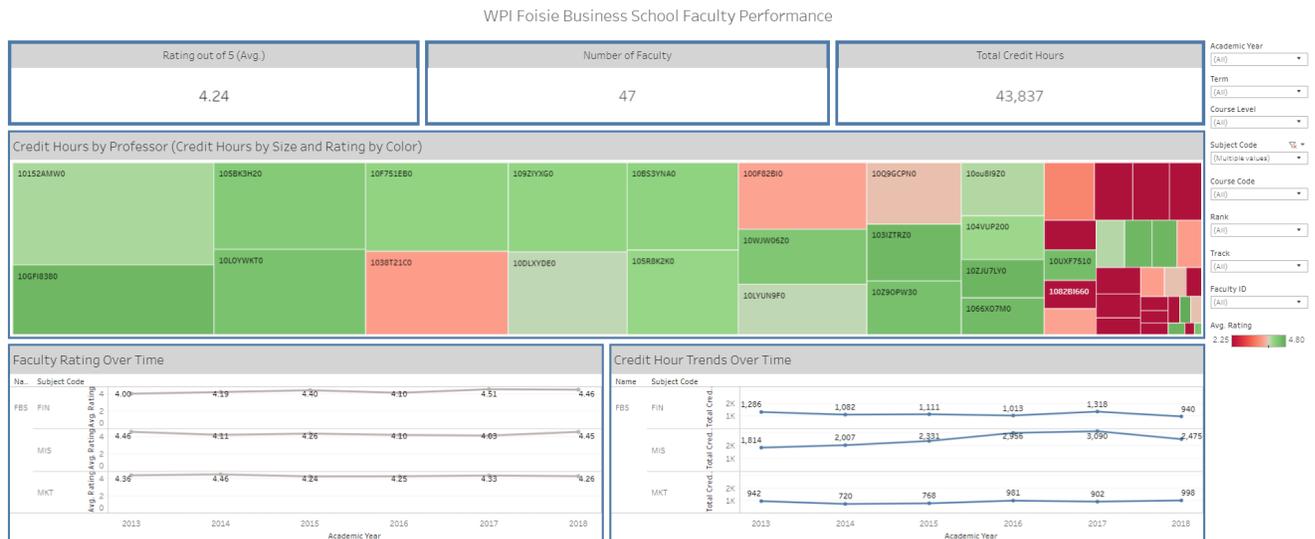


*Figure 22: Faculty Performance Dashboard with Department Comparison*

At the top of the dashboard are three cards that displays the overall average rating, number of faculty and total credit hours. The purpose of cards is to display key information that are quickly and easily spotted by the user. For a particular department or course the user could see the overall rating, number of faculty and total credit hours. All of these cards will change depending on the filters, or specific selection on a graph. For example, in Figure 23, one block is selected. This block represents an individual instructor. The cards at the top change to demonstrate only data for that selection.
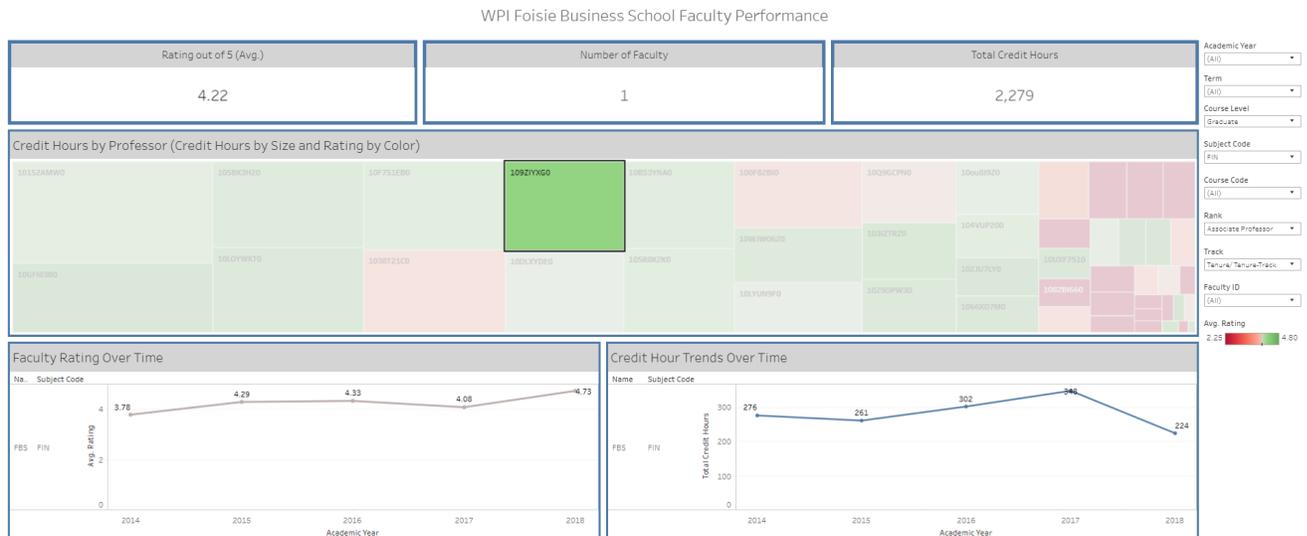
*Figure 23: Faculty Performance Dashboard showing Card Change based on Selection*

KPIs that measure the success of the KPA "Faculty Performance" are average professor rating, and total credit hours. As specified by a potential user, the "middle" point on the one to five rating scale is set to four. Ratings below a four begin to take on a red shade, signaling a warning to the user. Total credit hours can be used operationally or as a measure of success based on the user's need. All of these charts filter together like the previous dashboards in order for the user to experience the full value of the data presented.

Potential managerial questions this dashboard could answer are:
1. Has instructor rating continued to increase over time for a particular instructor, course or department?
2. Does there appear to be a correlation between a higher total amount of credit hours and a high rating?
3. Should management be better allocating instructors among courses to address faculty with a significantly higher amount of total credit hours?
4. What is the average rating for a particular professor over the past five years?
5. What is the total number of faculty in a particular department?

# 5.0 Discussion and Recommendations

Throughout the term of the project the team learned to compile multiple skills from different areas to complete the project. This required the team to continuously learn throughout the whole year. From the project the team was able to display the importance of BI and compile a set of learning to help improve the project in the future.

## 5.1 Interdisciplinary Nature

During the development of the Tableau Dashboards there were various different disciplines that were necessary to incorporate in order to get most of the project. The team followed the System Development Life Cycle as we defined KPIs and goals of the FBS, developed and secured the database, and finally created meaningful and appealing dashboards. Proficiency in each of these skills were necessary to create a system that was valuable to the FBS.

Throughout the project the team utilized skills related to project management in order to keep the project and the team on track. During the beginning of the project the team created a Gantt Chart that was utilized throughout the time span of the project. This allowed the team to set completion goals and estimate times for different tasks. The team also kept records of agendas and minutes for every advisor meeting, sponsor meeting, interview, usability test, or any other additional meeting. Working together as a team allowed the members to develop interpersonal skills throughout the year.

In order to properly achieve the objective to create meaningful data visualization dashboards for the FBS the team had to first plan what would be built. During the planning stage, it was necessary to first gather requirements and define goals. The team read through the FBS Management plan in order to evaluate the missions, objectives, structure, and strategic plan of the FBS. Through multiple stakeholder interviews and analyzing the school's management plans the important metrics and goals started to become clearer. Then KPIs were developed using the information gathered about the FBS and their requirements. This allowed the team to properly layout and begin their project in an organized manner

An understanding of databases and security was imperative since it is essentially the backbone to the dashboards. A data source was necessary to feed the dashboards, the team decided on MySQL as the relational database system since it was open source and easy to learn. This allowed the team to use their pre-existing database knowledge to create a database that was useful for Tableau in order to create the dashboards.

Lastly, the team needed an understanding of the design process and data visualization. It involved skills related to user experience design in order to create dashboards that were both visually appealing but also functional to the user. The dashboards needed to correctly draw the

user's eye to the correct charts in filters in the right order. This also required technical skills in order to build the dashboards to match the user experience design principles. It was important that all dashboards were both useful and artistically appealing. Through multiple edits and revisions, the team was able to come up with a prototype with good design and meaningful data, then took it into usability testing. The team then used the information from usability testing with potential users to even further improve on the design of the dashboards.

## 5.2 The Importance of Business Intelligence

BI was used in this project to measure and visualize the large amounts of data recorded by the FBS to help them improve their decision-making processes and outcomes. The team used the internal data recorded by the FBS, along with placeholder student data, to build the database. This database allowed the team to store the data used to build dashboards in Tableau that support FBS needs and processes.

The BI solution the team has developed allows users to reach data in a convenient and timely fashion increasing the efficiency of their work, as well as allowing users to spot trends in this data that are important to the FBS business processes. The system the team created is valuable to the FBS because it allows the users to measure the performance of the FBS, make data-driven decisions, and increase its effectiveness and efficiency in terms of faculty business processes like scheduling and measuring faculty performance.

Institutional Research dashboards already provide an overview of the FBS by revealing information such as demographics, admissions, and enrollment. Our dashboards complement those dashboards, specifically in the area of enrollment, by providing a more detailed insight into various aspects of the area such as seats filled and majors of enrolled students. The team has created a plan to integrate the BI system into the FBS through a user manual, which gives a detailed guide on how to navigate the dashboards and use them to full capacity. The team has also created a pass on guide meant to help those who will be managing the system recreate the dashboards the team has developed. These detailed guides will make for a smooth integration of the system into the FBS.

## 5.3 Dashboard Limitations

The team's final dashboards were presented to the FBS as prototypes because several limitations prevented the team from calling them final products. A portion of the data needed to display the KPI's was sensitive in nature and inaccessible by the team. Throughout stakeholder interviews, the team also identified data that would provide the FBS with key information but is not currently captured by the school. The following sections discuss the limitations addressed throughout this project, and the recommendations the team suggests for a final product.

### 5.3.1 Data Limitations

From the data the team received aspects of it were outdated or we were not able to access data necessary to display certain KPIs. The data that was received on faculty listed their rank but upon showing the dashboards to the team advisor and sponsor it was discovered that the data was old and not entirely up to date. The team decided not to adjust the faculty ranks to current ranks since it did not impact the functionality of the dashboards or the KPIs that were displayed. Also, the class data received from the WPI Registrar contained classes that were outdated or renamed. This made it difficult to compare classes over time since they appeared under multiple names. The team did not adjust any of the class names, since some of the classes changed content and direction when they changed names while others simply changed the class title. Additionally, the registrar data was not full records since course WPI only has online records of course evaluations from 2013 which caused our trends to not cover the full range of time of data we had. We had multiple KPIs relating to students and information about students for the dashboards but due to confidentiality of students we were not able to access any data related to students. This caused the team to not be able to accurately display all the KPIs with real data and dashboards to display a mix of real data and dummy data. Any data that is related to students (age, classes they took, etc.) in the dashboards and database is placeholder data created to show the potential functionality of the dashboards.

### 5.3.2 Security Limitations

Although for the team's development and design stages our database was secure enough, there were some limitations that did not allow us to make it more secure. The team's main limitations were those posed by using Tableau Online. If the data used by the team were more sensitive, some of these limitations would have to be confronted.

The main security vulnerability to the team's system would be through social engineering. Since an extremely strong password and private SSL encryption key was created, it would be nearly impossible to get into our system without gaining the information from someone who has access. That being said, this is under the assumption that all passwords and SSL keys are only given out verbally, though a USB that is safely stored, or a safe encrypted password/SSO manager. The best way to further secure the data would be to move the dashboards offline to a private client that was only physically accessible to those who needed it. This would eliminate the possibility of someone accidentally mishandling the SSL key and allowing a hacker to access the system since the system is not hosted on the internet.

### 5.3.3 Database Limitations

For this project, the team used a MySQL database that referenced static data imported from Excel sheets. This allowed the team to work with data that mimics real data. In order to

implement this into the final product, the team had to create placeholder tables that related the data in a way that could be used in Tableau.

While this database allowed the team to create versatile prototypes to demonstrate potential dashboards, it was not capable of real time updates and it did not provide a comprehensive picture of all the FBS records.

Despite the limited functionalities of the database used in this project, it allowed the team to focus on creating methods for displaying data.

## 5.4 Recommendations

Given these limitations, this project focused on developing KPAs, KPIs to create prototype dashboards that the FBS could use to make data driven decisions and improve management processes. Moving forward, the team recommends that the FBS implements these strategies for creating a durable database structure and dashboards.

### 5.4.1 Data Structure and Management

Instead of referencing static Excel sheets, the team recommends that the data be imported directly from Banner or Workday to Tableau. This would allow live updates and can be used to reflect changes in courses and their rosters in the most efficient way. Importing data from Banner would also allow access to student records without creating additional data privacy concerns.

For data that cannot be imported from Banner or Workday, the team recommends that the FBS stores the data on a WPI server. This would be more secure than continuing to use MySQL, which is open source and has additional security concerns.

### 5.4.2 Dashboards

Usability testing with potential users and consumers of the dashboards revealed several recommendations to the dashboard that could not currently be implemented. The team recommends that in the future, WPI should capture data relating to waitlist records and past majors of students. This could be looked into when WPI migrates management systems from Bannerweb to Workday. Additional data that we recommend adding in the real implementation of this project is the credit hours for professors based on lab sections that are adding extra credit hours to the professor's records. Waitlist data would improve resource allocation processes by knowing which classes consistently have large waitlists. Past majors could provide the FBS insight into why students switch from a non-FBS major to an FBS major, or vice versa. As previously mentioned, the team recommends making a live connection to the WPI Server. With this connection, we suggest accurately incorporating data surrounding class times, building and room codes. This would also improve resource allocation. These recommendations could not be

implemented by the team due to limitations surrounding data access and security. The team did not have information on the cost to provide licensing for the FBS or the actions in order to do so. While trying to find this information the team was unable to have access to it. The team recommends working with WPI Institutional Research in the future to extend the Tableau Server license WPI already owns.

In regard to KPIs, the team recommends that the KPI's be further developed to include targets and baselines. The team was not able to develop these measures due to time and data limitations. A major outcome of this project was providing the FBS with a foundation to collect baseline data to help the FBS create targets and recognize emergent KPIs that have not been looked at yet. In the future, dashboards could be created focused on research projects and independent studies in order to display information pertinent to those classes. The dashboards could be further developed to include analytics features to predict the number of students and sizes of classes.

The team recommends that the dashboard developers who will possibly be working on extending this BI solution to prepare a video-based tutorial for more effective implementation. Throughout usability testing, the team found that some visuals (e.g., the tree maps) or filters needed a brief explanation, but once explained were usable and useful to the user. A video demonstration would quickly and effectively provide the FBS management with appropriate knowledge to utilize the dashboards.

# 6.0 Conclusions

Through the use of organizational performance management, the team helped the FBS display current efforts for goals based on their Management Plan. From the analysis of the FBS Management Plan the team created a set of KPAs and KPIs to display metrics related to FBS "Biggest Exports," "Resources Allocation," and "Faculty Performance." Using these as guidelines the team created a BI solution utilizing Tableau and MySQL to store data. The dashboards were revised and improved over time before final products were presented to potential users who provided constructive feedback on the solution. With the considerations relating to data, data structure, and the database taken into account, the FBS BI solution can help guide FBS management towards goals and add value to WPI.

## 6.1 Reflections

Throughout the course of the year the team learned various lessons related to working with each other, with stakeholders, and technical lessons about the tools that were used. From the beginning of the project, the team needed to put the priorities of the sponsor first in detailing the needs and expectations of the project. Through stakeholder interviews, the team was able to integrate the different needs of different people into one final solution. With the development of the solution, the team learned how to handle constant feedback through an iterative RAD process. This kept the final dashboards in a constant changing state to meet the needs of the user and business requirements.

The team learned technical skills through the use of MySQL as a database and Tableau as a BI solution. Prior to this project, the team had very limited experience with both of these tools and spent time going through tutorials and documentation in order to fully use these tools in the project. The team learned how to leverage these tools to create a BI solution that would help an organization make efficient data driven decisions.

During the project it was of the utmost importance for the team to learn how to work together as it was a long-term project. The team learned each other's strengths and weaknesses and how to work together in the most optimal manner.

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# Appendix

## Appendix A: Gantt Chart

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|

**FBS BI GANTT CHART**

| TASK NAME | START DATE | END DATE | DURATION (WORK DAYS) | TEAM MEMBER | PERCENT COMPLETE |
|---|---|---|---|---|---|
| **Research** | | | | | |
| Sponsor Meetings | 8/27 | 3/6 | 171 | Team | 100% |
| Research | 8/27 | 10/5 | 38 | Team | 100% |
| Creating Project Proposal | 9/4 | 10/12 | 38 | Team | 100% |
| **Gather Data** | | | | | |
| Collect Data from FBS | 10/22 | 10/25 | 3 | Team | 100% |
| Cleaning the Data | 10/25 | 11/1 | 6 | Team | 100% |
| **Requirements Gathering** | | | | | |
| Interview with Norman Wilkinson | 10/22 | 10/22 | 0 | RM & SB | 100% |
| Interview with Steven Taylor | 10/23 | 10/23 | 0 | RM,PD,AL,SB | 100% |
| Interview with Kristopher Sullivan | 10/24 | 10/24 | 0 | RM,PD,AL,SB | 100% |
| Interview with Diane Strong | 10/24 | 10/24 | 0 | RM & SB | 100% |
| Interview with Rajiv Malholtra | TBD | TBD | 0 | | 100% |
| Develop KPIs | 10/22 | 11/6 | 14 | Team | 100% |
| **Develop Database and Dashboards** | | | | | |

| TASK NAME | START DATE | END DATE | DURATION (WORK DAYS) | TEAM MEMBER | PERCENT COMPLETE | |
|---|---|---|---|---|---|---|
| **Develop Database and Dashboards** | | | | | | |
| Create Database | 10/31 | 11/13 | 13 | Team | 100% | |
| Import Data | 11/11 | 11/15 | 4 | Team | 100% | |
| Connect to Tableau | 11/14 | 11/18 | 4 | Team | 100% | |
| Initial Dashboard Designs | 10/29 | 11/4 | 5 | Team | 100% | |
| Creation of Dashboard Prototype | 11/18 | 12/16 | 28 | Team | 100% | |
| Second Dashboard Prototype | 12/5 | 12/14 | 9 | Team | 100% | |
| **Implement and Improve** | | | | | | |
| Set up Usability Tests | 12/8 | 12/14 | 6 | Team | 100% | |
| Usability Tests | 1/13 | 1/25 | 12 | Team | 100% | |
| Create Third Prototype | 1/19 | 2/8 | 19 | Team | 100% | |
| Complete Paper | 1/26 | 3/14 | 48 | Team | 100% | |
| Create Final Product | 2/16 | 2/28 | 12 | Team | 100% | |
| **Final Paper** | | | | | | |
| Methodology | 12/8 | 12/14 | 6 | Team | 100% | |
| Results | 1/13 | 1/25 | 12 | Team | 100% | |
| Discussion and Recommendations | 1/19 | 2/8 | 19 | Team | 100% | |
| Conclusion | 1/26 | 3/14 | 48 | Team | 100% | |
| Formatting and Intros | 2/3 | 2/9 | 7 | Team | 100% | |
| Presentation and Poster | 2/16 | 2/28 | 12 | Team | 100% | |

# Appendix B: Usability Testing- Think Aloud

| Dashboard | Task | Completed | Challenges | Notes |
|---|---|---|---|---|
| **Biggest Exports** | Find the most popular non-business school major who took BUS1010 in 2018. | | | |
| | Find the most profitable courses based on ROI for BUS in 2015. | | | |
| | What is the average number of students in ETR 2900 in 2019? | | | |
| **Resource Allocation** | What are the top 10 highest and lowest filled classes for 2019? | | | |
| | What is the average number of empty seats for MIS? | | | |
| | What is the average rating of Business Undergrad classes? | | | |
| **Faculty Performance/ Ratings** | Find all the professors who teach BUS1010? | | | |
| | Who delivered the most credit hours for OIE in 2017? | | | |

**Additional Questions**
1. What additional features would you like to see?
2. Most useful visual and least useful visual?
3. If there were no data limitations, aka an "ideal scenario" what features, visuals or information would you find useful?

## Appendix C: Usability Test Minutes

**Interviewee**: Michael Elmes     **Date**: 2/4/20
**MQP Members**: Rachel, Anthony

| Dashboard | Task | Completed | Challenges | Notes |
|---|---|---|---|---|
| **Biggest Exports** | Find the most popular non-business school major who took BUS1010 in 2018. | YES | | |
| | Find the most profitable courses based on ROI for BUS in 2015. | YES | Add instructor name | |
| | What is the average number of students in ETR 2900 in 2016? | | | |
| **Resource Allocation** | What are the top highest and lowest filled classes? | Formatting is off | | |
| | What is the average number of empty seats for MIS? | YES | | |
| | What is the average rating of Business Undergrad classes? | YES | | |
| **Faculty Performance/ Ratings** | Find all the professors who teach BUS1010? | YES | | |
| | Who delivered the most credit hours for OIE in 2017? | YES | | |

**Additional Questions**
1.

**Their Recommendations:**
- Thought top one was number of classes that were full
- Look at formatting
- Look into the ROI numbering?

**Interviewee**: Brent French     **Date**: 1/29/20
**MQP Members**: Rachel, Anthony, Pete

| Dashboard | Task | Completed | Challenges | Notes |
|---|---|---|---|---|
| **Biggest Exports** | Find the most popular non-business school major who took BUS1010 in 2018. | YES | | Show how ROI is Calculated in the heading |
| | Find the most profitable courses based on ROI for BUS in 2015. | YES | | |
| | What is the average number of students in ETR 2900 in 2019? | YES | | Was not showing<br><br>Adjust the year to academic year |
| **Resource Allocation** | What are the top 5 highest and lowest filled classes? | YES | | Number of Sections offered in a year might be more than what is correct |
| | What is the average number of empty seats for MIS? | YES | | |
| | What is the average rating of Business Undergrad classes? | YES | | |
| **Faculty Performance/ Ratings** | Find all the professors who teach BUS1010? | YES | | |
| | Who delivered the most credit hours for OIE in 2017? | YES | | |

**Their Recommendations:**
- Have a better introduction that the business school has measurements that they hold themselves too, and we are creating data visuals that shows these measurements
- Percentage full title was confusing should be a number
- Filter some independent

**Interviewee**: David Saul        **Date**: 1/22/20
**MQP Members**: Sarah, Rachel, Anthony, Pete

| Dashboard | Task | Completed | Challenges | Notes |
|---|---|---|---|---|
| **Biggest Exports** | Find the most popular non-business school major who took BUS1010 in 2018. | | Major filter Not easy to see the full data | Size is largest to smallest was obvious, color blind would have issues, average rating scale (course title acronyms) Conclusion students are not taking because it is a poor class See the faculty to teach the class |
| | Find the most profitable courses based on ROI for BUS in 2015. | | | |
| | What is the average number of students in ETR 2900 in 2019? | | | |
| **Resource Allocation** | What are the top 10 highest and lowest filled classes for 2019? | | | Add in course name to the course's percentage fill graph |
| | What is the average number of empty seats for MIS? | | | How many faculty classes are qualified to teach? Graph term by term |
| | What is the average rating of Business Undergrad classes? | | | |

| **Faculty Performance/ Ratings** | Find all the professors who teach BUS1010? | | | |
|---|---|---|---|---|
| | Who delivered the most credit hours for OIE in 2017? | | | |

**Additional Questions**
1. What additional features would you like to see?
2. Most useful visual and least useful visual?
3. If there were no data limitations, aka an "ideal scenario" what features, visuals or information would you find useful?

**Their Recommendations:**
- Diversity is a goal, confidentiality and preserve the data
- Confused on the major
- Add more info on the ROI info (like building, faculty?)
- People look at the extremes
  - (should we add in 10 ten and bottom 10?)
- Doctrine of least surprise
- Bring me back to default button
- Year shows up as 2020
- 3000 students?
- Number of students for rating
- Weight the rating?
- Measure quality of instruction?

**Interviewee**: Laurie Stokes     **Date**: 1/22/20
**MQP Members**: Sarah, Rachel, Anthony, Pete

| Dashboard | Task | Completed | Challenges | Notes |
|---|---|---|---|---|
| **Biggest Exports** | Find the most popular non-business school major who took BUS1010 in 2018. | YES | | Major filter is a little confusing and misleading |
| | Find the most profitable courses based on ROI for BUS in 2015. | YES | | |
| | What is the average number of students in ETR 2900 in 2019? | YES | | |
| **Resource Allocation** | What are the top 10 highest and lowest filled classes for 2019? | YES | | Used the year filter first<br><br>The top and bottom ten filter is messed up and not showing all of the classes |
| | What is the average number of empty seats for MIS? | YES | | |
| | What is the average rating of Business Undergrad classes? | YES | | A little more description of the highest and lowest percent full classes |
| **Faculty Performance/ Ratings** | Find all the professors who teach BUS1010? | YES | | |
| | Who delivered the most credit hours for OIE in 2017? | YES | | Wants to Start from the top down on filters, so we might want to put the most used filters in order from top to bottom |

**Their Recommendations:**

- She finds it useful, thinks it would be most useful for Norm and Brent
- Have a better introduction that the business school has measurements that they hold themselves too, and we are creating data visuals that shows these measurements
- Percentage full title was confusing should be a number
- Filter some independent

**Interviewee**: Diane Strong     **Date**: 1/24/20
**MQP Members**: Sarah, Rachel, Anthony

| Dashboard | Task | Completed | Challenges | Notes |
|---|---|---|---|---|
| **Biggest Exports** | Find the most popular non-business school major who took BUS1010 in 2018. | YES | | -Ordering of courses in drop down (UG before grad) -wants to one click (default not all) → open drop down, can you deselect all options? |
| | Find the most profitable courses based on ROI for BUS in 2015. | YES | Not clear that ROI and rating are different scales (size vs. color) | |
| | What is the average number of students in ETR 2900 in 2019? | YES | Doesn't reset other filters each time | |
| **Resource Allocation** | What are the top 10 highest and lowest filled classes for 2019? | YES | Confused with highest full filter | Filter out independent study courses |
| | What is the average number of empty seats for MIS? | YES | Mis 507 is not real | Course level → not clear that filters g/ug Be able to exclude / change what data is shown while in the dashboard |
| | What is the average rating of Business Undergrad classes? | YES | Doesn't think to look at the cards first (common problem) | |

| Faculty Performance/ Ratings | Find all the professors who teach BUS1010? | YES | | Color for rating should not rescale<br>- Set midpoint to 4.0 → typical average rating (or use that as n) |
|---|---|---|---|---|
| | Who delivered the most credit hours for OIE in 2017? | YES | | |

**Their Recommendations:**

- Add class names to all tooltips

Faculty
- Change last name to instructor last name

Faculty Performance
- Add a question that uses the bottom sheet
- Change the bottom sheet color to not red (check all sheets to make sure they don't have rating colors)
- Wants to see a summary line for credit hours and rating over time (for the selected filters → see all oie faculty for 10 years)

**Interviewee**: Norm Wilkinson     **Date**: 2/4/20
**MQP Members**: Sarah, Rachel, Anthony, Pete

| Dashboard | Task | Completed | Challenges | Notes |
|---|---|---|---|---|
| **Biggest Exports** | Find the most popular non-business school major who took BUS1010 in 2018. | YES | | |
| | Find the most profitable courses based on ROI for BUS in 2015. | YES | | |
| | What is the average number of students in ETR 2900 in 2016? | YES | | Add instructor name? |
| **Resource Allocation** | What are the top highest and lowest filled classes? | | | |
| | What is the average number of empty seats for MIS? | YES | | |
| | What is the average rating of Business Undergrad classes? | YES | | |
| **Faculty Performance/ Ratings** | Find all the professors who teach BUS1010? | YES | | |
| | Who delivered the most credit hours for OIE in 2017? | YES | | |

**Additional Questions**
  1.

**Their Recommendations:**
  - Faculty Performance
    - The filter on credit hours is off for year
    - Academic year filter off
    - Look at all the extra filters?
  - Biggest Exports
    - Need to figure out the ROI table and why it is not showing the course that yields the most ROI

- Faculty Dashboard
  - Make a column that shows the section number of a class
  - Filter for section number?

## Appendix D: User Manual

# User Manual

## Dashboard 1: FBS Biggest Exports
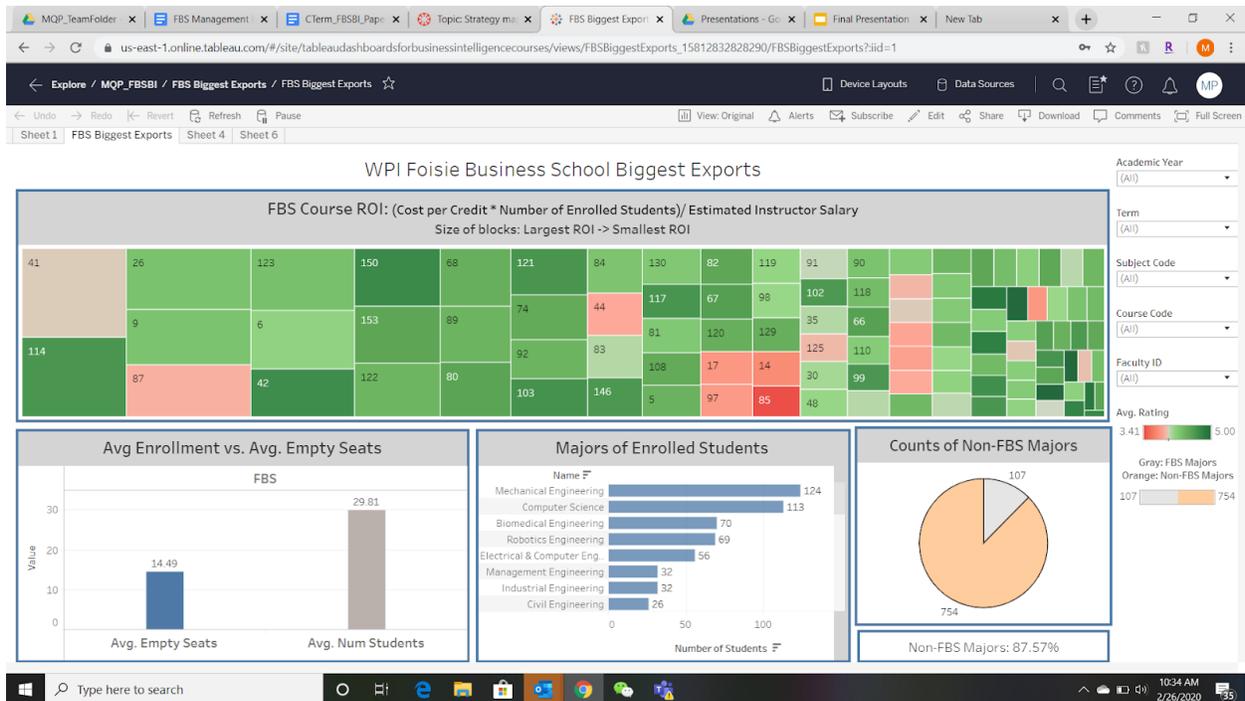


The final dashboard, "FBS Biggest Exports," uses KPIs such as course ROI, amount of non-FBS majors in FBS courses, course rating, and number of empty seats in a course to help address various questions about the benefit of particular courses. These KPIs better define how particular courses are contributing to the success of the FBS. Specifically, this dashboard could help answer questions such as:

What courses in a particular department have the highest ROI for a particular year?

What percentage of enrolled students were non-FBS majors for a particular course?

How can we address courses with a lower rating?

Which classes are attracting non-FBS majors?

These four KPIs are shown in the form of four charts. These charts and cards can be filtered using the different filters on the right-hand side of the dashboard or by clicking on specific professors within the tree chart. Each chart can be broken down and understood as follows:

At the top is the "FBS Course ROI" tree map which shows the ROI of each course over the last 10 years. ROI was calculated using the equation ROI = (Cost per Credit * Number of Enrolled Students) / Estimated Instructor Salary. The size of each block represents the ROI- bigger meaning a bigger ROI and smaller meaning a smaller ROI. Also, each block is color coded on a scale of green to red to indicate rating. Similar to the other dashboards, below a 4 rating is red, above 4 rating is green. The blocks also have a tool-tip that displays the course code, course title, ROI, average percent full and average rating.

On the bottom left is the "Avg. Enrollment vs Empty Seats" bar chart. This chart compares two bars, which displays the average number of enrolled students and the average number of empty seats for a filtered department or class. This helps the FBS administrators to decide whether to run more or less sections of a course or reserve smaller classrooms.

In the middle is the "Majors of Enrolled Students" bar chart. This chart displays the spread of majors of the enrolled students for a selected course or department. This provides useful insight into how to best market FBS courses to non-FBS students.

Lastly, on the bottom right is the "Percentage of Non-FBS Majors" pie chart. This pie chart displays the ratio of non-FBS majors to FBS majors. This gives FBS administrators a visual understanding of the enrollment difference between majors.

## Dashboard 2: Resource Allocation
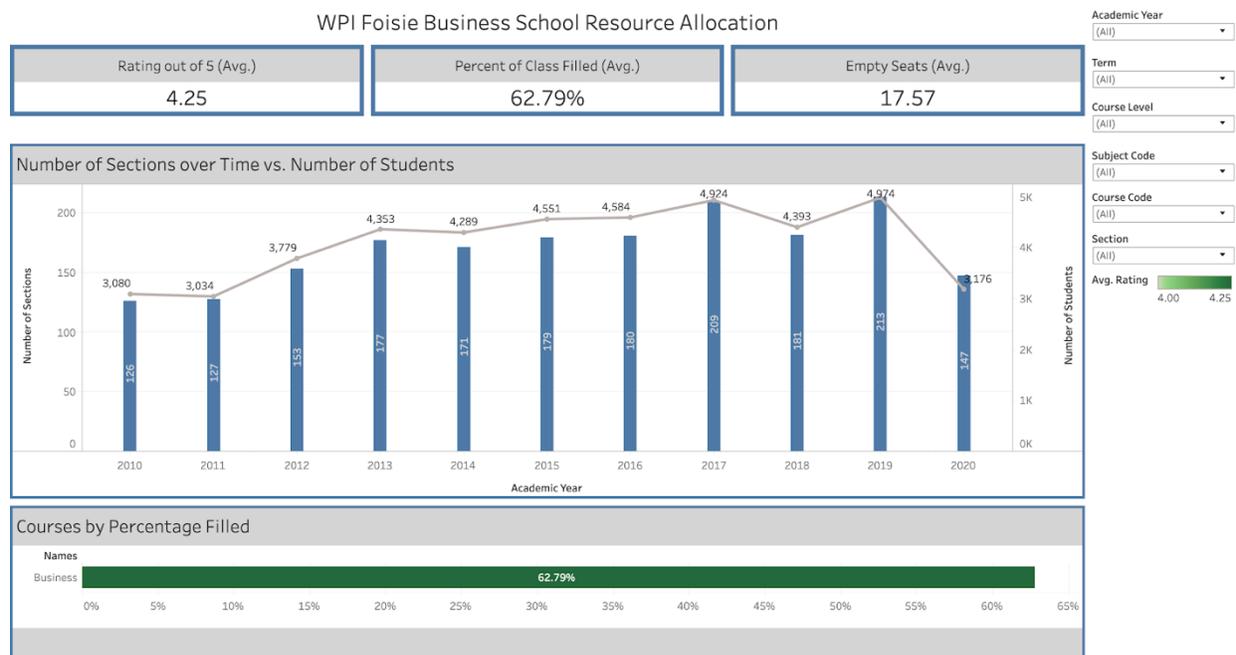


The first dashboard, "Resource Allocation," uses Key Performance Indicators (KPIs) such as number of sections over time, course percentage filled, and average course rating to help address various questions related to course performance. These KPIs will give a better idea to whether a class is losing or gaining popularity in order to properly allocate resources within the Foisie Business School (FBS). Specifically, this will help answer questions such as:

Should we increase the number of sections for a particular course based on the number of total students?

Can a particular course be moved to a smaller room?

Does there appear to be a correlation between the percent full and course rating?

Can we expect more students a particular course next year according to trends?

These three KPIs are displayed in the form of two bar charts and three cards. These charts and cards can be filtered using the different filters on the right-hand side of the dashboard. Each chart can be broken down and understood as follows:

There are three informational cards which display key information quickly for the user. The first card displays average rating for the department/course that is filtered. The second card displays average

percent full for the department/course that is filtered. Lastly, the third card displays average empty seats for the department/course that is filtered.

Below the cards is the "Number of Sections Over Time vs. Number of Students" bar chart, which provides FBS management growth trends over time and insight into whether enough sections are being offered based on the number of students. The bars on the chart represent the number of sections offered for the filtered course/department from 2010 to 2020. The trend line represents the total number of students or the filtered course/department from 2010 to 2020.

Lastly, at the bottom is the "Courses by Percentage Filled" bar chart. This chart shows courses/departments by average percentage filled. The bar is also color coded to indicate rating, to comply with FBS standard, below a four out of five rating is red and above a four out of five rating is green.

# Dashboard 3: Faculty Performance
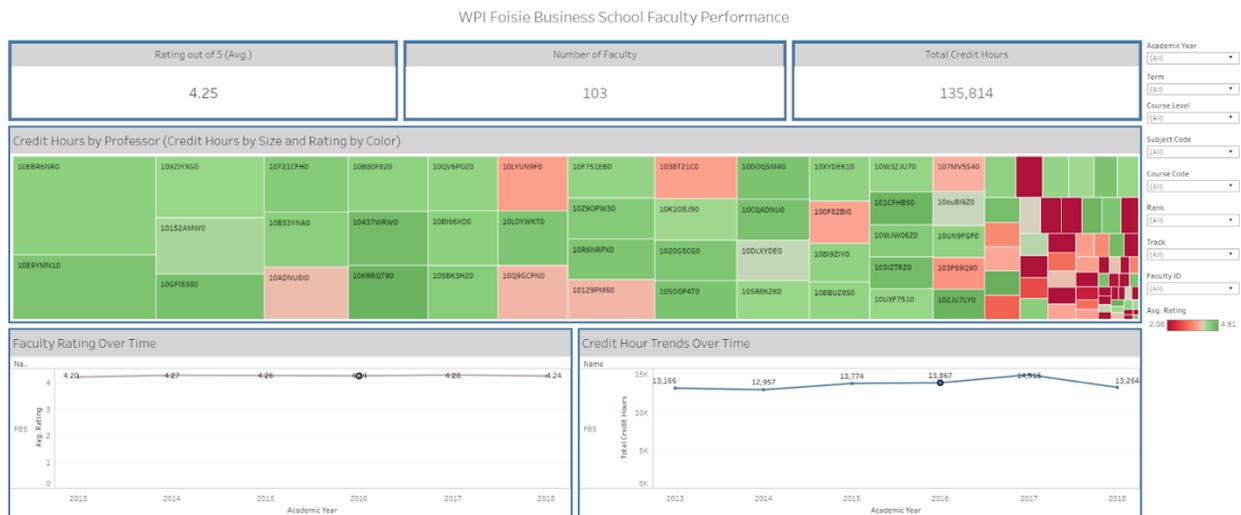


The next dashboard, "Faculty Performance," uses KPIs such as credit hours by professor, faculty rating over time, and total credit hours over time to help address various questions related to faculty performance. These KPIs will give a better sense to which faculty members are doing the most teaching and how they are rated. Specifically, it could help answer questions such as:

Has instructor rating continued to increase over time for a particular instructor, course or department?

Has an instructor with historically bad ratings shown improvement?

Does there appear to be a correlation between a higher total amount of credit hours and a high rating?

Have we seen an decrease in total credit hours over the past few years?

Should management be better allocating instructors among courses to address faculty with a significantly higher amount of total credit hours?

These three KPIs are displayed in the form of tree map, trendlines, and three cards. These charts and cards can be filtered using the different filters on the right-hand side of the dashboard or by clicking on specific professors within the tree chart. Each chart can be broken down and understood as follows:

There are three informational cards which display key information quickly for the user. The first card displays average rating for the class/department/professor that is filtered. The second card displays the

number of faculty for the class/department/professor that is filtered. The third card displays total credit hours for the class/department/professor that is filtered.

Below the cards is the "Credit Hours by Professor" tree map, which displays all FBS professors largest to smallest by the amount of credit hour taught. This means that larger blocks indicate higher total credit hours and smaller blocks indicate lower total credit hours. The blocks are also color coded, below a four out of five rating is red and above a four out of five rating is green. The visualization of this information helps FBS management better allocate their instructors to meet the required credit hours and track their success.

Below the tree map and to the left is the "Faculty Rating Over Time" trendline. This gives a great visualization on the performance of faculty member's rating over time to find whether we are seeing an overall improvement with the faculty. Also, on the bottom right of the dashboard is the "Credit Hour Trends Over Time" trend line. These graphics allow FBS management to view the total credit hours over time and the average rating over time for a particular department, course or professor.

Appendix E: Pass On Guide

# FBS Tableau Dashboards
# Pass On Guide

# The Basics of Using Tableau

To create a calculated field click the down arrows on any field, select create, select Calculated Field

# Calculated fields in our database are…

**Course ROI**

[Num Students]*[Credit Cost])/([Salary Per Course])|

Calculated the course ROI

The calculation is valid.    2 Dependencies    Apply    OK

**Stem Majors Num**

IF [Major ID]>=6 THEN 1 ELSE 0 END|

Each major is assigned an ID. FBS majors have IDs 1-6. This calculations labels FBS majors 1 and non-fbs majors 0

The calculation is valid.    3 Dependencies    Apply    OK

**Stem calc**

((SUM([Stem Majors Num]))/COUNT([Student ID]))*100|

This calculation counts the number of students with FBS majors, divides by the total number of students using student ID, then *100 to get the percentage of non-fbs majors

The calculation is valid.    2 Dependencies    Apply    OK

**Empty Seats**

[Max Enrl]-[Num Students]|

Maximum number of seats minus number of enrolled students

The calculation is valid.    2 Dependencies    Apply    OK

New blank worksheet will appear after the data source is saved.

To edit or re-visit the data source select Data Source tab



"Show Me" Creates visuals once dimensions are placed on rows or columns

"Marks" represents data by manipulating the size, color, data type. Click each button to edit the visual.

All tables and fields will appear in "Data" window as dimensions or measures

Click to create a new worksheet

Click to create a new dashboard

Drag table dimensions or measures from data window into the rows or columns



Click on drop down arrow to see editing window for a dimension or measure. Measures used in the FBS Dashboards are average (AVG) and sum (SUM).

Tooltip determines what data or description is displayed when you are hovered over an object. Drag elements over the tooltip button to add them to the tooltip, or click on the tooltip button to edit it manually



To change the mark type of the data in the visual, click the drop-down menu under "marks"

To add a filter to a visual, drag a dimension into the filter window. From there click the drop down on the dimension. Select "show filter" for it to appear on the worksheet.

To make the filter apply to all the worksheets in the workbook, select "apply to all worksheets with related data source" in "apply to worksheets"



Edit title by double clicking

To change the filter display (these dashboards mostly use the multiple values drop down option) click on the drop-down arrow on the filter.

The annotations on the first screenshot read:

Hierarchies act as drill downs in visuals.

Create a hierarchy by right clicking on a dimension, selecting hierarchy, then add to hierarchy



The annotations on the second screenshot read:

The sheets in the workbook will appear on the left. Drag and drop sheets into the dashboard window.

To make a dashboard, select the new dashboard button

# Recreating the Dashboards

# FBS Biggest Exports Dashboard
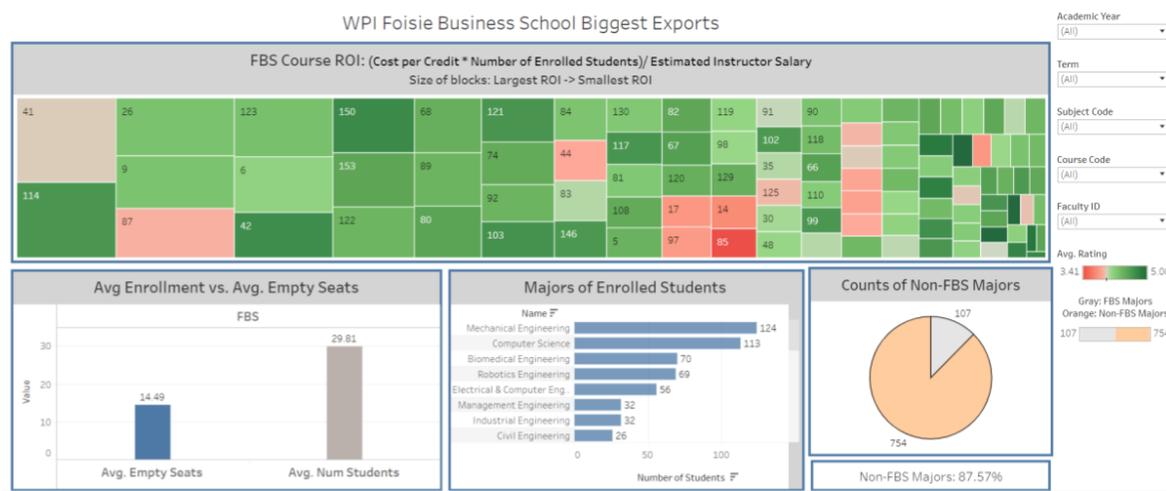


| Marks | |
|---|---|
| AVG(Rating) on color | |
| AVG(Course ROI) on size | |
| ATTR(Course Title) on details | |
| AVG(Perc Full) on details | |

| Filters | |
|---|---|
| Term (Shown) | |
| Course Code (Shown) | |
| Subject Code (Shown) | |
| Year (Shown) | |
| AVG(Rating) Shown | |

| ToolTip | |
|---|---|
| Course Code | |
| Course Title | |
| AVG(Course ROI) | |
| AVG(Rating) | |
| AVG(Perc Full) | |

ROI Treemap
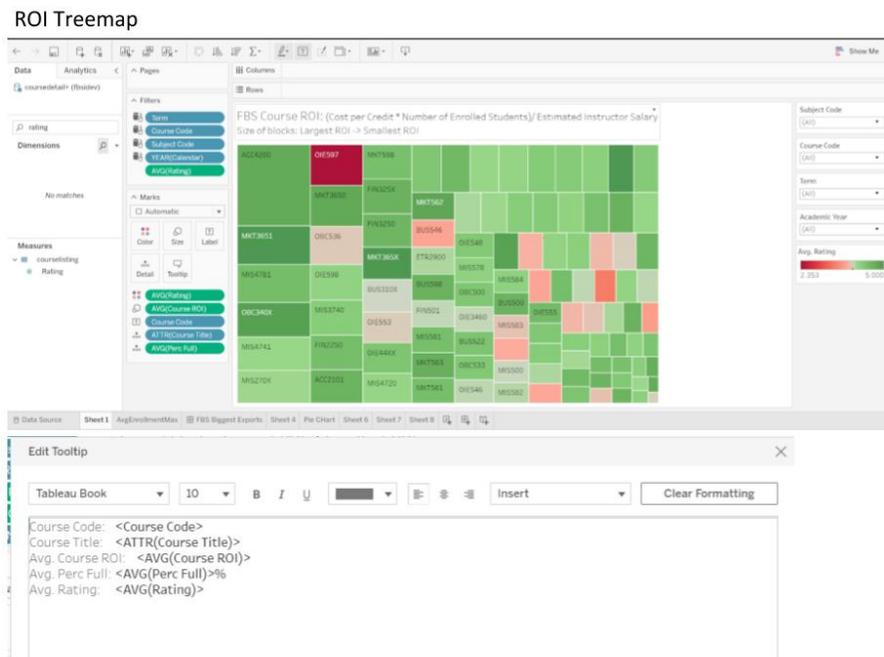
- To color the rating:

Select edit colors. Change the colors to red green diverging with red being low and green being high. Select the center checkbox and put center to four. (Shown below)
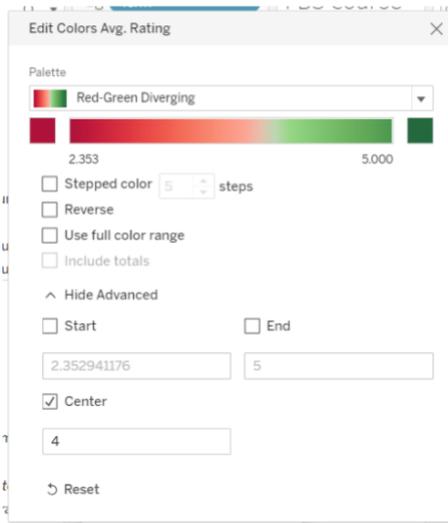


Enrolled Majors



| Marks | |
|---|---|
| CNT(Number of Records) on columns | |
| Name of major on rows | |

| Filters | |
|---|---|
| Term | |
| Course Code | |
| Subject Code | |
| Year | |
| Name | |

| ToolTip | |
|---|---|
| Name of major | |
| Count of Number of Records | |
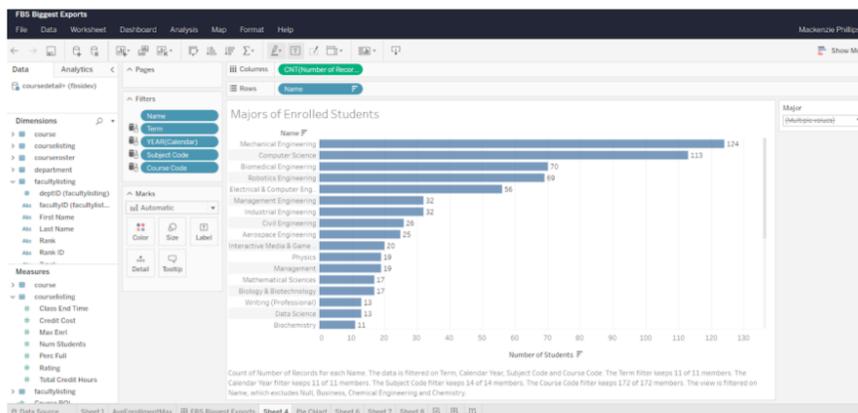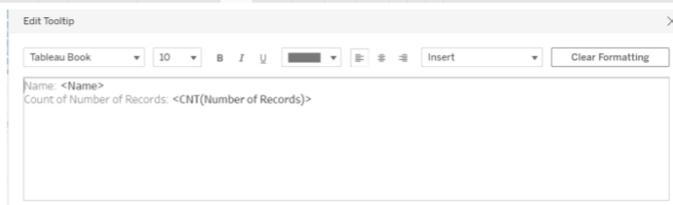
Avg Enrollment vs. Empty Seats Bar Chart

| Marks |
|---|
| Hierarchy of Department Name, Subject Code and Course code on Column |
| AVG(Num Students) on rows |
| AVG(Empty Seats) on rows |

| Filters |
|---|
| Subject Code (Shown) |

| ToolTip |
|---|
| Course Code |
| Course Title |
| AVG(Num Students) |
| AVG(Empty Seats |



| Marks |
|---|
| SUM( Number of Records of Student ID) on color |
| SUM( Number of Records of Student ID) on size |
| Stem Majors on detail |

| Filters |
|---|
| NO filters just color scales |

| ToolTip |
|---|
| Stem Majors |
| Number of Records |
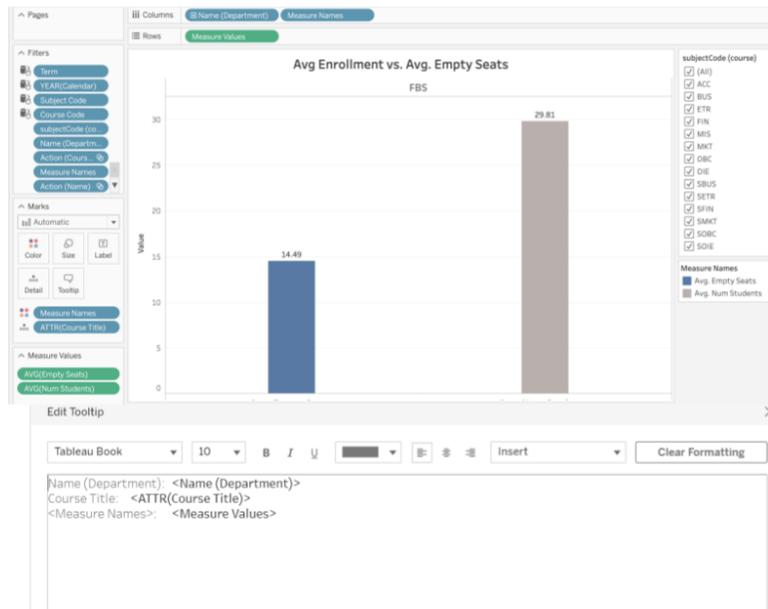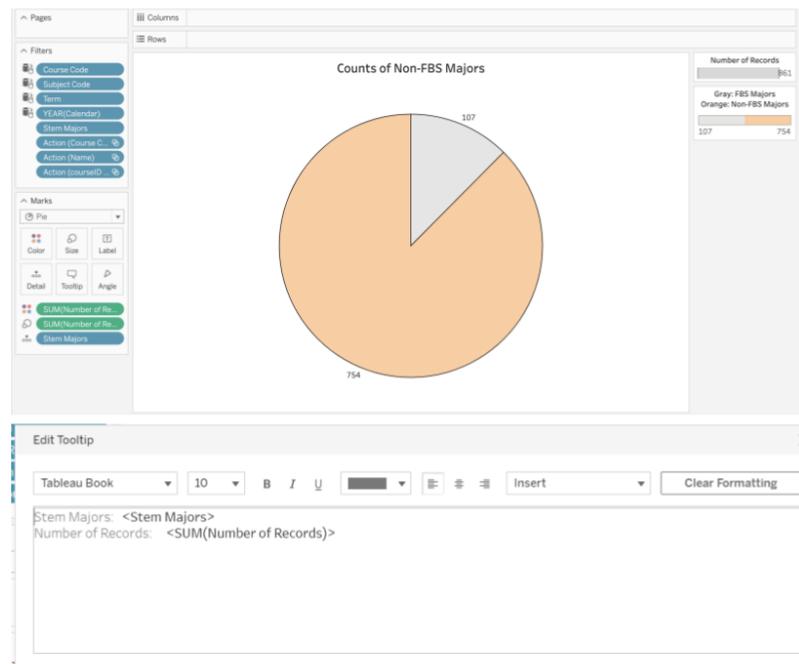
**Change marks to pie chart**

**To color pie chart select color, edit color, then select desired color diverge to ensure the two dimensions appear different colors.**

Non- FBS Majors % Card



| Marks |
| --- |
| AGG (Stem Calc) |

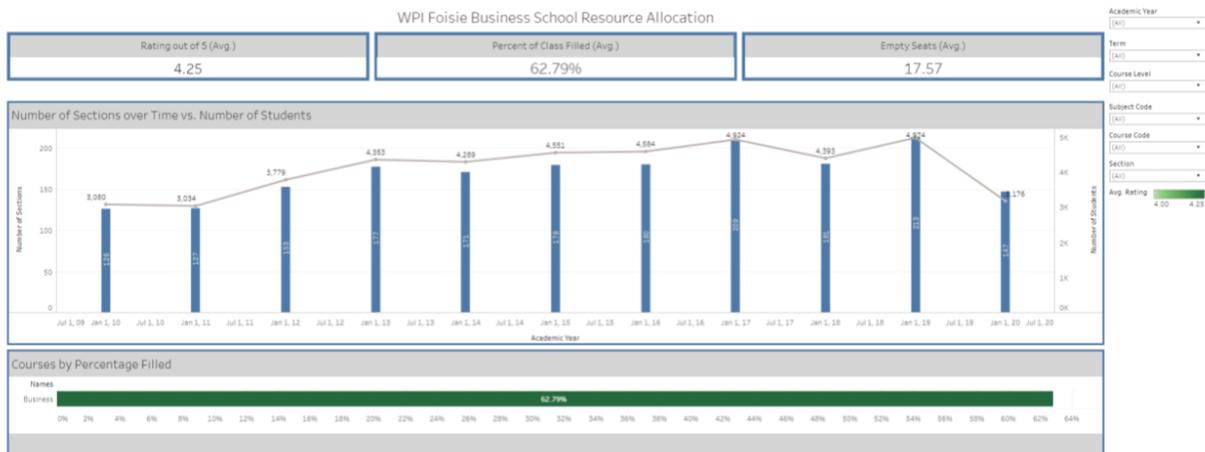| Filters |
| --- |
| None |

| ToolTip |
| --- |
| NON-fbs Students % <AGG(Stem Calc)> |

Arrange all sheets on dashboard

make the tree map the filter for all visuals.
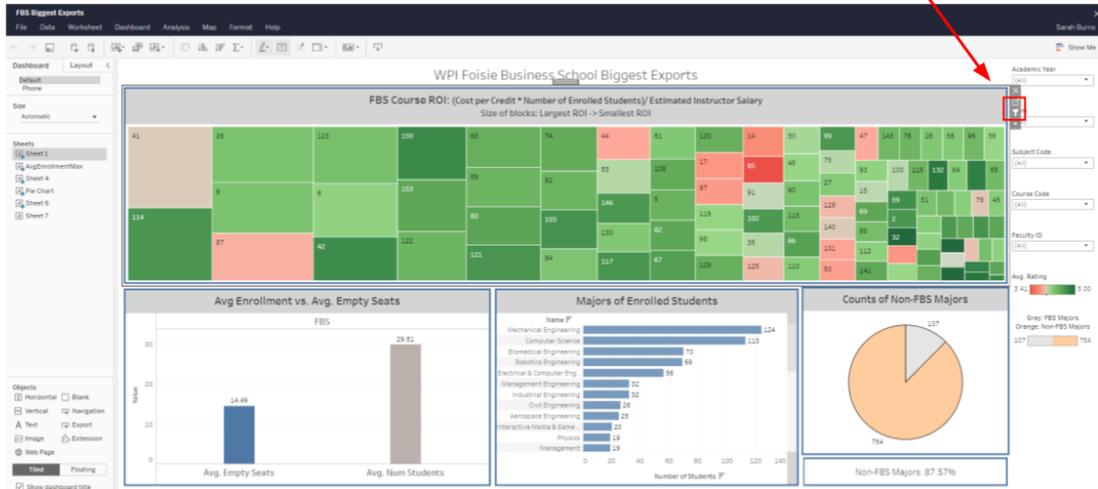
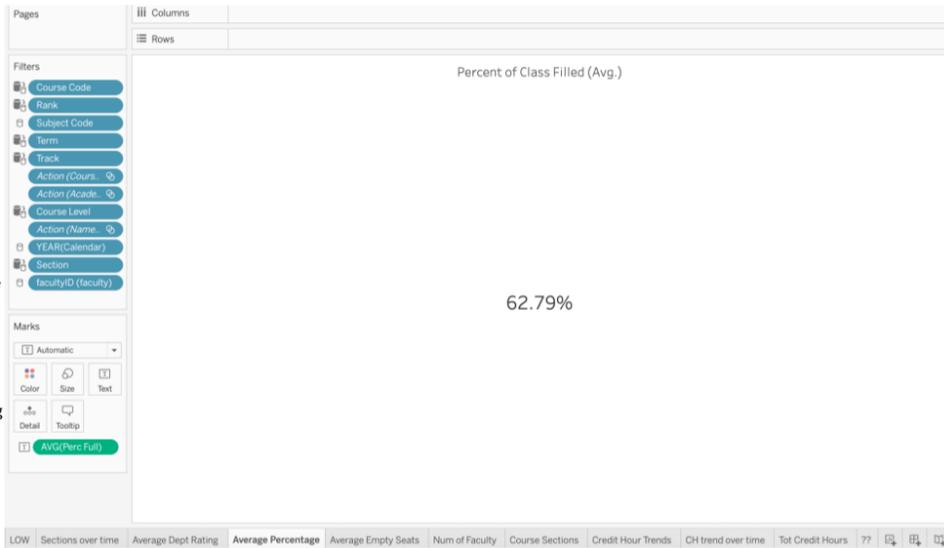# Resource Allocation Dashboard

### Rating out of 5 Card

| Marks |
|---|
| AVG (Rating) |

1. Change the view to "Entire View" in order to maximize the card
2. Change the title to match what you would like by clicking on the text and editing it
3. Center the value by clicking on the "Text" box and change the alignment to center



### Average Percentage Card

| Marks |
|---|
| AVG (Percentage) |

1. Change the view to "Entire View" in order to maximize the card
2. Change the title to match what you would like by clicking on the text and editing it
3. Center the value by clicking on the "Text" box and change the alignment to center

## Average Empty Seats Card



**Marks**

AVG (Enrollment)

1. Change the view to "Entire View" in order to maximize the card
2. Change the title to match what you would like by clicking on the text and editing it
3. Center the value by clicking on the "Text" box and change the alignment to center

## Number of Sections over Time vs. Number of Students

| Marks |
| --- |
| Calendar on columns |
| Count Course Detail ID on rows |
| Sum Num Students on rows |

| Filters |
| --- |
| Academic Year |
| Term |
| Course Level |
| Subject Code |
| Course Code |
| Section |

| ToolTip |
| --- |
| AVG(Perc Full) - Both |
| SUM(Num Students) - Students |
| SUM(Num Sections) - Sections |
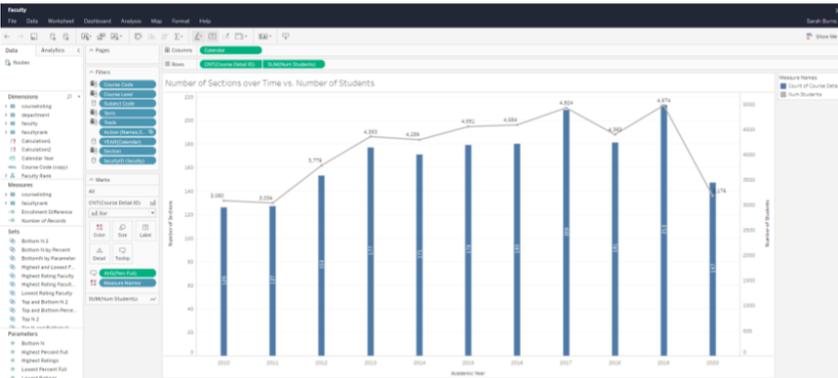
Courses by Percentage Filled



| Marks | |
|---|---|
| Average perc full on columns | |
| Hierarchy of Department Name, Subject Code and Course code on rows | |

| Filters | |
|---|---|
| Academic Year | |
| Term | |
| Course Level (Shown) | |
| Subject Code | |
| Course Code | |
| Section (Shown) | |

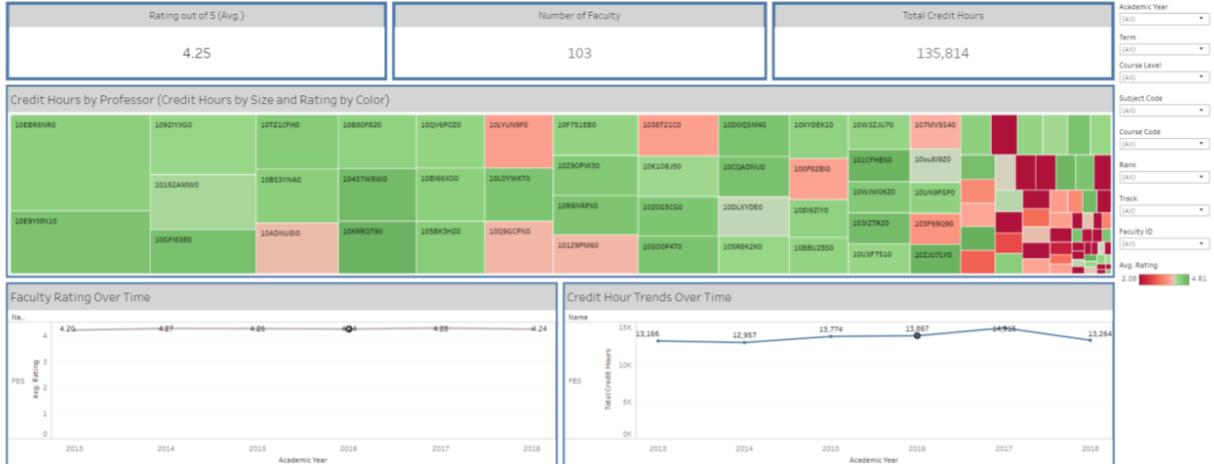| ToolTip | |
|---|---|
| Names | |
| AVG(Perc Full) | |
| AVG(Rating) | |
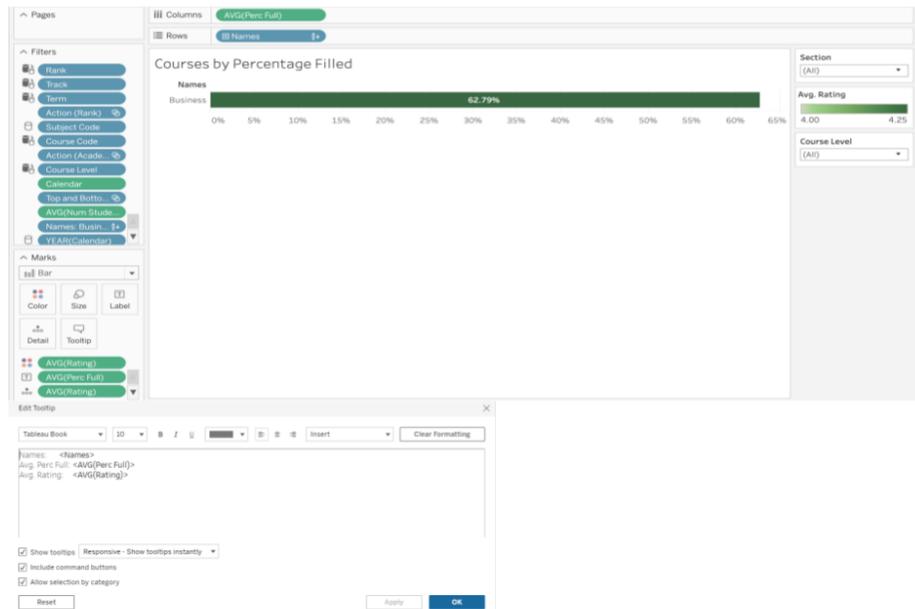
Arrange sheets on dashboard

Make the top bar chart the main filter for all sheets
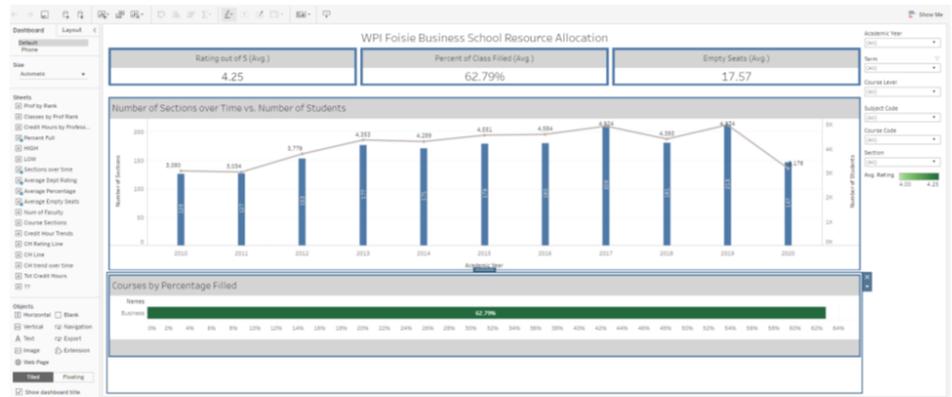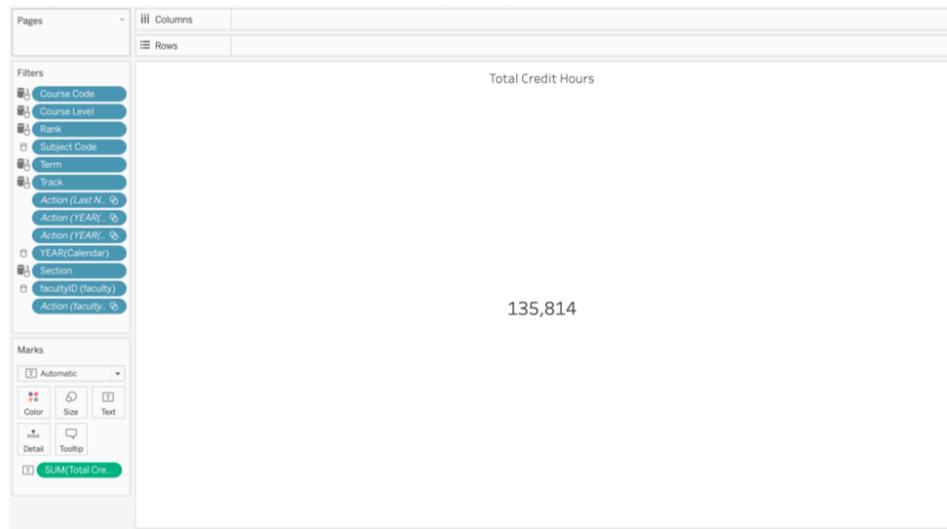
# Faculty Performance Dashboard

WPI Foisie Business School Faculty Performance



## Total Credit Hour Card



Marks

SUM (Total Credit Hours)

1. Change the view to "Entire View" in order to maximize the card
2. Change the title to match what you would like by clicking on the text and editing it
3. Center the value by clicking on the "Text" box and change the alignment to center

## Number of Faculty Card

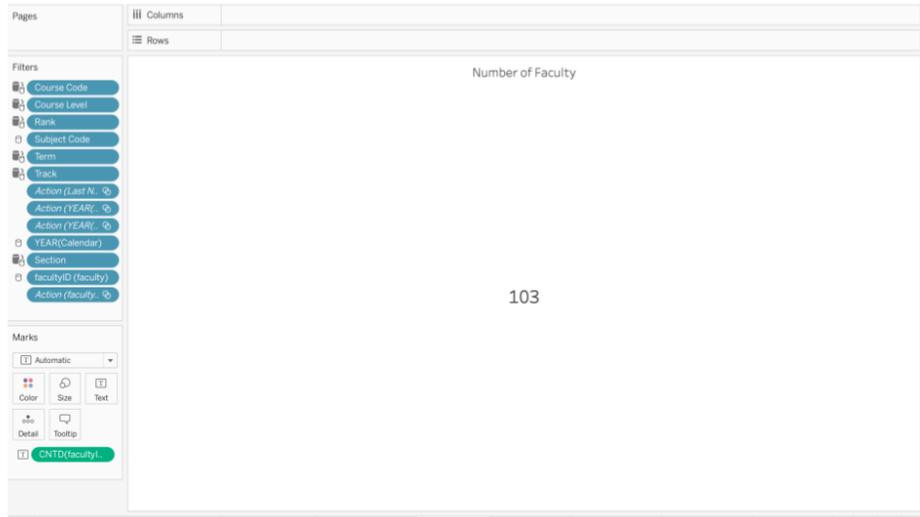| | |
|---|---|
| **Marks** | |
| CNTD (Faculty) | |

1. Change the view to "Entire View" in order to maximize the card
2. Change the title to match what you would like by clicking on the text and editing it
3. Center the value by clicking on the "Text" box and change the alignment to center



## Average Empty Seats Card

| | |
|---|---|
| **Marks** | |
| AVG (Enrollment Difference) | |

1. Change the view to "Entire View" in order to maximize the card
2. Change the title to match what you would like by clicking on the text and editing it
3. Center the value by clicking on the "Text" box and change the alignment to center
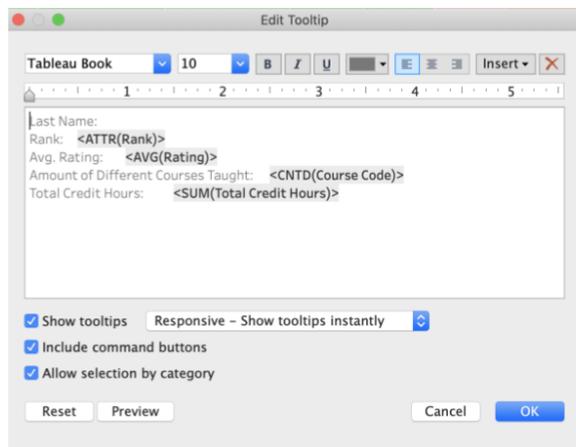
Credit Hours by Professor (note in this picture faculty ID was used instead of faculty Name for confidentiality)

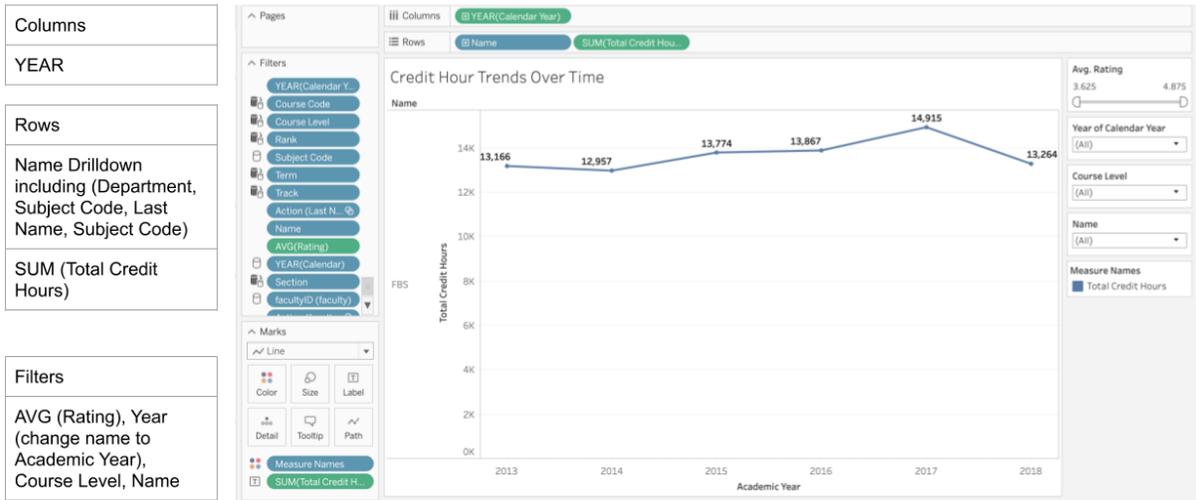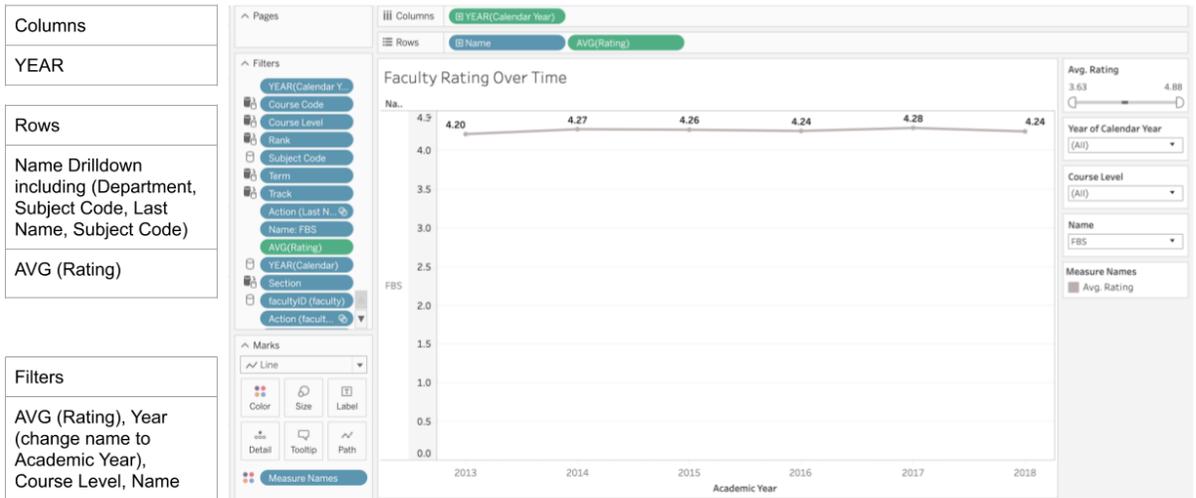| Color |
| --- |
| AVG (Rating) |
| Color |
| AVG (Rating) |
| Size |
| SUM (Total Credit Hours) |
| Label |
| Faculty Name |
| Filters |
| Faculty Name, Rank, Track, Course Code, Term, Subject Code, Course Level |



Credit Hours by Professor Tooltip

Credit Hours Trend Over Time

| Columns | |
|---|---|
| YEAR | |

| Rows | |
|---|---|
| Name Drilldown including (Department, Subject Code, Last Name, Subject Code) | |
| SUM (Total Credit Hours) | |

| Filters | |
|---|---|
| AVG (Rating), Year (change name to Academic Year), Course Level, Name | |



Faculty Rating Over Time

| Columns | |
|---|---|
| YEAR | |

| Rows | |
|---|---|
| Name Drilldown including (Department, Subject Code, Last Name, Subject Code) | |
| AVG (Rating) | |

| Filters | |
|---|---|
| AVG (Rating), Year (change name to Academic Year), Course Level, Name | |

Arrange sheets on dashboard

Make the treemap the main filter for all sheets

## Appendix F: Objectives from the FBS Management Plan

**Objective 1.1.** Continued AACSB and ABET accreditation
- Faculty Sufficiency by Area, Program and location
- Assurance of Learning Schedule
- Planned vs Actual Assurance of Learning Activity

**Objective 1.2.** A thriving, selective MBA program for STEM Professionals
- Number of New MBA students
- Current Rankings
- Student Satisfaction

**Objective 1.3.** Distinctive STEM MS programs and business breadth MS programs for STEM professionals
- Number of new students in the MS program
- Overall Rating of Instructor Quality

**Objective 1.4.** Mentor-driven PhD programs (OIE, IT, ETR)
- Number of PhD Students

**Objective 1.5.** Project-based, "distinctive WPI style", BS programs in business disciplines
- Number of Undergrad Majors
- FBS Minors completed by Non-FBS Students

**Objective 1.6.** Impactful and relevant research
- Research outputs
- External research funding

**Objective 1.7.** A dynamic, reciprocal relationship with the broader community
- FBS courses taken by non-FBS majors
- Business minors completed by non-FBS Students

**Objective 2.1.** Develop business-savvy STEM professionals
- Business minors completed by non-FBS Students

**Objective 2.2.** Contribute to WPI Projects Program
- GPS and IQP credit hours delivered
- Center Directors in FBS, Faculty going to project centers
- Global Scholars

**Objective 2.3.** Scholarly leadership for Innovation & Entrepreneurship
- Entrepreneurship credit hours delivered
- Participation in ETR related grants
- ETR minors completed

**Objective 2.4.** Partner to provide business domain knowledge in joint and interdisciplinary programs
- Number of joint program partners
- Number of BS/MS Students where BS is not in the FBS

**Objective 2.5.** Contribute to WPI governance and operations
- Financial Performance (vs. revenue and cost targets)

- Participation in Faculty Governance (Including committees and working groups)